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Are China's "Leftover Women" Really Leftover? An Investigation of Marriage Market Penalties in Modern-day China

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Abstract

A recent trend in Korea and Japan sees college-graduate women marrying later and at lower rates than less-educated women. In China, "leftover women" have also became a top policy concern. This paper finds, however, that China's higher-educated urban women attain marital outcomes more like those in the US than in other Asian Tiger countries: marrying later, but ultimately at comparable rates to less-educated women. For 1990-2009, we quantify marriage quality using the classic Choo-Siow (2006) estimator and find large returns to marrying later but minimal direct higher-education effects. Using the Choo (2015) dynamic estimator, we project future marriage rates to remain stable among the higher-educated and decline for lower-educated women.

JEL Classification: D13, J11, J12, J13, N35

Keywords: China, marriage markets, fertility, leftover women, education, assortative mating

1 Introduction

In 2007, China's Ministry of Education added the term "leftover women" to the national lexicon, broadly defining it as any unmarried woman over the age of 27. Quantifying the phenomenon on the basis of the 2010 Census, China's National Bureau of Statistics (NBS) contrasts percent unmarried for individuals with primary education or less (2.5% for women and 11.1% for men) with those of post-graduate education (49.2% for women and 39.1% for men), and purports that, "under the influence of the traditional notion that the husband should excel his wife in a marriage, many outstanding women and less advantaged men are having difficulty in finding their spouse." The All-China Women's Federation, appointed by the central government to resolve this "leftover women trap", proclaimed: "the tragedy is, women do not realize that, as they age, they are worth less and less. So by the time they get their MA or PhD, they are already old like yellowed pearls," (March, 2011).

These official statements suggest two main facets to the Chinese government's concern regarding "leftover women": first, a "success penalty" disadvantaging high-achieving women in marriage markets where traditional attitudes prevail; and second, an "age penalty" due to depreciation of reproductive capital over time for women who delay marriage. The recommended solution: earlier marriage. From the Chinese government's perspective, increasing marriage rates for the current cohort of college-graduate women has become integral to "upgrading population quality (*suzhi*)" and to resolving as well as possible huge imbalances in the marriage market tied to the fact that young men outnumber young women, at the national level, by approximately thirty million (Wei and Zhang (2011)).

On the surface, concerns of the Chinese government seem well founded. A recent trend in Korea, Japan, Taiwan, Singapore, and Hong Kong sees college-educated women not only delaying marriage, but also experiencing *declining* (completed) marriage rates. Kawaguchi and Lee (2017) document that, as these nations' highly educated women increasingly opt to remain single, native men are turning to the importation of brides from less developed Asian nations, such as Vietnam, the Philippines, and China, despite preferring a native wife. Although this phenomenon barely existed in the early 1990s, imported brides now comprise 4 to 35 percent of newlywed marriages among the nations studied. Focusing on Korea and Japan, Hwang (2016) finds that the gap in marriage rates between college and non-college women is *widening*, with highly educated women marrying at increasingly lower rates relative to their less educated female peers — despite the fact that cohabitation[1] is stigmatized, which presumably augments the opportunity cost of single-hood in Asia relative to Western nations.[2]

By contrast, a success penalty prominent in the US a generation ago has disappeared. In fact, the gap between the marriage rates of college-graduate women and their less educated female counterparts has actually reversed in sign since the mid-1970s (Rose (2003), Schwartz and Mare (2005), Stevenson and Wolfers (2007)).[3] Despite highly educated American women's tendency to delay marriage into their late twenties and thirties, their *completed* marriage rate catches up to and eventually overtakes those of women with lower educational attainment. Moreover, highly educated couples are known to have much lower divorce rates.

On account of geographical and cultural proximity, one might expect China's marriage mar-

[1]As a proxy for cohabitation (as it may not be frankly reported, due to social stigma), Hwang (2016) looks at out-of-wedlock childbirth and finds that it amounts to only less than 2% of total births in Korea and Japan.

[2]The consensus in the literature is that the current low rates of marriage among highly educated women in East Asia have been brought about by a combination of unprecedented economic growth within a relatively short period of time, and a failure of gender attitudes in the domestic marriage market to keep up with this rapid modernization of labour markets. Hwang points out that college-educated Korean and Japanese women *in America* marry at the same rate as non-college women, suggesting that women in their respective country of origin face a different set of options and payoffs. These problems may be exacerbated if there is limited commitment in marriage (Lundberg and Pollak (2007)). While a mutually acceptable bargaining outcome (over, say, contributions to home production) may be achieved for a potential marriage, there is no legally binding contract to hold either spouse to their word after marriage, particularly if the bride's parents-in-law disapprove of the contract.

[3]Goldin (2004) attributes women's decision to forego marriage in pre-1970 America to a lack of contraceptive methods, market substitutes for household production, and time-saving household appliances that made long-term career investments impracticable alongside family life. These technologies, however, are easily accessible to women in developed Asia today.

ket conditions to be more comparable to the experience of more developed East Asian nations than America. Perhaps surprisingly, and in sharp contrast to the warnings of the Chinese government, this paper finds instead that highly educated urban Chinese women ultimately marry at very comparable if not slightly higher rates than their less educated female counterparts in recent years. Moreover, we find little evidence of a "success penalty" for highly educated women in terms of estimated utility gains from marriage, and no evidence that this penalty has increased over the 20 year period leading up to 2010. The reasons are twofold. First, the estimated gains to marrying later have been increasing for women of all education levels over the period. Second, while *direct* marital gains from education appear to be low – that is, holding the distribution of likely spouses constant, receiving a college education does not raise the predicted gains from marriage for women and does so only modestly for men – an uptick in assortative mating on education between 1990 and 2009 makes the average marriage of a high educated woman more favorable compared to the average marriage of a less educated woman. In delaying marriage but eventually marrying, and marrying relatively well, high-educated Chinese women more closely resemble high-educated U.S. women.

To arrive at these conclusions, we draw on NBS nationally-representative surveys spanning 1990-2009 and quantify the *quality* of marriages in the context of a transferable utility model — specifically, through static and dynamic versions of the marriage matching framework developed in Choo and Siow (2006) and Choo (2015), respectively. We search for evidence of a "success penalty" and/or "age penalty" on the marital outcomes of urban Chinese women by comparing net gains to marriage, both across couples of varying educational attainment and age of marriage, as well as over time. Our basic results remain qualitatively similar whether we use the static gains estimator of Choo and Siow (2006) or the dynamic estimator developed recently by Choo (2015). Besides its intuitive appeal, the Choo (2015) estimator also allows us to incorporate evidence on changing population supplies and marriage rates to project marriage rates into the future, under certain assumptions about the path of systematic returns to marriage in future years. Our estimates suggest that highly educated women continue to marry at even higher rates as in 2009 up to 2015 while women with only high school education, who make up a declining share of the urban population at prime marriage ages, continue to marry at roughly the same rate, though these women will, on average, marry at increasingly younger ages relative to their high-educated peers. As higher-educated women continue to marry at higher rates than lower-educated women, we project that marital patterns among women in China will increasingly resemble patterns in the U.S. rather than in the Asian Tiger nations.

Amongst recently emerging quantitative studies, the finding that high-educated Chinese women marry at comparable rates to their less educated peers appears to be novel. Qian and Qian (2014), who also focus on recent trends in urban China (up to 2008), find that highly educated women marry at lower rates than other types across each of three age categories ('early' (20-24), 'normal' (25-29), and 'late' (30-49)).[4] You et al. (2016) also find "declining marriage rates" as well as a "marital college discount" (success penalty) for women with higher education. However, their marriage rates are not completed marriage rates, but rather the NBS age-15-and-above proportion married by education.[5] In both cases, the use of broad age categories confounds marriage delayers with never-marriers. Larger sample sizes at our disposal allow us to circumvent this problem with a finer grid.

Despite highly educated Chinese women (and men) marrying at the same rates as their lower-educated counterparts, government concern for the depreciation of women's reproductive capital because of delayed marriage still remains, and is only further exacerbated by the recent 2015 relaxation of the one-child policy. Moreover, as children are typically regarded as one of the most important components of marital output (Brandt et al., 2016), social and

[4]Qian and Qian (2014) use broad categorization as opposed to a finer age grid owing to the small sample size of their main data source, the Chinese General Social Survey (CGSS).

[5]You et al. (2016) look at women aged 27 to 60 and conduct a regression analysis on their likelihood of marriage on income over education and marital status, among various individual, household, and province controls. After obtaining the resulting coefficient estimates, You et al. re-arrange their regression equation to predict likelihood of marriage, given education and income and information on the other controls.

private returns to marriage may be diminished if highly educated couples find childbearing relatively less attractive and / or there is increased likelihood of childlessness in later marriages. Indeed, we find evidence of declining completed fertility for Chinese women in recent years. The decline is similar across education levels, but women with more than high school have the lowest fertility rates in all years. We see some suggestive evidence that recent cohorts of Chinese women who delay marriage consist increasingly of those who choose to forego childbearing, which could in turn stimulate public concern about *suzhi*.

The remainder of this paper proceeds as follows. In Section 2, we introduce and briefly describe the models we use to assess gains to marriage: the classic Choo and Siow (2006) and a dynamic extension, the Choo (2015) estimator, and discuss their relevance and application to the urban Chinese marriage market. In Section 3, we introduce our datasets and explain how we deal with various issues of compatibility and cleaning. Our results are presented in Section 4. Section 4.1 describes results using the Choo and Siow (2006) estimator and Section 4.2 presents results using the Choo (2015) estimator. With the dynamic estimator, we extrapolate marriage markets into the future under evolving gender ratios. Section 4.3 discusses evidence on assortative mating and its contribution to returns in the marriage market. Section 4.4 examines changing patterns of fertility and their relationship to marriage market outcomes. Section 5 concludes.

2 Model: Static and dynamic Choo-Siow models

2.1 Choo-Siow (2006)

The classic Choo-Siow matching function (and its extensions) has emerged as one of the core tools by which economists and demographers explore marriage market outcomes. Briefly, suppose there are I types of men and J types of women, where a type can be single- or multi-dimensional. Let i denote i-type men and j denote j-type women. At any point in time t, a marriage market has a population vector of available men M with types $i = 1, ..., I$ and typical element m_i, and a population vector of available women F with types $j = 1, ..., J$ and typical element f_j. A marriage matching function $\mu(M, F; \Pi)$ predicts changes in marriage distribution μ due to changes in population vectors M and F or changes in the parameters governing the gains to marriage Π. Effectively, μ is an $(I+1) \times (J+1)$ matrix, where each element μ_{ij} represents the number of couples of that specific $\{i, j\}$ type combination, with μ_{i0} and μ_{0j} giving the number of unmarried men and women of type i and j respectively. Accounting requires:

$$\begin{cases} \mu_{i0} + \sum_{j=1}^{J} \mu_{ij} = m_i & \forall i \\ \mu_{0j} + \sum_{i=1}^{I} \mu_{ij} = f_j & \forall j \\ \mu_{i0}, \mu_{0j}, \mu_{ij} \geq 0 & \forall i, j \end{cases}$$

Under the assumption of perfectly transferable utility, an $I \times J$ set of (possibly negative) transfers τ_{ij} from men i to woman j will emerge that function as the prices that clear the marriage market. An i-type man g who marries a j-type woman obtains net utility V_{ijg}. If he remains unmarried he receives net utility V_{i0g}. These are given by

$$V_{ijg} = \widetilde{\alpha}_{ij} - \tau_{ij} + \varepsilon_{ijg} \tag{1}$$

$$V_{i0g} = \widetilde{\alpha}_{i0} + \varepsilon_{i0g} \tag{2}$$

If man g marries a j-type woman, he obtains gross systematic return $\widetilde{\alpha}_{ij}$, pays equilibrium income transfer τ_{ij} to his spouse, and gains an additional individual-specific random component ε_{ijg} that is independent and identically distributed according to the Type I Extreme Value distribution (McFadden (1973)). The systematic payoff from marriage common to all i-type men who marry j-type women is characterized by $\widetilde{\alpha}_{ij} - \tau_{ij}$, and the individual man g-specific payoff deviation from this systematic component is given by ε_{ijg}. Alternatively, if i-type man g remains unmarried, he receives a systematic payoff to single-hood $\widetilde{\alpha}_{i0}$ as well as an individual-specific component ε_{i0g}, which is also an i.i.d. random variable with Type I Extreme Value distribution. Man g will therefore choose according to $V_{ig} = \max_j \{V_{i0g}, ..., V_{ijg}, ..., V_{iJg}\}$.

For each sub-market $\{i, j\}$, McFadden (1973) shows (a proof is also provided in Choo and Siow (2006)) that the quasi-demand equation is given by

$$\ln \mu_{ij}^d = \ln \mu_{i0}^d + \alpha_{ij} - \tau_{ij} \tag{3}$$

where μ_{ij}^d is the number of j-type spouses demanded by i-type men, μ_{i0}^d is the number of unmarried i-type men, and $\alpha_{ij} = \widetilde{\alpha}_{ij} - \widetilde{\alpha}_{i0}$ represents the systematic gross return of marriage relative to remaining single for i-type men. The women's problem is symmetric and yields a corresponding quasi-supply equation for woman j to man i:

$$\ln \mu_{ij}^s = \ln \mu_{0j}^s + \gamma_{ij} + \tau_{ij} \tag{4}$$

where $\ln \mu_{ij}^s$ is the supply of j-type women for i-type men and $\ln \mu_{0j}^s$ is the number of unmarried j-type women. ("Demand" and "supply" can be easily transposed across genders.)

Imposing equilibrium, $\ln \mu_{ij}^d = \ln \mu_{ij}^s$ and rearranging gives the Choo and Siow (2006) marriage matching function:

$$\pi_{ij} = \ln \left(\frac{\mu_{ij}}{\sqrt{\mu_{i0} \cdot \mu_{0j}}} \right) \tag{5}$$

where $\pi_{ij} \equiv \frac{\alpha_{ij}+\gamma_{ij}}{2}$ quantifies the per-capita systematic net gains to marriage for a couple consisting of an i-type man and j-type woman in any given marriage market year. Mathematically, π_{ij} is the natural log of the ratio of the total number of newlywed $\{i, j\}$-type couples to the geometric average of single i-type men and j-type women in any given marriage market year. Choo and Siow show that this ratio of observable marriage market outcomes is a sufficient statistic for quantifying the quality of marriage matches. Intuitively, more marriages of a $\{i, j\}$ match type (that is, higher μ_{ij}) indicates greater match desirability on average, for a given m_i and f_j. To separate desirability from abundance, the formula scales μ_{ij} by the number of unmarrieds of these types, i.e. those who could have formed an $\{i, j\}$ marriage but opted to reject the match. Consequently, the Choo-Siow statistic also tells us that *for a given number of marriages*, the more scarce the types involved (lower μ_{i0} and μ_{0j}), the more desirable on average is the match.

Furthermore, solving the Choo-Siow model gives the spouse-specific as well as the total net gains to marriage, i.e. husband-specific systematic net gains $\pi_{ij}^m \equiv \alpha_{ij} - \tau_{ij}$ and wife-specific systematic net gains $\pi_{ij}^f \equiv \gamma_{ij} + \tau_{ij}$:

$$\pi_{ij}^m = \ln\left(\frac{\mu_{ij}}{\mu_{i0}}\right) \tag{6}$$

$$\pi_{ij}^f = \ln\left(\frac{\mu_{ij}}{\mu_{0j}}\right) \tag{7}$$

These expressions capture the fact that the type-specific gains resulting from an $\{i, j\}$ match depend on the relative scarcity of the husband's and wife's types. Relative scarcity of type translates to increased bargaining power and therefore a greater type-specific share of the marriage's total systematic net gains. By 2009, for example, rapid growth of Chinese women's educational attainment from China's higher education enrollment expansion project (implemented in 1999) reduced the scarcity of high-type women, and thus their bargaining power. In general, if systematic absolute value $(\widetilde{\alpha}_{ij} + \widetilde{\gamma}_{ij})$ of marriages in which the wife is high-educated remained constant over time, then the denominator of (7) would rise and high educated women's bargaining power (reflected in τ) and their average private returns from marriage will fall. (In fact, as shown in tables 3 and 12, the rise in the educational attainments of men and women in urban areas have tracked each other fairly closely, suggesting that the marriage market returns to high education for men should also be falling relative to lower-educated men.) This outcome could be mitigated if, for instance, the fundamental returns $\widetilde{\alpha}_{ij} + \widetilde{\gamma}_{ij}$ to high-educated partners were rising over time due, for example, to increasing tolerance toward non-traditional (working) wives, or if the gains from marriage were becoming more concentrated around ages when the high educated were more free to marry, i.e. after completing a degree. Indeed, in section 4.1 we will see some evidence consistent with this latter idea.

The Choo-Siow framework has many nice properties; in particular it allows for unrestricted substitution effects across types of marriages when population vectors change. It is static in the sense that any cultural, social, or policy changes that affect marriage distributions will be reflected in changes to the systematic net gains of marriage over time, but *anticipated* changes to these gains, or to the population vectors, will not affect the behavior of individuals in a given marriage market. As well, the relative payoff to remaining single at a point in time (which can only be identified relative to the value of different types of marriages) will implicitly capture the option value of participating in future marriage markets, but purely in reduced-form. Both of these limitations can be circumvented using a dynamic estimator to which we turn next, but we treat the classic static model described above as our benchmark in examining the systematic net gains to marriage by educational attainment and first-marriage age in recent years, using 1990 as a baseline year for comparison.

2.2 The Choo (2015) framework

In a recent extension to the classic Choo-Siow framework, Choo (2015) develops a matching function that explicitly accounts for the fact that the returns to a particular match in a given marriage market represent a present discounted surplus and that committing to a marriage requires paying the opportunity cost of participating in subsequent marriage markets. This is likely to be especially important if the fundamentals of the marriage market – the gains to marriage types and the set of available partners – are changing over time and if agents are aware of these changes. Choo (2015) makes use of the same basic utility function as Choo and Siow (2006) with Type 1 Extreme Value matching function and male-to-female transfers $\tau_{i,j}$. In Choo (2015), the τs are up-front transfers (like bride prices or dowries) made at the time of marriage.

For our analysis based on the static estimator, we consider a two-dimensional type space: $i, j = \{age, educ\}$. Similarly, we consider a simple version of Choo's dynamic model, extended to the same multi-dimensional types (age and education categories), but in which there is no risk of divorce and in which the terminal age for participating in the marriage market, or gaining utility from a marriage, is $T = 44$ for both genders. Under these two assumptions, dynamic marriage gains to an $\{i, j\}$ marriage, $\Pi_{i,j}$ are given by

$$2\Pi_{i,j} = \ln\left(\frac{\mu_{i,j}}{m_i}\right) - \sum_{k=0}^{T_i-1} \ln\left(\frac{\mu_{i'(i,k),0}}{m_{i'(i,k)}}\right)^{\beta^k} + \ln\left(\frac{\mu_{i,j}}{f_j}\right) - \sum_{k=0}^{T_j-1} \ln\left(\frac{\mu_{0,j'(j,k)}}{f_{j'(j,k)}}\right)^{\beta^k} \tag{8}$$

where $i = \{age, educ\}$, $j = \{age, educ\}$, $T_i = T - age_i + 1$ and $T_j = T - age_j + 1$. The first two terms on the right hand side give the dynamic analog of π^m and the next two terms give the dynamic analog of π^f. $i'(i, k)$ is a function relating how state i changes with time k. If age were the only characteristic on which people sort, as in Choo (2015), then $i' = i + k$, which is the functional form given in Choo (2015). In the case where the two characteristics making up a type are age and education, then age increases one for one with k while education remains constant with both time and age. For now, we omit marriage market subscripts t from (8) as we did for (5), which assumes that the marriage market is in steady state. In principle, however, the πs, Πs, and μs can change over time as well as across types, which we will allow for in our fully dynamic version of the model. Note that if $T_i = T_j = 1$ then (8) reduces to

$$2\Pi_{i,j} = \ln\left(\frac{\mu_{i,j}}{m_i}\right) - \ln\left(\frac{\mu_{i,0}}{m_i}\right) + \ln\left(\frac{\mu_{i,j}}{f_j}\right) - \ln\left(\frac{\mu_{0,j}}{f_j}\right) = 2\pi \tag{9}$$

and π is the classic static Choo-Siow estimator. That is, the dynamic Choo-Siow estimator takes into account the fact that if a man (say) opts to remain single in the current marriage market (at any age before the terminal age T), he will have the opportunity to participate in next period's marriage market, with new state vector $i'(i, 1)$ and then potentially in subsequent markets, receiving new i.i.d. draws of the vector $\boldsymbol{\epsilon}$ at each $k \geq 1$. The present discounted value of participation in future marriage markets enters the expression for Π negatively to reflect the fact that it is the opportunity cost of marrying in the present. Note, however, that the closer $\mu_{i'}$ is to $m_{i'}$ in subsequent marriage markets, the closer this opportunity cost is to zero, since the likelihood that male i will be able to marry in the future when he is in state i' also goes to zero, as does the marital surplus he can hope to gain by waiting to participate in that marriage market. An identical argument holds for women j.

As in the classic static case, Π measures systematic net marital gains, or marital surplus: specifically, the difference between gross output or utility from the marriage and the gross output or utility received from remaining single for the duration of the marriage. In Appendix A we show the derivation of (8) for our simplified model without divorce. The derivation of the more general estimator in which individuals are subject to divorce shocks and expect with some probability to re-enter the marriage market at a later date, is of course provided in Choo (2015), for one-dimensional type agents.

2.3 Application to China

The Choo and Siow (2006) and Choo (2015) frameworks are appropriate in situations where the marriage market clears and marriage surplus is transferable. This implies that there are limited search frictions and all matches that produce positive surplus (conditional on all outside options) occur. A natural question is whether these assumptions are broadly appropriate characterizations of the Chinese marriage market. Ji (2015) notes that, even after more than 3 decades of rapid socioeconomic development, marriage in China remains not only relatively early by international standards, but also near universal, the latter fact which we also find to be true in our data as late as 2009.[6] There is also direct evidence for transferable utility in China with respect to spousal transfers. Wei and Zhang (2011) find evidence that husband-wife transfers are responsive to changes in the sex ratio, specifically, that China's rising sex ratio contributed substantially to an upsurge in competitive household savings rates between 1990 and 2009, as parents attempt to improve their son's relative attractiveness in the marriage market through large family investment purchases such as a house and car. Huang and Zhou (2016) provide new evidence for transferable utility by arguing that China's One-child Policy induces not only a higher unmarried rate among the Chinese Han population but also increased instances of inter-ethnic marriages since ethnic minorities are not generally subject to the one-child constraint. Moreover, while spousal transfers cannot be observed in the 2000 and 2005 Census data, Huang and Zhou use spouse education as a proxy and find that increases in fines for breaching the One-Child Policy lead to larger transfer payments from Han to ethnic minority spouses not subject to the one-child constraint.

Taken together, we think the recent evidence supports the view that a transferable utility model is appropriate to study the Chinese marriage market. Using the models described above, therefore, we explore the systematic net gains to marriage in four recent Chinese marriage markets for which we have sufficient data — namely, years $t = \{1990, 2000, 2005, 2008/9\}$. Within a marriage market t, let us define individual types across two dimensions {age, education}. In our analysis, due to both data and computational limitations, "age" refers to three-year age groups while "education" is also a categorical variable taking three values: "low", "medium" and "high" as discussed further in Section 3. Consistent with the Choo and Siow (2006) and Choo (2015) setups, let i denote i-type men and j denote j-type women.

[6] The arguments of To (2013) and Fincher (2014) lend insight into the near-universal marriage of Chinese women: Fincher (2014) argues that Chinese parents' first order priority is often to see their daughter married suitably early (with a pervasive fear that being "picky" will lead to being "leftover" and unable to marry) and then to see to the birth of their grandchild soon thereafter. The failure of a daughter to fulfill these wishes is considered unfilial.

The vectors I and J are of the same value for both genders, and we label this value N.

For each marriage market year t, we observe both singles and newlyweds; in both the Choo and Choo-Siow frameworks, previously wed individuals have exited the marriage market, make no further decisions, and receive no further payoffs. The N-dimensional population vectors $\mathbf{m}$ and $\mathbf{f}$ therefore consist of singles and those who have just made the decision to marry (newlyweds). Let μ_{ij} denote the number of newlywed couples with i-type husband and j-type wife. Let μ_{i0} denote the number of single i-type men and μ_{0j} the number of single j-type women. There are (potentially) N^2 types of recent marriages in each marriage market year t. The marriage matching distribution μ is an $N \times N$ matrix with typical element μ_{ij}. This paper then employs equations (5) - (7) and (8) to translate these marriage market outcomes into average, husband-specific, and wife-specific static systematic net gains and dynamic systematic net gains to marriage. When moving to the dynamic case, it is important to keep in mind that — as briefly discussed above — "dynamic" has two implications: first, agents who do not marry will experience an evolution in their state (specifically, they will age), and will consider the fact that remaining single at t allows them to participate, in their new state, in the marriage market at $t + 1$. Second, the marriage market itself is changing over time, so that forward-looking agents may anticipate changes in population vectors and average systematic surplus Π over time that will also influence their decisions today. To estimate this model, data on subsequent marriage markets at $t + k$ are necessary to estimate the Πs in the marriage market at t, which requires us to make assumptions about how marriage markets will continue to evolve in China. We will discuss these implications and data requirements in more detail in Section 4.2.

3 Data

To analyze marriage market trends, we employ four nationally-representative datasets: two NBS National Population Censuses {1990, 2000} (1% samples), the 2005 NBS Population Survey (0.2% sample), and the combined 2008 and 2009 waves of the annual NBS Urban Household Surveys (UHS), the most recent dataset available with sufficient size to construct measures of the gains to marriage along the lines laid out in the previous section.[7] The NBS UHS samples individuals residing in urban areas and focuses almost exclusively on individuals with urban hukou.[8] This focus on urban hukou holders should not detract from the analysis of "leftover women" in any meaningful way. In fact, You et al. (2016) find in their 2008-2011 sample of the Chinese General Social Survey (CGSS) that college-educated women with urban hukou are *more* likely to be never-married after age 27 compared to their rural hukou peers while the difference is insignificantly different using the 2010-2012 China Family Panel Studies (CFPS). Furthermore, within urban areas, the marriage markets for (local) urban hukou holders and (rural-urban migrant) rural hukou holders are largely segregated, especially for individuals with higher educational attainment.[9] For comparability between all years of data, all census and population survey samples are made consistent with the 2008/2009 UHS in that only urban areas of the same set of provinces (16 in total) for which we have UHS data are retained, and we consider only singles with urban hukou and couples in which *both* spouses have urban hukou.

[7]Because the 2010 NBS Population Census is only slowly being made available to researchers, popular (and accessible) alternatives include the China Family Panel Studies (CFPS) and Chinese General Social Survey (CGSS) household surveys. Unfortunately, the 2012 CFPS dataset is less than a third the size of the combined 2008 and 2009 UHS in total observation count, and less than one sixth if we consider only urban coverage. The CGSS is even smaller at about a third the size of the CFPS.

[8]94.7% of the 2009 UHS respondents have urban hukou registration.

[9]While Han et al. (2015) finds rural-urban marriages to be slowly increasing following a 1998 change in hukou law which allows children to adopt either parent's hukou status, the increase in rural-urban marriages is almost entirely restricted to lower educational types.

3.1 Methodology

The methodology employed in this paper to calculate systematic gains to marriage is as follows. Each dataset {1990, 2000, 2005, 2008/9} represents an observational marriage market year. In each of these years, we obtain a snapshot of the currently-single individuals in the marriage market. In an ideal world, we would collect newlywed data for the few years immediately following each marriage market snapshot.[10] In lieu of this, we exploit the fact that these surveys contain historical data on year of marriage. In order to obtain four corresponding sets of couples data, we therefore identify newlywed couples who married in the three years leading up to and including each snapshot of the singles market (see Table 1).

Table 1: Setup: marriage market construction

Singles	Newlyweds
1990	1988-1990
2000	1998-2000
2005	2003-2005
2008/9	2006/7-2008/9

We are primarily interested in looking at marital payoffs by spouse education levels and age at marriage so as to explore whether there is a marriage penalty associated with delaying marriage or with attending university, particularly for women. An obvious issue with our approach is that average educational attainment has increased very rapidly between 1990 and 2009 (see Table 3). These changes, which are plausibly exogenous to the marriage market, have implications for marriage expectations in a dynamic context; more generally, changing supplies imply that the average quality of spouse associated with each education level may also be changing over time. We therefore define our education categories "low", "medium", and "high" in two ways and conduct the analysis for both definitions of education.

First, our "fixed" education categories assign low education to those with less than high

[10] Indeed, Choo and Siow (2006) does exactly this; they use the US Censuses to quantify marriage market singles and then look at the Vital Statistics of the proceeding two years to quantify newlywed couples.

school, medium education to those who have completed high school or equivalent vocational / technical training, and high education to those with post-high school education, which can mean either junior college or university. These definitions are constant across our sample years. Second, our "moving" education categories reassign education levels so that the shares of "high", "medium" and "low" remain roughly constant over the 20 years of data with the "fixed" 2000 shares as the benchmark. In 2008/9 this means that only university-educated individuals are classified as "high educated", and in all years "high type" individuals correspond approximately to the top quintile of the education distribution. In order to have large enough cells in all four samples, we employ three-year age categories and focus mainly on ages 18 through 38 (that is, age categories 18-20 up to 36-38), with 20 being the earliest age at which it is legal for men to marry in China and 38 being the approximate age of women's completed fertility (after which most marriages are likely to be second marriages). For newlyweds, the age (grouping) of interest is age at time of marriage; for currently-single individuals, it is age (grouping) at time of survey.

Combining the four datasets to create samples that are comparable across time presents several challenges. The main challenges are (1) selecting comparable (urban) geographical areas from which to draw our sample population; (2) matching couples within households that contain more than one married pair; and (3) identifying newlywed couples from among the married population. The latter challenge arises only with regard to our 1990 and 2008/9 samples, since marriage tenure is not provided in the 1990 census or in the UHS. An in-depth discussion of all these issues and how we resolve them is provided in Appendix B.

3.2 Preliminary analysis

We now turn to a first-pass exploration of our main question: do highly educated women face a marriage market penalty in urban China? This penalty could take the form either of systematically less favorable marriages or a greater likelihood or not marrying at all.

Moreover, we are interested in whether this penalty is increasing or decreasing over time.

Figure 1 plots the percentage share of currently-single women over the age range 20-40 by educational attainment for each sample year. The figures show results using our fixed education categories: "low type" individuals are defined as those with educational attainment ranging from illiterate (no schooling) to middle school (the blue lines) while medium type individuals include those with high school or technical / vocational schooling (the red dashed lines). High type individuals (the green dash-dotted lines) include all those with college, undergraduate university, or higher degrees. There are two main takeaways from these graphs. First, the horizontal distance between the blue and red, and the red and green lines represents the tendency for individuals of higher educational attainment to delay marriage.[11] The difference across education categories has been increasing over time, consistent with the findings of the literature on Chinese marriage markets. Second, highly educated women aged 35-40 experience noticeably higher (near-completed) unmarried rates (and, thereby, lower marriage rates) than those of less educated women in 1990 but appear to "catch up" over the subsequent three samples.

We examine these near-completed unmarried rates more formally in Table 2, which compares mean unmarried rates across education categories and over time, focusing on women aged 35 to 40. The first four columns report the (weighted) means and Adjusted Wald test results for differences in means between women of high education and (pooled) low and medium education for each observational year. In the earlier years of 1990 and 2000, we observe that high educated women have significantly higher unmarried rates at ages 35-40 than their less-educated peers, which is in line with the idea of a "success penalty" in the marriage market for highly educated women. A comparison across observational years, however, shows that high educated women not only close this gap, but reverse it. Even in 2000, though highly educated women still experience a sizable 12% greater likelihood of being unmarried than

[11] We include as high types those individuals who have completed high school but also report their educational status (available all four years) as "student", which avoids a compositional effect at younger ages.

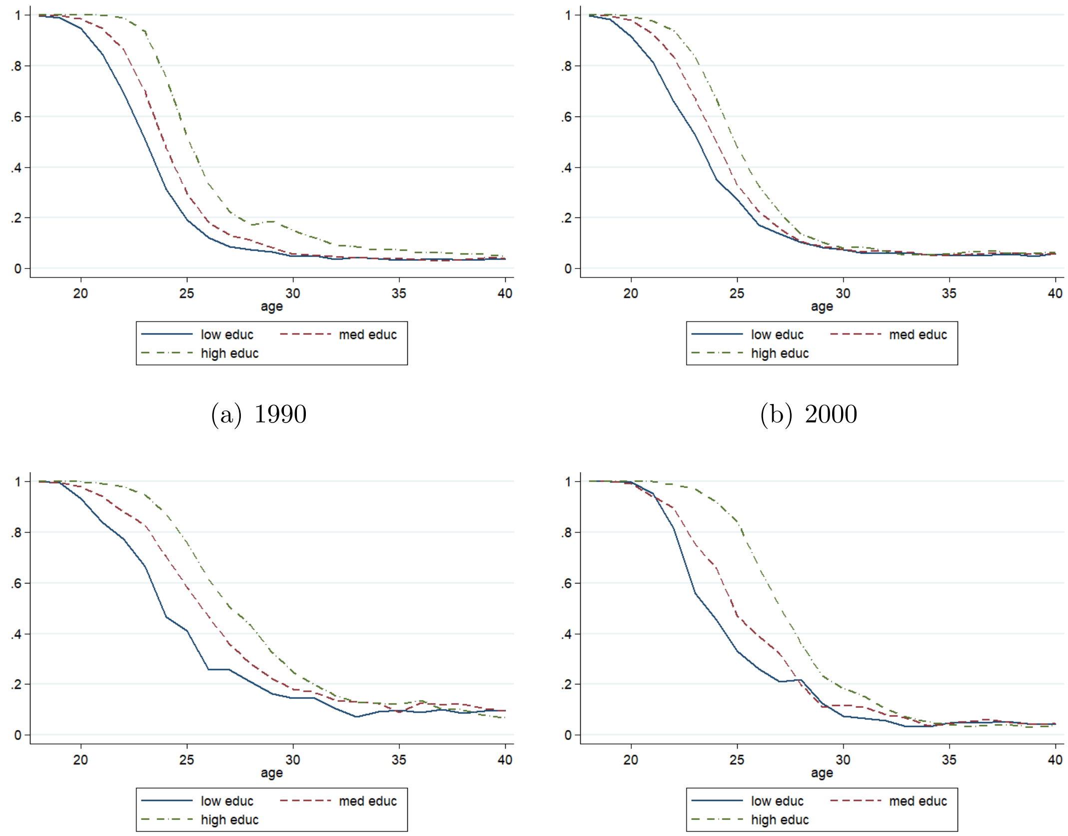
their less-educated peers (5.5% versus 4.9%), the difference in unmarried rates itself becomes fairly small economically, with only 0.6% more highly educated women remaining single, which is less than a third of the 1.9% gap in 1990. The difference across groups becomes insignificant in 2005 (column 3) and by 2008/9 the high educated sample is significantly *more* likely to be married between ages 35 and 40 than the low and medium educated.

An obvious possibility is that the disappearing gaps are a mechanical product of the global increase in education among urban Chinese women over the period (see Table 3; Table 12 in Appendix C shows similar results for men), combined with the lower statistical power available in the 2005 and 2008/9 samples. To check this possibility, column 5 (labeled 2009*) reports the results using the "moving" education category for 2008/9, in which only those women with undergraduate or graduate university degrees (or currently studying for one of these degrees) are categorized as high educated while college degree holders are re-labeled as medium type. Making this change narrows the gap in unmarried rates between high- and less-educated women in their late 30s, but it remains positive, though no longer statistically significant. In the last two columns of the table we report results from a test of equivalence of the unmarried rate for both (fixed) education categories between 1990 and 2009. Adjusted Wald F-tests reveal that the change is due both to falling high-educated unmarried rates for 35-40 year old women, and increasing unmarried rates among low and medium educated women. Unconditional (on education) completed marriage rates, however, have remained very high over the 20 year period with no significant overall change between 1990 and 2008/9, though with an apparent slight dip in 2000 and 2005.

Table 2: Near-completed unmarried rates for women (age 35-40)

education type	1990	2000	2005	2009	2009*	High type 90 vs 09	Low type 90 vs 09
high educ	0.050	0.055	0.058	0.035	0.037		
low/med educ	0.031	0.049	0.054	0.047	0.044		
F-stat	24.795	8.072	1.062	8.342	1.425	9.897	31.404
Adj Wald (Prob > F)	0.000	0.004	0.303	0.004	0.233	0.002	0.000

Figure 1: Share of currently-single women by age



(a) 1990

(b) 2000

(c) 2005

(d) 2008/9

Table 3: Shares of women with educ {low,medium,high} by year

educ	1990	2000	2005	2009	2009*
Low	0.497	0.412	0.312	0.202	0.373
Medium	0.389	0.393	0.306	0.317	0.416
High	0.114	0.195	0.382	0.481	0.211

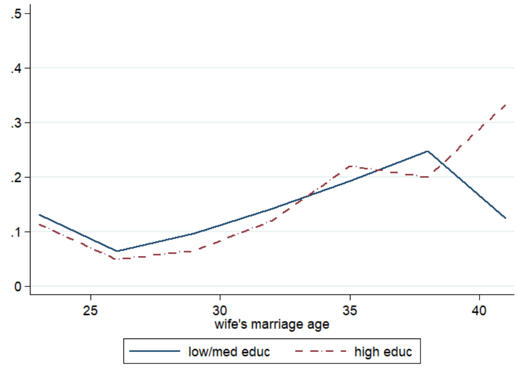
If we do not see a marriage penalty in terms of completed marriage rates, do we see evidence that women with more education, or who marry later, marry less well? Figure 2 provides some very cursory evidence against this idea. The top panel shows the percentage of newlywed ($\leq$ 3 years) women in 2000 (left) and 2008/9 (right) who are married to men six or more years older than themselves, disaggregated by whether they are "high" educated (the red dashed line) or less (the blue solid line) by age of marriage.[12] The bottom panel shows the same analysis using the percentage of women by education type and marriage age who marry low or medium (as opposed to high) educated men. We use the moving education categories for this analysis to control for changes in population supplies. In both 2000 and 2009, the likelihood of marrying a significantly older man increases with the bride's marriage age, and the effect is larger in 2008/9, though only for lower-educated women. As well, the highest-educated quintile of women in 2008/9 is less likely than lower quintiles to marry a man six or more years older than themselves at nearly all marriage ages. From the bottom two panels, we see no evidence that high educated women are more likely to "marry down" to lower educated men, or that lower-educated women are more likely to "marry up" to higher educated men either over time or by marriage age. Overall, we see little evidence to suggest that women are worse off in terms of their partner's observable characteristics when they marry late, and no evidence that high-educated women are doing systematically worse in the marriage market over time.

4 Returns to marriage 1990-2009

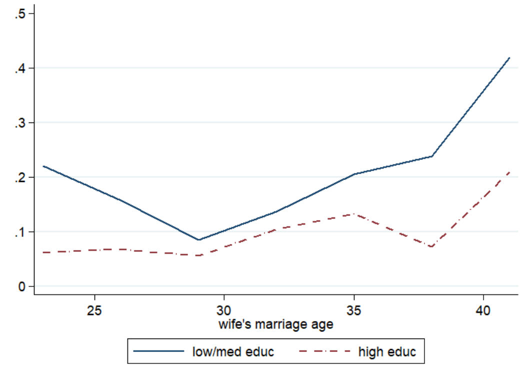
In this section we examine more formally the gains to marriage for newlywed men and women between 1990 and 2008/9. Again, we are mainly interested in whether the data provide evidence of a "success penalty" for women who delay marriage, attend university, or both. In Section 4.1, we study the average payoffs from different marriages using the classic Choo-Siow (2006) framework. Under the assumptions of this framework, the distribution of newly formed marriages and the share of singles across individuals of different age-education types maps into a relative discounted systematic gain to each potential marriage of a type i man with a type j woman, which we can compare over time as well as across individual types.

[12] We choose a six-year difference because it is approximately twice the average age gap between husbands and wives in China, which is approximately three years.

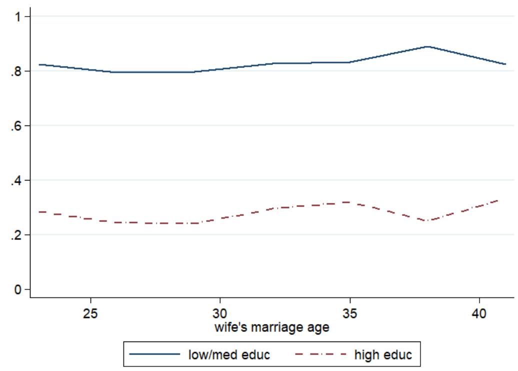
Figure 2: Preliminary evidence: do high educated or late marrying women “marry down”?



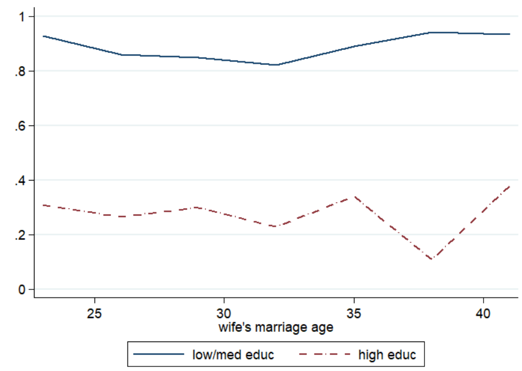
(a) 2000: older husband



(b) 2009: older husband



(c) 2000: low/med educated husband



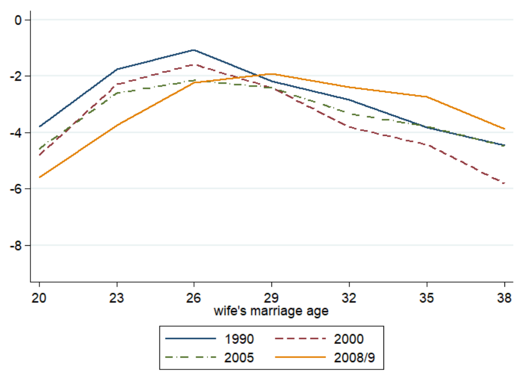
(d) 2009: low/med educated husband

In section 4.2, we explore these returns in a dynamic context using the extension recently developed by Choo (2015) and use this estimator to project marriage patterns among our population of interest into the years beyond our sample (up to 2015). In section 4.3 we relate our findings to changes in assortative mating on education over the period of interest. We conclude in section 4.4 by examining changes in fertility over the period and speculating on how changing fertility patterns may help explain the returns to marriage and the public concerns about “leftover women”.

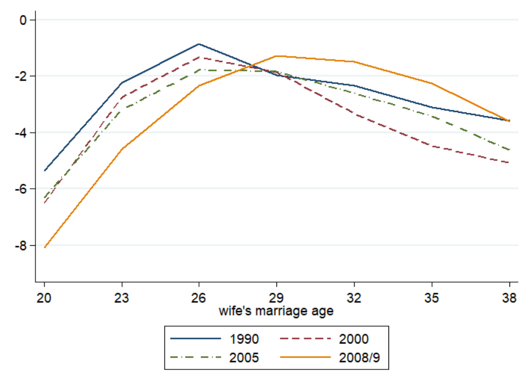
4.1 Gains to marriage in the Choo-Siow [2006] framework

Figures 3 and 4 show the calculated values of π and π^f (the total deterministic and female-specific deterministic gains) respectively for women between the (wife's marriage) age categories of 18-20 and 36-38 for all four years for which we have data. The upper panels show the deterministic gains using our fixed education categories and the lower panels show the gains when using our moving (constant-shares) education categories. In Appendix C we show corresponding figures for medium- and high-educated men between the age groupings 21-23 and 39-41, in terms of π and π^m, and also by (husband's) age of first marriage.

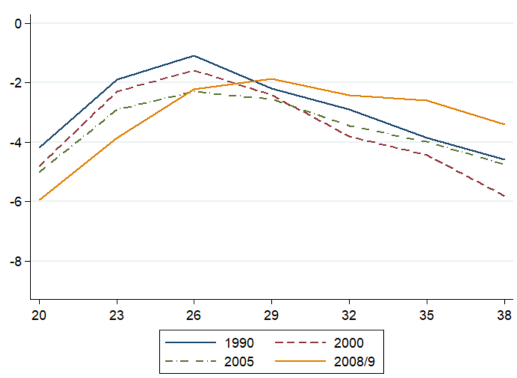
Figure 3: π by age for medium and high-educated women



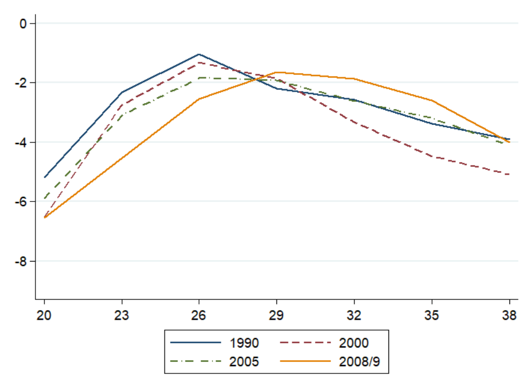
(a) Medium-educated women: fixed



(b) High-educated women: fixed



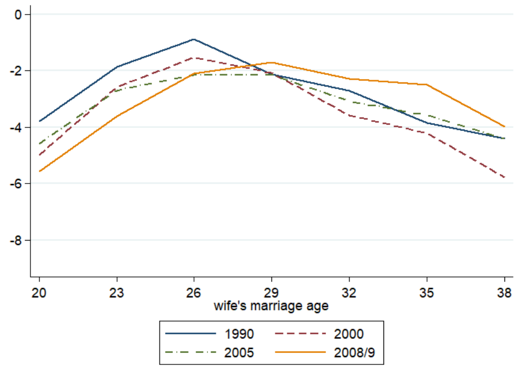
(c) Medium-educated women: moving



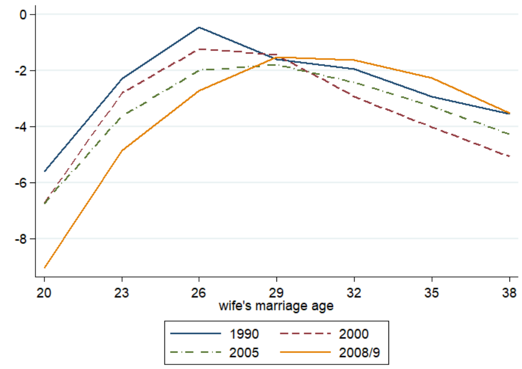
(d) High-educated women: moving

We begin by noting that the estimated πs are everywhere negative, that is for every age

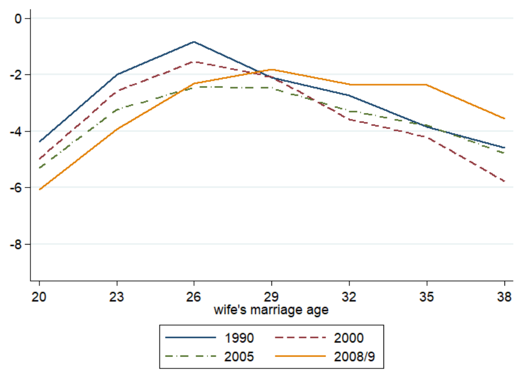
Figure 4: π^f by age for medium and high-educated women



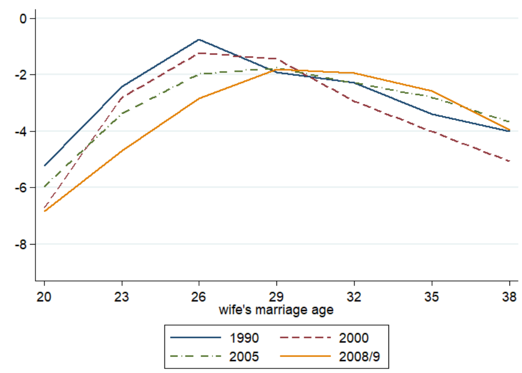
(a) Medium-educated women: fixed



(b) High-educated women: fixed



(c) Medium-educated women: moving



(d) High-educated women: moving

and education level and in every year, which is a common feature of Choo-Siow models. In any marriage market, the number of single individuals generally outnumber the number of newlyweds in any age group (even after aggregating newlyweds over three-year intervals and despite China's very high completed marriage rates), so the systematic or deterministic gains are likely to be low, and only those individuals who draw very high values of the idiosyncratic utility of marrying their preferred spouse type actually opt to pair off and exit the marriage market. We also note that the gains to marrying first rise and then fall in the bride's age. (In Appendix C we show that the same holds for men with respect to groom's age.) This pattern holds in every year. Third, the highest systematic marriage surpluses accrue to the men and women with the highest education, although these surpluses are concentrated at later marriage ages in recent years. The difference in the peak gains across education categories is also slightly larger when we use the fixed rather than the moving education categories which suggests that marriage gains to education are not concentrated at the very top of the education distribution.

Comparing across the years, we see that on average marriage gains at younger ages have been decreasing: for brides 24-26 and younger, π and π^f are highest in 1990 and fall more or less monotonically across time for both medium and high educated women. At later ages, however, this monotonicity breaks down: for women who marry at age 30 or older, gains first fall (to 2000) and then rise over time. They are largest in the 2008/9 sample. That is, total and female-specific gains to marriage are shifting toward later ages for all education groups, though especially among higher educated women. Note that, though we omit the low-type graphs for space, the same pattern of shifting gains toward later ages holds for low as well as for medium and high educated women.[13] Overall, we see no evidence of a specific marriage market penalty to high educated women. There is a penalty to delayed marriage (which is linked to more education) but it appears to be decreasing rather than increasing with time.

To study the question of penalties for delaying marriage more directly, Table 4 displays the results of four regressions. The dependent variables are normalized[14] average per-capita gains π (columns 1 and 3) and wife-specific gains π^f (columns 2 and 4), respectively for our fixed and moving education categories. These are regressed against our main variables of interest: husband and wife indicators for high-type education and their interactions with year dummies for 2000, 2005, and 2008/9 (1990 is the omitted category). The sample of

[13]Average πs for the low type women are higher than for medium-type women in 1990, then fall relative to medium-type women over the remaining years, being substantially lower in 2008/9. Average π^f are somewhat higher for low than for medium type women in all years but the difference is very small in the 2008/9 sample.

[14]While π has an intuitive interpretation, employing it directly as the dependent variable in the regression would lead to less directly comparable coefficients in terms of units for changes in π across types and over time. We therefore normalize the π so that the coefficients represent standard deviations from the sample mean π taken across all the years.

couples is the same used to make the graphs. Year dummies (again with 1990 as the reference group) control for any secular trends that affect everybody in the urban Chinese marriage market. Finally, both marriage age and its square for both spouses are added as controls to extract any age composition effects from the education effects we are trying to capture.

Table 4: Marriage gains and education

VARIABLES	(1) π: fixed	(2) π^f: fixed	(3) π: moving	(4) π^f: moving
high ed husband	0.0818***	-0.253***	0.165***	-0.0620***
	(0.0211)	(0.0249)	(0.0133)	(0.0157)
high ed husband x 2000	0.0728**	0.285***	0.0214	0.122***
	(0.0305)	(0.0361)	(0.0191)	(0.0226)
high ed husband x 2005	0.139***	0.777***	0.0990***	0.146***
	(0.0342)	(0.0405)	(0.0198)	(0.0234)
high ed husband x 2009	0.302***	0.933***	-0.0490**	-0.0504**
	(0.0232)	(0.0275)	(0.0203)	(0.0239)
high ed wife	-0.0284	0.304***	-0.160***	-0.0206
	(0.0237)	(0.0280)	(0.0141)	(0.0166)
high ed wife x 2000	-0.0732**	-0.245***	0.0872***	0.101***
	(0.0326)	(0.0385)	(0.0199)	(0.0234)
high ed wife x 2005	-0.0509	-0.804***	0.371***	0.493***
	(0.0352)	(0.0416)	(0.0204)	(0.0240)
high ed wife x 2009	0.0987***	-0.784***	0.0949***	0.0684***
	(0.0255)	(0.0302)	(0.0210)	(0.0248)
Constant	-28.51***	-34.99***	-28.44***	-36.94***
	(0.175)	(0.207)	(0.163)	(0.192)
Observations	59,882	59,882	60,585	60,585
R-squared	0.370	0.450	0.411	0.533
Year FE	YES	YES	YES	YES
FMA Quad Effects	YES	YES	YES	YES

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Compared to the graphs, we learn from Table 4 that, once we control for husband's education and marriage ages of both partners, the wife's education has only a small effect on total marriage gains in most of our sample years. Using the moving education categories, the direct effect of the wife's education on marriage gains is actually slightly negative in most years, reducing gains by about 6% of a standard deviation in 2008/9, though there is a modest sustained increase in returns to the wife's education after 1990 (i.e. they become less negative and even appear to be positive in 2005). The greater average gains to high-educated relative to medium-educated women seen in the graphs (and confirmed in columns 5 and 6 of tables 5 and 6 below) are therefore driven not by the direct returns to education but indirectly through more beneficial matches and timing of marriages among this group. There are slightly larger and positive returns to husband's education, which show a modest, monotonic increase over time using the fixed education categories; however, there is no obvious time trend using the moving categories, which gives the change in returns for the top quintile relative to the second and third quintiles of the education distribution.

The second column confirms this sorting story. The direct effect of *husband's* education on π^f is strongly increasing over time but the direct effect of *own* education is decreasing over time, using the fixed categories. The opposite is true for π^m which is simply the difference between 2π and π^f. With reference to the fixed education categories, this result should not be too surprising. The secular increase in education for both genders means that high educated mates are becoming less scarce while the average quality within an education category (in terms, say, of earning potential) is likely to be falling. Higher educated men and women are thus less valuable per se but benefit from their ability to marry good quality mates. This finding is a bit different for the moving education categories since, in this case, we are controlling at least in part for changes in supply, of both own and partner types. The direct effect on π^f of being married to a top-quintile husbands rises and then falls. The direct effect on π^f of *being* in the top education quintile rises modestly to 2000 and sharply to 2005 and then falls again to 2008/2009, conditional on spouse marriage age and year effects. The relatively large coefficient on the education-2005 year dummy interaction is likely due in part to noise.

To summarize our findings, Tables 5 (for the fixed education categories) and 6 (for the moving education categories) report the systematic gains to marriage in each of the four years, after year fixed effects are removed, for wife-husband couples of medium-medium, medium-high, high-medium, and high-high education type. The final two columns of the tables report the systematic gains for medium and high educated wives averaged across husband type. Again, the numbers give standard deviations, but this time relative to the *year-specific means* of π and π^f. Gains are highest under positive sorting, and highest for the most educated couples in all years, though the difference between high-high and medium-medium couples in terms of π^f is decreasing over time when using the fixed education categories.[15] Generally, couples are worse off if the wife rather than the husband "marries down", but the relative returns to couples in which the husband marries down decrease monotonically over the sample period using both fixed and moving definitions of education. The final two columns confirm the visual evidence from the graphs, that high type women are in more productive marriages overall than medium type women, by about 40% of a standard deviation in 2008/9 using the fixed education categories and 11% of a standard deviation in 2008/9 using the moving education categories. Women's private return from marriage π^f, however, is larger for high relative to medium educated women (with medium or higher type husbands) when using the moving education categories. From Table 6, we also see some evidence that overall and relative private gains shifted from middle education quintiles toward the highest educated quintile of women, but this movement occurred between 1990 and 2000 and has been constant or has slightly reversed itself since, depending on how much of the 2005 numbers, which are slight outliers, we attribute to noise.

4.1.1 Is there a cost to delaying marriage?

We now address our second question: Do women pay a penalty for delaying marriage conditional on education? Table 7 shows results from regressing the same dependent variables

[15]This net decrease over time suggests that the decrease in π^f for the high-educated due to the increase in own supply slightly outweighs the increase in π^f due to a higher supply of high-educated mates.

Table 5: Average systematic gains by year: fixed education categories

Year	$\pi_{avg}\{med, med\}$	$\pi_{avg}\{high, med\}$	$\pi_{avg}\{med, high\}$	$\pi_{avg}\{high, high\}$	$\pi_{avg} : med\ f$	$\pi_{avg} : high\ f$
1990	0.039	-0.983	-0.223	0.388	-0.027	0.082
2000	0.031	-0.990	-0.293	0.431	-0.081	0.118
2005	0.039	-1.111	-0.503	0.351	-0.173	0.122
2009	0.004	-1.125	-0.719	0.354	-0.262	0.137
Year	$\pi^f_{avg}\{med, med\}$	$\pi^f_{avg}\{high, med\}$	$\pi^f_{avg}\{med, high\}$	$\pi^f_{avg}\{high, high\}$	$\pi^f_{avg} : med\ f$	$\pi^f_{avg} : high\ f$
1990	0.068	-0.591	-0.416	0.380	-0.054	0.163
2000	0.031	-0.713	-0.421	0.436	-0.125	0.183
2005	0.089	-1.274	-0.238	0.269	-0.039	0.027
2009	0.183	-1.357	-0.380	0.248	-0.024	0.012

Table 6: Average systematic gains by year: moving education categories

Year	$\pi_{avg}\{med, med\}$	$\pi_{avg}\{high, med\}$	$\pi_{avg}\{med, high\}$	$\pi_{avg}\{high, high\}$	$\pi_{avg} : med\ f$	$\pi_{avg} : high\ f$
1990	0.105	-1.004	-0.228	0.241	0.011	-0.022
2000	0.031	-0.990	-0.293	0.431	-0.081	0.118
2005	-0.111	-0.555	-0.591	0.597	-0.255	0.256
2009	0.108	-0.876	-0.509	0.393	-0.039	0.064
Year	$\pi^f_{avg}\{med, med\}$	$\pi^f_{avg}\{high, med\}$	$\pi^f_{avg}\{med, high\}$	$\pi^f_{avg}\{high, high\}$	$\pi^f_{avg} : med\ f$	$\pi^f_{avg} : high\ f$
1990	0.125	-0.733	-0.346	0.219	-0.009	0.018
2000	0.031	-0.713	-0.421	0.436	-0.125	0.183
2005	-0.109	-0.295	-0.787	0.570	-0.313	0.314
2009	0.160	-0.681	-0.718	0.347	-0.049	0.081

π and π^f on indicators for husband's and wife's marriage age categories interacted with year dummies, while controlling for year fixed effects and educational attainment of both spouses (using the fixed categories in columns 1 and 2, and the moving education categories in columns 3 and 4), for the same samples of medium and high-type married individuals. We consider newlyweds as "young" if they marry before 24 (women) or 27 (men), and "old" if they marry after 30 (women) and 33 (men). The omitted category are those who marry in their mid to late 20s (24-29 for women, 27-32 for men).

Focusing on π, in 1990, there is a significant across-the-board direct cost to delaying marriage for both men and women. The coefficients on marriage age interacted with later year dummies represent the change in this direct cost with time after 1990. The penalty worsens in 2000 and then begins to attenuate with respect to both spouses. It is easy to see that by 2008/9, the penalty to newlyweds with a mature husband has disappeared, and the penalty for newlyweds with an older wife has similarly decreased by 49% to 69%, controlling for fixed and moving education categories, respectively. According to the estimates, delaying marriage until after 30 actually *increases* wife-specific gains π^f in the 2008/9 sample, especially if we condition on whether or not the bride is in the top quintile of the education distribution (moving education categories). Since men also increasingly delay marriage, our results suggest that older brides actually become relatively scarce relative to older grooms, driving up their personal returns from marriage. It also suggests that the overall higher gains to marriages involving high-educated women are driven mainly by the fact that these women marry at more favorable ages – an indirect effect of education on marital payoffs.

4.2 Dynamic returns: the Choo (2015) model

How, if at all, do our estimated returns to marriage change in the explicitly dynamic context of Choo (2015) in which individuals make marriage decisions weighing the opportunity costs of participating in future marriage markets? Implementing this estimator requires slightly

Table 7: Gains to marriage by spouses' age of marriage

VARIABLES	(1) π: fixed	(2) π^f: fixed	(3) π: moving	(4) π^f: moving
young husband	0.646***	0.932***	0.548***	0.711***
	(0.0290)	(0.0311)	(0.0253)	(0.0241)
young husband x 2000	-0.681***	-0.661***	-0.600***	-0.543***
	(0.0392)	(0.0421)	(0.0337)	(0.0320)
young husband x 2005	-0.948***	-0.981***	-0.844***	-0.779***
	(0.0428)	(0.0460)	(0.0357)	(0.0339)
young husband x 2009	-1.556***	-1.735***	-1.312***	-1.291***
	(0.0320)	(0.0344)	(0.0276)	(0.0263)
young wife	-1.233***	-1.793***	-1.207***	-1.495***
	(0.0250)	(0.0269)	(0.0215)	(0.0205)
young wife x 2000	0.217***	0.271***	0.295***	0.355***
	(0.0356)	(0.0383)	(0.0303)	(0.0288)
young wife x 2005	0.162***	0.376***	0.114***	0.235***
	(0.0399)	(0.0429)	(0.0332)	(0.0316)
young wife x 2009	-0.590***	-0.188***	-0.469***	-0.160***
	(0.0319)	(0.0343)	(0.0276)	(0.0263)
mature husband	-0.976***	-1.713***	-0.893***	-1.311***
	(0.0388)	(0.0418)	(0.0338)	(0.0322)
mature husband x 2000	-0.221***	0.0384	-0.142***	0.0362
	(0.0579)	(0.0622)	(0.0494)	(0.0470)
mature husband x 2005	0.356***	0.699***	0.346***	0.510***
	(0.0539)	(0.0579)	(0.0450)	(0.0428)
mature husband x 2009	0.994***	1.126***	0.869***	0.806***
	(0.0404)	(0.0434)	(0.0349)	(0.0332)
mature wife	-0.829***	-0.369***	-0.766***	-0.337***
	(0.0421)	(0.0453)	(0.0361)	(0.0343)
mature wife x 2000	-0.679***	-0.580***	-0.545***	-0.403***
	(0.0835)	(0.0897)	(0.0704)	(0.0670)
mature wife x 2005	-0.0607	0.0154	0.0876	0.212***
	(0.0677)	(0.0727)	(0.0557)	(0.0530)
mature wife x 2009	0.407***	0.394***	0.529***	0.506***
	(0.0439)	(0.0472)	(0.0374)	(0.0356)
Constant	-1.369***	-1.100***	0.507***	0.676***
	(0.0244)	(0.0262)	(0.0214)	(0.0204)
Observations	59,882	59,882	60,585	60,585
R-squared	0.368	0.379	0.358	0.395
Year FE	YES	YES	YES	YES
Education dummies	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

more formalization than implementing the Choo-Siow estimator. We assume that a new marriage market is formed every three years (that is, the old marriage market clears and all individuals remaining in the market enter the next age category) and that the tri-annual discount rate is $\beta = .94$. In the benchmark analysis, we assume there is no divorce or mortality before the terminal age of 44 and that individuals, both men and women, cease to receive utility from marriage after that age (specifically after age category 42-44).

The potential "dynamic" aspect of the Choo (2015) estimator is twofold. First, individuals make decisions in the marriage market taking explicit account of the fact that marrying today includes the opportunity cost of forfeiting participation in future marriage markets in a different (older) state. Second, the marriage market *itself* evolves over time. Taking advantage of the second aspect of marriage market dynamics, the fact that the marriage market is not stationary either in terms of population vectors or in terms of payoffs, means that we potentially require more than a single cross-section to estimate the gains for any marriage market since these gains depend on expectations about future marriage markets. As well, we need to take a stand on the nature of individuals' expectations. Our main estimates are based on the assumption that agents are perfectly forward-looking and foresee changes in subsequent marriage markets. In Appendix D, we contrast these results with results from a model in which agents are myopic and assume that the marriage market in the current year is a stationary equilibrium. The implications are broadly similar between the two versions of the model and we relegate discussion of the small differences to the appendix.

For the fully dynamic results reported in this section, we assume that agents in every cohort are forward looking with rational expectations: they are informed about the marriage markets they will encounter in the future at older ages, which depend on the parameters Π and on the population vectors $\mathbf{m}$ and $\mathbf{f}$, all of which evolve over time. While this assumption of forward-looking agents is a more traditional approach in economic modeling, in our case it introduces some complications. The 1990 marriage market is complete in the data since

17 (20) year old women (men) in 1990 are 36 (39) in 2009, and therefore have completed their marital history under our assumptions. The remaining three marriage markets are not completely represented in the data, however, since the choices that 20 year olds make in 2000 (and hence the estimated payoffs they receive from marrying in the current marriage market) depend on their expected payoffs they would receive in subsequent marriage markets up to 2024. Estimating these payoffs under rational expectations requires a simulation approach. Up to 2008/9, the time-varying, exogenous (to the marriage market) population vectors and the μs can be taken straight from our data sources, the 1990, 2000, and 2005 census files and the 2008/9 UHS. For the intermediate marriage markets, we can simply interpolate the population shares agents expect to face. These serve as simulation targets. For future marriage markets, we make use of the fact that the Choo-Siow (and by extension the Choo) estimators allow us to construct the elements of μ that individuals expect to characterize future marriage markets. Specifically, we use the fact that (from Choo's equations 3.33 and 3.34 applied to our out-of-steady-state model):

$$
\begin{aligned}
m_{i,t} - \mu_{i,0,t} - \sum_{j=1}^{N} \widetilde{\Pi}_{i,j,t} \sqrt{m_{i,t} f_{j,t}} \prod_{k=0}^{T_i - 1} \left(\frac{\mu_{i'(i,k),0,t+k}}{m_{i'(i,k),t+k}} \right)^{.5\beta^k} \prod_{k=0}^{T_j - 1} \left(\frac{\mu_{0,j'(j,k),t+k}}{f_{j'(j,k),t+k}} \right)^{.5\beta^k} &= 0 \\
f_{j,t} - \mu_{0,j,t} - \sum_{i=1}^{N} \widetilde{\Pi}_{i,j,t} \sqrt{m_{i,t} f_{j,t}} \prod_{k=0}^{T_i - 1} \left(\frac{\mu_{i'(i,k),0,t+k}}{m_{i'(i,k),t+k}} \right)^{.5\beta^k} \prod_{k=0}^{T_j - 1} \left(\frac{\mu_{0,j'(j,k),t+k}}{f_{j'(j,k),t+k}} \right)^{.5\beta^k} &= 0 \qquad (10)
\end{aligned}
$$

where t indexes the marriage market in question, T_i and T_j give the amount of time a man in state i and a woman in state j have left in the marriage market (see Section 2), and, as before, N is the number of types, which is symmetric across men and women. The only new parameter is $\widetilde{\Pi} = \exp(\Pi)$. If we take the vector Π as given this system generates a system of $2 \times 9 \times 3$ (gender $\times$ age categories $\times$ education levels) equations and unknowns for each marriage market.[16] It is then easy to calculate the $\Pi_{i,j,t}$ using equation (21) from Appendix

[16]The age groups are 18/20 - 42/44 for both genders. We assume nobody can marry after these ages so that $\mu_{i,0,t} = m_{i,t}$ and/or $\mu_{0,j,t} = f_{j,t} \forall t$ at these ages. Individuals receive utility α and γ from their marriage or from singlehood until the terminal age category 42/44.

A. To identify the system, we make the following two assumptions: (1) the education shares for "new" adults (18-20 years olds) within each gender remain constant at their 2009 levels (which are reasonably close to U.S. education shares in urban areas); and (2) the fundamental payoffs to each type of marriage Π also remain constant after 2009. This latter assumption is questionable given the trajectory of Π shown in Figure 6, and it can be relaxed so long as we assume that Π evolves after 2009 in a deterministic way, for instance if Π continues to follow the linear trend it has followed since 2000 for every marriage type. By contrast, we assume that the gender ratio continues to evolve reaching an equilibrium in 2015 after which all population shares $\mathbf{m}$ and $\mathbf{f}$ are constant.

We use data on the distribution of children under 20 in the 2008/9 UHS to set $\mathbf{m}_{18-20,t}$ and $\mathbf{f}_{18-20,t}$ for $t > 2009$. Perhaps surprisingly, the population of new adult women, with urban hukou and living in urban areas, appears to be growing relative to the population of men. The population share of women 15-17 is 9.6% larger than the population share of women 18-20, though the population share of women 12-14 is 4.6% smaller than the population share of women 15-17, for an overall growth in the new adult female population growth of 4.6% between 2009 and 2015. For men, the corresponding numbers 2.1% and 1.4% for an overall growth in the newly adult population of 3.6% between 2009 and 2015. In other words, we do not see evidence of a worsening gender gap among urban hukou holders in the cities, although these numbers naturally omit the effects of migration.

There is clear evidence of inflow into the cities (or acquisition of urban hukou status) after ages 20-22, so individuals expect the size and composition of future marriage markets to change independently of the flow-output of singles into marriage. This is not a challenge for the model but needs to be accounted for. We therefore use the overall population growth rates by age-education-gender category between the 2005/6 and 2008/9 UHS samples to construct these growth rates and we assume these rates remain constant over the subsequent six years.[17]

For our simulation exercise we consider marriage markets between 2000 and 2015 (six different markets), leaving out the 1990 market for computational feasibility. We require a nested loop to generate internally consistent estimates of the Πs. The actual process of simulation is as follows:

1. We take a draw of $\{\Pi_{98-00}, \Pi_{04-06}, \Pi_{07-09}\}$
2. We interpolate $\{\Pi_{01-03}, \Pi_{10-12}, \Pi_{13-15}\}$
3. We choose an initial draw of $\mu_{i,0,t}$ and $\mu_{0,j,t}$ for every i, j, and t (in practice, 70% of each type for both genders.)
4. We solve the "inverse Choo" problem given by (10) to get new values of $\mu_{i,0,t}$ and $\mu_{0,j,t}$ for each type i and j and marriage market t. It is then straightforward to calculate the $\mu_{i,j,t}$ for all marriages in each of the six periods.
5. We replace the initial μs with a weighted average of the initial and updated μs and iterate until we reach a fixed point for μ.
6. Once we have reached a fixed point, we compare the resulting simulated $\mu_{i,j,t}$ for $t = 98/00, 04/06, 07/09$ to the corresponding values from the from data. We then update the Πs and repeat steps (2)-(5) until we have minimized the difference between the simulated and empirical moments.

Because the Choo model is perfectly identified, it is possible to drive the error from both the inner and outer loops to approximately zero, which we do (0.1% error tolerance).

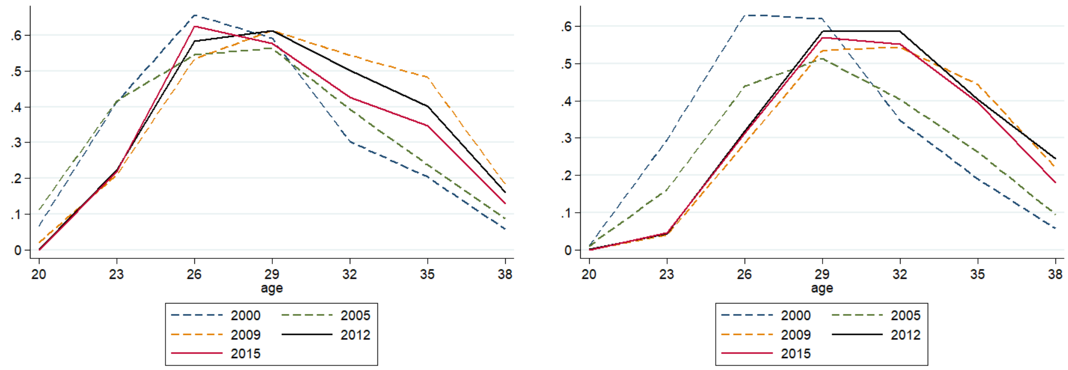
Figure 4.2 plots the predicted rates of exit from singlehood for medium and high educated

[17]Note that this is the same method required to assign newlywed status to couples from the stock of existing marriages in the 2008/9 UHS and relies on the same assumption that population growth of a given type in the cities (through in-migration or acquisition of hukou status) is independent of marital status. See Appendix B and Appendix E for details.

women from the simulation, under the assumption that Π is constant in 2012 and 2015 at its 2009 vector-value. The solid black and red lines show the projections for 2012 and 2015 respectively. The dashed lines show the exit rates from the 2000, 2005, and 2009 samples that are targeted (precisely) in the simulation. Although we calculate the model to age 44, we plot results only to age 38 for consistency with the previous graphs and because exit rates from singlehood at later ages are noisy due to very small sample sizes at these ages.

The graphs show the expected gradual increase in women's marriage age between 2000 and 2009. The pattern holds for both medium and high educated women (and also for low-educated women, not shown) but high-educated women marry slightly later on average in all years as expected and the trend away from early marriage (before ages 24-26) for medium-educated (high school and vocational school) women occurs later, between 2005 and 2008/9 while it begins between 2000 and 2005 for high-educated (college +) women. Interestingly, our projections suggest a slight reversion in average age of first marriage for medium-educated women in 2012 and 2015 while high-educated women continue to marry at almost identical rates but mostly at later ages. We do not project a decline in completed marriage rates: in 2012 and 2015 at ages 39-41 only .7% and 1.3% of high-educated women in the simulation remain in the marriage market, suggesting almost universal marriage among the high educated. By contrast, for medium educated women we project in 2012 and 2015 at ages 39-41 that 3.5% and 4.1% remain in the marriage market, dropping to 3.1% and 2.7% at ages 42-44. In comparison, the share of high and medium-educated women who are marriage market participants (either single or newlywed) at ages 39-41 in our 2008/9 UHS sample are 6.1% and 5.3% respectively. For medium educated women in the simulation, lower projected marriage rates in the early 30s, relative to 2009, mostly offset the increase in marriage rates at younger ages. The projected completed marriage rates of low-educated women fall in between those of high and medium educated women, although we put little weight on this finding given the small sample, and somewhat volatile population growth

Figure 5: Exit hazard from singlehood into marriage: medium and high educ women



(a) Med-educ women

(b) High-educ women

rates, of women with less than high school in the cities.

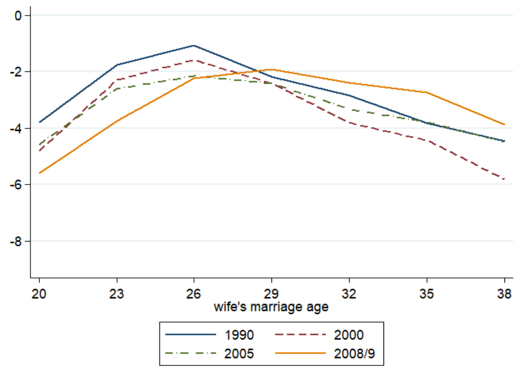
As previously discussed, these results are potentially sensitive to modeling assumptions, in particular to assumptions about the path of the Πs. In Appendix D, Figure 12 shows similar plots from a simulation exercise in which we assume that each element of Π in 2012 follows the linear projection from 2000 to 2008/9 and remains constant thereafter. As discussed above, the results are also likely to be sensitive to assumptions about agents' foresight. If individuals are "myopic" in the sense that they assume that future marriage markets will look like the current marriage market, this can also affect the results. Figure 13 shows the projected exit rates under this assumption (with future Π at 2008/9 levels). In both cases, the differences in projected completed marriage rates by age 40 are quite small compared to the benchmark forward-looking model.

Finally, we compare the Πs estimated from this exercise to the static πs. Figure 6 shows these results.

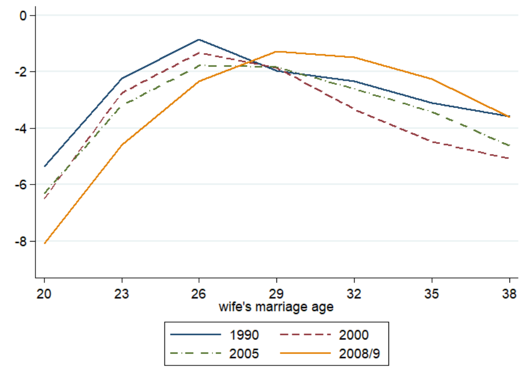
The first thing to note is that the Πs are larger than the πs, especially earlier in the life cycle. This is consistent with the results in Choo (2015) and to be expected from the formula for Π. Intuitively, the reason is that, in the dynamic model, an individual only marries if the gain from marrying (the sum of the systematic and his own idiosyncratic payoff from his best match) is larger than the immediate payoff from being single today *and* the opportunity cost of participating in future marriage markets, which is excluded from the static framework. Payoffs from marriage, among the young especially, must therefore be larger in order to induce empirically accurate numbers of marriages when individuals are forward looking. Formally, the reason that Π is larger than π at early ages is that the formula for Π is given by the formula for π plus the additional terms $-\sum_{k=0}^{T_i-1} \ln\left(\frac{\mu_{i'(i,k),0}}{m_{i'(i,k)}}\right)^{\beta^k}$ and $-\sum_{k=0}^{T_j-1} \ln\left(\frac{\mu_{0,j'(j,k)}}{f_{j'(j,k)}}\right)^{\beta^k}$, which are both positive but decreasing in t. Although Π is not very intuitive to interpret directly, the fact that it is positive in the "peak" marriage years and especially for high-educated women in 2009 implies that getting married provides positive value *in expectation* at these ages. That is, the ability to get married itself provides an expected increase in utility rather than providing utility only in the event of receiving a strong "love shock" specific to one partner type. The static and dynamic models therefore provide somewhat different social/institutional interpretations of marriage.

The second, related, thing to note when comparing Π to π is that the optimal (in expectation) marriage ages for women peak earlier in the dynamic model. For medium-educated women, π peaks at 29 (26) in 2008/9 (2000) and Π peaks at 26 (23). For other education categories and years, the estimated peak in systematic gains is the same, but the drop-off in these gains after the peak is much sharper for the Πs. Again, this is an intuitive result of the declining opportunity costs of participating in future marriage markets as women age and easy to see from the formula for Π. Otherwise, however, the static and dynamic models offer similar interpretations of how marriage gains have changed over time and how they vary across education groups. If anything, the dynamic model suggests slightly larger relatively gains for high-educated women compared to medium educated women in the most recent survey year, 2008/9.

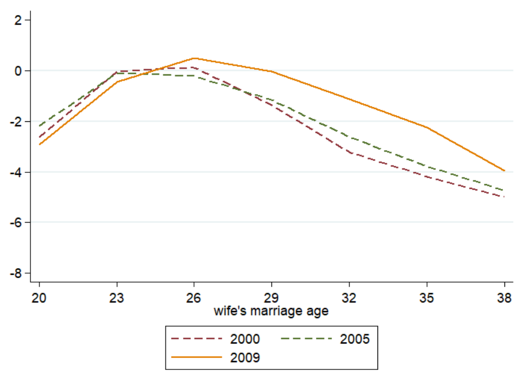
Figure 6: π and Π by age for medium and high-educated women (fixed education categories)



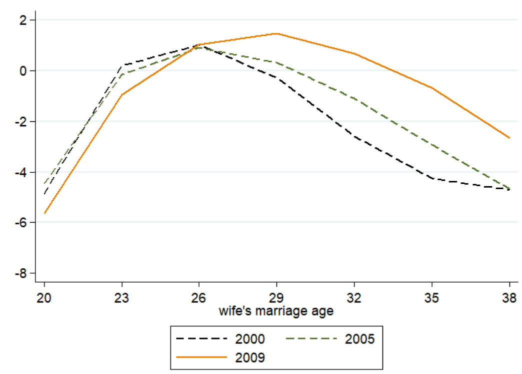
(a) Medium-educated women: π



(b) High-educated women: π



(c) Medium-educated women: Π



(d) High-educated women: Π

4.3 Assortative mating

The results from section 4.1 and 4.2 suggest that the overall high returns that high educated women reap in the marriage market come largely from their ability to make better matches. Education beyond high school is only valuable in the marriage market when it is paired with a husband's college or more education; the same is true to a lesser extent for men. It is therefore of interest to understand trends in assortative mating over time. Table 8 reports summary statistics using our fixed education categories: specifically, the shares of medium and high educated women married to low (column 1), medium (column 2), and high (column 3) educated men in each of our four sample periods. The trend toward higher education of both genders is clear in the tables, as is the prevalence of positive assortative mating on education. In all four years, high educated women are more likely than the medium educated to have a high-educated spouse and less likely than medium educated women to have a low or medium-educated spouse.

Table 8: Shares of medium and high type wives by husband's education

Med type women	husband's education:	*low*	*medium*	*high*
	1990	0.314	0.528	0.158
	2000	0.207	0.516	0.277
	2005	0.197	0.513	0.290
	2008/9	0.123	0.540	0.337
High type women	husband's education:	*low*	*medium*	*high*
	1990	0.094	0.215	0.691
	2000	0.042	0.200	0.758
	2005	0.040	0.151	0.808
	2008/9	0.019	0.159	0.822

Next, we use two techniques, borrowed from Greenwood et al. (2014), to look more formally at the extent of positive assortative mating after controlling for changes in supply. Table 9 shows how the wife's predicted education changes with husband's education over time.

Table 9: Assortative mating on education 1990-2009

	(1) wife's education level	(2) wife's education level
husband's educ level	0.490***	0.424***
	(0.002)	(0.003)
husband's educ level × 2000	0.049***	0.131***
	(0.001)	(0.003)
husband's educ level × 2005	0.101***	0.217***
	(0.002)	(0.005)
husband's educ level × 2008/9	0.157***	0.245***
	(0.001)	(0.003)
Year FE		YES
Prov FE	YES	YES
Observations	439914	439914

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Column 1 is a basic regression of wife's education level (1 for "low", 2 for "medium", 3 for "high") on husband's education interacted with year dummies and controlling for province fixed effects, but not controlling for year fixed effects. Since our regressors are indices, there is no intuitive interpretation in terms of units and we focus on signs and relative magnitudes. The interpretation of coefficients is similar to the regressions in Section 4.1 in that the coefficient on husband's education represents the relationship in 1990 and the coefficients on the subsequent terms represent the change between 1990 and the year indicated. The regression in column 1 suggests that positive assortative mating on education increased significantly over the course of the two decades and that husband's education is a better predictor of wife's education in 2009 than it was in 1990. Without controlling for year fixed effects, however, we will confound changes in assortativeness with the secular rise in education levels for the younger married population. Once we control for year fixed effects in column 2, we see that the time trend in positive assortative mating is actually steeper. High-educated men (who under standard theory of marriage markets have the best opportunity to marry whomever they like) do not appear to be opting to "marry down" at higher rates, leaving a pool of high-educated women without high-educated partners, as suggested in the context of the "Asian Tiger" economies by, for example, Kawaguchi and Lee (2017).

The second method we consider compares the pattern of actual matches to what would occur under random matching. Table 10 shows the actual couple shares in 1990, 2000, and 2008/9 by education types (the left entries) vs the shares that would arise if couples were randomly assigned within provinces (the right entries). The diagonal entries of each panel are bolded where husband and wife have the same education level. We can then compute a statistic δ as the ratio of the sum of the diagonal for actual over randomized bolded values. The consistent $\delta > 1$ indicates persistent positive assortative mating (the bottom row of each panel). δ increases from 1990 to 2000 and then falls to 2008/9 due to the large rise in education for both genders. However, when we consider, in the bottom-most panel, the 2008/09 "moving" education categories which adjust for this secular rise in education

(2008/9*), we see that assortative mating in fact rose between 2000 (for which the fixed and moving education categories are the same) and 2008/9.

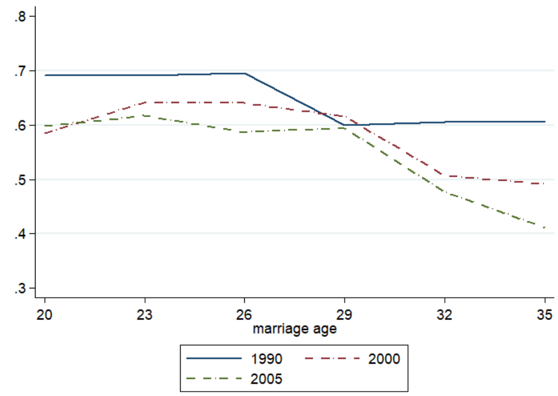
Table 10: Assortative vs random matching: 1990-2009

1990						
	Wife					
Husband	Low		Medium		High	
Low	**0.357**	**0.178**	0.130	0.194	0.026	0.089
Medium	0.130	0.240	**0.218**	**0.147**	0.065	0.043
High	0.007	0.076	0.016	0.023	**0.051**	**0.010**
$\delta = \mathbf{1.87}$						
2000						
	Wife					
Husband	Low		Medium		High	
Low	**0.271**	**0.074**	0.137	0.146	0.032	0.131
Medium	0.078	0.154	**0.194**	**0.149**	0.104	0.089
High	0.008	0.129	0.037	0.073	**0.139**	**0.056**
$\delta = \mathbf{2.16}$						
2008/9						
	Wife					
Husband	Low		Medium		High	
Low	**0.124**	**0.012**	0.078	0.078	0.022	0.109
Medium	0.043	0.038	**0.187**	**0.127**	0.117	0.144
High	0.008	0.124	0.068	0.128	**0.353**	**0.240**
$\delta = \mathbf{1.75}$						
2008/9*						
	Wife					
Husband	Low		Medium		High	
Low	**0.284**	**0.062**	0.098	0.181	0.019	0.091
Medium	0.082	0.157	**0.238**	**0.144**	0.094	0.100
High	0.008	0.155	0.048	0.057	**0.130**	**0.052**
$\delta = \mathbf{2.52}$						

4.4 Fertility rates

Overall, we see very little evidence of a marriage market penalty to high educated women, and certainly not one large enough to encourage women to forego marriage. Moreover, the traditional penalty to delayed marriage appears to be decreasing over time for both men and

Figure 7: Rate of first child birth by first marriage age



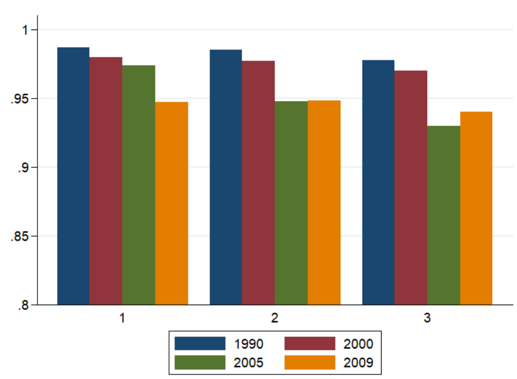
women who increasingly marry at older ages. This being said, the Chinese government may have other reasons for trying to warn women not to delay marriage. For example, policy makers may be concerned with declining fertility rates associated with delayed marriage, especially now that the one-child policy has been relaxed.

Figure 7 displays prevalence of child birth amongst newlyweds by marriage age over time. First, it is important to note that, given the nature of the setup, the figure cannot be interpreted using the standard definition of "fertility". Figure 7 plots the percentage of couples who have been married for four or five years and whose first child was born in the first three years of the marriage. We include only couples for whom neither the spouse nor a child is clearly absent in the survey (recall Table 11). We also exclude the 2008/9 near-newlyweds since we don't have information on the exact marriage tenure of couples in the UHS samples.

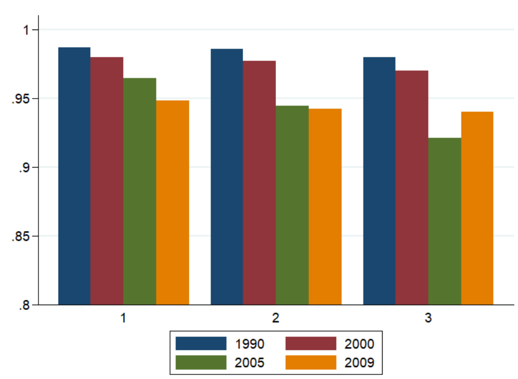
Figure 7 indicates that newlywed fertility fell between 1990 and 2005. More interestingly, in 2000 and 2005, we see a decline in newlywed fertility with the age of the wife at marriage after age 29. Since women who marry older have less option to delay pregnancy, the pattern may suggest that some couples are simply opting not to have children in recent years. However, we note that this graph in particular should be interpreted with caution due to the large number of missing household members in 2005.[18]

Figure 8 examines near-completed fertility rates for women between 33 and 36 for 1990, 2000, 2005, and 2008/9. For this graph we are able to make use of the census questions on surviving children and therefore we keep all married women who are enumerated in the census and bring in the 2008/9 sample. The age range 33-36 is chosen so that women will be near their completed fertility but still likely to have their children present in the household, which is necessary to identify them in the UHS. Here we see some evidence that fertility has fallen over the period under study. The decline is similar across all three education categories, but fertility is lowest among the highest educated in all years: using the moving education categories (the second figure), the near-completed fertility rate falls among the highest educated 20% of women from 98.0% to 94.0% between 1990 and 2008/9, while for the lowest 40%, it falls from 98.6% to 94.8%. If high type women are opting to delay or even forego childbearing, part of the Chinese government's motivation for promoting earlier marriages among this group could be as a means of "upgrading population quality (*suzhi*)."

Figure 8: Near-complete fertility rates by year and education: Categories 1 (low) to 3 (high)



(a) Fixed education categories



(b) Moving education categories

[18]Another possibility is that in 2005 we are observing more second marriages at later ages so any births would not be the first birth experienced by the woman. Reported rates of second marriages are still quite low however, at about 2.6% of reported marital statuses, and remain constant between 2000 and 2005, the only years we can observe this information.

5 Conclusion

In contrast to Korea, Japan, Taiwan, and Singapore, we do not see evidence up to 2009 that China's domestic marriage market is experiencing declining marriage rates among women, overall or among those with the highest educational attainment. In fact, Chinese women with college or more education have completed marriage rates (by ages 35-40) that are comparable to, or even slightly higher than, their less educated female counterparts. We similarly find little evidence that highly educated women suffer a "success penalty" in marriage markets. Based on the Choo-Siow estimator, we find a slight increase in the direct marriage market returns to education for women over the period 1990-2009. Because of strong positive assortative mating and declining costs to marrying at older ages (i.e. after the completion of an advanced degree), the top quintile of women by education actually attain higher marital payoffs on average than less educated women, though the difference has shrunk slightly since 2000. With respect to the cost of delaying marriage, this paper finds evidence of an initial significant penalty that dissipates over time as the marriage gains profile peaks at later and later ages. This result holds whether we consider a classic Choo-Siow estimator of marital gains or the dynamic estimator recently proposed by Choo (2015) in which individuals take into account their own future marital opportunities from waiting to wed and in which, by construction, returns to marriage should be highest when young.

We use this dynamic model to project future marriage rates out to 2015 and see no indication that marriage rates fall among the highest educated, though we do project a fall in marriage rates among medium-educated (high school educated) women. Falling relative returns to marriage among the young may be related to falling fertility, especially among high educated women, whose fertility rates are lowest over the whole sample period. Of course, we require data from more recent years to know whether these trends will continue and whether our projections hold, particularly as China's population becomes increasingly educated, rural-urban migration becomes easier, and – due in large part to the latter – changes in the population ratio of marriage-aged men and women potentially become increasingly favorable to women.

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Appendices: for online publication

A Derivation of the Choo (2015) estimator

To derive the estimator (8), we follow the exposition in Choo (2015) very closely, as our estimator is simply a special case of his with no divorce, a two-dimensional type space for agents, and without the assumption that the marriage market is in dynamic steady state. The underlying framework is essentially the same as in the classic static model. A man g in state i who participates in the marriage market at t has a payoff given by:

$$\begin{aligned} v_{g,i,t}(a_g) &= \alpha_{0,i,t} + \epsilon_{0,g,i,t} && \text{if } a_g = 0 \\ &= \boldsymbol{\alpha}_{i,j,t} - \tau_{i,j,t} + \epsilon_{j,g,i,t} && \text{if } a_g \in \{1, N\} \end{aligned} \tag{11}$$

A woman h in state j who participates in the marriage market at t has corresponding utility

$$\begin{aligned} w_{h,j,t}(a_h) &= \gamma_{0,j,t} + \epsilon_{0,h,j,t} && \text{if } a_h = 0 \\ &= \boldsymbol{\gamma}_{i,j,t} + \tau_{i,j,t} + \epsilon_{i,h,j,t} && \text{if } a_h \in \{1, N\} \end{aligned} \tag{12}$$

In both cases a is the action taken by the individual in the period given an idiosyncratic preference draw $\boldsymbol{\epsilon}_{g,t}$, which is an $N+1$ dimensional vector of idiosyncratic preferences for each of the N types of agent in the marriage market (assumed symmetric by gender) and to staying single. The ϵs are uncorrelated across time and partner type and are drawn from the Type 1 Extreme Value distribution. Focussing on men, the action can be to take a spouse of type j, $a_g = j$ or to remain single $a_g = 0$. α_{0_t} is the average payoff to remaining single at age i in marriage market t. $\tau_{i,j}$ is an upfront transfer man i must make to woman j in order to marry her.

The gain to men from marrying a type j spouse is a discounted present value of future returns given by

$$\boldsymbol{\alpha}_{i,j,t} = \sum_{k=0}^{T_i-1} \beta^k \alpha_{i,j,t+k}$$

and similarly for women:

$$\boldsymbol{\gamma}_{i,j,t} = \sum_{k=0}^{T_j-1} \beta^k \gamma_{i,j,t+k}$$

where the T_i and T_j are the terminal periods for man of type i and woman of type j respectively and capture how many periods the individual has left to enjoy utility from marriage or potentially participate in the marriage market. β is the discount factor. Once an individual marries, they exit the marriage economy permanently and make no further decisions, simply receiving their payoffs each period. As well, a married individual experiences no further shocks ϵ. Therefore, the only dynamic concern in the model applies to singles who choose whether to marry their best option in the current marriage market t or wait until $t+1$ to try again with a new draw of $\boldsymbol{\epsilon}$.

Next, we define a value function for a single male g that expresses his payoffs as resulting from his optimal decision a_g in marriage market t under the usual assumption that he will always optimize in the future if faced with a choice.

$$\begin{aligned} V(i, \boldsymbol{\epsilon}_{i,g,t}, t) = \max \Big\{ & \alpha_{0,i,t} + \beta \mathbb{E} V(i'(i,1), \boldsymbol{\epsilon}_{i',g,t+1}) + \epsilon_{0,g,i,t}, \\ & \max_{a_g \in \{1,Z\}} \left\{ \boldsymbol{\alpha}_{i,a_g,t} - \tau_{i,a_g,t} + \epsilon_{a_g,g,i,t} \right\} \Big\} \end{aligned} \tag{13}$$

and similarly for individual woman h:

$$\begin{aligned} W(j, \boldsymbol{\epsilon}_{j,h,t}, t) = \max \Big\{ & \alpha_{0,j,t} + \beta \mathbb{E} W(j'(j,1), \boldsymbol{\epsilon}_{j',h,t+1}) + \epsilon_{0,h,j,t}, \\ & \max_{a_h \in \{1,Z\}} \big\{ \boldsymbol{\gamma}_{a_h,j,t} + \tau_{a_h,j,t} + \epsilon_{a_h,h,j,t} \big\} \Big\} \end{aligned} \tag{14}$$

Because the evolution of the vector $\boldsymbol{\epsilon}$ is i.i.d. across time and states (in Choo's formulation the evolution of the state space satisfies Conditional Independence of the systematic and idiosyncratic components, which remains the case even in the more complicated case with exogenous divorce and/or spousal mortality in which agents who marry expect to return to the marriage market at some point) the value functions can be re-written as

$$V(\cdot) = \max_{a \in \{0,N\}} \{\tilde{v}_{i,a,t} + \epsilon_{a,i,g,t}\}$$
$$W(\cdot) = \max_{a \in \{0,N\}} \{\tilde{w}_{j,a,t} + \epsilon_{a,i,h,t}\}$$

where $\tilde{v}$ and $\tilde{w}$ are the systematic or predictable parts of V and W (specifically, all the non-ϵ terms). This is the discreet choice problem used in logit estimation and can be solved in a method very similar to that used to derive the static Choo-Siow estimator using the facts that, under the Type 1 Extreme Value distribution of the idiosyncratic part of marriage gains, there is a closed form solution for the expected payoff from marriage in any period and for the likelihood of any particular match as a function of the systematic utility generated by that match.

Specifically, in the pivotal step of his derivation, Choo shows (see his Appendix A.2), that, if we define $\mathbf{V}_{i,t} = \mathbb{E}\big(V(i, \boldsymbol{\epsilon}_{i,g,t}, t)\big) = \int V(\cdot) f(\boldsymbol{\epsilon}) d\boldsymbol{\epsilon}$, then for any age up to and including the terminal age T, $\mathbf{V}_{i,t}$ takes a recursive form

$$\mathbf{V}_{i,t} = \alpha_{i,0,t} + c - \ln P_{i,0,t} + \beta \mathbf{V}_{i'(i,1),t+1} \tag{15}$$

where $P_{i,0,t}$ is the likelihood that a type-i man remains single in the marriage market at t and c is Euler's constant. For any age after T, $\mathbf{V}_{i,t} = 0 \ \forall i, t$. Similarly for women, let $\mathbf{W}_{j,t} = \mathbb{E}\big(W(j, \boldsymbol{\epsilon}_{j,h,t}, t)\big) = \int W(\cdot) f(\boldsymbol{\epsilon}) d\boldsymbol{\epsilon}$, and

$$\mathbf{W}_{j,t} = \gamma_{0,j,t} + c - \ln Q_{0,j,t} + \beta \mathbf{W}_{j'(j,1),t+1} \tag{16}$$

where $Q_{0,j,t}$ is the likelihood that a type-j woman remains single in the marriage market at t.

In turn, by repeated substitution of the expected future payoffs into V and W, (15) and (16) allow us to express $\tilde{v}$ and $\tilde{w}$ as follows:

$$\begin{aligned}
\tilde{v}_{i,a>0,t} &= \boldsymbol{\alpha}_{i,a_g,t} - \tau_{i,a_g,t} \\
\tilde{v}_{i,a=0,t} &= \alpha_{0,i,t} + \sum_{k=1}^{T_i} \beta^k \big(\alpha_{i'(i,k),0,t+k} + c - \ln P_{i'(i,k),0,t+k}\big)
\end{aligned} \tag{17}$$

$$\begin{aligned}
\tilde{w}_{a>0,j,t} &= \boldsymbol{\gamma}_{a_h,j,t} - \tau_{a_h,j,t} \\
\tilde{w}_{a=0,j,t} &= \gamma_{j,0,t} + \sum_{k=1}^{T_j} \beta^k \big(\gamma_{j'(j,k),0,t+k} + c - \ln Q_{0,j'(j,k),t+k}\big)
\end{aligned} \tag{18}$$

Next, using the well known property of the Type 1 extreme value distribution that links probabilities to payoffs, we know that P is given by:

$$P_{i,j,t} = \frac{\exp(\tilde{v}_{i,j,t})}{\sum_{k=0}^{N} \exp(\tilde{v}_{i,k,t})}$$

we can derive the log-odds ratio for a type i man of forming a type $\{i, j\}$ match relative to remaining single as:

$$\begin{aligned} \ln\left(\frac{P_{i,j,t}}{P_{i,0,t}}\right) &= \tilde{v}_{i,j,t} - \tilde{v}_{i,0,t} \\ &= \boldsymbol{\alpha}_{i,j,t} - \tau_{i,j,t} - \boldsymbol{\alpha}_{0,i,t} - \sum_{k=1}^{T_i} \beta^k \big(c - \ln P_{i'(i,k),0,t+k}\big) \end{aligned} \tag{19}$$

where $\boldsymbol{\alpha}_{0,i,t} = \sum_{k=0}^{T_i} \beta^k \alpha_{i'(i,k),0,t+k}$, and similarly the log-odds ratio for a type-j woman of forming a type $\{i, j\}$ match relative to remaining single as::

$$\begin{aligned} \ln\left(\frac{Q_{i,j,t}}{Q_{0,j,t}}\right) &= \tilde{w}_{i,j,t} - \tilde{w}_{0,j,t} \\ &= \boldsymbol{\gamma}_{i,j,t} + \tau_{i,j,t} - \boldsymbol{\gamma}_{j,0,t} - \sum_{k=1}^{T_j} \beta^k \big(c - \ln Q_{0,j'(j,k),t+k}\big) \end{aligned} \tag{20}$$

Finally, to close the model, we use the fact that the (large) sample estimate of $\frac{P_{i,j,t}}{P_{i,0,t}}$ is given by $\frac{\mu_{i,j,t}}{\mu_{i,0,t}}$, of $\ln P_{i'(i,k),0,t+k}$ is given by $\frac{\mu_{i'(i,k),0,t+k}}{m_{i'(i,k),t+k}}$, of $\frac{Q_{i,j,t}}{Q_{0,j,t}}$ is given by $\frac{\mu_{i,j,t}}{\mu_{0,j,t}}$, and of $\frac{\mu_{0,j'(j,k),t+k}}{f_{j'(j,k),t+k}}$. Using these sample analogues imposes the assumption that, at marriage market equilibrium, we must have $P_{i,j,t} = Q_{i,j,t}, \ \forall i > 0, j > 0, t$. Then, adding together the empirical analogues of (19) and (20), gathering the terms relating the probabilities together on the lhs, and adding and subtracting $\ln(m_{i,t})$ and $\ln(f_{j,t})$ from the lhs, we get

$$
\ln\left(\frac{\mu_{i,j,t}}{m_{i,t}}\right) - \sum_{k=0}^{T_i-1} \ln\left(\frac{\mu_{i'(i,k),0,t+k}}{m_{i'(i,k),t+k}}\right)^{\beta^k} + \ln\left(\frac{\mu_{i,j,t}}{f_{j,t}}\right) - \sum_{k=0}^{T_j-1} \ln\left(\frac{\mu_{0,j'(j,k),t+k}}{m_{j'(j,k),t+k}}\right)^{\beta^k}
$$

$$
= \boldsymbol{\alpha}_{i,j,t} - \boldsymbol{\alpha}_{0,i,t} + \boldsymbol{\gamma}_{i,j,t} - \boldsymbol{\gamma}_{j,0,t} + \sum_{k=1}^{T_i} \beta^k c + \sum_{k=1}^{T_j} \beta^k c \equiv 2\Pi \tag{21}
$$

where Π relates population vectors of singles of type i and j now and in the future to the discounted present value of entering a type $\{i, j\}$ match today relative the the discounted present value of both partners remaining single up to age T. If we further assume that the marriage market is in dynamic steady state, we can omit the t subscripts indexing the chronological order of the marriage markets, which gives us equation (8).

B Sample restrictions and identification of couples and newlyweds in the censuses and UHS

In this appendix, we provide a detailed analysis of our data set-up and couple-matching methodology, which is designed to give us comparable samples of urban marriage market participants across our four surveys conducted by the National Bureau of Statistics (NBS): the 1990 and 2000 National Population Censuses (1% samples), the 2005 Population Survey (.2% sample) and the 2008 and 2009 waves of the Urban Household Survey (UHS).

First, in terms of preliminary data cleaning, it is important to note that since the 2008/9 NBS UHS is an exclusively urban sample from select provinces, we likewise restrict the sample of our 1990, 2000, 2005 censuses to urban-with-urban-hukou individuals from the same set of provinces. To identify urban areas from the three census years that are consistent with the UHS sample, we use the China Statistical Yearbook which lists, for each historical year, the percentage of the national population residing in urban areas. We employ each year-specific value as an 'urban cutoff' by ranking county codes from most to least urban (using the prevalence of urban hukou holders as a percentage of all county dwellers as a proxy) and retaining the higher-ranking county codes to the left of the cutoff as 'urban' (i.e. each county code has a population that constitutes a percentage of the national total; from these percentages and using the order of our urban ranking, we can construct a county code population CDF of sorts, for which the Statistical Yearbook provides a cutoff value – all county codes to the left of this year-specific cutoff we consider as 'urban', dropping the rest as 'rural').

For data setup, our four NBS datasets each classify households into two types {familial, collective}, provide unique geographical household identifiers, and label individuals of each household by their "relationship to household head"[19]. Unfortunately, "relationship to household head" does not always uniquely identify couples within a household. For tractability, we drop married individuals living in 'collective' households – since it is generally impossible for accurate spouse identification within such large households – and look only at married individuals living in 'familial' households. However, we keep singles living in collective households as these "households" include institutions like factory and university dormitories, where many individuals live prior to marriage and so form part of the urban single population. Within 'familial' households, only "household head" and "spouse of head" can be perfectly matched from the available information[20], which has led some researchers to focus only on household heads (e.g. Han et al. (2015)). For our analysis, however, omitting all but household heads and spouses is potentially problematic since, as can be seen from the first three rows of Table 11, the shares of "adult children", and "other" couples in the household (including parents, grandchildren, or siblings / siblings in law of the head) are fairly substantial, and decreasing over the sample period, so omitting these couples may give

[19]This is different from other survey designs. The China Health and Nutrition Survey (CHNS), for example, explicitly records spouse ID number for easy matching. The CFPS, on the other hand, directly lists the spouse attributes of all individuals in the survey.

[20]Households with more than one household head or spouse of household head are dropped

an incomplete picture of the marriage market. We also pair up 'child' with 'child-in-law', 'parent' with 'parent-in-law', as well as those with the same label as their spouse (i.e. each of 'grandparent', 'grandchild', 'sibling', and 'other relative'), who are listed as living together in the same household, of opposite sex, and are identified as married by marital status. In cases where there is ambiguity due to more than one pair of the same type living in the same household (e.g. if there are two children and two children-in-law in the household), we match people on reported marriage tenure where available (2000 and 2005) and on age (minimizing the sum of the age differences over the couples, conditional on the male partner being older) where it is not (1990 and 2009). Each matched couple is then assigned their unique couple ID. With regards to calculating marriage πs, we maintain consistency between our single and married samples by only retaining couples wherein both husband and wife have urban hukou.

Additionally, couple matching requires *both* spouses to be present in the household at the time of the survey. Rows 4 and 5 of Table 11 report the share of married household heads and other married household members for whom no spouse is identifiable in the survey. In all years but 2008/9, the surveys request information about temporarily missing members; the shares of couples with an unsurveyed spouse are fairly large, and in 2005 particularly, this share reaches almost 50% among urban couples under 45. Because couples with an unsurveyed spouse are also not likely to be random within the married population (and also for newlywed sample size concerns), we deal with this missing data by drawing "replacement" spouses for these individuals from the age-education distribution observed among the complete couples in that year, conditional on the age, education level, and gender of the spouse who appears in the census.[21]

[21] In the 2005 census, the enumerators record the number of family members living at the address which is very often less than the total enumerated members. This leads us to believe that the public file may contain information only on individuals who were physically present at the time of the initial visit. While the large number of missing spouses is potentially worrying, we compared the sample by age/education cells, including our replacement spouses, to similar cells taken from national statistics at the national level. The correlation was .985 suggesting that we have a representative sample overall.

Given this set of matched couples, we then identify the subset of 'newlyweds' who got married in the three years leading up to and including our four observational marriage market years. In the 2000 and 2005 censuses, we are directly given each individual's year of marriage. Since the censuses are backward-looking, we are able to use the 2000 census to compute the distribution of newlyweds for 1990. However, since year of marriage is not reported in the 2008/9 UHS, we back out marriage age by examining the growth in the stock of married households of each type between the 2005/6 UHS (to which we also have access) and the 2008/9 UHS, controlling for overall population growth by age group, education level, gender between the two periods and conditioning on the age of the first (and almost always, only) child of the couple being under three years old. For instance, the difference between the stock of marriages in which the husband is $\sim$28 and the wife is $\sim$25 and both spouses have high education in 2005/6 versus the stock of marriages in which the husband is $\sim$31 and the wife is $\sim$28 and both spouses have high education in 2008/9 and the couple does not have a child over 3 years of age, is the flow of new marriages of $i = \{31, 3\}, j = \{28, 3\}$ in 2008/9. As discussed in Appendix E below, for this method to be valid, we require that the population growth of each type be independent of marital status. Since this assumption can be challenged, we also construct a sample of likely newlyweds in 2008/9 based on fertility rates as a robustness check. We use the 2005 census combined with an 8% sample of the 2000 data to construct the distributions of marriage tenure for couples by age of the household head, education of the spouse, and age of the oldest child: 0-1 years, 2-3 years, 4-10 years and 11-18 years, and missing (childless couples). The maintained assumption for this alternative imputation method to be valid is that this distribution of *time from marriage to first childbirth*, or more specifically, the relationship between marital tenure and oldest child in the household, has not changed meaningfully between 2005 and 2009, conditional on age and education levels of the head and spouse. The results from the two methods are similar and results based on the fertility matching method are reported and briefly discussed in Appendix E; in the body of the paper we have focussed on results from our preferred stock-flow imputation method.

Table 11: Couples composition: share of hh heads, adult children, and other couples 18-44

	1990	2000	2005	2009
HH head	0.679	0.738	0.716	0.746
Adult child	0.239	0.168	0.171	0.142
Others	0.082	0.093	0.113	0.112
Missing "spouse" of married head	0.118	0.114	0.482	0.014
Missing "spouse" of other family members	0.129	0.074	0.205	0.034
Missing children	0.054	0.076	0.227	0.000
Share of childless couples	0.072	0.090	0.101	0.103
Share of couples in multi-family hhs	0.200	0.156	0.185	0.163

C Estimates of π for men

C.1 Men's education shares by census year

Table 12 reports shares of men by education level in each of the four survey years and compares the education shares under the "moving" education categories (indexed with a *) to those using the "fixed" categories for 2008/9. This table is the analog of Table 3 in Section 3.

Table 12: Shares of men with educ {low,medium,high} by year

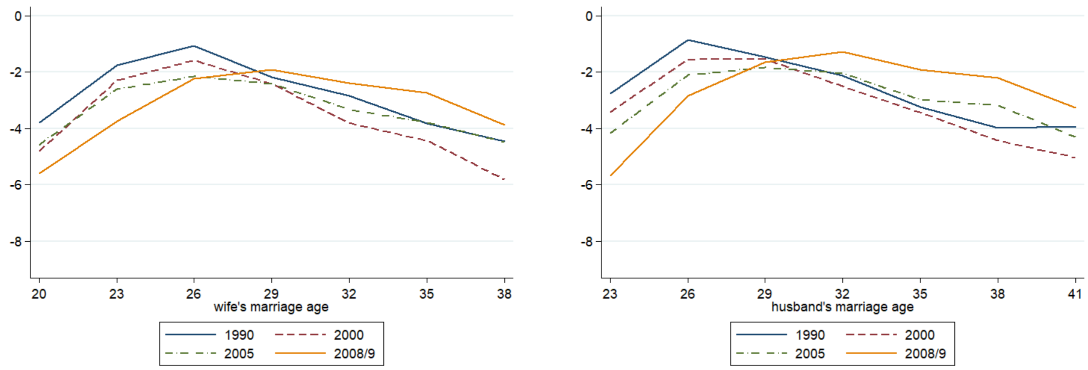
educ	1990	2000	2005	2009	2009*
Low	0.448	0.345	0.270	0.153	0.340
Medium	0.349	0.382	0.304	0.316	0.402
High	0.203	0.273	0.425	0.531	0.259

C.2 Static estimates of π and π^m by age of marriage

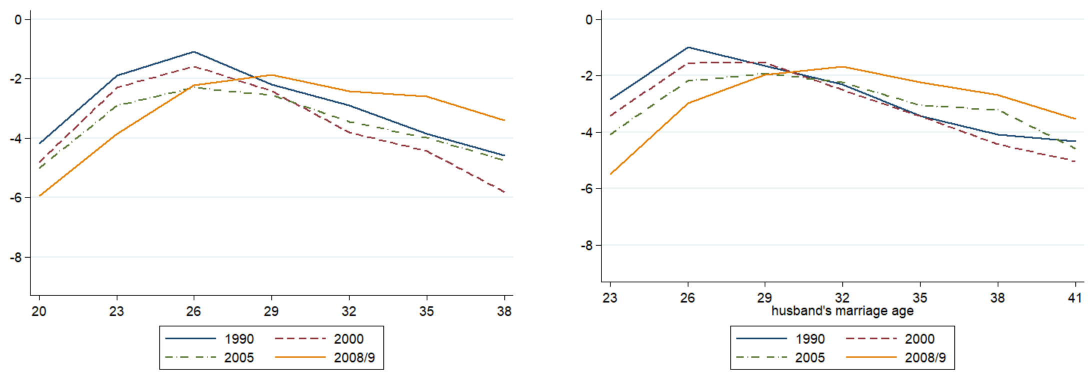
Figures 9 and 10 plot π and π^m for medium and high-educated men by (male) age of marriage across our four survey years using our samples of newlywed men. The patterns by year are similar to those for women shown in figures 3 and 4 and discussed in detail in Section 4, so we omit further discussion of them here. As for women, the peak in high educated men's

π and π^m is higher than for medium educated men, but the difference in the peak is more pronounced using the fixed than the moving education categories.

Figure 9: π by age for medium and high-educated men



(a) Medium-educated men: fixed (b) High-educated men: fixed

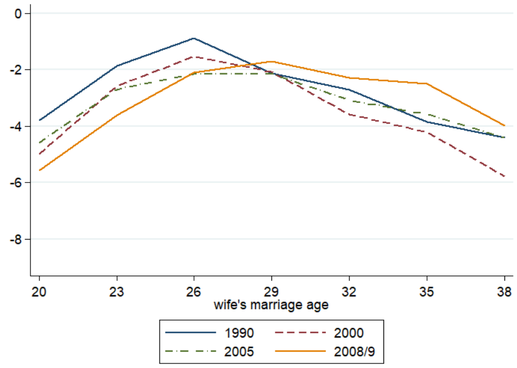


(c) Medium-educated men: moving (d) High-educated men: moving

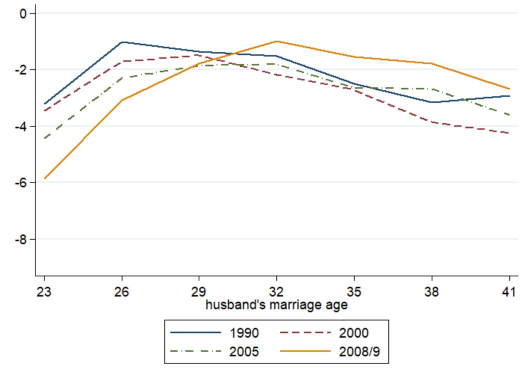
D Choo projected exit rates from singlehood: robustness

In this final section, we show results from two alternative specifications of the dynamic Choo model. Figure 11 replicates the rates of exit from singlehood for the benchmark model in which we assume that Π stays constant at its 2009 (vector) level for all subsequent years.

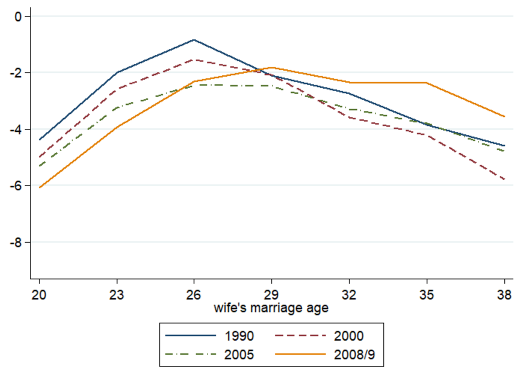
Figure 10: π^m by age for medium and high-educated men



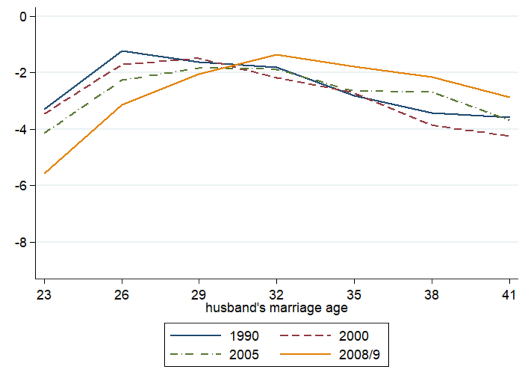
(a) Medium-educated men: fixed



(b) High-educated men: fixed



(c) Medium-educated men: moving



(d) High-educated men: moving

Figure 12 plots the exit rates from singlehood under the assumption that each element of Π evolves as a linear extrapolation from its 2000, 2005 and 2009 values. Figure 13 plots the exit rates from singlehood under the assumption that agents are "myopic": they assume the marriage market is in steady state. (We don't in fact require a simulation for this exercise since Π and the marriage rates can be calculated analytically, but we conducted the simulation for comparability.) The main takeaway from the figures is that the exit rates are similar in all three exercises.

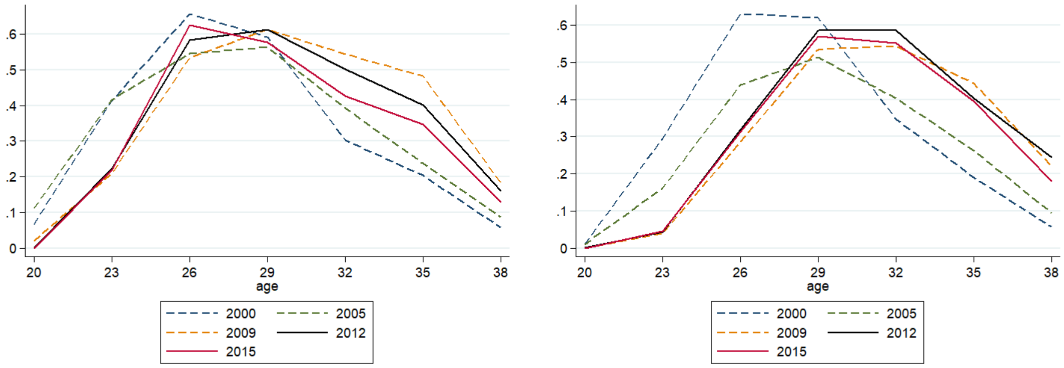
The major takeaway from a comparison of figure 11 with figures 12 and 13 is that, to a first approximation, the projected exit rates from singlehood, as shown by the black and red lines, change very modestly from the benchmark case under different assumptions about the evolution of Π and somewhat more substantially when agents assume that the marriage market will remain in its current state of population vectors and payoffs. When Π continues to evolve, in figure 12, the share of women who are still in the projected 2012 marriage market at ages 39-41 is almost identical for both medium and both medium (3.4% vs 3.3% in the benchmark) and high (20.6% vs 20.2% in the benchmark) educated women. Projecting to 2015, the share of women who are still in the marriage market at ages 39-41 is 3.4% (vs 3.3% in the benchmark) for medium and 24.1% (vs 23.7% in the benchmark) for high educated women.

By contrast, if agents are "myopic" about the marriage market – that is, they believe the conditions (and importantly the distribution of types in the marriage market) prevailing in the current marriage market will prevail in all future marriage markets – we see, as we might expect, that individuals marry earlier in the 2012 and 2015 projections than in the benchmark case and than in the 2009 marriage market. Women still marry at rates well below historical rates up to age 23, with the peak in marriage taking place at 26 (that is 24-26) for medium and 29 (that is, 27-29) for high educated women. This result is intuitive, since women in this simulation are not taking into account that more men will be available to marry at later ages.

E Estimates using alternative imputation of 2009 marriage tenure

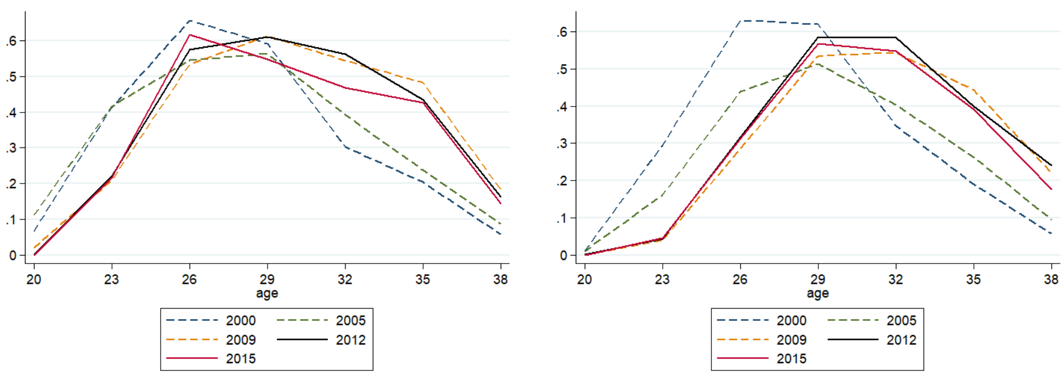
In our benchmark results, we assign 2009 marriage tenure by comparing the stocks of married couples by type in the 2005-6 UHS and the 2008-9 UHS so that the flow of newlyweds of type $\{i, j\}$ generate the stock of marrieds of type $\{i'(i, 1), j'(j, 1)\}$, controlling for changes in the overall population of types i and j. The assumption required for this imputation method to be valid is that the flow of individuals into urban dwelling / urban hukou status does not

Figure 11: Exit hazard from singlehood into marriage: benchmark



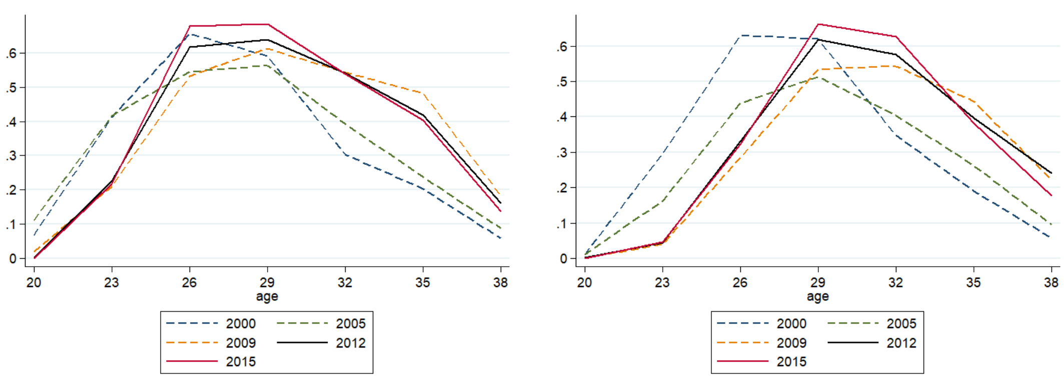
(a) Med-educ women (b) High-educ women

Figure 12: Exit hazard from singlehood into marriage: using linear projection of Π to 2012



(a) Med-educ women (b) High-educ women

Figure 13: Exit hazard from singlehood into marriage: agents are myopic



(a) Med-educ women (b) High-educ women

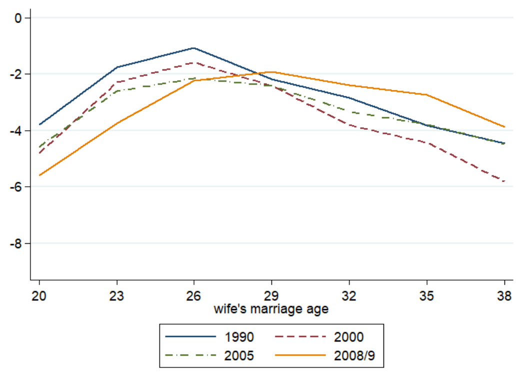
depend on marital status, only on gender and age-education type. An alternative way to assign marriage tenure to couples in the 2009 survey is to use information on fertility data, specifically on the delay between time of marriage and time of the birth of the first child. The assumption required for this imputation method to be valid is that the distribution of the delay between date of marriage and date of first birth has not changed substantially between 2000/05 and 2009.[22] If couples increasingly delay both marriage and fertility after marriage, which in fact appears to be the case, then we will likely understate the flow of newlyweds at these ages. To see why, consider a man age 32 married to a woman age 29, both with high education, and with no children. In the extreme case, if in 2000, the only couples fitting this description are those who married young but *could not* have a child, there will be no newlyweds of this type in the sample. If in 2008/9, the marriage climate has changed so much that most highly educated couples marry late and still postpone fertility for a few years, then we will clearly miss this change if we are drawing from the empirical distribution of childless couples from 2000. Of course, the actual difference between 2000 and 2009 is likely to be less extreme.

Figures 14 and 15 lend some credence to the above argument. Estimated marital gains in 2008/9 are lower across the board and especially at older ages using the fertility assignment (comparing the upper to lower panels in the figures), and suggest we are not generating quite enough newlyweds to explain the fact that the stock of married women aged 35-40 does not fall between 2005 and 2008/9. However, we see the same "flattening" of the marriage gains profile for both men and women at older marriage ages as in our preferred assignment specification, as well as the same patterns by education: focussing on women (figure 14),

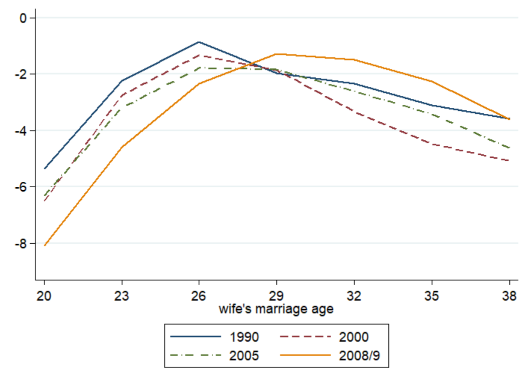
[22] Ideally, we would use the 2005 census sample exclusively to construct the empirical distribution since it is closer to 2008/9 in time. In fact, we combine it with an 8% draw from the 2000 sample. This is because, as shown in row 6 of Table 11, a substantial number of children, as well as spouses, are missing in 2005 (that is, the mother reports having surviving children but they are not enumerated in the household). We therefore use only 2005 households in which both spouses are enumerated and assume that any missing child in this subset of complete couples was born two years after the marriage started. This leaves us with a sample that is too sparse to create the conditional empirical distributions by spouse age and education and age of oldest child. The 8% sample from 2000 is chosen so as to exactly double the sample size.

the systematic gains to marriage are lower at young marriage ages for the high-educated but have a higher peak at ages 27-29 than medium educated women do at ages 24-26. Thus, the only one of our qualitative main findings that is sensitive to the method of identifying newlyweds in the UHS is the finding that *overall* marriage gains for women are not lower in 2008/9 compared to 2000 and 2005, i.e. that we do not observe a fall in the absolute gains to marriage across the decade among urban women with urban hukou. Falling gains to marriage over the whole age range of newlywed women, however, seems inconsistent with the very high completed marriage rates among urban women in 2008/9. R

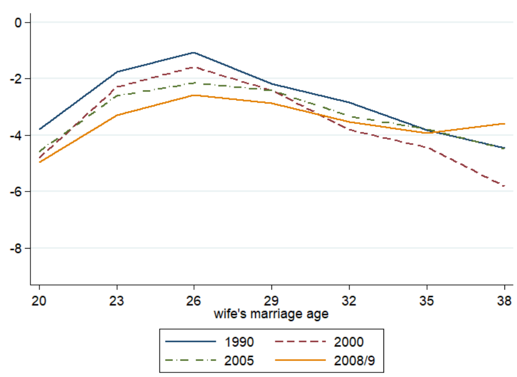
Figure 14: π by age for medium and high-educated women



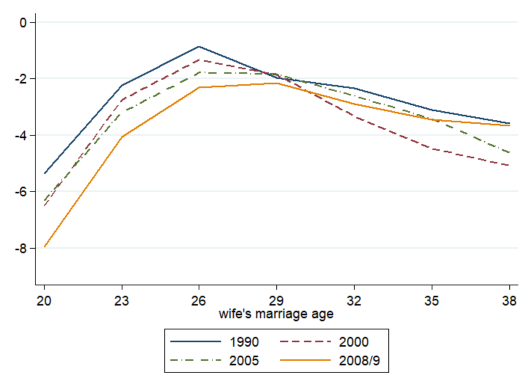
(a) Medium-educated women: benchmark



(b) High-educated women: benchmark

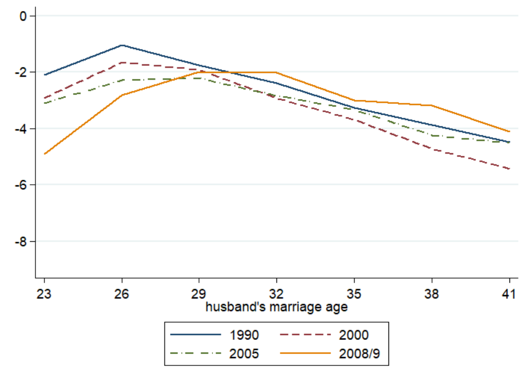


(c) Medium-educated women: fertility assignment

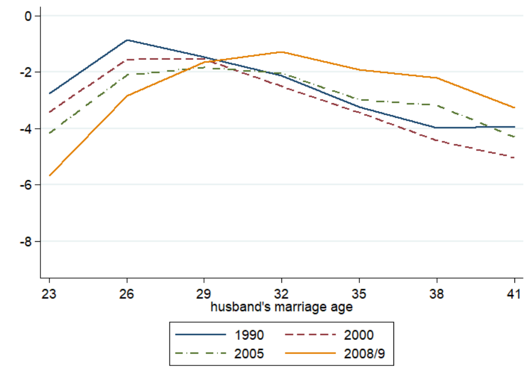


(d) High-educated women: fertility assignment

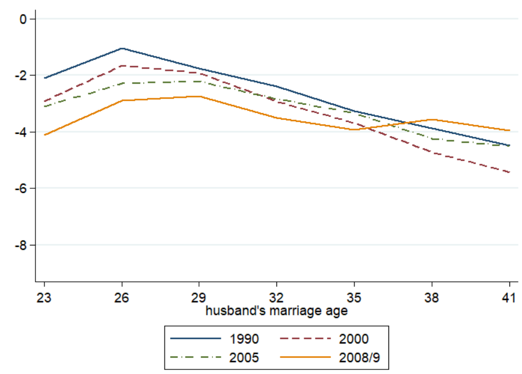
Figure 15: π by age for medium and high-educated men



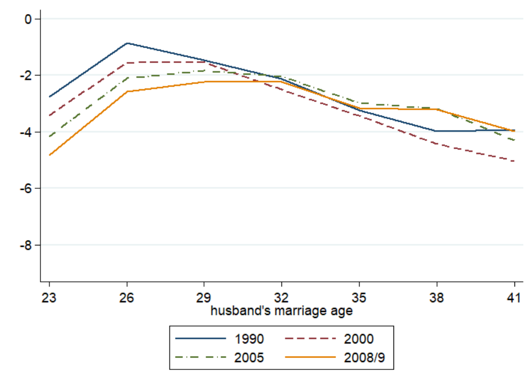
(a) Medium-educated men: benchmark assignment



(b) High-educated men: benchmark



(c) Medium-educated men: fertility assignment



(d) High-educated men: fertility assignment