Single by Choice or Rejection? Evidence on Mating Preferences in China

Xuchao Gao*

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Abstract

In China, the marriage rates increase with education for men but decrease for women. However, as in most countries, positive assortative matching is still observable in the data. This pattern is inconsistent with some simple models of marital matching. In this paper, I ask what preferences can explain the observed mating pattern for individuals born between 1972 and 1975 in China. I allow their utility from marrying to depend on their education and their spouse's education. The utility function allows for a discrete jump and a different slope if the wife's education exceeds the husband's. In addition, each person has idiosyncratic preferences for each potential spouse. I assume utility is nontransferable and solve for equilibrium assuming a deferred acceptance algorithm. I find that women are strongly averse to marrying less-educated men. In contrast, men are rewarded for marrying more-educated wives. The model fits the high single rate among low-educated men and high-educated women. Moreover, when I predict single rates for earlier birth cohorts, I fit the pattern for low-educated men and high-educated women born after 1970 relatively well, but not that for earlier cohorts. This suggests that mating preferences change significantly across generations.

Keywords: marriage, matching, preferences, gender

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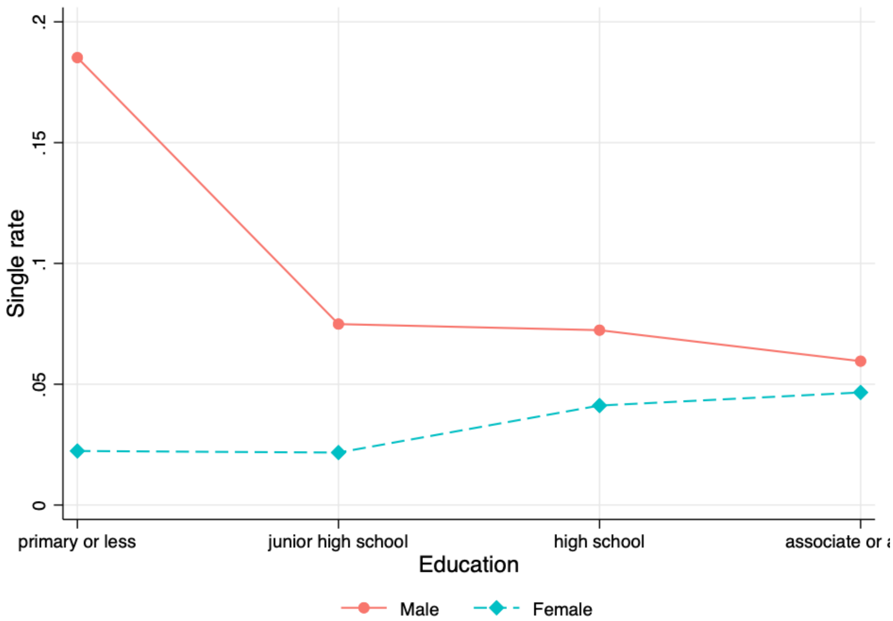
1 Introduction

Single rates have risen sharply among highly-educated women and low-educated men in China over the last few decades. Meanwhile, there is a striking divergence between men and women in how single rates change with education: for men, the likelihood of remaining single decreases with education, while for women, it increases. The birth cohort of 1975 in Figure 1 exhibits this contrast clearly. For older cohorts, the gaps in the single rates for different education groups are much smaller, especially for women. Overall, these observations lead us to ponder why education seems to benefit men and disadvantage women in the marriage market, and increasingly so over time.

Figure 1: Single rates: males and females born in 1975



Note: This figure summarizes the single rates for females and males who were born in China in 1975, i.e. 35 years old at the time of survey. All individuals born in 1975, who were not in school at the time of survey, and were married, divorced, or widowed with a non-missing value for marital status are included. Those who married for the first time after 35 are treated as single in the calculation. Data source: Census 2010 1% sample.

In this paper, I take education distributions as given and consider what mating preferences would explain the marriage patterns of people born in 1975. I then show that these same preferences, combined with the education distributions in earlier periods, can explain much of the increasing proportion of low-educated men who are single for birth cohorts between 1960 and 1975, and work better for women born closer to 1975.

To estimate mating preferences, I employ a flexible utility model that allows for a mixture of assortative matching and homogamy. The non-transferable utility gained through marriage does not only depend on the spouse's level of education but also on the difference between their education levels in some circumstances. Specifically, I assume that the difference in education levels affects their utilities when the woman's education is higher.

The reluctance of both women and men—or of one side—to enter a marriage where the woman has more education is consistent with the distinctive patterns observed in the single rates of the two genders. If men are resistant to marrying women with more education than themselves, more educated men will have more options in the marriage market and, therefore, exhibit lower single rates. This also means that the least educated men are the most constrained and will therefore have high single rates. If women are unwilling to marry men with lower levels of education than themselves, the most educated women may find themselves in a thin marriage market, whereas the least educated women are open to all potential marriage candidates. Either or both of these mechanisms could explain the patterns observed in the data. In conjunction with the more significant educational advancement among women in recent decades, this reluctance from either or both sides may help explain the rise in single rates for well-educated women, which the mass media often refers to as the "left-behind women" phenomenon.

These aversions related to relative education levels in marriage are deeply rooted in traditional culture and have started to draw the attention of researchers. Chen and Hu (2021) argue that the social norm that "men are breadwinners, women are homemakers" has not adapted to women's empowerment in education over the past few decades. They found that the couples are less satisfied with their marriage if the wife earns more, based on Chinese household survey data from 2014. With U.S. data, Bertrand et al. (2015) also documented similar aversion to a marriage with the wife earning more, which they show affects the marriage formation, women's labor supply, the undertaking of household chores as well as the couple's satisfaction in the marriage. This prejudice could also exist in non-economic factors like education. This paper provides evidence of the existence of this aversion in mating preferences along education dimensions, distinguishes which side(s) the aversion comes from, estimates the intensities of the aversion, and, using the estimated preferences, offers an explanation for the contrasting patterns between men and women in their single rate variations with education.

Based on the utility model and a simulated sample that retains the proportions for each education and gender group in the Census, I adopt the deferred acceptance algorithm to match men and women, in which men propose to women. Due to the complexity of the matching process, traditional Newton-Ralphson method or its variants do not apply. I use the smoothed Gauss-Newton algorithm by Forneron (2023) to perform the optimization.

The estimation results indicate that women prefer not to be in marriages where they are more educated than their husbands, while men have stronger preferences for wives more educated than themselves. Women's aversion is key in sustaining the negative/positive relationships between education levels and singlehood for men/women in the Census data. Men's pursuit of more educated wives makes the relationships less extreme, lowering the single rates of the most educated women and the least educated men to some extent. Women's aversion and men's preference for this type of marriage also play different roles in shaping the positive assortative matching outcome.

This paper contributes to the literature of marriage sorting by estimating a novel mating preference that rationalizes the distinctive patterns in single rates for men and women. Researchers have been interested in studying assortative mating along dimensions like income, education, or inherited attributes like caste in India or household registration in China, due to their impact on individuals' economic well-being, social inequality and intergenerational mobility (Greenwood et al. (2014), Gihleb and Lang (2020), Banerjee et al. (2013), Han et al. (2015), Almar et al. (2023)). Most of the previous work focuses on the identification of existence and intensity of assortative matching and how it affects socioeconomic outcomes. In this paper, based on the traditional roles assumed by men and women in a household, I account for the differences between spouses in their preferences alongside the assortative matching.

Two heavily studied mating preferences in the literature do not fit the patterns in the data. Positive assortative matching is one of the well-documented and measured preferences. Assuming positive assortative matching and that education is a valuable trait in the marriage market, the least educated group of the gender with a population in surplus would be forced to be single. For example, in China, there are more men than women. In this setup, the least educated men should have a positive single rate, while all other groups are predicted to be married. The matching should remain stable even if the education distribution of women shifts up or down because it is not the absolute amount of education but the rank of an individual in the education distribution of his or her gender that matters. In real data, we indeed observe a high single rate for men with the least education, but the single rates for other education groups of men are not negligible, though they are not predicted by the theory. Positive assortative matching also fails to rationalize all single rates of women.

Other than positive assortative matching, homogamy is another candidate to consider. Both women and men prefer to marry someone with similar education and get a disutility from marrying both up and down. It fits the marriage patterns reasonably well (Figure 7 and 8). Couples with matching education are most common, although there are a few groups for whom the degree of homogamy is less strong. However, given the relative sizes of each education and gender group in our sample based on the Census, and if we assume people would rather stay single if not married to a spouse with the same education, homogamy would predict single rates inconsistent with what we observe in the data, as shown in Figure 2. The relationships between single rates and education for men and women are almost the opposite of the patterns in the Census. The predicted single rates under this assumption reflect the surplus of available females and males at each education level in the marriage market. If the distaste for unequal education in marriage is not so extreme, it is not obvious what the single rates would be like, and an empirical estimation of preferences would be necessary.

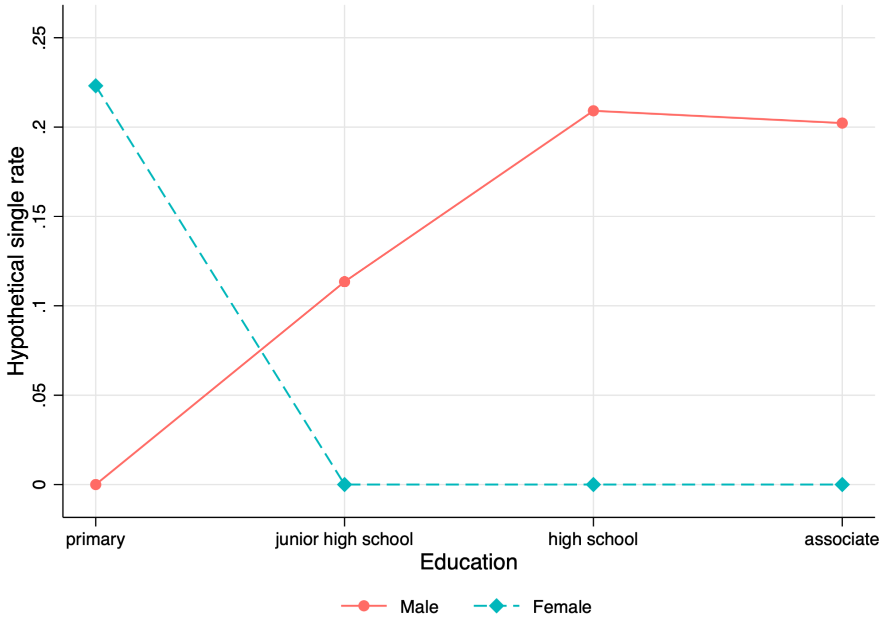
2 Data

I use the 1% sample from the 2010 Census, the most recent Census data currently available, in the analysis of this paper.

To detect patterns in the overall marriage market, my initial sample consists of individuals born between 1960 and 1975. I exclude a small number who were enrolled in school at the time of the survey. I impose the restriction on birth cohorts because I am interested in the relatively young population in the sample whose educational and marital outcomes have most likely unfolded by the time of the survey..

Figure 1, 3, 4, 5 and 6 are based on this sample.

Figure 2: Hypothetical single rates with the extreme homogamy



Note: This figure depicts the hypothetical single rates for females and males who were born in 1975, i.e. 35 years old at the time of survey by education level and birth cohort. All individuals born in 1975, not in school at the time of survey, and were married, divorced, or widowed with a non-missing value for marital status are included. Those who married for the first time after 35 are treated as single in the calculation. The extreme homogamy is defined to be the case where people marry spouses with equal education or stay single. Data source: Census 2010 1% sample.

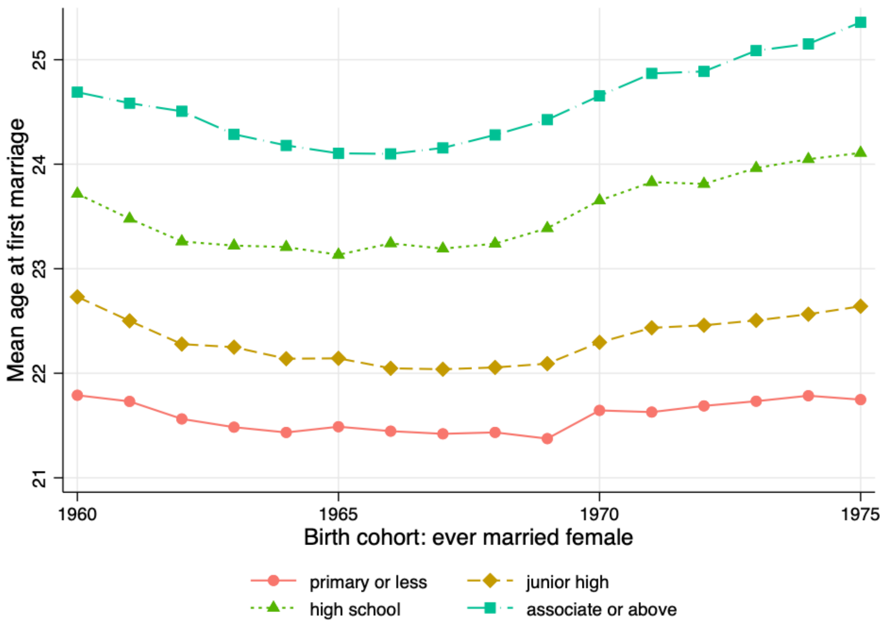
2.1 Several stylized facts

2.1.1 Single rates

A new definition of being single versus being married

Before discussing the patterns in single rates, it is important to clarify that the definition of single used in this paper differs from the common one adopted by the Census. Here, single rates are defined as the ratio of individuals who are single at the time of the Census or who marry for the first time after the age of 35 to the total population, categorized by gender and education level. The cutoff age of 35 was chosen because the Census data shows that the majority of people in China marry by that age. In the sample, only 0.3 % of the currently married females and 0.9 % of the currently married males married after 35. For those who married for the first time before 35, the mean ages at first marriage are summarized in Figures 3 and 4. The mean age slightly rises for the two more educated groups for both women and men, while it remains relatively constant for the two less educated groups. For individuals born in 1975, the mean age at first marriage is around 25.3 for women and 27 for men, which is significantly younger than 35. This further corroborates that using the age of 35 as a cutoff for this study is not too restrictive. Setting this cutoff ensures an equal time horizon for marriage across older and younger cohorts; otherwise, the single rates for the younger cohorts would be mechanically biased up. Matched fractions are defined as the ratio of the matched population in an education pair over the the total population for a particular gender and education level. By definition, the single rate and matching fractions for a specific gender and education level add up to 1. Any mention of being single or married throughout this paper refers to these customized definitions, unless noted otherwise.

Figure 3: Mean age at first marriage for females

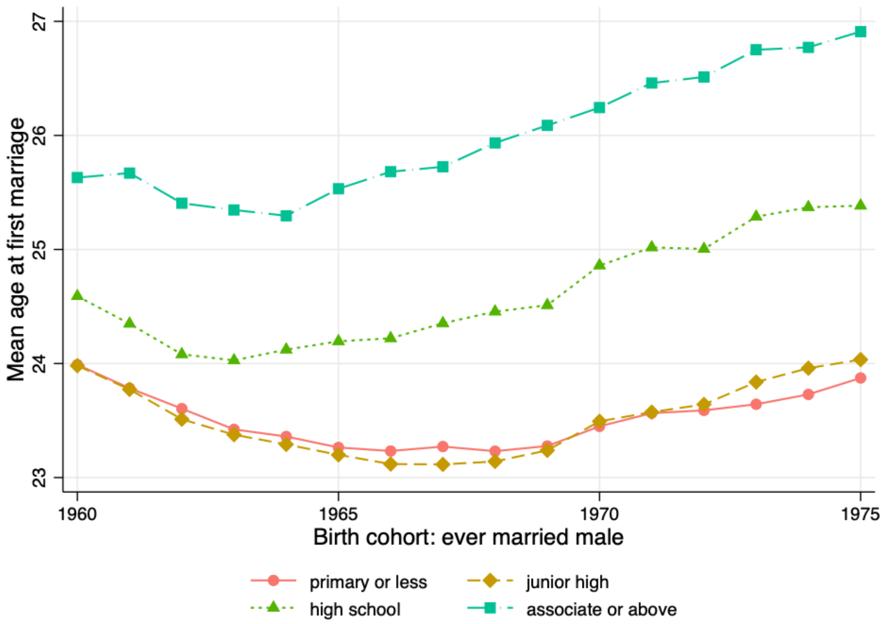


Note: This figure summarizes the mean ages at the first marriage for females who were at least 35 years old and no longer in school at the time of survey by education level and birth cohort. All women who were married, divorced, and widowed with a non-missing value for the age at the first marriage are included. Ages at the first marriage above 35 are not used for calculation. Data source: Census 2010 1% sample.

Two key features of interest

The first feature of single rates that this paper aims to explain is the contrasting variation

Figure 4: Mean age at first marriage for males



Note: This figure summarizes the mean ages at the first marriage for males who were were at least 35 years old and no longer in school at the time of survey by education level and birth cohort. All men who were married, divorced, and widowed with a non-missing value for the age at the first marriage are included. Ages at the first marriage above 35 are not used for calculation. Data source: Census 2010 1% sample.

in single rates by education level between women and men. Specifically, I focus on the single rates for the most recent birth cohort of 1975 (Figure 1). In general, single rates increase with education for women, although they are nearly identical for those with junior high school education and the least educated. Conversely, single rates decrease overall as men attain higher levels of education. Moving from the junior high school group to the high school group does not significantly reduce the likelihood of a man remaining single by age 35, though. It is not immediately clear what kinds of preferences could explain this positive relationship between single rates and education for women, and the negative relationship for men.

Furthermore, single rates have increased across all groups among younger cohorts. Notably, both women and men exhibit a widening gap in single rates between the more educated and the less educated within these cohorts (Figure 5 and Figure 6). Given the specific definition of being single used in this study, this widening gap is unlikely to be solely due to more educated women and less educated men delaying marriage.

Instead, it reflects significant changes in their decisions regarding whether to marry at all. Understanding the role of mating preferences behind these trends sheds light on ongoing discussions around phenomena such as the "left-behind women" and may help destigmatize certain population groups.

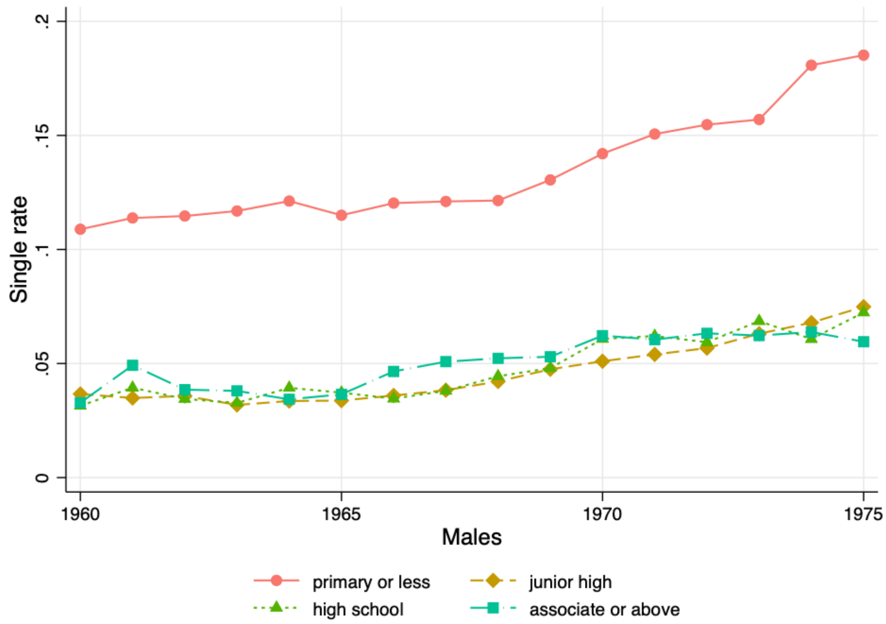
Figure 5: Single rates for females

Note: This figure summarizes the the single rates for females who were at least 35 years old and no longer in school at the time of survey by education level and birth cohort. Those who married for the first time after 35 are treated as single in the calculation. Data source: Census 2010 1% sample.

2.1.2 Marriage matching patterns

Homogamy, a matching phenomenon documented by researchers in many contexts, exists among people born between 1972 and 1975 in China. People are more likely to marry someone with approximately the same amount of education as themselves. However, they do not always find a spouse with equal education. In Figure 7 and 8, we can see that among those with junior high school and high school education, if they do not marry someone within the same education level, men are more likely to marry down rather than up, while women exhibit similar likelihoods of marrying up and down, being slightly more likely to marry up. Although it is impossible for the least educated groups to marry down by the definition of education groups I use, the number of the least educated

Figure 6: Single rates for males



Note: This figure summarizes the single rates for males who were at least 35 years old at the time of survey by education level and birth cohort. All men who were married, divorced, and widowed with a non-missing value for the age at the first marriage are included. Those who married for the first time after 35 are treated as single in the calculation. Data source: Census 2010 1% sample.

men marrying slightly more educated women is far outnumbered by the the number of them marrying women who have the same amount of education as themselves, which also supports the hypothesis of aversion. Similarly, aversion to women being more educated could explain why the most educated women show a much larger gap between marrying men with equal versus slightly less education compared to the corresponding gap for the most educated men.

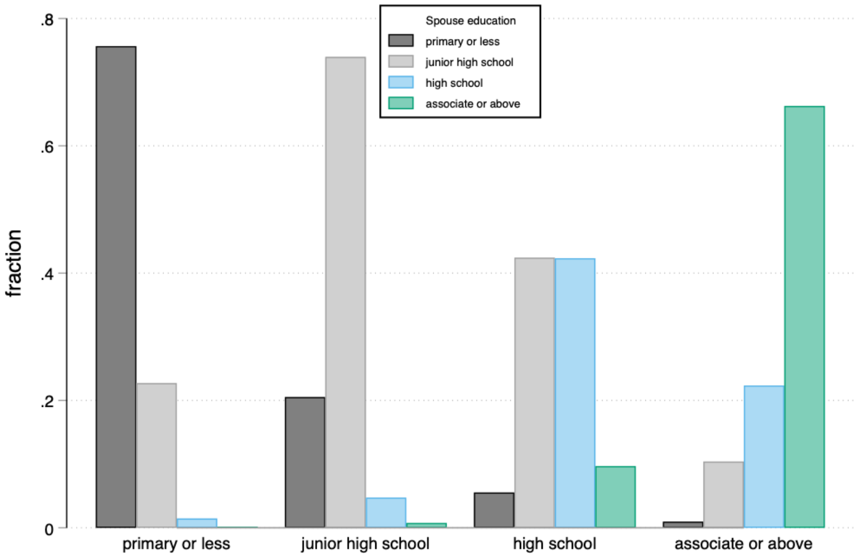
2.2 Sample construction

For the purpose of estimating preference parameters in the utility model, the simulated sample is constructed in the way I describe in detail below. Figures 7 and 8 are based on this simulated sample for estimation.

To calculate matching patterns, I first identify married couples or single-headed house-

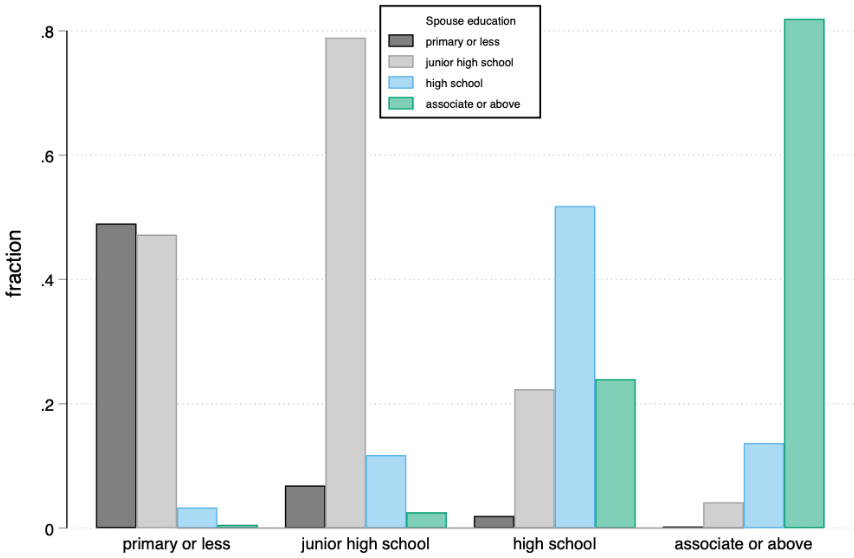
[1]Refer to Section 2.2 for more details.
[2]Refer to Section 2.2 for more details.

Figure 7: Marriage matching pattern: males



Note: This bar plot summarizes the distributions of spouse (female) education among married men where one of the spouses in the couple is born between 1972 and 1975.[1] Data source: Census 2010 1% sample.

Figure 8: Marriage matching pattern: females



Note: This bar plot summarizes the distributions of spouse (male) education among married women where one of the spouses in the couple is born between 1972 and 1975.[2] Data source: Census 2010 1% sample.

holds from the sample. Most households can be identified by specifying household ID and residential space features, like the home area and addresses. In some cases, multiple single individuals share all of this information and they are all heads of household. One example of this situation would be migrant workers sharing an apartment in a city. I treat them as separate households. I also only keep the individuals who are household heads themselves or the spouses of the household heads because the marriage relationships are harder to pin-point among the rest of the household relationships. Then I further drop couples with the different first marriage years or months. The data set does not have direct information on whether the current marriage is the first one for each of them, so different first-marriage times indicate that at least one member had one or more previous marriages. In omitting these couples, I avoid the complications of re-matching in my analysis. Besides, the fraction of married couples with different first marriage times is quite small, so this exclusion should not impact my conclusions. Among all the households with one married couple, only 2.2% of them fall into this category. The number is close to the divorce rate[3], 2.13 %, defined in a similar fashion around 2010. Ignoring this group should not threat the generality of the story. In the cases where there are more than one set of household heads and spouses, I separate the couples by matching males and females as couples by date of first marriage. This could happen when siblings and their spouses live in the same house, which is not common overall and mostly occurs in rural areas.

Due to the simplified attributes of the matching process, a woman or man can either be single (unmatched) or married (matched). There is no scope for being divorced or widowed. Moreover, the data do not include information on ex-spouses, including education and age, for the divorced and widowed. Therefore, when calculating the population moments, I exclude the divorced and widowed from the population counts as well.

In the constructed sample, the numbers of married females and males must be equal. Therefore, in the Census, if one person's marriage age is below 35 while his or her spouse is married after the age of 35, I consider both of them to be married after 35, thus being categorized as single. I restrict the Census sample to consist of people at the age of 35 or above, because the inclusion of younger cohorts might inflate the single rates and bring down the mean age at the first marriage. Thus, the youngest cohort from the Census

[3]https://www.globaltimes.cn/page/201809/1120041.shtml

would be born in 1975.

In the following estimation, I pool together four cohorts born between 1972 and 1975. It reduces the year-by-year fluctuation in the marriage market and also increases the sample size, which could be particularly useful in the estimation for the highest and lowest education categories where there are less people. Again, to avoid the situation where one side of the couple is dropped because he or she was not born in this range of years while his or her spouse was or vice versa, I keep the couple as long as one of them was born in the selected birth cohorts. Since it is not uncommon for people to marry someone a few years younger or older, a significant number of individuals born in the years close to the range of 1972 and 1975 are kept in the sample because their spouses were born in the range. Figure 9 shows the distributions of birth cohorts for the extended sample born before 1972 by gender. There are more males distributed on this side. This is due to the fact that women are more likely than men to marry someone older. Figure 10 contains the distribution of birth cohorts after 1975 by gender. There are more females distributed on this younger side due to the same reason.

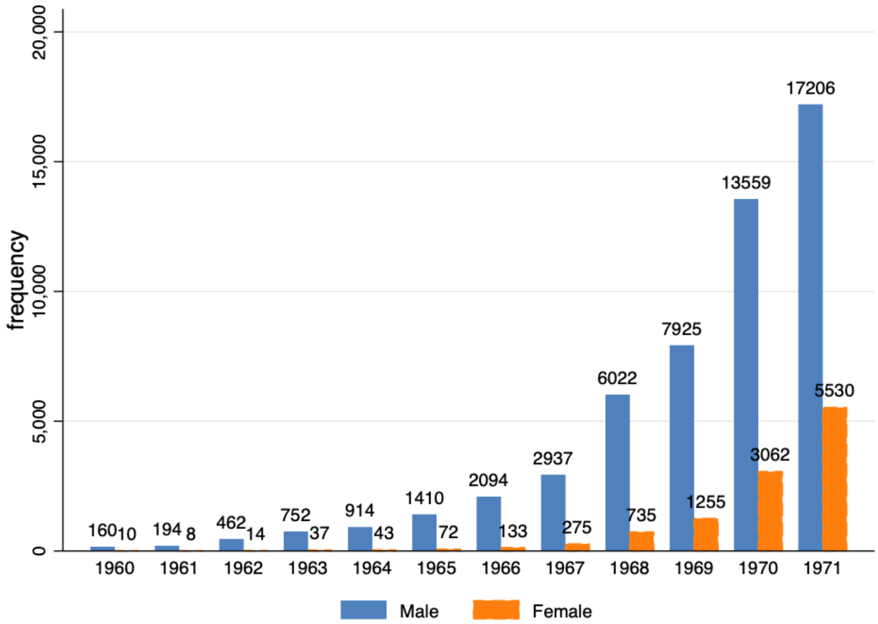
One caveat of this practice is that all of the additional individuals who were not born within the targeted age range but are included in the sample because their spouse was born in the range are married, which will bias the single rates downward. To address this, I construct the simulated sample in the following manner. The proportion unmarried in each gender/education group is the proportion in the data for the 1975 cohort. The distribution of matches across the remainder is the education match distribution for the expanded sample including spouses born outside the 1972-75 cohort. See Figure 18 in the Appendix for a simplified graphic illustration of this process.

3 Model

Utility. In this section, I model the utility of men and women from marriage and remaining single. To simplify the estimation, the utility of being single is set to be 0 for both males and females.

I assume that a man's utility from marriage does not only depend on the wife's education level but also the difference in education levels of the couple. Specifically, if the wife's education is higher, the man cares about the difference between their educations,

Figure 9: Spouse's age not in the targeted birth cohorts: Born before 1972



Note: This bar plot summarizes the distributions of birth cohorts for spouses born before 1972. They are included in the sample because their spouses were born between 1972 and 1975.Data source: Census 2010 1% sample.

although I do not impose assumptions on whether women in such case become more or less desirable in the marriage. A man m's utility of marrying a potential spouse, woman f, relative to remaining single, is given by Equation 1.

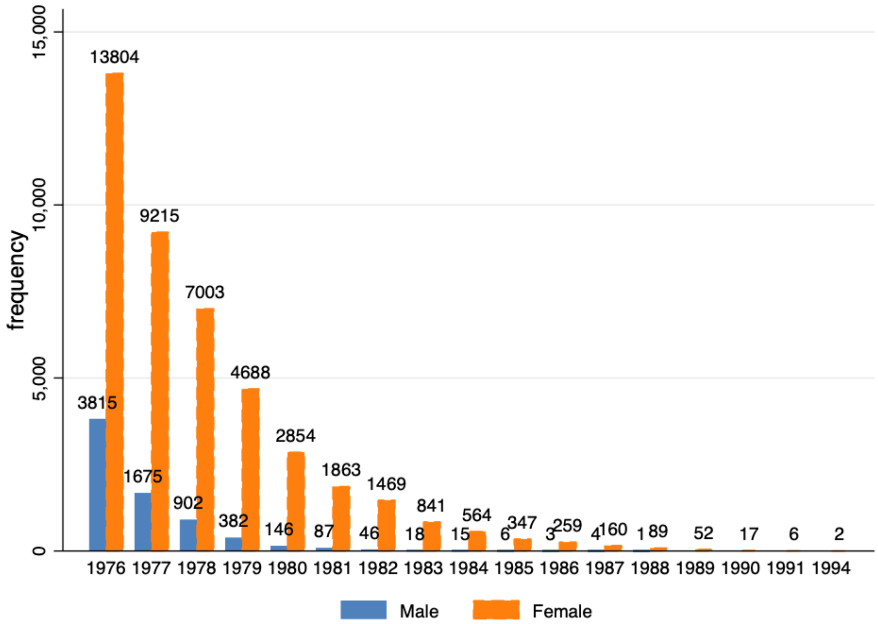
$$u_m = a_m + b \cdot educ_f + c \cdot \max(educ_f - educ_m, 0) + d \cdot \max(educ_f - educ_m, 0)^2 + k \cdot \mathbb{1}(educ_f - educ_m > 0) + \epsilon_{mf} \tag{1}$$

ϵ_{mf} is the random preference of the man m for women f. It follows a normal distribution of mean 0 and standard deviation 5. The choice of standard deviation only affects the magnitude of the estimated coefficients but not how well the matching outcome is.

a_m is a constant that varies by men's education. I use four education categories when estimating the preferences: primary school or below (including no schooling at all), junior high, high school, and associate degree and above (including associate degrees, four-year college, and graduate school).

The utility of marriage relative to being single for females is modeled in a similar

Figure 10: Spouse's age not in the targeted birth cohorts: Born after 1975



Note: This bar plot summarizes the the distributions of birth cohorts for spouses born after 1975. They are included in the sample because their spouses were born between 1972 and 1975. Data source: Census 2010 1% sample.

fashion.

$$u_f = \alpha_f + \beta \cdot educ_m + \gamma \cdot \max(educ_f - educ_m, 0) + \delta \cdot \max(educ_f - educ_m, 0)^2 + \kappa \cdot \mathbb{1}(educ_f - educ_m > 0) + \epsilon_{fm} \tag{2}$$

Matching. I abstract away from information friction in the matching procedure and assume the utility is non-transferable. I adopt the deferred acceptance algorithm pioneered by Gale and Shapley (1962) to perform the matching. Men (m_1, m_2, ..., m_M) and women ((w_1, w_2, ..., w_W) rank all the individuals on the other side based on the utility they can get if matched/married to that individual, given by Equation 1 and 2 above. Because I have set the utility of being single to zero, a spouse would be considered as unacceptable if the the utility of marrying him or her is less than zero. One side of the agents should propose while the other side makes decisions on whether to reject or keep the proposal. I assume men propose, because this is the social convention in China. The matching starts with proposal. In the first round of proposing, all the men propose to their first choices in the rank lists. If his set of acceptable spouses is empty, he does not propose to anyone and will remain single in the end. Each woman could receive zero or a positive number of proposals. She holds the most preferred acceptable proposal and rejects all the others. If all of the proposals she receives are from her unacceptable spouse set, she rejects all of the proposals. When the second round starts, if a man 's proposal was rejected in the first round, he moves down on his preference list and proposes to the second preferred mate among the acceptable ones. If his proposal in the first round is on hold, he does not propose to a new woman in this round. After the proposals in the second round are made, women update the best proposal received and reject the rest. This process repeats until no proposals are made. Men with proposals not rejected at this stage get matched to the women who are holding their proposals. The rest remain single or unmatched. The steps of the matching procedure is summarized in Table 1.

Although the deferred acceptance algorithm is highly stylized, it captures some essential features of the dating and marriage process. Men reach out to their most favored woman first and, if rejected, move on to their second choice. Women date the best man who has proposed to them so far. If they get a proposal from a man they like more, they reject the one that they are currently dating. Women settle as being single or married to the partner they are currently dating when no more proposals come in. Men settle when the women that they like the most, among the ones that have not rejected them yet, decide to marry them or stay single after exhausting their choice set before finding a stable match. Some alternative models, like sequential search models or Becker's models with transferable utilities, also abstract away from some details of the dating and marriage and do not present themselves as superior to the deferred acceptance algorithm in an economic or computational sense.

Modern technology makes it common for agents to submit a preference list and implement the matching in a centralized system, as we see in its application to student college matching problems. However, a centralized system is not necessary for carrying out a deferred acceptance style matching process. The decentralized marriage matching process described above also has the key features of a deferred acceptance algorithm.

In this paper, I apply the calibrated preference parameters to the sample and matching framework after completing the optimization. I find that, on average, women hold 3.6 proposals before the equilibrium in the sample marriage market is reached. It is a reasonable estimate of the number of dating partners prior to marriage, which also supports the validity of the setup.

Algorithm 1 Matching in the Marriage Market: Deferred Acceptance Algorithm (Gale and Shapley, 1962)

Input: Men $\{m_1, m_2, \ldots, m_M\}$ and Women $\{w_1, w_2, \ldots, w_W\}$, each with ranked preferences.

Output: A stable matching between men and women.

Step 1: Each person ranks all individuals on the other side based on the utility they can get if matched/married to that individual.

Step 2: Each person has a utility of being unmatched (single).

Step 3: One side of the agents proposes (e.g., men propose):

- **Step 3a:** Each man proposes to his most preferred acceptable choice.
- **Step 3b:** Each woman holds the most preferred and acceptable proposal she received and rejects all the others.

Step 4: The process repeats until all agents are matched or no more acceptable proposals can be made.

4 Estimation

I calculate the marriage market moments based on the sample constructed in the way described in Section 2.2. Then I create calibration samples to estimate the parameters in the utility functions by scaling down the numbers of men and women in each education category. Following these proportions, I make 50 samples by drawing 50 sets of random tastes. The loss function is constructed as the sum of squared deviations in fractions in each matched category and single category. The deviations are calculated as averages across 50 samples.

The loss function is defined as in Equation 3. The education category set is the same for both men and women, which is E = {primary or less, junior high, high school, associate or above }. K is the set of education pairs for matched couples. K = E ⊗ E.

$$L(\hat{\theta}) = \underbrace{\sum_{(m,f)\in\mathbf{K}} (g_m(\hat{\theta}) - g_{m0})^2}_{\text{male matched Ns}} + \underbrace{\sum_{m\in\mathbf{E}} (h_m(\hat{\theta}) - h_{m0})^2}_{\text{male single Ns}} + \underbrace{\sum_{(m,f)\in\mathbf{K}} (g_w(\hat{\theta}) - g_{w0})^2}_{\text{female matched Ns}} + \underbrace{\sum_{w\in\mathbf{E}} (h_w(\hat{\theta}) - h_{w0})^2}_{\text{female single Ns}} \tag{3}$$

The Newton-Raphson method is not applicable in this case due to the non-differentiable and non-convex nature of the matching process. Methods like Nelder-Mead can work with such problems, but are constrained by their local minima properties. I employ a new method by Forneron (2023), which uses smoothed Jacobian estimates and pairs the Gauss-Newton iterations with a global step setting to ensure global convergence. Table 1 summarizes the numbers for each education and gender type in the calibration sample. The estimates of parameters are summarized below in Table 4. The prediction precisions are shown in Table 2, Table 3 and Figure 11.

Table 1: Education distribution in the calibration sample

Education	Male	Female
primary or less	272	353
junior high	876	777
high school	225	178
associate or above	194	155
Total	1567	1463

Discussion At the baseline estimates I adopt for the rest of the analysis, the convergence is achieved by the optimization algorithm.

The prediction fits the single patterns in the calibration sample very well[4]. The predicted single rates reproduce the most distinctive features in the single rates we observed in the Census 2010, where women's single rates roughly increase with education while men's single rates roughly decrease with education (Figure 11).

The marriage matching patterns are also closely fitted. The results are summarized in Table 2 and Table 3. The degree of positive assortative matching is well approximated. Specifically, the prediction retains two patterns in the data. Firstly, a vast majority in each education and gender type marry people with the same or similar level of education. Secondly, other than marrying people with the same education, women are more likely to marry men with more education than themselves. Men behave conversely.

When interpreting the estimated parameters in Table 4, their ordinal properties and signs matter the most. Eight constant parameters a_m and α_f, each corresponding to one education and gender group, could not be directly interpreted as the mean utility of an average marriage, although they are factored into the values of marriage, because

[4]The loss function in Equation 3 takes a value of 9.5759 in terms of the sum of squared deviations in numbers of people or 0.0001370842 in terms of the sum of squared deviations in fractions.

the spouse education term and the terms related to the education differences cannot be zero simultaneously. Both men and women prefer a less educated spouse, with women's preference being a bit stronger (b = -2.70 for men, β = -6.04 for women). This set of linear preferences differ from the usual expectation that everyone prefers the most educated.

However, men have a solid preference for marrying women more educated than themselves (refer to c, d, e in men's utility function). Given that the maximum difference of the standardized schooling years between the most education and the least education is 2.37, the negative coefficient d, -0.96, for the squared term between the couple's education levels when the wife is more educated, cannot dominate the positive coefficient c, 71.71, even if the coefficient for the indicator term for such marriage combinations, e, is also negative. If the wife receives one more unit of education than the man, the man's additional utility from marriage is measured by (71.71 - 0.96 - 37.45). The magnitude of this overall positive effect of marrying a wife more educated than themselves is so large that it even overcompensates for the linear preference for less educated spouses, leading to a turn in men's attitude toward education[5].However, women do not like men less educated than themselves (Refer to γ, δ, ϵ in women's utility function). The negative linear term for education differences in such scenarios, -19.72, dominates the other two positive terms, 3.33 and 3.31. In the previous example where a woman is matched with a man with one unit less of education, her aversion is measured by (-19.72 + 3.33 + 3.31). The magnitude of this overall negative effect when marrying a man less educated than themselves is also powerful enough that women become education-inclined. Combined with the linear negative term in spouse education, women's preferences become single-peaked, with each education group giving the highest utility to matching with men of the same educational attainment.

Figure 5 plots the mean utilities of men and women at each education level from marrying spouses with different education. It gives us a general sense of the mean utility of getting married overall for all education and gender groups. Overall, men have much higher mean utilities from marriage than women do. This could be due to the multiple responsibilities that fall on a modern woman's shoulders—often being a wage earner, primary housekeeper, and main caregiver—after marriage and childbirth.

[5]The mean utilities from marrying a junior high school educated woman and marrying a high school educated woman are -5.90 and -5.84, respectively, for a junior high school educated man. It means the extra reward from marrying a more educated wife almost cancels out the man's linear preference for a less educated spouse.

Among all men, not considering the reward from marrying a more educated wife (the most left-hand side points in Figure 12a), the most educated get substantially higher values out of marriage. The utility this group of men get by marrying women at different education levels is relatively stable, given that there are no women in the market that are more educated than them. Thus, the terms that measure education differences never come into play, and men's preference for less educated spouses is also quite light. The utilities that the rest of the three education groups get increase as their education levels go up, although the magnitude of change is not as large. Among women, abstracting away from the penalty from marrying a less educated husband (the most right-hand side points in Figure 12b), their evaluations for marriage also increase with education, similar to what we observe for men, although they are more evenly spaced. This pattern could be due to the fact that higher education is typically associated with higher income. The relatively high income of the more educated groups allow them to provide for the family without too much stress. However, for the less educated, providing for the family may exacerbate their economic conditions so much that the disutility from worse financial conditions dominates the extra benefits they could get from marriage, resulting in a low value of getting married. The financial implications of marriage utilities from education and earning potentials could be more important for men because they are usually the main income source under the traditional social norm. The large utility gap between the most educated men and the other groups could be a result of college premium on wages.

Circling back to the question I raised in the beginning that why the highly educated women have the highest single rates among women of all education levels, the results suggest it is mainly due to women's aversion to marrying a less educated spouse.

The mean utilities of the most educated women from the marriage are relatively low [6]. Unless they are paired with an equally highly educated man, in which case the utility they get surpasses the other three groups of women, their utility from marriage remains the lowest among all education levels. This is because the penalty for marrying a husband less educated than themselves applies to all the men in the three education categories below

[6] Although the mean utility of women marrying men at any education level is less than that of being single, each woman still has a non-empty set of acceptable men due to the random tastes drawn for all potential mates. As long as one man from that acceptable set happen to like them and proposes, they can make a match and this woman will not end up being single. So, the mean utility being negative does not necessarily mean the majority of this group will be single. We can only interpret lower mean utilities as less likely being matched, given the same amount of proposals received.

them. From men's perspective, it is in fact quite desirable to marry the most educated women. They are the most preferred type by men with primary education or less, junior high school education, and high school education. Although the most educated men lean towards a less educated spouse, the preference is not strong. In the matching process, the majority of men in the three less educated groups will propose to the most educated women first; a significant portion, slightly less than a quarter, of the most educated men would propose to this group of women first. These observations indicate that many highly educated women turn down marriage proposals that would generate utilities lower than those from remaining single by choice.

When it comes down to the high single rates of the least educated men, in contrast, the results are mixed. Following the preference order, most of them will propose to the most educated women first, and mostly get rejected; then they move down the education ladder and keep proposing. Since the mean utilities of marrying the least educated men are well below 0, roughly between -20 and -15 as Figure 12b shows, within the three higher education groups of women, not many women will find their proposals "acceptable", i.e. better than staying single [7]. Even if they are acceptable in a few cases, they are not likely favored over more educated men. Nevertheless, they are the most preferred group by the least educated women. The mean utility of marrying the least educated men for this group of women is -3.52, within one standard deviation below 0. Due to the random taste, many women in this group will accept their proposals. One thing to note is that the sex ratio imbalance is not a direct reason for the highest single rate of the least educated men. There are more women than men with primary or less education (See Table 1). The low utility that the least educated men get from marrying equally low-educated women makes them prefer staying single to getting married.

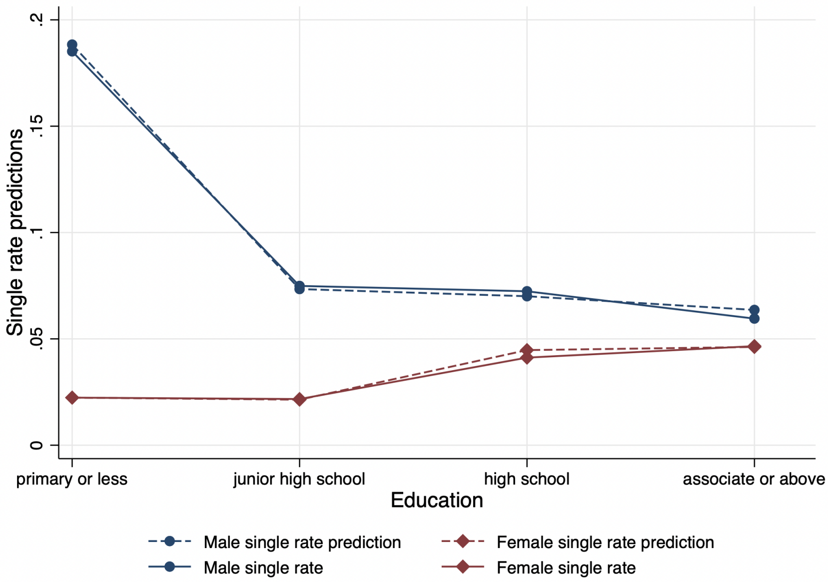
The other two groups with the lowest single rates, the most educated men and the least educated women, are not the focus of the research question, but still, the results still provide a straightforward explanation of the underlying preferences. The least educated men are mostly not accepted by the more educated women they propose to and finally have to propose to the least educated women. They happen to be most favored by this group of women, so they will likely make a match. Similar processes occur for men with a junior high school education. These are the two groups that the least educated women

[7]Recall that the random tastes follow a normal distribution of mean 0 and standard deviation 5.

end up marrying most frequently.

The most educated men have overall high utilities from marriage, so it is rare for them to choose being single over marriage by not proposing to a particular group for women with certain levels of education. In the meantime, they are in demand. They are the most preferred among all men by the most educated women; high school educated women also rank them the second behind the high school educated men.

Figure 11: Single rate prediction



Note: This figure summarizes the prediction of single rates and the true single rates in the sample for the estimation.

[8] Numbers are shown in Table 5

Table 2: Prediction precision- male matchings and singles

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	167.10	0.23
primary or less: junior high	50.45	50.36	-0.09
primary or less: high school	3.20	2.94	-0.26
primary or less: associate or above	0.36	0.36	0.00
primary or less: single	50.20	51.24	1.04
junior high: primary or less	164.30	164.64	0.34
junior high: junior high	601.74	602.38	0.64
junior high: high school	38.12	38.32	0.20
junior high: associate or above	6.14	6.34	0.20
junior high: single	65.60	64.32	-1.28
high school: primary or less	11.36	12.26	0.90
high school: junior high	88.56	89.00	0.44
high school: high school	88.74	88.10	-0.64
high school: associate or above	20.01	19.88	-0.13
high school: single	16.28	15.76	-0.52
associate or above: primary or less	1.67	1.10	-0.57
associate or above: junior high	18.64	18.62	-0.02
associate or above: high school	40.22	40.68	0.46
associate or above: associate or above	121.20	121.26	0.06
associate or above: single	11.50	12.34	0.84

Note: All the numbers are rounded to the second decimal place. The estimation sample takes the constructed sample with matched couples from the Census and scale down by 1/100 and round up to the nearest integers to keep estimation time for matching in a reasonable range. Target column used by objective functions are raw numbers after the sample is scaled down by 1/100 before rounding. This is the reason why the targets are not integers. Column "Prediction" records the average predictions over 50 simulated samples of equal size and the same numbers of men and women at each education level but with different randomly generated idiosyncratic tastes, given the set of estimates for preference parameters. For row "primary or less: junior high", the entry stands for the number of males with primary or less education marrying females with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 3: Prediction precision- female matchings and singles

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	167.10	0.23
primary or less: junior high	164.30	164.64	0.34
primary or less: high school	11.36	12.26	0.90
primary or less: associate or above	1.67	1.10	-0.57
primary or less: single	7.87	7.90	0.03
junior high: primary or less	50.45	50.36	-0.09
junior high: junior high	601.74	602.38	0.64
junior high: high school	88.56	89.00	0.44
junior high: associate or above	18.64	18.62	-0.02
junior high: single	16.85	16.64	-0.21
high school: primary or less	3.20	2.94	-0.26
high school: junior high	38.12	38.32	0.20
high school: high school	88.74	88.10	-0.64
high school: associate or above	40.22	40.68	0.46
high school: single	7.31	7.96	0.65
associate or above: primary or less	0.36	0.36	0.00
associate or above: junior high	6.14	6.34	0.20
associate or above: high school	20.01	19.88	-0.13
associate or above: associate or above	121.20	121.26	0.06
associate or above: single	7.22	7.16	-0.06

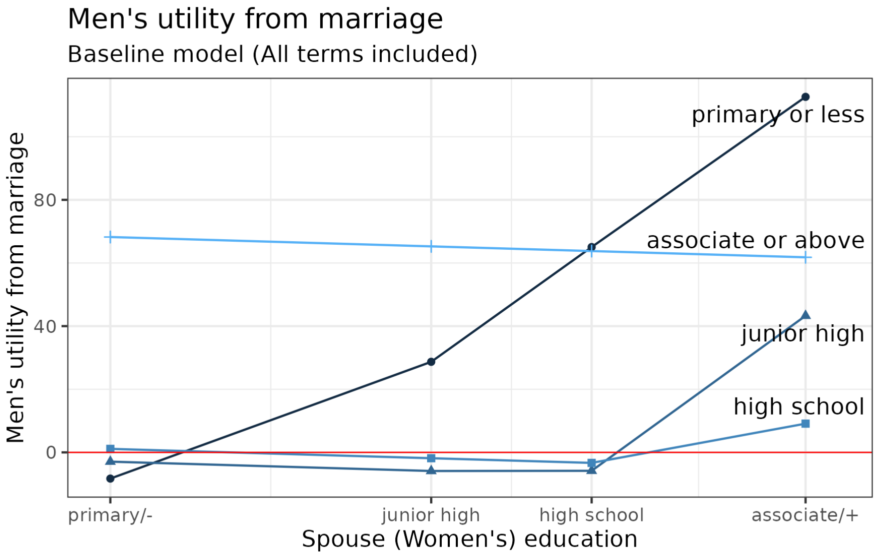
Note: This table presents results from the same estimation used by Table 2, reorganized by female education levels. The predicted average single numbers for women in this table provides new information. Matching numbers are shown again with single numbers for comparison. For row "primary or less: junior high", the entry stands for the number of females with primary or less education marrying males with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 4: Estimated preference parameters

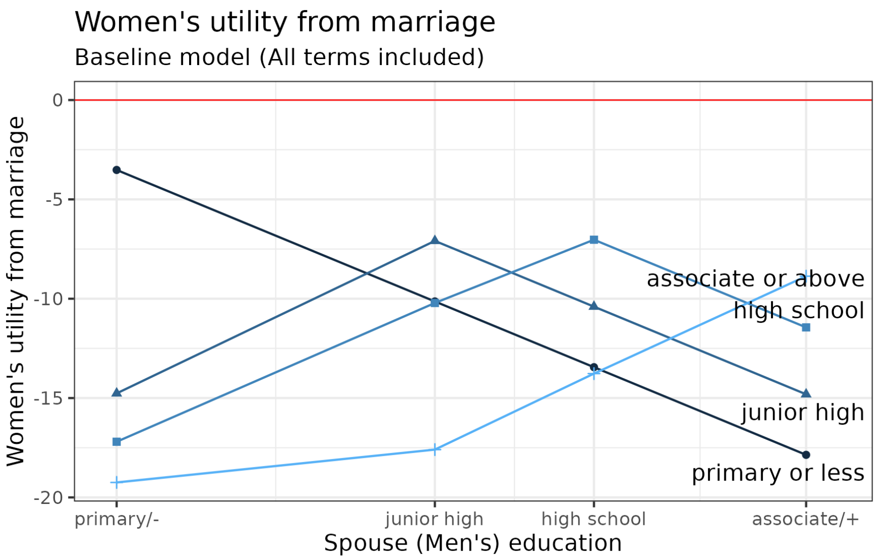
Parameter	Estimate
Male	
a_m *(Primary/-)*	-11.76
a_m *(Junior high)*	-6.39
a_m *(High school)*	-2.34
a_m *(Associate/+)*	64.77
b	-2.70
c	71.71
d	-0.96
e	-37.45
Female	
α_f *(Primary/-)*	-11.24
α_f *(Junior High)*	-8.19
α_f *(High school)*	-4.82
α_f *(Associate/+)*	-2.25
β	-6.04
γ	-19.72
δ	3.33
ϵ	3.31

Note: All estimates are rounded to the second decimal place. The utility functions of men and women are: $u_m = a_m + b \cdot educ_f + c \cdot \max(educ_f - educ_m, 0) + d \cdot \max(educ_f - educ_m, 0)^2 + e \cdot \mathbb{1}(educ_f - educ_m > 0) + \epsilon_{mf}$ and $u_f = \alpha_f + \beta \cdot educ_m + \gamma \cdot \max(educ_f - educ_m, 0) + \delta \cdot \max(educ_f - educ_m, 0)^2 + \epsilon \cdot \mathbb{1}(educ_f - educ_m > 0) + \epsilon_{fm}$, where a_m and α_f vary by education group as shown above.

Figure 12: Mean utilities from marriage [8]



(a) Baseline: men's utility from marriage



(b) Baseline: women's utility from marriage

5 Single rates when the utility is linear in the spouse education

As discussed in the previous section, men's utility from marrying a woman can be decomposed into two parts. First, their utility from marriage slightly decreases as the spouse's education increases. This comes from the negative coefficient, b, of the spouse education term in their utility function. Second, they value the extra education a spouse has if the woman has more education than they do. This is captured by a strong positive effect jointly from the coefficients, c, d, and e, which are activated only when a man's spouse has higher education. The second effect dominates when it applies. Women's utility from marriage also consists of two parts. They slightly prefer spouses with less education, as indicated by coefficient β, but have a strong aversion to spouses less educated than themselves. The latter dominates when it applies. In this counterfactual analysis, I keep the coefficient for the linear term of the spouse's education unchanged. I examine the effects on single rate patterns, especially for the most educated women and the least educated men, when the coefficients for terms relating to the differences between education levels of the couple are reset to zero for men and women, respectively. More straightforwardly, I investigate single rates when c, d, and e are all set to be zero, or when γ, δ, and κ are all set to zero, respectively.

When men's preference for more educated wives is turned off in their utility function, their utility from marriage becomes monotonically decreasing with spouse education. Their utility increases with their own education, given any spouse education level. The most educated men have significantly higher utility than the other groups from marrying women of any education. Compared to the baseline model, this framework continues to replicate the contrasting relationships between single rates and education for men and women but overpredicts the high single rates of the least educated men and most educated women. In contrast, the two groups with the lowest single rates in the baseline—the least educated women and the most educated men—are predicted to have even lower single rates. See Figure 13 for predicted single rates and Figure 15a for predicted mean utilities from marriage for men in this counterfactual case. Table 8 with predicted mean utilities for both genders, and Table 6 and Table 7 with prediction precisions are in the Appendix.

Without the special favoritism for more educated spouses, many more men among three less educated groups find little value from marriage and would rather stay single. They no longer propose to the most educated women, which explains the even higher single rate for this group of women in this scenario. In fact, high school educated women are also adversely affected because they receive fewer proposals as well, but the magnitude is not as large. Among men, those with primary education or less are affected the most. Their proposals to more educated women fall dramatically and their single rate is much higher. The most educated men are the group that benefits the most due to reduced competition from less educated peers. There is a further reduction in their single rate. Since the channel through which men value a more educated spouse is now muted, the linear preference for less educated spouses takes control, which gives the least educated women a small advantage over other groups of women. Hence, their single rate also decreases.

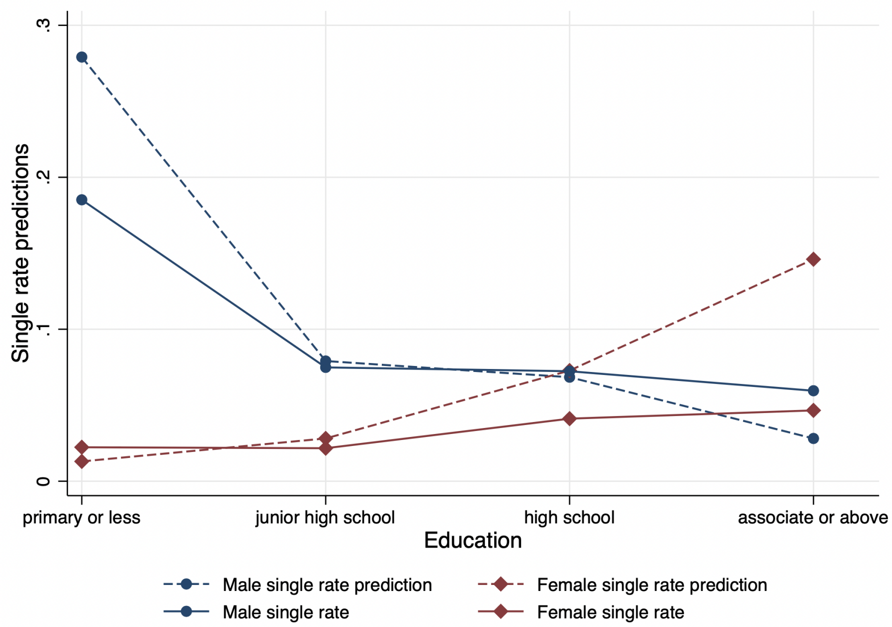
Alternatively, I set the women's utility function to be linear in their spouse's education and mute women's aversion to marrying less educated men. The single rate patterns in the prediction become opposite to the truth: women's single rates decrease with education while men's increase. This resolves the high single rate issues for the least educated men and the most educated women but creates new problems for other groups. In particular, the single rate for the most educated men is predicted to be extraordinarily higher than in reality. See Figure 14 for predicted single rates, Figure 15b for predicted mean utilities from marriage for women, and Table 9 and Table 10 for prediction precisions in this counterfactual case.

In the baseline model, an important reason why the least educated men have a high single rate is because more educated women have a strong aversion to marrying them. Eliminating the distaste for less educated husbands dramatically improves many women's utilities from marrying this group of men. Since men's preference for marrying more educated wives is still in place, they propose to more educated women as in the baseline, but this time, their proposals are favored and accepted. The most educated women are affected the most by muting the aversion. Their utility from marriage becomes the highest among all women, which explains their single rate being predicted as zero. Conversely, the single rate for the most educated men spikes because women now get the lowest mean utilities from marrying them. The single rates for the two less educated groups of women also tick up. Many proposals they receive in the baseline slip away because men who used to be turned down by more educated women are now being accepted.

With regard to matched patterns, muting men's preference for education when the potential spouse is more educated leads to a higher degree of homogamy (Table 6 and Table 7) Women still prefer men with the same education level as a result of favoring a less educated spouse but not one less educated than themselves. Men lose the strong incentive to marry up, so more men propose to equally educated women and get accepted.

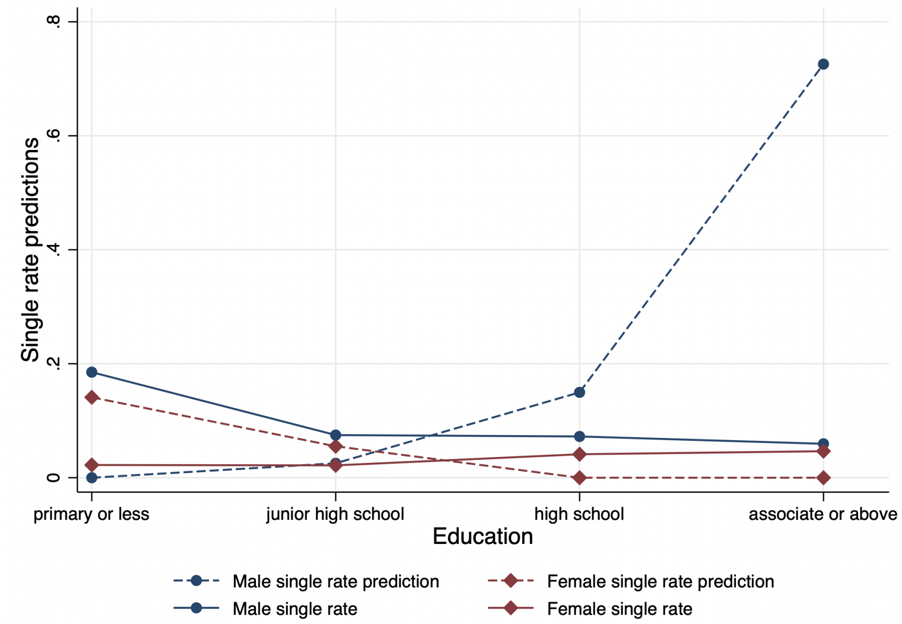
The positive assortative matching pattern is no longer preserved among more educated women when their aversion to less educated spouses is turned off ((Table 9 and Table 10). The majority of women with associate or more education and high school education marry the least educated men. The positive assortative matching pattern is retained among the two least educated groups of women because they are less affected or unaffected by muting the aversions. They are harmed in the sense that more end up being single, but they also benefit because the chance that they marry men with more education than themselves increases. This occurs because higher-educated women now prefer marrying lower-educated men, and more higher-educated men become available to them.

Figure 13: Single rate prediction: male's utility linear in spouse's education



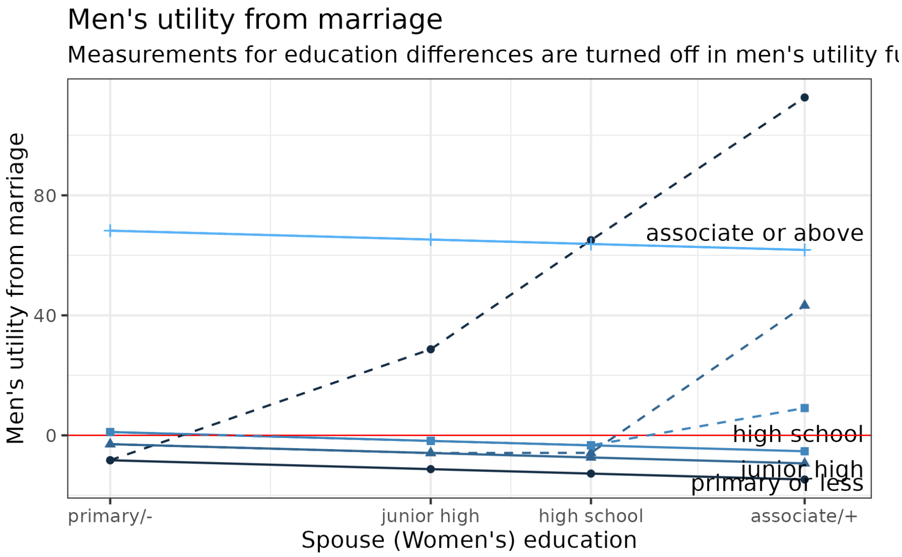
Note: This figure summarizes the prediction of single rates (dashed lines) under counterfactual parameter values and the true single rates (solid lines) in the sample for the estimation.

Figure 14: Single rate prediction: female's utility linear in spouse's education

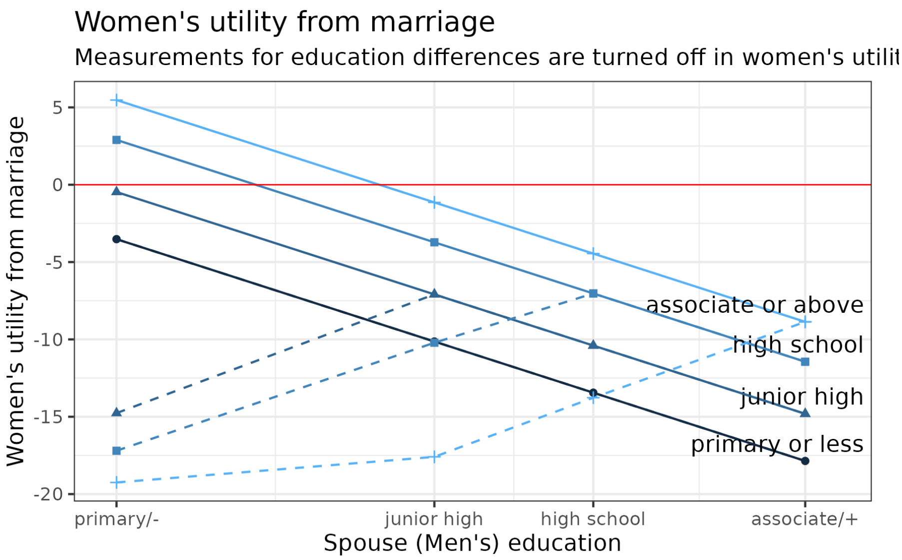


Note: This figure summarizes the prediction of single rates and the true single rates in the sample for the estimation.

Figure 15: Mean utilities from marriage [9]



(a) Counterfactual: men's utility from marriage



(b) Counterfactual: women's utility from marriage

Note: The solid lines represent the counterfactual mean utilities. The dashed lines are mean utilities from the baseline model.

[9]Refer to Table 8 in Appendix C.1 and Table 11 in Appendix C.2 for detailed numbers.

6 Are the rising single rates purely a result of changes in education distributions?

In this section, I ask whether the change in single rates across birth cohorts from 1960 to 1975 discussed earlier could be explained simply by changes in education distributions—more specifically, whether the rising single rates of the least educated men and the most educated women are caused solely by changes in education distributions.

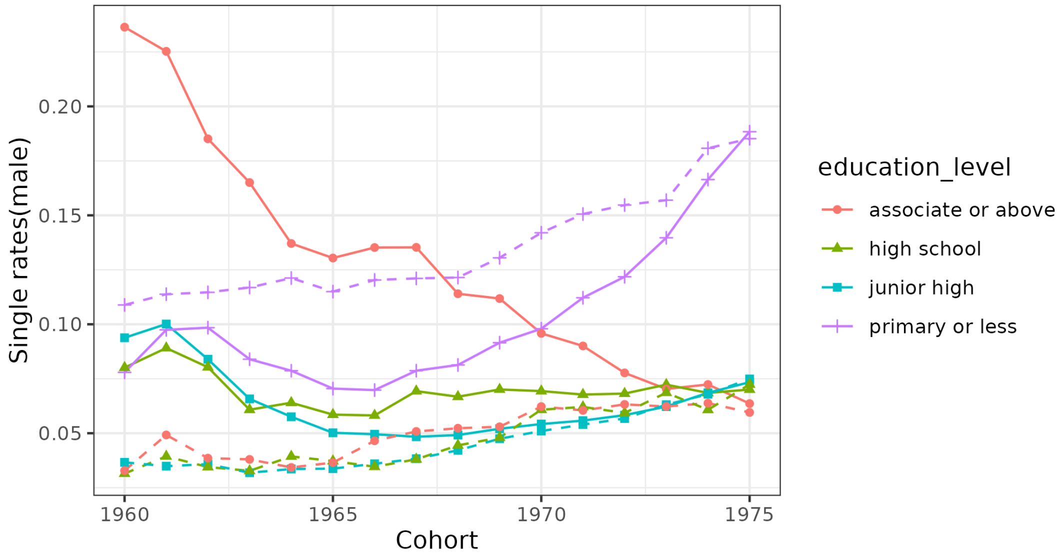
I construct the simulation sample for earlier cohorts in a manner similar to that used to estimate the baseline model parameters. I apply the estimated parameters from the baseline model, perform the matching following the deferred acceptance algorithm, and simulate the single rates.

In Figures 16 and 17, the dashed lines represent true single rates from the Census, and the solid lines are the predictions from the model. Again, the predicted rates are averages across 50 samples based on random draws of taste parameters.

The model is able to predict the general trend of rising single rates for men born between 1960 and 1975 and the large gap between the single rates of the least educated men and other groups of men born after 1970. However, it largely underpredicts the single rate levels of the least educated men. For the other three more educated groups, the model overpredicts their single rates. The deviations are smaller when the birth cohorts are closer to 1975 where the estimates for preferences are based on. The implications are twofold. First, mating preferences are evolving over generations. Second, compared to other men, the mating preferences of the most educated men or women's perceptions of them change the most over time.

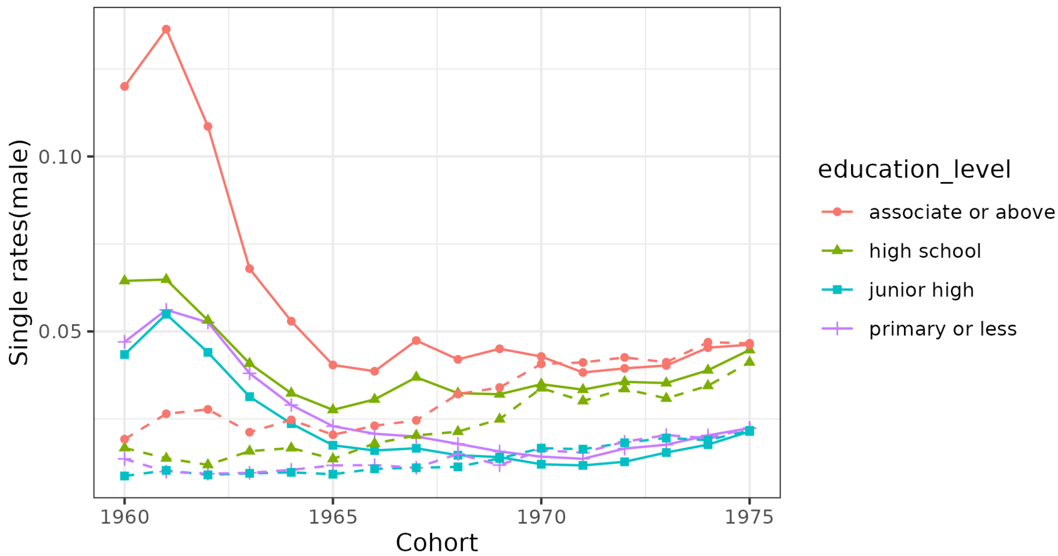
For women, the overall fit is better. Especially for cohorts born after 1970, the model replicates the slight upward trend in the single rates and the large gap between the two less educated groups and the two more educated ones. It largely overpredicts single rates for all education levels for women born before 1965. One possibility could be that women born in the 1960s have higher valuations for marriage overall.

Figure 16: Out-of-sample predicting: single rates for males



Note: This figure summarizes the predicted single rates for each cohort (1960-1975). The dashed lines are true single rates based on Census data. The solid lines stands for the simulated single rates. I construct the calibration sample for each cohort in the same way as what I did in the baseline estimation. Each prediction is based on the averages across 50 simulated samples.

Figure 17: Out-of-sample predicting: single rates for females



Note: This figure summarizes the predicted single rates for each cohort (1960-1975). The dashed lines are true single rates based on Census data. The solid lines stands for the simulated single rates. I construct the calibration sample for each cohort in the same way as what I did in the baseline estimation. Each prediction is based on the averages across 50 simulated samples

7 Conclusion

In line with the literature that has documented more household chores being assumed by women, lower labor market participation rates by women, and higher divorce rates when the wife earns more, as in the work by Bertrand et al. (2015), I find evidence that suggests women born around 1975 in China have strong aversions to marriages that consist of a more educated wife and a less educated husband. Surprisingly, men seem to be less affected by the traditional gender identities and value marrying more educated wives.

The aversion of women to marrying down shapes the single rate patterns in the data. Without it, we would not see the unique pattern of men's single rates decreasing with education and women's increasing with education. Regarding the high single rates of highly educated women that receive frequent attention in the media, the analysis suggests that alleviating women's aversion to marrying less-educated men would help. However, it also cautions against completely suppressing this distaste, because that would substantially increase the single rates of the most educated men, which is obviously not a socially optimal result either.

Women's empowerment in education is a change in the social landscape currently in motion in China and many other developing countries. This change has already occurred decades ago in developed countries. Understanding the mismatch between marriageable men and women caused by shifting education distributions and attitudes towards gender roles in marriage becomes increasingly relevant in this context.

When more recent data becomes available, I can extend my analysis to see if the model can explain the marriage rates in recent years.

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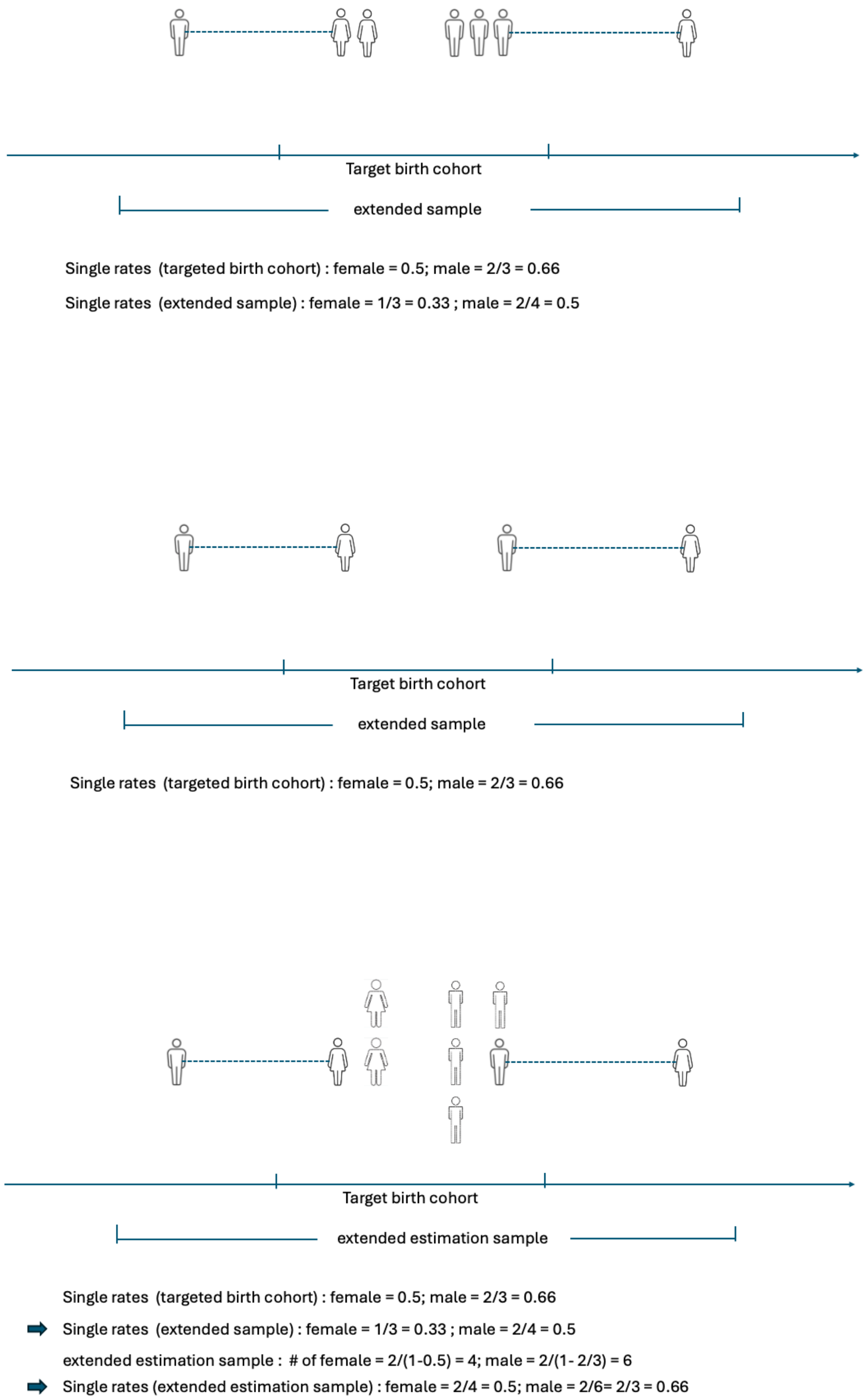
Appendix

A Sample construction

Figure 18: A simplified illustration of sample construction



B Baseline model

Table 5: Predicted mean utilities from marriage

Category	Male	Female
primary or less: primary or less	-8.30	-3.52
primary or less: junior high	28.69	-10.14
primary or less: high school	65.04	-13.45
primary or less: associate or above	112.63	-17.86
junior high: primary or less	-2.94	-14.77
junior high: junior high	-5.90	-7.09
junior high: high school	-5.84	-10.40
junior high: associate or above	43.28	-14.81
high school: primary or less	1.11	-17.20
high school: junior high	-1.85	-10.21
high school: high school	-3.33	-7.03
high school: associate or above	9.10	-11.44
associate or above: primary or less	68.22	-19.25
associate or above: junior high	65.26	-17.59
associate or above: high school	63.78	-13.77
associate or above: associate or above	61.80	-8.87

Note: All the predicted mean utilities are rounded to the second decimal place. They are mean utilities from marriage relative to being single. For row "primary or less: junior high" and column "male", the entry stands for the mean utility a male with primary or less education can get from marrying a female with junior high school education, relative to the utility of a male with this education level being single; for the same row and column "female", the entry stands for the mean utility a female with primary or less education can get from marrying a male with junior high school education, relative to the utility of a female with this education level being single. Similar definitions apply to the rest of the table.

C Counterfactual

C.1 Males' utility is linear in spouse's education

Table 6: Prediction precision: male matchings; male's utility linear in spouse's education

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	195.72	28.85
primary or less: junior high	50.45	0.36	-50.09
primary or less: high school	3.20	0.00	-3.20
primary or less: associate or above	0.36	0.00	-0.36
primary or less: single	50.20	75.92	25.72
junior high: primary or less	164.30	141.48	-22.82
junior high: junior high	601.74	641.66	39.92
junior high: high school	38.12	23.40	-14.72
junior high: associate or above	6.14	0.16	-5.98
junior high: single	65.60	69.30	3.70
high school: primary or less	11.36	10.44	-0.92
high school: junior high	88.56	96.32	7.76
high school: high school	88.74	101.14	12.40
high school: associate or above	20.01	1.70	-18.31
high school: single	16.28	15.40	-0.88
associate or above: primary or less	1.67	0.76	-0.91
associate or above: junior high	18.64	16.78	-1.86
associate or above: high school	40.22	40.50	0.28
associate or above: associate or above	121.20	130.50	9.30
associate or above: single	11.50	5.46	-6.04

Note: All the numbers are rounded to the second decimal place. The estimation sample takes the constructed sample with matched couples from the Census and scale down by 1/100 and round up to the nearest integers to keep estimation time for matching in a reasonable range. Target column used by objective functions are raw numbers after the sample is scaled down by 1/100 before rounding. This is the reason why the targets are not integers. Column "Prediction" records the average predictions over 50 simulated samples of equal size and the same numbers of men and women at each education level but with different randomly generated idiosyncratic tastes, given the set of estimates for preference parameters. For row "primary or less: junior high", the entry stands for the number of males with primary or less education marrying females with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 7: Prediction precision: female matchings; male's utility linear in spouse's education

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	195.72	28.85
primary or less: junior high	164.30	141.48	-22.82
primary or less: high school	11.36	10.44	-0.92
primary or less: associate or above	1.67	0.76	-0.91
primary or less: single	7.87	4.60	-3.27
junior high: primary or less	50.45	0.36	-50.09
junior high: junior high	601.74	641.66	39.92
junior high: high school	88.56	96.32	7.76
junior high: associate or above	18.64	16.78	-1.86
junior high: single	16.85	21.88	5.03
high school: primary or less	3.20	0.00	-3.20
high school: junior high	38.12	23.40	-14.72
high school: high school	88.74	101.14	12.40
high school: associate or above	40.22	40.50	0.28
high school: single	7.31	12.96	5.65
associate or above: primary or less	0.36	0.00	-0.36
associate or above: junior high	6.14	0.16	-5.98
associate or above: high school	20.01	1.70	-18.31
associate or above: associate or above	121.20	130.50	9.30
associate or above: single	7.22	22.64	15.42

Note: This table presents results from the same estimation used by Table 6, reorganized by female education levels. The predicted average single numbers for women in this table provides new information. Matching numbers are shown again with single numbers for comparison. For row "primary or less: junior high", the entry stands for the number of females with primary or less education marrying males with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 8: Predicted mean utilities from marriage- male's utility linear in spouse's education

Category	Male	Female
primary or less: primary or less	-8.30	-3.52
primary or less: junior high	-11.27	-10.14
primary or less: high school	-12.75	-13.45
primary or less: associate or above	-14.72	-17.86
junior high: primary or less	-2.94	-14.77
junior high: junior high	-5.90	-7.09
junior high: high school	-7.38	-10.40
junior high: associate or above	-9.36	-14.81
high school: primary or less	1.11	-17.20
high school: junior high	-1.85	-10.21
high school: high school	-3.33	-7.03
high school: associate or above	-5.31	-11.44
associate or above: primary or less	68.22	-19.25
associate or above: junior high	65.26	-17.59
associate or above: high school	63.78	-13.77
associate or above: associate or above	61.80	-8.87

Note: All the predicted mean utilities are rounded to the second decimal place. They are mean utilities from marriage relative to being single. For row "primary or less: junior high" and column "male", the entry stands for the mean utility a male with primary or less education can get from marrying a female with junior high school education, relative to the utility of a male with this education level being single; for the same row and column "female", the entry stands for the mean utility a female with primary or less education can get from marrying a male with junior high school education, relative to the utility of a female with this education level being single. Similar definitions apply to the rest of the table.

C.2 Females' utility is linear in spouse's education

Table 9: Prediction precision: male matchings; female's utility linear in spouse's education

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	0.00	-166.87
primary or less: junior high	50.45	0.00	-50.45
primary or less: high school	3.20	125.66	122.46
primary or less: associate or above	0.36	146.34	145.98
primary or less: single	50.20	0.00	-50.20
junior high: primary or less	164.30	262.78	98.48
junior high: junior high	601.74	539.08	-62.66
junior high: high school	38.12	43.38	5.26
junior high: associate or above	6.14	8.56	2.42
junior high: single	65.60	22.20	-43.40
high school: primary or less	11.36	36.06	24.70
high school: junior high	88.56	148.74	60.18
high school: high school	88.74	6.40	-82.34
high school: associate or above	20.01	0.10	-19.91
high school: single	16.28	33.70	17.42
associate or above: primary or less	1.67	4.34	2.67
associate or above: junior high	18.64	46.30	27.66
associate or above: high school	40.22	2.56	-37.66
associate or above: associate or above	121.20	0.00	-121.20
associate or above: single	11.50	140.80	129.30

Note: All the numbers are rounded to the second decimal place. The estimation sample takes the constructed sample with matched couples from the Census and scale down by 1/100 and round up to the nearest integers to keep estimation time for matching in a reasonable range. Target column used by objective functions are raw numbers after the sample is scaled down by 1/100 before rounding. This is the reason why the targets are not integers. Column "Prediction" records the average predictions over 50 simulated samples of equal size and the same numbers of men and women at each education level but with different randomly generated idiosyncratic tastes, given the set of estimates for preference parameters. For row "primary or less: junior high", the entry stands for the number of males with primary or less education marrying females with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 10: Prediction precision: female matchings; female's utility linear in spouse's education

Category	Target	Prediction	Deviation
primary or less: primary or less	166.87	0.00	-166.87
primary or less: junior high	164.30	262.78	98.48
primary or less: high school	11.36	36.06	24.70
primary or less: associate or above	1.67	4.34	2.67
primary or less: single	7.87	49.82	41.95
junior high: primary or less	50.45	0.00	-50.45
junior high: junior high	601.74	539.08	-62.66
junior high: high school	88.56	148.74	60.18
junior high: associate or above	18.64	46.30	27.66
junior high: single	16.85	42.88	26.03
high school: primary or less	3.20	125.66	122.46
high school: junior high	38.12	43.38	5.26
high school: high school	88.74	6.40	-82.34
high school: associate or above	40.22	2.56	-37.66
high school: single	7.31	0.00	-7.31
associate or above: primary or less	0.36	146.34	145.98
associate or above: junior high	6.14	8.56	2.42
associate or above: high school	20.01	0.10	-19.91
associate or above: associate or above	121.20	0.00	-121.20
associate or above: single	7.22	0.00	-7.22

Note: This table presents results from the same estimation used by Table 9, reorganized by female education levels. The predicted average single numbers for women in this table provides new information. Matching numbers are shown again with single numbers for comparison. For row "primary or less: junior high", the entry stands for the number of females with primary or less education marrying males with junior high school education, as the target or as the predicted. Similar definitions apply to the rest of the table.

Table 11: Predicted mean utilities from marriage- female's utility linear in spouse's education

Category	Male	Female
primary or less: primary or less	-8.30	-3.52
primary or less: junior high	28.69	-10.14
primary or less: high school	65.04	-13.45
primary or less: associate or above	112.63	-17.86
junior high: primary or less	-2.94	-0.47
junior high: junior high	-5.90	-7.09
junior high: high school	-5.84	-10.40
junior high: associate or above	43.28	-14.81
high school: primary or less	1.11	2.90
high school: junior high	-1.85	-3.72
high school: high school	-3.33	-7.03
high school: associate or above	9.10	-11.44
associate or above: primary or less	68.22	5.47
associate or above: junior high	65.26	-1.14
associate or above: high school	63.78	-4.45
associate or above: associate or above	61.80	-8.87

Note: All the predicted mean utilities are rounded to the second decimal place. They are mean utilities from marriage relative to being single. For row "primary or less: junior high" and column "male", the entry stands for the mean utility a male with primary or less education can get from marrying a female with junior high school education, relative to the utility of a male with this education level being single; for the same row and column "female", the entry stands for the mean utility a female with primary or less education can get from marrying a male with junior high school education, relative to the utility of a female with this education level being single. Similar definitions apply to the rest of the table.