Marriage and Crime: Evidence from China's Rising Sex

 Ratios^*

Lena Edlund^{\dagger}

Hongbin Li^{\ddagger}

Junjian Yi[§]

Junsen Zhang[¶]

September, 2010

^{*}Comments by Douglas Almond, Philip Brown, John Cawley, Avraham Ebenstein, Raquel Fernandez, Andrew Gelman, Michael Greenstone, Steve Levitt, Zhiqiang Liu, Derek Neal, Mark Rosenzweig, Bernard Salanie, Jeffrey Zax, Yves Zenou, two anonymous referees, and seminar participants at New York University, Hong Kong University of Science and Technology, University of Maryland, Brown University, National University of Singapore, Cornell University and Stockholm University, and conference participants at the 2006 Chinese Economists Society Meeting, IFAU May 2008 workshop, and 2008 Hong Kong Economic Association Meeting, are gratefully acknowledged. The work described in this paper was substantially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project no. CUHK 454608).

[†]Department of Economics, Columbia University.

[‡]Department of Economics, School of Economics and Management, Tsinghua University.

[§]Department of Economics, Chinese University of Hong Kong.

[¶]Department of Economics, Chinese University of Hong Kong.

Abstract

Sex ratios at birth in China rose sharply in the 1980s and 1990s, setting the stage for an unprecedented social experiment. We focus on the effect of surplus men on crime. Between 1988 and 2004 crime rates nearly doubled. Using annual province-level data, we estimate an elasticity of crime with respect to the sex ratio (16-25 year olds) of 3.7, implying that male sex ratios can account for one-sixth of the overall rise in crime. We hypothesize that adverse marriage market conditions drive the found association. We formalize the incentive effects and present corroborating marriage and labor market evidences.

JEL Classification: J12, J13, K42

1 Introduction

In 1979, China's leaders launched the one-child policy, part and parcel of a concerted effort to lift the country out of poverty. Ultrasound B machines (for prenatal screening) and induced abortions came to feature prominently in the arsenal employed to reduce the number and improve the quality of births (Zeng *et al.* (1993)). As the world now knows, to many Chinese, quality rhymes with son (Zeng *et al.* (1993); Chu (2001); PRC (2002); Yang & Chen (2004); Das Gupta (2005)).¹ Twenty five years on, the sex ratio at birth was 120 boys per 100 girls, and some thirty million boys in excess of the normal had been born (Zhu *et al.*, 2009).

The last decades have also seen a dramatic increase in crime. Between 1988 and 2004, criminal offenses rose at an annual rate of 13.6% (Hu (2006)), and arrest rates increased by 82.4%, (Figure 1).² Almost all crime is committed by men, 90% of arrestees in 2000 (*Law Yearbook of China* (2001)); and young men figure disproportionately, those aged 16 to 25 account for some 70% of violent and property crimes (Hu (2006)). This drastic increase in crime has not gone unnoticed by academic researchers and policy makers alike. Economic reforms and a weakening of social control figure among the main explanations (Liu *et al.*, 2001; Bakken, 2005).

In this paper we propose an additional factor: "surplus" men. Between 1988 and 2004, the sex ratio (men to women) for the 16-25 year old cohort went from 1.053 to 1.095 (see Figure 2), implying an almost doubling of surplus men (a trend that will continue until at least 2020, judging by the 2005 inter-census (Li, 2007)). A higher sex ratio implies a more

¹This is evident in a Chinese saying "Raising a daughter is like watering a plant in another man's garden." An old Cantonese saying is "A daughter is a thief."

²The marked increase in violent and property offenses in 1989-1991, was due to social unrest in the aftermath of the Tiananmen Square Protests of 1989. The drop in 1997 followed an amendment of the Criminal Law and Criminal Procedure Law.

male population, which trivially would raise the crime rate if men commit more crime than women.

A higher sex ratio also means that fewer men can be married. In addition to marriage itself having a socializing effect,³ higher sex ratios may increase crime through the fact that male-to-male competition for partner intensifies, possibly rendering criminal activity such as theft or robbery more attractive. This is the main hypothesis that we intend to test in this paper.

Employing province-level annual data covering the period 1988-2004,⁴ we estimate an elasticity of crime rates with respect to sex ratios of 16-25 year olds of about 3.7. The 16-25 sex ratio rose by 4 percentage points and crime rates by 82.4 percentage points over the study period, suggesting that the rise in sex ratios can account for one-sixth (14.8/82.4) of the overall rise in criminality during the study period. Our point estimate is robust to the inclusion of a number of province level covariates, notably the sex ratios of other age groups and measures of the economic climate such as income, employment rate, education, inequality, and urbanization rate, and a battery of robustness checks.

In addition to its economic and statistical significance, our finding suggests that crime rose not only because of more men, an effect we bound at $f \in (0, 0.5)$, where f is the fraction of females (the formal decomposition is in Appendix I), begging the question why higher sex ratios would raise male criminality.

There is a long socio-biological literature linking male⁵ behavior – such as risk taking,

³A man who attacked an elementary school in eastern China on March 23, 2010, told investigators that he carried out the attack because of "failures in his romantic life and in society." http://www.cnn.com/ 2010/WORLD/asiapcf/05/11/china.school.attack/index.html

⁴Annual province level data are first available for 1988, and 2004 is the most recent year we have access to. Unfortunately, breakdowns by sex and age are not available at this level.

⁵We would not expect a shortage of men to lead to women engaging in criminal activity. Rather, if

dominance, and male-to-male aggression – to male jockeying for partner access at least going back to Trivers (1972):

... females compete among themselves for such resources as food but not for members of the opposite sex, whereas males ultimately compete only for members of the opposite sex, all other forms of competition being important only insofar as they affect this ultimate competition (Trivers (1972, p. 153)).

Conceptually, sex ratios dictate the degree of competition for partners and what fraction of the sexes can eventually marry. Scarcity of the opposite sex may increase the returns to premarital investments. For most men that may mean studying or working harder. However, for those with little access to, or low returns from, conventional career building actions, crime may offer a shot at upward mobility, and in an environment of scarce women, at marriage in particular. If so, we would expect to observe higher sex ratios for a cohort to lead to higher crime rates as this cohort enters the age window between adulthood and marriage. Additionally, we would also expect higher levels of education for men of the cohort not pursuing crime, and assuming men do not choose crime over education, we would expect sex ratios to raise male education levels overall for the cohort (and lower that of women, almost any model of the family would predict). In other words, rising sex ratios exert a heterogeneous effect on males' labor market outcomes. On the one hand, the scarcity of women leads men to have higher levels of education, and higher mean earnings conditional on employment. On the one hand, the discouraged unmarried men might drop out of regular career paths and switch to criminal activities. The latter would reduce men's overall employment rates.

marriage is a source of unearned income to women, we would expect worse marriage market conditions to lead women to invest in education, which appears to be the case (Angrist, 2002; Lafortune, 2008).

Finally, the shortage of women will naturally increase women's bargaining power within the household given the spillover effect in the marriage market in which divorced women could remarry much more easily than divorced men. In Appendix II we formalize this incentive effect in a multi-prize lottery model where women are prizes and men participate by buying tickets, deriving the equilibrium level of male rent-seeking outlays as a function of the sex ratio (following Edlund (1996a)'s adaptation of Clark & Riis (1996)).

In addition to the evidence on crime, the paper also presents corroborative evidence that sex ratios affects marriage and labor market outcomes in the hypothesized directions. Using the 2000 Census, we find that higher sex ratios indeed reduce the fraction of men who have ever married and raise the fraction of men who are divorced. The results for women are the reverse. Additionally, using the Chinese Health and Nutrition Surveys we find that higher sex ratios raise both male time in household work and female participation in decision making. Finally, using the annual Chinese Urban Household Surveys, 1988-2006, we find that for men higher sex ratios are associated with higher education, higher probability of being a professional, and a higher wage or income conditional on working. However, employment rates are lower, and spousal characteristics for men are worse.

Our paper adds to the small empirical literature on sex ratio effects on pre-marital investments, the study of which is complicated by the fact that variation in adult sex ratios are often either too small to be consequential or driven by factors also likely to influence the outcome of interest, e.g., Edlund (2005). Angrist (2002) and Lafortune (2008) exploited the fact that immigrants to the United States tend to marry among themselves, generating arguably exogenous variation in the marriage market sex ratio, to study the impact of sex ratios on education and labor market outcomes of both sexes. Wei & Zhang (2009) studied savings behavior of parents of sons and parents of daughters in China arguing that higher savings of the former is driven by marriage market considerations: parents of sons being responsible for the bride price, whereas parents of daughters being recipients of the same. In addition, our results add heft to the argument that marriage may have a socializing effect for men, be it in the form of higher productivity (see Korenman & Neumark (1991) for a discussion of labor market marriage premium), or greater adherence to law and order (Messner & Sampson, 1991; Barber, 2000; Sampson *et al.*, 2006).

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 presents the empirical results. Section 4 concludes.

2 Data

We use annual province-level data from China's 26 provinces,⁶ covering the period 1988-2004,⁷ to analyze the effect of sex ratios and crime. Our main data sources are published data from various yearbooks and the 1990 census. We focus on the sex ratio of the 16-25 age group for two reasons. First, 16 is the age of full criminal responsibility, and 25 is the upper age for "juvenile crime." These are the most crime-prone ages, accounting for more than 70% of the total number of criminal offenders since the mid-1980s. For example, the share of homicides, rapes, robberies, and larcenies committed by this age group in 1993 was 46.73%, 55.31%, 78.77%, and 66.16%, respectively (Hu, 2006). Second, the average age at

⁶The four municipalities directly under the central government – Beijing, Shanghai, Tianjin, and Chongqing – are excluded, as they are governed by a different judicial system and are not comparable to other provinces. Guangdong is also excluded because of the substantial changes and Guangdong specific events affecting comparability of data over the period. Guangdong's proximity to Hong Kong meant that it was particularly affected by the establishment in 1979 of the Shenzhen Special Economic Zone and the 1997 return of Hong Kong to the Chinese rule.

⁷Note that 1988 was the first year for annual province-level crime statistics.

first marriage in the period 1982 to 2000 was 24 for men and 22 for women (NBS, 2002). Thus, marriage market conditions likely influence behavior of our chosen age group.

As a first approximation, the sex ratio at birth is the exogenous condition framing the marriage market for a cohort rather than the actual sex ratios at marriage age. The latter reflects adult migration decisions, which in turn are influenced by provincial differences in economic activity (Edlund, 2005), factors which directly affect crime. Furthermore, the majority of Chinese migrants are temporary migrants who still view their home province as the place to source their spouse (Yusuf & Saich, 2008; Fan, 2008).⁸

Sex ratios For want of natality data, we proxy the sex ratio for each birth year and province using the 1990 census. For instance, the sex ratio of the cohort 16-25 years old, henceforth the 16-25 sex ratio, for Zhejiang, in 1989, is calculated as the sex ratio of those in Zhejiang who were 17-26 years old in 1990. The 16-25 sex ratio rose dramatically during the study period, from 1.053 in 1988 to 1.095 in 2004, a rise of four percentage points in 16 years (Figure 2), and there was substantial variation across provinces. Migration may make this number different from the actual sex ratio at birth for this cohort. However, inter-provincial migration was very limited until 1991 (Fan (2008)). The sex ratios for age groups of 26-45 and 46-65 were similarly projected.

⁸In China, there is strict household registration system (hukou system). The hukou system was established in the early 1950s to consolidate socialist governance, control domestic migration, and administer the planned economy. Every person is required to be registered where he or she is born and get a hukou certificate under this system. All administrative activities, such as land distribution, the issuance of identity cards, the registration of a child in school, and the registration of marriage, are based on the hukou status. Until the early 1990s, it was also used to distribute food, cooking oil, and clothing coupons, and it has restricted internal mobility in both urban and rural areas. There are only a few exceptional circumstances that allow people to change their hukou. Although the system has been gradually reformed since the mid-1990s, the hukou system is still very strict in most places. People may be allowed to migrate to wealthy provinces to work since the mid-1990s, but the majority of migrants are temporary without change to their hukou status. Therefore, although cross-province migration has become more common since the mid-1990s, cross-province marriage in terms of hukou is still uncommon (Yusuf & Saich, 2008).

Our projected sex ratios are thus not those projected from the sex ratio at birth, and provincial differences in gender differential mortality may be a problem if these differences are also correlated with future crime rates for other reasons than those operating through the sex ratio. However, it is hard to see why that would be the case. To anticipate results, if provincial differences in gender differential mortality are the driving force underlying the estimated positive relationship between the projected 16-25 sex ratios and crime rates, we would expect to find a similar relationship between the projected 26-45 and 46-65 sex ratios and crime rates, which we do not.

One-child policy The one-child policy was formally launched by the Chinese government in 1979. Because of its sensitive nature, legislation was left to the provinces until 2002, an exception for a national policy of such prominence (PRC (2002)). Initially a literal one-child per couple policy, it was soon amended. Exemptions were allowed if the first child died, was physically handicapped or, for most rural couples, a girl. Households were given birth quotas, and "above-quota births" were penalized. Although there were variations at the sub-provincial level, e.g., the counties, the main variation of the policy was at the provincial level (Gu *et al.* (2007)).

It is widely recognized that the one-child policy, combined with a strong cultural imperative to bear sons and an ability and willingness to sex select prenatally, has led to male biased sex ratios at birth (Zeng *et al.* (1993); Chu (2001); Yang & Chen (2004); Das Gupta (2005)). Son preference is deeply rooted in Chinese culture and its uni-lineal view of decent. Couples without a son are reproved by family and friends – failure to carry on the family name is a serious sign of disrespect to ancestors.⁹ Moreover, old age support remains the responsibility of sons, rendering at least one son economically opportune if not a necessity (e.g., Das Gupta *et al.* (2003)).

Still, high sex ratios in China precedes the one-child policy, although historical demographic data are scarce, and large local variation renders generalizations difficult. For instance, while sex ratios may have balanced in parts of China, in Beijing, circa 1917, the sex ratio among the 1-5 age group was 145 boys per 100 girls (Gamble (1921), reported in Goode (1970, p. 308)). Traditionally, high sex ratios were achieved by infanticide or abuse and neglect of daughters to the point of death. These methods are costly, if only for the nine month gestation endured. The one-child policy also facilitated the spread of ultrasound B machines (Zeng *et al.* (1993)). Moreover, abortion went from being highly restricted to encouraged under the one-child policy regime (free of charge and with leave entitlement for the woman, and in the case of an unauthorized pregnancy, even mandated) (Scharping (2003)).

In an earlier version of the paper, we also presented results from instrumenting the sex ratio using province level variation in the timing of the introduction of the one-child policy and our results were similar. This finding, combined with little *a priori* reason to suspect endogeneity of our sex ratio measures, leads us to omit these results, available in Edlund *et al.* (2008).

⁹A sentiment vividly described by the saying: "Of the three ways we could disrespect our ancestors, not carrying on the family name is the most serious" (*bu xiao you san, wu hou wei da*). The seriousness of the infraction is further illustrated by expressions such as "extinction of descendants" (*duan zi jue sun*). The 2002 Law on Population and Birth Planning illustrates that this sentiment remains current: "[It is] forbidden to discriminate against or mistreat women who give birth to female infants and women who do not give birth [i.e., are infertile]. It is forbidden to discriminate against, mistreat, or abandon female infants." PRC (2002, Article 22).

Crime Our crime data are from the *China Law Yearbook* (Supreme People's Court, 1989-2005) and the *Procuratorial Yearbook of China* (Supreme People's Procuratorate, 1989-2005), which provide aggregate statistics for a province in a particular year (no age breakdowns). We define the crime rate as arrests for violent and property crimes per 10,000 population.¹⁰ Thus measured, criminality almost doubled in the study period: from 3.71 in 1988 to 6.77 in 2004 (Figure 1); and there was considerable variation ranging from 0.81 (Tibet, 1988) to 13.1 (Zhejiang, 2004).

We focus on violent and property crimes. These are low-skill crimes and perpetrators are predominantly young males. We cannot distinguish between violent crimes and property crimes, but these crimes are highly correlated (Figure 3) and may be similarly motivated (e.g., robbery). Property crimes made up between 77.3% and 90.7% of all criminal cases between 1981 and 2004.¹¹ Among property crimes, larceny is by far the most common (86.7% in the same period) (Hu (2006)).¹²

Crime statistics pertain to the province in which the crime was committed, not the province of birth of the perpetrator. By using a projected sex ratio, we estimate the part of variation in the crime rate in a province due to offenders who were "born" in the same province.

From the Comprehensive Statistical Data and Materials on 55 Years of New China (National Bureau of Statistics (2005)), and the China Statistical Yearbooks, 1989-2005, we obtain the following control variables: total population in each age category, per capita income, employment rate, secondary school enrolment rate, income inequality (urban over rural house-

 $^{^{10}}$ We focus on arrests rates for want of province-level offence rates. Conviction rates are very high in China.

¹¹At the national level, publicly available data go back to 1981.

¹²Unfortunately, we do not have age specific crime rates yearly or breakdown by gender.

hold income), urbanization rate, welfare expenditures, openness to trade (exports, imports and foreign direct investments as a share of GDP), share of (out-of-province) immigrants, construction (square meters), and police expenditures (as a share of provincial government expenditures). Further variable descriptions and summary statistics are in Table 1.

3 Results

As a descriptive start, Figure 4 plots the crime rate against the (projected) 16-26 sex ratio (both variables are de-meaned of province and year fixed effects) and a positive correlation is clear. The fitted line has a slope of 3.14 which, at the sample mean sex ratio of 1.05, corresponds to an elasticity of 3.3 (3.14×1.05). This result, qualitatively and quantitatively, will hold up in the regression analysis, to which we now turn.

Our results derive from estimating a regression model of the following form:

$$\ln c_{it} = \alpha_1 \ln(r_{it,16-25}) + \alpha_2 \ln(r_{it,26-45}) + \alpha_3 \ln(r_{it,46-65}) + X_{it}\beta + \delta_i + \tau_t + \varepsilon_{it}, \qquad (1)$$

where c_{it} is the crime rate in province *i*, year *t*; $r_{it,16-25}$, $r_{it,26-45}$ and $r_{it,46-65}$ are the projected sex ratios for the 16-25, 26-45, and 46-65 year old cohorts, respectively.

Our main focus is on the estimate of α_1 , were we expect $\hat{\alpha}_1 > 0$. The sex ratio having a positive effect on crime could follow simply from men being more crime prone than women, since a higher sex ratio imply more men. A more interesting possibility is that higher sex ratios raise the average crime propensity of men, for instance from their being more unmarried men. As we show in Appendix I, an estimate of $\alpha_1 > f$, for $f \in (0, 0.5)$ where f is the fraction of females, is supportive of such an effect.

 X_{it} is a vector of province-year level controls that include income, employment, secondary school enrolment, inequality, urbanization rate, welfare expenditures, openness to trade, immigration rate, construction, policy expenditures. We also include the total population of each age category in all specifications.

 δ_i and τ_t are vectors of the province and year dummies, which control for time invariant differences between provinces and year-specific effects that are common to all provinces. For instance, Tibet is a province with low sex ratios and low crime; and 1989 and 1990 were years of national wide social unrest and high arrest rates (culminating in the Tiananmen Square Protests). The error term ε_{it} is assumed to be *i.i.d* with zero mean. Throughout, we cluster standard errors at the province level.

Tables 2 presents the results from estimating Eq. 1 by OLS. We start by including only the sex ratios at different age categories (in addition to the total population in each age category) in Column 1. Sex ratio of 16-25 has a significant coefficient of 3.2, but sex ratios of other age groups are not significant. We add province and year dummies in Column 2, and obtain an estimate of the elasticity of crime with respect to the 16-25 sex ratio of 3.8. The estimated coefficient is positive on the 26-45 sex ratio, while it is negative on the 46-65 sex ratio, neither coefficient is statistically significant. Column 3 adds controls to pick up province differential changes in the socioeconomic environment: income, employment rate, secondary schooling, inequality, urbanization. The magnitude of the estimated elasticity with respect to the 16-25 sex ratio remains essentially unchanged.

As is well known, China introduced radical market-oriented reforms during the study period. Our identification strategy would be undermined if policies influencing the sex ratio at birth and those influencing crime 16 to 25 years hence were bundled. To address this concern, Column 4 includes additional covariates: welfare expenditures, openness of the province (foreign direct investments, export and import, as share of GDP); construction activities (square meters), share of immigrants, and police expenditures. Our main result remains. In the interest of space, we do not report the estimated coefficients on these control variables.

Column 5 adds province-specific year trends. As a control for potentially omitted variables, we interacted a time trend with provincial dummies to allow for different province time trends (Foote & Goetz, 2008). Adding province-specific year trends decreases the estimated coefficient on the 16-25 sex ratio somewhat. However, the estimated coefficient on the 16-25 sex ratio remains statistically significant (10% level).

Throughout, the estimated coefficient on the 16-25 sex ratio variable is statistically significant. In our preferred specification (Column 3), the elasticity estimate is 3.7. Since the 16-25 sex ratio rose by 4% (from 1.053 in 1988 to 1.095 in 2004) and crime rates rose by 82.4% over the same period, this suggests that the rise in sex ratios can account for 18% $((3.7\times4)/82.4)$ of the overall rise in criminality during the study period. Moreover, since the estimated elasticity are well above 0.5, we conclude that criminality rose not only because of more men but also because that men are more crime prone.¹³

3.1 Falsification Tests and Specification Checks

Table 3 presents further falsification tests and specification checks. One concern is that violent and property crime statistics reflect various province specific "fight crime" drives

 $^{^{13}}$ The 95% confidence interval of the estimated coefficient on the 16-25 sex ratio is (0.97, 6.44).

rather than underlying criminal activity. To address this concern, we replace violent and property crime with corruption as the dependent variable. A general law and order zeal would affect corruption statistics as well, but arguably there is little reason for the sex ratio of young adults to impact corruption rates – relative to violence and property crimes, corruption is high skilled and the perpetrators tend to be older and, tautologically, in a position of some influence. These factors would largely be insulated from the demographics of younger adults. In Column 1, consistent with our hypothesis that a marriage squeeze results in asocial behavior among those feeling the squeeze most acutely – unskilled young men – there is no significant effect of the 16-25 sex ratio on corruption rates.

To further check that our results are not spurious, driven by a bundling of reforms that affect sex ratios and crime, we include the sex ratio of those 10-15 years old. This cohort is too young to enter crime statistics, but we would expect this sex ratio to be affected by past population policies. In Column 2 we report the results from including the 10-15 sex ratio and in Column 3, we include it together with the sex ratios of other age categories. In neither case does the 10-15 sex ratio impact crime – and our main result remains. (The period is restricted to 1988-2000 since the 1990 census cannot project 10-15 sex ratios beyond year 2000.)

Finally, in Column 4 we present the results where the population of age 16-25 males and females are entered in (logged) levels rather than as a ratio.¹⁴ We obtain an estimate of the elasticity of crime with respect to the number of 16-25 males of 4.3, conditional on the number of 16-25 females. Conversely, the estimated elasticity with respect to the number of

¹⁴Because $\ln(16-25 \text{ sex ratio}) = \ln(16-25 \text{ male population}) - \ln(16-25 \text{ female population})$, the three variables cannot be put into the regression equation simultaneously.

16-25 females is -3.8 conditional on the number of 16-25 males. These results further validate the hypothesis that criminality rose not only because of more men. Column 5 includes the population of males and females for all three age categories (16-25, 26-45 and 46-65). The magnitude and significance of the estimated coefficients on the number of 16-25 males and the number of 16-25 females remain largely unchanged.

3.2 Marriage and Labor Market Behaviors

The marriage market effects of high sex ratios are at the center of our hypothesized link between sex ratios and behavior, and crime is but one of possible end points. In this subsection we first show evidence that high sex ratios do impact marriage market outcomes in the expected direction – using the Chinese 2000 Census, and the Chinese Health and Nutrition Surveys, 1989, 1991, and 1993 – findings that may not be surprising given the all but universal marriage rate of women. Second, we provide evidence from the China Urban Household Surveys, 1988-2006, consistent with higher sex ratios raising pre-marital investments. Moreover, high sex ratios raise the probability of holding a professional job for men (relative to women), but lowers the probability of employment. We interpret this finding in the light of our model where high sex ratios lead men to increase their premarital investments (and in a world with no slack, reduce employment) and, once the marriage market has cleared, leave more men unmarried (reducing employment in middle-age).

Marital Status We use aggregate data at county level which are from "Tabulation of the 2000 Population Census at County Level" documented by National Bureau of Statistics. Based on the full sample of the 2000 census, this data set contains marriage rates and divorce rates for the age cohort of 15-45 years old, and other socioeconomic variables at the county level.

We find that a higher sex ratio reduces the fraction of men who had ever married, and raises the fraction of men who had divorced (and not remarried), while the relationship for women is reversed (Table 4). We also control for a number of county characteristics computable from the 2000 census: the urbanization rate, minority rate, fraction of illiterate, the average number of years of education, the fraction of households which answered that they drink water from a tap in the house or apartment, and the immigration rate. The results are robust to the inclusion of these control variables.

Household Bargaining To test the hypothesis that higher sex ratios raise women's bargaining power within the household (predicted by almost any household bargaining model), we use the China Health and Nutrition Survey (CHNS), collected in 1989, 1991 and 1993 by the Carolina Population Center (CPC), the Institute of Nutrition and Food Hygiene, and the Chinese Academy of Preventive Medicine.

The CHNS contains extensive information on household time allocation and household decisions. We examine two sets of outcomes which measure bargaining power within the household. The first set of variables includes the number of hours per week spent on three types of household chores and the number of hours on total household chores, by each member of the household. The second set of outcomes concerns the decision making surrounding the purchase of one of the three major household durable goods: electric fan, TV and radio.¹⁵

Table 5 reports OLS estimates of sex ratios and household bargaining. As we expected,

¹⁵The CHNS has conducted seven waves from 1989 to 2006. However, only the first three waves (1989, 1991, 1993) contain information on household decision making.

Columns 1-4 show that high sex ratios lead to a decline of women's time spent on household chores. The effect on men's time is reversed. In addition, Columns 5-6 show that higher sex ratios directly decrease men's decision power. To sum up, higher sex ratios not only decrease men's marriage probability, as shown earlier, but also decrease male's bargaining power within the household even for those married.

These findings add to a large and growing literature on household bargaining. The study closest to our is Porter (2008), who also used the CHNS and found higher sex ratios to be associated with better outcomes for the wife (the outcome being fewer but better educated children).

Education, Labor Market, and Spousal Characteristics To examine education, labor market, and marriage market effects we turn to the Urban Household Surveys conducted yearly since 1988, by the Urban Survey Organization of the National Bureau of Statistics. We have obtained the data from the following six provinces: Beijing, Liaoning, Zhejiang, Sichuan, Guangdong, and Shaanxi. We analyze data from 1988-2006, that is, 19 rounds of repeated cross-sections.¹⁶

To calculate the sex ratio, we use the 1990 census (restricting the sample to those with urban registration status). To account for an average spousal age difference of two years (our results are not sensitive to this) we define the "marriage market" sex ratio for a man to be the number of men in that year and province who are his age \pm two years, divided by the number of women two years younger. For instance, for a 25 year old man in Beijing, this sex ratio is the number of men between the ages 23 and 27 to the number of women between

¹⁶For further information on these surveys, see, e.g., Zhang *et al.* (2005).

the ages 21 and 25, in Beijing. The sex ratio for women is calculated analogously.

The first four columns of Table 6 present regressions of educational outcomes on sex ratios. We find that higher sex ratios lead men to invest more heavily in human capital as measured by education. However, it decreases women's educational attainments. The last four columns of Table 6 report regressions of labor market outcomes on sex ratios. We find that (relative to women) higher sex ratios reduce men's probability of being employed but raise their probability of holding a professional job (Table 6, Columns 5-6). Conditional on being employed, sex ratios raise wages and incomes of both sexes, but more so for men than for women (Columns 7-8). The results are consistent with the notion that a surplus of men may increase the variance in men's labor market outcomes. This could be due to a heterogeneous incentive effect, depending on the initial endowment, where men with low initial endowments choose to engage in crime. Additionally, once the marriage market has cleared, higher sex ratios mean more men find themselves unmarried and they may adjust their labor supply accordingly.

Table 7 further explores the effects of sex ratios on spouse's educational and labor market characteristics. We expect men to fare worse with higher sex ratios and that is also what we find. Despite better education, higher sex ratios lead men to marry women with less education (Column 1). In addition, marriage market squeeze brought about by high sex ratios drives up the spousal age gap (Column 2). Finally, consistent with previous studies (Grossbard-Shechtman, 1993; Angrist, 2002), higher sex ratios lead women to marry men with higher wages (measured in monthly earnings) and incomes; while for men, the effect is reversed (Columns 3-4).

4 Summary and Discussion

In 2000, 120 boys were born for every 100 girls in China, a development that has raised a number of concerns, ranging from human rights issues related to the fate of the "missing females" to the social impact of surplus men. Who are these men going to marry, and, if they do not, what are the consequences? High sex ratios are not unique to China, but, unlike India, where population growth has buffered some of the impact, the shortage of brides is likely to be felt more acutely. International mobility means that brides need not be sourced locally, but given China's economic position in the world, it is more likely to be a net exporter than importer of brides for years to come.

The rise in the sex ratio has coincided with a dramatic increase in crime. Although the notion that unbalanced sex ratios may raise crime is longstanding, a causal link has been difficult to establish. Movements in sex ratios at birth tend to be very small and while sex ratios in the adult population can vary substantially, such variation may be in response to economic conditions likely to have a direct bearing on crime. This paper has exploited the fact that sex ratios at birth have increased dramatically in China since the 1980s, and consequently, the sex ratio of young adults has been trending upwards since the mid 1990s. We find that the sex ratio among those 16 to 25 years old has had a significant, economically and statistically, impact on crime. We estimate that male-biased sex ratios may account for up to one-sixth of the overall rise in violent and property crime during the period 1988-2004, a finding of particular salience given China's demographics. The 2005 by-census indicates that sex ratios at birth have kept climbing. The next decade may see another 10 percentage points increase in the 16-25 sex ratio.

China has seen other dramatic changes during the study period. As the state tightened its grip on fertility, its influence over virtually all other spheres of life loosened. The introduction of a *de facto* market economy, rapid economic growth, and reduced state control over most facets of life are factors that likely also contributed to the rise in crime rates. The fact that our findings are robust to the inclusion of many province-level variables that proxy for these developments, province specific time trends, and that the sex ratio for a younger cohort (10-15 years old, too young to be criminally responsible) has no impact on the crime rate, suggest that our finding is unlikely to be the result of unobserved time-varying factors. Furthermore, the fact that we find no effect of the sex ratio on corruption, a type of crime that we would not expect to be influenced by the sex ratio, bolsters our hypothesis that the surplus of young men has had a causal and economically important effect on low-skill crimes.

Still, remains the fact that our findings can account for only a fraction of the rise in crime – and crime is but one of the social challenges likely in store as the male cohorts of the last three decades reach adulthood and middle age.

Appendix I. Male-biased Sex Ratios and Crime – A Decomposition

A higher sex ratio implies more men and more unmarried men. In this section, we decompose the elasticity of crime and show that the fraction females $f \in [0, 0.5]$ is an upper bound on the elasticity of crime with respect to the sex ratio if the only source of the increase in crime is that there are more men.

Consider a population of measure 1 with m men and f = 1 - m women. Men can be unmarried, m^0 , or married, m^1 , and $m = m^0 + m^1$. Similarly for women, $f = f^0 + f^1$. We denote each demographic group's crime rate as c_m^0 , c_f^0 , c_m^1 , and c_f^1 , respectively. The crime rate, c, can then be expressed as

$$c = c_m^0 m^0 + c_m^1 m^1 + c_f^0 f^0 + c_f^1 f^1.$$

We restrict our attention to the case of male-biased sex ratios, and assume that men marry with probability f/m(<1) and women marry with certainty. Furthermore, we assume that

$$c_m^0 \ge c_m^1 > 0$$

$$c_f^0 = c_f^1 = c_f, c_f \in [0, c_m^1)$$

To assume that married and unmarried females are equally crime-prone is innocuous, as all women will be married by assumption. A higher sex ratio increases the fraction of males and the fraction of males who are unmarried, both of which may raise the crime rate. To focus on the first mechanism, we assume that

$$c_m^0 = c_m^1 (= c_m). (2)$$

In this case, the crime rate, c, is simply

$$c = c_m m + c_f (1 - m).$$

Let r denote the sex ratio:

$$r = \frac{m}{f} = \frac{m}{1-m}.$$
(3)

We can write the elasticity of the crime rate with respect to the sex ratio, conditional on Eq. 2, as

$$\epsilon(c,r)|_{c_m^0 = c_m^1 = c_m} = \left(\frac{dc}{dm} \cdot \frac{m}{c}\right) \cdot \left(\frac{dm}{dr} \cdot \frac{r}{m}\right)$$
$$= \frac{c_m m - c_f m}{c_m m + c_f (1-m)} \cdot f$$
$$\leq f. \tag{4}$$

That is, if the estimated elasticity of crime with respect to the sex ratio is greater than the fraction of females, then higher criminality cannot be due simply to more males.

Appendix II. Incentive Effects of Male-biased Sex Ratios

To fix ideas, consider a population of initially homogeneous men and women. Men compete for wives (for a variety of reasons, see e.g., Edlund & Korn (2002)). For our purposes, recall that women are literally scarce. Assume that when evaluating potential partners, earnings determine attractiveness. Earnings, in turn, are the usual product of the wage and labor supply, and the realized wage is a draw from a wage distribution whose moments are determined by activities when young. We will refer to these activities as investments or rent-seeking outlays. The latter term is used because, as a first approximation, to any given adult man, women of marriageable age are in fixed supply.

Scarcity of women may be conceptualized as a lottery model with multiple prizes where men compete to obtain one wife. Clark & Riis (1996) were the first to note that the fact that winners are eliminated (a man can only win one wife) implies that the problem has a nested structure. They show that as the number of contenders increase, rents are entirely dissipated. They note that the effect of changes to the number of prizes on rent-seeking outlays would depend on how the valuation of the prize varied with the number of prizes. For the situation that we are considering, it seems reasonable to assume that, to a first approximation, the value of obtaining a wife does not change with the number of wives available.¹⁷ Our application consists of considering the effect of changes in the number of prizes). This application was first formulated by Edlund (1996b), which below follows closely.

¹⁷It is possible that the social status conferred by marriage increases in its scarcity, although if one views marriage as an vehicle for children, the value of having offspring would seem largely insensitive to the prevalence of surrounding childlessness (and greater social acceptance of bachelorhood might counter any cache-effect).

We are interested in how a decrease in the number of prizes (women) relative to the number of contenders (men) affect the level of male rent-seeking outlays. We focus on a symmetric equilibrium, in fact the unique equilibrium in this game (Clark & Riis, 1996).

Let there be M men and F women, M > F. Denote the vector of (male) rent-seeking outlays by $\bar{h} = \{h_1, h_2, ..., h_M\}$, and let h denote the average outlay. A wife is the prize. Each winner obtains one, valued at z.¹⁸

Clark & Riis (1996) proposed the following contest success function: Let the probability of player i winning one of the F prizes be the sum of probabilities of winning the sth prize conditional on not having won in the previous rounds:

$$P_i = p_i^1 + \sum_{s=2}^F \prod_{k=1}^{s-1} (1 - p_i^k) p_i^s.$$
(5)

Following Clark and Riis, we assume the following version of independence of irrelevant alternatives,

$$p_i(h_1, h_2, \dots, h_{j-1}, 0, h_{j+1}, \dots, h_M) = \frac{p_i(h_1, h_2, \dots, h_{j-1}, h_j, h_{j+1}, \dots, h_M)}{1 - p_j(h_1, h_2, \dots, h_{j-1}, h_j, h_{j+1}, \dots, h_M)},$$

that is, the probability of man i winning, when j is not participating, could be expressed as the probability of winning conditional on j no winning, which together with

$$p_i^1 = \frac{h_i}{Mh} \tag{6}$$

yields the following expression for the probability of winning in the sth round,

 $^{^{18}\}ensuremath{\mathrm{Female}}$ heterogeneity would not change the qualitative results.

$$p_i^s = \frac{p_i^1}{(1 - (s - 1)p_j^1)}, \text{ for } s > 1.$$
 (7)

The expected payoff for player i is

$$\pi_i(\bar{h}) = P_i z - h_i. \tag{8}$$

Hence, man i sets h_i to satisfy the first order condition

$$\frac{\partial P_i}{\partial h_i} z - 1 = 0, \tag{9}$$

which evaluated at a symmetric equilibrium yields

$$h_i = h = \frac{z}{M} \frac{(M-1)}{M} \left(F - \sum_{k=1}^{F-1} \frac{F-k}{M-k}\right).$$
(10)

In order to study how male rent-seeking outlays are affected by a change in the sex ratio, we differentiate the expression for h in Eq. 10, which for large M implies that¹⁹

$$\frac{dh}{d\frac{M}{F}} > 0 \text{ for } \frac{M}{F} < c \tag{11}$$

$$< 0 \text{ for } \frac{M}{F} > c, \tag{12}$$

$$c \quad \approx \frac{e}{e-1} \approx 1.58. \tag{13}$$

¹⁹For smaller M the same qualitative results will hold. However, the particular cutoff point may vary. Also, symmetry as to differentiation with respect to F or M is a limit result.

In other words, there is a range for which higher sex ratios raise male rent-seeking outlays. In our setup, if there were equally many women as men, all men would be guaranteed a wife, and there would be no marriage market return to rent-seeking investments. As women become more scarce, the marginal return to investing in such actions increases.

References

- Angrist, Joshua. 2002. How do sex ratios affect marriage and labor markets? Evidence from America's second generation. *Quarterly Journal of Economics*, **117**(3), 997–1038.
- Bakken, B. 2005. Crime, punishment, and policing in China. Lanham: Rowman & Littlefield Publishers.
- Barber, Nigel. 2000. The sex ratio as a predictor of cross-national variation in violent crime. Cross Cultural Research, **34**(3), 264–282.
- Chu, Junhong. 2001. Prenatal sex determination and sex-selective abortion in rural central China. *Population and Development Review*, **27**(2), 259–281.
- Clark, D.J., & Riis, C. 1996. A multi-winner nested rent-seeking contest. *Public Choice*, **87**(1), 177–184.
- Das Gupta, M., Zhenghua, Jiang, Bohua, Li, Zhenming, Xie, Chung, Woojin, & Hwa-Ok, Bae. 2003. Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. *Journal of Development Studies*, 40(2), 153–187.
- Das Gupta, Monica. 2005. Explaining Asia's "Missing women": A new look at the data. Population and Development Review, 31, 529–535.
- Edlund, Lena. 1996a. Dear Son Expensive Daughter: Why Scarce Women Pay to Marry. Stockholm School of Economics.

- Edlund, Lena. 1996b. *The Marriage Market: How Do You Compare*. Ph.D. thesis, Stockholm School of Economics.
- Edlund, Lena. 2005. Sex and the City. Scandinavian Journal of Economics, 107, 25–44.
- Edlund, Lena, & Korn, Evelyn. 2002. A Theory of Prostitution. Journal of Political Economy, 110(1), 181–214.
- Edlund, Lena, Li, Hongbin, Yi, Junjian, & Zhang, Junsen. 2008. Sex Ratios and Crime: Evidence from China. IZA discussion paper no. 3214.
- Fan, C.C. 2008. China on the Move: Migration, the State, and the Household. Routledge.
- Foote, Christopher, & Goetz, Christopher. 2008. The Impact of Legalized Abortion on Crime: Comment. Quarterly Journal of Economics, 123(1).
- Gamble, Sideny B. 1921. Peking, A Social Survey. New York: George H. Doran.
- Goode, William Josiah. 1970. World Revolution and Family Patterns. New York: Free Press.
- Grossbard-Shechtman, Shoshana. 1993. On the economics of marriage: A theory of marriage, labor, and divorce. Boulder, CO: Westview Press.
- Gu, Baochang, Wang, Feng, Guo, Zhigang, & Zhang, Erli. 2007. China's Local and National Fertility Policies at the End of the Twentieth Century. *Population and Development Review*, **33**(1), 129–147.
- Hu, Lianhe. 2006. Zhuan Xing Yu Fan Zui: Zhong Guo Zhuan Xing Qi Fan Zui Wen Ti De Shi Zheng Yan Jiu. Beijing: Central Communist Party School Press. [Transition and Crime: An Empirical Analysis of Crime during China's Economic Transition].

- Korenman, Sanders, & Neumark, David. 1991. Does Marriage Really Make Men More Productive? Journal of Human Resources, 26(2), 282–307.
- Lafortune, J. 2008. Making Yourself Attractive: Pre-Marital Investments and the Returns to Education in the Marriage Market. *Working paper, University of Maryland*.
- Li, Shuzhuo. 2007. Imbalanced Sex Ratio at Birth and Comprehensive Intervention in China. Paper presented at the 4th Asia Pacific Conference on Reproductive and Sexual Health and Rights, October 29-31 Hyderabad, India. http://www.unfpa.org/gender/docs/studies/china.pdf.
- Liu, Jianhong, Zhang, Lening, & Messner, Steven. 2001. Crime and social control in a changing China. Westport, Conn.: Greenwood Press.
- Messner, Steven F., & Sampson, Robert J. 1991. The sex ratio, family disruption, and rates of violent crime: The paradox of demographic structure. *Social Forces*, **69**(3), 33–53.
- NBS. 2002. Tabulation on the 2000 population census of the People's Republic of China.Beijing: China Statistic Press.
- Porter, Maria. 2008. The effect of sex ratio imbalance in China on marriage and household bargaining. University of Chicago.
- PRC. 2002. People's Republic of China Law on Population and Birth Planning. Population and Development Review, 28(3), 579–585.

Sampson, Robert J., Laub, John H., & Wimer, Christopher. 2006. Does marriage reduce

crime? A counterfactual approach to within-individual causal effects. *Criminology*, **44**(3), 465–508.

- Scharping, Thomas. 2003. Birth Control in China, 1949-2000: Population Policy and Demographic Development. London and New York: Routledge.
- Trivers, Robert L. 1972. Parental Investment and Sexual Selection. Pages 136–179 of: Campbell, Bernard (ed), Sexual Selection and the Descent of Man. Chicago: Aldine de Gruyter.
- Wei, Shang-Jin, & Zhang, Xiaobo. 2009 (June). The Competitive Saving Motive: Evidence from Rising Sex Ratios and Savings Rates in China. Working Paper 15093. National Bureau of Economic Research.
- Yang, Dennis Tao, & Chen, Dandan. 2004. Transformations in China's population policies and demographic structure. *Pacific Economic Review*, 9(3), 269–290.
- Yusuf, S., & Saich, T. 2008. China urbanizes: consequences, strategies, and policies. World Bank Publications.
- Zeng, Yi, Tu, Ping, Gu, Baochang, Xu, Yi, Li, Bohua, & 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.
- Zhang, Junsen, Zhao, Yaohui, Park, Albert, & Song, Xiaoqing. 2005. Economic Returns to Schooling in Urban China, 1988-2001. Journal of Comparative Economics, 33, 730–752.
- Zhu, W.X., Lu, L., & Hesketh, T. 2009. China's excess males, sex selective abortion, and

one child policy: Analysis of data from 2005 national intercensus survey. *British Medical Journal*, **338**, b1211.



Figure 1: Arrest Rates (Property and Violent Crimes/10,000 Population), 1988-2004

Sources: Chinese Supreme People's Procuratorate (1986-2005), Procuratorial Yearbook of China, Beijing, The Publishing House of Law.



Figure 2: Sex Ratios 16-25 Year Olds, 1988-2004

Notes: Projected from the 1990 Chinese Population Census (1% sample).



Figure 3: Property Crime and Violent Crime Rates by Year

Sources: Chinese Supreme People's Court (1985-2005), Law Yearbook of China, Beijing, The Publishing House of Law.

Notes: The number of offense cases registered by the police per 10,000 population.



Figure 4: (Residual) Crime Rates by Sex Ratios 16-25 Year Olds

Notes: Property and violent crimes. Residuals from the regression of (log) crime rates on province and year fixed effects. Linear prediction coefficient: 3.140; *t*-statistic: 6.96.



Figure 5: (Residual) Corruption Rates by Sex Ratios 16-25 Year Olds

Notes: Residuals from the regression of (log) corruption rates on province and year fixed effects. Linear prediction coefficient: -0.876; t-statistic: -1.08.

		Standard		
Variable	Mean	deviation	Min	Max
Crime rate ^{a}	5.35	1.65	0.81	13.04
$(\operatorname{arrests}/10,000 \text{ pop.})$				
Corruption rate	0.46	0.21	0.08	1.51
(cases/10,000 pop.)				
16-25 Sex ratio, males to females	1.05	0.029	0.98	1.13
		1.00		
Income, per capital	2.70	1.09	0.99	8.00
(RMB 1,000 at 2000 prices)	07 40	0.00	40.01	07.00
Employment rate $\begin{pmatrix} 0 \\ - \end{array}$	67.42	9.06	40.81	97.96
(% employed, 16-65 year olds)	0.70	0.70	1 50	F 1 F
(unber / unel per capita income)	2.(2	0.70	1.52	0.10
(urban/rurar per capita income)	20.02	11 00	12 11	56 01
(% living in urban areas)	29.90	11.00	10.11	30.01
Secondary school enrollment	87 85	11 17	39.6	100
(%)	01.00	11.11	05.0	100
Welfare expenditures	2.45	0.77	1.03	11.41
(% of government expenditures)	2.10	0.11	1.00	11,11
Export+Import+FDI	0.17	0.16	0.03	0.97
GDP	0.11	0.110	0.00	0.01
Immigration rate	2.19	1.28	0.31	8.68
$\binom{0}{00}$ born outside province) ^b				
Construction	3,790	$5,\!659$	21.98	50,982
$(10,000 \ m^2)$,	,		,
Police expenditures	5.37	1.31	2.58	9.24
(% of government expenditures)				

Table 1: Descriptive Statistics of Province-Year Variables 1988-2004 (N=442)

 a - Violent and property crimes. A non-exhaustive list includes: homicide, as sault, robbery, rape, abduction of women and children, larceny, fraud, and smuggling.

^b - Official change of household registration status.

Data sources: China Population Statistical Yearbooks, 1989-2005; China Statistical Yearbooks, 1989-2005; China Population Statistical Data and Material by Provinces and Cities, 1992-2004; Comprehensive Statistical Data and Materials on 55 Years of New China; Chinese Population Censuses (1982, 1990), 1% Sample; Law Yearbook of China, 1989-2005; Procuratorial Yearbook of China, 1989-2005

	D	ependent ·	variable: ln	(Crime rate	e)
	(1)	(2)	(3)	(4)	(5)
$\ln(16-25 \text{ Sex ratio})$	3.232**	3.750**	3.706***	3.563^{***}	2.772*
	(1.284)	(1.465)	(1.330)	(1.284)	(1.656)
$\ln(26-45 \text{ Sex ratio})$	-1.072	2.828	2.331	2.213	3.442
	(1.420)	(3.208)	(2.363)	(2.302)	(2.704)
$\ln(46-65 \text{ Sex ratio})$	-0.075	-0.724	-1.056	-0.908	1.182
	(1.094)	(0.982)	(0.899)	(0.914)	(1.562)
Basic covariates	no	no	yes	yes	yes
Additional covariates	no	no	no	yes	no
Year-fixed	no	yes	yes	yes	yes
Province-fixed	no	yes	yes	yes	yes
Province specific year trend	no	no	no	no	yes
Observations	442	442	442	442	442
R-squred	0.14	0.61	0.63	0.64	0.75

Table 2: OLS Estimates of Sex Ratios and Crime, 1988-2004

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

All specifications includes ln(total population) in each age category. Basic covariates include ln(income, per capita), employment rates, secondary school enrollment rates, inequality, urbanization rates; additional covariates include ln(welfare expenditure), (export+import+FDI)/GDP, immigration rate, ln(construction), and police expenditures.

	Γ	ependent	variable (1	oaaeq).	
	Corruption rate	oponaono	Cri	me rate	
	1988-2004	1988	8-2000	1994-	-2004
	(1)	(2)	(3)	(4)	(5)
$\ln(10-15 \text{ Sex ratio})$		-0.241	0.648		
		(1.158)	(0.946)		
$\ln(16-25 \text{ Sex ratio})$	-1.070		4.330***		
	(2.262)		(1.313)		
$\ln(26-45 \text{ Sex ratio})$	1.780		3.104		
	(3.856)		(2.850)		
$\ln(45-65 \text{ Sex ratio})$	3.091		-0.209		
	(2.248)		(1.309)	1 2 2 2 4 4 4	$a \rightarrow + + + + +$
$\ln(16-25 \text{ Male population})$				4.263^{***}	3.857^{***}
				(1.294)	(1.308)
In(16-25 Female population)				-3.843	$-3.3(8^{+1})$
$\ln(26.45$ Male population)				(1.210)	(1.310) 1.939
m(20-45 male population)					(2, 383)
$\ln(26-45$ Female population)					(2.303) -2.807
m(20 49 remain population)					(2.364)
$\ln(46-65 \text{ Male population})$					-1.901
					(1.173)
$\ln(46-65 \text{ Female population})$					0.277
					(0.770)
					\
Basic covariates	yes	yes	yes	yes	yes
Province-fixed	yes	yes	yes	yes	yes
Year-fixed	yes	yes	yes	yes	yes
Observations	442	338	338	442	442
R-squared	0.55	0.42	0.57	0.60	0.63

Table 3: OLS Estimates of Sex Ratios and Crime. Falsification Tests and Specification Checks

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Basic covariates include ln(income, per capita), employment rates, secondary school enrollment rates, inequality, urbanization rates. Columns 1-3 also include ln(total population) for each age group. Columns 2-3 have fewer observations because the 1990 census can only project the 10-15 sex ratio until 2000.

	(1)	(2)	(3) Dependent	(4) variable: N	(5) ever Married	(6)	(2)
$\ln(15-45 \text{ Sex ratio})^a$	0.157^{***} (0.017)	$\begin{array}{c} 0.155^{***} \\ (0.017) \end{array}$	$\begin{array}{c} M_{\rm C} \\ 0.142^{***} \\ (0.017) \end{array}$	$\begin{array}{c} \text{an (mean=0)} \\ 0.146^{***} \\ (0.017) \end{array}$	$\begin{array}{c} .24 \\ 0.142^{***} \\ (0.017) \end{array}$	$\begin{array}{c} 0.146^{***} \\ (0.017) \end{array}$	0.130^{***} (0.015)
$\ln(15-45 \text{ Sex ratio})^a$	-0.103^{***} (0.022)	-0.110^{***} (0.022)	$\operatorname{Wor}_{-0.123***}$	nen (mean= -0.120*** (0.021)	=0.16) -0.125^{***} (0.021)	-0.120^{***} (0.021)	-0.130^{***} (0.018)
		Depend	lent variable	e: Divorced	(and not rer	narried)	
$\ln(15-45 \text{ Sex ratio})^a$	0.005^{***} (0.002)	0.004^{***} (0.002)	$Me \\ 0.004^{**} \\ (0.002)$	n (mean=0, 0.003** (0.002)	$\begin{array}{c} .013) \\ 0.004^{*} \\ (0.002) \end{array}$	0.003^{*} (0.002)	0.004^{**} (0.002)
			Wom	nen (mean=	(600.0)		
$\ln(15-45 \text{ Sex ratio})^a$	0.001	-0.001	-0.003**	-0.003*	-0.003*	-0.003**	-0.003**
•	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Regression controls for:							
Urbanization (%)	no	yes	yes	yes	yes	yes	yes
Minority rate $(\%)$	no	no	yes	yes	yes	yes	yes
Illiterate $(\%)$	no	no	no	yes	no	yes	yes
Education (years)	no	no	no	no	yes	no	no
Potable Water	no	no	no	no	no	yes	yes
Immigration $rate^{b}$	no	no	no	no	no	no	yes
N	2871	2871	2871	2871	2871	2871	2871

Table 4: OLS Estimates of Sex Ratios and Marital Status 15-45 Year Olds. 2000 Census

2000 Census. Each observation is a county-level unit, which could be an urban district, a count-level city or a county. All variables are from "Tabulations of the 2000 Population Census at County Level".

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

 a - The sex ratio is the number of men to women in the county-level unit between the ages 15 and 45 years. The mean is 1.065, Potable water – the fraction of households that answer yes to the question: Do you drink tap water in the house/apartment? the min 0.736 and the max 1.781.

 b - Immigration is measured as the fraction of the population that was born outside the province.

es	
Ag	
1993,	
1991,	
1989,	
rvey, 1	
Su	
Itrition	
nd Nu	
alth a	
ese He	
Chin	
vining,	
Barga	
ehold	
l Hous	
os and	
k Rati	
of Se ₃	
mates	
Estin	
OLS	
e 5:	10
Tabl	22-4,

	Preparing and	Washing and	Taking care	Total household	Decision	Decision
	cooking food ^{b}	ironing $\operatorname{clothes}^{b}$	of children	$\operatorname{chores}^{bc}$	$participation^d$	$making^d$
mean:	6.167	1.893	7.556	15.21	0.824	0.193
	(1)	(2)	(3)	(4)	(5)	(9)
Sex ratio ^a	-1.324	-1.157*	-5.636	-11.411**	0.034	0.038
	(1.202)	(0.497)	(3.853)	(3.580)	(0.042)	(0.037)
$\ln(Population)$	0.479^{**}	-0.054	-2.125^{**}	-1.978	0.010	-0.025
	(0.187)	(0.188)	(0.866)	(1.186)	(0.016)	(0.018)
Male	-13.673^{***}	-5.168^{***}	-15.275^{***}	-36.715^{***}	0.280^{***}	0.359^{***}
	(2.501)	(0.781)	(4.100)	(5.708)	(0.073)	(0.082)
$Male \times Sex ratio$	5.262^{**}	1.793^{**}	7.980^{*}	17.850^{***}	-0.109*	-0.127*
	(1.875)	(0.583)	(3.855)	(4.696)	(0.050)	(0.067)
Age (years)	0.041	-0.016	-0.110	-0.113	0.009^{***}	0.000
	(0.066)	(0.011)	(0.097)	(0.122)	(0.001)	(0.001)
Education (years)	0.159^{***}	-0.003	-0.459***	-0.279***	0.002^{*}	-0.001
	(0.022)	(0.008)	(0.045)	(0.056)	(0.001)	(0.001)
Observations	6048	5995	3520	3079	10281	10281
R-squared	0.15	0.25	0.12	0.22	0.08	0.09

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Survey year- and province-fixed effects are included in all specifications.

male aged 25 (in the rural area of province x and year t) is calculated as the number of men between 23-27 to the number of women between 21-25, as projected by the 1990 census. Similarly, for a female aged 25 in province x and year t, the sex ratio an age difference of two years between spouses. The calculation is most easily illustrated by an example. The sex ratio for a a – Sex ratio is projected by the 1990 census. The sex ratio is defined by province, age, sex, and rural/urban, and assumes is calculated as the (projected) number of males between 25 and 29 to the (projected) number of females between 23 and 27 in the rural areas of province x, year t.

 b – Number of hours per week.

^c – Household chores includes preparing and cooking food, washing and ironing clothes, taking care of children, etc.

 d – Decision on buying electric fan, TV, or radio.

	Education	College or	High school	Middle school	Employed	Professional	In(Wage)	$\ln(1ncome)$
	years	above	or above	or above		work		
	(1)	(2)	(3)	(4)	(5)	(9)	(2)	(8)
Sex ratio ^{b}	-0.579*	-0.042	-0.090	-0.045***	0.264^{**}	0.104^{***}	0.138	0.295^{*}
	(0.270)	(0.046)	(0.049)	(0.007)	(0.071)	(0.023)	(0.075)	(0.136)
$\ln(\text{Population})^c$	0.0869	-0.030	0.0297	0.059^{***}	-0.090	-0.040	-0.189	-0.189
	(0.162)	(0.031)	(0.035)	(0.006)	(0.077)	(0.033)	(0.096)	(0.143)
Male	-0.518	-0.027	-0.085*	-0.026	0.056^{*}	-0.039*	0.047	0.058
	(0.318)	(0.064)	(0.036)	(0.017)	(0.026)	(0.018)	(0.049)	(0.057)
$Male \times Sex ratio$	0.854^{**}	0.091	0.118^{***}	0.034^{*}	-0.041^{*}	0.036^{*}	0.095^{**}	0.103^{**}
	(0.229)	(0.047)	(0.024)	(0.013)	(0.020)	(0.014)	(0.026)	(0.034)
Age (years)	-0.089***	-0.010^{***}	-0.014^{***}	-0.003***	0.030^{***}	0.006^{***}	0.040^{***}	0.058^{***}
	(0.008)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.004)
Education (years)					0.030^{***}	0.026^{***}	0.093^{***}	0.090^{***}
					(0.002)	(0.003)	(0.004)	(0.003)
Observations	137527	137527	137527	137527	121288	91336	91336	101059
R-squared	0.13	0.08	0.10	0.03	0.27	0.16	0.46	0.41

OLS Estimates of Sex ratios, Education, and Labor Market Outcomes, Urban Household Survey 1988-2006, Ages Table 6: 99-450

at 1%.

Survey year- and province-fixed effects are included in all specifications. Surveys are annual.

 a – Ages 22-45 were chosen because university education is typically completed by age 22 and 45 marks the end of the family forming years (for women)

21-25 as projected by the 1990 census. Similarly, for a female aged 25, the sex ratio is calculated as the (projected) number of b – Projected by the 1990 census, urban population. The sex ratio is defined by province, age and sex and assumes an age difference of two years between spouses. The calculation is most easily illustrated by an example. The sex ratio for a male aged 25 (in a province and year 2000) is calculated as the number of men between ages 23-27 over the number of women between males between 25 and 29 over the (projected) number of females between 23 and 27 in that province. c – By province, age and sex.

		Spousal characteristics ^{b}		
	Education	Age	$\ln(Wage)$	$\ln(\text{Income})$
	(1)	(2)	(3)	(4)
Sex ratio ^{c}	0.449	1.182*	0.205***	0.196**
	(0.245)	(0.572)	(0.046)	(0.055)
$\ln(\text{Population})^d$	-0.130	-0.903***	-0.218**	-0.175*
	(0.092)	(0.093)	(0.074)	(0.072)
Male	-0.001	-1.449	-0.049*	-0.053
	(0.359)	(1.456)	(0.072)	(0.084)
$Male \times Sex ratio$	-0.563	-2.051*	-0.253***	-0.277***
	(0.285)	(0.981)	(0.050)	(0.057)
Age (years)	-0.041***	0.948***	0.007^{**}	0.005^{*}
	(0.005)	(0.007)	(0.002)	(0.002)
Education (years)	0.529^{***}	-0.092***	0.068^{***}	0.064^{***}
	(0.013)	(0.013)	(0.003)	(0.002)
Observations	100075	100077	95978	96979
R-squared	0.34	0.77	0.45	0.42

Table 7: OLS Estimates of Sex Ratios and Spousal Characteristics, Urban Household Survey 1988-2006, Ages 22-45^a

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Survey year- and province-fixed effects are included in all specifications. Surveys are annual. a – Ages 22-45 were chosen because university education is typically completed by age 22 and 45 marks the end of the family forming years (for women).

 b – Data are only available for household heads (and their spouses).

 c – Projected by the 1990 census, urban population. The sex ratio is defined by province, age and sex and assumes an age difference of two years between spouses. The calculation is most easily illustrated by an example. The sex ratio for a male aged 25 (in a province and year 2000) is calculated as the number of men between ages 23-27 over the number of women between 21-25 as projected by the 1990 census. Similarly, for a female aged 25, the sex ratio is calculated as the (projected) number of males between 25 and 29 over the (projected) number of females between 23 and 27 in that province.

 d – By province, age and sex.