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Departamento de Economía
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (34) 91 6249875

Gender Differences and the Timing of First Marriages*

Javier Díaz-Giménez
Department of Economics, Universidad Carlos III de Madrid and CAERP

Eugenio P. Giolito
Department of Economics, Universidad Carlos III de Madrid and IZA

Abstract

In this article we provide a simple model of the marriage market where singles search for spouses. In our model economy men and women live for many years and they differ in their survival probabilities, in their fecundity, and in their earnings. We show that modelling the marriage decision in a very simple model economy is sufficient to account for much of the observed marriage behavior in the United States in the year 2000. We conclude that gender differences in fecundity are all important in accounting for marriage behavior, and that differences in earnings matter little. We also conclude that, even though they are in short supply, the market power of fecund women is not enough for them to demand compensation in all cases. And that studying the marriage decision without modelling explicitly the roles played by age and by fecundity, as has been typically done by the previous literature, makes little sense.

Keywords: Marriage, Search, Sex ratio.
JEL Classification: J12, D83.

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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). In this article we try to understand what determines the timing of first marriages and we quantify the roles played by gender differences in earnings and fecundity in determining this timing. We find that gender differences in fecundity are all important and that differences in earnings matter little.

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. As in the real world, in our model economies people marry because they value each other's company, because they value bearing children, and because they value the income sharing features of marriage. Unlike the real world, in our model economies marriages last until "death does them apart" and widows and widowers never remarry. We assume also that the only economic decision that singles make is whether to marry, and that married 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.

Unlike the real world, love plays no role in our model economies. In our model economies, when two people meet, they each draw a realization of a random process that determines the value of that match for the other partner. Based on this match value, on the partner's age, and on the partner's earnings and fecundity profiles, they compute their expected life-time values of the marriage. They compare them with their expected values of remaining single. And they decide whether to propose. When both partners propose the meeting ends up in a marriage. Otherwise both partners remain single until they participate in a meeting that ends up in a marriage sometime in the future. Important features of this article are that we consider people's age as an explicit determinant of marriage behavior, that we model the search for spouses as a costly activity, that we endogenize the single sex ratios fully, and that we take the literature one step further by making our arguments fully quantitative.

As in the real world, 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 probabilities directly from United States data (see Panels B, C, D, and E of Figure 1). Naturally, in our setup the decision of whether to marry depends crucially on the shape of the utility function and on the utility shares of childbearing and company and marital income, which we lump together for convenience. We assume a fairly standard utility function with unit elasticity of substitution between its arguments. We show that our benchmark model economy approximates the main United States marriage-related age distributions to a comfortingly large extent (see Figure 2). And that it does so using only two free parameters.

Once we have established that our model world is a reasonable abstraction to study the timing of first marriages, we use it to quantify the roles played by earnings and fecundity in determining this timing. To do so we solve three counterfactual model economies. In the first 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. 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.

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. 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 only is even more interesting. This is because reducing the fecundity of women makes younger women more attractive to men, and older women less so. Consequently, reducing the fecundity of women leads men to lower their reservation values for younger women, and to raise 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 young 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, 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. And it leads us to conclude that, to account for the timing of first marriages quantitatively, gender differences in fecundity are all important and gender differences in earnings matter little.

Previous literature and the contribution of this article. There is a large body of literature on the implications of gender differences for marriage behavior in biology, 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. Like we do, the only economic decision that they study is when to marry. People in their model economy differ in match quality. But unlike us, 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 —albeit by construction. 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] The wait is over: the model economies described in this article include these two features.

The next path-breaking milestone 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 where risky human capital accumulation, parental investment in children, and labor markets interact with the marriage decision and determine 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 successful old men 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 study the roles played by gender differences in fecundity and earnings in accounting for the timing of marriages. And we quantify their significance.

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

[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.

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 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 —even though it 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 work related with this article is Caucutt, Guner and Knowles (2003), who constructed a general equilibrium model of the timing of fertility and human capital accumulation. They also model a marital process, which is the main force driving fertility delay. As children demand time and salaries depend on labor experience (given the exogenous agent's productivity), high productivity women have incentives to delay marriage and fertility and therefore they become choosy in the marriage market. By delaying marriage, they are able to marry a high productivity man in the future. The main result is that fertility rates are declining in family income and lower-wage women have children earlier than do higher-wage women. As in their model women marry men or their same generation, differences in marriage timing between men and women are not analyzed in this paper.[5]

Three recent unpublished contributions to the literature of marriage that are both important and somehow related to this article are Regalía and Ríos-Rull (2001), Giolito (2005), and Seitz (2007). 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. And 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.

[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).

Giolito (2005) is a follow up of Giolito (2003) and it is an immediate precursor of this article. He is the first to introduce age as a source of agents' heterogeneity (in addition of being a state variable) in a search model of marriage. He also the first to endogenize the single sex ratios fully and to replicate the age distributions of newly-weds. Our model economy has inherited these three features. Giolito (2005) studies a world men and women differ in fecundity and mortality only. He shows that differences in fecundity suffice to account for most of the observed features of the timing of marriages, if 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 world only partially. Moreover, she includes individual uncertainty and she endogenizes the 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.

Summing up, our contribution to the literature on marriage is the following: We focus on the timing of marriages. We model the search for spouses as a costly activity. We endogenize the single sex ratios fully. We consider people's age as an explicit determinant of their marriage decisions. And we show that it plays a key role in determining marriage behavior.

2 The model economy

We study a model of the marriage market whose participants are 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 $j = 16, 17, \ldots, T$. Our model economy men and women can be either single or married. And they may also differ in their earnings, in their fecundity, and in their longevity. Both men and women 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 partner's age, fecundity and earnings they decide whether or not to propose. A meeting ends up in a marriage when both partners propose. Otherwise both partners remain single and may 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 people make no economic decisions whatsoever.

2.1 Population dynamics

Each period every person in our model economy faces an exogenous probability of surviving until the following period. We denote these probabilities by σ_{ij} 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, $\{n_{it}(j)\}$, is

$$n_{it}(16) = n_i(16) \text{ for all } t \text{ and} \tag{1}$$

$$n_{i,t+1}(j) = \sigma_{ij} n_{it}(j) \text{ for } 16 < j \leq T \tag{2}$$

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, then the age-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, then all the age-sex ratios and the total sex ratio are identical and equal to the sex ratio of sixteen year-olds. We denote this ratio by $g(16) = n_1(16)/n_2(16)$, where variable $g(i)$ is the sex ratio of people of age i.[6] Finally, our assumptions also imply that the probability that an a year-old person of gender i survives until age b is

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

2.2 Earnings

To model 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_{ij}.

[6] Notice that, even though people get married in heterosexual pairs, the age-sex ratios of singles differ from age-sex ratios of the total population because they depend on the marriage behavior.

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, especially after ages 45 to 50 leads to a significant increase in the time to pregnancy.

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 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, after age 40, total fecundability changes rapidly as a result of large changes in the ovarian function. Between ages 25 and 40, total fecundability 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. Even accounting for intra-uterine loss, however, the pattern of effective fecundability remains fairly flat between ages 20 and 35.

Modeling these diffuse findings is not easy. We compromise as follows: We use f_{ij} to denote that the probability that a person of gender i bears children at age j. We assume that this probability is equal to 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, α_i and δ_i vary for men and women. Formally,

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

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 $k = \mu f_{1a} f_{2b}$. Notice that the value of k is determined at the moment of the 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

To model the intangible values of marriage such as companionship and sexual fulfilment we assume that when two people meet, they each draw an independent realization from a random process that determines the value of that match for the other partner. We denote the realizations by $x_i \in [0, 1]$, and the distribution by $G(x)$.

2.6 The marriage contract

As we have already mentioned, in our model economy 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.

Although these assumptions may seem somewhat extreme, 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 in that dataset. That same Table shows that in only 11.5 percent of the marriages a never previously married bride married a divorced groom and 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 idea is that the probability of participating in a meeting depends on the ratio of available singles. Since this ratio is fully endogenous in our model economies , our matching function is also the way in which the aggregate effects 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

$$q_1(b) = \rho \left[\min\left(\frac{S_1}{S_2}, 1\right)\right] \frac{s_2(b)}{S_2} \tag{5}$$

In Expression (5) we use parameter $0 < \rho < 1$ to measure the search frictions. Naturally the closer that parameter ρ is to zero the less meetings there are and, consequently, the less marriages. Notice that the probabilities of meeting a single woman of any given age are the same for single men of every age. Also, 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 single men only. To obtain the corresponding variables for 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 $q_2(a) = \rho\,[\min(S_2/S_1, 1)]\, s_1(a)/S_1$.

2.8 Payoffs

Let an a year-old single man meet a b year-old single woman who has drawn a match quality x_2. If they both propose to each other the meeting ends up in a marriage. And, while both spouses are alive, the period utility for the husband is

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

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. As is the case with parameters k, 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 (see Section 3 for a detailed description of this parameter).

If either partner fails to propose, then they both remain single, and the man's period utility is

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

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

2.9 The decision problem of singles

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

The probability of receiving a proposal. The probability that an a year-old man meets and receives a marriage proposal from a b year-old woman is

$$\lambda_1\left(a,b\right) = q_1(b)\left\{1 - G\left[R_2\left(a,b\right)\right]\right\} \tag{8}$$

where $R_2\left(a,b\right)$ is the reservation value that b year-old women set for a year-old men. The first term of Expression (8) is the probability that the meeting takes place, and the second term is the probability that the woman makes the proposal.

The probability of accepting the proposal and marrying. The probability that an a year-old man accepts the proposal of a b year-old woman and marries her is

$$\gamma_1\left(a,b\right) = \lambda_1\left(a,b\right)\left\{1 - G\left[R_1\left(a,b\right)\right]\right\} \tag{9}$$

where $R_1\left(a,b\right)$ is the reservation value that a year-old men set for b year-old women. The first term of Expression (9) is the probability of receiving the proposal and the second term is the probability of accepting it. Consequently, the probability that a single a year-old man marries a woman of any age is

$$\Gamma_1(a) = \sum_{b=16}^{T} \gamma_1(a,b) \tag{10}$$

Naturally the probability of a marriage depends on the reservation values of both spouses. Specifically, it is straight-forward to show that

$$\Gamma_1(a) = \sum_{b=16}^{T} q_1(b)\left\{1 - G\left[R_2(a,b)\right]\right\}\left\{1 - G\left[R_1(a,b)\right]\right\}. \tag{11}$$

The expected value of marrying. 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

$$EM_1(a,b,x_2) = u_1(x_2, y_{1a}, y_{2b}) + \sum_{\ell=1}^{D} \beta^{\ell} p_1(a,a+\ell) p_2(b,b+\ell) u_1(x_2, y_{1,a+\ell}, y_{2,b+\ell}) + \sum_{\ell=1}^{T-a-15} \beta^{\ell} p_1(a,a+\ell)[1 - p_2(b,b+\ell)] v_1(y_{1,a+\ell}) \tag{12}$$

where $D = \min\{T-a-15, T-b-15\}$. The first term of Expression (12) 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 value of remaining single. The value that an a year-old man expects to obtain from remaining single is

$$ES_1(a) = v_1(y_{1a}) + \sum_{\ell=1}^{T-a-15} \beta^{\ell} p_1(a,a+\ell) \times \left\{ \sum_{b=16}^{T} \gamma_1(a,b)\, EM_1\left[a,b,x_2 \mid x_2 \geq R_1(a,b)\right] + \left[1 - \Gamma_1(a+\ell)\right] v_1(y_{1,a+\ell}) \right\} \tag{13}$$

The first term in the curly brackets of Expression (13) is the expected value of getting married before a meeting 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 (12) and (13) 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

$$EM_1(a,b,x_2) = ES_1(a) \tag{14}$$

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

$$EM_2(a,b,x_1) = ES_2(b) \tag{15}$$

2.10 Equilibrium

A stationary equilibrium for this economy is an invariant measure of people, singles, and married people, $\{n_i(j),\ s_i(j),\ m_i(j)\}$ 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

$$s_i(16) = n_i(16) \text{ and} \tag{16}$$

$$s_i(j+1) = \sigma_{ij}\,[1-\Gamma_i(j)]\,s_i(j) \text{ for } j < 16 \leq T \tag{17}$$

where the $\Gamma_i(j)$ are defined in Expression (10)

(iii) Measure $\{m_i(j)\}$ satisfies

$$m_i(j) = n_i(j) - s_i(j) \tag{18}$$

(iv) The reservation values $\{R_1(a,b),\ R_2(a,b)\}$ solve the decision problems of singles described in Expressions (14) and (15).

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 maximum life-time, T, the measures of 16 year-olds, $n_i(16)$, the survival probabilities, σ_{ij}, the limits of the fecundity functions, α_i and δ_i, the life-time profiles of earnings, y_{ij}, the discount factor, β, the parameters that characterize the payoffs, k, ϕ, and θ, and the parameter that measures the search friction, ρ.

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 than the model period is yearly.

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

Maximum life-time, T. 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.

Measures of 16 year-olds, n_i. 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.

Survival probabilities, σ_{ij}. We take the survival probabilities from the Human Mortality Database for the year 2000. See Panel A of Figure 1.[7]

Fecundity functions, α_i and δ_i. We choose the limits of the fecundity function to be 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 equal to one between ages 16 and 54, that it declines linearly between ages 55 and 70, and that it is equal to zero afterwards. Similarly, we assume that the fecundity of women is equal to one between ages 16 and 34, that it declines linearly between ages 35 and 70, and that it is equal to zero afterwards. Consequently $\alpha_1 = 55$, $\alpha_2 = 35$, $\delta_1 = 70$, and $\delta_2 = 50$. See Panel B of Figure 1.

Wage profiles, y_{ij}. To characterize the gender and age profiles of wages we fit a four-degree polynomial to the data on earnings reported in the year 2000 United States Census. See Panel C of Figure 1.

Discount factor, β. We choose $\beta = 0.96$. This choice is standard in the literature and it implies that the yearly discount rate is four percent.

The number of children, k. Comparing fertility rates in our model economy and in the United States is tricky. This 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 $k = \mu f_{1a} f_{2b}$ and we have already chosen the values of the f_{ij}. 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 Total Fertility Rate reported by the National Center of Health Statistics for the United States economy for the year 2000.[8]

The economies of scale of marriage, ϕ. 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

[7]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.

[8]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.

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 $\phi = (1.5 + 0.3k)^{-1} = (1.5 + 0.3\mu f_{1a} f_{2b})^{-1}$. 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.

Free Parameters, ρ and θ. 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 model economy median ages of first-time brides and of grooms and our targets. The values of ρ and θ that deliver this result are $\rho = 0.4326$ and $\theta = 0.3594$.

Data Sources. 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.[9]

4 Findings

The mechanism behind the workings or our model economy is deceivingly simple. It is a double-sided search model embodied in an overlapping generations economy. Our model economy is populated by people who live for many years, who receive a deterministic endowment of earnings, who have a deterministic and age-dependent fecundity, and whose lifetime durations are random. Singles meet randomly and they decide whether to marry. Nobody else makes any other economic decisions whatsoever. Since we assume that the numbers of sixteen year-olds that enter the model economy and the survival probabilities remain constant, the model economy's age and sex distribution of people becomes stationary. The utility function and the search friction carry virtually all the weight of delivering our results. When all is told, our model economy has only two free parameters. The targets that we choose to determine their values are two aggregate statistics: the median ages at marriage of first-time brides and grooms in the United States. We do not use any distributional statistics whatsoever as part of our calibration targets. Why then should we trust our findings?

[9] 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).

4.1 Reasons to trust our findings

Our findings are trustworthy because our benchmark model economy replicates the essential features of the United States marriage market, in spite of its simplicity and in spite of having only two free parameters. We make this claim because our benchmark model economy approximates the United States the age and sex distributions of both ever and never married people, the age distributions of the probabilities of grooms marrying younger brides and of brides marrying younger grooms, and even the age distributions of birth-rates, to a comfortingly large extent. See Figure 2.

In Panels A through D of Figure 2 we report the age and sex distributions of the ever and never married people. We find that the differences between the model economy numbers and the United States data are encouragingly small. 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 similarities between our calibrated model economy numbers and the United States data are reassuringly small.

One of the exceptions is the probabilities of marriages between older grooms and younger brides that go to one as the grooms age in our model economy. This happens for three reasons. Because of the parsimonious way in which we model the expected values of being single and married. Because in our model economy everybody of the same sex and age has the same earnings. And because it turns out that single men refuse to marry any woman older than themselves after a given age. Similar reasons drive to zero the probabilities of marriages between older brides and younger grooms. This is the other exception.[10]

Finally, in Panels G and E of Figure 2 we report the age distributions of the first and the total birth-rates in our calibrated model economy and in the United States. These results are harder to interpret. This is because we assume that every child is begot instantaneously when a fecund marriage is formed. And because only marriages who will stay together for their entire lifetimes bear children in our model economy. In spite of these difficulties in interpreting our results, we are encouraged by the fact that the shapes of the distributions of the birth rates are reasonably similar in our model economy and in the United States.[11]

Overall we consider our distributional results to be both interesting and encouraging. First, because we are the first to provide them in the literature.[12] Second, because they do not arise by construction since we have used only the median ages of first-time brides and grooms as our

[10] See the discussion of this feature of our model economy in Section 4.2.

[11] 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 8.

[12] Giolito (2003) and (2005) also contain similar distributional results but they are previous versions of this paper.

calibration targets. And, third, because we can interpret them as overidentification results that come convincingly close to their targets. Consequently, we contend that our model economy is a useful abstraction to quantify the contributions of gender differences in fecundity and in earnings to account for the timing of first marriages.

4.2 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 match values. They compare the expected values of their marriage with the expected values of remaining single and perhaps 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 this reservation value they propose, and for smaller match 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 G of Figure 3 represent the reservation values that obtain in our benchmark model economy for singles of various ages. We discuss them in the following paragraphs.

Consider for instance Panel B. It represents the reservation values of thirty year-old singles. At thirty, both men and women are maximally fecund. Consider first the case of men. 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 increasing earnings profile more than compensates for their increased 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 reduced fecundity and the increased mortality risk of older women lower their value and more than compensate for their increasing earnings profile. Notice that the graph becomes steeper when women's fecundity starts to decrease after age 35 and that it becomes 1.00 at age 46 when the women's fecundity is only 0.2. We interpret a reservation value of 1.00 to mean that in our model economy thirty year-old men never marry women older than 45.

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 Panels A, C and D of Figure 3 we report the reservation values for 20, 40, and 50 year-old men and women for partners of all ages. Qualitatively, those figures display u-shapes that are very similar to those in Panel B. Quantitatively, the graphs are rather different but they all display similar patterns. In every graph the reservation values of the men are uniformly and sizably bigger than those of the women —except in the part of the range when they are both equal to one. This means that men are choosier than women of the same age. This result contrasts with those reported in part the literature where men use their higher earnings to compete for the relatively scarce women that are fecund and, hence, presumably choosier (see Siow, 1998). In every graph represented in those panels the minima of the reservation values of the men occur before those of the women. This means that the most preferred spouses for men are always younger than the most preferred spouses for women of the same age. Finally, in every single case the women are willing to accept spouses that are very much older than they are, and the men are very much less willing to do so.

In Panel E of Figure 3 we report the reservation values of men of ages 20, 30, 40, 50 and 60 and in Panel F 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. Quite naturally fifty and sixty year-olds come last. 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.

Panel F 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 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.

Finally, in Panel G of Figure 3 we report the shares of ever married men and women of various ages and in Panel H we report the single sex ratios, which we define as the number of single men divided by the number of single women. We find that the ever married shares are very similar for young people, although slightly larger for women than for men. For instance, at age twenty, 22.3 percent of the women and 20.7 percent of the men are or have been married. Later in life, these gender differences become larger. At age thirty, 63.9 percent of the women and 55.0 percent of the men are or have been married. And by age 40 these numbers are 85.2 and 74.1 percent. Since, overall men are choosier than women of the same age, women marry earlier than men of the same age, and single women outnumber single men of the same age until age 57. The single sex ratio is greater than one and hump-shaped between ages 16 and 56, it reaches and maximum value of 1.79 at age 43 and it becomes less than one and decreasing form age 57 onwards, when the higher mortality rates of men start to reduce their numbers.

4.3 Earnings, fecundity, and 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, 5 and in Panels A through D of Figure 6 we plot several arrangements of the reservation values of people of various ages. And in Panel E of Figure 6 we plot their single sex ratios.

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 identical and in Economy E2 they differ in their earnings profiles only. This change decreases women's earnings in every period of their lives. Since the women of every age are poorer in Economy E2 than in Economy E1, they value less any given marriage proposal because in Economy E2 there is less income to share. Moreover they also value less their now less affluent single lives. Quantitatively the reduction in the value of being single dominates because the

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

	US[a]	E0[b]	E1[c]	E2[d]	E3[e]	Δ_{21}^{f}	Δ_{31}^{g}
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.

earnings of men have not changed. And the women in Economy E2 lower their reservation values for every man and at every age. Panels B, D, F, and H of Figure 5 confirm this reasoning.

Moreover, reducing the earnings profile of women also reduces the value of married life for men, who now have to make do with poorer spouses. Consequently, in Economy E2 marriage becomes a less attractive alternative for men and they increase their reservation match values for every woman and at every age. Panels A, C, E and G of Figure 5 confirm this reasoning. Since women internalize the fact that they receive less proposals in Economy E2 than in Economy E1, they become even less choosy. And they reduce their reservation values more than what they would have done if this general equilibrium effect had been absent.

Panels A through D of Figure 4 show that reducing the earnings of women drives a wedge between the reservation values of men and women of every age. With men becoming choosier and women becoming 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 the rightmost panel of 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

Next, we discuss the role played by fecundity in accounting for the timing of first marriages. To do so we compare counterfactual Economies E1 and E3. In Economy E1 men and women are identical and in Economy E3 they differ in their fecundity profiles only. In Panels A, C, E, and G of Figure 5 and Panel A of Figure 6 we show that reducing the fecundity of women increases the value of younger women slightly, and that it reduces the value of older women sizably for men who are between 20 and 60 years old. By older women we mean those who are fecund in Economy E1 and who are barren in Economy E3. The crossing points of the reservation value functions of fecund men are between 39 and 34 years in every case. Age 35 is precisely when the fecundity of women in Economy E3 starts to decrease.

More interestingly, 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. In Economy E3 they refuse to marry any woman older than 48. And in Economy E1 they are willing to marry up to 59 year-old women. Finally, Panel C of Figure 6 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.

In contrast, reducing the fecundity of women changes their reservation values in an interesting way that is not monotonic in their age. Panel B of Figure 5 and Panel D of Figure 6 show that the reservation values of women who are twenty and seventy are al most identical in Economies E1 and E3. Panels D and F of Figure 5 show that thirty and forty year old women become less choosy in Economy E3. And Panel H of Figure 5 and Panel B of Figure 6 show that fifty and sixty year-old women become choosier in Economy 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 value of remaining single, they have fifteen years of full fecundity ahead of them and this is ample time to find a good spouse. Moreover, their search costs are sizably smaller in Economy E3 because the sex ratio of singles is significantly higher (see Panel E of Figure 6). And this allows them to be choosier. 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 much has changed for them.

Thirty and forty year-old women are less choosy in Economy E3 because the increased pressure from their biological clock increases their search costs and it reduces their values of being single. 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 willing to accept a spouse with a lower match value as long as he is fecund. This substitution effect —children for a higher 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 (see Panel E of Figure 6). The overall result is that fifty and sixty year-old women are choosier in the low fecundity world of Economy E3.

With twenty and seventy year-olds being indifferent, forty and fifty year-olds being less choosy, and sixty and seventy year-olds being choosier, the aggregate result could go either way. However, since in model 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 clock dominates.

Panel E of Figure 6 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.

We contribute to the literature in several ways. First, we endogenize the single sex ratio fully. Second, we show that women's shorter biological clock is a mixed blessing. It gives market power to young women in their twenties and it indeed makes them choosier than young men of the same age (see Panel E of Figure 4). However, by age 30 this situation is completely reversed. In spite of women still being the short side of the market by far, the increased pressure of their biological clocks make 30 and 40 year old women less choosy than men of their same age (see Panels F and G of Figure 4). We interpret this to mean that if there was any compensation it would go the other way. The women would have to compensate the men.

When we put all these effects together it results 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 (see Table 2). 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 gap at first marriage is of a whooping 2.79 years. Which dwarfs the 0.11 years that arise in Economy E2 where men and women differ in their wages only.

5 Concluding comments

In this article we provide a simple model of the marriage market where singles search for spouses. We show that modeling the marriage decision in a very simple model economy is sufficient to account for much of the observed marriage behavior in the United States in the year 2000. We conclude that gender differences in fecundity are all important in accounting for marriage behavior, and that differences in earnings matter little. We also conclude that, even though they are in short supply, the market power of fecund women is not enough for them to demand compensation in all cases. And that studying the marriage decision without modeling explicitly the roles played by age and by fecundity, as has been typically done by the previous literature, makes little sense.

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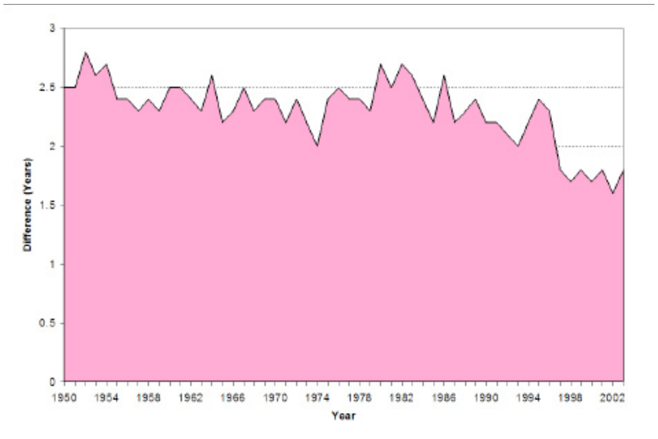
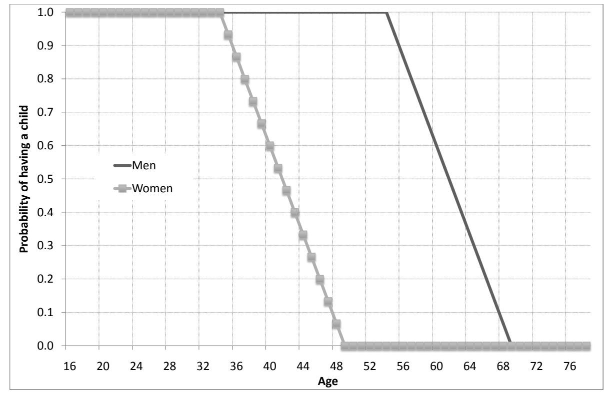
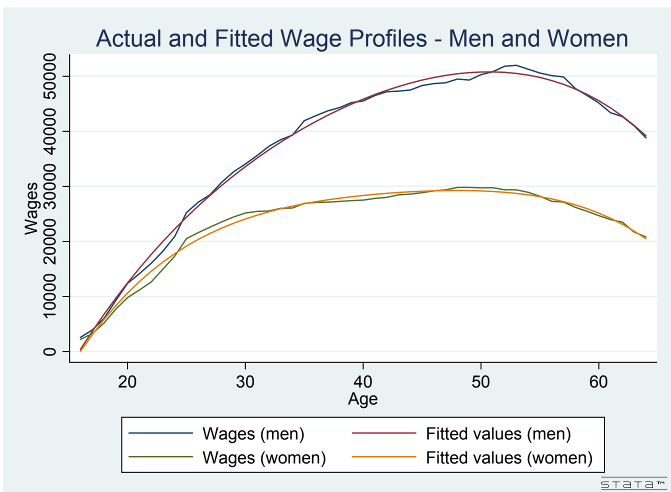
Figure 1: Biological and Economic Gender Differences



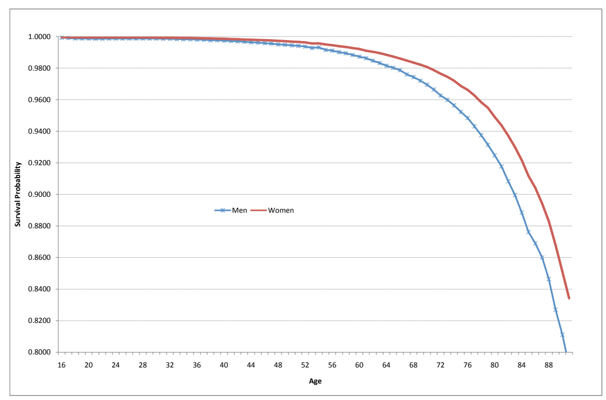
A. Age Differences at First Marriage



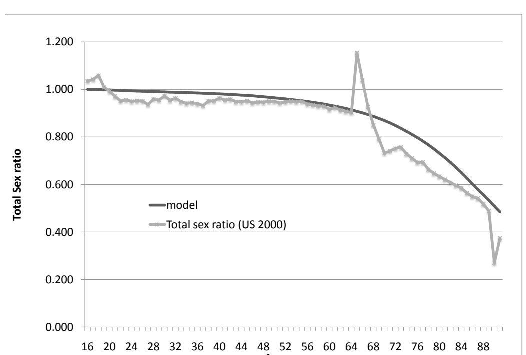
B. Fecundity Profiles by Gender



C. Earnings Profiles by Gender

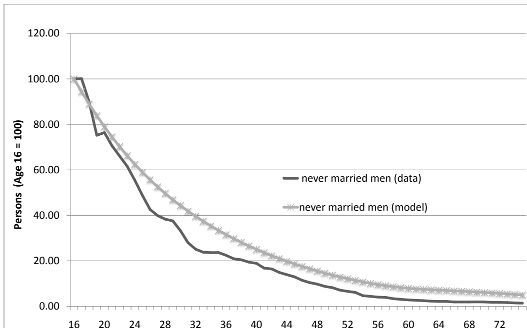


D. Survival Probability Profiles by Gender

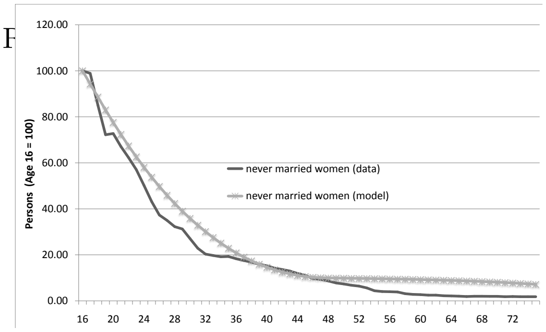


E. Total Sex Ratios

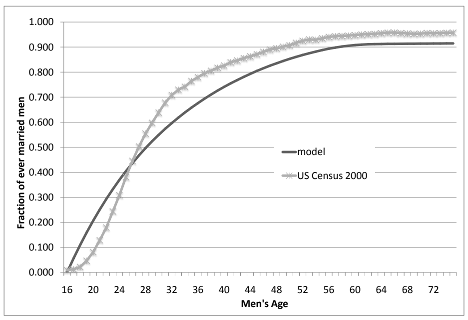
bration F



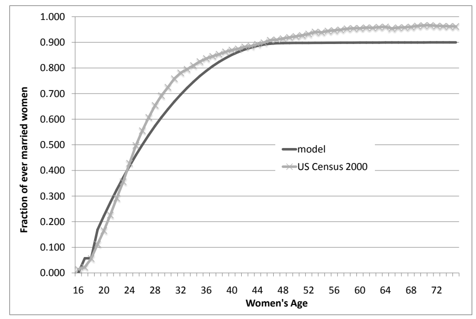
A. Never Married Men



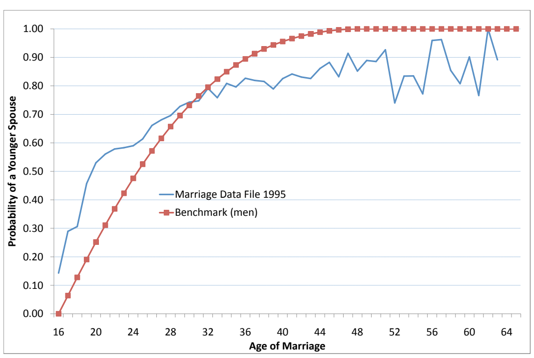
B. Never Married Women



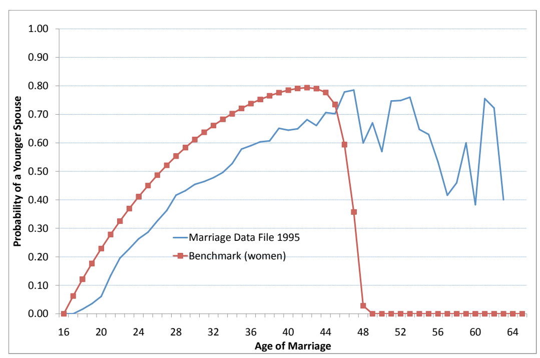
C. Ever Married Men



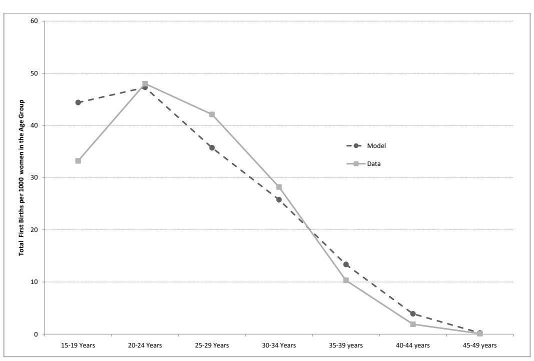
D. Ever Married Women



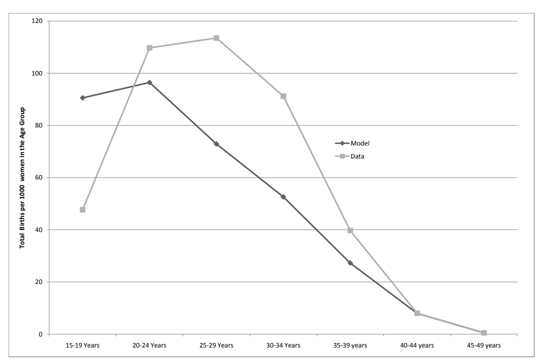
E. Prob. of marrying a younger bride



F. Prob. of marrying a younger groom

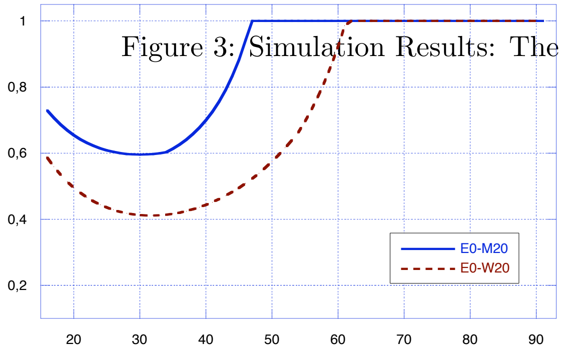


G. First Birth-Rates per 1000 Women

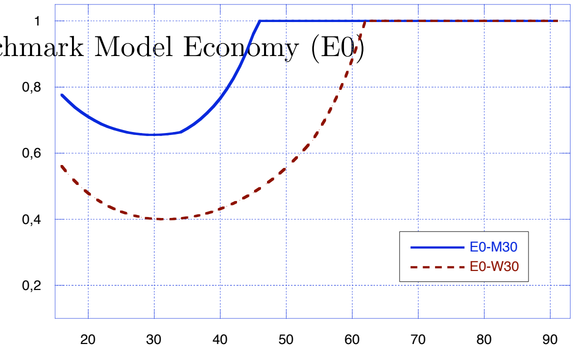


H. Total Birth-Rates per 1000 Women

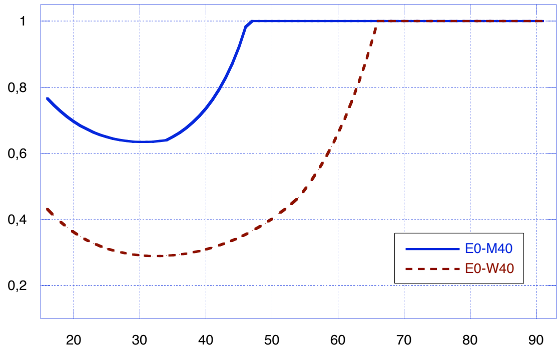
Figure 3: Simulation Results: The Benchmark Model Economy (E0)



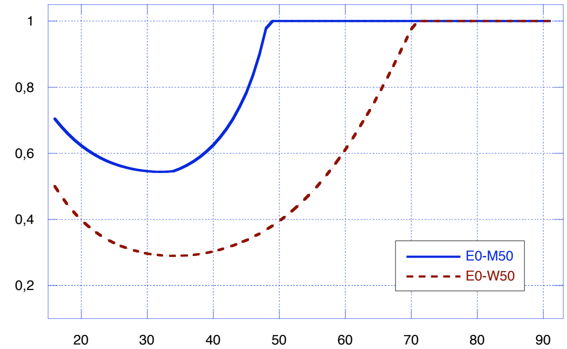
A. Men's and Women's Reservation Values at age 20



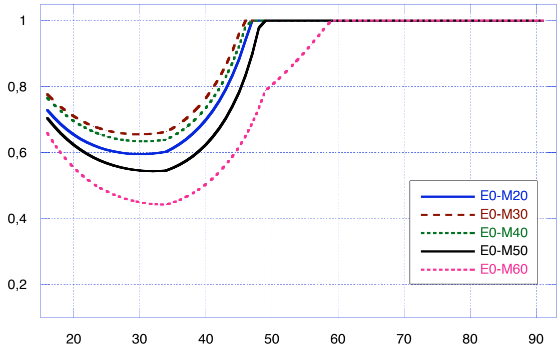
B. Men's and Women's Reservation Values at age 30



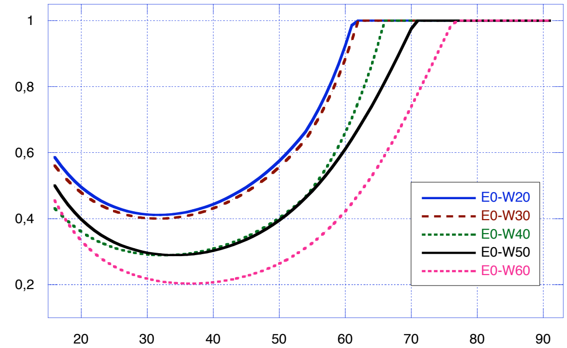
C. Men's and Women's Reservation Values at age 40



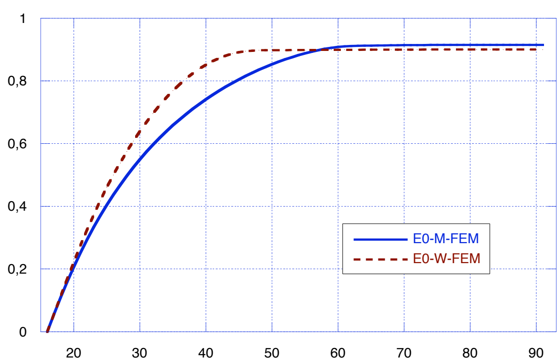
D. Men's and Women's Reservation Values at age 50



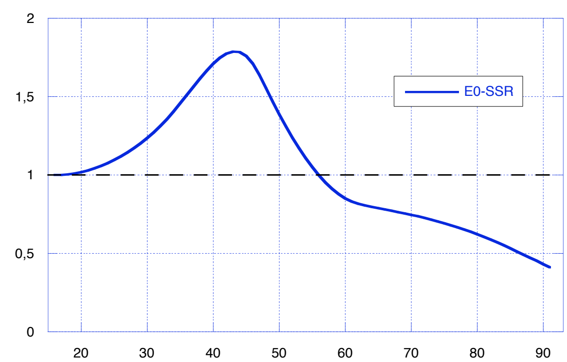
E. Men's Reservation Values at Various Ages



F. Women's Reservation Values at Various Ages

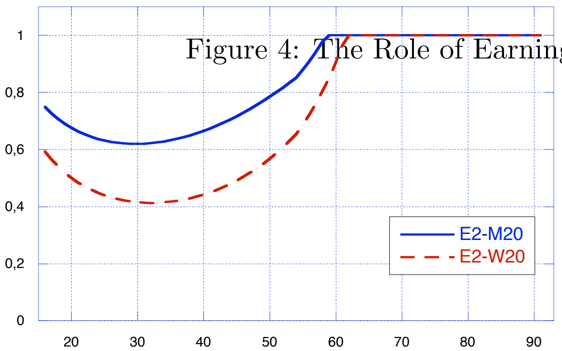


G. Shares of Ever Married Men and Women

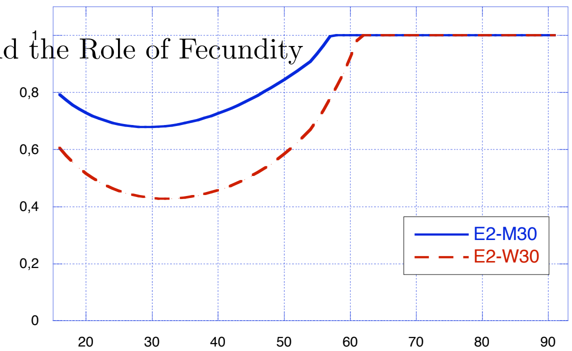


H. Single Sex Ratios

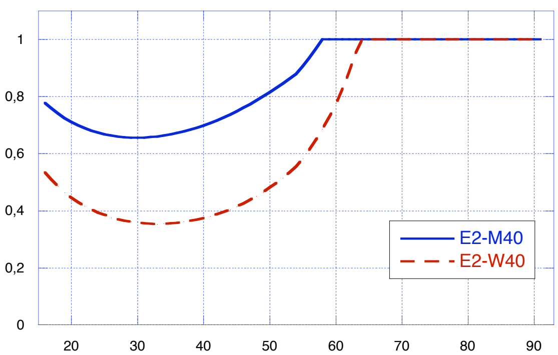
Figure 4: The Role of Earnings and the Role of Fecundity



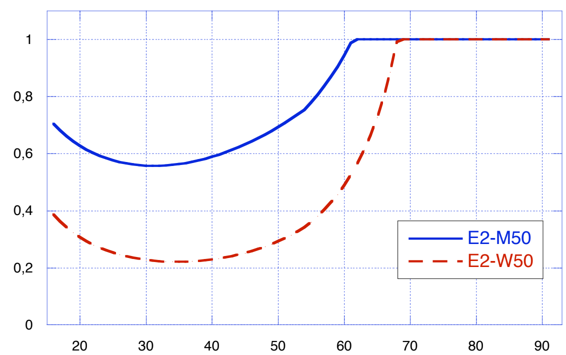
A. Reservation Values at Age 20 in E2



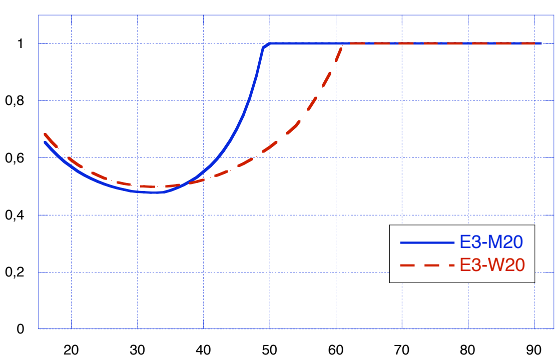
B. Reservation Values at Age 30 in E2



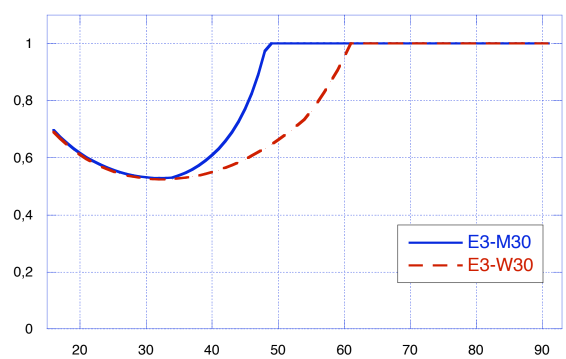
C. Reservation Values at Age 40 in E2



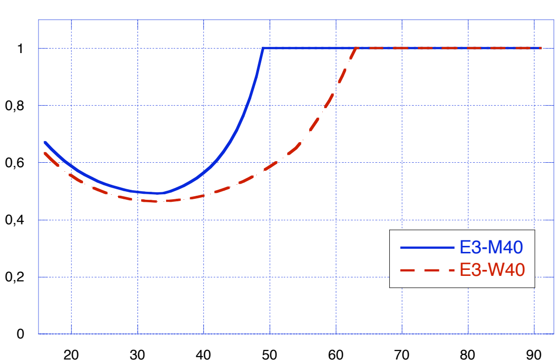
D. Reservation Values at Age 50 in E2



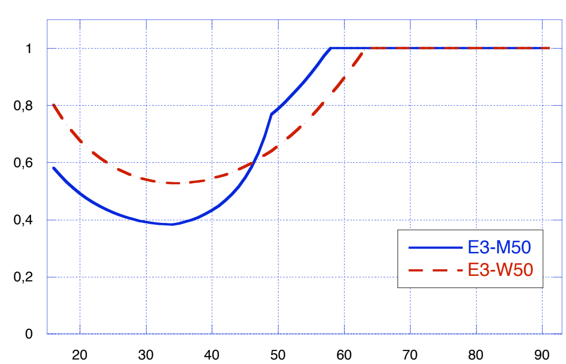
E. Reservation Values at Age 20 in E3



F. Reservation Values at Age 30 in E3

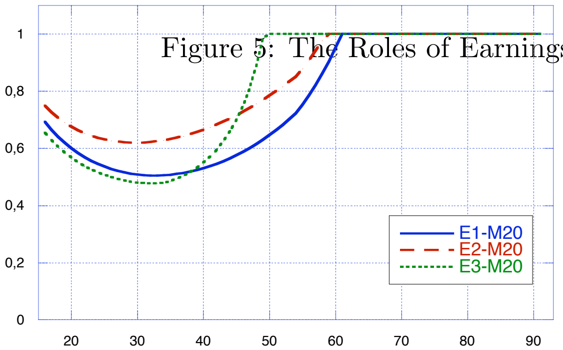


G. Reservation Values at Age 40 in E3

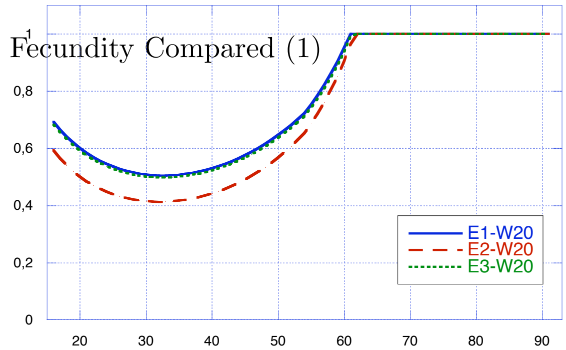


H. Reservation Values at Age 50 in E3

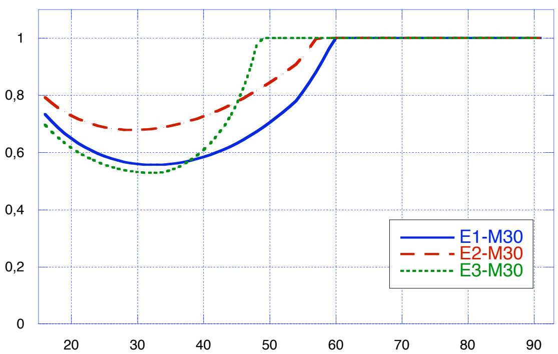
Figure 5: The Roles of Earnings and Fecundity Compared (1)



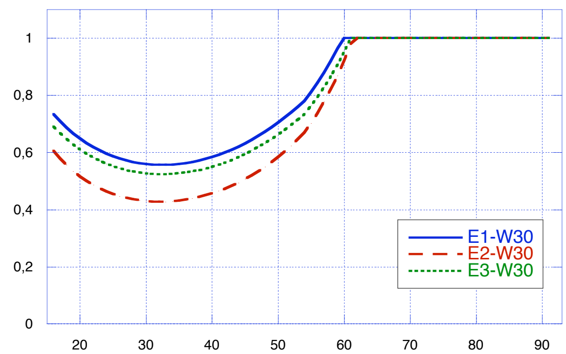
A. Men's Reservation Values at Age 20



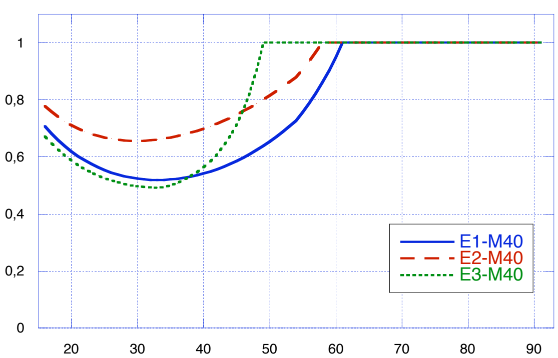
B. Women's Reservation Values at Age 20



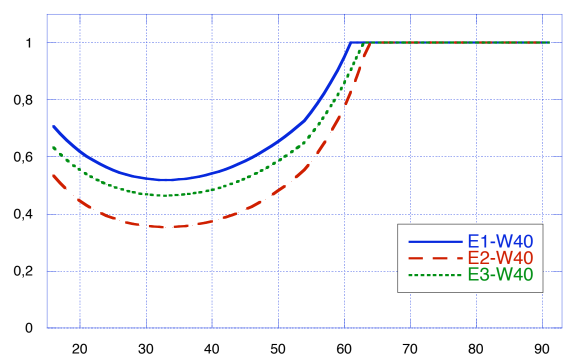
C. Men's Reservation Values at Age 30



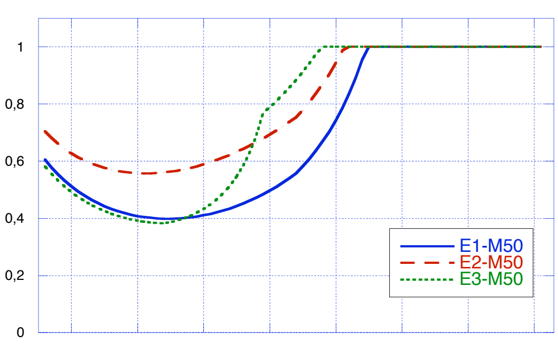
D. Women's Reservation Values at Age 30



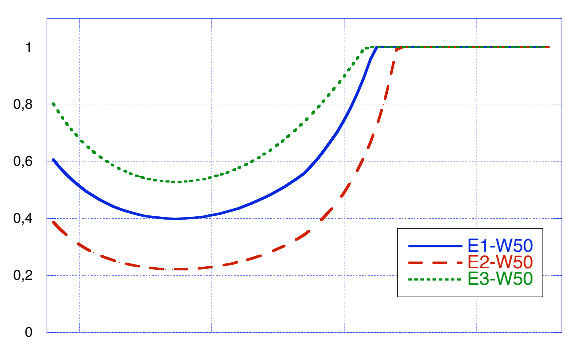
E. Men's Reservation Values at Age 40



F. Women's Reservation Values at Age 40

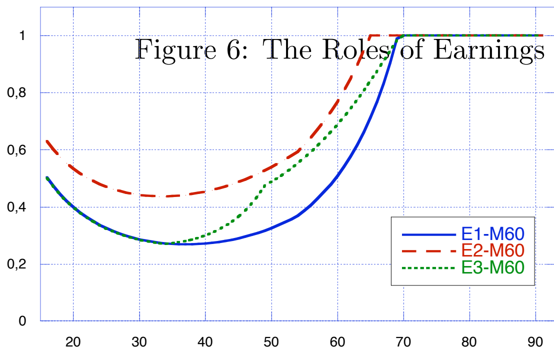


G. Men's Reservation Values at Age 50

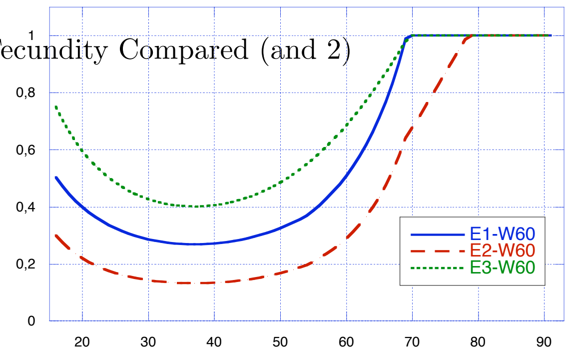


H. Women's Reservation Values at Age 50

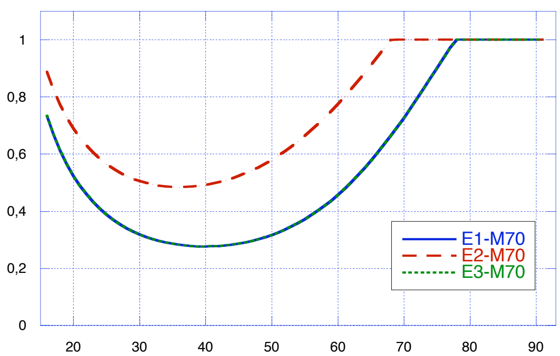
Figure 6: The Roles of Earnings and Fecundity Compared (and 2)



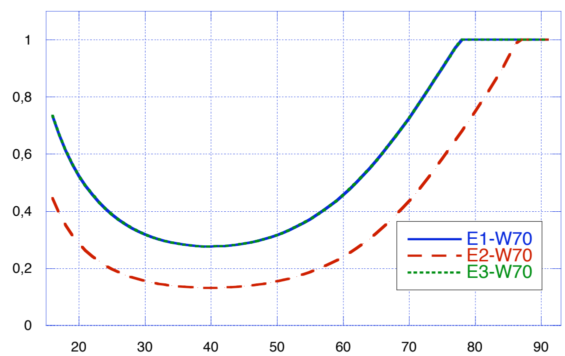
A. Men's Reservation Values at Age 60



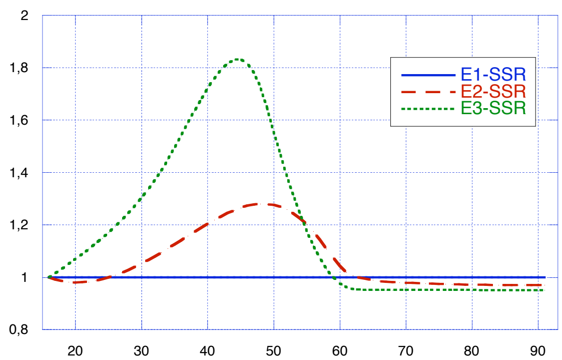
B. Women's Reservation Values at Age 60



C. Men's Reservation Values at Age 70



D. Women's Reservation Values at Age 70



E. The Sex Ratios of Singles