

# China's Bride Shortage & Upcoming Challenges for Elderly Men

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Fertility decline has fueled a sharp increase in the proportion of 'missing girls' in China. An increasing proportion of males will fail to marry, and face old age without the economic and other support of wives and children. We project the proportions of never-married men and their geographical distribution in China in the coming decades. This is based on the assumption that marriage formation continues its current pattern whereby women favor men with better prospects, migrating if needed from poorer to wealthier areas. We find that the national average of never-married males aged 30-39 will exceed 20 percent by 2030, but far higher rates of bachelorhood will prevail among poor men in low-income provinces that are least able to provide social protection programs. This geographic concentration of unmarried males could be socially disruptive, and the results suggest a need to expand the coverage and central financing of social protection programs.

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# 1 Introduction

In the wake of China's rapid fertility decline and the One Child Policy of 1979, the male fraction of births began to rise (Zeng et al. 1993). This is consistent with previous evidence of intensified sex selection in China during wars and famines, when parents were faced with sharper choices about whether to invest in raising girls (Das Gupta & Li 1999). Sex selection also became easier during the 1980s,<sup>1</sup> with the spread of ultrasound technology inducing many parents to engage in prenatal sex selection (Goodkind 1996).<sup>2</sup> The continued rise in the sex ratio, however, has surprised and alarmed observers worldwide. The Chinese Census in 2005 reflected a sex ratio at birth of 119, implying that each year there are roughly 1 million more boys born than girls.<sup>3</sup> For cohorts born between 1985 and 2005, there are 25 million more men than women,<sup>4</sup> implying a large number of men will fail to marry.

A "marriage squeeze" of this magnitude and duration can be expected to generate social change. Where marriage market sex ratios are higher, women exercise greater bargaining power within the marriage (Porter 2009a, 2009b, Edlund et al. 2009). Households in regions with a greater bride shortage are also found to have higher savings rates if they have a son (but not if they have a daughter) than matched households in other regions (Wei & Zhang 2009). The authors conclude that as much as half of the increase in the household savings rate during 1990-2007 can be attributed to efforts to enhance households' competitiveness in the marriage market. Consistent with this, Edlund et al. (2009) find that households in regions with higher sex ratios invest more in their sons' educations. A study in Taiwan finds that with the sudden shortage of brides caused by the influx of the Nationalist army and government from the mainland in 1949, bride prices rose and women's bargaining power within the household increased (Francis 2009).

Marriage norms could change over time in response to the marriage squeeze. Men may seek to marry into much younger cohorts, and other kinds of adjustment are possible.<sup>5</sup> Since son preference is related to a social norm where the wife joins the husband's family upon marriage, the central government has encouraged men to consider joining their wife's family instead, as a way to lower the perceived benefit having sons versus daughters (Li 2007). Some men will be

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<sup>1</sup> Anonymous sources reported 100,000 ultrasound machines in China in 1990 and a cost (bribe) of \$50-70 (in 2009 U.S. dollars) for a fetal ultrasound for sex determination (Kristof 1993). More recently, the cost in Beijing was estimated at \$360 (Schorn 2006).

<sup>2</sup> Postnatal selection continues to be an issue in China. Recent work by Das Gupta et al. (2009) finds that the child mortality differential between boys and girls has widened in recent years.

<sup>3</sup> The calculation of SRB is somewhat disputed, with credible estimates ranging from 118 to 120. The figure for births in the prior year may be subject to biases – see Cai (2008) for a full discussion. However we find that the sex ratios are relatively consistent, with approximately the same ratio of males to females among 5-9 year olds in 2005 as among 0-4 year olds in 2000. The figure we refer to here is the ratio of male to female children from birth to the age of 1.s

<sup>4</sup> Hesketh and Ding (2006) report a higher figure of 32 million, but we believe this to be an overcount. Our estimate of 25 million for the period 1985-2005 is based on the published tabulation of the 2005 Census which surveyed 1.41% of the population, and is more in line with previous estimates of 23.5 million by Poston and Glover (2005) for 1980-2000.

<sup>5</sup> Child betrothal was one way of securing a bride in China in the past, but it has been actively prohibited since 1950. Sommer (2005) documents cases of men resorting to polyandrous contracts in the past, but this seems to have been rare. Greenhalgh (2010) suggests these practices may reassert themselves, but radical changes in current social norms and government policies would be needed for this to happen on a scale large enough to affect the marriage squeeze.

able to attract brides from poorer neighboring countries. Still, given the scale and imminence of China's bride shortage, it seems unlikely that social norms regarding marriage will change or evolve rapidly enough to offset it significantly.

Some have also suggested that high levels of enforced bachelorhood may raise levels of crime and violence, and there are reports of some women being abducted and coerced into marriage (Banister 2004). Edlund et al. (2009) argue that China's increase in crime rates in the 1980s and 1990s is related to rising juvenile sex ratios from cohorts born during China's fertility decline during the 1970s. However, the potential unrest related to China's high sex ratio will become more pressing in the next several decades, as the cohorts born under the One Child Policy reach maturity. The China Academy of Social Sciences predicted that one in five men will fail to marry in 2020, a figure that has become widely cited by the Chinese leadership (CASS 2009). However, empirical evidence on the social and economic consequences of widespread marriage delay for males remains underdeveloped.<sup>6</sup> Even less is understood regarding the specifics of this impending collapse: which men will fail to marry, where these problems will emerge, and what can be done now to prepare for the fallout. This paper attempts to provide answers to these questions.

Given the sex ratio of cohorts already born, our projections indicate that the sex ratio of the marriage market will increase sharply in the next decade (Figure 1). The availability of marriageable women will hit an all-time low in the 2020s, regardless of the fertility and sex ratio scenarios considered. Our projections for beyond 2030 involve cohorts not yet born, so appreciable differences in the sex ratio of the marriage market begin to appear depending on how the sex ratio at birth and fertility evolve.

In order to anticipate the consequences, we examine patterns of marriage formation in China. We demonstrate two key facts regarding the Chinese marriage market using Census microdata from 1982, 1990, and 2000. First, economic status is a crucial predictor of entering marriage for men in China. We use years of education as the closest proxy for economic status, and find that while there is almost universal marriage for highly educated men, less-educated men are less likely to marry (Table 1). Women experience nearly universal marriage regardless of education, and are able to be hypergamous, marrying men more educated than themselves. Second, since many women migrate to marry (Figure 2a), this is likely to exacerbate the shrinking of marital prospects for men in poor areas of the country with less-educated populations.

Recognizing these patterns of marriage formation, we implement a macro-simulation of China's marriage market in the 21<sup>st</sup> century similar to the method used in Ebenstein & Sharygin (2009), but in this analysis we explicitly account for female preferences to marry men of higher status. Our marriage rule assumes hypergamous partner preferences among women (consistent with current practice as reflected in Table 1), meaning that women will marry men of higher education and income when possible, and will migrate to wealthier areas in pursuit of higher

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<sup>6</sup> A surplus of young single men may generate economic benefits for the national economy if having fewer dependents translates into more time spent working. However, the downstream costs may outweigh benefits if such men become a cost to society through increased problem behaviors or costs for old age support. In addition, the single young men will be concentrated among the least economically productive in the country. We refer the reader to the extensive literature regarding demographic dividends (Wang & Mason 2005), through which a population's age distribution plays a role in economic growth.

status males. Using this framework, and the known distribution of men's educational attainment, we project the proportion of unmarried men and their geographic distribution, casting light on the impending demographic pressures on China's marriage market.

Our findings indicate that China's looming problems in the marriage market, and the failure of men to marry, will be exacerbated by the unequal distribution of marriage outcomes. Unmarried men will tend to cluster in the rural areas of poor provinces. This means that it will be the men with the least access to financial security — through access to jobs and programs for social assistance and social insurance — that will also be faced with the prospect of having no familial support network. This unequal distribution raises the possibility of social instability in China. Our results suggest that China's current social protection framework needs a radical overhaul if it is to respond adequately to projected needs. Given that China's population currently has a large share of working-age young adults, revenue set-asides to capture economic surplus in the near future are more appealing than pay-as-you-go options.

The paper is organized as follows. In the next section, we examine patterns in marriage in China today and in the recent past, focusing on the importance of education and migration patterns. In section 3, we discuss our macro-simulation model of China's marriage market and in section 4 we present results of the model at the national and provincial level. In section 5, we discuss China's programs for social assistance and social insurance, and how they relate to our results. Section 6 concludes.

## **2 Marriage Markets in China**

### **2.1 Factors affecting selection into marriage**

In most societies, men of higher economic status are preferred in the marriage market. The closest proxy to economic status that is available in Chinese Census data is educational status. In the cohort aged 40-50 in the 2005 Census, nearly 99 percent of college graduates found wives compared with under 90 percent for men with less than a primary education (Table 1, cohort born in 1955-65). In contrast, women enjoy nearly universal marriage — across all education groupings and across all birth cohorts. Table 1 also reflects changes over time in the extent of bride shortage. Following the civil wars and Japanese invasion of the 1930s (when sex ratios at birth were highly male-skewed), sex ratios at birth declined (Das Gupta and Li 1999). During Mao's regime households were replaced by communes as the primary unit of production and allocation of resources to citizens, reducing parents' dependence on sons for old age support, so sex ratios at birth were more normal except for a small rise during the Great Leap Forward Famine. However, across all three birth cohorts than span these changes (Table 1), educational attainment is central to predicting marital status.<sup>7</sup>

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<sup>7</sup> The birth cohort of the Great Leap Forward has recently been found to have lower lifetime probability of marriage, controlling for educational attainment, which the authors attribute to the reduced availability of spouses and the reduced health or attractiveness of the cohort (Brandt et al. 2009; Almond et al. 2007).

## 2.2 Hypergamy and migration

The areas of China with the highest sex ratios at birth in 2000 tend to be the wealthier areas of the country, but our projections indicate that in 2030 the poorer areas will have the highest projected proportions of single men aged 30 and above (Figure 3). Additionally, Census data for 1990 and 2000 indicate that women in areas with the highest sex ratios on the marriage market tend to marry earlier, while men marry later, though this could partly be because they spend more time on education.<sup>8</sup> However, they have higher marriage rates by age 30 than poorer areas with more normal sex ratios at birth.

Women migrate from poorer areas into wealthier areas, leaving men in rural areas more exposed to the marriage squeeze. Comparing the 1995 and 2002 China Household Income Projects, Meng (2009) found that females who out-migrate are generally not replaced; so local males have lower prospects of marrying. In Figure 2a, we map the net migration of women by prefecture for the purpose of marriage in absolute terms. The areas shaded darker are experiencing inflows of women, and these areas overlap substantially with areas with a higher proportion of educated males (Figure 2b).<sup>9</sup>

Poorer provinces provide a ‘demographic subsidy’ to the marriage markets of wealthier provinces, through two routes. The first is the flow of female migration within central and coastal China, from the poorer to the wealthier areas. In Figure 2a, we map the net migration of women by prefecture for the purpose of marriage<sup>10</sup> in absolute terms. The areas shaded darker are experiencing inflows of women, and these areas overlap substantially with areas with a higher proportion of educated males (Figure 2b). We explore in more detail the relationship between the characteristics of prefectures within a province and the number of women who have migrated into the prefecture for the purpose of marriage (as a share of the total number of women) using regression analysis. The results, shown in Table 2, indicate that each year of additional average education among men is associated with an additional 0.196 percent of women who have relocated to the prefecture for marriage. The magnitude of this result is modest, but the implication is that even within a province, wealthier prefectures are able to attract women and mitigate problems associated with a skewed sex ratio at birth. In columns 2 and 3, we add control variables for the share of the prefecture with urban registration and the sex ratio of young children aged 0-4. The results indicate that more urbanized prefectures attract females, possibly since urban areas offer better economic prospects. Areas where sex ratios among young children are more skewed also attract females, being often wealthier than other parts of the country.

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<sup>8</sup> Authors’ calculations from the China 1990 and China 2000 Census (figures available upon request). Prefectures were divided into quintiles based on the ratio of males 22-32 to females 20-30. The share of males and females by marital status by age for each cross-section was compared across the highest and lowest quintiles. High sex ratio areas showed earlier marriage for females (~5 percentage points more females married among 25 year olds) or later marriage for males (~10 percentage points more males unmarried among 25 year olds).

<sup>9</sup> Table A1 also presents detailed figures regarding net female migration and provincial characteristics.

<sup>10</sup> The census questionnaire asks migrants to state their reason for migration, with one option being “marriage migration” or moving in to a marriage (*hunyin qianru*). The wording suggests that the count from this question may not include many female migrants who move with the intention to marry at their destination.

The second form of 'demographic subsidy' is a net inflow of less-educated Han men from central and coastal China to the Western provinces, helped by (sometimes informal) policies to promote migration to less developed minority areas (Bhattacharji 2009). Table 3 shows that migrants to these poorer provinces had less education than migrants to wealthier provinces. For example, only 12.8 percent of migrants to Xinjiang (to which many migrate and which has a relatively low GDP per capita) had completed senior middle education or higher. In comparison, over 30 percent of male migrants to such as Beijing and Tianjin (which have a relatively high GDP per capita) had completed senior middle education or higher.<sup>11</sup> Moreover, the men who migrate to poorer provinces are often less educated on average than the men already living in these provinces.

The implication for remote provinces is that, while their sex ratio at birth is relatively low compared with other provinces (Ebenstein & Sharygin 2009), they should anticipate high sex ratios in their marriage markets due to female out-migration and in-migration of single males. If sex-selective abortion is a form of injustice which leads to problems for the next generation, then there is also a certain injustice to the location-specific burden of unbalanced marriage markets. As an analogy, it would be considered unfair if one country were to create large amounts of environmental pollution but ship the problem to poorer neighboring countries. In essence, this is what we observe in China's marriage markets. As restrictions on internal migration continue to loosen, it seems very likely in the coming decades that China's marriage market—already highly mobile—will become truly national. As a result, disparities in men's marriage outcomes will become even more pronounced, as the scarcity and mobility of women allows for increasingly hypergamous pairings.

We discuss the ramifications of these observations on modeling the marriage market in the next section.

### **3 Simulating China's Marriage Market: Methods**

In this section, we outline the assumptions we make in order to simulate the Chinese marriage market. We make two sets of simulations, one up till 2030 and the second beyond 2030. The simulations till 2030 are based on cohorts already born. For this reason, the simulations require only assumptions regarding marriage formation, and do not depend on future changes in either fertility or the sex ratio at birth. The second set of simulations (beyond 2030) consists largely of cohorts not yet born. For this reason, the simulation results are predicated on both our marriage formation assumptions and our assumptions regarding the future course of Chinese fertility, and should therefore be interpreted with greater caution.

We also recognize that marriage formation patterns in China may adapt in the context of high sex ratios, and so we present a set of robustness checks in the appendix materials where we explore the potential impact of changing norms, such as women choosing to marry younger. Given their nature, such simulations should not be over-interpreted as yielding precise estimates of the numbers of unmarried men. Instead, they illustrate important national trends and regional differences in male non-marriage, should hypergamous marriage preferences in China persist.

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<sup>11</sup> Authors' calculations from the China 2000 Census 0.1 percent sample.

### 3.1 Key assumptions regarding marriage formation

Marriage formation is a complex process even when a population sex ratio is ‘normal’, and marriage simulation techniques are still in their infancy (see Appendix A). Our marriage model is an attempt to isolate a few important factors in mate selection, and in particular the factors that are currently important in Chinese marriage markets, such as hypergamy and migration. It is worth noting, however, that our model of mate selection is an extreme simplification of the marriage market, and cannot account for the host of potential changes in social norms on marriage that may take place under the pressure of high sex ratios.

As such, our simulation relies on assumptions selected to maximize the number of projected marriages given a somewhat flexible formulation of current social norms. The marriage model we employ is female dominant: in order to maximize the matches generated, males are not attributed any preference function for females. Our key assumptions in assigning marriage matches are a unitary national marriage market with an 8-year maximum age gap between spouses; no ethnic preferences<sup>12</sup>; and that (subject to the age constraint) the only preferences that matter are women’s preferences for more highly educated and older males. In addition, very few first marriages in China occur after age 30; we therefore prefer to refer to the share never married above age 30 or between the ages 30-39.<sup>13</sup> In the near term, this represents the proportion which will remain single for life.<sup>14</sup>

Flexibility in spousal age gaps, is a mechanism for ensuring clearing of the marriage market in the context of skewed sex ratios (Ni Bhrolchain 2001). We therefore allow for an age gap between spouses of 8 years, which is one of the largest observed average age gaps for marriages among men or women of any age (Lloyd 2005; Casterline et al. 1986), and which would represent a major break from current practice in China.<sup>15</sup> This wide age gap gives us conservative estimates of failure to find a bride. Regardless of the assumed maximum age gap, females’ preference for educated spouses may cause the share of unmarried males in a particular

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<sup>12</sup> Insofar as minority women in the future will prefer to marry minorities over Han men of higher status, our results will exaggerate the marriage failure rates of minorities.

Sociological research indicates that a potential mate’s ethnicity is not a first-order consideration in mate selection in China today, including in rural areas (Wei 2007). In addition, many who identify as minorities are actually of mixed ethnicity and may have more cultural affinity with the Han majority (Wei & Cao 2007).

<sup>13</sup> In the 2000 Census (.1 percent sample) over 97 percent of every-married men report marrying below age 30.

<sup>14</sup> Delaying marriage past age 30 may become more common in response to the marriage squeeze. This change would not alter our results much since the peak sex ratio of the marriage market will affect a cohort of males rather than a point in time. In other words, if we focus on the share never married between the ages 40-49 instead of 30-39, we would merely delay the year of the peak predicted share unmarried, and not the magnitude of the predicted share unmarried in that cohort.

<sup>15</sup> The current average age gap between spouses is under 2.5 years, and has remained under 3.5 years for as many years as China’s modern Census data can be projected backwards (Ebenstein & Sharygin 2009). 8 years is larger than the average age gap between spouses for men and women aged 20-30 in all countries for which DHS surveys have been conducted (with the exception of some countries in West Africa; see Lloyd 2005) and among the highest in populations included in the World Fertility Survey (Casterline et al. 1986). Marriages among males older than 30 tend to have a large age gap between spouses, which is largely but not entirely due to remarriages. To test for the effect of further increases in the average age gap, we additionally used a dynamic (increasing with age) gap that generated an age gap of 8 years for females at age 22 and increasing thereafter with age; our results using this method were consistent with these estimates (not shown).

age group to be higher than the SRB for that group, as more highly-educated men from different cohorts can choose brides first.

Another mechanism for adjusting to the shortage of women is to lower the age at which women marry. In the appendix we test for this, and find that a decline in age at marriage for females does not alter our core results on marriage failure rates, but merely postpones the timing of its peak. For example, if women marry at age 20 (instead of our base assumption of 23 based on recent practice<sup>16</sup>), the peak of marriage failure rates is delayed by roughly 20 years, and occurs in 2050 rather than 2030, but at similar levels of marriage failure (Figure A1). Other changes in marital norms are theoretically possible, such as a significant shift from monogamy to polygamy, but since there is no evidence of this yet it is outside the scope of this paper to consider them.

### 3.2 Projecting the population<sup>17</sup>

As noted above, our main conclusions derive from estimates for 2030, which are based on cohorts already born and therefore not affected by the alternative fertility and SRB scenarios described below. In order to simulate China's marriage market beyond 2030, we now discuss several different predictions regarding future population growth in China.<sup>18</sup>

Population change is defined as the balance of migration, mortality, and fertility. In the current Chinese case, we assume a closed population, as international migration is usually insignificant relative to the total population. The UN projects significant increases in longevity for China: life expectancy is projected to rise from 69.6 to 73.3 for males and 77.6 to 82 for females between the years 2000-2050 (UN 2008). However, if increases in longevity occur equally between sexes or primarily at advanced ages, then the effect on young adults in the marriage market (aged 20-40) will be minimal. Since we are concentrating on the share of males aged 30-39 that are single, we adopt age- and sex-specific mortality rates from year 2000 life tables (Banister & Hill 2004).<sup>19</sup>

Fertility and the sex ratio of births are the key inputs to the projections of share of males that are single in the years after 2030, besides the behavioral assumptions regarding the marriage market detailed above. Declines in fertility will further increase the sex ratio of the marriage market and increase the unmarried share of males. We provide results for the three alternate scenarios shown in Table A2 predicting changes in fertility, based on those that have been used

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<sup>16</sup> The average age at first marriage for females was 23 (and 24.8 for males) in 1999, according to the UN (UNPD World Fertility and Marriage Database 2003).

<sup>17</sup> Appendix A gives further details of the methods used for projecting the population and the sensitivity analysis of our core results.

<sup>18</sup> Only a few authors have attempted the challenging task of simulating changes in a population as large and complex as China's. Tuljapurkar et al. (1995) presented a model of the consequences of high sex ratios to the marriage market apparent already in the China 1990 Census, when the parity-combined sex ratio was only 113. Their model focused on the timing and size of the anticipated imbalance in the sex ratio of the marriage market, the effect of the sex ratios at birth on the probability of having a son, and the share of elderly with no son. They expect that the imbalance of the sexes at marriage ages will result in approximately 8 percent excess males. More recently, Zeng et al. (2008) have constructed a detailed probabilistic model of population growth in China including microsimulation of a two-sex marriage model with extremely promising initial results. We have adopted some of his assumptions about future changes in fertility into our model.

<sup>19</sup> We tested the sensitivity of the results using mortality rates interpolated between UN estimation years by the Brass logit method, and the effect on the outcomes presented here are minimal.

elsewhere in related literature (Chen & Liu 2009; Zeng et al. 2008). The “no change” scenario assumes that the fertility rate will remain constant at its current value of 1.65, while the “slow change” scenario assumes a 1.2 percent growth in fertility rates between 2010 and 2030, leveling off at the replacement fertility rate of 2.18 in 2030. The intermediate “late change” scenario assumes a one-time 19 percent increase in fertility rates in 2012 that models pent-up demand for children relieved by a sudden policy change.<sup>20</sup>

Similarly to our treatment of expected fertility rates, we use three different projections of the sex ratio at birth that capture the extremes of possible outcomes after 2005 (Table A2). The SRB is a figure that has been subject to a high degree of scrutiny and forecasting.<sup>21</sup> We use the estimate for 2000-05 from the China 2000 Census 0.1 percent sample. While the 2005 1 percent inter-census survey shows a modest increase in the sex ratio during 2000-2005, we prefer to err on the side of caution by carrying the lower sex ratio from 2000 forward to 2005, and then assuming an immediate adjustment starting in 2006. The ‘low’ scenario provides a point of comparison, as a SRB of 1.06 is within the biological norm. The ‘medium’ scenario assumes that the government's policy is effective at stabilizing the SRB at 1.09 for all births after 2005, identified as a policy target for the near future (Li 2007). The ‘high’ scenario assumes that the SRB in 2005 of 1.18 persists indefinitely. It is worth noting that none of these assumptions about future fertility patterns affect our projections for marriage markets through 2030, since these cohorts have already been born.

## **4 Results of the Simulations of China’s Marriage Market**

### **4.1 National results**

By 2030, an estimated 20.8 percent of men aged 30-39 will never have married. Table 4 shows the results of our projections of the percentage of men unmarried. Because we employ data from 100 percent summary tabulations of the China 2000 Census, statistics at the national level can be calculated for open-ended and closed age groups. In comparing numbers, two issues need to be highlighted.

First, results differ sharply between those for the closed age group of men 30-39 and those for the open-ended age group 30+, with the results more striking for the former. Sex ratios at birth began to rise sharply from the mid-1980s, so men born after 1990 are the first projected to face a significant squeeze on the marriage market. Thus, 78 percent of those aged 30+ in 2030 and 42 percent of those aged 30+ in 2050 are old enough to have avoided most of the marriage

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<sup>20</sup> This is based on age specific fertility rates from China NBS Sample Survey on Population Changes (2006). The fertility rate in China is the subject of much debate. Some have argued that official statistics are distorted due to under-reporting of births in the census, given the official One Child Policy. The lowest estimate currently in circulation is that of the China NBS, which estimated a TFR in 2005 at 1.38. The highest estimate is by the UN World Population Prospects 2009, which estimates a TFR of 1.77 during 2000-2005. Cai (2008) summarizes the debate and estimates a value of 1.5-1.6, in line with other third party calculations. See also Goodkind (2008) and Lutz et al. (2007) for discussions of competing estimates and Zeng et al (2008) for an upward fertility adjustment.

<sup>21</sup> For a review of the available estimates of SRB, and reasons for expecting differences between reported and actual sex ratios, see Goodkind (2008).

squeeze.<sup>22</sup> As a result, while one fifth of men aged 30-39 are estimated to remain single in 2030, only 7 percent of those in the open-ended age group 30+ are estimated to be unmarried. The estimates for the age-group 30-39 may be more critical for predicting issues related to social unrest in China, since people's views are most likely to be shaped by the experience of their own age peers.

Second, we find that the bride shortage is only mitigated after 2030, even if the sex ratio at birth dropped sharply after 2005. This is because those marrying before 2030 had already been born by then. As a result of sex ratio imbalances in cohorts already born, aggregate spousal availability will hit an all-time low before recovering, regardless of potential subsequent changes in fertility and sex ratios at birth. The effect of changes in the sex ratio is significant in the decades thereafter, with 18.2 percent of men remaining single in 2050 under current conditions. This would be nearly 7 percentage points lower if the sex ratio had been successfully contained at 1.09 after 2005 (Table 4).

This core finding – that substantial proportions of men in China will fail to marry at very high rates during the next several decades as the cohorts born during the One Child Policy reach marriage age – is highly robust to alternative assumptions regarding changes in fertility and the sex ratio at birth (Table A3).

## 4.2 Province-level results

At the provincial level and below, we present the results of simulations for the open-ended age group 30+ for the year 2030. In interpreting these results, we emphasize again that 78 percent of the men aged 30+ were born in more gender-balanced cohorts and faced little if any marriage squeeze. Due to limited data on sub-national geographies, it is difficult to simulate the marriage market for closed age-groups.<sup>23</sup> Our focus here is therefore not on the actual proportions of men projected to remain single, but on their geographic distribution.

Figure 3 maps the projected proportion of Han unmarried men aged 30+ in 2030 in each area by quintile. We estimate this spatial distribution by applying the education-specific share never married in 2030 to the local share of the male population with that level of education (based on the assumption that there will be no change in the relative standing of each area in the educational ranking). While females must migrate in order to achieve this distribution of marriage outcomes for males by education, males may or may not also migrate as long as the spatial distribution of relative education outcomes remains constant.

Poor provinces will be hit hardest by the marriage squeeze (Table 5).<sup>24</sup> Provinces in the lowest quintile of income per capita are projected to have unmarried shares among men aged 30+

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<sup>22</sup> The percent of males who are too old to have faced a marriage squeeze come from projections made by the UN Population Division (2008) regarding the population age distribution in China.

<sup>23</sup> For the provincial-level results, the underlying simulation technique is unchanged, but tabulations of population by sex, educational level, and age are not published for provinces, and we require this information (or a larger sample of the China 2000 Census microdata from which we could create our own estimates) to accurately calculate the share never married for closed age groups. For this reason, we report only the results for men aged 30+, whose reported share never married is relatively low due to the older age composition of the 30+ group.

<sup>24</sup> A full listing of provinces and their marriage rates in our simulation is in Table A1. The percent unmarried for sub-national areas is calculated by applying the corresponding rate for ages 30-39 to the population by prefecture and by educational attainment, which is only available for ages 6 and higher. Thus, the population will be more

in 2030 that are 50 percent higher than in the wealthiest provinces. While the share of men who are ever-married in the coastal region will remain close to that observed today, many more men are predicted to remain single in the poorer inland and western provinces. In most cases, these are not the areas that currently have high sex ratios at birth (Fig 3a).

The results of our simulation suggest several areas of concern. First, a concentration of unmarried men raises the potential for social instability, as entire cohorts of men perceive that they and their peers face a high likelihood of permanent bachelorhood. This is unlike other areas that have historically had high levels of non-marriage such as Ireland, where there was no shortage of women and men could have a 'sweetheart' whom they could hope to marry if they could save enough. Elsewhere, as in South Korea, the shortage of women was mitigated by marrying women from poorer parts of Asia. With its compact geography and high level of development, South Korea offers high living standards and access to good schools and services, even for its poorer residents. By contrast, low-income men living in remote parts of China have relatively little to offer while their large numbers (compared with South Korea) make it very difficult to mitigate the bride shortage through female immigration.

Second, high concentrations of unmarried men in areas with large populations of ethnic minorities could lead to increased civil unrest. The majority of prefectures where the never-married share is projected to be highest in 2030 are located in Guizhou, Qinghai, Tibet, and Yunnan. High fractions of unmarried males are also predicted for Ningxia, Sichuan and Xinjiang. Some prefectures will be especially hard hit. For example in Guizhou, the percentage of unmarried males aged 30-39 is projected to exceed 50 percent in all but one prefecture by 2050.

Finally, another source of concern is the aging into retirement of China's working class. Provinces with high dependency ratios will have increasing difficulty in supporting their elderly while being confronted with large numbers of unmarried men. We turn to this in the next section.

## **5 The Geographic Distribution of Poverty and Social Protection Programs in China**

Poverty in China is heavily concentrated in the rural areas. The northwestern and southwestern regions are especially poor (World Bank 2009: Table 4.21). Whether measured by income or consumption, nearly 30 percent of the rural elderly were classified as poor in 2006, compared with only 5 percent of the urban elderly (Cai et al. 2009: Table 2).

Many urban workers are covered by formal social insurance programs, though they cover far lower proportions of the poor than the non-poor (World Bank 2009: Figure 6.74). In 2007, around half of all urban workers had pension coverage, 45 percent had Basic Medical Insurance, and 40 percent had unemployment insurance and work injury insurance (World Bank 2009: Table 6.71). In contrast, the rural pension system (funded mainly by personal contributions and

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heavily weighted towards primary and junior middle level education, and the resulting overall share never married biased upwards.

collective subsidies) covered only about 10-11 percent of the rural labor force (World Bank 2009: Table 6.65), and coverage of the rural elderly population was particularly limited.

Less than 5 percent of the rural elderly had pension income in 2005 (Table 6). They continue to rely heavily on their families for support, customarily on their sons. In 1991 and 2006, pilot pension programs were launched, funded largely from individual and local contributions (Leisering et al. 2002, World Bank 2008:76-77). In September 2009, the central government introduced a new voluntary rural pension scheme based on individual accounts, which aims to reach full coverage by 2020 (State Council 2009). It is funded primarily by individual contributions, with modest subsidies from local governments.<sup>25</sup> In addition, the central government will give the very modest amount of 55 yuan (8 U.S. dollars)<sup>26</sup> monthly to rural residents over the age of 60.

The rural health insurance system (NCMS) is a voluntary health insurance scheme where the central government contributes 20 percent of the financing, and households and local governments contribute 40 percent each. As of 2007, reimbursement rates were very low (Yi et al 2009), offering little protection against being pushed into poverty by uninsured health shocks (World Bank 2009; Wagstaff et al. 2009). Other programs provide social assistance through direct transfers to the poor, but their coverage and benefit levels were very low in 2004 (World Bank 2009: Tables 6.63 and 6.64). While the percent of population receiving benefits was similar across richer and poorer regions, the average benefit per capita was much lower in the poorer regions. Coverage was very low nationwide as of 2005, and even lower in rural than in urban areas (Table 6). Since then, coverage in the *Di Bao* program has expanded rapidly, but benefit levels remain very low.<sup>27</sup> These programs rely on local government funding, so the residents of poorer areas with lower fiscal capacity are disadvantaged.

The implications for the rural elderly are not reassuring, and even less so given that unmarried men will be concentrated in poor rural areas. With low levels of social protection, the rural elderly depend heavily on their own labor income and family support, and this dependence rises sharply as they age (Table 6).<sup>28</sup> In addition, increasing proportions of China's elderly will be concentrated in rural areas, where old age dependency ratios are projected to rise sharply

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<sup>25</sup> The policy note states that the new voluntary rural pension scheme will be financed by (1) individual contributions from age 16 upwards of 100-500 yuan each year (2) subsidies from village collectives depending on their conditions, (3) local government subsidy of at least 30 yuan per year to the individual contribution, as well as all or part of the minimum pension premium for people, such as those with serious disabilities, who face difficulties in making the payments. In addition, the central government will pay 55 yuan monthly per person aged above 60.

<sup>26</sup> The dollar equivalent is reported by Yang (2010). In addition, Pu and Ran (2010) characterize these payments as "a drop in the bucket".

<sup>27</sup> This information is based on World Bank (2009), and personal communication from a report under preparation.

<sup>28</sup> Unfortunately, the surveys used in Table 6 did not ask about dependence on one's own savings in old age (Cai et al 2009). Other data indicate that rural households have high savings rates on average, which enables families to cope with risks and support their elderly (World Bank 2009: Table 2.15). However, these data also show that those below the poverty line are unable to save. The poor also receive fewer transfers than others (ADB 2004:40). This suggests that the poor elderly are unlikely to be able to draw on savings or transfers for significant support.

(Zeng et al 2008, Cai et al 2009), reducing the resources available at both household and local government levels for elderly support.<sup>29</sup>

For those who have never married, the picture is likely to be much bleaker. Not only are they less educated than married men, but even controlling for this they have lower incomes and savings than those who have married, and also report themselves to be in poorer health (Table 7). Whether this disadvantage is due to selection into marriage or due to the direct impact of marriage on male earnings or ability to save (Korenman and Neumark 1991), the implication is clear that unmarried men are quite significantly financially disadvantaged and in poorer health compared with married men.

Never-married men are thus likely to be unable to save adequately for their old age, or to work into their old age. They are also the most vulnerable to income and illness shocks, since they cannot smooth fluctuations in household income by pooling earnings from spouses or children. Unmarried people are also less likely to be living with family members who can serve as caregivers (Table 8). For example, in the 2000 Census, 65 percent of those aged 65-80 who had ever-married were co-residing with younger kin, compared with only 20 percent of those never-married. Moreover, levels of intergenerational co-residence have dropped sharply in recent decades (Table 8), and this trend can be expected to continue. Thus, the men who fail to marry are among the least likely to be able to save for their old age, to work in their old age, or to have access to old age support from family members.

## 6 Conclusions and Policy Implications

China's marriage squeeze will intensify rapidly as the heavily male cohorts born since the 1980s begin to saturate the marriage market. By 2030, an estimated 20.8 percent of China's men aged 30-39 will be never-married. Poorer areas are projected to experience much higher rates of non-marriage, as wealthier areas attract brides from them. Despite their more balanced sex ratios at birth, the poorer provinces will bear a disproportionate share of the social and economic burden of China's unmarried men.

The results paint a grim picture for China's ability to care for these men under the current policy structure of social protection programs that are primarily funded by individuals and their local governments (Wang 2006, World Bank 2009). Unmarried men are projected to cluster in poorer areas with low fiscal capacity to offer support. They are disadvantaged financially and in health relative to married men, and also less likely to co-reside with younger kin. These factors converge to raise unmarried men's likelihood of needing support, especially in their old age, while reducing their access to support from family or the state. For these reasons, the marriage squeeze will be experienced very unequally in different regions of China.

People have argued that high levels of bachelorhood in China may cause social unrest, based on national averages of the problem. We show that the national averages hide a great deal,

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<sup>29</sup> Zeng et al. (2008) project that rural areas (compared to urban areas) will have twice the share of over-80 population (4 percent in 2030; 13 percent in 2050), and approximately 1.5 times the share of over-65 population (22 percent in 2030; 33 percent in 2050).

and that the problem is highly clustered geographically. High concentrations of men facing enforced bachelorhood and vulnerable old age could significantly increase the potential for disaffection and social unrest, perhaps even more so since many of the poorer provinces also have large populations of ethnic minorities where demographic imbalances can add to other sources of social tension.

Our conclusions are based on the assumption that the sheer numbers of surplus men — 25 million already born 1985-2005 — in China will make it difficult to resolve much of the problem through adjustments in marriage systems, especially given the imminence of the marriage squeeze. Over time, adjustments of various kinds could be made, such as marrying women who are much younger or much older, and perhaps also other changes in the forms of marriage. If China's poorer provinces are able to raise their living standards quickly enough, some men may be able to attract women from poorer neighboring countries, but the potential demand for foreign-born brides is likely to far outstrip supply given the numbers involved.

Chinese policy must focus both on the short-run and long-run. Efforts to normalize the sex ratio at birth through advocacy and incentives can lower the prevalence of sex-selective abortion, while relaxing the One Child Policy can reduce parents' incentive to use sex-selection to have a son (Zeng 2007). These measures can help in the longer term, but for the coming decades there will be a severe surplus of men in cohorts already born. The more immediate need is to strengthen social protection programs, especially in poorer rural areas — where the percent of never-married elderly men is projected to rise most rapidly — and which are least-served by these programs because of heavy reliance on individual and local financing.

The World Bank (2009) recommends the strengthening of social protection programs that provide safety nets against destitution, and help people afford health insurance. We recommend that, in addition, these efforts pay special attention to areas which are projected to have large numbers of unmarried men. Central subsidies for these programs also need to increase, especially for poorer regions. The central government currently provides very limited support to the rural aged.<sup>30</sup> A progressively-structured national old age pension program could do much to reduce the vulnerabilities of the enforced bachelors. The resources can be found, since China continues to receive a significant demographic dividend from its large working-age population with few children to support. Mitigating the hardships faced by the emerging population of elderly bachelors can help reduce the potential for social instability.

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<sup>30</sup> Such programs may also be useful in lowering the prevalence of sex-selective abortion, insofar as this behavior is exacerbated by the incentive to produce a male child created by a lack of adequate social assistance programs for elderly care (Ebenstein & Leung 2009).

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**Table 1: Marriage and Education by Birth Cohort in China**

	Male Cohorts Born			Female Cohorts Born		
	1935-1945	1945-1955	1955-1965	1935-1945	1945-1955	1955-1965
Sex Ratio of Cohorts	1.13	1.08	1.04			
Total cohort size	569,588	873,505	1,024,910	504,251	809,753	987,090
Cohort Share Never Married by Education (%)						
Total share never married	5.64	5.41	3.95	0.20	0.28	0.38
Less than Primary	12.41	13.21	27.74	0.21	0.24	0.64
Primary	4.00	3.84	8.11	0.13	0.22	0.18
Secondary	1.82	1.21	2.15	0.51	0.98	0.40
College and Higher	0.79	0.66	1.30	0.67	2.30	1.56
Educational Attainment by Cohort (%)						
Less than Primary	22.41	20.23	2.12	57.81	42.83	8.28
Primary	67.60	67.45	22.00	37.61	50.57	35.48
Secondary	7.48	11.64	69.45	3.64	6.32	52.81
College and Higher	2.51	0.68	6.43	0.94	0.27	3.43

**Source :** China 1982 Census (1% sample), China 1990 Census (1% sample), China 2000 census (0.1% sample).

**Notes :** The share never married and the sex ratio of the cohorts in each column is calculated using data on individuals observed in these cohorts in the selected samples of the 1982 Census, 1990 Census, and 2000 Census, respectively. The observed sex ratios are slightly lower than when the individuals were of marrying age due to higher adult mortality among men. Ever married status is calculated using the 2000 Census, and so the sample is restricted to those still living at the time of the 2000 Census. Finally, it should be noted that eventhough the table's results are based on older cohorts (the most recent being born in 1965), we believe that the table accurately reflects present marriage market trends.

**Table 2: Prefecture Characteristics Associated with In-Migration of Females**

Variable	% In-Migration of Females		
	(1)	(2)	(3)
Years of Education (Men 20-30)	0.00196*** (0.0003)	0.00145*** (0.0005)	0.00139*** (0.0005)
Urban (1=yes)		0.00453 (0.0033)	0.00572* (0.0034)
Sex Ratio (Children 0-4)			0.0160*** (0.0050)
Observations	345	345	345
R <sup>2</sup>	0.346	0.354	0.394

**Source :** China 2000 Census (0.1% sample).

**Notes :** Asterisks indicate significance at 10%, 5%, and 1% levels. Robust standard errors are listed in parentheses under coefficients. Sample consists of all 345 prefectures in China in 2000. The dependent variable is the fraction of women in the prefecture who report having in-migrated for marriage from another prefecture (35% of these migrations occurred within the 5 years previous to the 2000 Census). All models include province fixed effects.

**Table 3: Male Migration to and from Key Provinces with Net Positive Male Migration**

	Province of Origin or Destination				
	Beijing	Tianjin	Xinjiang	Ningxia	Xizang
GDP per capita (2006)	58,204	46,122	16,999	14,649	12,109
Male migrants 6+ (1995-2000)					
Total in-migrants	1,135,000	249,000	724,000	55,000	44,000
% in-migrants completed Senior Middle	32.1	33.3	12.8	16.4	13.6
Total out-migrants	145,000	55,000	120,000	36,000	39,000
% out-migrants completed Senior Middle	50.3	65.5	53.3	52.8	23.1
All Males 6+ (2000)					
Total males 6+	6,600,000	4,556,000	9,155,000	2,496,000	1,036,000
% completed Senior Middle	42.2	32.2	19.5	18.7	6.4
% In-migrants	18.4	5.5	8.6	2.3	4.0

**Source :** 2006 GDP per capita (yuan per person) from China Yearly Macro-Economics Statistics, Provincial (China NBS 2007b). Population count, migration and education from China 2000 Census (0.1% sample).

**Notes :** Migration refers to movement between provinces during the 5 years preceding the 2000 Census for any reason, at any age 6 or above.

**Table 4: Projected Share Never Married among Males**

	Percent Never Married, by scenario of SRB change						
	Already Born			SRB=1.09		SRB=1.18	
	2010	2020	2030	2040	2050	2040	2050
Overall							
Males 30-39	2.19	2.15	20.80	11.10	11.46	14.75	18.21
Males 30+	3.47	3.12	6.69	8.11	9.74	8.81	11.88

**Source :** Authors’ projections from China 2000 Census data, according to scenario of change in SRB after 2005. For overall shares of never-married males age 25+, see Ebenstein & Sharygin (2009).

**Notes :** These projections assume female entry into marriage market at age 23 and male entry at age 25, female preference for educated males before males of similar age, and an age gap for spouses of up to 8 years. SRB change under each scenario is effected after 2005. Age-specific fertility rates from China NBS 2006 are adjusted to reflect TFR=1.65 in 2005 which assumes no change in age-specific fertility rates from 2006. Share never married among 30-39 year olds is highly turbulent due to movement of cohorts of highly skewed sex ratios through the age distribution, and is highly sensitive to the age preferences of females for partners.

**Table 5: Marriage Failure by Provincial per capita Income**

	Provincial Income Category				
	Highest	High	Middle	Low	Lowest
GDP per capita (2006)	38,557	22,119	16,083	13,627	10,772
% Rural (2006)	37.78	51.29	60.93	62.45	67.25
Dependency Ratio (2006)	36.06	40.26	46.52	46.65	45.41
% College Educated (2006)	9.62	6.20	5.86	5.23	3.80
% Illiterate (2006)	7.19	6.67	8.45	9.90	15.63
Life Expectancy (2000)	74.30	72.45	71.07	70.41	68.81
% Men 30+ Never Married (2030)*	6.09	6.76	7.11	7.65	9.42

**Source :** 2006 GDP per capita (yuan per person) from China Yearly Macro-Economics Statistics, Provincial (China NBS 2007b). Percent College Educated (of population over age 6), Percent Illiterate (of population over age 15), and Dependency Ratio (ratio of population under 15 and over 65 to population 15-64) in 2006, and Life Expectancy in 2000 from the National Sample Survey on Population Changes (China NBS 2007a). Table 5 shows relative share of *guang gun* (unmarried males) reported based on education-specific rates of non-marriage from authors' projections in 2030 applied to the distribution of males by education in the China 2000 Census (SRB=1.18, 'late' fertility growth scenario in Table A3).

**Notes :** \* Table 5 reports projected share of males never married for an open-ended age group, so the estimated share never married is relatively low due to the older age composition of the group (see Table 4 and Table A3 for comparisons of open-ended with closed-interval estimates). Age of entry to marriage market at 23 for females and 25 for males. Population-weighted averages reported. Provinces are stratified into groups by GDP per capita, and population-weighted means reported for each figure. The highest-income group consists of Shanghai, Beijing, Tianjin, Zhejiang, Jiangsu, and Guangdong provinces. The high income group includes Shandong, Fujian, Liaoning, Neimenggu, Hebei, Jilin, and Heilongjiang provinces. Xinjiang, Shanxi, Hubei, Henan, Chongqing and Ningxia are middle-income. Shaanxi, Hainan, Hunan, Qinghai, Sichuan and Jiangxi are low-income. The lowest-income group consists of Guangxi, Xizang, Anhui, Yunnan, Gansu, and Guizhou.

**Table 6: Sources of Support for the Elderly Population by Age Group, China 2005**

(Share of income in percent)

	Urban	Rural						
	60+	60+	60-64	65-69	70-74	75-79	80-84	85+
Family Support	37.0	54.1	28.6	46.6	66.9	79.1	87.2	91.1
Labor income	13.0	37.9	64.3	45.1	24.4	12.0	4.3	1.7
Property income	0.5	0.2	0.1	0.2	0.2	0.2	0.1	0.1
Pensions	45.4	4.6	4.7	5.1	4.7	4.4	3.8	2.6
<i>Dibao</i>	2.4	1.3	0.8	1.2	1.5	1.9	2.0	2.1
Insurance and subsidy	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other	1.5	1.8	1.2	1.7	2.2	2.3	2.4	2.3

**Source :** Cai et al. 2009: Table 1A-1B (derived from the 1% Inter-census survey, China NBS 2005).

**Table 7: Differentials in Income, Assets, and Health by Men's Marital Status**

	Personal Income	Financial Assets	Good Health
	(1)	(2)	(3)
Never Married	-760.2*** (261.96)	-3,686** (1685.66)	-0.105*** (0.03)
Age	-44.0*** (3.53)	25.2 (22.70)	-0.011*** 0.00
Years of Education	230.2*** (15.72)	529.3*** (101.17)	0.009*** (0.00)
Minority	30.5 (219.56)	-1,221 (1412.84)	0.024 (0.02)
Constant	7,801.9*** (371.89)	56,119*** (2393.06)	1.108*** (0.04)
Observations	10,033	10,033	10,033
R <sup>2</sup>	0.26	0.37	0.16
Sample Average	2,184	24,085	0.76

**Source:** Based on responses among male rural participants in the China Household Income Project (2002) who are age 30 and older.

**Notes:** Asterisks indicate significance at 10%, 5%, and 1% levels. Robust standard errors are listed in parentheses under coefficients. Good health is defined by respondents reporting themselves as "very healthy" or "healthy". The regressions are calculated by Ordinary Least Squares in which each column examines the partial correlation of each welfare measure with the demographic characteristics of the survey participants, shown in the rows of the table. The regressions are executed with prefecture-level fixed-effects to control for regional variation in the outcomes. One caveat to these results is that they are taken from a household survey, where the composition of households may be different than the composition of households where unmarried men usually reside. In fact, these results probably understate the welfare differences in household characteristics, since the average household size in the census for men age 30 and older is 3.01 for unmarried men and 4.03 for married men. In the CHIP, the average is 4.38 for unmarried men and 4.30 for married men. In reality, the unmarried men will on average be in smaller households and less able to rely on family assets for support.

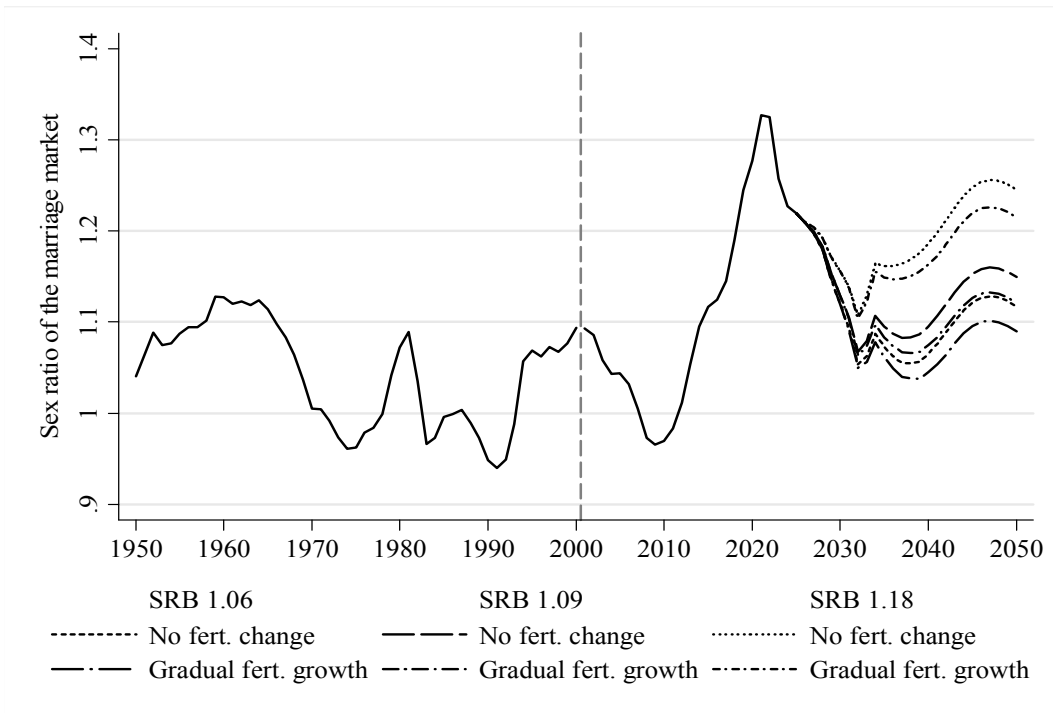
**Table 8: Cohabitation of Elderly with Younger Family Members Other than a Spouse**

	1982 Census		1990 Census		2000 Census	
	Never Married	Have Married	Never Married	Have Married	Never Married	Have Married
Fraction Cohabiting						
Elderly, Age 65-80	0.366	0.409	0.426	0.433	0.195	0.275
Elderly, Age 80+	0.746	0.733	0.732	0.751	0.653	0.73

**Source :** China 1982 Census (1% sample), China 1990 Census (1% sample), China 2000 Census (0.1% sample).

**Notes :** Cohabitation is defined as having a member of the household who is younger than age 60 and of kin (excluding a spouse).

**Figure 1: Projected Sex Ratio of China's Marriage Market**

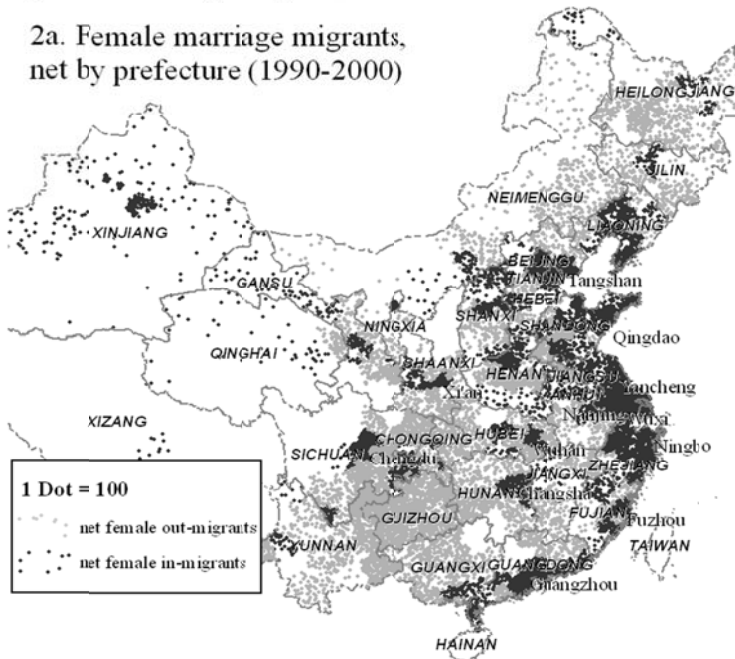


**Source :** Authors calculations from simulations using China's 2000 census.

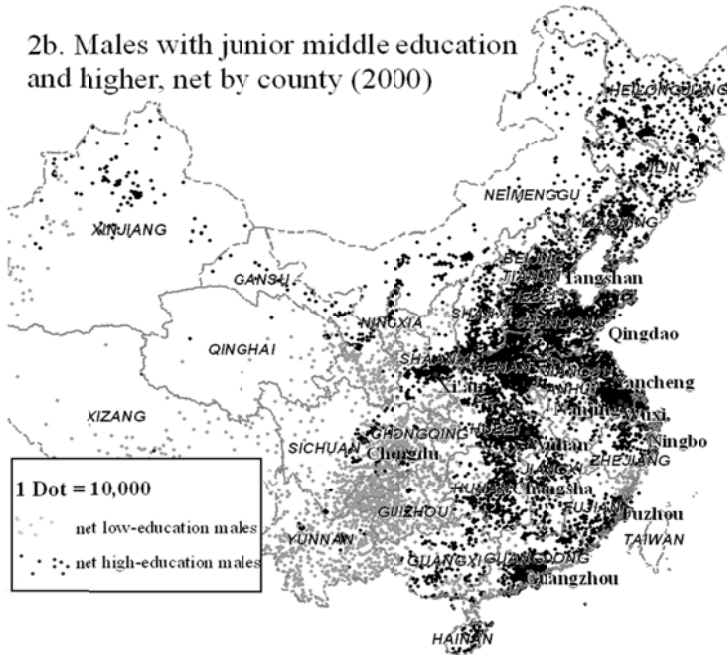
**Notes :** Marriage market sex ratio defined as sum of males age 22-30 divided by females age 20-30 (ratio of projected population for years after 2000). SRB refers to scenario of change in sex ratio of births after 2005 (low, medium, or high variants). Gradual fertility growth refers to 'slow' scenario mentioned in Table A3 ('late' scenario is not shown).

**Figure 2: Marriage Migration Patterns**

2a. Female marriage migrants, net by prefecture (1990-2000)



2b. Males with junior middle education and higher, net by county (2000)

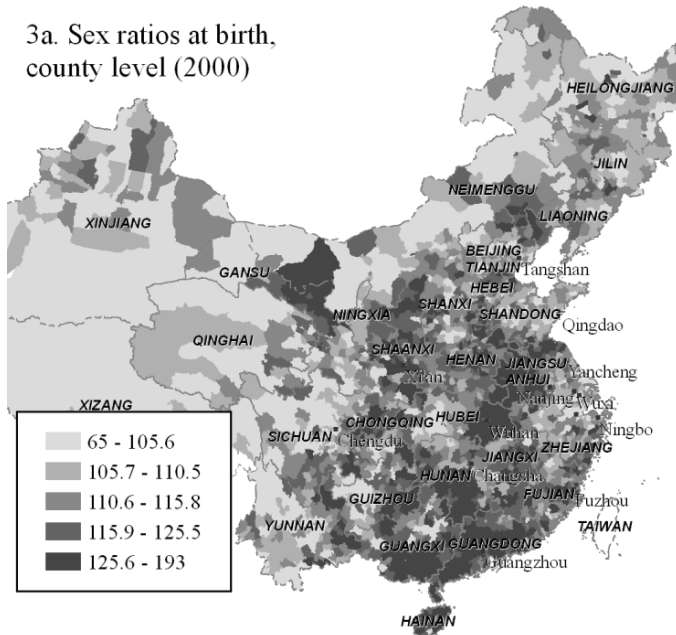


**Source:** (a) China 2000 Census (microdata 0.1% sample); (b) China 2000 Census (100% tabulation).

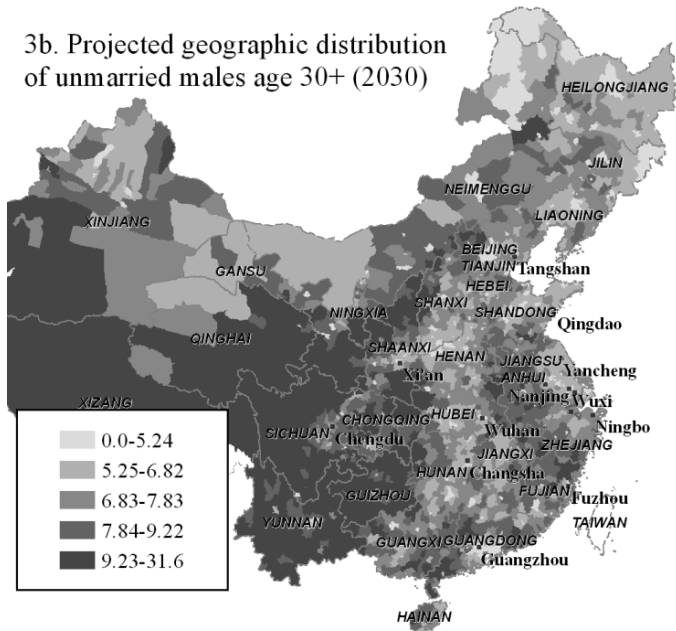
**Note:** High education males defined as those with senior middle school (*gaozhong*) education or higher.

**Figure 3: Regional Patterns of Sex Ratios and Single Men**

3a. Sex ratios at birth, county level (2000)



3b. Projected geographic distribution of unmarried males age 30+ (2030)



**Source:** (a) China 2000 Census, 100% tabulation; (b) authors' calculations from China 2000 Census (0.1% sample).

**Notes:** \* Figure 3 reports projected share of males never married for an open-ended age group, so the estimated share never married is relatively low due to the older age composition of the group (see Table 4 and Table A3 for comparisons of open-ended with closed-interval estimates). Age of entry to marriage market at 23 for females and 25 for males. Figure 3 shows relative share of *guang gun* (unmarried males) based on education-specific rates of non-marriage from authors' projections in 2030 applied to the distribution of males by education in the China 2000 Census (SRB=1.18, 'late' fertility growth scenario in Table A3).

# Appendix A

## A.1 Implementation of the population projection model

Using the sex- and age-specific mortality and fertility schedules outlined in the text, we employ a variation of the classical cohort component projection method (Preston et al. 2001). During each round of simulation, births are assigned a sex based on the known or simulated SRB. In a population where there is never a shortage of males, such as currently exists in China, population size is determined by the reproductive capability of females alone. Thus, we employ a female-dominant projection model in this paper. For  $n$  classes of 1-year age groups (maximum age  $n$ ), the initial age distribution is at time  $t_k$  is a matrix  $x^{(k)}$  where  $x^{(k)} = \{x_0^{(k)}, x_1^{(k)}, x_2^{(k)}, \dots, x_n^{(k)}\}$ .  $x_0^{(k)}$  is the sum of births between  $t_{k-1}$  and  $t_k$ . The number of newborns in turn is the sum of the products of each age-specific fertility rate  ${}_1F_x^{(k)}$ : across  $\beta$  reproductive years starting at age  $\alpha$ .

$$x_0^k = \sum_{i=\alpha}^{n-\beta} (F_i^{(k-1)} * x_i^{(k-1)})$$

Births thus calculated are divided by sex using the SRB, which depend on the scenarios described above. For all ages above 0, the population age  $x_n$  at time  $t_k$  are those age  $x_{n-1}$  at time  $t_{k-1}$  that have survived between time  $t_{k-1}$  and  $t_k$ , determined by a mortality function  ${}_1p_x^{(k)}$  that is estimated from the life table so that  $x_{n-1}^{(k)} = {}_1p_x^{(k)} * x_{n-1}^{(k-1)}$  (and  ${}_1p_n = 0$ ). The resulting system of linear equations can be rewritten in matrix notation as:

$$\begin{bmatrix} x_1^{(k)} \\ \vdots \\ x_n^{(k)} \end{bmatrix} = \begin{bmatrix} F_1^{(k-1)} & F_2^{(k-1)} & \dots & F_n^{(k-1)} \\ {}_1p_1 & 0 & & 0 \\ 0 & {}_1p_2 & \ddots & 0 \end{bmatrix} \begin{bmatrix} x_1^{(k-1)} \\ \vdots \\ x_n^{(k-1)} \end{bmatrix}$$

Given the initial age distribution from the 2000 Census and  $L$ , the Leslie matrix containing fertility and mortality schedules, we can compactly express these matrices and determine the age distribution of the population at any future time by  $x^{(k)} = L^{(k)} x^{(0)}$ . The values of  ${}_n p_x$  are from the China 2000 life table, and the values for the function  $F$  are the age-specific fertility rates. Values for  ${}_n F_x$  for times later than  $t_k = 2005$  depend on the fertility scenarios described above.

We use this framework to project multiple populations (by sex, marital status, and education, by using the simplifying assumption of no difference in vital rates by education and marital status). The resulting annual tables contain a set of approximately 4,000 cells by sex (2 categories), ever married status (2 categories), age (111 categories, birth to age 110), and education (9 categories). Education is assumed to be completed by age 22 (education in progress at age 22 is assumed to be completed). For those with incomplete education in 2000, we randomly assign completed education level such that the distribution of educational attainment of each cohort upon reaching age 22 matches the distribution of education (including in-progress) at age 23 in 2000.<sup>31</sup>

<sup>31</sup> After this time period, the effect of increases in education is dependent on how they are distributed geographically. A nationwide increase in education in all areas would preserve spatial inequality and therefore not affect the results.

It is important to note that, until 2030, the projections of males age 30 and over is only a function of mortality, and fertility and sex ratio assumptions do not affect the population subject to the marriage model.

## A.2 Sensitivity analysis and robustness checks of core results

The cohort component projection model used in this paper is an adaptation of the model developed in earlier work on the marriage market in China (Ebenstein & Sharygin 2009). The model calculates share of males and females never married overall by specific ages or level of education. Our model includes a number of options for the age at which males and females enter the marriage market, the age preference function of women for spouses, and the trajectory of fertility change and change in the sex ratio of births since 2005 (the date of the China 1 percent inter-Census survey). The main components of the model are marriage, fertility, and mortality, and the factor that is of most interest for this discussion is marriage. The marriage sorting algorithm matches females to males according to the following variables, in the following order: female age (from high to low); male education (from high to low), and male age (from high to low).

The program currently assumes no change in relative mortality or the distribution of educational outcomes of marriage-age adults from the achievement or current status of the 23-year-old population in the 2000 Census. The model also assumes perfect mobility between geographical areas, so that there is no implicit preference for nearer males over more distant potential spouse.

This model is the first to our knowledge to introduce educational preferences of females on the marriage market, which enables calculation of ever-married status by single years of age or by educational level, or some combination of age and education. In order for this to function, it is necessary to project educational attainment forwards in order to create an educational distribution for males whose education is not directly observed because they are generated by the fertility model. We address this issue by calculating the distribution of educational attainment among males age 23 in the 2000 Census. We assume that educational status at age 23 (counting students as graduates equal to the level of education they were enrolled in at age 23) roughly approximates the completed education of males, and allows us to use the most recent years of data in the 2000 Census.<sup>32</sup>

Once the model has calculated national-level education-specific marriage failure rate for men, we apply it to the current age and education distribution last observed in the 2000 Census (Table A4). This admittedly synthetic measure highlights areas where a large percentage of the males have education below junior-middle school (*xiao zhong*) level. Education may improve from the year 2000 without compromising the applicability of the results as long as the relative

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<sup>32</sup> The result is that the overall level of education in China improves until the point at which ergodicity dominates when those born during or after 1977 comprise the entirety of the population. Thus, the average level of education will rise at an arithmetic rate instead of a geometric rate.

gaps in education between areas remain stable. Since the projection of education-specific marriage failure rates is so sensitive to changes in enrollment patterns or government education campaigns, it may be important to revisit this portion of the projection model when changes in the spatial distribution of education become significant. To the extent that programs to alleviate educational inequality in rural areas are implemented in areas which we identify as ‘hotspots’ in Figure 3, our results may in some sense be externally validated. We assume no constraints on males’ search for female partners, thus we did not apply educational progression to females generated by the fertility steps. Our projections assume no ethnic preferences of Han males for or against minority females (and vice versa). However, the results are robust to limiting to the Han population only.

In a market where females are scarce, the decision to think about marriage in terms of women seeking out men seems justified. Since virtually all females in China marry, we have implicitly assumed no mating preferences on the part of men. We aggregated females into a single sum by year, age, and ever-married status and any pre-existing information on their educational characteristics is disregarded. The number of single females of a given age is calculated, and then if it is greater than zero, those women are ‘married off’ to men according to some specifiable age function. Thus the oldest females are married first, to the best educated and oldest men. The last to be married are the youngest women to the youngest and least educated men. The education level of the males is assigned higher priority than their age. Theoretically, this has little effect on the overall share never married rate since women can be fully married off, but it has important consequences for the share never married by education. To allow for the possibility that a shortage of brides may pressure women to marry earlier, we allow for a lower age at which females enter the marriage market. We use the age of 23 for females, although we also generated numbers for other ages.<sup>33</sup> We have also developed the model further to include an option to set the age of male entry into the marriage market. In effect, we can now formulate a response to the question, “is there an age gap at which universal or near-universal marriage can be achieved?” by varying the age at which females and males enter the marriage market.

Two types of age preference functions can be specified: age-independent, and dynamic or age-dependent. The age independent function used in this paper specifies a set age band for marriages to occur, and the band remains constant with the female’s age. The second type might use a formula to calculate the permissible age gap for a female of any given age. The current paper uses the static age preferences, capping the age gap between male and female at 8 years (females matched to males 0 to 8 years above their own age). Females age 25, for example, are first married to males age 33 through age 25, by education across ages before by age. This process is iterated each year for every age at which unmarried women exist.

The fertility and mortality processes are updated to reflect more recent fertility and mortality schedules. We use age-specific fertility rates from the National Sample Survey of Population Changes (China NBS 2007a), which applies to childbirth during 2006. However, since these rates produce a TFR known to be too low, we inflate all age specific fertility rates by a factor such that the aggregate fertility level equals approximately 1.65 (following Zeng et al.

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<sup>33</sup> The average age at first marriage for females was 23 (and 24.8 for males) in 1999, according to the UN (UNPD World Fertility and Marriage Database 2003). For sensitivity testing purposes, we also tested from the ages of 20 and 25 (see Figure A1).

2008). This results in slightly older ages of peak fertility compared to the previously published estimates for age specific fertility from the same survey in 2004. We previously used sex-and-age-specific mortality rates from Banister and Hill (2004). However, in this paper we use more recent data from the WHO (2006) which shows mortality improvement since the 1999-2000 period discussed by Banister and Hill. The sex ratio of post-2000 births until 2005 is pre-set based on data from the 2000 Census and thereafter dependent on the SRB scenarios (Table A3), ranging from 1.18 (no change) to 1.06 (biological norm). Fertility and mortality are applied before the marriage model, and fertility is assumed not to vary by marital status (although this is not an important assumption, since female marriage remains near-universal). The projection assumes no further change in relative mortality rates and currently supports three alternate scenarios of fertility change (Table A2): no change, gradual change (linear growth function for fertility at all ages, with a cap on TFR), and immediate change (specifiable multiplier for fertility at all ages).

Finally, our sensitivity analysis finds that the percent never marrying is most sensitive to the sex ratio at birth and the average age gap between spouses. Most importantly, the sensitivity analysis confirms that correcting the sex ratio today is not a panacea; the share of unmarried males will remain high well into the future even in the case of an immediate correction to the biological norm. The sex ratio of births that are occurring today have a significant impact on marriage outcomes starting only in the mid-2030s (Figure A1; Tables 4 and A3), since those marrying before then have already been born. Even if a lower sex ratio at birth was achieved immediately, the percentage of unmarried adult men age 30+ and 30-39 in 2050 would remain high. Sensitivity analysis to account for the possibility of fertility growth (either slow growth beginning immediately or rapid growth in the near future) projects that a change in fertility could lower the share never married in 2050 by no more than 1.8 percentage points (Table A3). Scenarios that only raise or lower the minimum age at marriage for males and females find that changing age patterns of marriage affect the amplitude but not the level or trend of the share never married (see Figure A1).<sup>34</sup> Marriage delay for males can thus delay the peaking of period share of males, pushing it to a later cohort, but cannot postpone the marriage squeeze indefinitely without concomitant reduction of SRB or increases in fertility. Correcting the sex ratio at birth is the most prudent course of action, but even immediate improvements are insufficient to avoid a demographic squeeze in the short- to mid-term.

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<sup>34</sup> As we demonstrate in the appendix materials, a decline in age at marriage for females forestalls the problem but does not alter our core results on marriage failure rates. For example, if women marry at age 20 (instead of our base assumption of 23), the peak of marriage failure rates is delayed by roughly 20 years, and occurs in 2050 rather than 2030, but at similar levels of marriage failure.

**Table A1: Net Female Migration by Province and Provincial Characteristics**

Province	Net Female Marriage Migrants (1995-2000)	GDP Per Capita (2006)		Dependency Ratio (2006)	Percent Rural (2006)	Life Expectancy at Birth (2000)	Percent of Males 30+ Never Married* (2030)
		Nominal	Quintile				
Jiangsu	176,000	33,928	1	12.4	48.1	73.9	6.14%
Guangdong	99,000	33,151	1	8.9	37.0	73.3	5.67%
Zhejiang	96,000	37,411	1	12.2	43.5	74.7	7.58%
Shandong	65,000	27,807	2	11.4	53.9	73.9	6.33%
Beijing	62,000	58,204	1	10.8	15.7	76.1	3.13%
Liaoning	43,000	25,729	2	10.6	41.0	73.3	5.92%
Shanghai	42,000	66,367	1	15.0	11.3	78.1	3.98%
Tianjin	30,000	46,122	1	11.2	24.3	74.9	4.60%
Hebei	29,000	19,877	2	10.0	61.6	72.5	6.73%
Xinjiang	26,000	16,999	3	6.9	62.1	67.4	8.44%
Fujian	22,000	25,908	2	9.5	52.0	72.6	8.09%
Shanxi	13,000	16,945	3	9.3	57.0	71.7	6.38%
Chongqing	7,000	14,660	3	11.4	53.3	71.7	8.24%
Hainan	4,000	14,555	4	10.2	53.9	72.9	6.68%
Ningxia	2,000	14,649	3	6.7	57.0	70.2	8.78%
Tibet	1,000	12,109	5	7.4	71.8	64.4	19.54%
Henan	0	16,012	3	10.6	67.5	71.5	6.80%
Qinghai	-3,000	14,257	4	6.7	60.7	66.0	10.94%
Shaanxi	-5,000	14,607	4	8.9	60.9	70.1	7.33%
Anhui	-9,000	12,045	5	11.4	62.9	71.9	8.31%
Gansu	-13,000	10,346	5	7.7	68.9	67.5	9.96%
Jilin	-21,000	19,383	2	8.1	47.0	73.1	6.16%
Hubei	-23,000	16,206	3	9.1	56.2	71.1	6.81%
Jiangxi	-27,000	12,633	4	9.2	61.3	69.0	7.07%
Hunan	-31,000	14,492	4	10.6	61.3	70.7	6.82%
Neimenggu	-43,000	25,393	2	7.5	51.4	69.9	6.84%
Guangxi	-47,000	12,555	5	11.0	65.4	71.3	7.68%
Heilongjiang	-62,000	18,478	2	7.4	46.5	72.4	5.80%
Sichuan	-66,000	12,893	4	10.8	65.7	71.2	8.66%
Yunnan	-119,000	10,540	5	9.0	69.5	65.5	10.71%
Guizhou	-177,000	6,915	5	9.3	72.5	66.0	10.96%

**Source :** GDP per capita (yuan per person) from China Yearly Macro-Economics Statistics, Provincial (China NBS 2007b). Percent College Educated (of population over age 6), Percent Illiterate (of population over age 15), Elderly Dependency Ratio, Percent Rural, and Life Expectancy (both sexes combined in 2000) from National Sample Survey on Population Changes (China NBS 2007a).

**Notes :** \* The share of males never married is for an open-ended age group, so the estimated share never married is relatively low due to the older age composition of the group (see Table 4 and Table A3 for comparisons of open-ended with closed-interval estimates). Age of entry to marriage market at 23 for females and 25 for males. Elderly dependency ratio refers to the ratio of the population age 65+ to the population 15-64. Share unmarried reported under SRB=1.18 and 'late' fertility growth scenario in Table A3.

**Table A2: Scenarios of Fertility and SRB Change**

Scenario	TFR in:			
	2000-09	2010-19	2020-29	2030+
None	1.65	1.65	1.65	1.65
Slow	1.65	1.67→1.88	1.88→2.18	2.18
Late	1.65	1.65→1.96	1.96	1.96

Scenario	SRB in:		
	2000-05	2006-09	2010+
Low	1.18	1.06	1.06
Medium	1.18	1.09	1.09
High	1.18	1.18	1.18

*Note:* Increase from 1.65 to 1.96 in 'late' scenario occurs by imposing a one-time 19% increase in all age-specific fertility rates, to attain Zeng et al.'s (2008) use of TFR of 1.96 in 2012. Growth in TFR in 'slow' scenario calculated by 1.2% growth per annum in all age-specific fertility rates.

**Table A3 : Sensitivity of Share of Males Never-Married to Sex Ratio and Fertility assumptions**

<u>Males 30-39</u>												
Year	No Change in Fertility				"Slow growth" in fertility +1.2% annually in 2010 (to 2.18)				"Late growth" in fertility +19% in 2012 (to 1.96)			
	TFR	SRB after 2005			TFR	SRB after 2005			TFR	SRB after 2005		
		1.06	1.09	1.18		1.06	1.09	1.18		1.06	1.09	1.18
2040	1.65	9.78	11.1	14.75	2.18	9.25	10.74	14.41	1.96	7.33	8.49	13.71
2050	1.65	8.96	11.46	18.21	2.18	7.02	9.43	16.34	1.96	7.96	10.66	16.33

<u>Males 30+</u>												
Year	No Change in Fertility				"Slow growth" in fertility +1.2% annually in 2010 (to 2.18)				"Late growth" in fertility +19% in 2012 (to 1.96)			
	TFR	SRB after 2005			TFR	SRB after 2005			TFR	SRB after 2005		
		1.06	1.09	1.18		1.06	1.09	1.18		1.06	1.09	1.18
2040	1.65	7.86	8.11	8.81	2.18	7.76	8.04	8.74	1.96	7.4	7.62	8.61
2050	1.65	8.97	9.74	11.88	2.18	8.45	9.25	11.49	1.96	8.28	9.12	11.44

**Source:** China 2000 Census; authors' calculations. Simulations described in detail in the text and Appendix A.

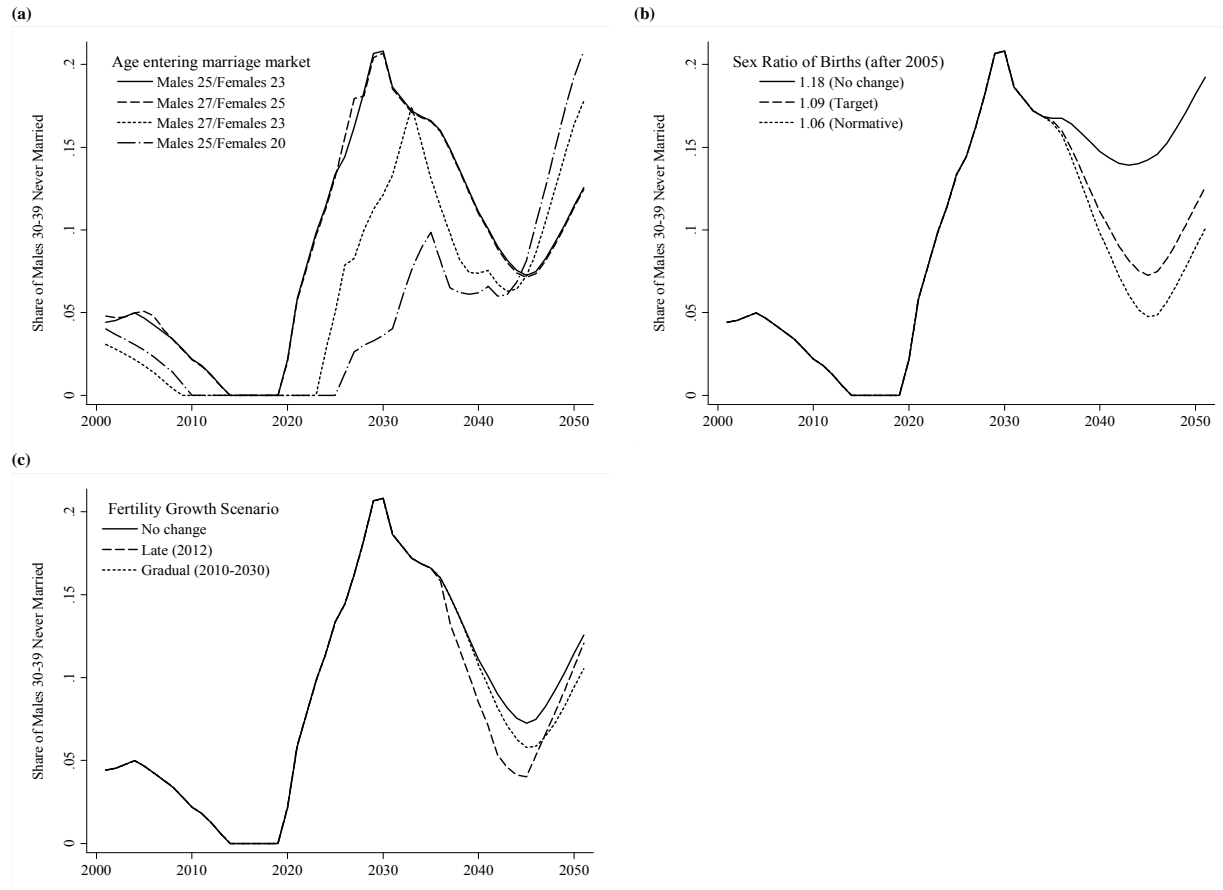
**Notes:** Age of entry to marriage market at 23 for females and 25 for males. Marriage occurs each round between females age 23-32 and males 25-40. Figures reported are percent of males age 30-39 in the never-married state. TFR=2.18 results in Natural Rate of Reproduction of 1.0 under the post-2005 SRB=1.18 scenario. Changes in fertility and the sex ratio at birth do not alter the results up to 2030, since these cohorts have already been born. The results for these cohorts are in Table 4.

**Table A4: Educational Attainment in China at age 22.**

Sex	<i>Education Level</i>				
	None	Adult Lit	Primary	Junior Mid	Senior Mid
Male	1.1	0.27	14	54.2	11.5
Female	2.1	0.62	19.2	50.2	9.1
Sex	Vocational	Junior College	College	Post-graduate	Total
Male	8.7	5.5	4.5	0.25	100.0
Female	11	5.2	2.5	0.07	100.0

*Source:* China 2000 Census; authors' tabulations.

**Figure A1: Sensitivity of Share Never Married to Modeling Assumptions**



**Source:** Authors calculations from simulations using China's 2000 census.

**Note:** These projections apply age-specific fertility rates from China NBS 2006, adjusted to reflect TFR=1.65 in 2005. Share never married among 30-39 year olds is presented under (a) alternate ages of entry to the marriage market, under the assumption of no change in fertility and that a sex ratio at birth of 1.09 is attained in 2006; (b) alternate scenarios of sex ratio of births after 2005, under the assumption of no change in fertility, and (c) alternative scenarios of fertility change starting, assuming that a sex ratio at birth of 1.09 is attained in 2006.