
The “Missing Girls” of China and the Unintended Consequences of the One Child Policy

Avraham Ebenstein

ABSTRACT

High ratios of males to females in China have concerned researchers (Sen 1990, Yi et al. 1993) and the recent increase has alarmed policymakers worldwide. This paper presents an analysis of China’s census data that indicates that the “missing girls” phenomenon is causally linked to enforcement of the One Child Policy. Fertility is lower and sex ratios are higher among those under stricter fertility control, and the overall increase in the sex ratio is driven by an increase in the prevalence of sex selection among first and second births. By exploiting regional and temporal variation in fines levied for unauthorized births, I find that higher fine regimes discourage fertility, but are associated with higher ratios of males to females.

I. Introduction

When the People’s Republic of China was founded in 1949, the country had a population of approximately 540 million. Only three decades later, its population reached more than 800 million. This unprecedented population increase from the 1950s to the early 1970s created a global concern that China was destined for a “Malthusian collapse”—unchecked population growth that eventually outstrips growth in the food supply and results in massive famine. Chinese fertility policy was redirected toward limiting fertility, culminating in the One Child Policy in 1979. While China’s family planning programs successfully reduced the fertility

Avraham Ebenstein is a Lecturer, Department of Economics, Hebrew University, Jerusalem, Israel. The author thanks Ronald Lee, David Card, William Lavelly, and three anonymous referees for helpful comments. The author also received helpful guidance from Rodney Andrews, Kenneth Chay, Richard Crump, Monica Dasgupta, Gretchen Donehower, Griffith Feeney, Simon Galed, Gopi Shah Goda, Susan Greenhalgh, Jonathan Gruber, Damon Jones, David Levine, Marit Rehavi, David Romer, Claudia Sitgraves, Kevin Stange, Kenneth Wachter, Feng Wang, and Danzhen You. The data used in this article can be obtained beginning August 2010 through July 2013 from Hebrew University, Mount Scopus Campus, #4208, Jerusalem, Israel, ebenstein@mscc.huji.ac.il.

[Submitted February 2008; accepted September 2008]

ISSN 022-166X E-ISSN 1548-8004 © 2010 by the Board of Regents of the University of Wisconsin System

rate, as this paper will demonstrate, it also had the unintended consequence of exacerbating the distortion in the country's sex ratio.¹

Researchers have long been concerned with the unusually high fraction of males to females in the Chinese population. In 1990, Amartya Sen alerted Western researchers to a "sex bias in relative care"—decades of mistreatment and neglect of China's women. He suggested this bias was responsible for the high Chinese sex ratio, and estimated that 50 million Chinese women and 100 million women worldwide were unaccounted for relative to natural birth and mortality rates. Sen's finding aroused the concern of policymakers and has provoked a wave of research on the topic: Where did the "missing girls" go? In recent years, the female deficit has grown. In spite of a general improvement in infant health care in China, the number of male children below the age of 15 exceeds the number of female children by 13 percent. Some caution that the marriage prospects for the next generation of Chinese men are grim if the situation is not corrected (Poston and Glover 2005).

A consensus has emerged that the sex ratio distortion in China is due to prenatal discrimination against female conceptions. This consensus is based primarily on evidence from fertility surveys (Hull 1990), field work (Junhong 2001), and census data (Yi et al. 1993, Das Gupta 2005). In this paper, I improve on the existing literature in several ways. First, by exploiting rich microdata from China's census samples (1982, 1990, 2000), I am able to more robustly document the practice of sex selection and more concretely estimate the number of "missing girls" due to this behavior. Second, my analysis reveals new information on striking patterns in birth interval lengths—sons are preceded by longer intervals than daughters. This provides new and further evidence that sex selection is responsible for the "missing girls," rather than biological factors such as hepatitis (Oster 2005). Third, I present novel and compelling evidence that implicates the One Child Policy in this phenomenon: The timing of the increase in the sex ratio and cross-sectional variation in the policy enforcement highlight the importance of the policy in explaining China's gender imbalance.² Parents under tighter fertility control are characterized by lower fertility and higher sex ratios among births, indicating that parents are engaging in sex selection to satisfy their dual interest in complying with the fertility policy and having at least one son. Lastly, this paper provides the first in-depth look at China's 2000 census offering the most comprehensive and conclusive look at recent Chinese fertility patterns. The analysis reveals several alarming patterns, such as a steep rise in the sex ratio of first births during the 1990s in the wake of stricter enforcement of the One Child Policy.

The paper is organized as follows. Section II provides background information regarding China's fertility policies, the historical evolution of sex ratios at birth, and existing demographic analysis on the "missing girls" of China. Section III documents the increase in sex selection at earlier parities and estimates the number of "missing girls" in the last two decades in China. In Section IV, I demonstrate that the sex

1. Sex ratio refers to the ratio of males to females.

2. Also see Johannson and Nygren (1991) and Qian (2008) for analyses of the One Child Policy's impact on sex ratios at birth during the 1980s.

ratio distortion is related to enforcement of the One Child Policy. I conclude in Section V with a brief discussion of the policy implications of the results.

II. Background

Historically, Chinese parents have favored large families and have directed family resources to sons at the expense of daughters. As the population grew rapidly, Chinese policymakers felt compelled to limit fertility, and in the wake of the One Child Policy (1979), the sex ratio of births began to rise. As I will later discuss, this forced decline in fertility and rise in the male fraction of births appear to be causally linked.

Following a famine associated with Mao's Great Leap Forward (1958–60), total fertility exceeded six births per mother throughout the 1960s (Banister 1987). The rapid population growth alarmed Chinese officials, and the Communist Party subsequently enacted a series of fertility control policies, culminating in the One Child Policy in 1979. The policy excluded additional children from free public education and parents were subject to fines. Following a forced sterilization and abortion campaign in 1983 that created domestic unrest, Chinese policymakers began considering revisions to the policy. By allowing some mothers to have a second child, the government hoped to discourage violations and increase public support for the policy (Gu et al. 2007).

In 1984, the Chinese government instituted a localized fertility policy in which residents of different provinces were subject to different mandated limits (Greenhalgh 1986). Though the one child limit was enforced on urban residents, mothers of a daughter in several rural provinces were allowed to have a single additional birth (a "1.5-child" policy) and families in remote areas a second or third child. Today, Chinese fertility policy imposes a one-child limit on urban residents who make up about a third (35 percent) of the population, a 1.5-child policy limit in rural areas³ (54 percent), and a two- (10 percent) or three-child (1 percent) policy limit for provinces in remote areas. The policy also grants exclusions to various groups, including Chinese ethnic minorities and those employed in dangerous occupations.

In China, parents have historically preferred sons to daughters and in some circumstances discarded daughters upon birth (Coale and Banister 1994). In the 1960s, when fertility was high and infant mortality was low, this pattern was temporarily muted by the fact that most mothers were likely to have at least one surviving son without resorting to sex selection. However, while the female deficit was reduced, high fertility and low infant mortality were contributing to unsustainable population growth. During the late 1960s and early 1970s, the Chinese government promoted a "Two Is Enough" policy, and the sex ratio following first and second-born daughters began to rise (see Figure 1).

3. Parents in the 1.5-child zone who have a first-born daughter are in many (but not all) localities eligible for a second child permit. Local variability in the policy is unobserved in the census data but known to be important (McElroy and Yang 2000).

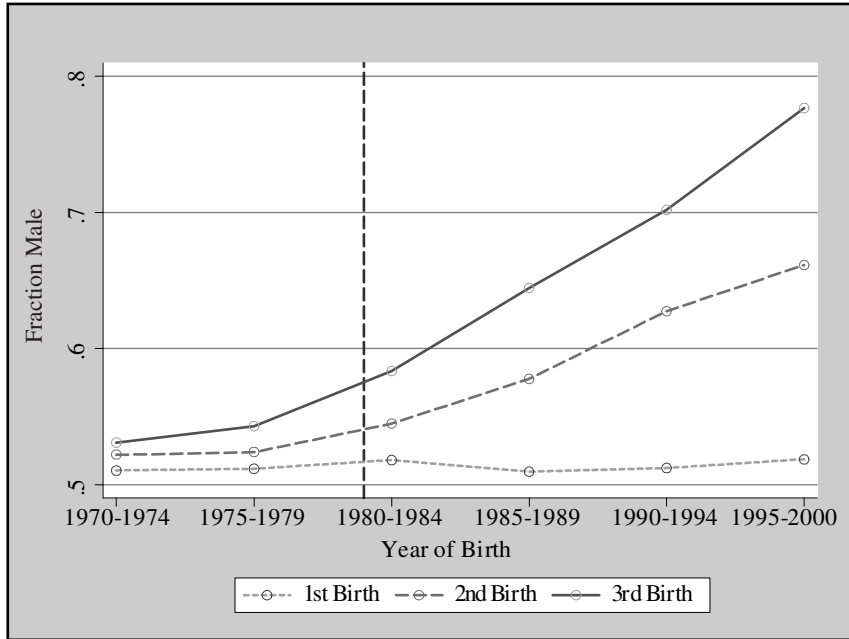


Figure 1
Male Fraction of Births Following Daughters in China

Source: China census 1982–2000. Sample restricted to mothers ages 21–40. See technical appendix at author's website for details. Vertical line indicates year of introduction of China's One Child Policy (1979).

While the extent of prenatal sex selection during this period was limited by the unreliability of traditional methods of identifying sex in utero, the introduction of ultrasound technology greatly facilitated the availability of sex-selective abortion. In the early 1980s, population control officials sent portable ultrasound machines to hundreds of cities across the nation. Ironically these machines were later used for sex-selective abortion (Ertfelt 2006). These machines represented a major development in sex selection technology, as ultrasound can reliably determine the sex of a fetus roughly 20 weeks into a pregnancy, allowing mothers to abort and reconceive with less time and potentially less psychological distress than following infanticide.

Demographers have explored several explanations for the high sex ratios observed in China including adoption (Johansson and Nygren 1991), differential mortality rates (Coale and Banister 1994), and sex-selective abortion (Hull 1990, Yi et al. 1993, Junhong 2001). In the next section, I update the analysis of China's census data (Yi et al. 1993, Das Gupta 2005) to include the 2000 census and expand on previous work by documenting the rising sex ratio at each birth parity following daughters. Using rich census microdata, I am able to improve upon existing studies

that rely most heavily on fertility surveys⁴ (Hull 1990, Yi et al. 1993) or field surveys⁵ (Junhong 2001) to more robustly document the practice of sex selection. The results demonstrate convincingly that sex selection is responsible for the female deficit and the recent increase is due to its increased prevalence among first and second births.

III. China's Census and the Sources of the Female Deficit

The China census sample contains basic demographic information for every man, woman, and child surveyed.⁶ Because there is no census question that matches mothers to children, I infer the relationship using the census question that identifies each household member's relationship to the head.⁷ The census has no information on children no longer living at home, so I restrict the sample to mothers and children who are most likely to be living in the same household. The sample comprises all married women 21 to 40 who are successfully matched to at least one child. The matching algorithm matches over 95 percent of children to a mother and the sex ratio among matched children is almost identical to the sex ratio for the cohort as a whole, suggesting that unmatched children are not driving the results found in the matched sample used for this analysis. As a further check that unmatched children are not confounding the results, I use a direct question in the China 1990 and 2000 census in which mothers report the number of living sons and daughters. For 91 percent of the mothers in each year, the reported number and matched number of children are equal. Excluding the mothers for whom there is a discrepancy only changes the results slightly.⁸ I include these mothers, however, so that the sample is as comprehensive as possible.⁹ The summary statistics for the China census samples are shown in Appendix Table A1.

Table 1 reflects the large impact of sex preference on parental stopping probability and the close correspondence between the number of a mother's living daughters and the male fraction of subsequent births. With only a small distortion observed among first-born children in recent years, the high share of mothers having children following daughters, in combination with the high sex ratios at these parities, is

4. Hull examines roughly 229,000 births that occurred between 1986 and 1987. Yi et al. rely mainly on the 1988 Two Per Thousand Fertility Survey, but also cite results from the 1990 census indicating a relationship between the sex composition of existing children and the sex of the next child.

5. Junhong (2001) surveyed 820 married women in a village in rural central China.

6. Sample size of the China census data: 1982 1 Percent Survey (10,037,508), 1990 1 Percent Survey (11,568,585), 2000 One Per Thousand Survey (1,180,111).

7. The IPUMS-Minnesota matching rules for assigning the most probable child to mother are used for all data sets. Information on the IPUMS algorithm is available at <http://www.ipums.umn.edu>.

8. A version of the tables excluding these mothers is available from the author upon request. The results are actually slightly stronger, with higher sex ratios observed following daughters.

9. Other reasons to include these mothers include the prevalence of adoption in China, and the difficulty in verifying that these questions are answered honestly in light of the fertility policy.

Table 1
Fertility Patterns in China by Sex of Existing Children

Parity	Sex Combination	Percent who have another child			Fraction Male (of next birth)		
		1982	1990	2000	1982	1990	2000
	Overall				0.516	0.520	0.533
1st	None				0.511	0.510	0.515
2nd	One boy	0.71	0.54	0.35	0.51	0.50	0.50
	One girl	0.75	0.60	0.49	0.52	0.55	0.62
3rd	Two boys	0.53	0.30	0.18	0.50	0.43	0.39
	One girl, one boy	0.54	0.29	0.16	0.52	0.52	0.53
	Two girls	0.68	0.55	0.46	0.54	0.61	0.70
4th	Three boys	0.40	0.24	0.17	0.48	0.40	0.37
	One girl, two boys	0.36	0.17	0.11	0.51	0.49	0.52
	Two girls, one boy	0.44	0.23	0.14	0.52	0.55	0.58
	Three girls	0.62	0.54	0.50	0.56	0.64	0.72

Source: China Census 1% sample (1982), 1% sample (1990), .10% sample (2000). Married women ages 21–40 and their matched children ages 0–18.

Notes: Data in thousands. Sex ratio (boys/girls) at birth is calculated by assigning weights to each male and female that account for differential mortality rates by age, sex, and year. China life tables taken from Banister (2004).

clearly responsible for the high overall sex ratio in China.¹⁰ Sons represent over 60 percent of births to mothers with one daughter, and over 70 percent of births to mothers with two daughters. In the 2000 China census, mothers of two daughters are nearly three times as likely to have a third child as mothers of two sons (46 percent versus 18 percent). Since mothers are less likely to have another child following sons, the high sex ratios following daughters have a pronounced impact on the overall sex ratio and explain the high overall sex ratio despite the relative lack of sex selection at the first parity.

In Table 2, I attempt to account for the overall female deficit by examining the share of missing girls (or boys) following each observed sex combination. Using a baseline estimate that the natural sex ratio at birth is 1.059 (implying a natural share

10. Researchers have cautioned that Chinese census data following stricter enforcement of the One Child Policy may not accurately reflect the number of females in the population. Mothers who give birth to a daughter and subsequently give birth to a son may choose to hide the earlier female birth in census responses. Banister (2004) finds that the deficit of daughters is real: the high sex ratios in PRC (People's Republic of China) demographic data are approximately true, not merely an artifact of faulty data. Cai and Lavelly (2005) confirm this finding, suggesting that 71 percent of the missing girls in the 1990 census are not enumerated in the 2000 census. Most experts on China suggest that girls are registered when they are enrolled in school (age seven), and the problem of unregistered births is less severe among girls age six or older, and will have a smaller effect on the results presented here using living children observed in the matched sample.

Table 2
Accounting for the Female Deficit in China (000s) by Parity: 1982–2000

Parity	Sex Combination	1982	1990	2000
1st	None	–882	–1,234	87
2nd	One boy	–372	–846	–1,041
	One girl	906	3,569	7,773
3rd	Two boys	–305	–1,066	–644
	One girl, one boy	149	152	209
	Two girls	860	2,280	2,370
4th	Three boys	–155	–159	–52
	One girl, two boys	–45	–75	7
	Two girls, one boy	168	252	126
	Three girls	368	575	404
	“Missing” Girls	691	3,448	9,239
	Female Births	136,723	133,538	110,371
	Share Missing	0.51%	2.58%	8.37%

Source: China Census 1% sample (1982), 1% sample (1990), .10% sample (2000). Married women ages 21–40 and their matched children ages 0–18.

Notes: These calculations represent the weighted average of the distortion to the fraction of sons born following a combination by the actual number of women who are observed with another child. These results will not exactly match the female deficit reported in Appendix Table A1.

of male births of 51.4 percent), I can estimate the number of missing girls at each parity.¹¹ The results indicate that the female deficit observed in aggregate natality data is composed of a large female deficit following daughters, and a smaller female surplus following sons that slightly mitigates the deficit following daughters. Prenatal selection and infanticide can account for a female deficit of roughly 9.3 million missing girls in China’s 2000 census.¹² In the earlier Chinese census of 1982, I find that sex selection is less common and the net female deficit is small relative to total births. However, the pattern of high sex ratios at birth following daughters and low sex ratios following sons suggests the presence of human manipulation even in this earlier period. Note also that the results shown in Table 2 imply a female surplus at the first parity in the 1982 and 1990 samples. This is due to the choice of a high

11. Banister (2004) writes: “In Caucasian and Asian populations where no prenatal sex-selection is practiced, the SRB is in the narrow range 105.0–107.0. For example, the annual recorded SRB in Japan during 1980–2000 was 105.2–106.0.” I choose 1.059 as the natural sex ratio at birth in accordance with Coale (1991).

12. These calculations are based on the matched sample of children and mothers aged 21 to 40. Others have used responses in retrospective fertility surveys and report higher baseline estimates for the female deficit at birth in China (for example, Coale and Banister 1994). Differences between the methods include sampling variability, under-reporting of infant mortality, or possible omission of female births in fertility surveys. The analysis here is aimed at addressing the patterns in the sex ratio among mothers observed with their children, and as such may differ slightly from estimates presented elsewhere.

baseline “natural” sex ratio for this exercise (51.4 percent), which provides a more conservative estimate of the total number of missing girls, but implies that the male fraction of first births (51 percent) in these samples was unnaturally low.

When the missing girls are identified by parity, the rising sex ratios among first and second births are almost entirely responsible for China’s growing imbalance. Table 2 shows that in China, the number of “missing girls” among children aged 0–18 increased from 3.4 million to 9.2 million between the 1990 and 2000 census. The 5.8 million increase in missing females can be traced in large part to the rise in the sex ratio following a first-born daughter: in the 1990 census sample, 55 percent of births following a daughter were male whereas in the 2000 census sample, over 62 percent of these births were male. Since many parents in the sample (49 percent) had a second child following a daughter, these births account for 7.7 million of the 9.3 million missing girls in these data. While higher order births are even more distorted, they are less common, and thus the bulk of the increase in China’s sex ratio is explained by childbearing behavior following a single daughter. Ironically, the “1.5-child” policy in China discourages higher order births following sons more than births following daughters. This has the effect of increasing fertility among parents who want a son and may engage in sex selection in favor of a male birth, but reducing fertility among parents who want a daughter and might engage in sex selection in favor of a female birth, and further increasing the overall female deficit. The sex ratio of first births rose between 1990 and 2000 as well, rising from 51 percent to 52 percent and increasing the number of “missing girls” by 1.6 million. In total, the increased sex ratio of first births and second births following daughters is responsible for 5.7 million of the 5.9 million increase in “missing girls” observed in the census, or 97 percent of the total change.

Das Gupta (2005) presents evidence from China’s 1990 census that the high sex ratios in China are driven by “missing girls” following daughters, and that this is most likely due to “parental intervention.” In Table 3, I present additional support for this hypothesis by examining the duration between mothers’ births. If sex selection is responsible for the distorted sex ratios following girls, birth intervals should be distorted for women who choose to abort a female fetus. Specifically, one would anticipate finding a longer delay between an initial birth and a subsequent male birth than a subsequent female birth, due to the fact that a child born following an abortion should be born approximately 30 weeks later than a child born on a first attempt.¹³ (The expected interval distortion associated with infanticide is even larger, since ultrasound is available less than five months into pregnancy.) Since boys are more likely to be preceded by a sex selection induced delay, on average sons will be preceded by a longer birth interval than daughters. The difference in birth interval length also will be larger at parities with more distorted sex ratios, since a larger share of males will presumably have been preceded by a female conception. Consistent with this prediction, in the 1990 census data, following two daughters the share of mothers who have a son is 62 percent and male births arrive 0.14 years

13. A sex-identification procedure can only be administered roughly 20 weeks subsequent to conception, and a reasonable estimate of the time to reconceive following abortion is 10 weeks. <http://pregnancy.about.com/>

Table 3
Birth Interval Length Following Daughters by Sex of Next Child in China

Year	Parity	Sex Combination	Fraction Male	Birth Interval Before Male	Birth Interval Before Female	Difference (M-F)
1990	2nd	One girl	0.55 (0.001)	2.91 (0.004)	2.85 (0.004)	0.055*** (0.005)
	3rd	Two girls	0.62 (0.002)	2.80 (0.006)	2.66 (0.007)	0.134*** (0.008)
	4th	Three girls	0.64 (0.003)	2.77 (0.013)	2.58 (0.016)	0.196*** (0.014)
2000	2nd	One girl	0.62 (0.003)	3.59 (0.016)	3.46 (0.021)	0.133*** (0.009)
	3rd	Two girls	0.70 (0.006)	2.64 (0.025)	2.33 (0.034)	0.305*** (0.057)
	4th	Three girls	0.72 (0.015)	2.72 (0.061)	2.26 (0.084)	0.459*** (0.057)

* significant at 10% ** significant at 5%. *** significant at 1%.

Source: See Table 1.

Notes: Data on a child's month of birth are used for this calculation. The first column represents the fraction of male births following each sex combination. The second and third columns represent the average birth interval separated by whether the next birth is a boy or girl. The fourth column is the observed delay before male births relative to female births.

later than female births. In the 2000 census data, the percentage male for these mothers is 70 percent, and sons arrive 0.34 years later than daughters. The distorted birth intervals are strong evidence that the high sex ratios observed are the product of human decision. There exists no biological explanation that can account for these extended birth intervals preceding the desired sex.

While the Chinese preference for sons is well known, the data also indicate that following sons, parents appear to practice sex selection to ensure the birth of a daughter. In the 2000 census, mothers with two sons who have a third child have a 61 percent chance of having a daughter. Junhong (2001) in field work found that 7 percent of male fetuses at higher birth parities are aborted following ultrasound, and this is consistent with qualitative evidence that Chinese parents prefer a daughter following sons. Greenhalgh (1994) cites one rural village in which villagers refer to a second son as *fudan zhong* or a “heavy burden,” since a second son requires a new house at the time of his marriage, which may cost up to 10 years of annual income. Some suggest that mothers in China prefer at least one daughter to help the mother with household chores (Junhong 2001). In any event, the 2000 census reveals that among parents with sons, they exhibit a preference for daughters, and the overall female deficit is in fact composed of large deficit following daughters and a surplus following sons.

Others assert a known cause of the sex ratio distortion is the adoption of unwanted girls by Chinese families with no daughters (Johansson and Nygren 1991). While published figures indicate that only 10,000 adoptions occur per year in China, some have estimated that as many as 500,000 adoptions occur when one includes informal adoptions (Johnson 1993). Though adoption within China is common, external migration via adoption is much less common and cannot explain these results. Recipient countries document that fewer than 10,000 Chinese infants are sent abroad annually, and while 95 percent of those adopted are girls, this represents only a negligible share of the missing girls.¹⁴ Although I cannot distinguish sex selection from within-China adoption, the practice should not affect the paper’s core result regarding the female deficit associated with sex selection, since the adopting family will enumerate the daughter. As such, Table 2 should be interpreted as the combined impact of female conceptions terminated and unwanted daughters adopted by a different family within China.

Though the orthodox opinion is that parental intervention following daughters is responsible for the sex ratio distortion, Oster (2005) proposes that high hepatitis rates in several Asian countries may be responsible for the high sex ratios observed in these countries.¹⁵ However, any biological hypotheses are difficult to reconcile with the analysis in this section: The high sex ratios following daughters and extended birth intervals preceding sons represent strong evidence that sex selection is

14. In 2005, the United States naturalized nearly 8,000 Chinese adopted children, and over 95 percent of the children were female. The Chinese government reports a total of 60,000 adopted births sent to foreign countries between 1992 and 2006. (<http://www.washingtonpost.com/wp-dyn/content/article/2006/03/11/AR2006031100942.html>).

15. Lin and Luoh (2006) find that hepatitis carriers are only slightly more likely to have sons than other mothers. In recent work, Oster et al. (2008) also argue that hepatitis does not explain the high sex ratio in China.

the primary explanation for the “missing girls” of China. As such, in the next section I extend this analysis to examine variation within China in sex selection. The results indicate that parents under stricter fertility limits are characterized by lower fertility and higher sex ratios, further supporting the claim that human decision is responsible for China’s “missing girls,” and directly implicating the One Child Policy in the rising sex ratio at birth in China.

IV. Sex Ratios and the One Child Policy

While the sex ratio distortion in China is a long-standing demographic pattern, fertility policies instituted to slow population growth have exacerbated the female deficit. Under the One Child Policy, parents in China who exceed their fertility limit are forced to pay a fine and are subject to a variety of other monetary punishments, including the seizure of property and forced dismissal from government employment. There are four fertility limits for four different categories of parents. Those registered to an urban work zone (or *hukou*) are subject to the one-child limit; those registered to a rural *hukou* are often allowed a second child if the first child is a daughter (resulting in an average of 1.5 children per mother, the “1.5-child” policy); residents in autonomous regions are generally allowed a second birth; and ethnic minorities are subject to weaker regulations in almost all provinces (Gu et al. 2007).¹⁶

In Table 4, which stratifies births by the mothers’ fertility limit category and parity, one observes that in the 2000 census data mothers are more likely to have a son once they face a fine for childbearing. For example, at the first birth mothers facing different fertility policies have similar sex ratios at birth, but following one daughter, mothers facing the One Child Policy are three percentage points more likely to have a son than those facing less strict fertility limits. Following two daughters, mothers under the One Child Policy and mothers under the “1.5-child” policy are two and one percentage points more likely to have a son than mothers under the two-child policy, respectively. In comparison, in the 1982 census data, which captures births prior to the implementation of the One Child Policy in 1979, mothers in these different categories had similar sex ratios among first and second births.¹⁷ For mothers whose peak childbearing years were under the One Child Policy (2000 census data), at each parity, those under the strictest fertility control are the most likely to have a son, which suggests a direct role for fertility control in the rising sex ratio at birth. I explore this hypothesis graphically in Figures 2 and 3.

Figure 2 indicates that following the government crackdown in the early 1990s, the male fraction of first births began to rise among parents under the provinces

16. The registration status of the household during the 2000 census will only approximate the fertility regime the family faced when making fertility choices. Some families may have migrated and registered in an urban zone. As a robustness check, I exclude the 11 percent of mothers who in the 2000 census report that they currently do not live in their *hukou*, and the results are very similar.

17. Note that during the 1970s parents were generally subject to a “two is enough” rule during the 1970s. The sex ratio distortion during this earlier window is observed only among 3rd and 4th births following daughters.

Table 4
Male Fraction of Births by Fertility Policy in China

Parity	Sex Combination	Prior to One Child Policy (China 1982 Census)				Post One Child Policy (China 2000 Census)			
		One	1.5	Two	Minority	One	1.5	Two	Minority
1st	None	0.51	0.51	0.51	0.51	0.52	0.51	0.51	0.51
2nd	One girl	0.53	0.53	0.52	0.51	0.65	0.62	0.62	0.58
3rd	Two girls	0.54	0.55	0.52	0.52	0.71	0.70	0.69	0.65
4th	Three girls	0.55	0.57	0.52	0.50	0.73	0.73	0.68	0.67

Source: See Table 1.

Notes: Based on average fertility rates and sex ratios for provinces under the three main fertility regimes in China described in Feng et al. (2005). Mothers under a "1.5" policy rule are generally allowed one additional birth following a first born daughter. Mothers who are non-Han (minority) are granted exceptions to the fertility control policy as well (Scharping 2003).

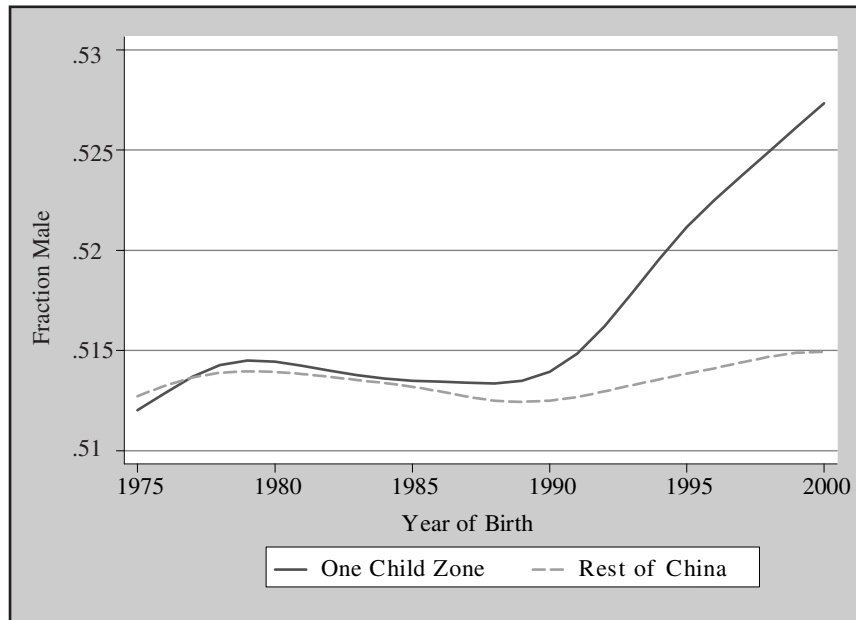


Figure 2
Rising Sex Ratio among First Births in China

Source: China census 1982–2000. The graph is created by calculated the running-mean smoother applied by the `lowess` command using STATA 9 software.

covered by a strict one-child limit. Likewise, Figure 3 indicates that the increase in the sex ratio of second births has been more pronounced in the One Child zone relative to the rest of China—strong evidence that the policy is affecting the sex ratio at birth. Though the time series evidence confounds the separate effect of the increased enforcement of the fertility regulations and the introduction of ultrasound, the technology was widely available in rural China by the early 1990s (Greenhalgh and Winckler 2005). As such, comparisons between policy regions in the 1990s can be thought to capture the effect of the fertility regulations, whereas the intercensus comparison in Table 4 reflects the combined impact of better technology and the introduction of the One Child Policy.

In Table 5, I further test the claim that the fertility reduction induced by the One Child Policy is affecting the sex ratio of births by exploiting variation in the fines on excess fertility, catalogued by province, year, and ethnicity (Scharping 2003).¹⁸

18. As one anonymous reviewer noted, I can only impute the financial punishment, and other components of the total punishment and reward structure have to go unmeasured, such as potential expulsion from the Communist Party for an unauthorized birth. It is known, however, that the financial fines are a major component, out-weighing, for example, rewards. Also, the structure of nonfinancial penalties, because they are informal and exercised optionally, are essentially random in the data. As such, the paper's results should be interpreted up to a scale in which the imputed fines presented here represent the full sum of financial punishment meted out for excess fertility.

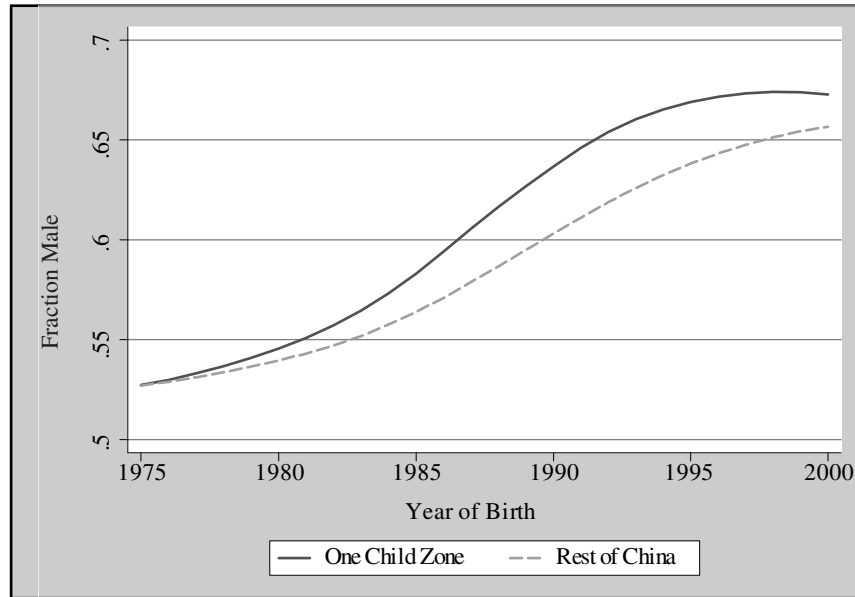


Figure 3
Rising Sex Ratio among Second Births Following a Daughter in China

Source: China census 1982–2000. The graph is created by calculated the running-mean smoother applied by the `lowess` command using STATA 9 software.

I describe the calculation of these fines in an appendix to this paper, and provide a link to a data set of fine rates by province and year (1979–2000). Additionally, a visual summary of the spatial dispersion of the fines is presented in Figure 4, where I show the average fine on a third birth in each of China's 345 prefectural zones. As seen in Figure 4, the variation in the average fine rate is driven by geographical differences, such as provincial regulations, ethnic composition, and the share of parents with urban registration. Note that the geographic variation in the average fine rates reflected in the figure corresponds reasonably well to recent efforts by other scholars to document local variation in enforcement of China's fertility policy (see Gu et al. 2007), suggesting that the imputed fine is capturing key elements of the variation in the strictness of the policy.¹⁹ If this paper's main hypothesis is valid and the regulations are causally linked to fertility outcomes, the fines should not be correlated with the sex ratio prior to the policy but should be positively correlated with the sex ratio in recent years. Table 5 reflects that both of these predictions are

19. Gu et al. (2007) have access to prefecture-level data on the share of parents facing a one-, 1.5, two-, or three-child policy. They produce a figure using this restricted-access data and the geographic variation is similar to the variation in the fine rates observed in Figure 4.

Table 5
Regression (OLS) Estimates of Male Fraction of 5-year Birth Cohort (LHS) on Fertility Fines (RHS)

	Five Years Before One Child Policy (1975–1979)		Five Years Before 2000 Census (1996–2000)	
	(1)	(2)	(3)	(4)
Fertility Fine	−0.0038 (0.006)	−0.0068 (0.005)	0.0083* (0.005)	0.0111** (0.004)
Controls for Regional Characteristics	No	Yes	No	Yes
Observations	345	345	345	345

* significant at 10% ** significant at 5%. *** significant at 1%.

Source: China 2000 Census.

Notes: The fine is measured in years of household income, taken from Scharping (2003). Each regression examines the partial correlation between a 5-year age group and the fertility fines in 2000 by prefecture. China's 2000 census is broken into 345 prefectural boundaries, and this is the finest geographic breakdown available in the data. Controls for regional characteristics are the share of individuals with access to tap water, share with electric or gas fuel, share with concrete or brick households, and the average education of those 30–39 years old. The male share of births is proxied by the living share of those in each cohort. Standard errors are robust and clustered at the province level.

borne out by the data, consistent with the claim that the female deficit is related to the stringency of fertility control.

As shown in Table 5, the average fine in each prefecture is uncorrelated with the sex ratio prior to the introduction of the policy, and positively correlated with the sex ratio following the implementation of the fine policy. In Column 1, I regress the male fraction of births in each of China's 345 prefectures prior to the policy (1975–79) on the fine rate in each prefecture in 2000. The correlation between the male fraction of births and the fine is small (−0.0038) and statistically insignificant, suggesting that the fines in my data are not systematically related to preexisting patterns of son preference. In Column 2, I perform the same regression but control for regional characteristics in each of the prefectures (for example, share with electric or gas fuel) and again find only a weak correlation between the fines (−0.0068) and the male fraction of births. In Column 3, I regress the male fraction of births in years following the policy (1996–2000) on the fine rate. During this recent window in the “post-policy” period, the fines are positively correlated with the sex ratio (0.0083) and the relationship is statistically significant at the 10 percent level. In Column 4, I perform the same regression with controls for regional characteristics, and find that the estimated relationship is positive (0.0111) and statistically signifi-

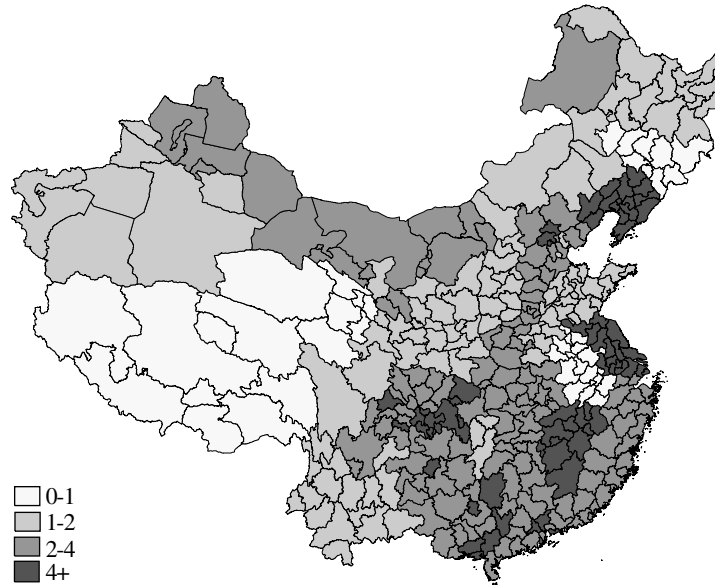


Figure 4
Fine Rates in China

Source: Scharping (2003). Fine rates in years of household income. Darker shades correspond to higher penalties. Average fine is calculated for having a 3rd birth among residents of each prefecture using demographic information and the policy rule in the province.

cant at the 5 percent level.²⁰ This suggests that the impact of the fertility fines on the sex ratio in recent years is not simply related to preexisting features of the regions.²¹ Enforcement of fertility regulations is responsible for the connection between sex ratios and fertility fines, rather than a spurious regional correlation between lower fines and lower son preference. The parameter estimates indicate that increasing the fine in each prefecture by 100 percent yields roughly a 1 percent increase in the male fraction of births.

In Table 6, I perform an individual-level test of whether the fertility reduction induced by the One Child Policy is affecting the sex ratio of births. If indeed the policy is having this effect, one would anticipate that the fines on excess fertility

20. One anonymous reviewer noted that migration of parents across provinces (and fine regimes) could bias the coefficient on the fine variable. A version of these regressions excluding any parents who were born in a different *hukou* is available upon request. The results are very similar but slightly less statistically significant, since migration by women for marriage in China is common.

21. A legitimate concern may be that parents under higher urban fine regimes would have fewer children than those in rural areas, even in the absence of the policy. Fertility surveys still indicate that most parents would prefer to have at least two children (Zhang et al. 2006), and so the fertility limit (and therefore the fine) is a binding constraint for most parents.

Table 6
Regression (OLS) Estimates of Fertility Outcomes (LHS) on Fertility Fines (RHS)
Following Daughters: China 1964–2000

	Did you have another child? (1 = yes)		Among those with another child, was the next birth male? (1 = yes)	
	Those with one daughter	Those with two daughters	Those with one daughter	Those with two daughters
Log of Fertility Fine	−0.102*** (0.024)	−0.102*** (0.034)	0.008* (0.004)	0.023** (0.009)
Mother's Education	−0.014*** (0.002)	−0.004** (0.002)	0.001 (0.001)	0.002 (0.002)
Farmer	0.288*** (0.019)	0.185*** (0.021)	0.000 (0.006)	−0.009 (0.013)
Sample Average	0.788	0.647	0.540	0.601
Observations	234,570	85,074	184,955	55,045

* significant at 10% ** significant at 5%. *** significant at 1%.

Source: Matched sample of mothers and children from census taken in 1982, 1990 and 2000 pooled and weighted by probability of being sampled. Sample restricted to mothers ages 35–40 and their matched children ages 0–18.

Notes: The fine is measured in years of household income, taken from Scharping (2003). Education is measured in years. The first two regressions examine the partial correlation between the fine for a 2nd/3rd birth and the chance parents have a 2nd/3rd child. The second two regressions are restricted to those who have a 2nd/3rd birth and examine the partial correlation between the fine paid for the 2nd/3rd birth and the chance the birth is male. All specifications include province fixed effects, a fixed-effect for the year of the previous birth, and control variables for the age and years of education of both parents. Robust standard errors clustered at the province level.

are negatively correlated with the share of parents having second or third births, but positively correlated with the fraction of these births which are male. The results are consistent with both of these predictions. The sample is restricted to parents who have not yet had a son to focus on the group of parents responsible for the female deficit observed in China, and mothers aged 35–40 who are likely to have completed their fertility.²² The regressions are estimated using the mothers in this group and their births in the 1982, 1990, and 2000 China census samples between 1964 and 2000. The sample includes parents who were bearing children prior to the policy and face a zero fine regime (1982 census sample) versus those who were subjected to the One Child Policy (1990 and 2000 census samples). This allows for a rich set of controls accounting for differences that may have varied by region in China in tastes for fertility predating the policy. As such, the parameter estimates for the fine

22. Very few women in China during the years of the One Child Policy give birth past 35 (Ding and Hesketh 2006).

rate can be thought derived from a “differences in differences” estimator, where the results are robust to time-invariant differences in fertility tastes across regions.²³

In Columns 1 and 2 of Table 6, I estimate linear probability models of whether parents had a second child or third child on the log of the fine rate facing the parents and a set of control variables.²⁴ The results indicate that raising the fertility fine by 100 percent reduces the probability of a second and third birth by 10.2 percentage points and 10.2 percentage points respectively. Better educated mothers appear less likely to have an additional child following daughters, possibly reflecting weaker son preference and lower dependence on sons for elderly support. Each additional year of education reduces the probability of a second and third birth by 1.4 and 0.4 percentage points respectively. Farming families are 28.8 and 18.5 percentage points more likely to have a second and third birth respectively. This is most likely due to greater reliance among peasants for their labor, and anticipated old-age support (Wang 2006).²⁵ In Columns 3 and 4, I estimate linear probability models for the chance of observing a male birth after one or two daughters and the results indicate that an increase in the fine rate of 100 percent is associated with a 0.8 (significant at the 10 percent level) and 2.3 percentage point increase (significant at the 1 percent level) in the probability of a male birth respectively. The other covariates appear less important: the coefficient on mother’s education and the coefficient on the family being employed in agriculture are small in magnitude and statistically insignificant. This suggests that among those having “out of plan” fertility, the group is composed of parents who want a son. So, conditioned on the punishment (the fine), the observable features of the parents are no longer very important in predicting the chance of a son. The results presented in Table 6 of these regressions also provide important information regarding potential modifications to China’s current fertility regulations. For example, the coefficients imply that if China were to lower the financial punishments on second births, each percentage point decline would yield a 0.1 percent increase in fertility but lower the male fraction of births by .008 percent.

The observation that parents who have children in higher fine regimes are more likely to have a son reflects two factors operating in this context. The first is that parents who are unwilling to practice sex selection in high fine regimes are less likely to have an additional child. Therefore, higher fines are associated with higher sex ratios among those who have an additional birth. The second factor is that the higher fine reflects that these parents will have lower anticipated fertility in ways not captured by the fine. Parents who are determined to have a son in high fine

23. This follows the strategy employed by Li et al. (2005), who exploit the fact that minorities in China were generally exempt from the One Child Policy to produce a “differences-in-differences” of the policy’s impact on fertility rates.

24. I include in all specifications province fixed-effects and control variables for the mother’s age, the father’s age, and the education level of both parents, and a fixed-effect for the year of the previous birth. The fines vary over province, year, ethnic group, and whether the household is registered in an urban area. Details of the fine imputation to the census sample is described in the appendix.

25. This coefficient may also reflect that the fine variable cannot fully capture local variation in regulations which allow farming families greater leeway in having “out of plan” births. See the technical appendix for details regarding how I incorporate the provisions allowing a second birth to peasant families with a first-born daughter into the fine rates. The fines are not conditioned on whether the parents are employed in the agricultural sector, but rather on province and hukou status.

regimes will often be compelled to complete fertility earlier, and will be forced to engage in sex selection at a lower parity. In recent years, China's fertility policy has actually tightened. Tabulations of China's 2005 intercensal survey (1 percent national sample) indicate that the sex ratio of first births reached 108.4 (Li 2007), consistent with recent reports that officials in rural areas are increasingly unwilling to authorize second births following a daughter.

V. Conclusion

Although rapid industrialization and large changes in fertility have reshaped China in the last 40 years, sex preferences have survived the transition. In an earlier era of high fertility, they were manifested in higher stopping probabilities following sons and had a muted effect on the overall sex ratio. Today, fertility in China has slowed but the imbalance in the sex ratio has become a pressing concern and the situation appears to be worsening. Chinese government figures indicate that the female deficit has worsened since the 2000 Census, with the overall sex ratio at birth reaching 118 boys born for every 100 girls in 2005.²⁶ Recent reports that Chinese gangs are beginning to traffic in Vietnamese and North Korean women for would-be husbands are particularly alarming and suggest the China marriage market squeeze could become an even larger policy issue (Zhao 2003). A long history of sex preferences and the economic realities favoring sons in China make it unlikely that the problem will resolve itself by parents choosing to alter their fertility decisions in favor of scarce daughters. Policymakers in India should consider the experience of China as they move to slow the growth of their own population.²⁷

The lesson to policymakers in family planning is this: encouraging or forcing people to change their fertility behavior without addressing their fundamental preferences may have unanticipated consequences. Although the future course of Chinese policy is yet to be determined, the discussion has now appropriately turned to revising the current regulations (Feng 2005, Yi 2007). A relaxation in the One Child Policy could reduce the sex ratio at birth by allowing more parents to have a son without resorting to sex selection. Failure to act may prove costly for the next generation.

References

- Banister, Judith. 1987. "China's Changing Population." Palo Alto, Calif.: Stanford University Press.
- . 2004. "Shortage of Girls in China Today." *Journal of Population Research* (21)1:20–45.

26. Report issued by Chinese State Council and Central Committee (January 2007).

27. I present evidence in the appendix that higher educated women in India are more likely to engage in sex selection than less educated women who have more children. The results also indicate that sex selection has increased as the total fertility rates have begun to decline.

- Banister, Judith, and Kenneth Hill. 2004. "Mortality in China 1964–2000." *Population Studies* (58)1:55–75.
- Cai, Yong, and William Lavelly. 2005. "China's Missing Girls: Numerical Estimates and Effects on Population Growth." *The China Review* 3(2):13–29.
- Coale, Ansley. 1991. "Excess Female Mortality and the Balance of the Sexes in the Population: An Estimate of the Number of "Missing Females." *Population and Development Review* 17(3):517–23.
- Coale, Ansley, and Judith Banister. 1994. "Five Decades of Missing Females in China." *Demography* 31(3):459–79.
- China. 1982. Integrated Public Use Microdata Series-International: Preliminary Version 1.0. Minneapolis: Minnesota Population Center, University of Minnesota, 2002.
- . 1990. China Population and Information Research Center, 1 percent Sample of the 1990.
- China Population Census Data, accessed from the Texas A&M University China Archive.
- . 2000. 0.10 percent Sample of the 2000 China Population Census.
- Das Gupta, Monica. 2005. "Explaining Asia's 'Missing Women': A New Look at the Data." *Population and Development Review* 31(3):529–35.
- Ding, Qu Jian, and Therese Hesketh. 2006. "Family Size, Fertility Preferences and Sex Ratio in China in the Era of the One Child Policy: Results from National Planning and Reproductive Health Survey." *BMJ*, May 11 [online]. Available at: <http://bmj.com/> (Accessed: September 3, 2007).
- Ertfelt, Steven. 2006. "Study Confirms China Forced Abortion Policy Created Gender Imbalance," *Reuters News Release*, August 18 [online]. Available at: <http://www.freerepublic.com/>. (Accessed: August 25, 2007).
- Feng, Wang. 1996. "A Decade of the One-Child Policy: Achievements and Implications." In *China*, edited by Alice Goldstein and Wang Feng, 96–116. Boulder, Co: Westview Press.
- . 2005. "Can China Afford to Continue Its One-Child Policy?" *Asia Pacific Issues*, East-West Center #77.
- Greenhalgh, Susan. 1988. "Shifts in China's Population Policy, 1984–86: Views from the Central, Provincial, and Local Levels." *Population and Development Review* 12(3):491–515.
- Greenhalgh, Susan, and E Winckler. 2005. "Governing China's Population From Leninist to Neoliberal Biopolitics." Stanford, Calif.: Stanford University Press.
- Greenhalgh, Susan, Zhu Chuzhu, and Li Nan. 1994. "Restraining Population Growth in Three Chinese Villages, 1988–1993." *Population and Development Review* 20(2):365–395.
- Gu, Baochang, Feng Wang, Guo Zhigang and Erli Zhang. 2007. "China's Local and National Fertility Policies at the End of the Twentieth Century." *Population and Development Review* 33(1):129–47.
- Hudson, Valerie, and Andrea den Boer. 2004. *Bare Branches: The Security Implications of Asia's Surplus Male Population*. Cambridge: MIT Press.
- Hull, Terence. 1990. "Recent Trends in Sex Ratio at Birth in China." *Population and Development Review* 16(1):63–83.
- Jha, Prabhat Rajesh Kumar, Priya Vasa, Neeraj Dhingra, Deva Thiruchelvam, Rahim Moineddin. 2006. "Low Male-to-Female Sex Ratio of Children Born in India: National Survey of 11 Million Households." *Lancet* #367.
- Johansson, Sten, and Ola Nygren. 1991. "The Missing Girls of China: A New Demographic Account." *Population and Development Review* 17(1):35–51.
- Johnson, Kay. 1993. "Chinese Orphanages: Saving China's Abandoned Girls." *Australian Journal of Chinese Affairs* 30:61–67.

- Junhong, Chu. 2001. "Prenatal Sex Determination and Sex-Selective Abortion in Rural Central China." *Population and Development Review* 27(2):259–81.
- Li, Hongbin, Zhang, Junsen, and Yi Zhu. 2005. "The Effect of the One-Child Policy on Fertility in China: Identification Based on the Differences-in-Differences." Discussion Paper, Chinese University of Hong Kong.
- Li, Shuzhuo. 2007. "Imbalanced Sex Ratio at Birth and Comprehensive Intervention in China." Prepared for 4th Asia Pacific Conference on Reproductive and Sexual Health and Rights.
- Lin, Ming-Jen, and Ming-Ching Luoh. 2006. "Can Hepatitis B Mothers Account for the Number of Missing Women? Evidence from Three Million Newborns in Taiwan." National Taiwan University Faculty Working Paper.
- McElroy, Marjorie, and Dennis Tao Yang. 2000. "Carrots and Sticks: Fertility Effects of China's Population Policies." *American Economic Review* 90(2):389–92. Papers and Proceedings of the One Hundred Twelfth Annual Meeting of the American Economic Association.
- Oster, Emily. 2005. "Hepatitis B and the Case of the Missing Women." *Journal of Political Economy* 113(6):1163–1216.
- Oster, Emily, Gang Chen, Xinsen Yu, and Wenyao Lin. 2008. "Hepatitis B Does Not Explain Male-Biased Sex Ratios in China." Draft.
- Poston, Dudley, and Karen Glover. 2005. "Too Many Males: Marriage Market Implications of Gender Imbalances in China." Paper presented at the 25th IUSSP World Population Conference. Tours, France. July 18–23.
- Qian, Nancy. 2008. "Quantity and Quality and the One Child Policy: The Only-Child Disadvantage on School Enrollment in Rural China." Unpublished.
- Scharping, Thomas. 2003. "Birth Control in China 1949–2000." New York, NY: Routledge Curzon.
- Sen, Amartya. 1990. "More than 100 Million Women are Missing." *New York Review of Books* 37(20):61–66.
- Taiwan Panel Study of Family Dynamics. 1999. Office of Survey Research of Academia Sinica.
- Trivers, Robert, and Dan Willard. 1973. "Natural Selection of Parental Ability to Vary the Sex Ratio of Offspring." *Science* (179)4068:90–92.
- Welch, Finis. 1974. "Sex of Children: Prior Uncertainty and Subsequent Fertility Behavior." RAND Research Report R-1510-RF. Santa Monica, Calif.: Rand Corporation.
- Yi, Zeng, Tu Ping, Gu Baochang, Xu Yi, Li Bohua, and Li Yongping. 1993. "Causes and implications of the recent increase in the reported sex ratio at birth in China." *Population and Development Review* 19(2):283–302.
- Yi, Zeng. 2007. "Options for Fertility Policy Transition in China." *Population and Development Review* 33(2):215–46.
- Zhao, Gracie Ming. 2003. "Trafficking of women for marriage in China: Policy and practice." *Criminal Justice* 3(1):83–102.
- Zhang, Li, Xiaotian Feng, and Qingsong Zhang. 2006. "Changing Patterns of Desired Fertility." *Fertility, Family Planning, and Population Policy in China*, ed. Dudley Poston, Che-Fu Lee, Chiung-Fang Chang, Sherry L. McKibben, and Carol S. Walther. New York, N.Y.: Routledge Curzon.

Appendix

I. Sex Ratios and the Rural/Urban Comparison

In Table A2, I present results that compare fertility patterns among parents in the 2000 census by rural and urban status. Columns 1 and 2 reflect that rural parents are more likely to have a second child after either a daughter or son. For example, following a daughter, 82 percent of rural parents have a second child, whereas only 23 percent of urban parents have a second child, possibly owing to harsher penalties on extra births for parents with urban registration. However, Columns 3 and 4 indicate that among parents who have a second child after a daughter, urban parents are *more* likely to have a son, with 60 percent of births being male versus 59 percent of second births to rural parents. While the One Child Policy effectively lowers urban fertility, among those who have an additional birth, there is little difference between the behavior of rural and urban parents.

Table A1
Matched Mothers and Children (000s)—China, 1982–2000

Statistic	1982	1990	2000
Mothers	108,555	145,204	148,341
Sons	129,612	138,099	121,550
Daughters	122,685	127,008	105,464
Children per Mother	2.324	1.826	1.530
Sex Ratio of Children	1.056	1.087	1.153
Sex Ratio at Birth	1.064	1.085	1.143
Female Deficit (0–18)	0.51%	2.59%	8.37%

Source: China Census 1% sample (1982), 1% sample (1990), .10% sample (2000). Married women ages 21–40 and their children ages 0–18.

Notes: Sex ratio (boys/girls) at birth is calculated by assigning weights to each male and female that account for differential mortality rates by age, sex, and year. China life tables taken from Banister (2004).

Table A2
Fertility Patterns by Rural/Urban Status, 2000

Sex of First Child	Did you have another child? (1 = yes)		Among those with another child, was the next birth male? (1 = yes)	
	Rural	Urban	Rural	Urban
Boy	0.649 (0.004)	0.159 (0.005)	0.489 (0.005)	0.501 (0.016)
Girl	0.822 (0.003)	0.232 (0.005)	0.589 (0.004)	0.597 (0.013)

Source: China 2000 Census. Sample restricted to married women ages 35–40.
 Notes: Urban/rural defined by hukou registration status. Standard errors in parentheses.

II. Sex Selection in India and Declining Fertility

In India, mothers face no mandated fertility limit but in recent years are choosing to have fewer children, due to many causes related to economic development, and the country has witnessed a rising sex ratio at birth due to sex selection (Jha et al. 2006). In order to examine the connection between these trends, Table A3 compares the sex ratio following daughters for mothers of different education levels who were surveyed in India's Demographic and Health Survey (DHS). Educated Indian women prefer fewer children, which is thought to reflect higher opportunity costs of childbearing in the labor market, and a taste for child quality rather than quantity. While India has no fertility policy in place, a comparison of mothers stratified by education is similar in spirit to examining the sex ratio at birth in China for parents subject to different policy regulations.

In Table A3, the survey results for 1992 and 2006 reflect that mothers with more education appear *more* likely to have a son than those less educated.²⁸ While more affluent women presumably have better access to sex selection technology, the skewed sex ratio for these women is consistent with an interpretation that anticipated fertility is affecting the sex selection decision. Also note that higher educated women experienced larger average fertility declines and a more marked increase in the male fraction of births between the 1992 and 2006 surveys. For example, for mothers with a high school degree, the average number of children fell from 2.16 to 1.77, and the male fraction of second births after a daughter rose from 51 percent to 58 percent. This provides further support for the hypothesis that declining fertility is in part responsible for the rising sex ratio at birth.

28. Jha et al. (2006) find similar patterns analyzing the 1998 India DHS survey.

Table A3
Male Fraction of Births and Total Fertility by Mother's Education, India

Parity	Sex Combination	India (1992)					India (2006)				
		Illiterate	Primary	Middle	HS +	Illiterate	Primary	Middle	HS +		
1st	None	0.52	0.51	0.52	0.51	0.51	0.51	0.51	0.52		
2nd	One girl	0.53	0.52	0.52	0.51	0.53	0.53	0.53	0.58		
3rd	Two girls	0.52	0.51	0.52	0.52	0.53	0.55	0.58	0.70		
4th	Three girls	0.52	0.53	0.57	0.62	0.52	0.59	0.62	0.75		
Total Fertility Rate		3.32	3.02	2.52	2.16	3.34	2.82	2.28	1.77		

Source: Calculations based on the India DHS in each year using all living children, ever-married women ages 15–49.

III. Calculating the Fines for Excess Fertility in China

The fertility policy in China is enforced by a complex system of financial disincentives for excess fertility, including reduction of land allotments, denial of public services, and fines for unauthorized births. The fines represent the critical variable in the model's estimation, and they are taken from Scharping (2003). The complete record of the published fine rates collected by Scharping are listed in Table A4, and they reflect wide variation in the punishments on excess fertility across province and year. While comprehensive fine rates for this period are not publicly available, a good deal of information regarding the strength of enforcement across regions, time, and ethnicity is available from smaller-scale surveys conducted during this period.²⁹ The algorithm used to combine these sources of information to impute the fine rates is described below, and the corresponding STATA code and data are available for download at the author's website.³⁰

During the 1980s, the provincial regulations reflect that the vast majority of provinces collected the fine from wage earners in the form of regular deductions (Scharping 2003). For fines levied as wage deductions, I calculate the present value of the deduction at a 2 percent discount rate yielding a single amount of the fine in years of income. For example, in February 1980 Guangdong province ratified a fine of 10 percent of income from each parent for 14 years for an unsanctioned birth, which in my data is calculated as having a present value of 1.21 years of income. In the 1990s, fines began to be levied as a share of annual income, partly in response to difficulties in collections as fewer workers rely on the state for their livelihood. For example, Shanghai reported in 1981 that an unauthorized birth carried a 10 percent wage deduction from both parents for 16 years. In 1992, this amount was raised to an immediate payment of three years of household income. When provinces report a specific deduction as a share of annual income, like Shanghai, the fine variable used in the analysis is taken directly from these provincial regulations. For nonwage workers, such as the peasantry following decollectivization, I am forced to assume the fines were in proportion to the published rates on wage-earners.³¹

I use the published fine rates in Appendix Table A4 and aforementioned imputation procedure to create a data set of fine rates by province and year for 1979–2000. For provinces in which no fine information is available for 1979, I assume that each province instituted a baseline fine of 10 percent deductions for 14 years in 1979, consistent with historical accounts for the provinces for which regulations are available. When a province discloses their policy, I assume that the explicit

29. The China Health and Nutrition Survey has fine data for 1989, 1991, and 1993, but the rates are only for a small number of communities (156 in 1989) in several provinces. As described in this appendix, the information in the CHNS is used to guide imputation of the fines to the national census.

30. <http://pluto.mscc.huji.ac.il/~ebenstein/>

31. One anonymous reviewer noted that in rural areas, the income of self-employed farmers is difficult for authorities to observe, and a deduction as a share of income may be difficult to implement. There is evidence, however, that wealthier farmers were subject to higher fertility fines due to their greater ability to pay (Scharping 2003). The published rates will be appropriate provided fine collectors deal similarly with those paying wage deductions and those who are self-employed, and that only the timing of the payment varies across these groups.

Table A4
Monetary punishments for excess fertility, China 1979–2000

Province	First Report	Second Report	Third Report	Fourth Report	Fifth Report
Beijing	1982: 7Y, 10%	1991: 1Y, 500%			
Tianjin	1988: 5Y, 20%	1997: 5Y, 20%			
Hebei	1982: 14Y, 10%	1989: 1Y, 250%	1997: 1Y, 250%		
Shanxi	1982: 7Y, 15%	1986: 7Y, 25%	1989: 7Y, 20%		
Inner Mongolia	1982: 14Y, 10%	1995: 1Y, 200%			
Liaoning	1979: 14Y, 10%	1980: 14Y, 10%	1988: 14Y, 10%	1992: 1Y, 500%	1997: 1Y, 500%
Jilin	1988: 1Y, 30%				
Heilongjiang	1982: 14Y, 10%	1983: 1Y, 120%	1989: 14Y, 10%		
Shanghai	1981: 16Y, 10%	1982: 3Y, 10%	1992: 1Y, 300%	1995: 1Y, 300%	1997: 1Y, 300%
Jiangsu	1982: 10Y, 10%	1990: 1Y, 300%	1995: 1Y, 300%	1997: 1Y, 300%	
Zhejiang	1982: 7Y, 5%	1985: 5Y, 15%	1989: 5Y, 50%	1995: 5Y, 50%	
Anhui	1979: 14Y, 5%	1988: 7Y, 10%	1992: 7Y, 10%	1995: 7Y, 10%	
Fujian	1982: 14Y, 5%	1988: 7Y, 20%	1991: 1Y, 300%	1997: 1Y, 300%	
Jiangxi	1997: 1Y, 300%				
Shandong	1996: 1Y, 100%				
Henan	1982: 7Y, 15%	1985: 7Y, 15%	1990: 7Y, 30%		
Hubei	1979: 14Y, 10%	1987: 5Y, 20%	1991: 5Y, 60%	1997: 5Y, 60%	
Hunan	1979: 14Y, 5%	1982: 5Y, 10%	1989: 1Y, 200%		
Guangdong	1980: 14Y, 10%	1986: 7Y, 20%	1992: 1Y, 350%		
Guangxi	1994: 1Y, 500%				
Hainan	1989: 7Y, 20%	1995: 1Y, 300%			

Chongqing	1997: 1Y, 300%			
Sichuan	1984: 7Y, 5%	1987: 7Y, 20%	1997: 7Y, 30%	
Guizhou	1984: 14Y, 10%	1998: 1Y, 500%		
Yunnan	1986: 1Y, 10%	1990: 7Y, 40%	1997: 7Y, 40%	
Tibet	1986: 1Y, 30%	1992: 1Y, 50%		
Shaanxi	1981: 7Y, 10%	1982: 7Y, 10%	1991: 7Y, 30%	1997: 7Y, 30%
Gansu	1982: 10Y, 10%	1985: 10Y, 10%	1986: 7Y, 10%	1997: 7Y, 30%
Qinghai	1982: 7Y, 10%	1986: 7Y, 10%	1992: 7Y, 25%	
Ningxia	1982: 14Y, 10%	1986: 14Y, 10%	1990: 14Y, 30%	
Xinjiang	1988: 7Y, 10%	1991: 14Y, 30%		

Notes: Taken from Scharping (2003). Monetary punishments listed above as "Year of Report: Length of wage deduction, percent of annual salary". Fines that are levied as one-time punishments are listed above as being collected in a single year. Social support fees for additional births are included in the fine where possible. The manner in which fines are imputed for years where no report was available is outlined in the data appendix.

policy of the new fine is constant for the remainder of the period. For every province, I have a direct observation of the size of the fine for at least one point in time.

In recent years, several provinces have moved to a system of enforcement which provides greater latitude to local officials in assessing the appropriate fertility fine. For example, in Beijing fines are assessed as “social support fees” for an unauthorized birth and the regulations indicate that the fine is assessed as an amount between 5,000 and 50,000 yuan. In these circumstances, I am forced to impute the fine with the fine charged by other provinces within the same fertility policy region (discussed below) for which I have reliable measures of the fine amount as a share of income.³²

As discussed in the text, while unauthorized births are subject to severe fines, parents in certain circumstances are granted authorization for a second child, and these births carry milder financial consequences. Gu et al. (2007) classify each of the 31 provinces and autonomous regions of China into a one-, 1.5-, or two-child zone, which broadly classifies the average number of children allowed to each couple. For parents in the one-child zone, I presume that the entire value of the fine is levied on all second births. Parents in the 1.5-child zone who have a first-born daughter are in many (but not all) localities eligible for a second child permit. Local variability in the policy is unobserved in the census data but known to be important (Mcelroy and Yang 2000). For example, the China Health and Nutrition Survey (CHNS) documents that in Hubei province (classified in the 1.5-child zone) Han couples with a first-born daughter were not allowed a second child in five out of 24 villages in the 1993 survey, and so I approximate this phenomenon with a fine rate of 25 percent of the baseline fine. For parents living in the two-child policy zone and minority parents, I apply a fine equal to 10 percent of the provincial fine rate, to attempt to capture the closer to universal permits on second births to these parents. This value is chosen since all parents were eligible for a one-child bonus, and the CHNS reflects that the average annual one-child bonus (roughly 100 yuan) was approximately 10 percent of the average fine (roughly 1,100 yuan) in the villages sampled.

I also adjust upward the penalty on third births in the one- and 1.5-child zone to account for the premium punishments applied to couples that had a third child. Most provinces report more severe wage deductions or fines for third births, such as Shanghai which doubled the standard fine associated with a second birth. For parents within the one-child zone, I assign a 100 percent premium to the punishment for a third birth relative to the base fine. The markup of 100 percent is chosen consistent with the reported policy in Zhejiang, Shanghai, Jiangsu, and Beijing, each of which explicitly dictated punishments on 3rd births to be twice the fine on 2nd births. For parents in the 1.5-child zone, I assign a 50 percent premium to a third birth, since this will only be the first unauthorized birth for many of these families. For minorities and residents of the two-child zone, the fine on a third birth is equal to 50 percent of the provincial fine rate. This roughly matches the average difference in fines

32. The following provinces require imputations in the recent years: Beijing (one-child policy), Inner Mongolia (1.5-child policy), Liaoning (1.5), Jilin (1.5), Jiangxi (1.0), Shandong (1.5), and Guangxi (1.5).

observed in the CHNS (1993), which indicates that the average fine was twice as large in areas where all couples are allowed a second child.³³

The fine relevant for the analysis should be the *effective* fine, which would account for variability in the enforcement of fines. While in urban areas the fines are easily enforced, and excess fertility can be punished with the denial of state services, this is not always the case in the rural areas.³⁴ As such, I raise the fine assumed to apply to all individuals registered in an urban *hukou* an extra 50 percent spike to both second and third births in all zones. This partly based on Scharping's calculation that roughly half of all levied fines were collected, and so as an approximation between full collections and no collections, I raise the urban fine rate by 50 percent. The second justification is that I attempt to reconcile my fine distribution with data in Gu et al. (2007) on policy fertility.³⁵ They have access to more detailed data and can observe the large concentration of state workers in urban areas (who are subject to stricter rules and harsher punishments) and they produce a distribution of fines similar to those used in my analysis.

33. Author's calculations from the 1993 CHNS community survey (1,950 versus 3,900 yuan).

34. Scharping writes that before China began liberalizing its economy "[T]ight state control of the urban economy made enforcement of these measures relatively easy." In recent years, the cities have experienced more difficulty deducting wages, but urban residents continue to be more reliant on social services and are therefore subject to more effective enforcement of the policy. pp. 136.

35. Gu et al. (2007) place all urban residents into a one-child fertility policy, regardless of their province of residence. I observe in my data that fertility rates are higher for urban residents in the 1.5-child and two-child policy regions, and so I allow for urban residents to be subject to different fines in different regions.