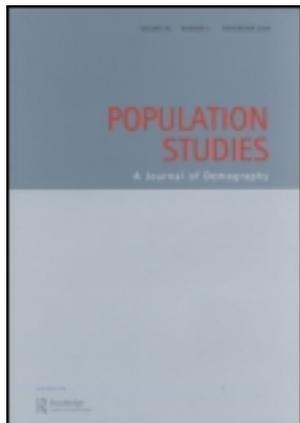


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Implications of China's future bride shortage for the geographical distribution and social protection needs of never-married men

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Because sex ratios at birth have risen sharply in China in recent decades, an increasing proportion of men will be unable to find a bride, and will face old age without the support of a wife and children. We project the proportions of never-married men and their geographical distribution in China in the coming decades. Our projections assume that two tendencies in current marriage patterns will persist: that women will continue to migrate to wealthier areas and to prefer men with better prospects. We find that, by 2030, more than 20 per cent of men in China aged 30–39 will never have married, and that the proportion will be especially high among poor men in low-income provinces that are least able to provide social protection programmes. The projected geographic concentration of bachelors could be socially disruptive, and the results suggest a need to expand the coverage and central financing of social protection programmes.

Keywords: China; never-married men; marriage market; sex-selective abortion; missing girls; old-age support

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1. Introduction

It is generally agreed that the rise in the sex ratio at birth (SRB) in China in recent decades (Li 2007), though partly a result of the under-reporting of girls, largely reflects a real and significant shortage of them in recent birth cohorts. The reason is that the gradual spread of sex-selection technology, and the availability of abortion, has enabled parents to comply with the small-family policy, but still act on their preference for at least one son. This behaviour creates a considerable shortage of future brides. The most recent inter-census population survey of China (China NBS 2005) reported a SRB of 1.19, which implies that 1 million more boys than girls were born in the previous year. In the cohorts born between 1985 and 2005, males outnumber females by 25 million. The shortage of potential brides is exacerbated by the fact that, because cohort size is shrinking as fertility declines, and because men usually marry women younger than themselves, they are marrying into cohorts smaller than their own.

Scholars have debated the potential benefits and costs of the marriage-market imbalance now facing

China, one for which there is little historical precedent. Studies indicate that the bride shortage has increased women's bargaining power within marriage (Edlund et al. 2009; Porter 2009a, 2009b; Francis 2011). Arguing that China's current high savings rate is partly related to the bride shortage, Wei and Zhang (2011a, 2011b) showed that households in areas with high sex ratios save more, and that they are more prepared to undertake higher-risk activities for higher returns, in the hope of improving their sons' chances in the marriage market. Other scholars argue that growing numbers of never-married men raise levels of crime and violence (Edlund et al. 2009), or lead to women's abduction and coercion into marriage (Banister 2004).

Very little is known about how China's marriage market will evolve in the face of the coming challenges. Feldman et al. (1995) modelled the marriage squeeze using data from the 1990 Census of China—conducted when the sex ratios at birth had just started rising—and estimated an 8 per cent excess of men. More recently, Jiang et al. (2007) predicted that the proportion of men who would not be able to find a bride would reach 15 per cent

between 2015 and 2045, and the China Academy of Social Sciences (2009) predicted that in 2020 one in five men would not find a bride. However, these projections provide little detailed information, such as which categories of men are least likely to marry, their geographical distribution, and what can be done to prepare for the outcome. This paper seeks to answer these questions.

We started by projecting the marriage-market sex ratio (the sum of the population of males divided by that of females, weighted by the age-specific first-marriage rates from China's 2000 Census). Given that the sex ratio of cohorts already born is known from the census, it is certain that the marriage-market sex ratio will increase sharply in the next decade (Figure 1). In particular, the availability of brides is projected to reach an all-time minimum in the 2020s, regardless of the assumptions adopted about changes in fertility and the SRB. Since projections beyond 2030 involve cohorts not yet born, they are particularly dependent upon assumptions of future fertility and the SRB.

Our projections should be interpreted with caution because they are based on data from the official census for 2000, which may have undercounted girls more than boys. Several studies have estimated that girls are undercounted up to school age—though estimates of the undercount vary (Johansson and Nygren 1991; Zeng et al. 1993; Coale and Banister 1994; Cai and Lavelly 2003; Banister 2004; Goodkind 2011). Goodkind (2011) estimated that girls were undercounted by about 2–3 per cent in the 2000 Census of China. We propose one method of

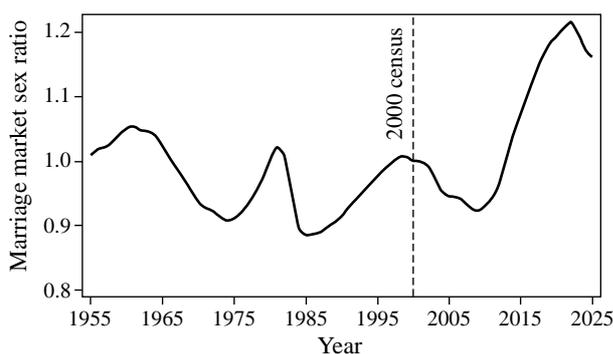


Figure 1 Projected sex ratio of marriage market, China 1955–2025

Notes: The method is derived from Feldman et al. (1995), who use the nuptiality-weighted sex ratio to derive the sex ratio of those entering the marriage market. The marriage-market sex ratio is defined as the sum of the population of men divided by the sum of the population of women, weighted by age-specific first marriage rates from the 2000 Census.

Source: China 2000 Census.

adjustment and find that Goodkind's estimated undercount has a fairly small impact on our results (see the Appendix). In view of that, and given the controversy over the accuracy of estimating the extent of undercounting, we made no attempt to adjust for it in our main results.

We first examined recent patterns of marriage formation in China. Using census micro-data for 1982, 1990, and 2000 and years of education as a proxy for economic status, we find that the economic status of men in China is a crucial predictor of whether they marry, and that marriage is almost universal for highly educated men, but not for the less educated (Table 1). In contrast, nearly all women marry, whatever their education. Second, the fact that many women migrate to marry (Figure 2(a)) is likely to shrink the pool of available women yet further for men in poor areas with less educated populations.

Poorer provinces provide 'demographic subsidies' to the marriage markets of wealthier provinces. One such 'subsidy' occurs when women migrate from poorer areas to wealthier ones, leaving men in poorer rural areas exposed to an intensified marriage squeeze. Although the wealthier areas of China attract labour migrants of both sexes, the 2000 Census indicates that women form over 85 per cent of all those who migrate across provinces for the express purpose of marriage (see also Fan and Huang 1998). Comparing the 1995 and 2002 China Household Income Projects, Meng (2009) found that women out-migrants are generally not replaced, implying that local men are less likely to find wives. Figure 2(a) maps the net migration of women—the number of women migrating into an area for the purpose of marriage, minus the corresponding number migrating out—by prefecture. The darker-shaded areas, those experiencing larger numbers of inflows of women, overlap considerably with those in which the proportion of educated men is relatively high (Figure 2(b)). The presence of a large number of well-educated men is a strong predictor of the in-migration of women. Additional province-level indicators associated with the migration of females for the purpose of marriage are presented in the Appendix (Table A4).

Taking these migration patterns for marriage into account, we projected the progress of China's marriage market over the coming decades. Our method was a refinement of that used by Ebenstein and Sharygin (2009). We took account of women's preference for marrying men with higher earning capacity, by using educational qualifications as a proxy (consistent with current practice, as reflected

Table 1 Marriage and educational attainment by birth cohort in China, 1935–65

	Men born in:			Women born in:		
	1935–45	1945–55	1955–65	1935–45	1945–55	1955–65
Sex ratio of cohorts	1.13	1.08	1.04			
Cohort size	569,588	873,505	1,024,910	504,251	809,753	987,090
	Proportion never married, per cent					
Total proportion never married	5.64	5.41	3.95	0.20	0.28	0.38
Below 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
	Profile by educational attainment, per cent					
Below 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

Notes: The proportion never married and the sex ratio of the birth cohort in each column were calculated using data from selected samples of the 1982 Census, 1990 Census, and 2000 Census, respectively. The sex ratios above are slightly smaller than for those of marriageable age owing to the higher adult mortality of men.

Source: China 1982 Census (1 per cent sample), China 1990 Census (1 per cent sample), China 2000 Census (0.1 per cent sample).

in Table 1). We also sought to estimate the geographical distribution of forced bachelorhood and the impending squeeze in the marriage market. We assumed that women would, when possible, migrate to wealthier areas, where there were relatively more eligible men—whether specifically for marriage or because these areas offered better employment prospects as well as better opportunities to find eligible husbands. We then applied this assumption and the known distribution of men's educational

qualifications to project the proportion of never-married men and their geographical distribution.

Our findings indicate that China's looming shortage of brides will occur unevenly across the country. Never-married men will tend to be clustered in the rural areas of poor provinces. The implication is that the men who are least financially secure—those with poorer access to jobs and social assistance and social insurance programmes—will be the ones most likely to be bachelors. Owing to the stringent

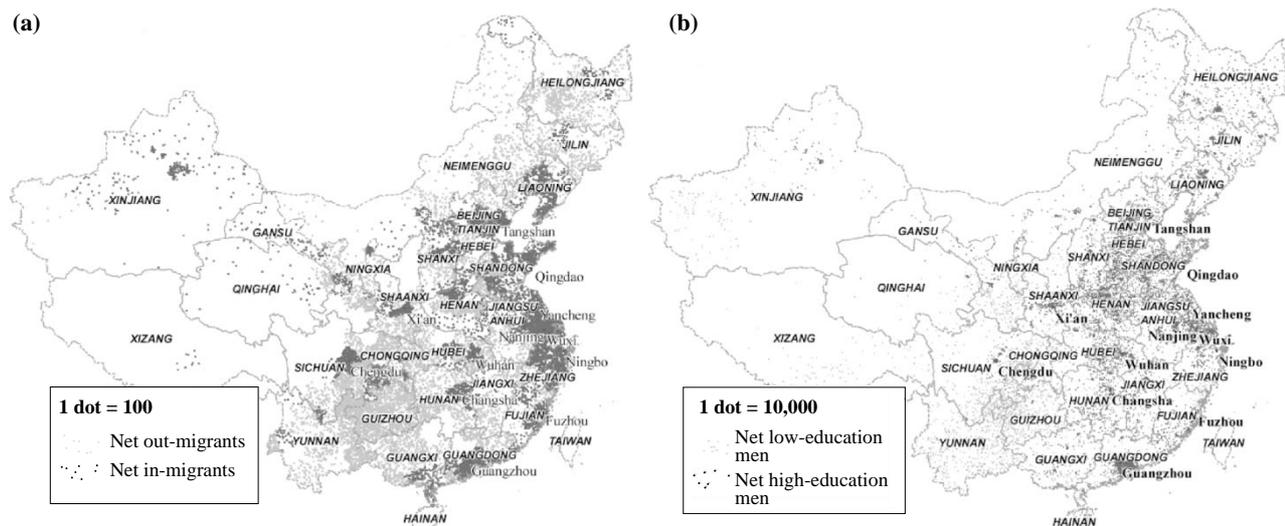


Figure 2 Marriage migration patterns, China 1995–2000: (a) net migration of women for the purpose of marriage by prefecture, 1995–2000; (b) men with junior middle education and higher, net by county (2000)

Note: High-education men defined as above junior middle school (*xiao zhong*). Areas with net out-migration of women or a net positive balance of 'low-education' men are shaded light grey. Areas with net in-migration of women or net positive balance of 'high-education' men are shaded dark grey.

Source: (a) China 2000 Census (0.1 per cent sample); (b) China 2000 Census (100 per cent tabulation).

fertility-control policies adopted in China since 1970, these men will have few, if any, close living relatives to help support them, which is a situation that raises the possibility of social instability. Our results suggest that China's current social protection framework will need a radical overhaul. Since working-age adults currently form a large proportion of China's population, revenue set-asides, that is, year-by-year savings from China's current large economic surpluses seem more likely than a pay-as-you-go regime to provide for future needs of the population.

The rest of the paper is organized as follows. In Section 2, we examine current patterns of marriage in China, and in the recent past, focusing on the importance of education and migration. In Section 3, we discuss our projection of China's marriage market. In Section 4, we present projection results at the national and provincial levels. In Section 5, we present our conclusions, and discuss the implications for policy.

2. The marriage market in China

2.1. Factors affecting selection into marriage

In most societies, men with higher economic status are generally preferred in the marriage market. The proxy variable closest to economic status available in Chinese census data is educational status. In the cohort aged 35–45 in the 2000 Census, 99 per cent of men graduates had found wives, compared with only 72 per cent of men who had not completed a primary education (Table 1, cohort born in 1955–65). In contrast, nearly all women had married, irrespective of educational level and birth cohort. This pattern will presumably persist, even if the difference in educational levels between the sexes shrinks. As long as there is a shortage of brides, women will be able to choose the most promising candidates from among many potential husbands. Furthermore, if the proportion of highly educated women outstrips that of men (as projected by Samir et al. 2010, Table A1), the data from earlier censuses (Table 1) suggest that some women may withdraw from the marriage market, further tightening the marriage squeeze.

Table 1 reflects changes over time in the bride shortage in China. The sex ratio of children increased sharply during China's civil wars and the Japanese invasions of the 1930s, and declined thereafter to levels closer to 'normal', except for a small rise during the Great Leap Forward Famine (Das Gupta and Li 1999). However, across all three birth cohorts in Table 1 that span these sharp changes in

the availability of brides, educational attainment remained central to the probability of men marrying.

2.2. Eligible grooms and migration

In the 2000 Census of China, the areas with the largest proportions of never-married men amongst men aged 30 or over tended to be the poorer inland areas. In addition, using census data for 1990 and 2000, we found (details not shown) that women in areas with the highest sex ratios at marriageable ages tended to have married at younger ages. Men had married at older ages, perhaps partly because they had spent longer in education. However, larger proportions of men had eventually married in the wealthier areas with high SRBs than in the poorer areas with sex ratios closer to the 'normal'. This disparity between wealthier and poorer areas in the proportions of men never married, already apparent in 2000 Census data, may be even more pronounced in 2030 if present trends continue in the imbalance between the numbers of men and women (see Section 4).

Using regression analysis, we explored how the characteristics of a prefecture were related to the proportion of women who migrated into the prefecture for the purpose of marriage (as a proportion of the total number of women in the prefecture). Our results indicate that, on average, each additional year of education among men is associated with an additional 0.196 per cent of women who relocated to the prefecture for marriage (Table 2). The magnitude of this result is modest, but a possible conclusion is that—even within a province—wealthier prefectures can attract women and mitigate problems associated with a high SRB. When we added control variables for the proportion of the prefecture registered as resident in an urban prefecture and for the sex ratio for those aged under 5 (Table 2, columns 2 and 3), two further results emerged. First, women had migrated to more urbanized prefectures, possibly because they offered better economic prospects. Second, they had migrated to areas with higher sex ratios among those aged under 5—areas that were, in many cases, wealthier than other parts of the country.

While the migration of women to wealthier areas is one form of 'demographic subsidy', another is the net inflow of less-educated Han men from central and coastal China to the western provinces. This inflow has been increased by the effects of policies (some of them informal) to promote migration to poorer provinces with large populations of ethnic minorities (Bhattacharji 2009). Table 3 shows that migrants to these provinces are less educated than

Table 2 Results of regressing the proportion of women who migrated into a prefecture for the purpose of marriage (expressed as a percentage of women in that prefecture) on selected characteristics of the prefecture, China 2000

Variable	Control variables added		
	None	Whether prefecture urban	Sex ratio (aged 0–4)
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 aged 0–4)			0.0160*** (0.0050)
No. of prefectures	345	345	345
R ²	0.346	0.354	0.394

*Significant at 10 per cent; **significant at 5 per cent; ***significant at 1 per cent.

Notes: Standard errors are listed in parentheses under coefficients. Sample consists of all 345 prefectures in China in 2000. All models include province fixed effects. Migration refers to movement between prefectures during the 5 years preceding the 2000 Census for the purpose of marriage.

Source: China 2000 Census (0.1 per cent sample).

migrants to wealthier provinces. For example, only 12.8 per cent of in-migrants to Xinjiang (to which many migrate and which has a relatively low GDP per head) had completed senior middle education or higher. In contrast, more than 30 per cent of men migrating to wealthier provinces, such as Beijing and Tianjin (which have a relatively high GDP per head), had completed senior middle education or higher. Moreover, the men who migrate to poorer

provinces are, on average, less educated than the men already living in those provinces.

These disparities imply that, even though the SRB is lower in remote provinces than in others (Ebenstein and Sharygin 2009), these provinces should expect greater shortages of brides because of the out-migration of women and the in-migration of single men. With restrictions on internal migration continuing to become looser, we predict that in the coming decades China's marriage market—already highly mobile—will become truly national. Whereas most marriages in China currently occur between partners from the same province, we predict that the tighter marriage market will create highly desirable marriage opportunities for women in wealthy coastal provinces, and induce women to travel farther for the purpose of marriage. In this scenario, disparities in men's marriage prospects may become even more pronounced.

In the next section, we discuss the ramifications of these observations for modelling the marriage market.

3. Projecting China's marriage market: method and assumptions

We made two sets of projections for the Chinese marriage market, one for the period from 2000 to 2030, and the other for the period beyond 2030. Because the projections for 2000–30 were based on cohorts already born in 2000, the only assumption required was for marriage. In contrast, the projections beyond 2030 were based on cohorts not yet born by 2000, which meant that assumptions had to

Table 3 Migration of men into and from key provinces with net positive in-migration, China 1995–2000

	Province of origin or destination				
	Beijing	Tianjin	Xinjiang	Ningxia	Xizang
GDP per head, 2000	24,127	17,353	7,372	5,376	4,572
Ratio to Shanghai GDP per head	0.82	0.58	0.25	0.18	0.15
Male migrants aged 6 or over, 1995–2000					
In-migrants (thousands)	1,135	249	724	55	44
Proportion of in-migrants completed senior middle school	32.1	33.3	12.8	16.4	13.6
Out-migrants (thousands)	145	55	120	36	39
Proportion of out-migrants completed senior middle school	50.3	65.5	53.3	52.8	23.1
Men aged 6 and over living in province, 2000					
Number (thousands)	6,600	4,556	9,155	2,496	1,036
Proportion completed senior middle school	42.2	32.2	19.5	18.7	6.4
Proportion who are in-migrants	18.4	5.5	8.6	2.3	4.0

Notes: Migration refers to movement between provinces during the 5 years preceding the 2000 Census for any reason. The migration question was asked of people aged 6 or above.

Source: 2000 GDP per head (yuan per person) from *China Yearly Macro-Economics Statistics, Provincial* (China NBS 2001). Population count, migration, and education from China 2000 Census (0.1 per cent sample).

be made about future marriage and fertility. The projections beyond 2030 should therefore be interpreted with greater caution.

Recognizing that marriage patterns in China may adapt to the larger imbalances between the numbers of marriageable men and women, we conducted robustness checks (details in the Appendix) to explore the potential impact of changing norms, such as women choosing to marry at younger ages. The projections should not be interpreted as yielding precise estimates of the numbers of never-married men. Instead, they illustrate probable national trends and regional differences in men not marrying, based on the assumption that women will continue to prefer more highly educated men.

3.1. *Key assumptions about marriage formation*

Marriage formation is a complex process even when a population's sex ratio is 'normal'. Norms could change in response to the marriage squeeze: men might seek to marry much younger women, and other kinds of adjustment are, in theory, possible, such as a shift to polyandry (Sommer 2005; Greenhalgh 2010). Our marriage model attempted to identify factors important in spouse selection, such as women's migration, and preference for husbands with better prospects. Even so, our model of spouse selection is an extreme simplification of the marriage market, and cannot account for the many possible changes in marriage patterns and arrangements that could occur.

Our projections relied on assumptions chosen to leave as few men and women as possible unmarried in each year. The marriage model we employed is one in which women's choices are the sole determinant; mechanisms which might reflect men's choices are not included. The key assumption in 'assigning' men to women in marriage was that of a unitary national marriage market with no geographic or ethnic preferences (except in one projection where we allowed marriages only among the Han). We allowed a maximum age difference between spouses of 8 years, and assumed that, subject to this constraint, women preferred men who were more highly educated and older than they were. The sorting mechanism of the marriage algorithm, by which men were assigned to women in marriage, is described in detail in the Appendix. Our projections focused on men aged 30–39, since more than 97 per cent of ever-married men in the 2000 Census (0.1 per cent sample) reported marrying before age 30. Postponing marriage until after age 39 might become

more common in response to the marriage squeeze, although this change would affect only the timing of the shortage of potential brides—not its severity. If we had focused on the proportion of men aged 40–49 who had never married rather than of those aged 30–39, the year of the predicted peak in the proportion never married would have only been delayed, while the magnitude of that proportion would have been unchanged (Table 4, panel H).

Flexibility in age difference between spouses is a mechanism for clearing the marriage market when sex ratios are larger than normal (Ni Bhrolchain 2001). We therefore allowed for an age difference between spouses of up to 8 years—one of the largest average age differences observed for marriages among men or women of any age (Casterline et al. 1986; Lloyd 2005). An 8-year age difference would represent a major change in China, so this assumption should give a conservative estimate of the proportion of men never marrying. Another mechanism which can adjust for the shortage of women is for men to marry at older ages. On examining the robustness of our results to a shift to older ages at marriage, we found that the proportion of men who would never marry did not change, although it peaked later. For example, if men were to marry from age 30 (instead of from age 25, our base assumption, which is the United Nations Population Division's 2003 estimate for China for 1999), the proportion of men who would never marry would reach a maximum in 2050, rather than 2030—but be at a similar level (Table 4). We did not investigate other possible changes in marriage patterns, such as a shift from monogamy to polyandry because there is as yet no significant evidence of these changes occurring.

3.2. *Projecting the population*

Our main findings in this paper are derived from estimates for 2030 that are based on cohorts already born and therefore not affected by potential changes in fertility and SRB. We also present results for China's marriage market beyond 2030, based on different scenarios of fertility, SRB, and marriage pattern.

Population change is defined as the net balance of fertility, mortality, and migration. For China, we assumed a closed population, because international migration is usually insignificant relative to the total population, although we relaxed this assumption in sensitivity testing (see the Appendix). The United Nations has projected significant increases in longevity

Table 4 Model sensitivity to varying assumptions about marriage formation and future fertility, China 2010–50

Variable	Proportion of men aged 30–39 never married (per cent) in (except for Panel H):				
	2010	2020	2030	2040	2050
Panel A: Baseline scenario					
A.1. Base case assumptions	1.72	4.74	21.82	14.37	18.34
Panel B: Varying the sex ratio at birth					
B.1. SRB = 1.06 after 2005	1.72	4.74	21.82	13.73	9.65
B.2. SRB = 1.09 after 2005	1.72	4.74	21.82	13.96	11.93
Panel C: Varying the minimum age at marriage					
C.1. Women at 23, men at 27	0.00	0.00	12.12	11.92	22.77
C.2. Women at 25, men at 27	2.19	2.03	20.69	14.65	18.11
C.3. Women at 25, men at 30	0.00	0.00	7.02	10.85	25.15
Panel D: Varying the age difference between spouses					
D.1. (Man's age – woman's age) ≤ 6	2.43	4.74	21.82	14.37	18.34
D.2. (Man's age – woman's age) ≤ 10	0.96	4.74	21.82	14.37	18.34
Panel E: Varying the preference ordering of women for men					
E.1. Men first by age, then education	2.28	4.74	22.32	13.82	18.34
Panel F: Varying the age sorting order of the marriage algorithm					
F.1. Women and men decreasing	0.84	1.96	10.09	6.85	19.54
F.2. Women decreasing, men increasing	1.58	1.67	21.82	14.37	18.34
F.3. Women increasing, men decreasing	1.72	4.74	21.82	14.37	18.34
Panel G: Varying fertility assumptions					
G.1. Fertility increase (to 1.92 in 2012)	1.72	4.74	21.82	12.27	17.28
G.2. Fertility increase (to 2.18 by 2030)	1.72	4.74	21.82	14.37	16.57
G.3. Fertility decrease (to 1.5 by 2018)	1.72	4.74	21.82	11.06	21.58
Panel H: Varying the age of the reference group					
H.1. Men aged 40–49	4.13	1.71	4.77	21.78	14.36
H.2. Men aged 40 or over	3.88	3.26	3.62	8.29	11.02

Notes: The base case involves the following assumptions: SRB of 1.18 persists indefinitely; preference of women for more educated men, subject to an 8-year maximum age difference; women marry in order of increasing age (younger women marry first) to men in order of increasing age (younger men marry first); women enter the market at age 23, men at age 25; no fertility change (from 1.65 in 2000). These assumptions are varied in the panels, one dimension at a time. For results where we model simultaneous change in the sex ratio at birth and fertility, see Table A3. The marriage sorting method and sensitivity tests are described in greater detail in the text and the Appendix.

Source: China 2000 Census (0.1 per cent sample), author's simulations. Foreign-bride data from China 2010 Census report.

as China's economic expansion has continued. Over the period 2000–50, life expectancy is projected to rise from 69.6 to 73.3 for men and from 77.6 to 82.0 for women (United Nations Population Division 2008). Yet the effect of increased longevity on young adults in the marriage market (aged 20–40) will be minimal because the increases will occur primarily at much older ages. Since the main findings are based on 2000 Census data, we adopted age-specific and sex-specific mortality rates from the 2000 life tables (Banister and Hill 2004), and these were held constant in the projection model.

During the period 2000–05, the SRB and fertility rates were held constant: the SRB at 1.18 (China NBS 2000) and total fertility rate (TFR) at 1.65 (China NBS 2005; Zeng et al. 2008). The age-specific fertility rates were based on more recent data than 2000, reflecting the gradually older age of mothers at childbirth (China NBS 2007). The SRB and TFR were assumed to vary after 2005 according

to scenario, but the age-specific fertility rates were held constant. These were the key inputs to all our projections of the proportion of never-married men in the period beyond 2030. In our baseline scenario, the SRB, TFR, and age-specific fertility rates were all held constant from 2005 to 2030.

Outside our baseline scenario, we allowed the SRB and TFR to vary after 2005. Declines in fertility would further increase the imbalance of numbers between men and women, and increase the proportion of never-married men. In Table A3, changes in fertility under three alternative scenarios are projected, based on those used by Zeng et al. (2008). The 'no change' scenario (our baseline case) assumed that the TFR would remain constant at its current value of 1.65, while the 'slow change' scenario assumed a 1.2 per cent annual growth in fertility rates between 2010 and 2030, levelling off in 2030 at the replacement TFR of 2.18. The intermediate 'sudden change' scenario assumed a step

change to a 19 per cent permanent increase in fertility rates in 2012 that models a ‘pent up’ demand for children relieved by a sudden policy change.

As with the different scenarios for future fertility, three different scenarios for future values of the SRB after 2005 were formulated, representing the extremes of possible outcomes (Table A3). The ‘low’ scenario assumed that the SRB would be 1.06 after

2005, the biological norm. The ‘medium’ scenario assumed that the government’s policy would stabilize the SRB at 1.09 for all births after 2005—a policy target for the near future (Li 2007). The ‘high’ scenario (our baseline case) assumed that the SRB of 1.18 for 2000–05 would persist indefinitely. As noted above, none of these assumptions about future fertility patterns affected our projections up to 2030, because the cohorts entering the marriage markets had already been born.

Also used in the model were projected educational-level ratios, which were derived from population projections by age, sex, and educational level. These projected ratios, adopted from Samir et al. (2010), consisted of the proportions of men at each educational level at regular intervals during the period 2000–50. These proportions were held constant in all scenarios (see the Appendix for full details). In projections of the geographical distribution of never-married men, the set of proportions of men at the different educational levels in a prefecture was held constant after 2000 for each prefecture. This geographical distribution of men by educational level was used (see Figure 3), because Samir et al. did not project sub-national changes in educational level.

To summarize, we held the SRB and TFR constant from 2000 to 2005, and, for our baseline scenario, they were held constant until the end of the projection period. In the alternative scenarios, the values for the SRB and TFR varied after 2005. Finally, we held constant several factors in the marriage-sorting algorithm, such as the age at entry into the marriage market, the maximum age difference between spouses, and the ranking of men’s cohorts by women’s cohorts—see Section 3.1. These and other factors, were not, of course, held constant in the sensitivity tests (Table 4).

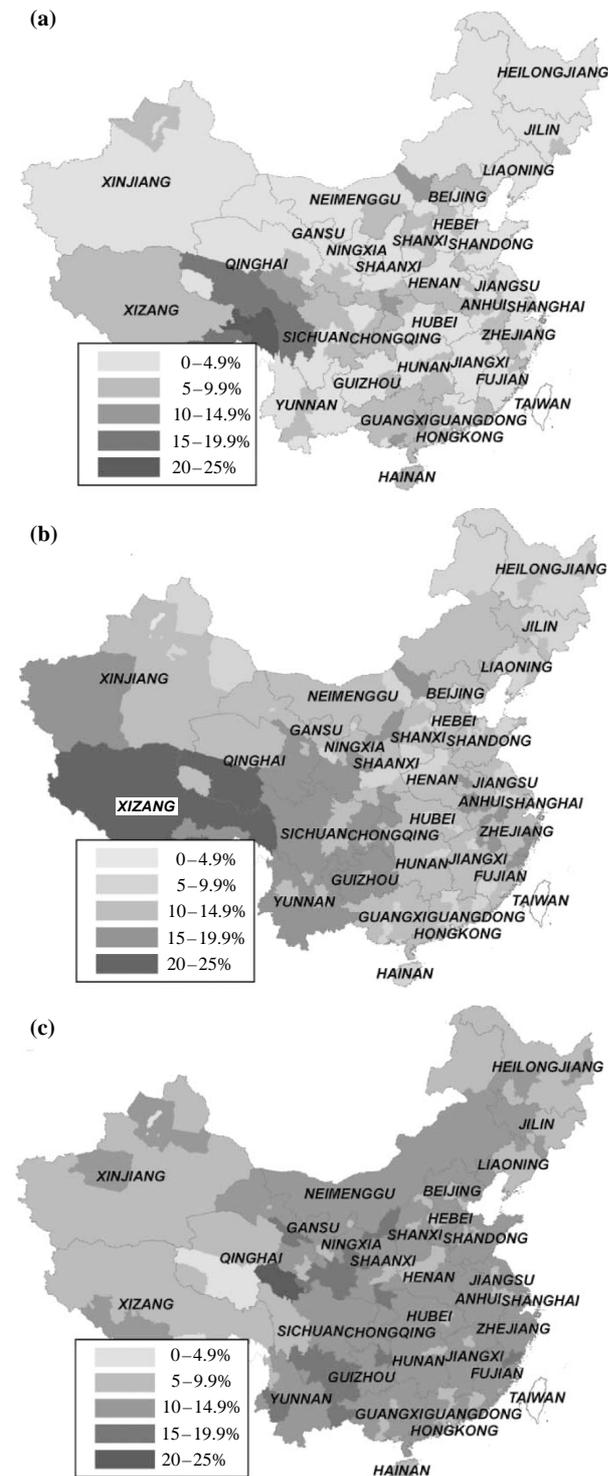


Figure 3 Actual and projected proportions of men aged 30 and over never married, by prefecture, China 2000 and 2030: (a) proportion of men aged 30 and over never married, 2000; (b) projected proportion of men aged 30 and over never married, assuming inter-ethnic marriage, 2030; (c) projected proportion of men aged 30 and over never married, assuming no inter-ethnic marriage, 2030

Notes: Figure 3(b) shows the projected proportion never married in 2030 by prefecture assuming no ethnic preferences (the simulation is run with all ethnicities in a common marriage pool). In Figure 3(c), the analysis is restricted to Han men and women, and shows the projected proportion of men never married among Han men.

Source: China 2000 Census.

4. Results of projecting China's marriage market

4.1. National results

We estimate that 21.8 per cent of men aged 30–39 in 2030 will never have married. Our projections for the proportion of never-married men (Table 5) used data from the 100-per-cent summary tabulations of the China 2000 Census. Accordingly, results at the national level can be derived for both these closed and open-ended age groups. In comparing the proportions never married, two issues need to be highlighted.

First, the projection results are more striking for men aged 30–39 than for those aged 30 or over. For example, nearly 22 per cent of men aged 30–39 in 2030 are projected to remain single, compared with about 7 per cent of men aged 30 or over. The reason is that the SRB began to rise from the mid-1980s, which means that men born after 1990 were the first to face a significant marriage squeeze. Thus, 78 per cent of men aged 30 and over in 2030 and 42 per cent of those age 30 and over in 2050 would be old enough to have avoided most of the marriage squeeze (United Nations Population Division 2008). We focus primarily on men aged 30–39 in 2030, who were born almost entirely during the 1990s, since they will be the first birth cohort to experience the full impact of the rise in the sex ratio in recent decades. Their chances of marrying fall sharply by the time they reach their 30s in 2030 (Figure A1). Second, a sharp decline in the SRB will not mitigate the bride shortage until after 2030, because the cohorts in the marriage markets for all years before 2030 have already been born, and their high sex ratios have already been determined. Spousal availability will reach a minimum before recovering, regardless of future changes in the SRB and in fertility. For the decades after 2030, the effect

of the changes in the SRB will be significant: under current conditions, 18.3 per cent of men will remain single in 2050, but were the SRB to remain at 1.09 after 2005, the proportion would be close to 12 per cent (Table 5).

Our core finding—that, during the next few decades, substantial proportions of men in China will never marry—is highly robust to alternative assumptions on the SRB and fertility. It is also robust to alternative assumptions on marriage formation, such as the age at entry into the marriage market and the age difference between spouses (Table 4).

In our various scenarios we examined the sensitivity of our results to changes in the following: (i) age at entry into the marriage market; (ii) the SRB; (iii) age differences between spouses; (iv) the age preferences and order of matching for marriage of women (whether the young or old marry first); (v) future fertility rates; and (vi) the age of the reference group (men aged 30–39 vs. men aged 40–49). In these various scenarios, it is largely the timing of the problem that changes. The projections show about 2–4 per cent of men aged 30–39 in 2010 being never married, rising to 20 per cent of those in their 30s in 2030 before declining to 10–15 per cent in 2040. If women were to become willing to marry even older men, or to marry at even younger ages (or both), the change would postpone, but not eliminate, the problem for men. For example, if men were to delay entry into the marriage market until age 30 (with women entering at age 25), the proportion of never-married men aged 30–39 in 2030 would fall from 21.8 to 7 per cent—but would rise from 18 to 25 per cent in 2050. If we focus on men aged 40–49, the proportion never married would peak later, at nearly 22 per cent in 2040, before falling to 14 per cent in 2050. These proportions are the same as those in the base scenario for men aged 30–39, except that they are delayed by a decade.

Table 5 Projected proportion of never-married men, China 2010–50

	Pre-existing SRB			Change in 2005 of SRB to:			
	Already born			SRB = 1.09		SRB = 1.18	
Overall	2010	2020	2030	2040	2050	2040	2050
Men aged 30–39	1.72	4.74	21.82	13.96	11.93	14.37	18.34
Men aged 30 and over	3.31	3.64	7.35	9.35	11.13	9.44	12.57

Notes: These projections assume entry of women into marriage market at age 23 and entry of men at age 25, preference of women for educated men before men of similar age, and an age difference between spouses of up to 8 years. Age-specific fertility rates from China NBS 2007 are adjusted to reflect TFR = 1.65, following Zeng et al. 2008.

Source: Authors' projections from China 2000 Census data, according to scenario of change in SRB after 2005. For overall proportions of never-married men age 25 and over, see Ebenstein and Sharygin 2009.

In the next section, we examine the geographical distribution of the problem.

4.2. Province-level results

We present results at the province level and below for those aged 30 and over in 2030. Recall that 78 per cent of men aged 30 and over will have experienced little, if any, of China's marriage squeeze. However, because data are not available by age group at sub-national level, making projections for men in their 30s at provincial level is difficult. This section therefore focuses not on the proportions of men projected to remain single but on their geographical distribution.

Figure 3 maps the projected proportion in 2030 of never-married men aged 30 and over for each area, and also the corresponding proportions of never-married men in 2000. These results were derived by applying projected national-level proportions of men (and women) never marrying by educational level to the population in 2000 by area, sex, age, and educational level. As such, the results are intended only to indicate which areas in 2030 would experience the largest proportions of never-married men, were the pattern of educational level attainment by area to remain as it was in 2000.

In Figure 3, three maps show the proportions of men aged 30 or over who were never married in each prefecture. Figure 3(a) gives the situation in 2000

from the census. Figure 3(b) gives the baseline projection for 2030, in which inter-ethnic marriage was not restricted. In Figure 3(c), the projection for 2030 refers only to the Han population, that is, no inter-ethnic marriage was allowed.

Poor provinces appear most likely to be severely affected by the marriage squeeze (Table 6). We predict that, in 2030, the proportions of never-married men aged 30 and over in provinces with the lowest quintile of GDP per head, will be 50 per cent larger than those in the wealthiest provinces. Although the proportion of never-married men in the coastal region is likely to remain close to the current proportion, we predict that proportionately more men will remain single in the poorer inland and western provinces. In most cases, these are not areas with a currently high SRB (Figure 3(a)).

4.3. Interpreting the results

The projection results suggest several areas for concern. A concentration of never-married men, with little prospect of ever marrying, raises the potential for social instability. In this respect, China is unlike other countries that have experienced high levels of bachelorhood. For example, when bachelorhood was prevalent in Ireland, there was no shortage of women (so men could have 'sweethearts' whom they could hope to marry once they had saved enough). In South Korea, a shortage of women was mitigated by men

Table 6 Characteristics (percentages) of provinces grouped into five income bands, and projections for 2030, China 2006

	Provincial income group (quintiles)				
	Highest	High	Middle	Low	Lowest
GDP per head (2010)	57,768	39,103	27,250	23,258	17,771
Dependency ratio (2010)	27.98	31.49	31.31	39.63	42.04
Per cent rural (2010)	48.13	57.11	62.88	74.20	80.09
Per cent college educated (2009)	12.76	7.37	7.42	6.12	3.95
Human Development Index (2008)	84.90	82.68	78.86	77.39	73.03
Life expectancy (2000)	74.85	72.97	71.16	70.69	67.45
Net migration of women for the purpose of marriage (1995–2000; thousands)	363	237	–68	–97	–364
Projected proportion of men aged 30 or over never married (2030)	6.47	6.71	7.10	7.54	9.01

Notes: Dependency ratio defined as ratio of population under 15 and over 65 to population 15–64. Total migrants may not sum to zero owing to rounding. Population-weighted averages reported. Provinces are stratified into groups by GDP per head, from which the above population-weighted averages have been derived. For data by province and a list of provinces included in each group, see Table A4. The proportion of never-married men assumes: (i) SRB of 1.18; (ii) 'sudden' fertility growth scenario in Table A3; and (iii) ethnic intermarriage (Figure 3(b)). Because of the older average age of the group aged 30 or over, the estimated proportion never married is lower than estimates for men aged 30–39.

Source: 2010 GDP per head (yuan per person), dependency ratio, and per cent rural from *China Economic and Statistical Yearbook* (China NBS 2011b); per cent college educated (of population over age 6) from 2009 Sample Survey on Population Changes (China NBS 2010); Human Development Index from *China Human Development Report 2009/10* (UNDP 2010); life expectancy in 2000 from the 2006 Sample Survey on Population Changes (China NBS 2007); net migration of women for the purpose of marriage from China 2000 Census 0.1 per cent sample; population in 2010 from Statistical Communiqué of the China NBS (China NBS 2011a).

marrying women from poorer parts of Asia. With its compact geography and high level of development, South Korea offers a high living standard and access to good schools and services, even for its poorer residents. By contrast, low-income men living in the remote parts of China have relatively little to offer to potential brides, while their large numbers (compared with South Korea) mean that it would be very difficult to attract enough foreign brides to reduce the shortage significantly.

In addition, high concentrations of never-married men in areas with large ethnic minorities could further increase civil unrest. The majority of prefectures with the largest projected proportions of never-married men in 2030 are located in Guizhou, Qinghai, Tibet, and Yunnan, and large proportions are also predicted for Ningxia, Sichuan, and Xinjiang. Some prefectures are predicted to have particularly large proportions. For example, in Guizhou the proportion of never-married men aged 30–39 is projected to exceed 50 per cent in all but one prefecture by 2050. Our results at the sub-national level should, however, be interpreted with caution, since women may choose to marry men of lower socio-economic status whom they meet early in life. Our modelling results represent an extreme scenario, in which women are matched with men solely on factors of age and educational level. The geographical distribution of never-married men will be less concentrated if education programmes raise men's educational levels more quickly in remote, poorer, rural areas than in wealthier areas, or if some women prefer to marry locally, despite the lower living standards their potential husbands have to offer (or if women are prohibited from some types of migration). Nevertheless, the patterns reflected in the results highlight the possibility of a large prevalence of bachelors in the poorer provinces—at levels which will be unprecedented in China's modern history.

Moreover, the elderly poor have little access to social protection programmes. Poverty in China is heavily concentrated in the rural parts of the country, especially the north-western and south-western regions (World Bank 2009, Table 4.21), where the proportions of never-married men are projected to be largest. Nationally, nearly 30 per cent of the rural elderly were classified as poor in 2006, compared with only 5 per cent of the urban elderly (Cai et al. 2009, Table 2). In 2005, less than 5 per cent of the rural elderly aged 60 and over had a pension income, compared with 45 per cent in urban areas (Cai et al. 2009, Table 1A and B). The coverage of safety-net arrangements and other social insurance programmes

is low in rural areas, as are the levels of benefits. They offer little protection from poverty in the event of such shocks as losing a job or experiencing a serious health problem (World Bank 2009, Table 6.63 and 6.64). Efforts are being made to expand these programmes, but they continue to be severely restricted by the heavy reliance on individual contributions and local subsidies. In consequence, it is programmes in the poorer areas, where they are most needed, that have the lowest level of funding (Government of China, State Council 2009). Old-age dependency ratios are also increasing most rapidly in the rural areas, as young people migrate to find work elsewhere, putting additional pressure on limited local fiscal resources (Zeng et al. 2008).

The lives of men who have never married are likely to be much bleaker than those of married men. Not only are they less educated, but—even when we control for their educational level—their incomes are lower and their assets fewer than those of married men, and they also report poorer health (Table 7). Whether the advantage of married men

Table 7 The association between each of three key variables of well-being and whether never married and other demographic variables, China 2002

Independent variables	Dependent variable of well-being		
	Personal income (1)	Financial assets (2)	Good health (3)
Never married	−760.2*** (261.96)	−3,686** (1,685.66)	−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 (1,412.84)	0.024 (0.02)
Constant	7,801.9*** (371.89)	56,119*** (2,393.06)	1.108*** (0.04)
Observations	10,033	10,033	10,033
R ²	0.26	0.37	0.16
Sample average	2,184	24,085	0.76

*Significant at 10 per cent; **significant at 5 per cent; ***significant at 1 per cent.

Notes: The results shown are based on responses from male rural participants aged 30 or over. 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 the Ordinary Least Squares method, which derives the partial correlation of each well-being measure with each demographic variable. The regressions are executed with prefecture-level fixed effects to control for regional variation in the outcomes.

Source: China Household Income Project (2002).

results from selection into marriage or from the direct impact of marriage on men's earnings or ability to save (Korenman and Neumark 1991), it is clear that never-married men are significantly disadvantaged financially, and in poorer health.

Never-married men are thus less likely to be able to save adequately for old age, or to remain working into old age. They are also the most vulnerable to income and illness shocks, since they cannot smooth out fluctuations in household income by pooling earnings from spouses or children. Never-married men and women are also less likely to be living with family members who can serve as caregivers (Table 8). In the 2000 Census, 63 per cent of those aged 65–80 who had ever married were co-residing with younger kin, compared with only 19 per cent of those who had never married. Moreover, levels of inter-generational co-residence have fallen sharply in recent decades (Table 8), and this trend can be expected to continue.

5. Conclusions and policy implications

The marriage squeeze in China will intensify rapidly as the cohorts with relatively high sex ratios, born in recent decades, begin to reach marriageable age. We estimate that by 2030, 20.8 per cent of men aged 30–39 in China will never have married. However, we project that this squeeze will occur very unevenly across the different regions of China—poorer rural areas will experience much higher prevalence levels of bachelorhood, as the wealthier areas attract brides from them. Despite their more balanced sex ratios, the poorer provinces will bear a disproportionate share of the social and economic burden of China's never-married men.

Our results should be interpreted with caution for two reasons. First, since the official census data for 2000 undercounted young girls, the marriage squeeze may be less pronounced than our projections indicate. Second, we assumed perfect mobility between regions (though not always between ethnicities)—possibly an unrealistic assumption despite a progressive lifting of restrictions on migration in recent years.

Various factors could mitigate the marriage squeeze, but they are difficult to determine and beyond the scope of our analysis. The intensity of the squeeze might be reduced by a combination of factors, such as a rise in fertility, a reduction in sex selection, and more flexibility over age at marriage (an upward shift for men or a downward shift for women). Over time, changes could be made in marriage arrangements, perhaps even involving

Table 8 Proportions of the elderly co-resident with younger family members other than a spouse, China 1982–2000

	1982 Census			1990 Census			2000 Census		
	Never married (1)	Have ever married (2)	Difference (3) (1) – (2)	Never married (4)	Have ever married (5)	Difference (6) (4) – (5)	Never married (7)	Have ever married (8)	Difference (9) (7) – (8)
Elderly, aged 65–80	0.351	0.740	0.390***	0.404	0.721	0.390***	0.194	0.634	0.440***
Elderly, aged 80 or over	0.404	0.687	0.293***	0.404	0.700	0.293***	0.250	0.680	0.430***

*Significant at 10 per cent; **significant at 5 per cent; ***significant at 1 per cent.

Source: China 1982 Census (1 per cent sample), China 1990 Census (1 per cent sample), China 2000 Census (0.1 per cent sample).

radically changed marriage forms (such as polyandry). A lessening in women's preference for husbands with better prospects could lead to a different future for the country and its poorest regions. A shift in the distribution of investment in boys' schooling away from wealthier regions towards the poorer, remote, regions could improve the prospects of men from poorer regions in the marriage market. If the living standards of China's poorer provinces were raised quickly enough, the men living there might be able to attract women as brides from poorer neighbouring countries—though the potential demand for foreign brides is likely to far outstrip supply, given China's large population.

It has been argued that high levels of bachelorhood in China may cause social unrest. Such arguments generally focus on the national prevalence of projected bachelorhood. Our results suggest that focusing on the national prevalence may significantly understate the problem, since bachelorhood is likely to be highly clustered geographically. High concentrations of men facing bachelorhood and vulnerable old age could significantly increase the potential for disaffection and social unrest—perhaps exacerbating other social tensions in poorer provinces with large ethnic minorities.

The results paint a grim picture for future cohorts of elderly bachelors in rural China. Social protection programmes in China are heavily dependent on financing by local government, with relatively small subsidies from the central government (Wang 2006; World Bank 2009). These programmes are therefore least effective in the poorer regions, where never-married men will tend to be clustered. The World Bank (2009) recommends strengthening programmes that provide safety nets against destitution. We recommend that particular attention be paid to areas with large projected proportions of never-married men. Central subsidies for these programmes also need to be increased further, especially for the poorer regions. A progressively structured national old-age pension programme could do much to mitigate the financial risks facing those forced to remain bachelors. The resources for such a programme could be found, since China continues to reap a significant demographic dividend from its large working-age population and small population of dependent children.

Notes

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Technical Appendix

Existing work on projecting the marriage market in China is limited. Feldman et al.'s model focused on the timing and size of the anticipated imbalance in the sex ratio of the marriage market, the effect of the sex ratio at birth (SRB) on the probability of having a son, and the proportion of the elderly with no son (1995). More recently, Zeng et al. (2008) constructed

a detailed probabilistic model of population growth in China, including a two-sex marriage model. We have incorporated some of their fertility assumptions into our model.

Our method of projecting the married population was based on both the classical cohort component projection model (Preston et al. 2001) and an earlier, innovative, model of the Chinese marriage market (Ebenstein and Sharygin 2009).

A.1. Sources of data

Data on fertility and the SRB were drawn from official Chinese sources. The SRB used for each of the years 2000–05 was the unadjusted value, 1.18, from the China 2000 Census, 0.1 per cent micro-data sample. In the sensitivity analysis, we varied the child sex ratio to account for the fact that the sex ratio in the census had undercounted girls aged 1–4. The SRB value of 1.18 from the census is an appropriate choice because it is readily observable, and it is lower than other, newer, estimates, such as the one derived by back-projecting births from the population aged 4–5 in the 2005 1 per cent inter-census survey in China.

Two types of fertility data were used. The first was the 2006 fertility-by-age profile, which we extracted from the *China 2007 Demographic Yearbook* (China NBS 2007). This age profile at childbearing is slightly older than those from earlier surveys. Following Zeng et al. (2008), the total fertility rate (TFR) used was 1.65, a compromise value falling within the range of likely values, as discussed in Zeng et al.'s paper. The TFR was varied in different scenarios in the years after 2005; but the annual change in fertility rates from 2005 to 2006, whether an increase or a decrease, was carried forward into successive future years.

There were several options in making assumptions about mortality. Since mortality was of less importance in our analysis than the other assumptions (except perhaps at the youngest ages), we used mortality data from the life tables for China in 2000 (Banister and Hill 2004). We tested an alternative life table, the WHO life tables for China for 2009 (World Health Organisation n.d.), but the results were very similar.

As men's educational level is a required input to the marriage sorting algorithm, we had to decide how to determine the proportion of men at the different levels of education in future years. Education progression ratios (the proportion of a cohort that progresses from one level of education to the next) were used from those developed by Samir

et al. (2010), as a part of the Human Capital Database project at the International Institute for Applied Systems Analysis. These are national-level projections for China of the proportions of women and men at each educational level from 2000 to 2050 (5-year age groups and 5-year projection periods), based on the experience of countries that were once at a similar level of development as China in 2000. These education progression ratios were used for cohorts which were either younger than 25 in 2000, or had not been born by 2000.

Future mortality and proportions at the different educational levels were held constant across scenarios. The age at entry into the marriage market, the age difference between spouses, and the ordering of men by educational level by the marriage algorithm to match against appropriate women were all held constant between scenarios, and allowed to vary only in sensitivity tests presented in Table 4. Some of the priorities that could be changed, such as educational level being a more important factor than age of the woman (and similar ages for spouses being next in importance after educational level), were based on the tendency towards hypergamy ('marrying up') in China, demonstrated in Table 1 (see also Parish and Farrer 2000). Another flexible variable was the age at marriage used in the marriage algorithm, which was based on the modal ages at marriage of men and women, and the legal age minima. The marriage sorting algorithm was not intended to be a realistic model of spouse matching (a significant project for another time). Rather, it was used as a non-behavioural, mechanistic method of matching, which was simple and achieved the maximum number of marriages, subject to some constraints developed by the investigators to replicate conditions unique to China.

A.2. Implementation of the population projection model

The base population by sex, age, educational level, and ever-married status for 2000 was extracted from the China 2000 Census, 0.1 per cent micro-data sample.

Our projection model is primarily focused on women. For n single-year age groups (maximum age n), we express the age distribution of population at year t as a matrix $\mathbf{x}^{(t)}$ where $\mathbf{x}^{(t)} = \{x_0^{(t)}, x_1^{(t)}, x_2^{(t)}, \dots, x_n^{(t)}\}$. Here $x_0^{(t)}$ is the sum of births between year $t - 1$ and t . The number of newborns in turn is the sum of the products of each age-specific fertility rate ${}_1F_x^{(t)}$ across β reproductive years starting at age α . As the official statistics from the 2000

Census produced a TFR acknowledged to be too low, we increased all age-specific fertility rates by a factor such that the TFR equalled 1.65 (following Zeng et al. 2008). Values of ${}_nF_x$ for years later than $t = 2005$ depended on the fertility scenarios described above. The numbers of births by sex were then derived using the SRB, which was 1.18 up to 2005, and taking varying values in the different scenarios subsequently. We calculated the population at each educational level, starting with the set given in the 2000 Census (Table A1). After 2000, each cohort progressed in educational level according to the education progression ratios discussed above (Samir et al. 2010). To our knowledge, our model is the first to introduce women's preference for educated partners in an analysis of the marriage market in China—providing estimates of those never married by single years of age and educational level. To make the projections, it was necessary to project the educational levels of men, including those of men who were projected using the assumed fertility rates and SRBs.

Populations were projected by sex and educational level. For each set of assumptions, and for each future year, a matrix was obtained of population by sex, whether ever married, age, and educational level. It is important to note that, up to 2030, the projections of men aged 30 and over depend primarily on the mortality assumption, and not the fertility or sex ratio assumptions.

A.3. Modelling marital status changes

The marriage projection model used in this paper is an adaptation of the method developed in an earlier study of the marriage market in China (Ebenstein and Sharygin 2009). The model calculated the proportions of never-married men and women by certain ages, and also as elaborated in this paper, by level of education. We used the proportions of never-married men and women by educational level,

Table A1 Percentage distribution by educational attainment at age 22, men and women, China 2000 and 2030

Education level	Men		Women	
	2000	2030	2000	2030
None/adult literacy	1.3	0.0	2.7	0.0
Primary	14.6	5.7	19.8	5.7
Secondary	74.0	77.9	69.1	74.3
Tertiary	10.1	16.3	8.4	20.0

Source: Samir et al. 2010 ('Global Education Trends' scenario, ages 20–24 combined); China 2000 Census.

and the geographical distribution of the population by sex and educational level to indicate where levels of bachelorhood might be highest in China.

In each projection, the educational levels of men and women were first determined and then marriage 'matches' were made, followed by the implementation of the fertility and mortality assumptions. Individuals in the census were 'married' according to a marriage queue, whose order was determined by a rank preference function. Our woman-centred model assumed that women first make offers to their most preferred men; however, which women make the first offers and which men receive the first offers are changeable parameters. In addition, our model included a number of alternative assumptions about the following: the ages at which men and women enter the marriage market; future fertility after 2005; and future values of the SRB after 2005. The model also assumed perfect mobility between geographical areas, so that there was no implicit preference for geographically closer men, compared with those more distant. Clearly, this is an unrealistic assumption. However, not assuming perfect mobility would probably cause the national projected proportion never marrying to increase, since it would prevent local surpluses of women from being married.

To illustrate the marriage algorithm under baseline assumptions, consider the following example. Four queues exist—two for each sex. In the first queue, women aged 23 and older queue in a line according to age, the youngest first. In the second queue, men stand in an arbitrary order. One by one, women step forward from the first queue to fill an empty third queue. Men then move from the second to the fourth queue according to education, with the most educated first. Within each education group, they queue from youngest to oldest. Only the men who are the same age as, or up to 8 years older than, the women are allowed in the fourth queue. Women and men step out of the third and fourth queues in order from the front and are matched pairwise from the front of the queue, until one of the queues is empty. If the women run out first, then the men return to the second queue and the process repeats itself—for the next oldest age of the women. If the men run out first, then the women stand outside the third queue until every woman in the first queue has had a chance to stand in the third queue and attempt to marry.

Once every woman has had a chance in the third queue, everyone becomes 1 year older and the process repeats. The routine described above relies on a series of assumptions, each of which we varied

to test the sensitivity of the results: the minimum ages of men and women on entering the marriage market; whether women choose men by their age or educational level first; whether women marry youngest first or oldest first; whether we queue men by youngest or oldest first; and the limits of the allowable age difference between spouses. We also considered how increases or decreases in fertility, and changes in the sex ratio and additional numbers of net marriageable immigrant woman, might affect our results.

A model at the micro level would allow a more detailed analysis of local marriage pattern markets than an analysis at the macro level. Analysis at the macro level is appropriate only for examining a limited range of possibilities. As the number of parameters of the marriage model increases, this type of analysis becomes cumbersome. Since it is very difficult to obtain more detailed data from the Chinese censuses, we focused on a limited set of parameters and used a model at the macro level. To project the extent of future bachelorhood, and its geographical distribution, we implemented a model reflecting both a preference for educated husbands and allowing full migration for marriage.

A.4. Robustness checks of core results

To test whether our results depend upon the sequence of making the assumptions, we produced results for a number of alternative scenarios. The results of the different scenarios are presented below and in Table 4. In particular, we allowed women to prefer husbands first by husband's age and then by his educational level (holding men's age constant and then considering educational levels in turn, starting with the highest level). We also changed the order of women marrying, starting with the oldest to the youngest rather than vice versa, starting with the oldest men, down to the youngest, rather than vice versa. In addition, we tested the results of restricting age differences to just 6 years (rather than 8), and also to 10 years. We also allowed the minimum age at marriage to be either age 20, 23, or 25 for women, and either 25 or 27 for men. (The actual distribution of age at marriage for men and women in 2000 is shown in Figure A1.)

We also tested alternative assumptions for fertility and the sex ratio (Table A2). While our baseline assumption of increased fertility erred on the conservative side, we also included a scenario in which fertility fell to 1.5 children per woman. We also modelled the effect of changing the sex ratio of

births after 2005 by using the following values: 1.06 (biological norm); 1.09 (policy target); 1.18 (current approximation).

According to our sensitivity analyses (Table A3), the results are robust to the following: age at entry into the marriage market; age difference between spouses; the husband preference ordering of women; the sorting order of the marriage algorithm (whether the young or old are married first); and the assumed fertility rates. In particular, the sensitivity analysis confirms that China's demographic destiny has in large part been determined for the coming decades, and that an immediate correction of the sex ratio would change the outcome only after a significant delay, with the proportion of never-married men remaining high well into the future. The current sex ratio of births occurring today would have a significant impact on marriage only from the mid-2030s (Figure A1). Even if a lower SRB were achieved immediately, the proportion of never-married men aged 30 and over, and 30–39 in 2050 would remain high.

Scenarios that only increased or decreased the minimum ages at marriage for men and women showed that they affected the amplitude but not the level or trend of the proportion ever married. For example, if women marry from age 20 (instead of our base assumption of 23), the peak of bachelorhood is postponed by roughly 20 years, and it occurs in 2050 rather than 2030, but at similar levels of prevalence. The peak proportion of men never marrying can also be postponed by older ages at first marriage, with shortages of brides occurring in later cohorts, but postponing marriage cannot over-

come the marriage squeeze indefinitely without a reduction in the SRB or an increase in fertility. However, even an immediate normalization of the SRB would be insufficient to avoid a marriage squeeze in the short-term to mid-term.

We conducted two additional sensitivity tests not reported in this paper, to correct for the under-reporting of girls younger than 5 and to take account of the possible immigration of marriageable women. Under-reporting of girls younger than 5 is likely in the Chinese censuses, including the China 2000 Census, which we used as the basis for our projections. As our baseline scenario did not correct for an undercount, we included a special case that added girls younger than 5 to the base population in 2000. Noting that the sex ratios at birth for those born in the 4 years up to 2000 (estimated from the China 2000 Census) (Goodkind 2011) were 2–3 per cent lower than that for 2005 (estimated from the 2005 1 per cent inter-census survey), the number of extra girls added to these cohorts was just sufficient to reduce the sex ratio by 3 boys per 100 girls. Because the sex ratios of those born from 1990 to 1995 do not differ greatly from the corresponding ones estimated from 2000 or 2005 data, we chose not to adjust the numbers for these cohorts. The result is a net gain of 625,000 extra girls aged under 5, with a reduction in the sex ratio for those aged under 5 from 120.5 to 117.5.

With this adjustment for the undercount, but with other factors held as in the base scenario, the projected proportion of never-married men is as follows: 1.72 per cent in 2010; 4.72 per cent in 2020; 20.60 per cent in 2030; 14.19 per cent in 2040; and 18.13 per cent in 2050. The difference from the estimate in

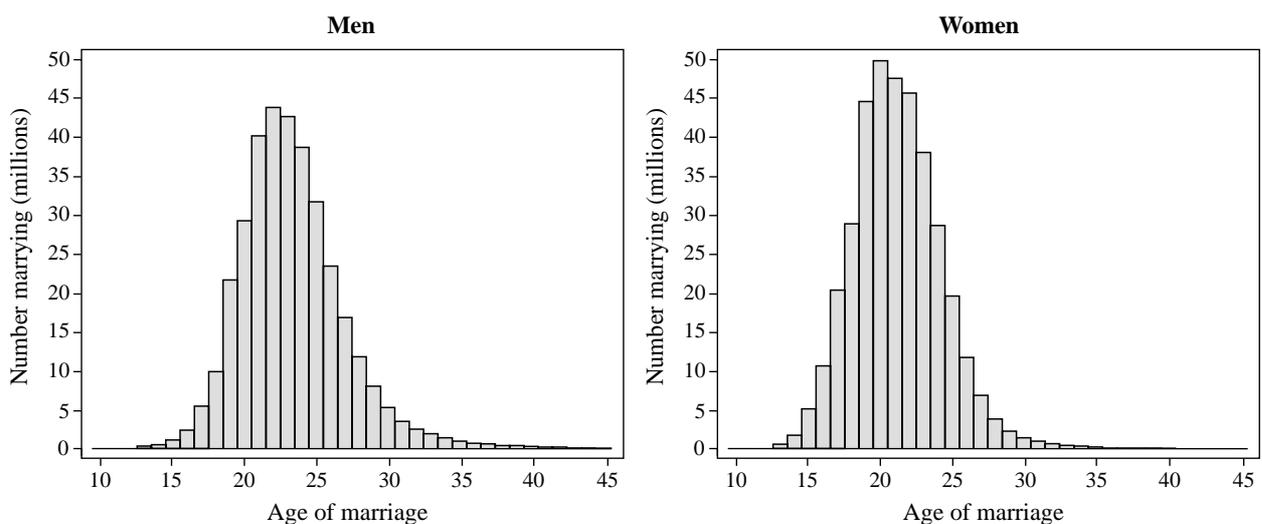


Figure A1 Number of marriages by age and sex, China 2000

Notes: Age at marriage imputed from each respondent's reported date of marriage and date of birth. Figure shows all marriages recorded in 2000, regardless of year of occurrence.

Source: China 2000 Census (0.1 per cent sample).

Table A2 Scenarios of fertility and SRB change, China 2000–30 +

Scenario	TFR in:			
	2000–09	2010–19	2020–29	2030 and thereafter
None	1.65	1.65	1.65	1.65
Slow decline	1.65	1.65 → 1.5	1.5	1.5
Slow growth	1.65	1.67 → 1.88	1.88 → 2.18	2.18
Sudden (baseline)	1.65	1.65 → 1.96	1.96	1.96

Scenario	SRB in:		
	2000–05	2006–09	2010 and thereafter
Low	1.18	1.06	1.06
Medium	1.18	1.09	1.09
High (baseline)	1.18	1.18	1.18

Note: Increase from 1.65 to 1.96 in 'sudden' scenario occurs by imposing a one-time 19 per cent 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 per cent growth per annum in all age-specific fertility rates.

Source: China 2000 Census; Zeng et al. (2008).

the baseline scenario (Table 4) would be largest in 2030, when the estimate would be 21.82 per cent.

We also considered the possibility that women would immigrate into China to marry—expanding the potential number of brides to include women from South-east Asia and elsewhere. Quite apart from the fact that the sheer number of projected bachelors in China is very large compared with the populations of the neighbouring countries, our

projections indicate that the prevalence of bachelorhood would be highest in the rural areas, for less educated men, whose ability to attract marriageable immigrants might be limited. There is no definitive information on women entering China for the purpose of marriage, but there is some evidence that some Chinese women leave the country to marry abroad; for example, significant numbers of Chinese women marry Taiwanese men (Jones and

Table A3 Sensitivity of estimated percentage never married to assumptions about sex ratio and fertility, China 2040 and 2050

		Men aged 30–39										
		No change in fertility			'Slow growth' in fertility + 1.2 per cent annually starting in 2010 (to 2.18)			'Sudden growth' in fertility + 19 per cent in 2012 (to 1.96)				
		SRB after 2005			SRB after 2005			SRB after 2005				
Year	TFR	1.06	1.09	1.18	TFR	1.06	1.09	1.18	TFR	1.06	1.09	1.18
2040	1.65	13.73	13.96	14.37	2.18	13.26	13.93	14.37	1.96	11.11	11.12	12.28
2050	1.65	9.65	11.93	18.34	2.18	8.11	10.03	16.57	1.96	8.75	11.29	17.28

		Men aged 30 or over										
		No change in fertility			'Slow growth' in fertility + 1.2 per cent annually starting in 2010 (to 2.18)			'Sudden growth' in fertility + 19 per cent in 2012 (to 1.96)				
		SRB after 2005			SRB after 2005			SRB after 2005				
Year	TFR	1.06	1.09	1.18	TFR	1.06	1.09	1.18	TFR	1.06	1.09	1.18
2040	1.65	9.31	9.36	9.44	2.18	9.22	9.35	9.43	1.96	8.81	8.82	9.03
2050	1.65	10.62	11.13	12.57	2.18	10.19	10.73	12.23	1.96	9.88	10.47	12.11

Notes: Simulations described in detail in the text and the Appendix. Age of entry to marriage market at 23 for women and 25 for men. Marriages occur during each iteration between women aged 23–32 and men aged 25–40. Changes in fertility and the sex ratio at birth do not alter the proportions never married up to 2030, since men then aged 30–39 had already been born by 2000. The results for the two cohorts are shown in Table 4. The 'sudden growth' is in line with Zeng et al.'s assumptions (2008).

Source: China 2000 Census.

Table A4 Net migration of women for marriage by province and province's characteristics, China 1995–2000

Province	Net migration of women for marriage (thousands)	GDP per head (2010)		Dependency ratio (2010)		Per cent rural	Average years of education	Human Development Index	Life expectancy at birth (years)	Projected per cent of men aged 30 or over never married
	(1995–2000)	Nominal	Quintile	Overall	Elderly	(2010)	(2009)	(2008)	(2000)	(2030)
Beijing	62	75,943	1	21.0	10.5	21.3	11.2	89.1	76.1	3.96
Tianjin	30	72,994	1	22.4	10.4	38.9	10.1	87.5	74.9	4.99
Hebei	29	28,668	2	33.5	11.0	68.2	8.4	81.0	73.1	6.84
Shanxi	13	26,283	3	32.8	10.1	67.1	8.9	80.0	71.7	6.47
Neimenggu	–43	47,347	1	27.6	9.7	59.1	8.5	80.3	73.3	7.22
Liaoning	43	42,355	2	27.8	13.2	49.1	9.2	83.5	72.6	5.91
Jilin	–21	31,599	2	25.6	10.5	54.7	8.9	81.5	72.5	6.34
Heilongjiang	–62	27,076	3	25.4	10.4	51.6	8.7	80.8	71.1	6.21
Shanghai	42	76,074	1	23.1	12.5	11.1	10.6	90.8	78.1	4.41
Jiangsu	176	52,840	1	31.4	14.3	49.2	8.5	83.7	74.7	6.54
Zhejiang	96	51,711	1	29.1	12.0	69.1	8.4	84.1	73.9	8.17
Anhui	–9	20,888	5	39.2	14.2	77.3	7.6	75.0	71.3	8.50
Fujian	22	40,025	2	30.5	10.3	66.1	8.3	80.7	69.9	7.54
Jiangxi	–27	21,253	4	41.8	10.8	73.0	8.5	76.0	71.2	7.34
Shandong	65	41,106	2	34.4	13.2	59.8	8.3	82.8	73.3	7.32
Henan	0	24,446	4	41.6	11.8	78.0	8.4	78.7	72.9	6.75
Hubei	–23	27,906	3	29.9	11.8	64.1	8.5	78.4	72.4	7.02
Hunan	–31	24,719	4	37.7	13.5	77.6	8.5	78.1	70.1	7.28
Guangdong	99	44,736	2	31.0	8.8	47.9	8.9	84.4	73.9	6.21
Guangxi	–47	20,219	5	44.8	13.4	80.7	8.1	77.6	64.4	6.96
Hainan	4	23,831	4	38.5	10.9	61.7	8.4	78.4	66.0	5.88
Chongqing	7	27,596	3	39.9	16.2	66.5	7.9	78.3	67.4	8.66
Sichuan	–66	21,182	4	38.7	15.2	73.8	7.7	76.3	69.0	8.75
Guizhou	–177	13,119	5	51.0	13.0	83.9	7.1	69.0	66.0	10.17
Yunnan	–119	15,752	5	39.6	10.7	83.4	6.9	71.0	67.5	10.17
Xizang	1	17,319	5	41.5	7.1	82.9	4.5	63.0	71.9	16.48
Shaanxi	–5	27,133	3	30.3	11.1	65.9	8.6	77.3	71.7	7.26
Gansu	–13	16,113	5	35.8	11.2	74.2	7.3	70.5	65.5	9.38
Qinghai	–3	24,115	4	37.4	8.6	69.9	7.4	72.0	70.7	9.62
Ningxia	2	26,919	3	38.5	8.8	62.3	8.2	76.6	71.5	8.85
Xinjiang	26	25,034	4	36.9	8.5	57.3	8.7	77.4	70.2	7.77

Notes: Overall dependency ratio refers to the ratio of the population aged under 15 or 65 or over to the population aged 15–64. Elderly dependency ratio refers to the ratio of the population aged 65 and over to the population aged 15–64. The proportion of never-unmarried men assumes: (i) SRB of 1.18; (ii) ‘sudden’ fertility growth scenario in Table A3; (iii) ethnic intermarriage (Figure 3(b)). Because of the older average age of the group aged 30 or over, the estimated proportion never married is lower than estimates for men aged 30–39.

Source: Net migration of women for marriage from China 2000 Census 0.1 per cent sample; 2010 GDP per head (yuan per person), dependency ratio, and per cent rural from *China Economic and Statistical Yearbook* (China NBS 2011b); average years of education (of population over age 6) from 2009 Sample Survey on Population Changes (China NBS 2010); Human Development Index from *China Human Development Report 2009/10* (UNDP 2010); and life expectancy in 2000 from the 2006 Sample Survey on Population Changes (China NBS 2007).

Shen 2008). (Table A4 shows the estimated net migration of women for marriage by province and province's characteristics, China 1995–2000.)

In our sensitivity analysis, we explored the possibility of a net inflow of marriageable women into China. The exercise was not intended to 'predict' the size of a possible migration of women to China, but rather to examine to what extent it might mitigate the size and timing of the bride shortage. As one would expect, China currently experiences modest in-migration from poorer neighbours (such as Vietnam) and out-migration to wealthier neighbours (such as Taiwan).

For this exercise, we assumed a net inflow of 9,000 women per year during 2000–10 and then increased this flow by a constant proportion each year until 2020, when it was assumed to be 75,000 per year.

Our choice of 9,000 annual immigrants for the first period is a rough estimate, based on recent patterns from the 2000 Census, and the assumption of 75,000 per year in 2020 is largely arbitrary; this is approximately the current level of bride immigration into South Korea, and represents an eightfold increase over the decade from 2010 to 2020.

On these assumptions, the percentages of never-married men would be as follows: 1.70 per cent of men aged 30–39 would be never married in 2010; 4.66 per cent in 2020; 20.71 per cent in 2030; 12.51 per cent in 2040; and 15.55 per cent in 2050. These very rough estimates indicate that significant numbers of foreign brides might reduce the marriage squeeze somewhat after 2030, but little more can be said in the absence of further research on immigration flows into China for the purpose of marriage.