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Do Skewed Sex Ratios Among Children Promote Parental Smoking? Longitudinal Evidence from Rural China

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Abstract

China and some other Asian countries have experienced skewed sex ratios, triggering intense competition and pressure in the marriage market. Meanwhile, China has more smokers than any other country, with half of men smoke while few women smoke. Men are the major income earners in most Chinese families and thus bear much of the financial burden in preparation for children's marriage. This paper investigates how a demographic factor – a large number of surplus men in the marriage market in China – affects their fathers' smoking behavior. We utilize two household longitudinal surveys as well as a random subsample of the China Population Census to examine fathers' smoking in response to skewed sex ratios. Strikingly, fathers smoke more for families with a son living in communities with higher sex ratios. In contrast, those with a daughter do not demonstrate this pattern. Coping with the marriage market pressure is a more plausible pathway linking the observed skewed sex ratios among children and intense smoking among fathers. Considering worsening sex ratios and highly competitive marriage market in the coming decade as well as lasting health impacts due to smoking, policies suppressing unbalanced sex ratios could lead to welfare gains.

Keywords: Sex Ratios, Marriage Market, Paternal Smoking, Stress
JEL: J13, D12, I19

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1. Introduction

Tobacco use is prevalent and addictive, imposes health impacts, impairs labor market performance, and raises negative externalities within society through increased use of public health care and addiction treatment services. Understanding and suppressing the determinants of tobacco use could lead to substantial welfare gains, especially in countries like China that is still in early stage of a tobacco epidemic (Yang et al. 1999). China has more smokers than any other countries in the world, generating significant health problems due to both firsthand and secondhand smoking that result in about a million premature deaths each year (Hu at al. 2006).

This paper aims to examine how demographic factors, particularly a large number of excess men in the marriage market, affect smoking. The widely available ultrasound technology in recent decades and the ingrained culture of son preference, together with one of the most radical birth control policies in history, lead to highly skewed sex ratios favoring women in contemporary China. According to the China Population Census, sex ratio at birth (SRB) in China has increased from 106.32 in 1975 to 118.06 in 2010. Sex ratios are more skewed in impoverished western and central China than eastern China (Figure 1). Meanwhile, the 2000 population census and the 2005 inter-census survey indicate that rural areas possess more skewed sex ratios than urban areas (Ebenstein and Sharygin 2009). The scale of involuntarily single men is frightening. According to the 2005 inter-census China national survey, the number of excess Chinese men under age 20 exceeded 32 million, which is greater than the entire male population of Italy or Canada (Zhu, Lu, and Hesketh 2009). Ebenstein and Sharygin (2009) simulate that at least 10.4 percent of these additional men will fail to marry.

Faced with the pressure to marry their sons, parents improve sons' relative attractiveness via investing more in education, spending more on positional goods, throwing extravagant wedding parties, paying high bride prices and building fancy houses for marriage, which occupy a great proportion of lifetime income (Foreign Policy 2012). However, almost none of these expenses are incurred by the brides' families. Wei, Zhang and Liu (2012) find that rising sex ratios accounts for two fifths of the rise in real urban housing prices in China. To make ends meet, men have to work harder (Wei and Zhang 2011a)[1], take more risky jobs (Robson 1996;

[1] In contrast, Angrist (2002) finds a large negative effect of high sex ratios on female labor force participation.

Hopkins 2011), and tend to save more and amass more assets (Chang and Zhang 2012). The savings rate for grooms' families peaks in the year before the wedding, while it is almost always lower for brides' families (Wei and Zhang 2011b). According to Wei and Zhang (2011b), rising sex ratios may account for half of the recent increase in the household savings rate. Evidence from multiple countries suggests that skewed sex ratios widen the dispersion of marriage market rewards, males of low socioeconomic status who fail to marry often bear grave consequences, such as lack of care in old age (Ebenstein and Sharygin 2009), committing crimes (Edlund et al. 2007), vulnerability to social instability (Den Boer and Hudson 2004), prevalent sexually transmitted infectious diseases (Ebenstein and Sharygin 2009), psychological distress (Pearlin and Johnson 1977), and high mortality rate (Hu and Goldman 1990).

Despite a growing literature on the consequences of gender imbalance, few studies investigate its impact on stress coping behavior, especially for the parental generation. This study aims to make two main contribute to the literature. First, we are among the first to examine parental smoking behavior in response to skewed sex ratios and distinguish by the gender of their children; second, our rich primary data enable us to explore potential mechanisms that promote smoking, such as through income effect, marriage market stress, and wealth signaling.

Nicotine is a psychoactive (mood altering) drug, and tobacco use may make the subjective effects of stress (such as feelings of frustration, anger, and anxiety) less severe (Peski 2013). Psychological studies link increasing psychosocial strain with more tobacco use to self-medicate anxiety disorders (Shaw et al. 2011). Consequently, we might observe more frequent smoking as a stress coping strategy among the grooms' families, while brighter prospects for marriage among females reduce their tobacco use (Umberson 1987).

We study parental smoking behavior in response to skewed sex ratios of their children's generation in rural China. Our empirical investigations focus on paternal smoking behavior for two reasons. First, smoking by men is deeply ingrained in Chinese culture, while social norms are against women smoking. In China, men smoke at a much higher rate than women (53% vs.

2%) (The Economist, 2012). Second, men are the major income earners in most Chinese families and thus naturally bear much of the financial burden in preparation for children's marriage.[2]

We focus on comparing families with the first child being a son versus being a daughter. Much evidence suggests that there are very few gender selections at the first birth parity in rural China: no strict fertility control policy has been implemented for ethnic minorities in China (Scharping, 2003); sex selections at the first birth are low in rural areas, where more than one child is allowed; sex ratio for the 1st birth parity has been almost constant over time (Ebenstein, 2009); experiencing different fertility policies at the 1st birth result in similar sex ratios at birth (Ebenstein, 2010); sex ratio at birth by parity shows that the availability of ultrasound does not affect the 1st birth but higher parities (Chen, Li and Meng, 2010). Moreover, evidence suggests that endogenous fertility decisions on the first-born child may not be a concern in our rural sample. Regressing the number of children (or whether stopping at the second child) on household minority status finds no significant results, suggesting that neither minorities nor the major Han group is subject to binding fertility control policy. Summary statistics indicate that sex ratios at the 1st birth parity are similar to the natural rate (Ebenstein, 2009).

Our results suggest that fathers with a son in the competitive marriage market favoring females smoke more, especially for the poor. In contrast, those with a daughter do not demonstrate this pattern. Compared to income effect and wealth signaling motives, coping with the pressure to marry their sons is a more plausible pathway linking the observed unbalanced sex ratios and smoking behavior. Some indirect evidence on reduced paternal life satisfaction and happiness in communities with skewed sex ratios also suggests that stress may matter. Results from two key placebo tests suggest that our identified effect is likely to be causal. The first test using sex ratios for age cohorts not in the competitive marriage market shows no effect. The second test indeed finds growing marginal effects as a son approaches the marriage age. Future work is required to rule out all other unobserved mediated factors, such as lack of job opportunities sons may encounter due to skewed sex ratios that can have an impact on their fathers smoking behavior and lifestyle in general.

[2] Smoking among sons is likely to be simultaneously motivated by the pressure to get married and suppressed due to their weak bargaining power in the marriage market that favors women. Fortunately, the latter is irrelevant when we investigate paternal tobacco use, which gives us a cleaner identification of the marriage market pressure.

The rest of the paper is organized as follows. Section 2 introduces methods and data used and documents trends in the data. Section 3 presents the main results, placebo tests, and robustness. Section 4 discusses potential mechanisms. Finally, section 5 concludes.

2. Empirical Methods

2.1 Datasets

We utilize two household longitudinal datasets from rural China – a primary census-type survey in Guizhou province between 2004 and 2009 and a secondary national survey in nine provinces between 1991 and 2006 - to examine paternal smoking in response to skewed sex ratios. The national sample of the China Health and Nutrition Survey (CHNS) covers a wide range of nationally representative counties. We follow the literature to merge the survey with sex ratios at the county level based on a 1‰ sample of the 2000 China Population Census. Though the Guizhou survey only covers villages in one county, its census feature allows us to accurately gauge sex ratios at the village level, which can be an appropriate measure of localized marriage market competition in impoverished rural China.[3]

For the purpose of this study, the rural sample of the CHNS is employed. The CHNS covers nine provinces in China that vary substantially in geography and economic development. Each province is drawn following a multistage, random cluster process. Stratified by income, a weighted sampling scheme was used to randomly select four counties in each province. Villages and townships within the counties were selected randomly. There are about 18,000 individuals in some 4,200 rural households surveyed. We utilize the information on cigarette consumption per day in six waves of the survey between 1991 and 2006. Table 1 suggests that around half of the fathers smoke.

[3] First, the marriage market competition can be quite localized. More than half of the marriages in the Guizhou survey are within villages (Appendix Table 1). It has been well documented that grooms' families build fancy houses and spend lavishly in social events to signal to local matchmakers and improve the relative standing in the local marriage market (Brown et al., 2011). More generally, Mangyo and Park (2011) find that village reference groups are the most salient for residents living in close proximity in rural China. Second, county-level sex ratios calculated using the Chinese population census may oversample residents living in county seat where sex ratios tend to be less biased and therefore underestimate the actual sex ratios in rural areas. Third, the mountainous landform in our surveyed area in Guizhou leads each village to function like an isolated community.

The county level sex ratios merged from a 1‰ sample of the 2000 China Population Census increase from 109 males (per 100 females) to 117 males (per 100 females) between 1991 and 2006 (Table 1). Together with the worsening skewed sex ratios, their standard deviations increase as well, suggesting that the gender gap among communities may widen. The population census data suggests that the national average county level sex ratios at the 1st, 2nd and 3rd birth parities are 108.4, 143.2 and 152.9, respectively.

Appendix Figure 1 plots the positive relationship between sex ratios and paternal tobacco use and distinguishes the relationship by child gender composition. Families with one son and no daughter show a positive association between sex ratios and tobacco consumption, especially when sex ratios are more biased favoring females. However, no clear association is found for families with one daughter and no son.

Appendix Figure 2 compares tobacco consumption pattern among households along the income distribution. We distinguish between families with a son and those with a daughter, and families living in high sex ratio counties and those living in low sex ratio counties. The two types of counties are categorized by their sex ratios relative to the median level in our sample. The overall increase in smoking in relation to income may capture a positive income effect. The left figure suggests that poor families with a son living in high sex ratio counties smoke more, while the intensity is much lower for their poor counterparts living in counties with low sex ratios. This may suggest that these families are especially stressed and are less capable of coping with the marriage market pressure. However, in the right figure no similar pattern is found for families with a daughter.

Moreover, families living in high sex ratio counties with a son demonstrate significantly higher smoking intensity (left figure of Appendix Figure 2) than those with a daughter (right figure of Appendix Figure 2), while a comparison between the two types of families in low sex ratio counties generates no distinct pattern. Appendix Figure 2 consistently suggests that the marriage market pressure can be explicitly distinguished from other factors, such as income and demographic effect.

We also utilize a three-wave Guizhou survey administered between 2004 and 2009. Though the survey has a limited geographic scope, it covers all households and their members

in 26 randomly selected villages. The rich information on both manufactured tobacco products and homemade tobacco products (Table 1) helps us distinguish other potential motives from signaling wealth in driving tobacco use. Compared to the national average tobacco consumption of 281.08 yuan (in 2004) and 324.73 yuan (in 2006)[4], our sampled individuals spend more on tobacco. The reported higher tobacco consumption in the Guizhou survey than that in the CHNS may originate from its inclusion of homemade tobacco products. Table 1 indicates that the village level sex ratios at the 1st, 2nd and 3rd birth parities in our sample are 106.0, 119.7 and 138.9, respectively.

2.2 Empirical Identification

To distinguish the smoking effect for families with a son from those with a daughter and families with a different number of children, we estimate

$$y_{ijt} = \alpha_1 sexratio_{jt} + \beta_1 son1st_{ij} + \gamma_1 sexratio_{jt} * son1st_{ij} + X_{ijt}\Gamma + \mu_i + \nu_t + e_{ijt} \quad (1)$$

where i denotes family; j represents county (for the CHNS data) or village (for the Guizhou survey); *t* is year. $sexratio_{jt}$ is sex ratio at the county level (for the CHNS data) or the village level (for the Guizhou survey). Sex ratios are calculated for age cohort 10-19 at each wave of survey and therefore vary over time *t*. $son1st_{ij}$ is a dummy variable equaling 1 when the first child of the family is a son. y_{ijt} denotes two outcome variables, including expenditures on tobacco use in the Guizhou survey and number of cigarettes one smoke per day in the CHNS data. Only outcomes that capture the intensive margin of tobacco use are investigated since people tend to form the habit of smoking at a much younger age and thus are less likely to change this decision.

X_{ijt} are covariates, including the current price of cigarette at the village level, household income per capita, paternal year of education, household head's gender and age, marital status, share of the elderly, share of the youth, household size, whether they suffer from major diseases, and ethnicity. ν_t denotes year fixed effects, and μ_i represents household fixed

[4] China Tobacco Yearbook (2007).

effects. Since our interested tobacco use variables may reflect individual habit and local norms, estimations utilizing within-household variation in should mitigate these concerns.

We also estimate equation (2) for nuclear families with a son and those with a daughter.

$$y_{ijt} = \alpha_1 sexratio_{jt} + X_{ijt}\Gamma + \mu_i + \nu_t + e_{ijt} \qquad (2)$$

3. Results

3.1 Main Results

The first set of results using the CHNS data is reported in Table 2. The first column uses sex ratios of 5-19 age cohorts. The second column through the fourth column adopt sex ratios of 5-9, 10-14, and 15-19 age cohorts, respectively. Sex ratios of the 15-19 age cohort capture a more significant effect. Because most sampled households have one or two children, most families in the 5-9, 10-14, and 15-19 age cohorts do not overlap, and the marginal effect of the first column (age cohort 5-19) is close to the sum of the effects of the other three age cohorts.

Restricting the sample to households with no more than two children in columns (1) and (4) of Table 3, we show that having a son first does not affect tobacco use. However, the combination of having a son and living in a community with more skewed sex ratios is associated with more smoking among fathers. Our results further suggest that skewed sex ratio promote more smoking among nuclear families with a son (columns (2) and (5)), while no such pattern is found for those with a daughter (columns (3) and (6)).

The marriage market pressure is expected to exert a bigger impact on households with a son approaching marriage age. Using the CHNS, we estimate the equation (1) with various age cohorts from 1-5 to 26-30 to gauge the heterogeneous effects and draw their marginal effects in Appendix Figure 3. The growing marginal effects of the interaction term (sex ratio*first child being son) suggest that the marriage market pressure becomes more intensified as a son grows up. Though the small sample size in the Guizhou survey prohibits us from testing the heterogeneous effects, a separation into 1-11 and 12-19 age cohorts[5] suggests that the 12-19 cohorts demonstrate a much higher marginal effect than the 1-11 cohorts.

[5] In rural Guizhou province, families with boy reaching 12 hold a coming-of-age ceremony, signaling to the community that the boy grows up into the marriage age. Our age cohort classification is consistent with this norm.

3.2 Robustness

First, the number of children in a household might be an endogenous choice of the parents. Therefore, in Appendix Table 2 we check using the Heckman two-step estimations that model the parental fertility choice to stop at one child. Following Wei and Zhang (2011), we use the minority status of the household, the age of the first child and whether the first child is disabled or suffers from major diseases as the exclusive variables in the selection equation of whether parents stop at the first child. The main equations for nuclear families with the first child being a son still maintain statistical significance, while no such result is obtained for nuclear families with first child being daughter.

Second, Table 3 also shows the result of a falsification test that replaces the sex ratios (age cohort 10-19) best capturing the mating competition by sex ratios of less relevant age cohorts (30-40). The effects disappear, indicating that the combination of having an unmarried son and living in an area with a skewed sex ratio at marriage age, rather than unobserved potential trend, promote fathers' tobacco use.

Third, estimations using the CHNS national sample cluster standard errors at the county level. For our Guizhou survey collected from 26 villages in one county, the Cameron-Gelbach-Miller (2011) bootstrapping method is adopted to address the issue of small number of village clusters, and adjusted p-values are presented in the brackets.

Fourth, the main results calculate sex ratios for age cohorts 10-19, which fits the age range that rural residents normally enter into the marriage market in China. Meanwhile, age cohorts 10-19 are widely used in micro studies on sex ratio imbalances and the marriage market, such as Wei and Zhang (2011a, 2011b), Wei et al. (2012) and Chang and Zhang (2012). Though most young men in rural China are already married or in the marriage market by age 19, this age range may not apply to some developed rural areas. Therefore, we also calculate sex ratios for age cohort 15-25. The results are very similar and available upon request.

4. Discussions

In this section, we discuss potential mechanisms between skewed sex ratios and parental smoking. Do sex ratios motivate more tobacco use through income effect? Evidence suggests that unbalanced sex ratios stimulate grooms' families to work harder to earn more money (Wei and Zhang, 2011). To test whether income effect dominates the pathway, in Appendix Table 3 Panel A we regress per capita income on local sex ratios and compare the effects for families with different demographic structures. When interact sex ratio with first child being a son and restrict the sample to families with one or two children, we find an insignificant effect on income. We further restrict the sample to families with one child. Results even suggest a negative, though insignificant, effect of sex ratio on income for families with a son (column 2) and a positive but insignificant effect for families with a daughter (column 3).

Meanwhile, if skewed sex ratios affect smoking though a positive income effect, we should at least expect more smoking among richer families living in communities with high sex ratios. Re-estimating the main results in Table 3 but interacting local sex ratios with four income quartiles, Appendix Table 4 suggest that smoking is biased towards the lower income quartiles, which echoes the pattern in Appendix Figure 2 that poorer households with a son living in a high sex ratio community tend to consume more tobacco. These pieces of evidence clearly do not support the story of income effect.

Since cigarette smoking is positional (Heffetz, 2011), do poor households consume as a means to signal and improve social status? Though the positional feature of cigarette smoking makes it difficult to fully distinguish marriage market pressure from wealth signaling motives, the rich Guizhou survey data on different types of tobacco consumption enables us to partially distinguish between the two mechanisms. Relative to packed cigarettes with publicly recognizable brands, tobacco pipe smoking generally has little to do with wealth signaling. If wealth signaling is the dominant motive, we should find little evidence on tobacco pipe smoking. However, results from Appendix Table 3 Panel B show families with a son living in high sex ratio villages experience more tobacco pipe smoking. In other words, factors other than wealth signaling should be in effect.

Other potential mechanisms are ruled out. First, fathers who smoke more may select to live in male-dominant communities in which smoking rate and intensity are higher. However, our sex ratios capture gender imbalance for very young age cohorts whose pressure to get married accumulate. When we use sex ratios for age cohorts 30-40 that better describe male-dominant communities, no significant effect is found. Moreover, our identification relies on the well-recognized fact that the gender of the first child in rural China is quasi-random, while male-dominant communities have to increase the likelihood of first child being a son as well as smoking rate to establish the relationship, which is unlikely. Further, our individual fixed effect models remove potential time-invariant community characteristics on smoking prevalence, and all regressions control for the average smoking rate in the community. Clearly, none of the evidence suggests reverse relationship between paternal smoking and sex ratios of the next generation or omitted variable bias that may drive the results.

Second, fathers having a son may smoke more as there can be stronger behavior interactions between the two generations. However, compared to the high smoking rate among fathers in the CHNS national sample, only 4.8 percent of children start to smoke before age 19, respectively. We also do not find significantly positive association between paternal and son smoking in the national sample. All these evidence seem to rule out the possibility of intergenerational smoking interactions in rural China.

Third, people may smoke more when ceremonies, such as weddings and funerals, are more frequently held. Using the rich information on all ceremonies in the past few years in Guizhou survey, we estimate the number of ceremonies each household attended and organized on sex ratios, gender of first child and their interactions. There is no evidence that families with a son living in communities with unbalanced sex ratios attended or organized more social events, which goes against this hypothesis.

Finally, coping with stress can be a key motive for intense smoking (Peski, 2013). It is most plausible that those who are less able to manage the marriage market stress smoke more. Though stress is not directly measured in the CHNS data or the Guizhou survey, we can indirectly test whether having a son and living in a community with skewed sex ratios favoring females actually reduce paternal life satisfaction and hedonic happiness. Results are presented in Appendix Table 3 Panels C and D. For families with one or two children, having a son and

experiencing skewed sex ratios in the marriage market indeed predict lower life satisfaction and happiness. This pattern is salient for families with a son but not for families with a daughter when the sample is restricted to one child families.

5. Conclusions

China has experienced increasingly skewed sex ratios in the past decades and has more smokers than any other country in the world. Utilizing two longitudinal datasets, the CHNS national sample and the Guizhou survey, we find that the marriage market competition promotes tobacco use. Fathers with a son consume more tobacco, while those with a daughter do not demonstrate this pattern. Our results may underestimate the marriage market impact as rural China is subject to less stringent family planning policy.

Due to the strong social norms in China that discourage women from smoking, we limit our analysis to the male subsample. We find that paternal smoking is more intense for families with a son living in communities with higher sex ratios. In contrast, those with a daughter do not demonstrate this pattern. Both direct and indirect evidence suggests that coping with the marriage market pressure is the most plausible pathway connecting the observed skewed sex ratios and the intensified tobacco use, while there is no solid evidence supporting income effect and wealth signaling motives.

Since sex ratio imbalance in China will probably become worse in the next decade, investigating the marriage market pressure and behavior consequences could help design effective policies that improve parental well-being through the rebalancing of skewed sex ratios. Moreover, widespread tobacco use in the world imposes large negative health impacts, affects the labor market, and brings various negative externalities to society. Therefore, understanding and suppressing the determinants of tobacco use, such as the skewed sex ratios explored in this paper, could lead to welfare gains.

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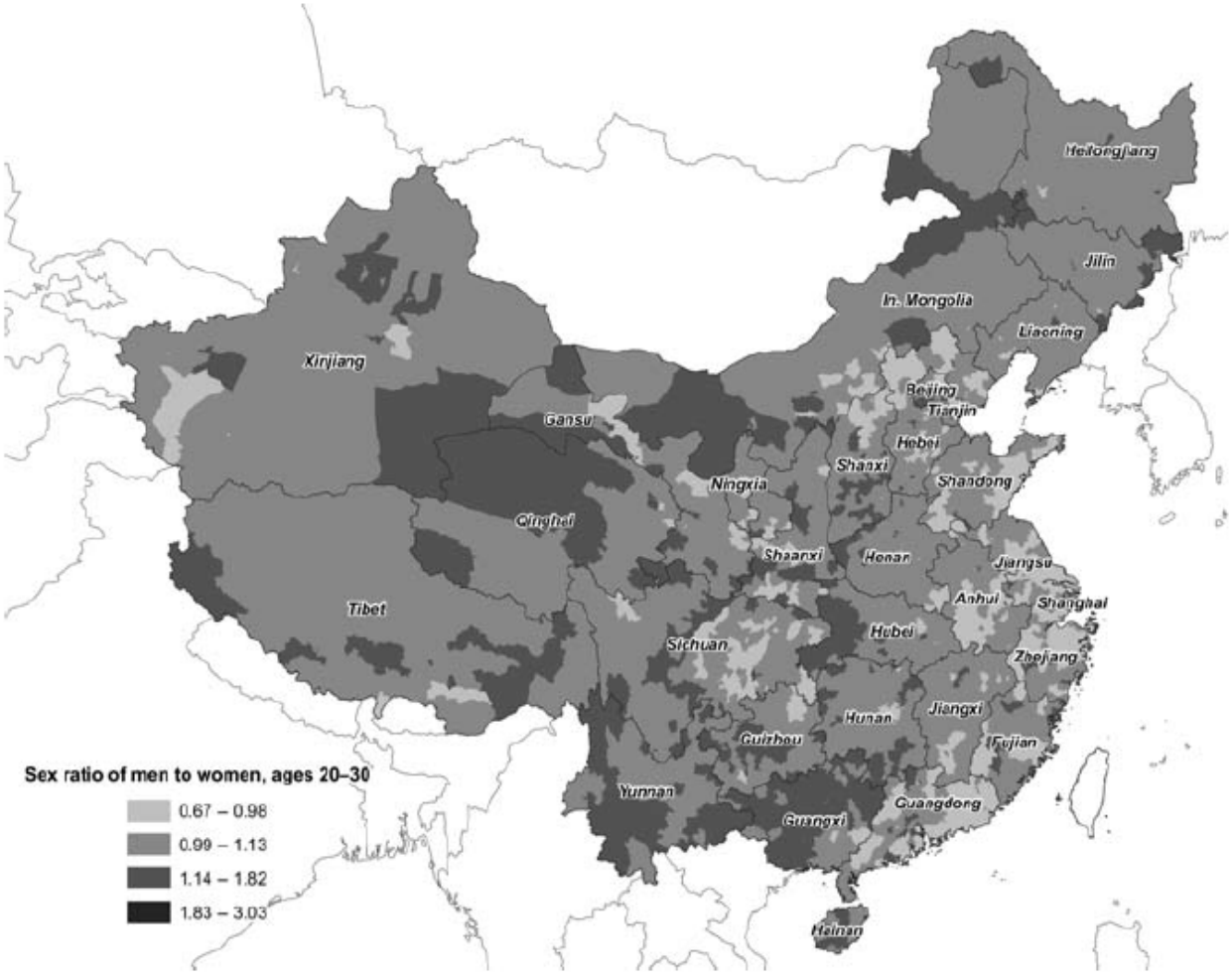
Figure 1 Sex ratios of men to women, ages 20-30



Source: National Bureau of Statistics of China (2000)
Notes: Sex ratios are defined as number of males per female.

Table 1 Summary Statistics for Key Variables

	Mean	Standard Deviation
Guizhou sample		
Dummy for paternal smoking in 2004	0.66	0.35
Dummy for paternal smoking in 2006	0.65	0.36
Dummy for paternal smoking in 2009	0.71	0.39
paternal tobacco consumption expenses in 2004	265.39	293.81
paternal tobacco consumption expenses in 2006	387.86	540.21
paternal tobacco consumption expenses in 2009	536.44	709.43
paternal homemade tobacco consumption in 2004 (in 50g)	30.96	34.28
paternal homemade tobacco consumption in 2006 (in 50g)	27.15	37.82
paternal homemade tobacco consumption in 2009 (in 50g)	26.82	35.47
Sex ratio for the age cohort 10-19 average over 2004-2009	1.16	0.08
Sex ratio at first birth (# males per female)	1.06	0.14
Sex ratio at second birth (# males per female)	1.20	0.15
Sex ratio at third birth (# males per female)	1.39	0.15
China Health and Nutrition Survey (CHNS) National Sample		
Dummy for paternal smoking in 1991-2006	0.52	0.50
Paternal tobacco consumption in 1991-2006 (# cigarettes per day)	5.32	7.44
Life satisfaction (1=least satisfied, 5= most satisfied)	3.97	0.85
Happiness (1=least happy, 5=most happy)	3.17	0.71
Sex ratios inferred from a 1‰ sample of the 2000 China Population Census		
Sex ratio for the age cohort 10-19 in 1991 (# males per female)	1.09	0.16
Sex ratio for the age cohort 10-19 in 1993 (# males per female)	1.09	0.16
Sex ratio for the age cohort 10-19 in 1997 (# males per female)	1.10	0.16
Sex ratio for the age cohort 10-19 in 2000 (# males per female)	1.12	0.16
Sex ratio for the age cohort 10-19 in 2004 (# males per female)	1.13	0.17
Sex ratio for the age cohort 10-19 in 2006 (# males per female)	1.17	0.20
Sex ratio at first birth (# males per female)	1.08	0.12
Sex ratio at second birth (# males per female)	1.43	0.12
Sex ratio at third birth (# males per female)	1.53	0.12

Source: Author's Guizhou household survey data (2004-2009); CHNS household survey data (1991-2006); A 1‰ sample of the 2000 China Population Census.
Notes: The sex ratios for the age cohorts 10-19 in 1991, 1993, 1997, 2004, and 2006 are respectively inferred from the age cohorts 19-28, 17-26, 13-22, 6-15, and 4-13 in the 2000 population census. Sex ratios are defined as number of males per female.

Table 2 Baseline Results: Sex Ratios and Smoking

	Ln(# Cigarettes Smokes Per Day)			
	5-19	5-9	10-14	15-19
Sex ratio	0.541***	0.090	0.115*	0.104**
	(0.128)	(0.060)	(0.061)	(0.047)
Year FEs, HH FEs	Yes	Yes	Yes	Yes
Adjusted R2	0.443	0.422	0.372	0.328
AIC	8310.47	8282.45	8300.67	8340.37
N	21321	21321	21321	21321

Source: CHNS household survey data (1991-2006).

Notes: Sex ratios are measured at the county level using a 1‰ sample of the 2000 China Population Census data. Sex ratios in columns 1-4 are calculated for 5-19, 5-9, 10-14, 15-19 age ranges, respectively. Robust standard errors are in the brackets.

*, **, *** denote statistical significance at the 10%, 5% and 1% level, respectively. All regressions have a constant term that is not reported.

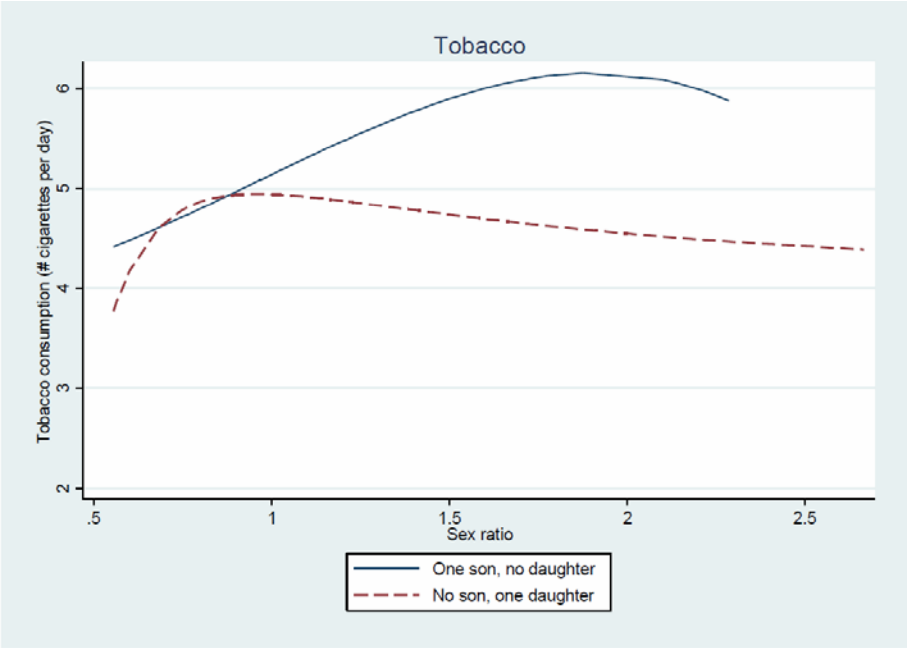
Table 3 Sex Ratios, Family Composition and Tobacco Consumption

	Guizhou Survey			China Health and Nutrition Survey (CHNS) National Sample		
	Ln(Tobacco Consumption Expenditure)			Ln(# Cigarettes Smokes Per Day)		
	(1) One or two children	(2) One son	(3) One daughter	(4) One or two children	(5) One son	(6) One daughter
Sex ratio for age cohort 10-19	-0.128	0.763***	0.046	-0.211	1.289***	-0.286
	(0.520)	(0.000)	(0.842)	(0.133)	(0.278)	(0.226)
Sex ratio (10-19) *first child being a son	0.946*			2.335***		
	(0.079)			(0.330)		
Year FEs, HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.123	0.141	0.094	0.465	0.425	0.483
AIC	3614.98	693.94	500.97	2119.04	6057.94	2882.86
N	1261	310	250	15380	3407	4136
Falsification Test: Using Sex Ratios for Age Cohort 30-40						
Sex ratio for age cohort 30-40	-0.255	-0.166	-0.158	-0.433	-0.330	-0.381
	(0.457)	(0.421)	(0.614)	(0.356)	(0.396)	(0.657)
Sex ratio (30-40) *first child being a son	0.024			0.053		
	(0.419)			(0.443)		
Year FEs, HH FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.108	0.112	0.078	0.066	0.178	0.143
N	1261	310	250	15270	3407	4136

Source: Author's Guizhou household survey data (2004-2009), CHNS household survey data (1991-2006), and 1‰ sample of the 2000 China Population Census.
Notes: Control variables included but not reported here.
Left panel (Guizhou sample): Sex ratios are measured at the village level using the 26-village census-type survey. The Cameron-Gelbach-Miller (2011) bootstrapping method is adopted to address the issue of small number of village clusters, and adjusted *p-values* are presented in the brackets.
Right panel (CHNS national sample): Sex ratios are measured at the county level using a 1‰ sample of the 2000 China Population Census data. Robust standard errors at the county level are presented in the brackets.

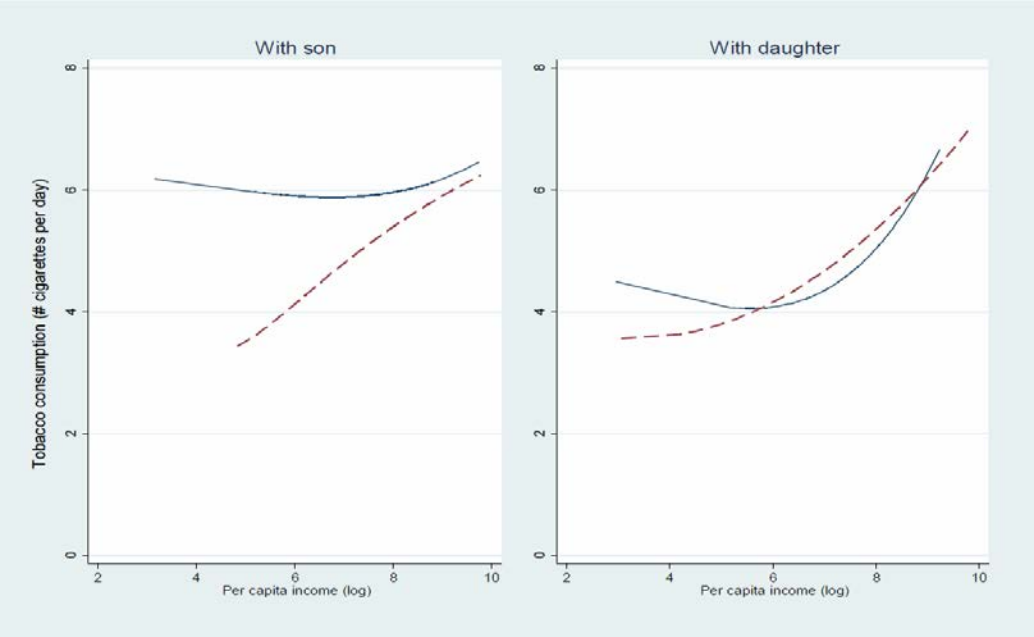
Online Appendix

Appendix Figure 1 Sex Ratios and Tobacco Consumption, by Child Gender Composition



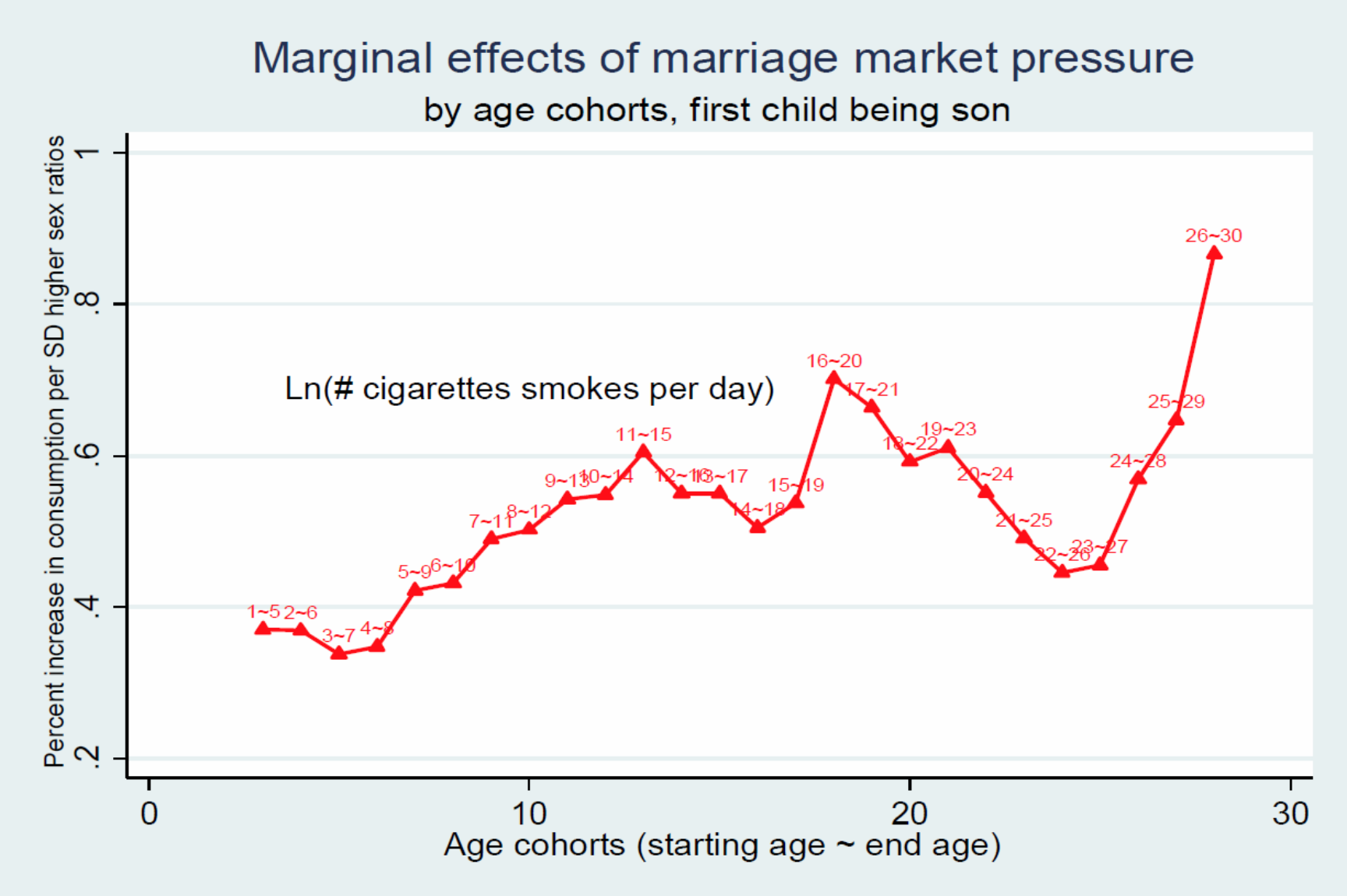
Source: CHNS household survey data (1991-2006).
Notes: Vertical axis denotes fathers' tobacco consumption (# cigarettes per day). This Figure only plots families with one child. Sex ratios are defined as number of males per female.

Appendix Figure 2 Paternal Tobacco Consumption by Income



Source: CHNS household survey data (1991-2006).
Notes: This figure compares fathers' smoking patterns between counties with high sex ratio (in dashed line) and counties with low sex ratio in the year of survey, and between families with son (age 10-19) versus families with daughter (age 10-19).

Appendix Figure 3 Marginal Effects of Marriage Market Pressure



Source: CHNS household survey data (1991-2006).

Appendix Table 1 Marriage Migration Pattern (The Guizhou Survey)

	Stay in the village	Same township different village	Same county different township	Same province different county	Different province
2004	53.5%	12.4%	24.2%	8.9%	1.0%
2006	54.0%	13.4%	24.5%	7.5%	0.6%
2009	54.6%	10.5%	24.9%	9.4%	0.6%

Source: Author's Guizhou household survey data (2004-2009)

Appendix Table 2
Heckman Two-step Estimations on the Likelihood of Family Bearing Only One Child

	Nuclear family with 1st child a son		Nuclear family with 1st child a daughter	
	Ln(# Cigarettes per day)	Stop at 1st child	Ln(# Cigarettes per Day)	Stop at 1st child
	0.94***	0.04	-0.44	0.03
Sex ratio for age cohort 10-19	(0.19)	(0.09)	(0.55)	(0.13)
	0.21	0.06	0.35	0.07
Ln(per capita income)	(0.14)	(0.05)	(0.25)	(0.06)
	-0.04	-0.01	0.02	0.00
Year of education	(0.04)	(0.02)	(0.05)	(0.02)
	1.34***	-0.38*	-0.33	-0.35
Household head gender	(0.44)	(0.22)	(0.49)	(0.25)
	-0.24	-0.08	0.77	-0.40***
Marriage status	(0.21)	(0.15)	(0.87)	(0.15)
	0.00	0.06***	-0.04***	0.07***
Household head age	(0.01)	(0.01)	(0.01)	(0.01)
	-0.07	-0.22	1.40**	0.25
Share of the elderly	(0.49)	(0.21)	(0.70)	(0.26)
	-0.26	-0.26	-3.05***	-0.57***
Share of youth	(0.45)	(0.25)	(0.70)	(0.16)
	0.17	-0.21***	0.11	-0.27***
Household size	(0.11)	(0.04)	(0.23)	(0.06)
Whether parents suffer from major	-0.42**	-0.07	0.15	-0.04
diseases	(0.17)	(0.09)	(0.51)	(0.15)
		0.06		0.06
Minority status of the household		(0.14)		(0.18)
		-0.06***		-0.10***
Age of the first child		(0.02)		(0.01)
Whether the 1st child disables or suffers		-0.15		-0.16
from major diseases		(0.09)		(0.18)
Log Likelihood	-1121.91		-638.08	
N	13183		11142	

Source: CHNS household survey data (1991-2006). Notes: Robust errors are in the brackets. Standard errors clustered at the county level.

Notes: Dependent variables in the main equation = Fathers' consumption of Ln(# Cigarettes per day); DV in the selection equation = likelihood that parents stop at the 1st child.

Appendix Table 3
Testing Potential Mechanisms – Income Effect, Wealth Signaling, and Stress Coping

	Families with one or two children	One son	One daughter
Testing income effect	**Panel A: Dependent Variable: ln(per capita income)**		
Sex ratio for age cohort 10-19	-0.557*	-0.028	0.727
	(0.421)	(0.227)	(1.238)
Sex ratio*first child being a son	0.490		
	(0.443)		
Year FEs, HH FEs	Yes	Yes	Yes
Adjusted R2	0.213	0.230	0.192
N	15380	3407	4136
Testing Wealth Signaling	**Panel B: Dependent Variable: ln(tobacco pipe consumption (in 50g))**		
Sex ratio for age cohort 10-19	-0.122	0.560***	-0.069
	(0.763)	(0.010)	(0.569)
Sex ratio*first child being a son	0.729**		
	(0.041)		
Year FEs, HH FEs	Yes	Yes	Yes
Adjusted R2	0.060	0.154	0.124
N	1261	310	250
Testing Stress Coping	**Panel C: Dependent Variable: Life satisfaction**		
Sex ratio for age cohort 10-19	-0.466***	-2.281***	0.181
	(0.163)	(0.275)	(0.259)
Sex ratio*first child being a son	-0.873*		
	(0.444)		
Year FEs, HH FEs	Yes	Yes	Yes
Adjusted R2	0.249	0.215	0.399
N	16736	4220	3991
Testing Stress Coping	**Panel D: Dependent Variable: Hedonic happiness**		
Sex ratio for age cohort 10-19	-0.308***	-1.685***	0.156
	(0.090)	(0.230)	(0.119)
Sex ratio*first child being a son	-0.789***		
	(0.282)		
Year FEs, HH FEs	Yes	Yes	Yes
Adjusted R2	0.102	0.050	0.351
N	16082	3855	3873

Source: Panel A, C, D: CHNS household survey data (1991-2006). Panel B: Author's Guizhou household survey data (2004-2009)

Notes: Year FEs and household FEs are controlled for. Robust errors are in the brackets. Control variables included but not reported here. Sex ratios in Panels A, C, D are calculated at the county level for the age cohort 10-19, and standard errors clustered at the county level; Sex ratios in Panel B are calculated at the village level for the age cohort 10-19, and standard errors clustered at the village level. *Life satisfaction* ranges from 1 to 5 with 5 the most satisfied. *Happiness* ranges from 1 to 5 with 5 the happiest.

Appendix Table 4 Effects by Income Quartiles (for one child family)

	Ln(# Cigarettes Smokes Per Day)		
	One son	One daughter	One Child
sex ratio*have a son			1.269*
			(0.656)
sex ratio*poorest income quartile	0.886***	0.031	0.402**
	(0.188)	(0.279)	(0.198)
sex ratio*second income quartile	0.716***	0.368	0.311
	(0.175)	(0.967)	(0.333)
sex ratio*third income quartile	0.701***	-3.367*	0.190
	(0.212)	(1.811)	(0.247)
sex ratio*richest income quartile	0.438	-1.061	0.571
	(0.578)	(0.836)	(0.641)
Year FEs, HH FEs	Yes	Yes	Yes
Adjusted R2	0.294	0.155	0.157
N	3407	4136	7543

Source: CHNS household survey data (1991-2006).

Notes: sex ratios are calculated at the county level for the age cohort 10-19. Robust errors are in the brackets. Standard errors clustered at the county level. Control variables included but not reported here.