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Gender Differences and the Timing of First Marriages

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ABSTRACT

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We study the steady state of an overlapping generations economy where singles search for spouses. In our model economy men and women live for many years and they differ in their fecundity, in their earnings, and in their survival probabilities. These three features are age-dependent and deterministic. Singles meet at random. They propose when the expected value of their current match exceeds that of remaining single. If both partners propose, the meeting ends up in a marriage. Marriages last until death does them apart, widows and widowers never remarry, and people make no other economic decisions whatsoever. In our model economy people marry because they value companionship, bearing children, and sharing their income with their spouses. The matching function depends on the single sex-ratios which are endogenous. Our model economy has only two free parameters: the search friction and the utility share of bearing children. We choose their values to match the median ages of first-time brides and grooms. We show that modeling the marriage decision in this simple way is sufficient to account for the age distributions of ever and never married men and women, for the probabilities of marrying a younger bride and a younger groom, and for the age distributions of first births observed in the United States in the year 2000. The previous literature on this topic claims that marriage is a waiting game in which women are choosier than men, and old and rich pretenders outbid the young and poor ones in their competition for fecund women. In this article we tell a different story. We show that their shorter biological clocks make women uniformly less choosy than men of the same age. This turns marriage into a rushing game in which women are willing to marry older men because delaying marriage is too costly for women. Our theory predicts that most of the gender age difference at first marriage will persist even if the gender wage-gap disappears. It also predicts that the advances in the reproductive technologies will play a large role in reducing the age difference at first marriage.

JEL Classification: J12, D83

Keywords: marriage, search, sex ratio

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1 Introduction

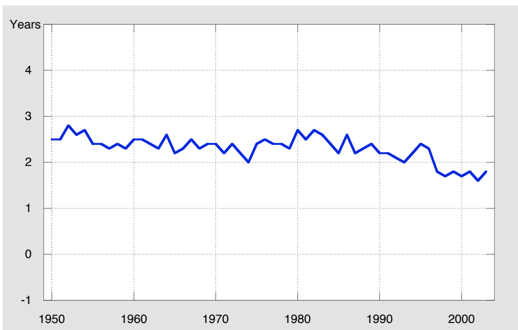
Over time and across societies women tend to marry older men. In the United States, the age difference at first marriage has remained stable since World War II. According to the United States Census in 1950 first-time grooms were 2.5 years older than first-time brides in median. Forty years later, in spite of large socioeconomic changes, first-time grooms were still 2.3 years older (see Panel A of Figure 1). The traditional story to account for this fact is that marriage is a waiting game in which young women are choosy and old and rich pretenders outbid the young and poor ones in their competition for young fecund women. In this article we tell a different story. We quantify the roles played by gender differences in fecundity, earnings, and longevity in determining the timing of first marriages. And we show that the shorter biological clocks of women turns marriage into a rushing game in which young women marry older men because delaying marriage is too costly for women.

To construct our argument, we compare the steady states of several overlapping generations model economies. Our model economies are populated by men and women who live for many periods, meet at random, and decide whether to marry. Men and women differ only in their fecundity and in their earnings, which are age-dependent and deterministic, and in their longevity, which is age-dependent and stochastic. And people marry because they value companionship, bearing children, and sharing income with their spouses. In our model economies marriages last until "death does them apart", and widows and widowers never remarry. Moreover, in our model economies the only economic decision that singles make is whether to marry. And married and widowed people make no economic decisions whatsoever. It turns out that studying first marriages in such a simplified model world is sufficient to make our argument convincingly.

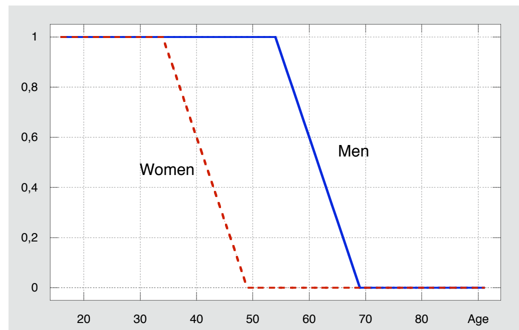
In our model economies, when two people meet they each draw a realization of an identical and independently distributed random process that determines the value of the match for the other partner. Based on this match value and on the partner's age, which determines his or her fecundity, earnings, and survival probabilities, they compute their expected values of the marriage. They compare them with their expected values of remaining single. And they decide whether to propose. If both partners propose, the meeting ends up in a marriage. Otherwise they both remain single, and they continue their search for a spouse. Features of our model economies that distinguish them from those in the literature, are that we consider people's age as an explicit determinant of their marriage behavior, that we model the search for spouses as a costly activity, that we endogenize the single sex ratios fully, and that we make our arguments fully quantitative.

In our benchmark model economy men earn more than women, they are fecund for a sizably longer period of their lives, and their life-expectancy is shorter. In this model economy we take the gender earnings profiles, the fecundity profiles, and the survival probability profiles directly from United States data for the year 2000 (see Panels B, C, and D of Figure 1). Naturally, the decision to propose depends crucially on the shape of the utility function and on the utility shares of companionship, child-bearing, and marital income. We assume a standard utility function with unit elasticity of substitution between its arguments. When all is told, our model economy has only two free parameters: the parameter that measures the search friction, and the parameter that measures the utility share bearing children. We choose the values of these parameters using the median ages of first-time brides and grooms in the United States in the year 2000 as our calibration targets.

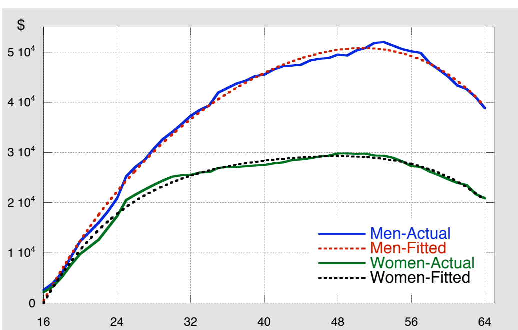
Figure 1: Biological and Economic Gender Differences in the United States



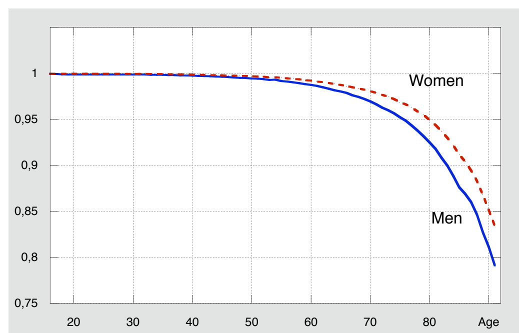
A. Age Differences at First Marriage



B. Fecundity Profiles in 2000



C. Earnings Profiles in 2000



D. Survival Probability Profiles in 2000

We show that modeling the marriage decision in this way in our extremely simple framework is sufficient to account for the age distributions of ever and never married men and women, for the probabilities of marrying a younger bride and a younger groom, and for the age distributions of first births observed in the United States in the year 2000 (see Figure 2). We also show that the shorter biological clocks of women make them uniformly less choosy than men of the same age. This turns marriage into a rushing game in which women are willing to marry older men provided that they are fecund. In other words, we show that women tend to marry older men mostly because for them delaying marriage is too costly. This result contrasts with those in the previous literature which models marriage as a waiting game in which fecund women are the short side of the market. This makes women choosier than men of the same age. And it encourages men to wait so that they can outbid the young pretenders once they have become rich.

In the final sections of this article we use our model economy to quantify the roles played by earnings and fecundity in determining the timing of first marriages. To this purpose we solve three counterfactual model economies. In the first one men and women are exactly alike. Consequently, they all have the same earnings and fecundity profiles, and the same survival probabilities. In the second model economy men and women differ in their earnings profiles only. And in the third one they differ in their fecundity profiles only. Naturally in the model economy in which men and women are exactly alike their marriage decisions are identical, and the median age difference between first-time grooms and brides is zero. In contrast, when men and women differ in their earnings only, men of every age become choosier and women of every age become less so. Whether these changes delay or advance the timing of first marriages is a quantitative question to be answered by our model economy. It turns out that reducing the earnings of women delays the median age of both first-time grooms and brides. The age of grooms by 0.27 years and the age of brides by 0.17 years. Therefore the overall effect of the gender earnings gap is to increase the median age difference at first marriage by 0.11 years.

The marriage behavior in the model economy in which men and women differ in their fecundity profiles only is more interesting. This is because reducing the fecundity of women makes younger women more attractive to men, and older women less so. Consequently, men reduce their reservation values for young fecund women, and they increase them for older women whose fecundity starts to decline. Women's shorter biological clock increases their cost of searching for a spouse. And it makes fecund women lower their reservation values for fecund men. In contrast, older women who can no longer bear children become choosier. And they raise their reservation values for fecund men. When we put these effects together and we take into account their implications for the sex-ratios of singles, it turns out that reducing the fecundity of women delays the median age of grooms by 1.57 years, and that it advances the median age of brides by 1.22 years. Therefore the gender fecundity-gap increases the median age difference at first marriage by a whooping 2.79 years. This number is many times larger than the 0.11 years that obtain when men and women differ in their earnings profiles only.

We conclude that gender differences in fecundity play a sizably larger role than gender differences in earnings in accounting for the timing of first marriages. And that, since searching for spouses is costly, their longer biological clock makes men choosier than women. Moreover, our theory predicts that most of the age difference at first marriage will persist even if the gender wage-gap disappears. It also predicts that the advances in the reproductive technologies will play a large role in reducing the age difference at first marriage.

Review of the literature. There is a large body of literature on the implications of gender differences for marriage behavior in biology, in economics, and in the other social sciences.[1] Bergstrom and Bagnoli (1993) is one of the early formal studies of the timing of marriages in economics. They model the marriage decision as a two period waiting game with incomplete information. The only economic decision that they study is when to marry, and the people in their model economy differ in match quality. But, while the quality of their young women is public information, the quality of their young men is private information. They use an assortative matching rule and they show that there exists a unique equilibrium in which every woman marries young. The top quality young women marry the top quality old men, and the remaining young women marry young lower quality men. Thereby men marry at an older age that women on average. In the last sentence of the section where they describe the marriage market equilibrium, Bergstrom and Bagnoli state that "a thorough treatment of strategies of this type must await a model with a more detailed search theory and with more than two possible ages of marriage".[2] Our model economies have these two features.

The next major contribution in the economics literature is Siow (1998). Siow uses Bergstrom and Bagnoli's idea that the marriage quality of males is uncertain and he takes it one step further. He studies a much richer economic environment in which risky human capital accumulation, parental investment in children, and labor markets interact with the marriage decision and determine the gender roles. Like Bergstrom and Bagnoli (1993), Siow studies a two-period model economy. And he shows that it accounts for many of the observed qualitative features of marriages including the fact that grooms tend to be older than their brides on average. However this result arises because he assumes that women are fecund only when young, and that people marry only to have children. The age difference appears because old men who are successful in the labor market outbid young men in their competition for young women, and because every woman marries when young —once again, by construction. In the last line of his article Siow states that "the quantitative significance of the concerns discussed here for explaining gender roles remains to be established".[3] In this article we do precisely that: we quantify the roles played by gender differences in fecundity, earnings, and longevity in accounting for the timing for first marriages.

Continuing with this line of argument, a more recent contribution is Hamilton and Siow (2007). This article is particularly interesting because it uses a detailed 18th century dataset from the Quebec region to estimate the contributions of differential fecundity, social heterogeneity, assortative matching, and search frictions in accounting for aggregate marriage behavior. Hamilton and Siow also provide a behavioral model that is consistent with their reduced form estimates. The main

[1] In the biology camp Trivers (1972) is one of the first to study the implications of differential fecundity. In the economics camp, Akerloff, Yelin and Katz (1996), Edlund (1998), and Willis (1999) study the implications of differential fecundity for out of wedlock childbearing. And Siow and Zhu (1998) study the implications of differential fecundity for gender biased parental investment in children. For many other references outside economics see Betzig (1999).

[2] See Bergstrom and Bagnoli (1993), page 190.

[3] See Siow (1998), page 352.

distinguishing feature of their study is that their model people differ in social status. The only difference between their model men and women is that women exit the marriage market at a higher rate than men because they receive an exogenous shock that represents menopause —in spite of the fact that this shock is age-independent. This feature of their model economy generates all the gender differences in marriage behavior including the age difference at first marriage.

Age is not a state variable in Hamilton and Siow's economy. As they admit themselves "While inaccurate at the individual level, this is a convenient abstraction for studying aggregate behavior. Fleshing out the model to fit individual level data is left for future research".[4] In our model economies age is a state variable of the individual decision problem. We also provide a structure that is consistent with the age distributions of many demographic statistics related to marriage.

Another paper related to this article is Caucutt, Guner and Knowles (2003). They study the roles played by wage inequality, human capital accumulation, and returns to experience for the timing of marriage and fertility in a general equilibrium model economy. They show that highly productive women marry and have children later in life than their less productive colleagues. In their model economy singles only meet and marry other singles of the same age by construction. Consequently, the age difference at first marriages is zero.[5]

Three recent unpublished contributions to the literature of marriage that are both important and related to this article are Giolito (2005), Seitz (2007), and Regalía and Ríos-Rull (2001). Giolito (2005) is a follow up of Giolito (2003) and it is an immediate precursor of this article. He is the first to model the age of his model people, both as a state variable and as a source of agents' heterogeneity, in a search model of marriage. He is also the first to endogenize the single sex ratios fully, and to replicate the age distributions of the newly-weds. Our model economy has inherited these three features. Unlike us, Giolito studies a world in which men and women differ only in fecundity and in mortality.[6] He shows that these differences suffice to account for most of the observed features of the timing of marriages, as long as people care enough about child-bearing. However, since he abstracts from gender differences in earnings, per force he cannot compare the roles played by fecundity and earnings in accounting for the timing of marriages.

Seitz (2007) studies the effects of marriage market conditions on the marriage and employment behavior of blacks and whites. She models search for spouses in a way that is very similar to ours. Her model world also resembles ours in that and her stocks of singles are endogenous —although, in her case only partially. Moreover, she includes individual uncertainty and she endogenizes the

[4]See Hamilton and Siow (2007), page 551.

[5]Other important contributions to the literature of fecundity, economic incentives, and marriage are Aiyagari, Greenwood, and Guner (2000) and Greenwood, Guner, and Knowles (2003). These articles also remain silent about the age difference at first marriages.

[6]Giolito's economy is very similar to the counterfactual model economy in which we assume that men and women differ in their fecundity profiles only. In this sense we can say that Giolito's model economy is a particular case of ours.

employment and the divorce decisions. This makes her model economy richer than ours. But her agents' decisions do not depend on their age. And this implies that her structure cannot be used to study the timing of marriages.

Finally, Regalía and Ríos-Rull (2001) study the causes of the large increase in the shares of single females and single mothers that took place in the United States between 1975 and 1990. They calibrate a very detailed model economy in which marriage, divorce, fertility, and education are all endogenous decisions. But in their model economy people age exponentially. Their single sex ratios are independent of their marriage and divorce decisions, and they are always equal to one. Consequently, in their model economy people's ages are irrelevant, the search for spouses is costless, and they remain silent about the timing of marriages.

2 The model economy

We study a model economy populated by a continuum of men and a continuum of women. Following the conventions of the United States Census we denote the men with subindex $i = 1$ and the women with subindex $i = 2$. Men and women live for at most T years, which we denote with subindex $j = 16, 17, \ldots, T$. Men and women in our model economy differ in their earnings, in their fecundity, and in their longevity. And they derive utility from their earnings and from being married and having children.

In our model economy singles meet in heterosexual pairs at most once each period. When two people meet each of them draws a random number which represents the value of the match for the other person. Based on this information and on the prospective spouse's age, fecundity, and earnings they decide whether or not to propose. A meeting ends up in a marriage when both parties propose. Otherwise they both remain single until they participate in another meeting sometime in the future. We assume that marriages last until "death does them apart", and that widows and widowers never remarry. We also assume that the only economic decision that singles make is whether to marry, and that married and widowed people make no economic decisions whatsoever.

2.1 Population dynamics

In our model economy each period every person faces an exogenous probability of surviving until the following period. We denote these probabilities by $\sigma_{i,j}$ and we assume that they are gender and age dependent and time-invariant. Since people live at most for T periods, $\sigma_{1T} = \sigma_{2T} = 0$. Every period a measure $n_{i,16}$ of sixteen year-old people of gender i enter the economy. Therefore the gender and age distribution of people in period t, $\{n_{i,j,t}\}$, is

$$n_{i,16,t} = n_{i,16} \text{ for all } t \text{ and} \tag{1}$$

$$n_{i,j,t} = \sigma_{i,j-1} n_{i,j-1,t-1} \text{ for } 17 \geq j \leq T \tag{2}$$

Expressions (1) and (2) and the assumptions that the survival probabilities are time-invariant and that $\sigma_{1T} = \sigma_{2T} = 0$ imply that the total sex and age distribution of people in our model economy converges to a stationary distribution which is independent of the marriage behavior.

Our assumptions also imply that when the survival probabilities of men and women of any age differ, the sex ratios of older people differ from each other and from the total sex ratio. In contrast, when there are no gender differences in survival probabilities, the sex ratios of people of all ages are identical and equal to the sex ratio of sixteen year-olds.[7] Finally, our assumptions also imply that the probability that an a year-old person of gender i survives until age b is

$$p_i(a,b) = \prod_{j=a}^{b-1} \sigma_{i,j} \tag{3}$$

2.2 Earnings

We assume that each period each person in our model economy receives an exogenous and deterministic endowment of earnings which is gender and age dependent. We denote this endowment by $y_{i,j}$.

2.3 Fecundity

Measuring fecundity is hard and relating it to age is harder. According to Hassan and Killick (2003), the effect of men's age on fecundity remains uncertain. Evaluation of standard sperm and endocrine parameters in age groups is typically inaccurate, because these parameters do not reflect the sperm fertilizing capacity or fecundability. Experiments that study the effect of age on male fecundity have been criticized on methodological grounds for using age at conception and for not taking into account confounding factors such as the age of the female or coital frequency. Hassan and Killick study male infecundity by comparing the time to pregnancy —measured from the onset of the attempts to achieve pregnancy— for men of different age groups. They found that male aging leads to a significant increase in the time to pregnancy, especially after ages 45 to 50.

Wood and Weinstein (1988) study the fecundity of women. They distinguish between total fecundability and effective fecundability. Total fecundability is a woman's monthly probability of any conception, regardless of its outcome. While effective fecundability is the woman's monthly

[7]Notice that the sex ratios of singles differ from sex ratios of the total population because they depend on the marriage behavior.

probability of a conception that results in a live birth. Therefore, effective fecundability accounts for the probability that a conception will end in an intra-uterine death. According to Wood and Weinstein, total fecundability of women changes rapidly after age 40, as a result of large changes in the ovarian function. Between ages 25 and 40, total fecundability of women is remarkably constant. This finding suggests that any reduction in the physiological capacity to bear children between ages 25 and 40 is attributable to an elevation in intra-uterine mortality rather than to a decline in the ability to conceive. But, even accounting for intra-uterine loss, the pattern of effective fecundability remains fairly flat between ages 20 and 35.

Modeling these diffuse findings is not easy. We compromise as follows: Let $f_{i,j}$ denote the time-invariant probability that a person of gender i bears children at age j. We assume that this probability is one from age 16 until that person reaches age α_i. Next, we assume that the probability of bearing children decreases linearly between ages α_i and δ_i. And that it is zero afterwards. To model the gender differences in fecundity, we assume that the age limits vary for men and women. Formally,

$$f_{i,j} = \begin{cases} 1 & \text{for } 16 \le j \le \alpha_i \\ (\delta_i - j)/(\delta_i - \alpha_i) & \text{for } \alpha_i < j \le \delta_i \\ 0 & \text{for } \delta_i < j \le T \end{cases} \tag{4}$$

2.4 Fertility

To model fertility in a parsimonious way we assume that when an a year-old man marries a b year-old woman they beget instantly and costlessly k children. We assume that the value of parameter k is a function of the fecundity of the spouses at the time of the marriage. Specifically we assume that $k = \mu f_{1,a} f_{2,b}$. Notice that the value of k is determined at the moment of a marriage and that it remains unchanged for its duration. To simplify the notation we do not use age subscripts for k.

2.5 The intangible values of marriage

We use a random process to model the intangible values of marriage such as companionship and sexual fulfilment. When two people meet they each draw an independent and identically distributed realization from the random process. The realization determines the value of the match for the other party. We denote the realizations by $x_i \in [0, 1]$, and the distribution from which they are drawn by $G(x)$.

2.6 The marriage contract

As we have already mentioned, we assume that never-married singles search for partners during their entire lifetimes; that people get married only once in their lifetimes; that married couples never get divorced; and that widows and widowers never remarry.

Table 1: Marital Status at First Marriage

	Bride's Marital Status			
Groom's Marital Status	Never Married	Divorced	Widow	Row Total
Never Married	946,787	211,951	1,355	1,160,093
Share of Row Total (%)	81.6	18.3	0.1	100.0
Share of Column Total (%)	82.6	32.6	3.4	63.2
Share of Total Marriages (%)	51.6	11.5	0.1	
Divorced	198,305	436,499	2,060	636,864
Share of Row Total (%)	31.1	68.5	0.3	100.0
Share of Column Total (%)	17.3	67.1	5.2	34.7
Share of Total Marriages (%)	10.8	23.8	0.1	
Widower	547	2,090	35,940	38,577
Share of Row Total (%)	1.4	5.4	93.2	100.0
Share of Column Total (%)	0.1	0.3	91.3	2.1
Share of Total Marriages (%)	0.0	0.1	2.0	
Column Total	1,145,639	650,540	39,355	1,835,534
Share of Row Total (%)	62.4	35.4	2.1	100.0
Share of Column Total (%)	100.0	100.0	100.0	100.0

Source: National Center for Health Statistics. The data are for 1995 and they account for 77% of the total number of marriages celebrated in the United States during that year.

These assumptions may seem somewhat extreme. But Table 1 shows that according to the National Center for Health Statistics in 1995 in the United States marriages between never previously married brides and grooms accounted for 51.6 percent of the total number of marriages reported. That same table shows that in only 11.5 percent of the marriages a never previously married bride married a divorced groom, and that in only 10.8 percent a never previously married groom married a divorced bride. Finally, Table 1 shows that widows and widowers participated in only 2.1 percent of the marriages.

In this article we focus exclusively on marriages between never married people because we think that it is in those marriages where fecundity plays a larger role. A large share of divorced people have children from their previous marriages. And the role that these children play in determining the value of the current marriage is controversial.

2.7 Search

Costly double sided search for spouses is a distinguishing feature of our model economies. The probabilities of being matched depend on an exogenous parameter that measures the search frictions, and on the ratio of available singles. Since this ratio is fully endogenous in our model economies, our matching function also captures the way in which the aggregate effects of the marriage decision feed back into the individual decision problem. Let $s_{i,j}$ denote the number of j year-old singles of gender i and let $S_i = \sum_{j=16}^{T} s_{i,j}$ denote the total number of singles of gender i. Then the probability that a single man meets a single b year-old woman is

$$q_{1,b} = \rho \left[\min \left(\frac{S_1}{S_2}, 1 \right) \right] \frac{s_{2,b}}{S_2} \tag{5}$$

Parameter $0 < \rho < 1$ measures the search frictions. Naturally the closer that parameter ρ is to zero matches and, consequently, marriages are less likely. Notice that the probabilities of meeting a single woman of any given age are the same for bachelors of every age. Notice also that, since $\rho < 1$, singles do not participate in meetings every period of their lives.

In our model economies the decision problem of single men and women are exactly identical. For notational convenience we describe the problem and variables that pertain to bachelors only. To obtain the corresponding variables for single women simply substitute the 1's for 2's and the b's for a's. For instance, the probability that a single woman meets a single a year-old man is $q_{2,a} = \rho \left[\min \left(S_2/S_1, 1 \right) \right] s_{1,a}/S_1$.

2.8 Payoffs

The period utility of an a year-old husband who is married to a b year old wife who drew match quality x_2 when they met is

$$u_1(x_2, y_{1,a}, y_{2,b}) = [x_2(1+k)]^{\theta} \left[\phi \left(y_{1,a} + y_{2,b} \right) \right]^{1-\theta} \tag{6}$$

In Expression (6) parameter $0 < \theta < 1$ is the utility share of being part of a family and parameter $0 < \phi < 1$ measures the economies of scale of living together. The first term of the right-hand side of Expression 6 models the joys of living together and bearing children with one's spouse. The second term of that expression models the income sharing features of marriages. The value of parameter ϕ is determined at the time of the marriage. It is a function of the fecundity of the spouses. And it never changes during the entire duration of the marriage. We discuss parameter ϕ in detail in Section 3 below.

The period utility of an a year-old bachelor is

$$v_1(y_{1,a}) = y_{1,a}^{1-\theta} \tag{7}$$

Expression (7) represents also the period utility of an a year-old widower.

2.9 The decision problem of singles

In our model economy when two singles meet they compare their expected values of being married to their current match until "death does them apart" with their expected values of remaining single and marrying a different person sometime in the future. The value of the marriage is uncertain because lifetime durations and, consequently, marriage durations are uncertain. The value of remaining single is uncertain for this reason, and because matches and, consequently, marriages are uncertain. To compute these expected values, we must first calculate the probabilities of marriage.

The probabilities of marriage. The probability that an a year-old bachelor marries a b year-old single woman is

$$\gamma_1(a,b) = q_{1,b}\left\{1 - G\left[R_1(a,b)\right]\right\}\left\{1 - G\left[R_2(a,b)\right]\right\} \tag{8}$$

where $R_1(a,b)$ denotes the reservation value that a year-old bachelors set for b year-old single women, and $R_2(a,b)$ is the reservation value that b year-old single women set for a year-old bachelors. The first term of Expression (8) is the probability that the match takes place, the second term is the probability that the man proposes, and the third term is the probability that the woman proposes.[8] Consequently, the probability that a single a year-old bachelor marries a woman of any age is

$$\Gamma_{1,a} = \sum_{b=16}^{T} \gamma_1(a,b) = \sum_{b=16}^{T} q_{1,b}\left\{1 - G\left[R_1(a,b)\right]\right\}\left\{1 - G\left[R_2(a,b)\right]\right\} \tag{9}$$

which naturally depends on the reservation values of both spouses

The expected values of marriage. The value that an a year-old groom expects to obtain from marrying a b year-old bride who has drawn realization x_2 and has proposed to him is

$$\begin{aligned} EM_1(a,b,x_2) = u_1(x_2, y_{1,a}, y_{2,b}) + \sum_{\ell=1}^{D} \beta^{\ell} p_1(a, a{+}\ell) p_2(b, b{+}\ell) u_1(x_2, y_{1,a+\ell}, y_{2,b+\ell}) + \\ \sum_{\ell=1}^{T-a-15} \beta^{\ell} p_1(a, a{+}\ell)[1 - p_2(b, b{+}\ell)] v_1(y_{1,a+\ell}) \end{aligned} \tag{10}$$

where $D = \min\{T-a-15, T-b-15\}$. The first term of Expression (10) is the value of the first period of the marriage. The second term is the value of the marriage during its expected duration. And the third term is the utility of widowerhood during its expected duration.

The expected values of remaining single. The value that an a year-old bachelor expects to obtain from remaining single is

$$\begin{aligned} ES_1(a) = v_1(y_{1,a}) + \sum_{\ell=1}^{T-a-15} \beta^{\ell} p_1(a, a{+}\ell) \times \\ \left\{ \sum_{b=16}^{T} \gamma_1(a,b) \int_{R_1(a+\ell,b)}^{1} EM_1\left[a+\ell, b, x_2\right] g\left(x_2 \geq R_1(a+\ell,b)\right) dx_2 + \left(1 - \Gamma_{1,a+\ell}\right) v_1(y_{1,a+\ell}) \right\} \end{aligned} \tag{11}$$

[8] Notice that this notation is not exactly symmetrical for men and women. We use it because, nonetheless, we think that it is clearer.

where function g denotes the density function of the distribution of match values, G. The first term of Expression (11) is the value of remaining single during the current period, the first term in the curly brackets the expected value of getting married before a match takes place and the second term is the expected value of remaining single.

Reservation values. The optimal reservation values that a year-old men and b year-old women set for each other can be found solving the system of $2T^2$ equations in $2T^2$ unknowns that results from equating the T^2 expressions (10) and (11) for the men and the corresponding T^2 equations for the women. Formally, the $\{R_1(a,b)\}$ are the T^2 values of x_2 that solve the T^2 equations

$$EM_1\left(a, b, x_2\right) = ES_1\left(a\right) \tag{12}$$

one for each value of $a, b \in \{16, 17, \ldots, T\}$. Similarly, the $\{R_2(a,b)\}$ are the T^2 values of x_1 that solve the T^2 equations

$$EM_2\left(a, b, x_1\right) = ES_2\left(b\right) \tag{13}$$

2.10 Equilibrium

A stationary equilibrium for this economy is an invariant measure of people, $\{n_{i,j}\}$, an invariant measure of singles, $\{s_{i,j}\}$, and a matrix of the optimal reservation values that singles set for each other, $\{R_1(a,b), R_2(a,b)\}$, for $i \in \{1,2\}$ and $a, b, j \in \{16, 17, \ldots, T\}$ such that:

(i) Measure $\{n_{i,j}\}$ satisfies Expressions (1) and (2)

(ii) Measure $\{s_{i,j}\}$ satisfies

$$s_{i,16} = n_{i,16} \text{ and} \tag{14}$$

$$s_{i,j+1} = \sigma_{i,j} s_{i,j}\left(1 - \Gamma_{i,j}\right) \text{ for } j < 16 \leq T \tag{15}$$

where the $\Gamma_{i,j}$ are defined in Expression (9)

(iii) The reservation values $\{R_1(a,b),\, R_2(a,b)\}$ solve the decision problems of singles described in Expressions (12) and (13).

3 Calibration

To calibrate our model economy we must choose the duration of the model period, a functional form for the distribution function of the match values, $G(x)$, and a value for every parameter in our model economies. These parameters are the measures of 16 year-olds, $n_{i,16}$, the maximum life-time, T, the fecundity profiles, $f_{i,j}$, the earnings profiles, $y_{i,j}$, the survival probability profiles, $\sigma_{i,j}$, the discount factor, β, the parameters that characterize the payoffs, k, ϕ, and θ, and the parameter that measures the search friction, ρ.

The model period. Our main source of demographic data is the United State Census of the year 2000. To be consistent with this data source we assume the period in our model is yearly.

The distribution of the match values. We assume that the distribution of match values is a uniform distribution with support on $[0, 1]$.

The measures of 16 year-olds. We normalize the measures of 16 year-old entrants to be $n_{1,16} = n_{2,16} = 100$. According to the Census of the year 2000 the total sex ratio at age 16 in the United States was 1.04. But it declines monotonically to reach 0.95 at age 22. In our model economy we chose to make this ratio equal to one because it is approximately the average of those two values and because we take our survival probabilities from a different dataset.

The maximum life-time. We assume that $T = 92$. We choose this age because the United States Census of the year 2000 supplies information on marriages up to that age only.

The fecundity profiles. To characterize the functions that determine the fecundity profiles we must choose the values of α_i and δ_i. We choose these values so that our fecundity profiles are roughly consistent with the findings of Hassan and Killick (2003) and Wood and Weinstein (1988) discussed in Section 2.3 above. Specifically we assume that the fecundity of men is one between ages 16 and 54, that it declines linearly between ages 55 and 70, and that it is zero afterwards. Similarly, we assume that the fecundity of women is one between ages 16 and 34, that it declines linearly between ages 35 and 50, and that it zero afterwards. These choices imply that $\alpha_1 = 55$, $\delta_1 = 70$, $\alpha_2 = 35$, and $\delta_2 = 50$. We represent the fecundity profiles in Panel B of Figure 1.

The earnings profiles. To characterize the earnings profiles we fit a four-degree polynomial to the data on earnings reported in the year 2000 United States Census. In Panel C of Figure 1 we plot the actual and the fitted values of the earnings profiles.

The survival probability profiles. We take the survival probability profiles from the Human Mortality Database for the year 2000. We represent them in Panel D of Figure 1.[9]

The time discount factor. We choose $\beta = 0.96$. This choice is standard in the literature and it implies that the yearly discount rate in our model economies is four percent.

The number of children. Comparing fertility rates in our model economy and in the United States is tricky. This is because in our model economy we assume that women beget all their children instantaneously upon marriage. And because only couples that remain married for their entire lifetimes beget children. Moreover, we have assumed that $k = \mu f_{1,a} f_{2,b}$, and we have already

[9]The Human Mortality Database is compiled by the University of California, Berkeley (USA) and the Max Planck Institute for Demographic Research (Germany). This dataset is available at www.mortality.org.

chosen the values of the $f_{i,j}$. Therefore, to determine the fertility of every marriage, we have to choose the value of only one parameter, μ. We choose $\mu = 2.05$. This choice implies that the number of children that women expect to bear in our model economy coincides with the Total Fertility Rate reported by the National Center of Health Statistics for the United States economy for the year 2000.[10]

The economies of scale of marriage. To calculate the economies of scale in consumption that result from income sharing and cohabitation, we use the "OECD-modified scale". This scale was proposed by Haagenars, de Vos and Zaidi (1994). It assigns a value of 1 to the household head, a value of 0.5 to each additional adult member of the household, and a value of 0.3 to each child. Therefore, when an a year-old groom marries a b year-old bride their scale factor is $\phi = (1.5 + 0.3k)^{-1} = (1.5 + 0.3\mu f_{1,a} f_{2,b})^{-1}$. Parameter ϕ depends on the ages of the bride and the groom at the time of the marriage, and its value remains unchanged for the entire duration of the marriage. To simplify the notation, we omit the age subscripts also from this parameter.

The free parameters. To complete the calibration of our benchmark model economy we are left with two free parameters only: the parameter that measures the search friction, ρ, and the parameter that determines utility share of being part of a family, θ. To choose the numerical values of these two parameters we target the median ages of first-time brides and grooms in the United States according to the Census for the year 2000. Our numerical procedure is the following: first we define two evenly spaced grids of 100 points for θ and ρ on the interval $(0, 1)$, and then we choose the values of θ and ρ that minimize the sum of the squared differences between the median ages of first-time brides and of grooms in our model economy and our United States targets. The values of ρ and θ that deliver this result are $\rho = 0.4326$ and $\theta = 0.3594$.

Our data source. Unless otherwise indicated, our data source for all the statistics reported in this article for the United States economy is the United States Census for the year 2000.[11]

4 Findings

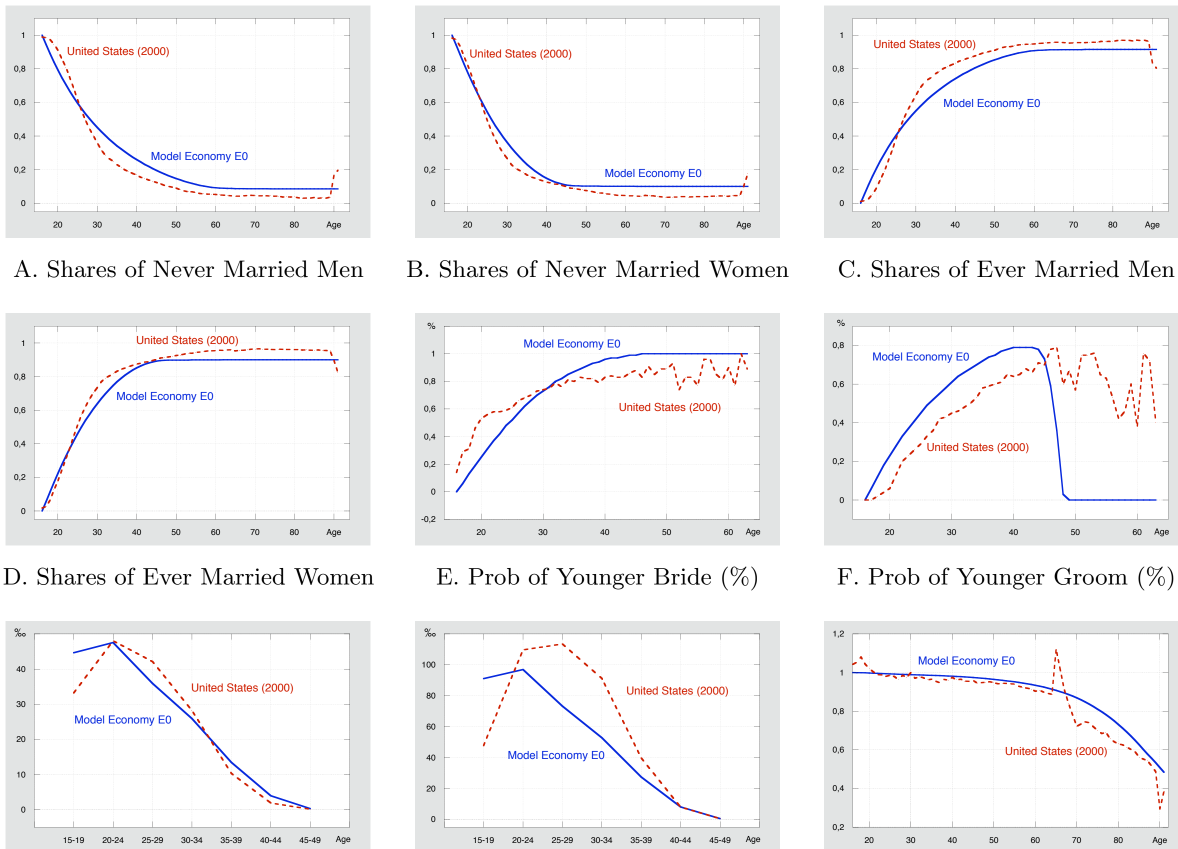
Our model economy is a double-sided search model embodied in the steady-state of an overlapping generations structure. Its salient features are the following: First, marriage is the only economic decision that we study. Second, search is costly: in our benchmark model economy the probabilities of being matched each period are 39.0 for bachelors and 43.3 percent for single women. Third, our single sex ratios are endogenous and the people in our model economies take them into account

[10]The total fertility rate computed by the National Center of Health Statistics is the sum of the birth rates of mothers in 5-year age groups multiplied by five. The birth rates are the numbers of live births per 1,000 women in a given age group. Beginning in 1970, the total fertility rate excludes the children born by nonresidents. The National Center of Health Statistics data is available at www.cdc.gov/nchs/data/statab/t991x07.pdf.

[11]The United States Census for the year 2000 uses the micro dataset collected by the Minnesota Population Center known as the Integrated Public Use Microdata Series 5 percent (see Ruggles, Sobek et al., 2003).

when they decide whether to marry. And, fourth, when all is told, we are left with only two free parameters that we calibrate using the median ages of first time brides and grooms in the United States in the year 2000 as our only targets. The first question that we address is whether we should trust our findings.

Figure 2: Calibration Results



A. Shares of Never Married Men B. Shares of Never Married Women C. Shares of Ever Married Men

D. Shares of Ever Married Women E. Prob of Younger Bride (%) F. Prob of Younger Groom (%)

G. First Birth Rates (‰) H. Total Birth Rates (‰) I: Total Sex Ratios

4.1 Findings: The Calibration Exercise

In the various panels of Figure 2 we plot the fractions of ever married and never married people, the probabilities of marrying a younger bride and a younger groom, and the first and total birth rates in the United States in the year 2000 and in the steady state of our benchmark model economy. With some exceptions, these eight panels show that, overall, the differences between our benchmark model economy numbers and the United States data are encouragingly small.

In Panels A through D of Figure 2 we report the age and sex distributions of the fractions of never and ever married people. The shapes of these four distributions are remarkably similar. If anything, after age 25 the fractions of never married people are somewhat larger in our benchmark model economy, and the fractions of ever married people somewhat smaller.

In Panels E and F we report the age distributions of the probabilities of grooms marrying younger brides and of brides marrying younger grooms. Once again, we find that, with some exceptions, the shapes of these distributions in our model economy resemble those in the United States quite closely. One of the exceptions is that in our model economy the probabilities of marrying a younger bride go to one as the grooms age in Panel E. This happens because after a certain age bachelors refuse to marry anybody older than themselves. The other exception is that in our benchmark model economy women do not marry at all once they reach age 49 and they become infecund (see Panel F).

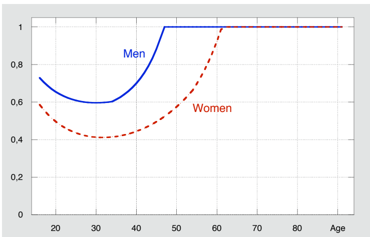
In Panels G and H of Figure 2 we report the age distributions of the first and the total birth-rates in our benchmark model economy and in the United States. These results are harder to interpret for two reasons. Because in our model economy we assume that people bear every child instantaneously when a fecund marriage is formed. And because in our model economy there are no children born out of wedlock, and there are no second marriages. In spite of these difficulties, the distributions of the first birth rates depicted in Panel G are reasonably similar in the United States and in our model economy. In the case of total birth rates, the differences are larger. This is because in our benchmark model economy total birth rates are first birth rates scaled up by a factor of 2.05. While this is obviously not the case in the United States.[12]

Finally, in Panel I of Figure 2 we report the total sex ratios in the steady state fo our benchmark model economy and in the United States in the year 2000. The shape of the two curves is reassuringly similar. This means that our assumption of equal measures of sixteen year old men and women and our estimates of the survival probabilities are a good way to approximate to the data. Naturally our model economy is too parsimonious to capture the three sizable spikes observed in the United States.

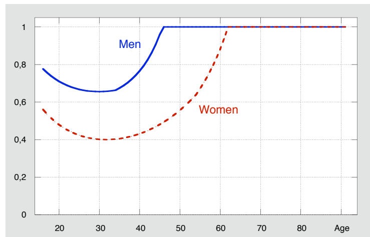
Overall, we consider our distributional results to be very encouraging. Since we did not target any of these statistics in our calibration procedure, we can treat them as if they were overidentification conditions. They have turned out to be surprisingly close to their targets. And they have convinced us that, in spite of its simplicity, our model economy is a useful abstraction to study the roles played by gender differences in fecundity and in earnings in accounting for the timing of first marriages.

[12]To compute the birth-rates in our model economy we use its stationary distribution of women and the procedure used by the National Center of Health Statistics to compute the fertility rates in the United States described in Footnote 10.

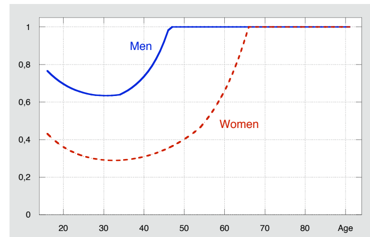
Figure 3: The Benchmark Model Economy



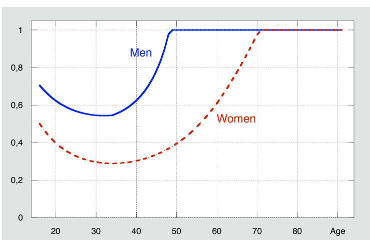
A: Reservation Values at Age 20



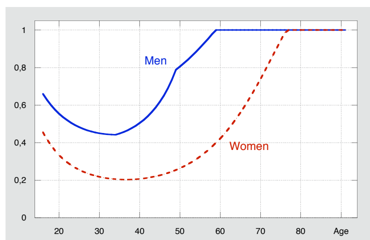
B: Reservation Values at Age 30



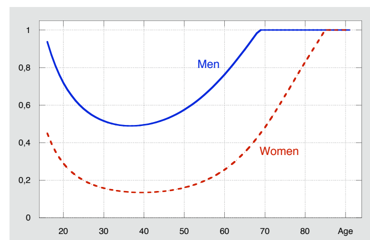
C: Reservation Values at Age 40



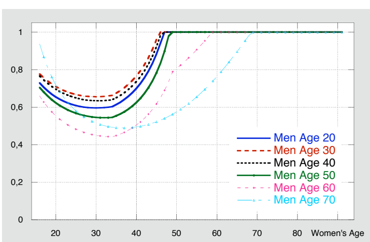
D: Reservation Values at Age 50



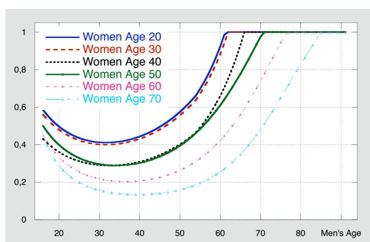
E: Reservation Values at Age 60



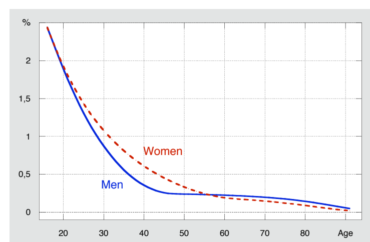
F: Reservation Values at Age 70



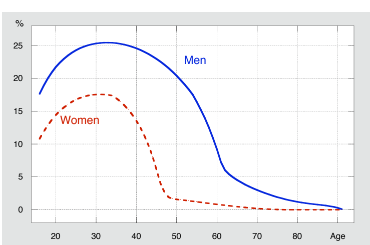
G: Reservation Values of Men



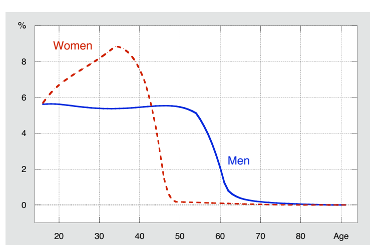
H: Reservation Values of Women



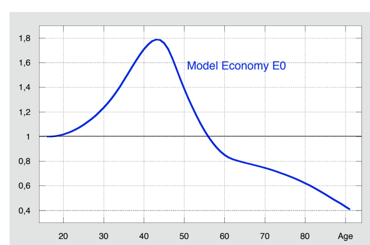
I: Match Probabilities (%)



J: Proposal Probabilities (%)



K: Marriage Probabilities (%)



L: Single Sex Ratios

4.2 Findings: The Benchmark Model Economy

In our model economies people value marriage because it allows them to partake of the joys of family-life and because it allows them to share their income with someone else's. When two singles meet they observe their ages and their match values. They compare the expected values of their marriage with the expected values of remaining single, which include the possibility of marrying somebody else sometime in the future. Their reservation values are the match values that make them indifferent between proposing and remaining single. For match values greater than their reservation values they propose, and for match values smaller than their reservation values they remain single. These reservation values are a compact way to describe the marriage decision, because they summarize both its individual and its aggregate aspects.

In Panels A through H of Figure 3 we represent the reservation values that obtain in our benchmark model economy for singles of various ages. In the horizontal axis we plot the age of the potential spouse. Qualitatively, all those figures display similar u-shapes and quantitatively, they all display similar patterns. In every graph the reservation values of the men are uniformly and sizably higher than those of the women —except in the part of their range when they are both equal to one. This means that men are choosier than women of the same age. This result is one of the main findings of our paper. It contrasts with those reported in the literature. The traditional story is that older men use their higher earnings to compete for the relatively scarce fecund women who are presumably choosier (see Siow, 1998). We show that when we consider true double-sided search this is not the case. Men are uniformly choosier than women because their higher earnings and their sizably longer fecund period allow them to be uniformly and sizably more demanding than women of their same age.

This finding is confirmed by two additional features that are common to every panel. The first one is that the minima of the reservation values of men occur at a younger age of the potential spouse than those of women of the same age. This means that the most preferred spouses for men are always younger than the most preferred spouses for women of the same age. The second one is that in every single case the reservation values of the men reach 1.00 many years before those of women of the same age. We interpret a reservation value of 1.00 to mean that a person does not marry anybody of that age regardless of their match quality. Once again, the lower earnings and their shorter fecundity spans make women accept spouses that are very much older than they are, while the men are very much less willing to do so.

We next discuss one of the panels, say Panel B, in some detail. Panel B represents the reservation values of thirty year-old singles. At thirty, both men and women are maximally fecund. Consider the case of men first. The reservation value of thirty year-old men for 16 year-old women is 0.78. It decreases monotonically with the woman's age until it reaches its minimum at 0.66 for thirty year-old women. This is because thirty year-old women are still maximally fecund, and because their higher earnings more than compensate for their higher mortality risk. The reservation values of thirty year-old men increase monotonically for women older than thirty, and they reach a value of 1.00 at age 46. This is because the lower fecundity and the higher mortality risk of older women reduce their value as spouses, and they more than compensate for their higher earnings. Notice that the graph becomes steeper when women's fecundity starts to decrease after age 35, and that it reaches 1.00 at age 46 when the women's fecundity is only 0.2.

Next consider the case of thirty year-old women. The shape of their reservation value function is very similar to the one of thirty year-old men, but their lower earnings and the pressure of their biological clock —they only have four years left of full fecundity— conspire to make women much less choosy. The reservation value of thirty year-old women for 16 year-old men is only 0.56 and it decreases with the men's age until it reaches its minimum at 0.4 for 32 year-old men. Notice that this minimum is 0.24 smaller than that of thirty year-old men. And also that the most desired men for thirty year-old women are aged 32, while the most desired women for thirty year-old men are aged only thirty. Finally, thirty year-old women are willing to marry older men to age 61. This is because the fecundity of 61 year-old men is still reasonably high (0.53), and so are their earnings (1.35).

In Panel G of Figure 3 we report the reservation values of men of ages 20, 30, 40, 50, 60, and 70, and in Panel H we report the corresponding values for women. We find that the highest graph corresponds to the thirty year-old men, followed by the forty year-olds and by the twenty year-olds. Fifty and sixty year-olds come next, and seventy year olds are somewhat different. Thirty year-old men are the choosiest. This is because they are maximally fecund and their earnings are already fairly high. Consequently their value as spouses is high. Moreover their value of remaining single is also high because they are young enough to afford to do some further resampling in the future. Forty year-olds, although still maximally fecund and earnings richer than thirty year-olds, are a bit more in a hurry. Therefore they are willing to accept matches of a somewhat lower quality. Twenty year-olds come next because their earnings are still in the lower part of their range and this reduces both their value as spouses and their value of remaining single. Seventy year old men can no longer have children. This makes them raise their reservation values for young women because their fecundity is irrelevant and they are earnings poor.

Panel H shows some interesting differences in the case of women. Their reduced fecundity span makes twenty year-old women the choosiest because they are the ones who can afford to wait the longest. Thirty year-olds come in at a close second place. And the gap between them and both forty and fifty year-olds, whose reservation values are very similar, is large. Forty year-old women are still fecund and they refuse to marry infecund men. Not so fifty year-olds who are willing to marry men to age 71. Therefore, forty year-old women are choosier than fifty year-olds when it comes to men who are older than 34. In contrast, since fifty year-old women can no longer have children, they are more demanding when it comes to younger men because their earnings are low.

This makes fifty year-old women choosier than forty year-olds when it comes to men up to age 34. Sixty and seventy year olds are willing to marry almost anyone because they are both infecund and earnings poor.

In Panels I, J and K of Figure 3 we report the probabilities of being matched, of receiving a proposal, and of marrying. The probabilities of being matched are decreasing with age because the shares of singles are also decreasing in age. Since women marry younger than men the probabilities of being matched are higher for young women than for young men. After age 55 this relation is reversed. This is because most men have already married, and because the mortality rate of older men is higher than the mortality rate of older women. Panel J shows that men of all ages receive more proposals than women of the same age, and it confirms that men are the more sought after than women.[13] Panel K is much more interesting because the shape of the marriage probabilities of women are very different from those of men. The marriage hazards of young women are increasing until age 34 and they decrease steeply afterwards. In contrast the marriage hazards of young men are almost constant between 16 and 54 and they decrease steeply after that age. This illustrates the large role played by fecundity in our benchmark model economy. Marriage probabilities start to decrease exactly at the same age as fecundity both for men and for women.

Finally, in Panel L of Figure 3 we report the single sex ratios, which we define as the number of bachelors divided by the number of single women. We find that the single sex ratios are greater than one and hump-shaped between ages 16 and 56. This is because women are less choosy than men of their same age and, consequently, they marry younger. They reach a maximum value of 1.79 at age 43, and they are less than one form age 57 onwards. As we have already mentioned, this is because at age 57 most of the men have already married, and because the higher mortality rates of older men start to reduce their numbers faster than those of older women.

4.3 Findings: Earnings and fecundity in the timing of first marriages

To quantify the contributions of gender differences in earnings and in fecundity to account for the timing of first marriages, we solve three counterfactual model economies. In the first counterfactual model economy men and women are exactly alike. They all have the same life-time earnings and fecundity profiles as the men in the benchmark model economy, and the same survival probabilities as the women. We call this model economy Economy E1. In the second counterfactual model economy men and women differ in their earnings profiles only, and in the third one they differ in their fecundity profiles only. We call these model economies Economy E2 and Economy E3. In Table 2 we report the main statistics that describe marriage behavior in these model economies. In Figures 4 and 5 we plot several the reservation values of people of various ages, and the match,

[13] This is clearly not the case in the real world. Perhaps because traditional women propose indirectly signaling their willingness to marry.

proposal, and marriage probabilities in these model economies.

Table 2: Median Ages, Shares of Never Married People, and Sex Ratios

	US[a]	E0[b]	E1[c]	E2[d]	E3[e]	Δ^f_{21}	Δ^g_{31}
Groom's Median Age at First Marriage	26.70	26.67	25.57	25.84	26.98	0.27	1.41
Bride's Median Age at First Marriage	24.79	24.77	25.57	25.74	24.46	0.17	–1.11
Median Age Difference at First Marriage	1.91	1.91	0.00	0.11	2.52	0.11	2.52
Share of Never Married Men (%)	0.28	0.30	0.23	0.25	0.28	0.02	0.05
Share of Never Married Women (%)	0.23	0.25	0.23	0.24	0.23	0.01	0.00
Never Married Sex Ratio (M/W)	1.13	1.11	1.00	1.04	1.19	0.04	0.19
Total Sex Ratio (M/W)	0.92	0.93	1.00	1.00	1.00	0.00	0.00

[a] United States Economy: The data are taken from U:S. Census data for the year 2000.

[b] Economy E0: The benchmark model economy. The earnings and fecundity profiles and the survival probabilities of men and women are taken directly from United States data.

[c] Economy E1: Men and women are identical. They all have the earnings and fecundity profiles of the benchmark model economy men and the survival probabilities of the benchmark model economy women.

[d] Economy E2: Men and women differ in their earnings profiles only.

[e] Economy E3: Men and women differ in their fecundity profiles only.

[f] Differences between the statistics in Economies E2 and E1.

[g] Differences between the statistics in Economies E3 and E1.

4.3.1 Earnings and the timing of first marriages

First, we discuss the role of earnings in accounting for the timing of first marriages. To do so we compare counterfactual Economies E1 and E2. In Economy E1 men and women are exactly alike, and in Economy E2 they differ in their earnings profiles only. In Economy E2 women's earnings are smaller in each and every period of their lives. Reducing the earnings of women reduces their value of being single and makes them more eager to marry. Consequently, they lower their reservation values for every man at every age. Panels A through F of Figure 4 confirm this reasoning.

Moreover, reducing the earnings profile of women reduces the value of married life for men, who now have to make do with poorer spouses. Therefore, marriage becomes a less attractive alternative for men in Economy E2, and they increase their reservation match values for every woman and at every age. Panels G through L of Figure 4 confirm this reasoning. These combined effects decrease the number of proposals received by women of every age and they increase the number of proposals received by men of every age (see Panels M and P). They lower the marriage probabilities of women, specially at both ends of their life-cycle (see Panel N). And they also lower the marriage probabilities of women, except at both ends of their life-cycle where they increase slightly (see Panel Q).

Panels A through F of Figure 5 show that reducing the earnings of women drives a wedge between the reservation values of men and women of every age. Since men become choosier and women become less choosy their median ages at first marriage could go either way. It turns out that increasing the earnings profile of women delays the median age at first marriage of both men and women. Men's median age by 0.27 years —from 25.57 in Economy E1 to 25.84 in Economy E2— and women's by 0.17 years —from 25.57 to 25.74 (see Table 2). When we put these two effects together, it turns out that increasing the earnings of women reduces the age difference at first marriage by only 0.11 years.

4.3.2 Fecundity and the timing of first marriages

To evaluate the role played by fecundity in accounting for the timing of first marriages, we compare counterfactual Economies E1 and E3. In Economy E1 men and women are exactly alike, and in Economy E3 they differ in their fecundity profiles only. In Economy E3 the fecundity of women starts to decrease at 35 and they become barren at 49, just like in our benchmark model economy.

We find that reducing the fecundity of women changes their reservation values in an interesting way that is not monotonic in their age. Panels A, B, and C of Figure 4 show that twenty, thirty, and forty year old women become less choosy in Economy E3 than in Economy E1. Panels D and E show that fifty and sixty year-old women become choosier in Economy E3. And Panel F shows that the reservation values of women who are seventy are identical in Economies E1 and E3.

Twenty year-old women are almost indifferent between Economies E1 and E3 because, even though they are less fecund in Economy E3 and this reduces their life-time value, at twenty they still have fifteen years of full fecundity ahead of them, and this is ample time for them to find a good spouse. Moreover, their search costs are sizably smaller in Economy E3 than in Economy E1 because the bachelors are relatively more abundant (see Panel O of Figure 4). Thirty and forty year-old women are sizably less choosy in Economy E3 because the increased pressure from their biological clocks increases their search costs, and it reduces their values of being single which include resampling again in the future.

The cases of fifty and sixty year-old women are perhaps the most interesting. In Economy E3 fifty and sixty year-old women can no longer bear children, and this makes them demand a high match value if they are to marry. In contrast, in Economy E1 fifty and sixty year-old women are still fecund and they are approaching the end of their fecund years —in Economy E1 their fecundity starts to decrease at age 55 and they become infecund at age 69. This makes them eager to get married and willing to accept a spouse with a lower match value, as long as he is fecund. This substitution effect between children and match value is reinforced at age fifty by the fact that the singles sex ratio is still sizably higher in Economy E3 than Economy E1. Consequently, fifty and sixty year-old women are choosier in the low fecundity world of Economy E3.

The case of seventy year old women is different. Their reservation values are the same in

Economies E1 and E3 because at that age they are infecund in both models. Therefore, nothing has changed for them. With twenty, thirty, and forty year-olds being less choosy, and fifty and sixty year-olds being choosier, the aggregate result could go either way. However, since in Economy E3 approximately eighty percent of the women marry before they are forty, it turns out that the reduced choosiness of younger women brought about by the increased pressures from their biological clocks dominates, and makes women marry significantly earlier in Economy E3 than in Economy E1.

Panels G through K of Figure 4 show that reducing the fecundity of women increases the value of younger women slightly for men who are between 20 and 60 years old, and that it reduces the value of older women sizably for these same men. By older women we mean those who are fecund in Economy E1 but who are barren in Economy E3. Age 35 is precisely when the fecundity of women in Economy E3 starts to decrease, and the crossing points of the reservation value functions of fecund men are between 34 and 39 years in every case. Finally, Panel L of Figure 4 shows that the reservation values of 70 year old men in Economies E1 and E3 are identical. This is because 70 year-old men are no longer fertile and therefore they are indifferent to the increased fertility of women.

Moreover, when there are no gender differences in fecundity, younger men are willing to marry women up to a sizably older age. Consider for instance the case of thirty year old men depicted in Panel H of Figure 4. While in Economy E1 thirty year old bachelors are willing to marry up to 59 year-old women, in Economy E3 they refuse to marry any woman older than 48.

Panels M and N of Figure 4 show that young women receive more proposals and are more likely to marry in Economy E3 than in Economy E1, and that the situation is reversed for older women. The crossing points of the proposal and marriage hazard functions occur when women are in their early forties. Interestingly Panels P and Q of that same figure show that men receive less proposals during most of their life-times and are less likely to marry in Economy E3 than in Economy E1. This is because the reduced fecundity of women reduces quite sizably the value of marriage for both women and men.

Panel O of Figure 4 shows that in Economy E3 fecund women are clearly the short side of the marriage market. Specifically, the single sex ratio increases continuously from age 16 onwards and it reaches a maximum of no less than 1.83 at age 44. At age 49, when women are no longer fecund, it is still 1.65. The literature has picked up on this result, and it has interpreted it to imply that this gives market power to fecund women who demand some form of compensation if they are to marry. But in this article we tell a different story. Essentially we show that women's shorter biological clock is a mixed blessing. It gives market power to young women in their twenties and it makes them choosier than young men of the same age (see Panel G of Figure 5). But, by age 30 this situation is already reversed. In spite of women still being by far the short side of the market, the increased pressure of their biological clocks make 30 and 40 year old women less choosy than men of their same age (see Panels H and I of Figure 5). We interpret this to mean that if there was any compensation to induce people to marry it would go the other way, and women would have to compensate men.

As we report in Table 2), when we put all these effects together, it turns out that decreasing the fecundity of women delays the median age of first-time grooms by 1.57 years; from 25.57 years in the Economy E1 to 27.14 in Economy E3. And that it advances the median age of first time brides by 1.22 years; from 25.57 to 24.35 years. The resulting gender age difference at at first marriage is a whooping 2.79 years. Which dwarfs the 0.11 years that result from the differences in wages.

5 Concluding comments

In this article we study a simple model of the marriage market where singles search for spouses. We show that modeling the marriage decision only in a very simple overlapping generations model economy is sufficient to account for much of the observed marriage behavior in the United States in the year 2000. The previous literature on the timing of marriages claims that marriage is a waiting game in which women are choosier than men, and in which old and rich pretenders outbid the young and poor ones in their competition for fecund women. We tell a different story. We show that their shorter biological clocks make women uniformly less choosy than men of the same age. This turns marriage into a rushing game in which women are willing to marry older men, because delaying marriage is too costly for women. Our theory shows that the role played by gender differences in fecundity is sizably larger than the role played by gender differences in earnings in accounting for the age difference at first marriages. It predicts that most of the gender age difference at first marriage will persist even if the gender wage-gap disappears. And it also predicts that the advances in the reproductive technologies are playing and will play a large role in reducing the age difference at first marriage.

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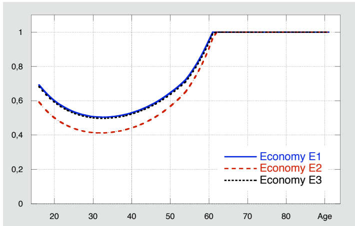
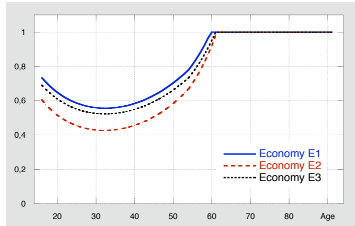
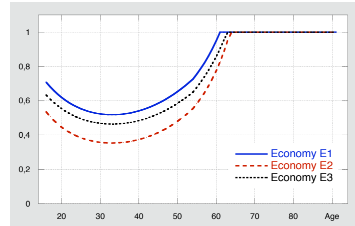
Figure 4: The Roles of Earnings and Fecundity Compared (1)



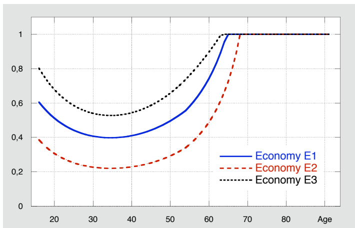
A: Res Val of Women at Age 20



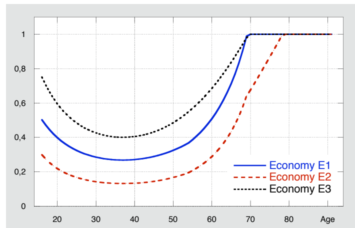
B: Res Val of Women at Age 30



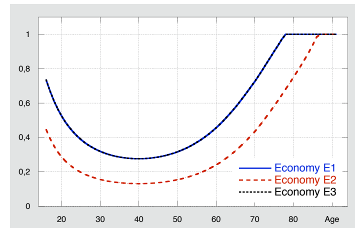
C: Res Val of Women at Age 40



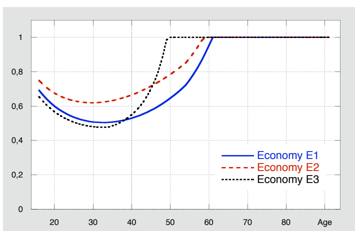
D: Res Val of Women at Age 50



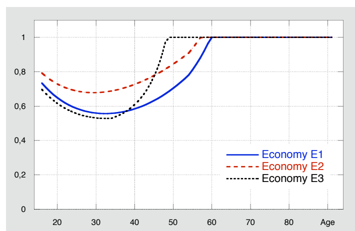
E: Res Val of Women at Age 60



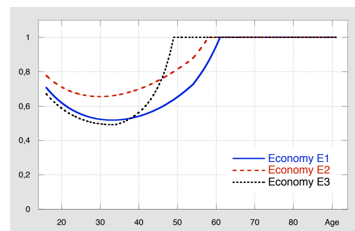
F: Res Val of Women at Age 70



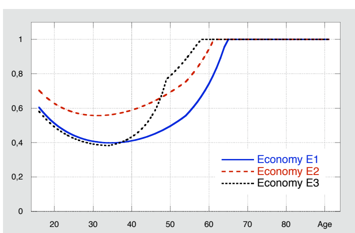
G: Res Val of Men at Age 20



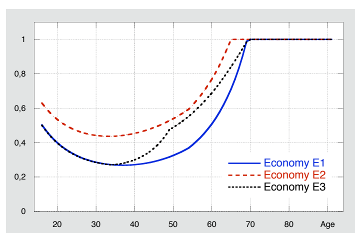
H: Res Val of Men at Age 30



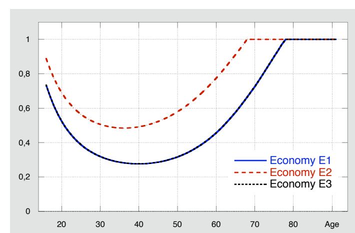
I: Res Val of Men at Age 40



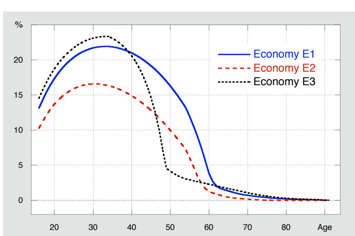
J: Res Val of Men at Age 50



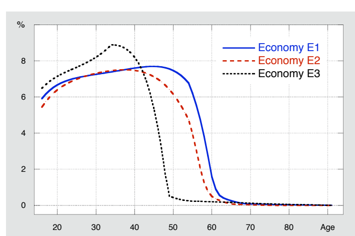
K: Res Val of Men at Age 60



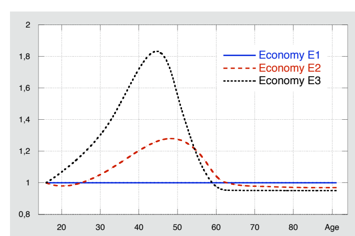
L: Res Val of Men at Age 70



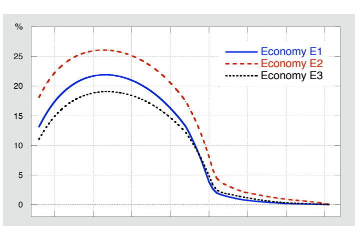
M: Proposal Probs for Women (%)



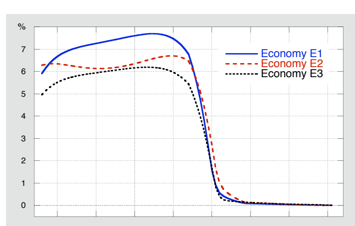
N: Marriage Probs for Women (%)



O: Single Sex Ratios

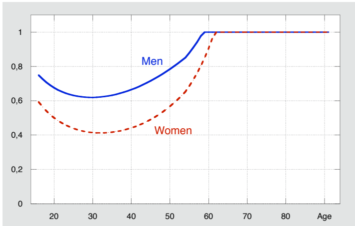


P: Proposal Probs for Men (%)

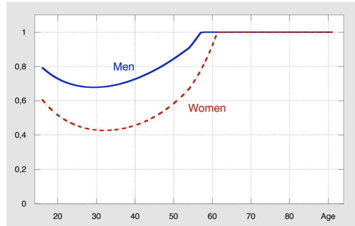


Q: Marriage Probs for Men (%)

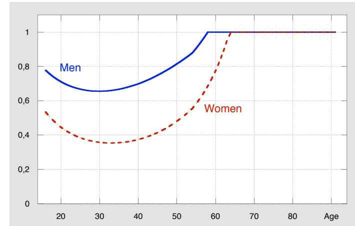
Figure 5: The Roles of Earnings and Fecundity Compared (and 2)



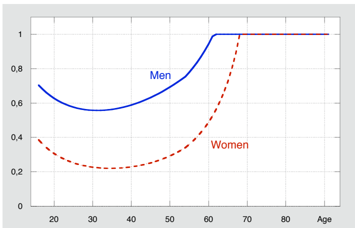
A: Res Val at Age 20 in E2



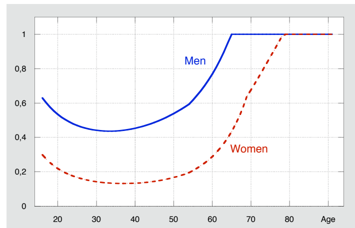
B: Res Val at Age 30 in E2



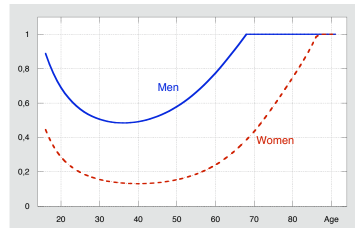
C: Res Val at Age 40 in E2



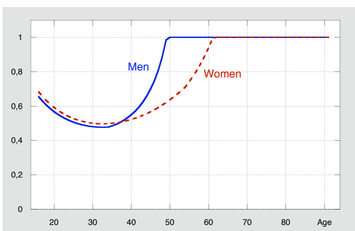
D: Res Val at Age 50 in E2



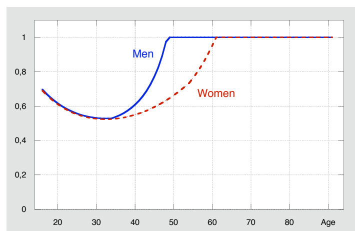
E: Res Val at Age 60 in E2



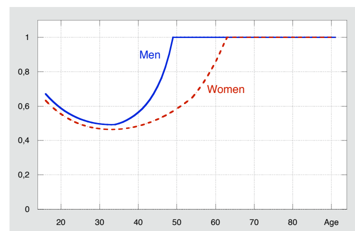
F: Res Val at Age 70 in E2



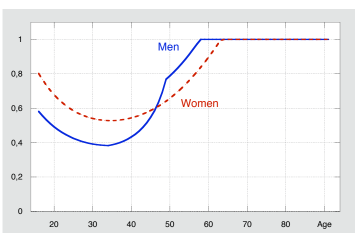
G: Res Val at Age 20 in E3



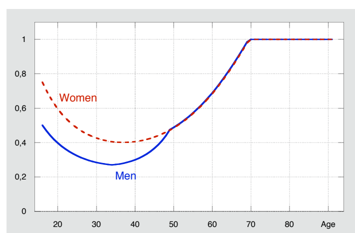
H: Res Val at Age 30 in E3



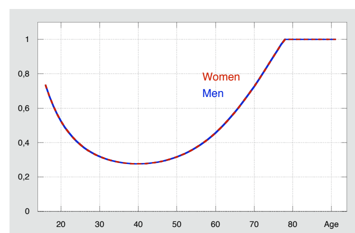
I: Res Val at Age 40 in E3



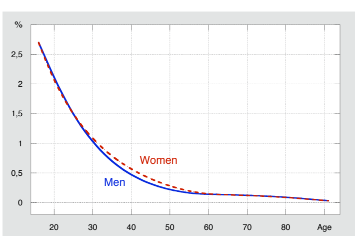
J: Res Val at Age 50 in E3



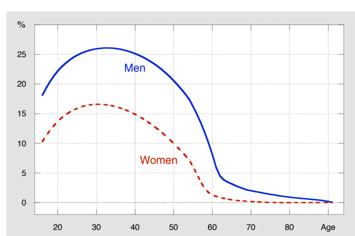
K: Res Val at Age 60 in E3



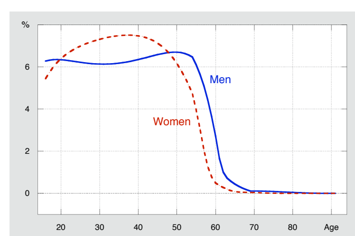
L: Res Val at Age 70 in E3



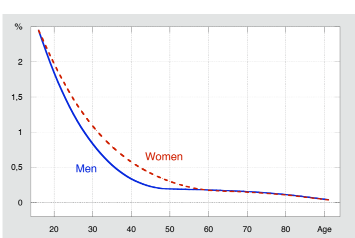
M: Match Probs in E2 (%)



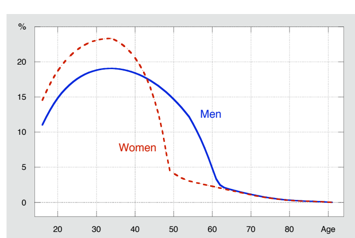
N: Proposal Probs in E2 (%)



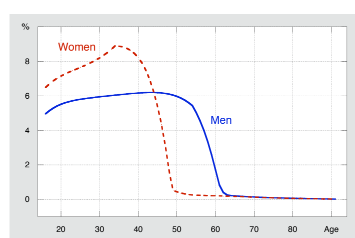
O: Marriage Probs in E2 (%)



P: Match Probs in E3 (%)



Q: Proposal Probs in E3 (%)



R: Marriage Probs in E3 (%)