Sex Ratios and Crime:

Evidence from China*

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Abstract

In China, traditional son preference combined with modern sex selection technology and the one-child policy has resulted in high and rising sex ratios (males to females) at birth since the 1980s. In 2005, 120 boys were born for every 100 girls in China, a surplus of one million boys in that cohort alone. Unprecedented in its scale, the social implications of a large number of men with little or no prospect of marriage are largely unknown. In this paper, we look at crime rates, which nearly doubled in the last two decades, and argue that male-biased sex ratios have contributed to this rise. Using annual province-level data for the period 1988-2004, we find that a 1 percent increase in the sex ratio raised violent and property crime rates by some 3.7 percent, suggesting that the sex imbalance may account for up to one-sixth of the overall rise in crime. The finding is robust to a wide range of sensitivity tests. We also show that sex ratios have had opposite effects on men and women's marriage market outcomes in the expected direction and a heterogeneous effect on male labor market outcomes. Relative to women, higher sex ratios are associated with better education and higher income conditional on employment, but lower likelihood of being employed. This finding is consistent with greater male-to-male competition on the marriage market having both an incentive and a disincentive effect. Higher sex ratios may raise the private returns to human capital investments. However, scarcity of brides can also have a disincentive effects for those at the bottom of the barrel, whose chances of marriage are reduced further.

JEL Classification: J12, J13, K42

1 Introduction

In 1979, as part and parcel of a massive effort to lift the country out of poverty, China's leaders launched the one-child policy. Ultra-sound 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 is widely known by now, to many Chinese, quality rhymes with son (Zeng *et al.* (1993); Chu (2001); PRC (2002); Yang & Chen (2004); Das Gupta (2005)).[1] In 2005, the sex ratio at birth exceeded 120 boys per 100 girls, implying a one-million surplus of boys in that cohort alone.

These developments have been a source of concern for a number of reasons. Notably, the prospect of hordes of young men with little or no possibility of marriage looms large (e.g., Hudson & Den Boer (2004)). 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 1), implying an almost doubling of "surplus" men. And judging by the 2005 by-census (Li (2007)), this trend will continue until at least 2020.

The last decades also saw a dramatic increase in crime. Between 1988 and 2004, criminal offenses rose at an annual rate of 13.6% (Hu (2006)), and arrest rates were up by 82.4% (Figure 2), albeit from a low level.[2] Breakdowns by age and gender are limited, but in 2000, 90% of all arrestees were men (*Law Yearbook of China* (2001)); and the overwhelming

[1] This 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."

[2] Crime rates are still low in international comparison.

majority (70%) of perpetrators of violent and property crimes in China are between 16 and 25 years old (Hu (2006)).[3]

Employing province-level annual data covering the period 1988-2004,[4] we find – by OLS and instrumenting using the one-child policy programs – that sex ratios raised crime rates, and estimate an elasticity of about 3.7 percent. Since the 16-25 sex ratio have risen by 4% (from 1.053 in 1988 to 1.095 in 2004) and crime rates by 82.4% over the same period, this suggests that the rise in sex ratios can account for up to 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 that may conceivably influence crime, such as income, employment rate, education, inequality, and urbanization rate, and a battery of robustness checks briefly outlined below.

Our empirical strategy is to regress (province-year) arrest rates[5] on the sex ratio of young adults, 16-25 years old, as projected from the 1990 census. That is, our identifying assumption is that whatever moved the sex ratio in a province in a particular year did not influence criminality in that province 16-25 years hence through any other mechanism than

[3]The drastic increase of crime in China during the past three decades has also drawn increasing attention from academic researchers and policy makers. Social scientists, especially criminologists, try to link the crime increase to the economic modernization, the loss of social control, and other factors (Liu *et al.* (2001); Bakken (2005)). Figure 2 shows a marked increase in violent and property offenses in 1989-1991, and a sharp drop in 1997. The former was due to weakened government and social control in the aftermath of the Tiananmen Square Protests of 1989; and the latter was resulted by the amendment of the Criminal Law and Criminal Procedure Law in 1997. In our empirical analysis, we include year fixed effects in regressions and control for an extensive array of social economic variables.

[4]Annual province level data are first available for 1988, and 2004 is the most recent year we have access to.

[5]We focuss on arrest rates since we do not have offence rates at the province level.

the (projected) sex ratio.

Our identification strategy would be undermined if, for instance, the family planning policies in place 16-25 years ago were bundled with other policies that affected crime with an approximate 16-25 years lag. As is well known, the same period saw transformative market-oriented reforms, and it is conceivable that past "reform mindedness" impacted both sex ratios and crime. To address this concern, we include as a covariate a measure of the openness of the province (foreign direct investments, export and import, as share of GDP), and our main result remains robust. Moreover, if the relationship between crime and sex ratios were spurious, the sex ratio of 10-15 years old would also be able to predict crime rates, which we do not find.

Another concern is that the data on violent and property crime reflect province-level "fight crime" drives rather than underlying criminal activity. To address this concern, we look at corruption. A general law and order zeal would affect corruption statistics as well; while there is little reason for the sex ratio of young adults to affect 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 influences. These factors insulate their marriage market prospects from the demographics of younger adults. Consistent with our hypothesis, we find no effect of the sex ratio of 16-25 years old on corruption.

The exogeneity requirement is also why we prefer projected sex ratios from the 1990 census over the sex ratio of 16-25 years old actually present in the province, since the latter is heavily influenced by internal migration, and migrants may both have a direct impact on criminality and is driven by factors likely related to crime such as the economic climate of the province. Our projection uses those 2 to 27 years old in the 1990 census, where the 16-25 sex ratio in say, Sichuan province in 1988 is calculated as the sex ratio among those 18 to 27 year old in Sichuan in the 1990 census. On the other end, the sex ratio of 16-25 years old in Sichuan in 2004 is calculated as the sex ratio of those 2-11 years old in the 1990 census. These projected sex ratios likely reflect the sex ratios at birth fairly closely for two reasons. First, internal migration was heavily regulated until the early 1990s. Second, even with a so called floating population estimated in hundred millions, migration before age 16 is negligible according to the data in the 2000 census.[6] Nonetheless, as a falsification test, we use the 2000 census to project sex ratios that would reflect actual sex ratios (inclusive of domestic migration) more closely, and we find that this sex ratio does not predict crime rates. Moreover, our favored sex ratio (16-25 years old projected from the 1990 census) remains statistically significant when the sex ratio from the 2000 census is included (albeit, halved in magnitude).[7]

While we believe sex ratios to be exogenously driven, as an additional robustness check, we instrument using the one-child policy. Specifically, we exploit different establishment

[6]Differential gender mortality rates across different age cohorts may also raise a problem. However, our province and year fixed effects estimation makes it less of a concern. Moreover, differential gender mortality is more likely to be exogenous to crime than migration.

[7]In fact, there are no data on either sex ratios at birth or actual sex ratios after birth each year in China. Since migration is extremely restricted before the early 1990s, adolescent sex ratios projected from the 1990 census and from the 2000 census should be close to sex ratios at birth and actual sex ratios after birth, respectively, in our study period. Conceptually, the sex ratio at birth is better than the actual sex ratio after birth even if both were available, as we discussed.

dates of three family planning programs (*Birth Planning Science and Technology Research Institutes*, *Birth Planning Education Centers*, and *Birth Planning Association*) across provinces. The IV results are quantitatively and qualitatively similar to our OLS results.

As the attentive reader has noted, higher sex ratios would trivially raise the crime rate if men are more crime-prone than women, since a higher sex ratio implies more men (per capita). However, assuming that average male propensity to commit crime was unchanged, it is easy to see that a one percent increase in the fraction of men could at most result in a one percent increase in crime. In fact, the elasticity of crime with respect to the sex ratio exceeding 0.5 would indicate that crime rose not only because of more men, but also because men became more crime prone (see derivation in the Appendix).

Our estimated elasticities are well above 0.5 and thus support the more interesting proposition that crime rose not only because of more men, but also because men got more crime prone. This raises the question why male sex ratios would have this effect. While there are several possibilities, e.g., peer group effects, marriage market related mechanisms seem first order (if only for the fact that if it were not for reproduction, sexes would be of little relevance). High sex ratios imply that some men will not be able to marry, or will be married only briefly. Thus, from a marriage market perspective, high sex ratios may be similar to polygyny. On the latter Bernard Shaw famously observed: Polygamy when tried under modern democratic conditions as by the Mormons, is wrecked by the revolt of the mass of inferior men who are condemned to celibacy by it (Shaw, 1930). The notion of marriage as a socializing force has been echoed elsewhere, notably in the labor economics literature on the marriage premium (for a review, see Korenman & Neumark (1991)). Also, the sociology of crime has noted unmarried young men to be the most crime-prone demographic, an association that has often been construed as causal (Messner & Sampson (1991); Barber (2000); Sampson *et al.* (2006)).

In addition to the socializing effect of marriage, prospective marital status could affect male criminality through several channels. High sex ratios lowers the probability of marriage and raises the importance of the ranking among males. Anticipation of this competition may lead to higher male effort to acquire the resources needed to outcompete a sufficient number of men. For instance, men (or their parents) may invest more in human capital or raise savings rates (for the latter, see Wei & Zhang (2008)). These options are not available to everybody, and for some, heightened competition may prompt theft or the physical elimination of rivals (physical violence). While heightened competition may spur more effort, it may also have a discouraging effect. Men for whom marriage is clearly out of range may even stopping trying (holding down a job, showing up sober, etc.). Thus, higher sex ratios are likely to raise the variance in male marriage *and* labor market outcomes.

While our main focus is on male-biased sex ratios and crime rates, we also investigate education, labor market and marriage market outcomes for two reasons. First, the possibility that high sex ratios have affected these outcomes is of interest in its own right. Second, such evidence may shed light on the possible channels through which male biased sex ratios have affect crime.

Using county-level data from the Chinese 2000 census (full sample), we show that marriage market outcomes were affected by the sex ratio in the expected direction: Higher sex ratios reduce the fraction of men who had ever married and raise the fraction of men who had divorced (and not remarried), while the results for women were reversed.

To investigate outcomes for years other than the census years, we analyze data from the annual Chinese Urban Household Surveys, 1988-2006. These surveys confirm that higher sex ratios lead to worse marriage market outcomes for men, and we also find evidence suggestive of high sex ratios raising the variance of male labor market outcomes. For men, relative to women, higher sex ratios are associated with higher education, higher probability of being a professional, and conditional on observing a non-zero wage or income, a higher wage or income. But employment rates are lower, and conditional on marriage, some spousal characteristics are worse.

Finally, additional evidence on worse marriage market outcomes for men can be obtained from the Chinese Health and Nutrition Surveys which contains information on time allocation and decision making in the household. Higher sex ratios tilts bargaining power towards wives as measured by time dedicated to household chores and participation in decision making.

The remainder of the paper is structured as follows. Section 2 provides a brief background on the one-child policy and its link to sex ratios. Section 3 describes our data. Section 4 presents our results and Section 5 concludes.

2 One-Child Policy and Sex Ratios

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. Exemption is allowed if the first child died, is 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 tradition of son preference and the arrival of prenatal sex determination technology in the early 1980s, 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 the Chinese tradition. Chinese culture traces lineage solely through males. Households that do not have a son are reproved by friends and relatives – failure to carry on the family name is a serious sign of disrespect to ancestors.[8] 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)).

Son preference is age old and cannot explain the recent *increase* in the sex ratios. An

[8]A 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).

important catalyst has been the fertility cap that is at the heart of the one-child policy. Assuming that rural parents strive for at least one boy to continue the (father's) family name, high fertility renders gender selection superfluous.[9] However, at low fertility levels, the probability of having only daughters is high, absent sex selection.

Still, China is no stranger to high sex ratios. 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)).

3 Data

We analyze annual province-level data from China's 26 provinces,[10] covering the period 1988-2004.[11] Our main data sources are published data from various yearbooks and the 1990 census.

[9]The average total fertility rate during the period of 1949-1979 is 5.22, a fertility at which the probability of having only daughters is less than 2.5 percent.

[10]The 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. Hainan was spun off, and 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.

[11]Note that 1988 was the first year for annual province-level crime statistics.

We focus on 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." Second, 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)).

Variable Description

Sex ratios 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 1), and there was substantial variation across provinces.

Conceptually, we focus on the 16-25 sex ratio as projected by the sex ratio at birth. The primary reason for favoring a projection rather than the actual sex ratio in a province is that we believe the sex ratio at birth to be the exogenous constraint framing the marriage market conditions for the cohort as it ages (slippage arising from, e.g., provincial differences in gender differential mortality and spousal age gaps), whereas the actual sex ratio will reflect adult migration decisions that may be in response to provincial differences in economic and marriage conditions (e.g., Edlund (2005)).

1990 census 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. Migration may make this figure different from the actual sex ratio at birth for this cohort. However, inter-provincial migration was very limited until 1991 (the first year of the *de facto* lifting of the household registration system in many provinces).

1982 census We also use the 1982 census to calculate the 16-25 sex ratio. The cohorts in question were eight years younger in 1982, and thus the 1982 census provides another check. We can only compute the 16-25 sex ratio for the period 1988-1998, since the 16 year olds in 1999 were born in 1983.

2000 census As an alternative to the province sex ratio given by the sex ratios at birth in the past, we may be interested in the sex ratio of young adults present in the province. The 2000 census offers a window on this. We compute the sex ratio for 21-23 years old (using ages 17-35 in the 2000 census, the ages that has the most migration, see Figure 3). Since the people who were 35 years old and immigrants in say Zhejiang in 2000, were most likely not in Zhejiang in the 1980s and early 1990s (from the restrictions on migration then in place), we restrict the back-casting to the period 1994-2004.

Crime We define the crime rate as arrests for violent and property crimes per 10,000 population. Thus measured, criminality almost doubled in the study period, from 3.71 in 1988 to 6.77 in 2004 (Figure 2); and there was considerable variation ranging from

0.81 (Tibet, 1988) to 13.1 (Zhejiang, 2004). Our 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).

Our focus is on violent and property crimes. These are low-skill crimes with young perpetrators likely to have had their marriage market affected by the rise in the sex ratio. While we cannot distinguish between violent crimes and property crimes, they are highly correlated (Figure 4) 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.[12] Among property crimes, larceny is by far the most common (86.7% in the same period) (Hu (2006)).

Additional controls Additional control variables include provincial level per capita income, the employment rate, the secondary school enrolment rate, income inequality (urban over rural household income), the urbanization rate, welfare expenditures, the share of the male population that is between ages 16 and 25, openness to trade (exports, imports and foreign direct investments as a share of GDP), the share of (out-of-province) immigrants, construction (square meters), and police expenditures (as a share of provincial government expenditures). These data are 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.[13]

[12] At the national level, publicly available data go back to 1981.

[13] Further variable descriptions and summary statistics are in Table 1.

One-Child Policy variables The one-child policy is an umbrella term for a raft of family-planning policies (see Peng (1996)) officially launched in 1979. We focus on the following three programs established between 1976 and 1992:[14]

1. *Birth*[15] *Planning Science and Technology Research Institutes* are medical and research facilities present at all government levels. These institutes provide birth control services and collect data on the cost effectiveness of various birth control methods (chiefly intra uterine devices, sterilizations, and abortions). They also distribute free contraceptives to couples.

2. *Birth Planning Education Centers* promote family planning through the distribution of educational materials such as movies, pictures, books, and posters. These centers educate people on the use and usefulness of contraceptives and extol the virtues of a small family.

3. *Birth Planning Associations* hold academic exchange activities on local population issues, conduct socioeconomic research on family planning, and make recommendations concerning population policy and planning.

There was substantial variation in the roll-out of the three programs across provinces, as shown by Table 5. This was especially the case for the *Birth Planning Science and*

[14] The omitted programs either did not exhibit variation in timing or were not statistically significant in the first stage in the IV analysis. They were: Population information agent; Press agent; Cadre training center; and Medicine and medical equipment management center.

[15] The Chinese term is "Birth" rather than "Family" (PRC (2002)).

Technology Research Institutes – the first program was already established in 1976 (in Jiangsu) and the last in 1992 (Inner Mongolia). We view an earlier establishment as a more intense implementation of the one-child policy in a broad sense.

4 Results

As a descriptive start, Figure 5 plots the crime rate against the sex ratio (both variables are demeaned of province and year fixed effects). A positive correlation is evident. The fitted line has a slope of 3.140 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:

$$\ln c_{it} = \alpha \ln(r_{it}) + X_{it}\beta + \delta_i + \tau_t + \varepsilon_{it}, \tag{1}$$

where c_{it} is the crime rate in province i, year t, and r_{it} is the corresponding sex ratio projection for the 16-25 year old cohort in that year (males to females).

Our main focus is on the estimate of α and we expect $\hat{\alpha} > 0$. 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 crime propensity of men, for instance from more men being unable to find a marriage partner. As we show in the Appendix, an estimate of $\alpha > f$, for $f \in [0, 0.5]$,where f is the fraction of females, suggests that there is also an effect on the "intensive margin".

The intuition for f being the upper bound of the effect of sex ratios on crime rates when male's crime propensity is held constant is as follows. The crime rate per capita is the weighted average of the crime propensity of men and the crime propensity of women. Holding the crime propensity of each demographic group constant, raising the fraction of men by one percent can at most result in a one percent increase in the overall crime rate. It is easy to see that a one percent increase in the sex ratio corresponds to a f percent increase in the fraction of male.[16] Thus, an estimate of $\alpha > f$ would imply that male crime propensity itself has risen.

X_{it} is a vector of province-year level controls that includes income, employment, secondary school enrolment, inequality, urbanization rate, welfare expenditures, the fraction of the male population that is between ages 16-25, openness to trade, immigration rate, construction, policy expenditures.

We expect income inequality to increase crime rates (Ehrlich (1973); Kelly (2000); Bourguignon (1999)). The influence of per capita income is *a priori* ambiguous. On the one hand, it can magnify the returns to illegal activities relative to legal ones. One the other, as incomes rise, possessions may be better protected. We expect urbanization to be positively

[16] For a derivation, see the Appendix.

related to crime rates (Glaeser & Sacerdote (1999)). By contrast, we expect the employment rate (the fraction of the working age population who are employed), secondary school enrollment, and welfare expenditures (pension and social welfare expenditures as a share of total government expenditure) to be negatively related to crime rates (Zhang (1997)).

δ_i and τ_t are vectors of the province and year dummies. These 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. The year dummies pick up year specific effects that were common to all provinces. For instance, social unrest raised arrests rates in 1989 and 1990 (epitomized by the Tiananmen Square Protests). The residual ε_{it} is assumed to be $i.i.d$ with zero mean.

We estimate variations of Eq. 1 by OLS and IV, where for the latter we instrument for the sex ratio using the one-child policies (described in Section 3 and Tables 5-6). Throughout, we cluster standard errors at the province level.

4.1 Base Specifications

Tables 2-4 present the results from estimating Eq. 1 by OLS. Table 2 presents our basic specifications. We start by including only the sex ratio (in addition to the province and year dummies) in Column 1 (cf., Figure 5), and obtain an estimate of the elasticity of crime with respect to the sex ratio of 3.3. Adding controls picking up province differential changes in the socio-economic environment (income, employment rate, secondary schooling, inequality, urbanization, welfare expenditures) raises the estimated elasticity somewhat, Columns 2-4. Throughout, the estimated coefficient on the sex ratio variable is statistically significant at the 1% level, and neither the point estimates nor the standard errors are much affected by the inclusion of additional controls. In our preferred specification (Column 4), our estimate of the elasticity 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% ((3.7×4)/82.4) of the overall rise in criminality during the study period.

Since well above 0.5, the estimated elasticity suggests that criminality rose not merely because of more men (see the Appendix). The 95% confidence interval is (1.30, 6.09), well above 0.5. Most of the control variables enter with the expected sign, but only the urbanization rate is statistically significant.

4.2 Additional Controls

Our estimate of the elasticity of crime with respect to the 16-25 sex ratio remains robust to the inclusion of a number of additional control variables, Table 3.

As is well known, China underwent far reaching market-oriented reforms during the study period, reforms that have profoundly changed the Chinese society. Our identification strategy would be undermined if, for instance, the family planning policies in place 16-25 years ago were bundled with other policies that affect crime with a lag. It is conceivable that market reforms, coincided with one-child policy, impact both sex ratios and crime. To address this concern, we first include as a covariate a measure of the openness of the province (foreign direct investments, export and import, as share of GDP). The coefficient estimate is positive but not statistically significant, and our main result remains (Column 1).

Column 2 replaces province dummies with province-specific year trends. Foote & Goetz (2008) argued that provincial and year fixed effects are not sufficient, and raised the possibility that there may be other omitted variables which could affect the change of outcomes across states differently in panel data. As a control for potentially omitted variables, we interacted a time trend with provincial dummies to allow for different province time trends. The estimated coefficient on the sex ratio does not change much when we include these interactions, and it remains statistically significant (10% level).

A much visible facet of China's economic growth is the construction boom. Since construction is an important employer of migrant, low-skill, male labor, a demographic which may also be crime prone, our estimated effect of sex ratios on crime may be confounded. To address this concern, we include a measure of construction activity in the province (square meters). While the coefficient is positive, it is not statistically significant and our main result remains, Column 3.

Since the estimated elasticities of sex ratios on crime rates are well above 0.5, we conclude that high sex ratios increase crime through not only more men, but also an increase of men's crime propensity. To check this hypothesis, we include the share of male aged 16-25 in Column 4. The estimated coefficient on this new variable is positive and statistically significant, confirming that men are more crime prone than women. The regression result also confirms that higher sex ratios increase male crime propensity – our main result remains robust to this inclusion.

Migration is another measures of openness and economic activity, and possibly a force in its own right with respect to crime. Column 5 include the official immigration statistic that refers to the share of the province population that were from out of the province and had an official change of residence location. The estimated coefficient on the share of immigrants is positive in all specifications, which is consistent with the theoretical prediction of the standard crime model (Becker (1968); Ehrlich (1973)).[17] Still, the magnitude and significance of the estimated coefficient on the sex ratio remain essentially unchanged.

Last, Column 6 includes police expenditures (in log form) to capture its potential impact on crime. Police expenditures are expected to have a negative effect on crime rates. However, reverse causality – rising police expenditure as a result of rising crime – is a concern (Levitt (1997, 1998)). For want of a suitable instrument to identify the causal effect of police expenditure, we include it only as a sensitivity test. Counter-intuitively, but suggestive of reverse causality, the coefficient on the police expenditure variable is positive (but not statistically significant). Importantly, our main result remains robust throughout.

[17]High population mobility presumably reduces the probability of being caught. Alternatively, a high immigrant share may reflect the economic climate (not captured by the income measures).

4.3 Falsification Tests

Table 4 presents further falsification and robustness tests. One concern is that the data on violent and property crime reflect various "fight crime" drives (at the province level since we control for year fixed effects) rather than underlying criminal activity. To address this concern, we look at corruption. A general law and order zeal would affect corruption statistics as well while we believe that 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, we replace the crime rate with the corruption rate. 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 effect of the 16-25 sex ratio on corruption rates.

Another concern is that our found relationship between crime and sex ratios is spurious. For instance, past "reform mindedness" of province party leaders could drive both sex ratios and crime rates. To check for this possibility, we include the sex ratio of those 10-15 years old. This cohort is too young to enter the 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 16-25 sex ratio. 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 2000.)

The way we calculate sex ratios means that the projected sex ratio for different years use different age groups in the 1990 census. If there was no (post-natal) mortality for our ages in question (2-27 years old), those sex ratios would perfectly mirror the sex ratios at birth. However, this is not the case, and as a robustness check, we also project sex ratios using the 1982 census, the idea being that if province-level differential gender mortality was an issue, we would obtain very different results using sex ratios projected from different age groups (and a different census). Column 4 presents the results, and while the point estimate is larger, this stems from having to restrict the analysis to 1988-1998.

Another area of concern is that current factors which impact crime may also impact the sex ratio. For instance, economic activity dictates migration flows; migration is both young and gendered; and the presence of migrants and the economic environment that attracted them likely has a bearing on crime rates. This is the reason why we have used *projected* sex ratio from the 1990 census. Nonetheless, we can check the soundness of this choice by also using the 2000 census to construct sex ratios that as closely as possible reflect the actual (including migrants) province-year sex ratios. Since migrants were heavily concentrated in the 16-35 age range (Figure 3), we want a sex ratio that would reflect migration and would overlap with our 16-25 year group. Therefore, we chose to look at the sex ratios for the 21-23 years old, that is, those between 17 to 35 years old in the 2000 census. Column 5 presents the results from only including the sex ratio from the 2000 census, and while the relationship is positive, it is not significant. Column 6 presents the results when the sex ratios from the 2000 and the 1990 censuses are both included. The sex ratio from the 2000 census is not significant, while our favored (projected from the 1990 census) sex ratio is (1% level).[18]

4.4 IV Estimates

While it is reasonable to believe that the sex ratio at birth is exogenous to crime rates 16-25 years in the future, as an additional robustness check, we instrument using the one-child policies. Specifically, we use lagged (one year before the birth year for the cohorts aged 16-25) provincial-level family planning variables as IVs, which are described in Section 3 and Table 5. Table 6 presents the first stage. Table 7 presents the IV analogue to the OLS regressions in Table 2. Throughout, the results are similar, quantitatively and qualitatively.

The first-stage estimates are presented in Table 6. As expected, the program variables raise the sex ratio. The instruments are jointly significant in all four specifications.[19]

Table 7 presents the IV analogue to Table 2. The IV results confirm our OLS results: after controlling for other social and economic variables, increasingly male-biased sex ratios

[18]Recall the reason for focussing on the period 1994-2004 is that migration was very limited in the early 1990s. In the preliminary analysis, we did the estimation on the entire period (1988-2004) and the results were stronger. The coefficient on the 21-23 sex ratio (projected from the 2000 census) was negative but insignificant, and the coefficient on the 16-25 sex ratio (projected from the 1990 census) was 3.8 and statistically significant at the 1% level.

[19]However, to the extent that the "rule of thumb" critical value is 10 to qualify for strong IVs, our IVs may be considered as not strong (Stock & Yogo (2002); Hausman *et al.* (2005)). To mitigate a possible weak instrument problem, we also conduct the limited information maximum likelihood estimation (LIML), which is more robust to weak instrument problem than two stage least square (TSLS)(Staiger & Stock (1997); Stock & Yogo (2002)). The LIML estimates are similar to the IV estimates. Results are not reported due to space considerations, but are available from the authors on request.

have had an economically and statistically significant impact on crime (Columns 3-4). The overall similarity between the IV estimates and the OLS estimates is not surprising given the exogeneity of sex ratios and the influence of the one-child policy on sex ratios.[20] The estimated coefficient on the 16-25 sex ratio variable ranges from 2.32 to 3.52. In our preferred specification (Table 7, Column 4), α is estimated at 3.52, only marginally less than the estimate obtained in the corresponding OLS specification (Table 2, Column 4).

4.5 Sex Ratios and Education, Labor Market and Marriage Market Outcomes

Crime is but one of the areas potentially affected by high sex ratios. Of interest in their own right, and in order to shed some light on the mediating mechanisms, we now present evidence of the effects of male sex ratios on education, labor market, and marriage market outcomes using the Chinese 2000 Census, the China Urban Household Surveys from the years 1988-2006, and the Chinese Health and Nutrition Surveys, 1989, 1991, and 1993. First, a male-biased sex ratio decreases (increases) the fraction of men (women) who are ever married, and increases (decreases) the fraction of men (women) who are divorced (and not remarried). Consistent with the findings of Wei & Zhang (2008) that high sex ratios raised the savings rates of households with sons, we find higher sex ratios to raise male investment

[20] We also apply the IV estimations for the same specifications as those reported in Tables 3 and 4, and the results are similar to the OLS estimates. Results are not reported due to space considerations, but are available from the authors on request.

in human capital. This higher level of education may be behind our labor market outcomes where we find evidence of higher variance in labor market outcomes. High sex ratios raise the probability of having a professional job for men (relative to women), but lowers the probability of employment. Finally, we find that a higher sex ratio reduces the gender gap in household chores and decision making, suggestive of higher sex ratios tilting bargaining power in favor of women.

4.5.1 Marriage Market Outcomes: 2000 Census

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 8. We also control for a number of county characteristics computable from the 2000 census (1 percent sample): the urbanization rate, minority rate, fraction 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.

4.5.2 Labor Market, Education, and Spousal Outcomes: Urban Household Surveys, 1988-2006

We now turn to labor market, education and marriage market effects as captured by the Urban Household Surveys. These surveys have been 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.[21]

To calculate the sex ratio, we use the 1990 census and restrict 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 the ages 21 and 25, in Beijing, in that year. The sex ratio for women was calculated analogously.

Consistent with the notion that a surplus of men may increase the variance in men's labor market outcomes, 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 9, Columns 1-2). Conditional on being employed, sex ratios raise wages and income of both sexes, but more so for men than for women (Columns 3-4).

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

To help understand the effect of sex ratios on labor market outcomes, the first four columns of Table 10 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 10 further explore the effect of sex ratio on spouse's educational and labor market outcomes. 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 5). In addition, marriage market squeeze brought about by high sex ratios drives up the spousal age gap. With higher sex ratios, women married older men, and men married younger women (Column 6). 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 7-8).

4.5.3 Household Bargaining: China Health and Nutrition Surveys, 1989, 1991 and 1993

Having examined the effect of sex ratios on marriage and labor market outcomes, we now turn to how intra-household behaviors respond to high sex ratios. We expect higher sex ratios to raise women's bargaining power within the household (and decrease that of men). To test this hypothesis, we use the China Health and Nutrition Survey (CHNS), collected 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 include the probability of participating in the decision making of buying three major household durable goods, electric fans, TVs and radios, and the probability of dominating the afore mentioned decision making.[22]

Table 11 reports OLS estimates of sex ratios and household bargaining. As we expected, 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 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.[23]

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

[23]Porter (2008) also studies the effect of sex ratios on the resource allocation within the household looking different outcome variables.

5 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 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 (e.g., Hesketh & Xing (2006) and references therein)?[24] 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. Also, whereas South Korean men have been able to turn to poorer neighbors to source brides, China's bachelors (the poorest in a still poor country) are unlikely to be in a position to do so.

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

[24] Also see "Missing sisters", *The Economist*, April 17, 2003 and "China: Too Many Men", *CBS 60 Minutes*, http://www.cbsnews.com/stories/2006/04/13/60minutes/main1496589.shtml (April 16, 2006).

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 (Li (2007)), implying that the next decade may see another 10 percentage points increase in the 16-25 sex ratio.

Our study suffers from a number of limitations. Unfortunately, we do not have age specific crime rates yearly even at the national level. Nor do we have the breakdown by gender. We have favored the sex ratio before adult migration since crime or factors associated with it are likely to influence migration decisions (and possibly in a gender differential way). One reason the sex ratio before adult migration would affect criminality is that it shapes the psyche (e.g., growing up knowing that there are not enough women to go around). Moreover, many migrants view their home province as the place to source a spouse and therefore the sex ratio where they are temporarily does not necessarily influence their marriage market prospects (and thus their behavior, we hypothesize). An alternative story is that it is the contemporaneous sex ratio in place locally that affect men's propensity to commit crime. In that case, the sex ratio including migrants would be the relevant one. However, the results using the 2000 census suggest that this is not so much the case.

Focussing on the sex ratio before adult migration is conceptually clean, but draws attention to another source of slippage: crime statistics pertain to the province in which the crime was committed, not necessarily the province of birth of the perpetrator. In a world without migration, or migrants do not commit crime, this is not a problem. However, if (some) migrants do commit crime, which seems likely, the crime rate was partly generated by men who grew up in another province, and according to our preferred story, were subject to a different sex ratio. Nevertheless, as indicated above, what we have identified is the part of variations in the crime rate in a province that is due to the rising sex ratios (at birth) in that province. Putting it differently, we have identified the variation in the crime rate that is related to local offenders who were born in the same province. Moreover, it should be born in mind that even among young adults, some 90 percent had not migrated out of province according to the 2000 census.

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 vaned. 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, young to commit crimes) has no impact on the crime rate, suggest to us that our finding is unlikely to be the result of confounding by 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. Finally, it should be born in mind 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. 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

$$c_m^0 \geq c_m^1 > 0,$$

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

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

$$c_m^0 = c_m^1 (= c_m). \tag{2}$$

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

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

Let r denote the sex ratio:

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

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

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

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.

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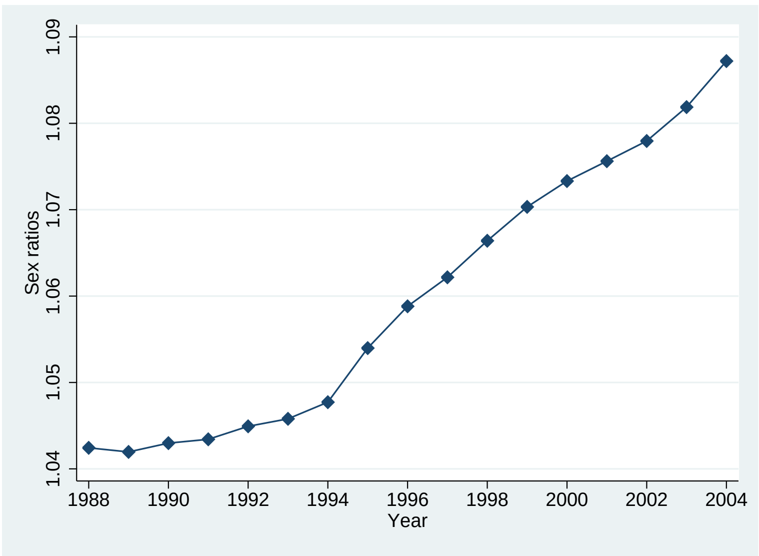

Figure 1: Sex Ratios 16-25 Year Olds, 1988-2004

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

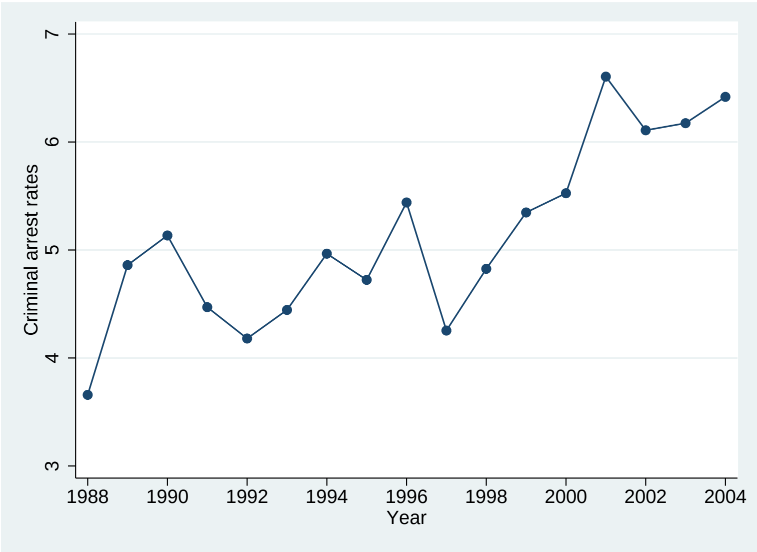

Figure 2: Arrest Rates (Property and Violent Crimes/10,000 Population), 1988-2004

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

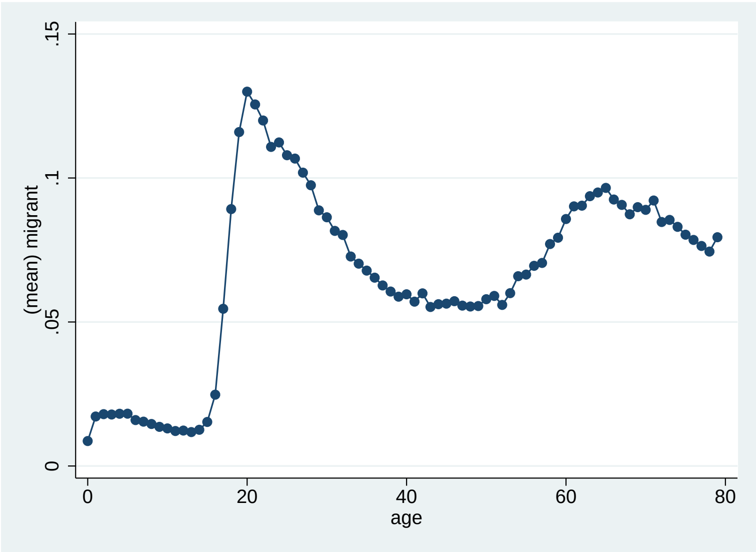

Figure 3: Migrants by Age, 2000 census

Notes: The fraction who are are enumerated in a province different from their province of birth by age

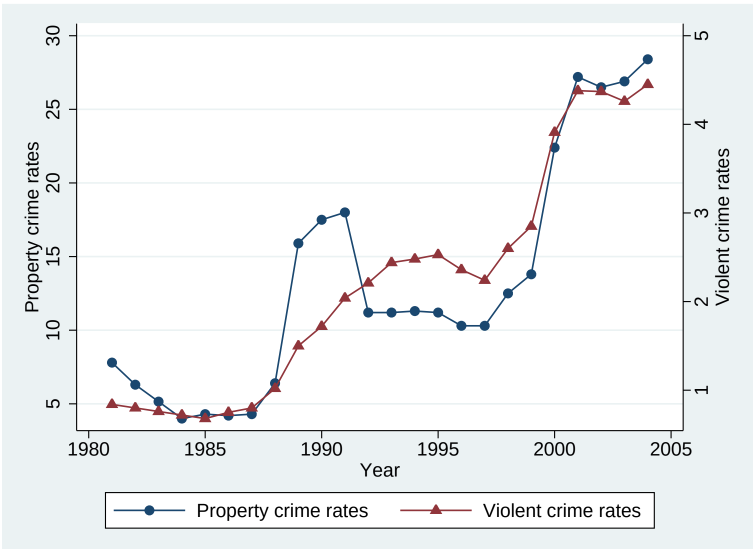

Figure 4: Property Crime and Violent Crime Rates by Year

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.

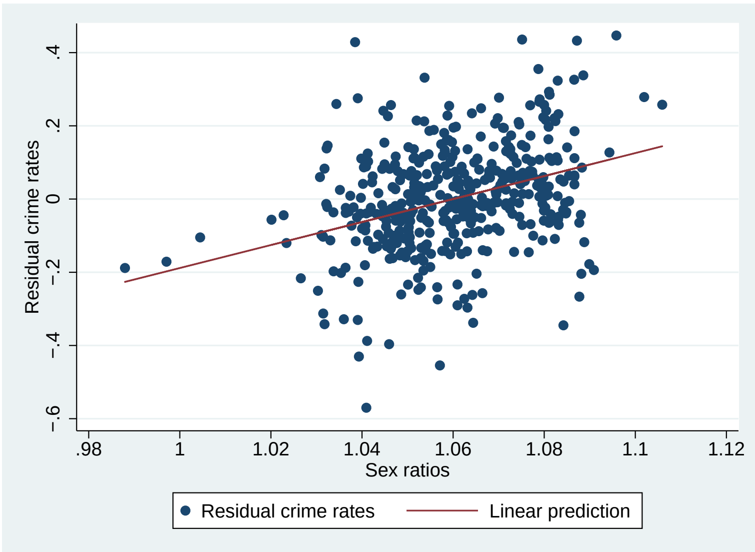

Figure 5: (Residual) Crime Rates by Sex Ratios

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.

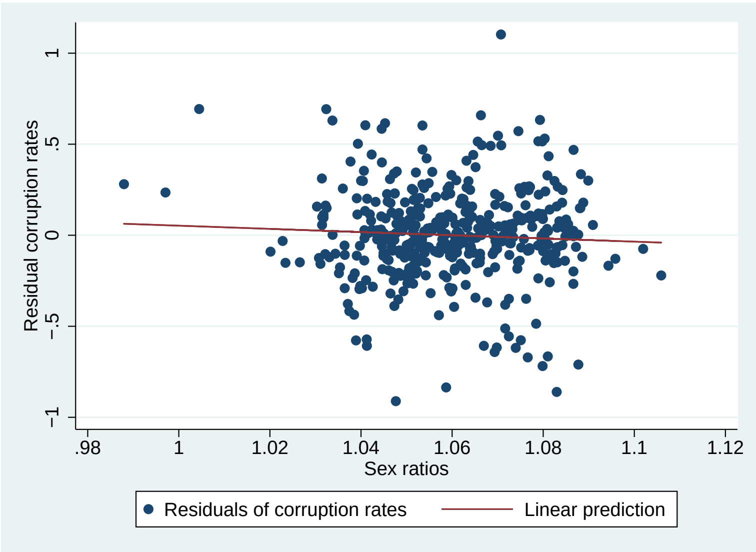

Figure 6: (Residual) Corruption Rates by Sex Ratios

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

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

Variable	Mean	Standard deviation	Min	Max
Crime rate[a] (arrests/10,000 pop.)	5.35	1.65	0.81	13.04
Corruption rate (cases/10,000 pop.)	0.46	0.21	0.08	1.51
16-25 Sex ratio, males to females (1990-census projections)	1.05	0.029	0.98	1.13
Income, per capital (RMB 1,000 at 2000 prices)	2.70	1.09	0.99	8.00
Employment rate (% employed, 16-65 year olds)	67.42	9.06	46.81	97.96
Inequality (urban/rural per capita income)	2.72	0.70	1.52	5.15
Urbanization rate (% living in urban areas)	29.93	11.08	13.11	56.01
Secondary school enrollment (%)	87.85	11.17	39.6	100
Welfare expenditures (% of government expenditures)	2.45	0.77	1.03	11.41
Male 16-25 years old (% of population)	10.40	1.32	7.10	12.99
$\frac{\text{Export+Import+FDI}}{\text{GDP}}$	0.17	0.16	0.03	0.97
Immigration rate (‰ born outside province)[b]	2.19	1.28	0.31	8.68
Construction (10,000 m^2)	3,790	5,659	21.98	50,982
Police expenditures (% of government expenditures)	5.37	1.31	2.58	9.24

[a] - Violent and property crimes. A non-exhaustive list includes: homicide, assault, 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

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

	Dependent variable: ln(Crime rate)			
	(1)	(2)	(3)	(4)
ln(16-25 Sex ratio)	3.339***	3.436**	3.753***	3.694***
1990 census	(1.126)	(1.286)	(1.195)	(1.164)
ln(Income, per capita)		-0.063	0.013	-0.009
		(0.209)	(0.169)	(0.171)
Employment rate		-0.006	-0.004	-0.004
		(0.004)	(0.004)	(0.004)
Secondary school		0.003	0.004	0.003
enrollment		(0.002)	(0.003)	(0.003)
Inequality			0.137	0.135
			(0.091)	(0.087)
Urbanization			0.008*	0.008*
			(0.004)	(0.004)
ln(Welfare exp.)				-0.053
				(0.058)
Observations	442	442	442	442
R-squred	0.54	0.55	0.58	0.59

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

Table 3: OLS Estimates of Sex Ratios and Crime, 1988-2004. Robustness.

	Dependent variable: ln(Crime rate)					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(16-25 Sex ratio)	3.575***	4.381**	3.578***	3.568***	3.484***	3.446***
	(1.075)	(1.752)	(1.080)	(1.064)	(1.055)	(1.082)
ln(Income, per capita)	-0.029	-0.116	-0.032	-0.026	-0.028	-0.028
	(0.163)	(0.245)	(0.160)	(0.151)	(0.151)	(0.151)
Employment rate	-0.004	-0.012***	-0.005	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Secondary school	0.004	0.007*	0.004	0.004	0.004	0.004
enrollment	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Inequality	0.144	0.091**	0.143	0.115	0.108	0.113
	(0.090)	(0.035)	(0.090)	(0.072)	(0.073)	(0.072)
Urbanization	0.007	0.009	0.007	0.003	0.003	0.003
	(0.005)	(0.007)	(0.005)	(0.006)	(0.006)	(0.006)
ln(Welfare exp.)	-0.039	0.045	-0.038	-0.019	-0.028	-0.028
	(0.055)	(0.062)	(0.053)	(0.054)	(0.057)	(0.056)
$\frac{\text{Export+Import+FDI}}{\text{GDP}}$	0.193	0.196	0.189	0.273	0.261	0.249
	(0.181)	(0.135)	(0.176)	(0.181)	(0.181)	(0.181)
ln(Construction)			0.008	0.012	0.010	0.008
			(0.041)	(0.045)	(0.045)	(0.045)
Male age 16-25(%)				0.050**	0.049*	0.049*
				(0.025)	(0.024)	(0.025)
Immigration ‰					0.020	0.020
					(0.017)	(0.017)
ln(Police exp.)						0.061
						(0.107)
Observations	442	442	442	442	442	442
R-squared	0.59	0.51	0.59	0.61	0.61	0.61

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Year- and province-fixed effects are included in all specifications, except Column 2, which includes province fixed effects and a linear year trend interacted with province dummies.

Table 4: OLS Estimates of Sex Ratios and Crime. Falsification Tests.

	Dependent variable (logged):					
	Corruption rate	Crime rate				
	1988-2004	1988-2000		1988-1998	1994-2004	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(16-25 Sex ratio)	-1.501		4.883***			1.855**
1990 census	(1.511)		(1.473)			(0.769)
ln(10-15 Sex ratio)		-0.193	0.323			
1990 census		(1.229)	(1.015)			
ln(21-23 Sex ratio)					0.290	0.291
2000 census					(0.323)	(0.313)
ln(16-25 Sex ratio)				4.900***		
1982 census				(1.025)		
ln(Income, per capita)	0.208	0.191	-0.000	0.059	-0.065	-0.109
	(0.284)	(0.222)	(0.197)	(0.287)	(0.114)	(0.101)
Employment rate	0.006	-0.007	-0.006	-0.012	0.004	0.004
	(0.005)	(0.006)	(0.005)	(0.008)	(0.003)	(0.003)
Secondary school	-0.003	0.004	0.005	0.007	-0.000	0.000
enrollment	(0.002)	(0.004)	(0.004)	(0.005)	(0.002)	(0.003)
Inequality	-0.211***	0.196*	0.183*	0.197**	-0.058	-0.055
	(0.055)	(0.114)	(0.092)	(0.091)	(0.067)	(0.061)
Urbanization rate	0.003	-0.003	0.004	-0.004	0.003	0.004
	(0.008)	(0.007)	(0.007)	(0.007)	(0.005)	(0.004)
ln(Welfare exp.)	0.137	-0.042	0.002	-0.013	0.000	-0.005
	(0.118)	(0.067)	(0.069)	(0.049)	(0.077)	(0.072)
Observations	442	338	338	275	286	286
R-squared	0.54	0.41	0.51	0.54	0.59	0.61

Robust standard errors clustered at the province level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
Year- and province-fixed effects are included in all specifications.
Columns 2-3 have fewer observations because the 1990 census can only project the 10-15 sex ratio until 2000. Column 4 has fewer observations because the 1982 census can only project the 16-25 sex ratios until 1998, and Hainan was not yet a province. Columns 5 and 6 have fewer observations because the point of using the 2000 census is to capture the actual province population inclusive of migrants, and this back-casting gets worse with the time lag away from 2000. Since migration was highly restricted until the early 1990s, we restrict the sample period to 1994-2004.

Table 5: One-Child Policy Instruments: Year of Establishment by Province.

	Birth Planning		
Province	Science & Tech. Research Inst.	Education Center	Association
Hebei	1977	1981	1980
Shanxi	1986	1984	1983
Inner Mongolia	1992	1992	1985
Liaoning	1982	1983	1981
Jilin	1979	1983	1981
Heilongjiang	1983	1983	1980
Jiangsu	1976	1982	1984
Zhejiang	1985	1983	1980
Anhui	1983	1983	1979
Fujian	1986	1984	1981
Jiangxi	*none**	1983	1984
Shandong	1980	1983	1982
Henan	1983	1983	1978
Hubei	1989	1988	1981
Hunan	1984	1984	1982
Guangdong	1976	1980	1985
Guangxi	1986	1991	1985
Hainan	1976	1979	1985
Sichuan	1978	1984	1984
Guizhou	1984	1985	1984
Yunnan	1980	1983	1980
Tibet	*none**	*none**	*none**
Shaanxi	1990	1983	1981
Gansu	1991	1989	1982
Qinghai	*none**	1989	1982
Ningxia	*none**	1984	1981
Xinjiang	1986	1985	1984

* - as of 1996. Source: Peng (1996, pp. 455-459).

Table 6: First Stage Regressions of Sex Ratios.

	Dependent variable: ln(16-25 Sex ratio)			
	(1)	(2)	(3)	(4)
IVs				
Birth Planning:				
Science & Technology	0.027	0.028*	0.028*	0.027*
Research Inst.	(0.019)	(0.016)	(0.015)	(0.015)
Education Center	0.036	0.031	0.030	0.031
	(0.029)	(0.025)	(0.026)	(0.027)
Association	0.043**	0.034	0.033	0.034
	(0.020)	(0.022)	(0.023)	(0.023)
Control variables				
ln(Income, per capita)		0.030	0.031**	0.027
		(0.019)	(0.015)	(0.016)
Employment rate		-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)
Secondary school		-0.000	-0.000	-0.000
enrolment		(0.000)	(0.000)	(0.000)
Inequality			0.001	0.000
			(0.010)	(0.010)
Urbanization rate			-0.000	-0.000
			(0.001)	(0.001)
ln(Welfare exp.)				-0.008
				(0.009)
Joint F test of IVs				
F-statistic	7.62	5.90	4.41	4.23
p-value	0.001	0.003	0.013	0.015
Observations	442	442	442	442
R-squared	0.50	0.53	0.53	0.53

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

Table 7: IV Estimates of Sex Ratios and Crime, 1988-2004.

	Dependent variable: ln(Crime rate)			
	(1)	(2)	(3)	(4)
ln(16-25 Sex ratio)	2.318	2.268	3.535**	3.522**
	(1.702)	(1.716)	(1.758)	(1.717)
ln(Income, per capita)		-0.008	0.023	-0.002
		(0.189)	(0.175)	(0.176)
Employment rate		-0.007*	-0.004	-0.004
		(0.004)	(0.004)	(0.004)
Secondary school enrollment		0.003	0.003	0.003
		(0.002)	(0.003)	(0.003)
Inequality			0.137	0.135
			(0.087)	(0.083)
Urbanization			0.008*	0.008*
			(0.004)	(0.004)
ln(Welfare exp.)				-0.055
				(0.053)
Overid. test:				
Hansen J-statistic	1.72	1.91	2.38	2.70
p-value	0.42	0.39	0.30	0.26
Observations	442	442	442	442

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

Table 8: OLS Estimates of Sex Ratios and Marital Status 15-45 Year Olds. 2000 Census.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: Never Married						
	Men (mean=0.24)						
ln(15-45 Sex ratio)[a]	0.157***	0.155***	0.142***	0.146***	0.142***	0.142***	0.136***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.015)
	Women (mean=0.16)						
ln(15-45 Sex ratio)[a]	-0.103***	-0.110***	-0.123***	-0.120***	-0.125***	-0.124***	-0.134***
	(0.022)	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)	(0.018)
	Dependent variable: Divorced (and not remarried)						
	Men (mean=0.013)						
ln(15-45 Sex ratio)[a]	0.005***	0.004***	0.003**	0.003**	0.003*	0.003*	0.003**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	Women (mean=0.009)						
ln(15-45 Sex ratio)[a]	0.001	-0.001	-0.003**	-0.003*	-0.003*	-0.004**	-0.004**
	(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	no	no
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

2000 Census. Each observation is a county-level unit, which could be an urban district, a count-level city or a county. The dependent variable is from *"Tabulations of the 2000 Population Census at County Level"*. The explanatory variables are authors's calculations from the 1 percent sample of the 2000 Census. (Counties have about 40,000 inhabitants, thus, the 1 percent sample would only give us 400 observations per county, too small to meaningfully calculate marital status statistics by sex and finer age groups.)

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

Potable water – the fraction of households that answer yes to the question: Do you drink tap water in the house/apartment?

[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, 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.

Table 9: OLS Estimates of Sex Ratios and Labor Market Outcomes, Urban Household Survey 1988-2006, Ages 22-45[a].

	Employed	Professional work	ln(Wage)	ln(Income)
	(1)	(2)	(3)	(4)
Sex ratio[b]	0.264**	0.104***	0.138	0.295*
	(0.071)	(0.023)	(0.075)	(0.136)
ln(Population)[c]	-0.090	-0.040	-0.189	-0.189
	(0.077)	(0.033)	(0.096)	(0.143)
Male	0.056*	-0.039*	0.047	0.058
	(0.026)	(0.018)	(0.049)	(0.057)
Male×Sex ratio	-0.041*	0.036*	0.095**	0.103**
	(0.020)	(0.014)	(0.026)	(0.034)
Education (years)	0.030***	0.026***	0.093***	0.090***
	(0.002)	(0.003)	(0.004)	(0.003)
Age (years)	0.030***	0.006***	0.040***	0.058***
	(0.001)	(0.001)	(0.003)	(0.004)
Observations	121288	91336	91336	101059
R-squared	0.27	0.16	0.46	0.41

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] – 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.

[c] – By province, age and sex.

Table 10: OLS Estimates of Sex ratios, Education, and Spousal Outcomes, Urban Household Survey 1988-2006, Ages 22-45[a].

	Education years	College or above	High school or above	Middle school or above	Spousal[b]			
					Education	Age	ln(wage)	ln(income)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sex ratio[c]	-0.579*	-0.042	-0.090	-0.045***	0.449	1.182*	0.205***	0.196**
	(0.270)	(0.046)	(0.049)	(0.007)	(0.245)	(0.572)	(0.046)	(0.055)
ln(Population)[d]	0.0869	-0.030	0.0297	0.059***	-0.130	-0.903***	-0.218**	-0.175*
	(0.162)	(0.031)	(0.035)	(0.006)	(0.092)	(0.093)	(0.074)	(0.072)
Male	-0.518	-0.027	-0.085*	-0.026	-0.001	-1.449	-0.049*	-0.053
	(0.318)	(0.064)	(0.036)	(0.017)	(0.359)	(1.456)	(0.072)	(0.084)
Male×Sex ratio	0.854**	0.091	0.118***	0.034*	-0.563	-2.051*	-0.253***	-0.277***
	(0.229)	(0.047)	(0.024)	(0.013)	(0.285)	(0.981)	(0.050)	(0.057)
Age (years)	-0.089***	-0.010***	-0.014***	-0.003***	-0.041***	0.948***	0.007**	0.005*
	(0.008)	(0.001)	(0.002)	(0.001)	(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	137527	137527	137527	137527	100075	100077	895978	96979
R-squared	0.13	0.08	0.10	0.03	0.34	0.77	0.45	0.42

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.

Table 11: OLS Estimates of Sex Ratios and Household Bargaining, Chinese Health and Nutrition Survey, 1989, 1991, 1993, Ages 22-45.

	Preparing and cooking food[b]	Washing and ironing clothes[b]	Taking care of children	Total household chores[bc]	Decision participation[d]	Decision making[d]
mean:	6.167	1.893	7.556	15.21	0.824	0.193
	(1)	(2)	(3)	(4)	(5)	(6)
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×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.

[a] – Sex ratio is projected by the 1990 census. The sex ratio is defined by province, age, sex, and rural/urban, 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 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 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.