

Gender Imbalance and Parental Health-Compromising Behavior in Rural China

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Abstract

China and India, as well as several other Asian states, have experienced increasingly skewed sex ratios, which may have triggered intensified competition in the marriage market. The existing literature captures the competition pressures by aggregate sex ratios, while marriage market competition tends to be highly localized. This paper utilizes two household longitudinal datasets from rural China - a primary census-type survey from Guizhou province and a secondary national survey from nine provinces - and a 1% sample of the 2000 China Population Census to examine parental health-threatening responses to skewed local sex ratios, such as tobacco smoking and alcohol drinking. Strikingly, parents with son in the marriage market engage in more health-compromising behavior. In contrast, parents with daughter do not demonstrate this pattern. Income effect (motivated by earning more wealth to prepare for son's marriage) is not a viable explanation for the observed consumption pattern. Coping with marriage market stress and depression is the most plausible pathway linking the observed unbalanced sex ratios and health-compromising behavior. Wealth signaling in the competitive marriage market may play a role as well. Moreover, this paper

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employs unique social network datasets with detailed information on household lineal relationships and long term spontaneous gift exchanges to spatially identify and distinguish indirect marriage market pressure within the networks from the direct effect in non-spatial models. Non-spatial models underestimate direct marriage market pressure by up to 5 percent and ignore indirect pressure spillover to the networks. Given the unbalanced sex ratio and highly competitive marriage market in China in the coming decade, disentangling the sources of marriage market impact with negative network externalities will help design efficient targeting policies that improve parental well-being.

Keywords: Skewed Sex Ratio, Risky Behavior, Health Compromising, Spatial Econometrics

JEL Codes: J13, J22

1 Introduction

Health-compromising behaviors, such as smoking and problem drinking, are widespread among human beings. Many health-compromising behaviors are addictive, which could impose long term negative impacts on health and impair labor market performance. This paper aims to examine how demographic factors, in particular more men than women in the marriage market, affect health-threatening behavior.

The widely available ultrasound technology in recent decades, the ingrained culture of son preference, together with one of the most radical birth control policies in history lead to highly skewed sex ratios favoring women in contemporary China. According to the China population census 1982, 1990, 2000 and 2010, Sex ratio at birth (SRB) in China has been increasing from 106.32 in 1975 to 118.06 in 2010. Compared to the developed eastern region, sex ratios are even more unbalanced in the impoverished western and central China (Ebenstein and Sharygin, 2009) (Figure 1). Meanwhile, the 2000 population census and 2005 1% population census survey indicate that rural areas possess more skewed sex ratios compared to their city and township counterparts.

Many surplus men in the marriage market widen the dispersion of marriage market rewards, while those of low socioeconomic status and unable to get married have to bear grave consequences. Faced with grave pressures to get married, men tend to spend more on visible goods, throw extravagant parties, pay high bride prices and build fancy houses, which occupy a great proportion of lifetime income (Appendix Table 1). Therefore, they have to work harder and take more risky jobs (Robson, 1996; Hopkins, 2011; Wei and Zhang, 2011). Consequently, both the stress coping motive of the groom families and their increased income may promote more health-promising behavior, such as smoking and problem drinking. In contrast, brighter prospects for marriage among females reduce the occurrence of a number of health-threatening behaviors (Umberson, 1987).

Health-compromising behavior can be risky but stress reducing, such as alcohol drinking and smoking. For example, nicotine is a psychoactive (mood altering) drug, tobacco use does seem to make the subjective effects of stress (such as feelings of frustration, anger, and anxiety) less severe. Health-compromising behavior can also be risky but help accumulate wealth for marriage, such as taking risky and unpleasant jobs and selling body parts.

This paper studies health-compromising behavior in response to skewed sex ratio in rural China. To the best of our knowledge, the contributions of this paper involve four aspects: this is among the first studies to examine the link between sex ratios and health-compromising behavior as well as its differential gender responses; meanwhile, it is the first time that parental health-threatening responses to skewed sex ratios are investigated; while most studies calculate sex ratios at the prefecture level, we uniquely measure community

sex ratios and investigate the consequences of localized marriage market competition in accordance with the fact that in rural areas marriage within village has been prevalent. The intensive social network data enables us to spatially distinguish the direct marriage market effect on health-compromising behavior from the indirect effect in the networks. The census-type survey enables us to accurately capture the sex ratios in each village; finally, we attempt to distinguish different mechanisms, i.e., income effect, stress/depression, and status signaling, in promoting health-compromising behavior.

Village sex ratios are probably the most relevant measure that captures localized marriage market competition in impoverished rural China. First, our census-type survey in 26 representative villages in rural western China suggests that more than half of the marriages are within village (Table 1). Aggregating village sex ratios to higher level may blur variations in the marriage market pressure. Meanwhile, county-level sex ratio figures may oversample residents living in county seat and therefore underestimate the actual sex ratios, especially in rural areas, as population census suggests that rural sex ratios are even more biased than township sex ratios. Moreover, male mobility for marriage purpose is likely to be low due to restrictions on household registration and inherited contracted land. Furthermore, it has been well documented that males in the marriage market compete locally via building fancy houses and spending lavishly in social events to signal to the matchmakers. The signaling process is usually localized (Brown et al., 2011). Finally, the especially mountainous condition in this study leads each village to function like an isolated community.

We focus on comparing families with their first-born child of different gender. Much evidence suggests that there are very few sex selections at first birth parity in China. No strict fertility control policy has been implemented for ethnic minorities in China (Scharping, 2003). Sex selections at first birth are low in rural areas, where at least two children are allowed. In China, sex ratio for the 1st birth parity has been almost constant over time (Ebenstein, 2009). Ebenstein (2010) finds that at the 1st birth mothers facing different fertility policies demonstrate similar sex ratios at birth. Furthermore, sex ratio at birth by parity shows availability of ultrasound does not affect the 1st birth but higher parities (Chen, Li and Meng, 2010). Chinese parents generally prefer one daughter one son to two sons. In our sample, endogenous fertility decisions on the first-born child are not a concern. No fines or penalties have been reported in the surveyed villages for the first three births during the last five years, and the area is populated with ethnic minorities. Regressing household minority status on number of children (or whether stopping at the second child) finds no significant results, suggesting that both ethnic minorities and the major Han group are not subject to binding fertility control policy. Finally, sex ratio at the 1st birth parity (# males per 100 females) equals 105.98 (Table 2B), which is similar to the natural rate of 106 reported by Ebenstein (2009).

The results strikingly suggest parents with son in the marriage market saliently engage in more health-compromising behavior. In contrast, parents with daughter do not demonstrate this pattern. Marriage market pressure is the most plausible pathway linking the observed unbalanced sex ratios and health-compromising behavior. Wealth signaling in the competitive marriage market may play a role as well. We also employ spatial methods to distinguish indirect marriage market pressure within the networks from the direct effect in non-spatial models. We find that non-spatial models underestimate direct marriage market pressure by up to 5 percent and ignore indirect pressure spillover to the networks.

The rest of the paper is organized as follows. Section 2 reviews the investigated consequences of skewed sex ratios in the literature. Section 3 introduces data collection for this paper and documents basic trends from the data. Section 4 presents the main results, main robust checks, investigation of the main mechanism and spatial econometric estimations. Finally, section 5 concludes.

2 The Consequences of Skewed Sex Ratios

The most direct effect of skewed sex ratios is on the marriage market. Empirical results are largely consistent with the theories that high sex ratios increase female bargaining power in the marriage market. Angrist (2002) shows that high sex ratios have a large positive effect on the likelihood of female marriage. Using the 2005 inter-census China national survey, Zhu, Lu and Hesketh (2009) find large size of the surplus Chinese men in the marriage market. Using the national census data, Ebenstein and Sharygin (2009) document that there were 22 million more men than women in cohorts born between 1980 and 2000. Based on their simulations, about 10.4 percent of these additional men will fail to marry. However, Edlund (1996) documents that dowry payments have been deteriorating despite a worsening shortage of brides in India. Edlund argues that female scarcity may work against female marriage market status via increasing the return on male human capital investment.

Skewed sex ratios may bear macroeconomic impacts through more intense marriage market competition. Wei and Zhang (2011a) provide evidence that the gender imbalance in mainland China may stimulate economic growth by inducing more entrepreneurship and hard work. Utilizing the defeat of the Kuomintang Party in China in the late 1940s with more than one million soldiers and civilians (mainly young males) retreated to Taiwan as a natural experiment, Chang and Zhang (2012) find that young men were more likely to become entrepreneurs, work longer hours, save more, and amass more assets. Wei and Zhang (2011b) argue that Chinese parents with a son save competitively to improve their son's relative attractiveness for marriage as the sex ratios rise, which may account for half the recent increase in the household savings rate. Wei, Zhang and Liu (2012) find that rising sex

ratios accounts for around two fifths of the rise in real urban housing prices in China due to the status good feature of housing in the marriage market.

Skewed sex ratios may affect social security. Ebenstein and Sharygin (2009) discuss the large concern over China's ability to care for its elderly, with a particular focus on elderly males who fail to marry. The current social security system provides little support for the childless elderly.

Evidence suggests that skewed sex ratios can account for many public security issues. Analyzing data from 70 countries, Barber (2000) argues that low sex ratios (more females than males) are likely to correspond to increased family conflict and aggression, and these societies are predicted to have higher rates of violent crimes, such as homicide, rape and assaults. Barber concludes that skewed sex ratios explain a substantial amount of the cross-national variance in violent crimes. However, crime rates nearly double with the markedly rising sex ratios in China in the last two decades. These seemingly contradictory trends can be reconciled with the fact that many males are not able to get married with the highly skewed sex ratios. In other words, marriage fails to act more effectively as a socializing force. Edlund et al. (2007) find that a 0.01 increase in the sex ratios raise violent and property crime rates by 3 percent, and the rise in sex ratios may account for up to one-seventh of the overall rise in crime. Sex ratios raise security concerns across country borders. Den Boer and Hudson (2004) argue that possibilities of meaningful democracy and peaceful foreign policy might be diminished as a result of high sex ratio induced internal instability and therefore altered security calculus for the state. Den Boer and Hudson further predict that the high sex ratios in China and India, in particular, have implications for the long-term security of these nations and the Asian region more broadly.

Skewed sex ratios also affect labor market. Ebenstein and Sharygin (2009) document the unprecedented internal migration from the west to the east region in China partly motivated by marriage purpose to seek better lives. This migration trend makes the unbalanced sex ratios even more unbalanced in rural western China, as more females are married up to the more developed eastern region. The migration trend may further determine labor market dynamics, industry agglomeration and economic growth momentum. Angrist (2002) finds a large negative effect of high sex ratios on female labor force participation. Higher sex ratios raise male earnings and the incomes of parents with young children.

Unbalanced sex ratios have been found to affect public health. Ebenstein and Sharygin (2009) argue that as males greatly outnumber females in the marriage market, more men are likely to pay for sex. Consequently, prostitution and sexually transmitted infections, such as HIV/AIDS, may become more prevalent. Hu and Goldman (1990) analyze marital-status-specific death rates for a large number of developed countries. The results indicate that the excess mortality of unmarried persons relative to the married has been generally increasing

over the past few decades. Moreover, as high sex ratios increase female bargaining power in the marriage market and evidence suggests that divorced males have the highest death rates among the unmarried groups, one may anticipate that the economic and physical well-being of men who divorce or fail to marry will be of special concern. Further, some studies document the relationship between marital status and psychological distress among the never married and formerly married people, while some other studies examine the depressive consequences of economic hardship, social isolation and parental responsibilities that unmarried people are especially vulnerable and exposed to (Pearlin and Johnson, 1977).

Though the impact of gender imbalance on stress and stress-related illness is studied, very few studies investigate its impact on stress coping behavior, especially its impact on behavior and well-being of the parental generation. Little attention is paid towards gender differential responses to unbalanced sex ratios, the focus of this paper. Compared to the existing literature, different mechanisms, such as income effect, stress and depression and status signaling, are further distinguished. Meanwhile, we utilize social network data to innovatively gauge the marriage market pressure imposed by other people in the networks.

3 Datasets

We utilize two household longitudinal datasets from rural China - a primary census-type survey from Guizhou province and a secondary national survey from nine provinces - to examine parental health-threatening responses to skewed local sex ratios, such as tobacco smoking and alcohol drinking. Besides, sex ratios are calculated based on a 1 % sample of the 2000 China Population Census.

During the three-wave Guizhou survey conducted in 2005, 2007 and 2010, information on health-compromising behavior, smoking and tobacco use, were collected for each household member (Table 2A). The tobacco consumption data includes both manufactured tobacco products and homemade tobacco products, and the latter accounts for a greater proportion of daily tobacco consumption in rural China. Compared to the national mean tobacco consumption of 281.08 yuan (in 2004) and 324.73 yuan (in 2006)¹, our sample has lower tobacco consumption expenses. Tobacco consumption in packs is also lower than the national averages, which are 72.1 packs (in 2004) and 71.8 packs (in 2006).

Village sex ratios are calculated. Table 2B indicates that sex ratios at 1st, 2nd and 3rd birth parities in our sample are 106.0, 119.7 and 138.9, respectively, while the national averages are 108.4, 143.2 and 152.9 respectively². Meanwhile, average prefecture/city level

¹China Tobacco Yearbook (2007).

²The sex ratios at the prefecture/city level are inferred from China Population Census 2000 and 20 percent random sample of the China Population 1 percent Sampling Survey 2005.

sex ratios for the age cohort 0-19 have increased from 108 to 112 between 2004 and 2009, our surveyed average village sex ratios for the age cohort 0-19 have increased from 115 to 116 during the same period. Though the skewed sex ratio is not worsening much, its standard deviation increases from 5 to 8, suggesting that the gender gap among villages may widen.

Figure 2 plots the positive relationship between sex ratio and tobacco and alcohol consumption. Figure 3 further distinguishes the relationship by child gender composition. No matter for tobacco consumption or alcohol consumption, families with one son and no daughter show positive association between sex ratio and tobacco and alcohol consumption, especially when sex ratios are more biased favoring girls. However, no clear association is found for families with one daughter and no son.

Due to the limit in geographic scope of the Guizhou survey, we also employ China Health and Nutrition Survey (CHNS)³ that cover nine provinces in China that vary substantially in geography, economic development, public resources, and health indicators. The samples in each of the provinces are drawn following a multistage, random cluster process. Stratified by income, a weighted sampling scheme was used to randomly select four counties in each province. In addition, in each province a large city and a lower income city were selected. Villages and townships within the counties and urban and suburban neighborhoods within the cities were selected randomly. There are about 4,400 households in the overall survey, covering some 26,000 individuals. After the first round survey in 1989, additional panels were collected in 1991, 1993, 1997, 2000, 2004, 2006 and 2009. For the purpose of this study, only rural samples are used. We utilize the information on cigarette consumption per day and grams of liquor drinks per week. Unlike the census-type Guizhou survey, CHNS only selects a few households within each rural community, making it nationally representative but less accurate in terms of measuring community sex ratios. However, sex ratios at the community level for both Guizhou survey and CHNS data may suffer from endogeneity. Therefore, our empirical tests further merge sex ratios, measured using a 1 % sample of the 2000 China Population Census, with CHNS household data at the county and prefecture level.

Figure 4 compares tobacco consumption patterns among households along the income distribution. We distinguish families with son and those with daughter, and families living in high sex ratio villages and those living in low sex ratio villages. The two types of villages are categorized by the median village sex ratio in our sample. The left figure suggests that poor families with son that live in high sex ratio villages smoke more, while smoking intensity

³We thank the National Institute of Nutrition and Food Safety, China Center for Disease Control and Prevention; the Carolina Population Center, University of North Carolina at Chapel Hill; the National Institutes of Health (NIH; R01-HD30880, DK056350, and R01-HD38700); and the Fogarty International Center, NIH, for financial support for the CHNS data collection and analysis files since 1989. We thank those parties, the China-Japan Friendship Hospital, and the Ministry of Health for support for CHNS 2009 and future surveys.

is much lower for their poor counterparts living in low sex ratio village. This may suggest that these families are less capable in coping with the marriage market pressure. The fact that families with son living in low sex ratio villages increase smoking with income may capture some positive income effect. In the right figure, no similar pattern is found for families with daughter. The increase in smoking with income mainly captures positive income effect, no matter for low sex ratio villages or high sex ratio villages. However, families living in high sex ratio villages with son demonstrate significantly higher smoking intensity (left figure) than those with daughter (right figure), while a comparison for the two types of families in low sex ratio villages generates no distinct smoking pattern.

Similar to Figure 4, Figure 5 compares alcohol consumption patterns between poor and rich families, between families with son and those with daughter, and between families living in high sex ratio villages and those living in low sex ratio villages. The findings in both figures consistently suggest the marriage market pressure that can be explicitly distinguished from other factors, such as income and demographic effect.

4 Empirical Results

4.1 Main Results

The first set of main results using our Guizhou survey data is reported in Tables 3-4. In Table 3, the first column for each outcome variable uses sex ratios of 5-19 age cohorts. The second column through the fourth column for each outcome variable adopts sex ratios of 5-9, 10-14, and 15-19 age cohorts, respectively. The 15-19 age cohorts Sex ratio captures larger and more significant marriage market pressure. Because most sampled households have one or two children, most families in the 5-9, 10-14, and 15-19 age cohorts do not overlap, the marginal effect of the first column (age cohort 5-19) is generally similar to the sum of the effects for the other three age cohorts. However, these baseline results do not distinguish families with son from those with daughter, and do not distinguish families with different number of children.

To distinguish families with son from those with daughter, we run regression (1) in the first column for each outcome variable in Table 4.

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

where i denotes family; j is village unit; t is year. $sexratio_{jt}$ is sex ratio at village units, and $son1st_{ij}$ is a dummy variable equals one when the first child of the family is a son. X_{ijt} is

a series of other control variables. ν_t denotes year fixed effects, and μ_i represents household fixed effects. All results are generated from household fixed effect estimations. Since our main interested variables, i.e., tobacco use and alcohol drink, may reflect individual habit and local norms, household fixed effect estimations utilizing within-household changes in the consumption should help us get rid of these potential factors.

Restricting the sample to households with no more than two children, having a son itself is not found matter to the health-compromising behavior. However, the combination of having a son first and living in a village with more skewed sex ratios lead parents to more likely take risks.

Further, we release the assumption that the effects of control variables on parental inclination to engage in health-compromising behavior are identical regardless of the sex composition of children and the number of children. Running separate regressions for different types of families, nuclear families with a son and those with a daughter, we attempt to achieve unbiased estimates of the interested parameters at the cost of lower efficiency.

$$y_{ijt} = \alpha_1 \text{sexratio}_{jt} + X_{ijt}\Gamma + \mu_i + \nu_t + e_{ijt} \quad (2)$$

Specifically, we run regression (2) in the second column (for nuclear families with a son) and the third column (for nuclear families with a daughter) for each outcome variable in Table 4. Results comparing the two types of homilies suggest more health-threatening behavior among the nuclear families with a son, while no significant pattern is found for the nuclear families with a daughter.

The same set of results using the CHNS data is reported in Table 10. Unlike expenditures on tobacco use and alcohol smoking collected by the Guizhou data, the CHNS data surveys information on number of cigarettes one smoke per day and grams of liquor drinks per week. The main findings in Table 4 are confirmed.

One may hypothesize that the marriage market impact in promoting health-compromising behavior should be more intense for households with son reaching marriage age. CHNS has larger sample size, which facilitates testing heterogeneous marriage market impact by different age cohorts. Regressions (1) on CHNS age cohorts starting from 1-5 to 26-30 are estimated, and their marginal effects are drawn in Figure 6. The growing marginal effects of the interaction term (sex ratio*first child being son) suggests that marriage market pressure becomes more intensified as a son grows up to marriage age. Though the limited sample size in Guizhou survey prohibits us from testing heterogeneous effect by age cohorts as we do with CHNS data, a separation into 1-11 and 12-19 age cohorts suggests that the 12-19 cohorts demonstrate much higher marginal marriage market effect than the 1-11 cohorts. In Guizhou, families with boy reaching 12 hold a coming-of-age ceremony, signaling

to the community that the boy grows up to the marriage age. This norm is consistent with our evidence using Guizhou survey.

4.2 Robustness of the Main Findings

First, the number of children in a household might be an endogenous choice of parents. Therefore, in Table 5 we check Heckman two-step estimations that model parental fertility choice to stop at one child. Following Wei and Zhang (2011), we use minority status of the household, age of the first child and whether the first child disables or suffers from big diseases as the series of exclusive variables in the selection equation of whether parents stop at the first child. The main equations for nuclear families with first child being son still maintain statistical significance, while no significant result is found for main equations for nuclear families with first child a daughter.

Table 6 shows the result from a falsification test that replaces the sex ratios (age cohort 5-19) best capturing current marriage market competition by sex ratios of less relevant age cohort (30-40). The effects immediately disappear and even change signs. This test indicates that the combination of having son and living in an area with skewed sex ratio at marriage age, rather than some unobserved potential trend, promote parents to engage in more health-compromising behavior.

Due to the small number of village clusters in our Guizhou survey, we cluster the standard errors using the Cameron-Gelbach-Miller (2008) bootstrap methods. Compared to the main result in Table 4, the adjusted results in Table 9 do not differ significantly.

4.3 Potential Mechanisms

Does income status affect parental engagement in health-compromising behavior? Table 7A tests the main results by income quartiles. Smoking and alcohol drinking seem to bias towards the lower income quartiles, which echoes the pattern in Figure 4 and Figure 5 that poorer households with son living in high sex ratio villages tend to consume more health-threatening goods. It is plausible that the poor with limited resources are less able to cope with marriage market pressure and therefore consume more tobacco and alcohol. However, both tobacco smoking and alcohol drinking are highly visible and positional (Heffetz, 2011), which may suggest that the poor households signal to improve social status. Besides, one may be concerned that unbalanced sex ratios might motivate more smoking and alcohol drinking through income effect. For example, evidence suggests that unbalanced sex ratios stimulate grooms' families to work harder to earn more money (Wei and Zhang, 2011).

To test whether income effect dominates the pathway that sex ratios affect smoking and alcohol drinking, in Table 7B we regress sex ratios on per capita income and compare

the effect for families with different demographic structures. When the sample includes all families, we do not find positive impact of sex ratio on income. When interact sex ratio with first child being son and restrict the sample to families with one or two children, we find positive but insignificant effect on income. We further restrict the sample to families with one child - a son (column 3) or a daughter (column 4). Results suggest even negative (but insignificant) effect of sex ratio on income for families with son and positive (and insignificant) effect for families with daughter. This piece of evidence clearly does not support the story of income effect.

Though the positional feature of tobacco and alcohol consumption makes it difficult to fully distinguish marriage market pressure from status seeking motive, the rich Guizhou survey data on different types of tobacco consumption enables us to partially distinguish the two mechanisms. Specifically, tobacco pipe smoking generally has little to do with status signaling. If status signaling is the dominate motive, we should find little evidence on tobacco pipe smoking. However, results from Table 7C show those families with a son living in high sex ratio villages experience more tobacco pipe smoking. In other words, coping with marriage market stress / depression is an important motive for more health-compromising behavior.

4.4 Spatial Estimation Evidence

To separately account for the direct effect (own effect in the marriage market) and the indirect effect (marriage market effect due to other households in the networks), we conduct spatial estimations (Table 8A) and measure the direct and indirect effects (Table 8B). Specifically, we estimate the Spatial Durbin Model (SDM) with fixed effects. Following Elhorst (2012), define Spatial Durbin Model (SDM):

$$y_{it} = \rho W y_t + X_{it} \beta + W X_t \varphi + \epsilon_{it} \quad (3)$$

in which W , named the adjacency matrix, represents an $N \times N$ matrix of spatial weights, X_{it} is an $1 \times k$ row vector of independent variables for panel unit i at time t . y_t is an $N \times 1$ column vector of the value of y for all panel units in period t . Compared to Spatial Autoregressive Regression (SAR) model, the SDM model further include $W X_t$, which denotes spatially weighted independent variables that captures the interactions via independent variables.

Lineal relationship networks information is utilized in constructing the adjacency matrix W and the following spatial econometric estimations. Due to the concern about endogenous network formation, spatial estimations based on gift networks are conducted (with similar results) but not reported here. Quasi-maximum likelihood (QML) estimations are conducted.

Spatial econometric estimation results confirm the significance of own pressure in the marriage market (the combination of own localized village sex ratios and having a son) on own health-compromising behavior (*the direct effect*⁴), and in the meantime they suggest that non-spatial estimation underestimate this effect by up to 5.2% $((0.77-0.73)/0.77=5.2\%)$.

Results in the Spatial Durbin Model (SDM) indicate that peer pressure in the marriage market (via friends having son and living in areas with unbalanced sex ratios) can spill over to this family in driving its health-compromising behavior (*the indirect effect*⁵). However, the indirect effect is not identified in the non-spatial estimation.

5 Conclusions

China and some other East Asian countries have experienced increasingly skewed sex ratios. Utilizing two datasets, the Guizhou longitudinal survey and the CHNS, we find that highly localized marriage market competition promotes health-compromising behavior. Parents with son consume more tobacco and alcohol, while those with daughter do not demonstrate this pattern. Our results may underestimate the marriage market effect as rural China is subject to less stringent family planning policy.

Income effect motivated by grooms' families desire to earn more income to afford wedding expenses seems not viable in explaining the observed pattern of health-threatening behavior. Meanwhile, significant consumption of different types of tobacco consumption with distinct visibility suggests that status signaling among the poor in the marriage market, if exists, is unlikely to be the only motive behind the observed behavior. Therefore, coping with marriage market stress / depression seems most plausible in explaining the behavior.

Employing unique social network datasets, interactive marriage market effect within the networks is identified and distinguished from the direct effect. Compared to our spatial

⁴Rewriting the SDM model in matrix form, $y_t = [I - \rho W]^{-1}(X_t\beta + WX_t\varphi + \mu)$. Differencing with respect to X_t and averaging the result over all households generates the direct effect and the total effect as follows:

$$M_{dir}(k) = trace([I - \rho W]^{-1}[I_N\beta_k + W\varphi_k])(1/N)$$

$$M_{tot}(k) = i'_N([I - \rho W]^{-1}[I_N\beta_k + W\varphi_k])i_N(1/N)$$

where i_N is an $N \times 1$ vector of 1's. The direct effect measures the impact of a unit change in variable X_k in household i on outcome in household i average over all households $i=1N$. In the language of matrix, the direct effect is defined as the average of the diagonal elements of the matrix. In contrast, the total effect measures the impact of the same unit change in variable X_k in all households on outcome in household i and averages over all households.

⁵The indirect effect is $M_{ind}(k) = M_{tot}(k) - M_{dir}(k)$. In the language of matrix, the indirect effect is defined as the average of either the row sums or the column sums of the non-diagonal elements of these matrices (since the numerical magnitudes of these two calculations of the indirect effect are the same, it does not matter which one is used).

econometric estimations, non-spatial models underestimate direct marriage market pressure by up to 5 percent and ignore the indirect spillover effect within the networks.

Given the fact that sex ratio imbalance in China will probably worsen in the next decade, disentangling the sources of marriage market pressure with negative network externalities and behavior consequences should help design efficient targeting policies that improve parental well-being. Effective policies should work through balancing highly skewed sex ratios.

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