The Changing Wage Distribution and the Decline of Marriage*

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Abstract

In the last forty years, the share of married adults has declined in the United States. At the same time, the structure of labor market earnings has greatly changed, both in its cross-sectional distribution and in terms of life-cycle dynamics. In this paper, I estimate a novel equilibrium model of the marriage market characterized by search frictions, endogenous divorce, aging, and wage mobility. This structural approach allows me to provide a quantitative assessment of the impact of changes in the wage structure on the decline of marriage. I find that changes in the wage distribution as a whole can account for about 35% of the decline in the share of married adults between the 1970s and the 2000s, and partly explain why the decline has been stronger among the low educated. I show that changes in positional wage inequality matter far more than changes in wage mobility: increased inequality among men and a shrinking gender wage gap have caused the gains from marriage to shift from household specialization to the possibility of joining efforts on the labor market.

Keywords: marriage market, divorce, wage inequality, life-cycle model, search and matching.

JEL Classification: D13, J11, J12.

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1 Introduction

In the last few decades, Americans have faced major changes in the structure of their labor market earnings. In particular, wage inequality has increased both between and within educational groups (Acemoglu and Autor, 2011). Coincidentally, Americans have also experienced a radical transformation of their family life: the share of married adults has steadily declined since the 1970s, and a decomposition of this trend reveals that the decline has been larger for the low educated.

The relationship between these two synchronous trends has drawn a great deal of attention in the economic literature. However, few papers have so far focused on how the marriage market adjusts when we consider changes both in the cross-sectional inequality and in the life-cycle dynamics of labor market earnings[1]. In particular, the structure of wage dynamics along the life-cycle may affect the expected duration of singlehood spells - before the first marriage and after a divorce - as well as marriage duration. This is a highly pertinent economic issue, in that being exposed to longer singlehood spells - be it due to either divorce or lack of marriage - can bear significant welfare implications.

In this paper, I provide a quantitative assessment of the adjustments of marriage and divorce patterns spurred by the changes in the wage distribution that occurred between the 1970s and the 2000s. To the best of my knowledge, this paper is the first to analyze changes in marital patterns in response to changes not only in the inequality across education and gender groups, but also in the age profile of wages and in the degree of wage mobility[2]. The empirical analysis focuses on changes in the extensive margin of the marriage market, i.e., the decline of married adults. In particular, the paper aims to address the following questions: *to what extent changes in the wage distribution can explain the overall decline of marriage? How have these changes affected different subgroups of the population, i.e., the high vs the low educated or the younger vs the older? And, finally, how have these changes reshaped the distribution of welfare?*

In order to answer these questions, I build an empirically tractable search-and-matching

[1]As I will extensively discuss later in the introduction, many papers have studied the relationship between cross-sectional inequality and marital patterns. Moreover, a different strand of literature analyzes the life-cycle labor supply and savings decisions of households including marital status as a relevant state variable, and discuss differences in terms of economic outcomes between single-adult and married households. A growing number of papers in this literature also includes marriage (and/or divorce) as a choice variable, although very few papers characterize the marriage market equilibrium.

[2]Kopczuk et al. (2010) suggest that one natural measure of mobility is the rank correlation in earnings from year t to year $t+p$: I focus on hourly wage mobility in the empirical analysis, and employ an analogous measure - wage rank correlation - to characterize mobility.

model of the marriage market where the motives for entering the marriage relationship are both economic and noneconomic. The economic gains from marriage stem from both household specialization and economies of scale. However, along the life-cycle, risk-averse agents face wage shocks and random changes in the quality of the relationship: married couples benefit from the intrinsic insurance mechanism provided by the marriage contract, but, in lack of full commitment, uncertainty may as well lead them to break up. After a divorce, agents are free to marry again, although their prospects change with time due to age and mobile wages. On the aggregate level, systematic differences in matching behavior across educational groups arise as the result of the complex interplay between the primitives of the model: these include the structure of earnings, the home technology, the taste for homogamy, and the way single people meet each other. When taken to the data, the model can rationalize both the cross-sectional marital patterns - *who is married, and with whom* - and the hazard of marriage and divorce for different subgroups of the population.

This structural approach is motivated by the two following considerations: first, a model is needed to single out the role of changes in labor market earnings in explaining the decline of marriage, as opposed to other confounding factors. This is particularly important when comparing marital patterns across an extended timespan, as many factors of different kinds - including demographic, technological, legal, cultural - change at the same time. Second, a model is needed to derive the welfare implications of changes in the expected length of singlehood and marriage spells. In this way, it is possible to identify the demographic subgroups that have experienced the largest losses in the population.

The empirical analysis relies on the following steps. I first extend the empirical strategy of Goussé et al. (2017b) and provide a formal discussion on how to separately identify the key unobserved parameters of the model: the meeting function, the domestic production function and the cost of divorce. I estimate the model at its stationary state using data moments from both the Current Population Survey (CPS) and the Panel Study of Income Dynamics (PSID) for the American population aged between 20 and 60 in the 1970s. I then simulate a series of counterfactual equilibria where all primitive factors are held constant at their 1970s levels, except for one primitive parameter of interest. In this way, I am able to isolate the adjustments of the marriage market due to changes in a single factor, e.g., the entire wage distribution or one of its parameters.

I find that changes in the wage structure of both men and women can jointly induce a 8% decrease in the share of married adults. Hence, they account for about 35% of the overall decline of marriage between the 1970s and the 2000s. In particular, declining real wages among men at the middle and the bottom of the distribution have eroded the gains from marriage for a large part of the population, as men's earnings constitute the larger share of the household budget. Moreover, women's wages have increased. Changes on both sides of the market bear the following implications: the gender wage gap shrinks, decreasing gains from household specialization and pushing married women to increase their labor supply; since joining efforts on the labor market has become more important, individuals tend to sort more according to their wages, penalizing low earners; on top of that, women become more selective as they gain economic independence. As a result, gains from marriage decline.

Changes in the wage structure can also partly explain why the share of married adults among the low educated has decreased more than among the high educated. The decrease induced by the changing wage structure is around 9% of the 1970s benchmark level among both men and women without a college degree, while it is only 3% among male college graduates and 5% among female college graduates. The decline is larger among younger men (-11% for those aged between 20 and 30) than among older men (-6.5% for those aged between 40 and 50). These adjustments mirror the increased wage inequality between educational groups and the steeper wage curve with respect to age. The mechanism described in the previous paragraph can explain why this occurs: the impact of changing wages is stronger for those groups that experience a larger wage decline.

The rich characterization of the wage structure allows me to delve further into these findings. While I document an increase in wage mobility among men and a decrease among women, I show that - holding wage levels constant - they only have a small impact on the marriage market outcome. I argue that this is due to the estimated high cost of divorce, which indicates that marriage contracts imply a strong commitment, both in the 1970s and in the 2000s. In other words, spouses are likely to insure each other when a labor market shock hits. On the other hand, this implies that individuals are very selective in the choice of the partner, and that the drop in the equilibrium shares of married adults is mainly due to a decrease in the odds of getting married for singles and to an increase of the age of first marriage.

Finally, the structural model allows me to quantify the changes in the distribution of welfare and of the gains from marriage. My findings suggest that, in the 2000s, the marriage market amplifies economic inequality, already on the rise due to changes in the wage distribution. I show that between the 1970s and the 2000s, the gains generated by the marriage market have decreased, consistently with the marital patterns observed in the data. However, the market has shifted from an equilibrium where the low and the high educated enjoy, on average, the same level of gains from marriage to an equilibrium where individuals with a college degree enjoy substantially more gains. Hence, individuals at the bottom of the wage and schooling distribution have not only lost ground in terms of human wealth with respect to those at the top[3], but are also relatively less successful in taking advantage of the additional welfare surplus generated by the marriage market. These considerations leave room for redistributive policies that take into account the monetary value of the gains from marriage: while the framework proposed in this paper is suitable for this kind of analysis, I leave this to future work[4].

The theoretical framework employed in this paper builds on the seminal work of Shimer and Smith (2000), who extend the classic assignment problem of Shapley and Shubik (1971) and Becker (1973) to its two-sided search-and-matching version under Transferable Utility. Chade and Ventura (2002) extend it to allow for random shocks to the agent's types. Wong (2003) estimates the model of Shimer and Smith in order to study marital sorting with respect to wages and education. Goussé et al. (2017a, henceforth, GJR) and Goussé et al. (2017b) merge a non-cooperative household model of consumption, housework and labor supply into a similar search framework; they endogenize divorce by introducing random shocks to the quality of the match, and study the relationship between the marriage market, within-couple bargaining power, and labor supply. The present paper extends their theoretical framework in several directions, and in particular by introducing wage uncertainty, risk aversion and aging. Recent working papers moving in the same direction are the works of Flabbi and Flinn (2015), who model both the labor and the marriage market equilibrium, and Shephard (2018). The latter also introduces the life-cycle dimension in the search framework, but complements it with savings and human capital accumulation; the paper focuses on the analysis of age asymmetries in marriage behavior: some key differences between this model and the one in the present work, particularly about the commitment device available to households, are discussed throughout the paper.

From a broader perspective, this work is methodologically related to a larger literature on marriage and matching. Choo and Siow (2006) and Galichon and Salanié (2015) discuss the identification of match surplus when the econometrician observes part of the ex-ante heterogeneity but not the match transfers. Applications to the marriage market are becoming more and more common (e.g. Dupuy and Galichon, 2014). Extensions to the dynamic case - where agents are free to choose the age of marriage - include Choo and Siow (2007); Choo (2015); Bruze et al. (2015): the latter endogenize divorce in a similar fashion to GJR, but introduce a duration-dependent cost function. This group of papers bears interesting similarities with the search-and-matching literature outlined in the previous paragraph, particularly in the identification strategy: these similarities will be discussed throughout the paper.

[3]Here and throughout the text, human wealth refers to the discounted sum of life-cycle earnings.

[4]The missing step in the current paper is a monetary evaluation of the gains from marriage identified through the matching behavior of agents. Throughout the paper, I briefly discuss how to extend the tools proposed by Chiappori and Meghir (2014), i.e., their Money Metric Welfare Index, to the present search-and-matching framework.

Another strand of literature incorporates elements of search and/or competitive matching in order to discuss the macroeconomic implications of marital sorting. Aiyagari et al. (2000) and Fernández and Rogerson (2001) study the relationship between Positive Assortative Mating (PAM) and intergenerational mobility; Fernández et al. (2005) focus on the relationship between human capital investment, PAM and household income inequality. Regalia and Rios-Rull (2001) and Greenwood et al. (2003) set up intergenerational models of household formation and dissolution in order to study how marital patterns, fertility and inequality are jointly determined at equilibrium. Greenwood et al. (2016) focus on the determinants of rising cross-sectional income inequality: they estimate a dynamic model of educational choice, marriage, divorce, and labor supply, and show that marriage market adjustments as a response to changes in wages can partly account for the increase in the Gini coefficient. The propagation mechanism they describe explains why the share of married adults falls, and is similar to the one suggested in this paper: in particular, both papers stress the importance of increasing wage inequality across education groups and shrinking gender wage gap.

In spite of a much simplified labor supply setting, this paper is also related to a large strand of literature that studies labor supply, savings, fertility and/or childcare decisions along the life-cycle. Building on the seminal work of Eckstein and Wolpin (1989), many works in this literature include marital status as one of the household's state variable, and transitions are modeled as exogenous shocks (e.g. Eckstein and Lifshitz, 2011; Blundell et al., 2016; Adda et al., 2017). Some works focus on marital dissolution and take the initial family composition as given: for instance, Gemici (2011) and Voena (2015) study the determinants of divorce - focusing on geographical mobility and divorce laws respectively - taking the initial household composition as given.

Building on this life-cycle labor supply literature, a growing number of papers considers endogenous marriage and divorce decisions: a precursor is Van der Klaauw (1996), while more recent examples are Sheran (2007), Keane and Wolpin (2007), Keane and Wolpin (2010), Bronson (2014), Mazzocco et al. (2017) and Fernández and Wong (2017). Each of these papers focuses on a specific empirical issue, but all of them are characterized by a rich characterization of household behavior (particularly, of savings and human capital accumulation) and a focus on the welfare implications of changes in earnings, policy parameters and marriage market opportunities. In this paper, I depart from this literature by treating the supply of available partners as an endogenous equilibrium object rather than imposing an exogenous distribution from where to draw candidate partners. Two notable exceptions are the works of Reynoso (2017) and Beauchamp et al. (2018): the first studies the impact of divorce laws on marriage, labor supply and divorce; the marriage market is thought as a static matching game played at the beginning of adulthood, and remarriage is not allowed. The second paper estimates an equilibrium model of the marriage market with divorce and remarriage in order to study the determinants of single parenthood: their definition of equilibrium differs from the one used in this paper as agents are only allowed to marry within their own cohort.

The paper is structured as follows: I first present the model in section 2; I provide a formal discussion on how to identify its key unobserved parameters in section 3; I introduce the CPS and PSID samples in section 4; I provide details about the empirical specification and the estimation procedure in section 5; I present the results of the estimation, of the counterfactual analysis and of the welfare analysis in section 6; I conclude in section 7.

2 The Model

The theoretical framework extends the original two-sided search-and-matching model by Shimer and Smith (2000) in the vein of GJR. Single agents search for possible partners on the marriage market. Married households face two layers of uncertainty: first, about the future quality of the current match; second, about the future wage rates of the spouses. When uncertainty is resolved, the couple needs to make a decision about whether to continue the match or not: in this way, divorce decisions are endogenous.

In contrast with the previous literature, I introduce some key elements that extend the empirical analysis to the life-cycle level. First, I introduce aging: agents get older as time goes by, and age influences their odds of marriage, divorce and remarriage. Second, I assume agents are risk-averse and experience wage shocks along the life-cycle: wage uncertainty partly explains marital instability, as economic gains from marriage may disappear following a wage shock.

Before turning to the setup, let me anticipate some key implications of these assumptions. On the one hand, the definition of a *deterministic* steady-state equilibrium[5] requires some strong assumptions on market entry and exit. In the stationary environment, new cohorts do not differ from the previous in terms of size and composition, and, on the aggregate, display the same matching behavior along the life-cycle: both business cycles and secular drifts are not captured by the model, and only comparative statics can help make sense of differences across time and space. On the other hand, the introduction of aging does not require the wage process

[5]As opposed to a *stochastic* steady-state, where equilibrium quantities are functions of an aggregate state of the world (see Coeurdacier et al., 2011, for an exhaustive discussion). In this OLG search-and-matching model, there are several assumptions that could be relaxed in order to introduce aggregate uncertainty. Some possible extensions will be discussed in this section and in the conclusion.

to be stationary, nor new marriages to be outbalanced by an equal amount of divorces for a given group of agents. Different groups *within* the same cohort may take strongly diverging paths in terms of both earnings and family achievements, exactly as we see in the data.

The section is organized as follows. First, in subsections 2.1, 2.3 and 2.2, I describe the general environment and the *ex-ante* heterogeneity characterizing agents. Then, in subsections 2.4, 2.5 and 2.6, I describe the household problem for couples and singles. Finally, in subsections 2.7, 2.8, 2.9 and 2.11, I describe the search environment and marriage and divorce decisions, and, in section 2.12, I conclude by providing a definition of the steady-state equilibrium.

2.1 Heterogeneous Agents and Aging

Men are *ex-ante* heterogeneous and are associated with a publicly observable *type* i, a vector comprising the following elements:

- a time-invariant human capital type h_i;
- age a_i, which is deterministically updated over time;
- current wage w_i, which changes over time according to an $AR(1)$ random process described in the section 2.3.

Similarly, the type of a woman is given by $j = (h_j, a_j, w_j)$. The men's (women's) set of types is named $\mathcal{I}$ ($\mathcal{J}$) and is discrete. Note that the time subscript t is unnecessary, since I will focus on the steady-state equilibrium. Agents care about time because of the aging and stochastic wage process, but live in a stationary environment.

Aging individuals discount future at rate $1/\beta - 1$, and face an exogenous probability of exiting the market. A man i exits the marriage market with probability $1 - \psi_m(i)$ at the end of the period. If he survives, he grows one-year older, so that i' is such that $a_{i'} = a_i + 1$. A similar process governs women's aging, with a different vector of survival probabilities ψ_f. In addition, assume agents eventually leave with probability one at $\bar{a}$, i.e., $\psi_m(\bar{a}) = \psi_m(\bar{a}) = 0$. Market exit is primarily intended as death, although it could also encompass other situations where the agent is unable to live in a two-adult household nor to look for a partner: these may include active duty in the army, incarceration, long-term stay in health-care institutions, and so on.

2.2 Marital Status and Timing

Time is discrete, and a period is defined as the timespan between t and $t+1$. In t, an agent is associated with his (her) current type i and (j) and is either married or single. Married couples are characterized by the joint type (i, j). At the very beginning of the period, in t_+, uncertainty is resolved. First, agents learn whether they will live on to the next period, with exit probabilities described by ψ_g, $g \in \{m, f\}$. If they do, they draw new wages according to the stochastic $AR(1)$ wage process and grow one-year older.

Consider the time-line of a given period for a man i and a woman j that are married at the beginning of the period (see figure 1). On top of drawing new wages, the couple also observes the realization of a vector $\boldsymbol{\eta}$ of temporary shocks that help characterize the quality of the current match. The distribution and exact role of $\boldsymbol{\eta}$ will be described in the next section. However, assume from now that the vector $\boldsymbol{\eta}$ is *i.i.d.* across time and couples. Conditionally on their new types i' and j' and on $\boldsymbol{\eta}$, the spouses decide whether they should stay together until the end of the period. If they divorce, they both stay single until the end of the period. Finally, conditionally on their updated marital status, agents make consumption and labor supply choices.

Consider the time-line of a given period for an individual who is single at the beginning of the period (see figure 2). In t_+, she draws a new wage and learns her new type, and she may also meet a someone of the opposite of sex (in the case of women, they could meet a man of type i). The pair draws a vector of shocks $\boldsymbol{\eta}$ that will influence the subsequent matching decision, namely whether to get married or to stay single until the end of the period. Finally, conditionally on her updated marital status, the woman makes consumption and labor supply choices.

2.3 Wage Process

Wages follow an $AR(1)$ process, so that, at the beginning of every period, a man draws a new wage $w_{i'}$ conditionally on both his current wage w_i and his deterministic traits h_i and a_i. Because of the randomness of the wage process, the probability of transiting from type i to type i' is denoted $\pi_m(i, i') \equiv Pr(i'|i)$. The notation used for $\pi_m(i, i')$ stresses that $\pi_m(i, i')$ depends on the full vector i, i.e., on both the current wage w_i, age a_i and human capital h_i[6]. Analogous considerations hold for women, whose probability of transiting from j to j' is given by $\pi_f(j, j')$,

[6] Note that the corresponding transition matrix $(\pi_m(i, i')) \in \mathbb{R}^{|\mathcal{I}| \times |\mathcal{I}|}$ is such that $\pi_m(i, i') = 0$ if $h_{i'} \neq h_i$ or if $a_{i'} \neq a_i + 1$.

where π_f is possibly different from π_m.

The wage process does not need to be stationary due to life-cycle dynamics being taken into account. Importantly, for a given cohort of people, mean wages depend on age, and a cohort's wage dispersion may increase along the life-cycle. While I let time-invariant traits and age directly influence the conditional distribution of wages, I do not attempt to decompose wages in multiple factors, and in particular to distinguish between a permanent and a temporary component as it is common in the literature (see Meghir and Pistaferri, 2011). Therefore, wage shocks need to be interpreted as permanent: I will often refer to *wage mobility* as the extent to what individuals are likely to move along the wage distribution from one period to the next (see Kopczuk et al., 2010).

Finally, note that the assumption that the wage process is fully exogenous - and in particular that it is not affected by the agent's marital status - is likely to be highly counterfactual, particularly for women. Joint household labor supply decisions may have an impact on human capital accumulation, especially if household specialization plays an important role as a motive to marry. Hence, one's marital status may influence the evolution of his/her wage rate. These crucial limitations are discussed in the conclusion.

2.4 Household Problem: Preferences and Domestic Production

With time-lines 1 and 2 in mind, it is possible to characterize agents' rational behavior by solving backwards for their optimal choices. In this section, I will introduce agents' preferences, while in sections 2.5 and 2.6 I will solve the household problem. Only starting from section 2.7, I will proceed by describing the optimal matching decisions (i.e., marriage and divorce).

Agents enjoy utility from the consumption of both a private good q and a public good Q. The agents' utility is represented by the following function:

$$u(q, Q) = \frac{1}{2}\log q + \frac{1}{2}\log Q. \tag{2.1}$$

The good Q can be thought of as intermediary and is produced domestically using both time and money input. The production function of Q is

$$Q = \begin{cases} (t_m + t_f)^{\gamma_1(i,j)} \exp(\gamma_2(l_f; j) + \gamma_3(i,j) + \eta_{l_f}) & \text{for married households} \\ t_m^0 & \text{for single men} \\ t_f^0 & \text{for single women} \end{cases} \tag{2.2}$$

For married households, t_m and t_f represent the husband's and wife's share of public good expenditure, assumed to be perfect substitutes. The elasticity of Q with respect to the total expenditure is equal to γ_1, and may depend on the spouses' characteristics: γ_1 plays an important role in the empirical analysis of marriage, in that it determines the size of the economies of scale enjoyed by married couples. As concerns single adults, they can only produce Q via a monetary input: t_g^0 is the share of their budget allocated to home production[7].

The total amount of time available to an agent is normalized to one, so that $l_f \in \mathcal{L}_f$ represents the wife's share of time spent on the labor market, where $\mathcal{L}$ is assumed to be discrete. Married men always spend the entire time endowment on the labor market: while the theoretical framework does not require the labor supply of men to be fixed, restricting the choice set in this direction is convenient for the empirical analysis and is broadly consistent with the patterns observed in the data[8]. There exist possible public benefits of having a stay-at-home spouse, which are captured by the productivity shifter γ_2. In other words, if γ_2 were decreasing in l_f, the couple benefits from a higher public good production when the spouse reduces her labor market effort, all else constant. In practice, γ_2 is left unrestricted and is estimated for different levels l_f in the empirical analysis.

The term γ_3 is an additional productivity shifter, which depends on the couple's type (i, j) only. It has the role of capturing the relevance of additional interactions between traits, such as a preference for educational homogamy or age proximity. Finally, the term η_{l_f} is a random shifter taken from the vector $\boldsymbol{\eta} \in \mathbb{R}^{|\mathcal{L}_f|}$: each option l_f is associated with an element of $\boldsymbol{\eta}$, and each η_{l_f} is distributed logistically with location and scale parameters normalized to 0 and 1 respectively. While $\boldsymbol{\eta}$ is *i.i.d.* across time and couples, its elements may be correlated with each other, with $0 < \sigma_\ell \leq 1$ representing their degree of independence (see Train, 2009, Chapter 4, for details, and note that with $\sigma_\ell = 1$ we have a standard logit model).

In the case of married households, an allocation $(q_m, q_f, t_m, t_f, l_f)$ is feasible if the following private budget constraints are respected:

$$q_m = w_i - t_m \tag{2.3}$$

$$q_f = l_f w_j - t_f \tag{2.4}$$

where the sign of t_m and t_f is unrestricted. Hence, $t_m < 0$ ($t_f < 0$) implies that the wife (husband) is actually transferring money into the husband's (wife's) pocket.

Analogous budget constraints hold for single agents. However, it is assumed hereafter that

[7] The elasticity of Q with respect to t_g^0 is normalized to 1. The role of this normalization to ensure the identification of the model is remarked in section 3.

[8] In the CPS, only about 10% of married men between 20 and 60 are out of the labor force in the 1970s, 8% in the 2000s.

singles always work full-time. Since the household problem is fully static, the labor supply of singles does not have an impact on their future marriage choices, and is thus not included in the analysis[9].

2.5 Household Problem: Public Good

As a first step to solve the household problem for married agents, assume the optimal household allocation $(q_m^*, q_f^*, t_m^*, t_f^*, l_f^*)$ is efficient. This assumption puts the model in the general collective framework introduced by Chiappori (1988, 1992). Moreover, the preferences implied by the utility function (2.1) verify the Transferable Utility (TU) property.

The efficiency assumption and the TU property bear two important implications. First, the demand for public good $Q^*(l_f; i, j)$ conditional on the wife's labor supply l_f does not depend on the point of the Pareto frontier chosen by the household. On the other hand, the couple may disagree on the repartition (t_m, t_f): this will be dealt with in the next section. Second, the spouses always agree on the level l_f that puts them on the outermost Pareto frontier. This second statement relies on the absence of private incentives (e.g., private leisure) for the wife to manipulate her supply l_f: in this particular case, the $|\mathcal{L}|$ Pareto frontiers are parallel, and there is no disagreement about how much the wife should work. The underlying economic intuition is that, while the wife might be "unhappy" about the selected l_f, she can always be compensated through a more favorable division of the public good expenditure.

In order to derive the demand for public good, substitute the budget constraints (2.3) and (2.4) into the utility function (2.1) and define the *conditional indirect utilities* as follows:

$$\begin{aligned}
\phi_m(t_m, t_f, l_f; i, j) + \frac{\eta_{l_f}}{2} &= \frac{1}{2}\log(w_i - t_m) + \frac{\gamma_1(i,j)}{2}\log(t_m + t_f) + \frac{\gamma_2(l_f; j)}{2} + \frac{\gamma_3(i,j)}{2} + \frac{\eta_{l_f}}{2} \\
\phi_f(t_m, t_f, l_f; i, j) + \frac{\eta_{l_f}}{2} &= \frac{1}{2}\log(l_f w_j - t_f) + \frac{\gamma_1(i,j)}{2}\log(t_m + t_f) + \frac{\gamma_2(l_f; j)}{2} + \frac{\gamma_3(i,j)}{2} + \frac{\eta_{l_f}}{2}.
\end{aligned}$$

The demand $Q^*(l_f; i, j)$ is then obtained by maximizing any weighted sum of ϕ_m and ϕ_f with respect to t_m and t_f, holding l_f fixed. The share of household budget used as an input for Q is:

$$\frac{\gamma_1(i,j)}{1 + \gamma_1(i,j)}(w_i + l_f w_j). \tag{2.5}$$

[9] Allowing singles to adjust their labor supply is possible, and would be crucial if human capital accumulation choices were considered. However, it implies a slightly more complicated discrete choice setting. Shephard (2018) shows a convenient way of handling larger discrete choice sets by partly postponing the resolution of uncertainty after the matching phase.

It is possible to provide a linear characterization of the Pareto frontier associated with a given level l_f by summing up the exponentials of the indirect utility functions (see Chiappori and Gugl, 2014). Their sum is equal to a constant, and helps characterize the Pareto set in a way that the Pareto frontier is a straight line with slope -1:

$$\exp(\phi_m(t_m, t_f, l_f; i, j)) + \exp(\phi_f(t_m, t_f, l_f; i, j)) \equiv \Gamma(l_f; i, j) \tag{2.6}$$

where Γ is calculated explicitly in appendix A.1.

When it comes to labor supply decisions, the spouses will choose l_f in order to select the outermost Pareto frontier, once the random shocks $\boldsymbol{\eta}$ are taken into account:

$$l_f^*(i, j) = \arg\max_{l_f \in \mathcal{L}} \Gamma(l_f; i, j). \tag{2.7}$$

2.6 Household Problem: Sharing Rule

Another key implication of the Transferable Utility property is that it is impossible to recover the *sharing rule* (t_m, t_f), i.e., the exact point on the Pareto frontier chosen by the spouses. The solution $(t_m^*(l_f; i, j), t_f^*(l_f; i, j))$ can only be pinned down if the distribution of power within the household is known. As suggested by Becker (1973), the sharing rule within the couple responds to shifts in supply and demand of mates of a given type in the marriage market. However, when search frictions are present, it is not possible to uniquely characterize Pareto weights starting from the marriage market outcome (Shimer and Smith, 2000). The underlying intuition can be explained with this thought example: consider a man who proposes to a woman and offers her a marriage contract that makes her just indifferent between marrying him and keeping on searching. Due to search frictions, she cannot turn to another similar man and agree on a better deal where she extracts a slightly larger share of surplus. In fact, waiting might be too costly, and, if the surplus is positive, the woman still has an incentive to accept. Yet, the marriage market still plays a crucial role in determining whether there is a set of allocations that make both candidates better off together than singles. If the set is not null, the choice of the allocation also depends on an additional *within-couple bargaining mechanism*. In some markets, the set of feasible allocations can be small, and competition might greatly reduce the role of within-couple bargaining; in others, the reverse can be true.

The discussion above implies that it is necessary to introduce an additional bargaining mechanism in order to recover the sharing rule and close the model. To understand how $(t_m^*(i, j), t_f^*(i, j))$ is selected, let me first introduce the relevant bargaining payoffs. These are given by the present discounted value of all expected flows in the future, once accounted for the possibility of breakups. Define $(W_m(t_m, t_f, l_f; i, j), W_f(t_m, t_f, l_f; i, j))$ as the *present discounted* *value of marriage* for a man and a woman in a couple (i, j) under sharing rule (t_m, t_f) and with labor supply l_f. In addition, define $(V_m^0(i), V_f^0(j))$ as the respective *present discounted value of singlehood*. The latter constitute the bargaining breakpoint and are shaped by market forces: agents take them as exogenous during the bargaining phase.

Call $(t_m^*(l_f; i, j), t_f^*(l_f; i, j))$ the solution to the bargaining process for a couple (i, j) conditional on labor supply l_f. The respective marriage payoffs are

$$V_m(l_f; i, j) + \frac{\eta_{l_f}}{2} \equiv W_m(t_m^*(l_f; i, j), t_f^*(l_f; i, j), l_f; i, j) + \frac{\eta_{l_f}}{2} \tag{2.8}$$

$$V_f(l_f; i, j) + \frac{\eta_{l_f}}{2} \equiv W_f(t_m^*(l_f; i, j), t_f^*(l_f; i, j), l_f; i, j) + \frac{\eta_{l_f}}{2} \tag{2.9}$$

and are chosen according to the following *surplus splitting rule*:

$$V_f(l_f; i, j) - V_f^0(j) = \frac{V_f(l_f; i, j) - V_f^0(j) + V_m(l_f; i, j) - V_m^0(i)}{2} \equiv \frac{S(l_f; i, j)}{2} \tag{2.10}$$

where S is the *systematic marriage surplus*, i.e., the total surplus net of the temporary match-quality shock η_{l_f}. In practice, the spouses split the total surplus in equal parts.

The splitting rule assumed in this model is arguably a simple one. Yet, it is able to generate a significant amount of variation across individuals in terms of private consumption. A closed-form equation for individual demand functions q_m^* and q_f^* is derived in appendix A.2. Once the sharing rule has been recovered, it is possible to derive the per-period indirect utilities $v_g(l_f; i, j) \equiv \phi_g(t_m^*(l_f; i, j), t_f^*(l_f; i, j), l_f; i, j)$ for $g \in \{m, f\}$.

In the previous literature, Shimer and Smith (2000) and GJR assume that couples select a sharing rule through Nash bargaining. A more general representation of the household problem is its collective form, which only relies on the efficiency assumption. In this paper, I restrict the *Pareto weight* to 0.5 for all couples[10]. This simple rule turns out to deliver a closed-form equation for surplus, and thus to make the computation of the steady-state equilibrium faster. Alternatively, the Pareto weight may be allowed to differ across couples, or even depend on some (time-invariant) *distribution factors* in the spirit of Browning and Chiappori (1998). However, this would require a more elaborate empirical strategy.

To conclude this section, the following lemma can now help characterize the wife's labor supply decision.

Lemma 2.1. *Assume that ϕ_m and ϕ_f verify the Transferable Utility property and that surplus is split according to rule (2.10). Then,*

$$S(l_f; i, j) + \eta_{l_f} > S(l_f'; i, j) + \eta_{l_f'} \Rightarrow \Gamma(l_f; i, j) > \Gamma(l_f'; i, j). \tag{2.11}$$

[10] GJR estimate the Nash bargaining parameter, which corresponds to the Pareto weight when utility functions are taken to be quasilinear. They find it to be not significantly different than 0.5.

Proof. It is possible to write $V_m(l_f;i,j) = \phi_m(t^*_m(l_f;i,j), t^*_f(l_f;i,j), l_f;i,j) + C_m(i,j)$ and $V_f(l_f;i,j) = \phi_f(t^*_m(l_f;i,j), t^*_f(l_f;i,j), l_f;i,j) + C_f(i,j)$, where C_m and C_f are, respectively, the continuation values for the husband and the wife. The latter do not depend on current labor supply due to the household problem being static. Consider l_f and l'_f such that $S(l_f;i,j)+\eta_{l_f} > S(l'_f;i,j)+\eta_{l'_f}$, and introduce the notation $\delta f(x) = \delta f(l_f;x) - f(l'_f;x)$, so that $\delta S(i,j)+\delta\eta > 0$. Both the reservation utilities and continuation values are the same regardless of the choice of l_f: hence, the surplus differential is given by $\delta S(i,j) = \delta\phi_m(i,j) + \delta\phi_f(i,j)$. Similarly, the husband's surplus differential is $\delta V_m(i,j)+\delta\eta/2 = \delta\phi_m+\delta\eta/2 = \delta S(i,j)/2+\delta\eta/2$, where the last equality is due to the splitting rule (2.10). Since $\delta S(i,j)+\delta\eta > 0$, both $\delta\phi_m+\delta\eta/2$ and, for analogous reasons, $\delta\phi_f + \delta\eta/2$ are positive. Now, recall that a necessary and sufficient condition for the TU property to hold is the existence of two functions g_m and g_f, continuous and increasing, s.t. the Pareto frontier can be expressed as

$$g_m(\phi_m(t_m,t_f,l_f;i,j)+\frac{\eta_{l_f}}{2}) + g_f(\phi_f(t_m,t_f,l_f;i,j)+\frac{\eta_{l_f}}{2}) = \mathit{\Gamma}(l_f;i,j),$$

a result exposed, e.g., in Chiappori and Gugl (2014) and Demuynck and Potoms (2018). Due to g_m and g_f being increasing, $g_m(\phi_m(l_f)+\frac{\eta_{l_f}}{2}) > g_m(\phi_m(l'_f)+\frac{\eta_{l'_f}}{2})$ and $g_f(\phi_f(l_f)+\frac{\eta_{l_f}}{2}) > g_f(\phi_f(l'_f)+\frac{\eta_{l'_f}}{2})$. Adding up the two inequalities, one obtains $\mathit{\Gamma}(l_f) > \mathit{\Gamma}(l'_f)$. □

Lemma 2.1 establishes that the splitting rule (2.10) implies that the household always chooses the level of labor supply associated with the highest total surplus $S(l_f;i,j)+\eta_{l_f}$. The chosen level of labor supply l_f, $(t^*_m(l_f;i,j), t^*_f(l_f;i,j))$ lies on the outermost Pareto frontier if $S(l_f;i,j)+\eta_{l_f} > S(l'_f;i,j)+\eta_{l'_f}$[11]. The proof suggests that, when switching from l'_f to l_f, the additional surplus is always redistributed proportionally, so that the ratio of the shares is always 0.5. Thanks to the additive separability of η_{l_f} and the logit assumption, the probability of selecting a given level l_f can be written as:

$$\begin{aligned}\ell(l_f;i,j) &\equiv \Pr\left\{S(l_f;i,j)+\eta_{l_f} > S(l'_f;i,j)+\eta_{l'_f}\ \ \forall l'_f\in\mathcal{L}\right\} = \\ &= \frac{\exp(S(l_f;i,j)/\sigma_\ell)}{\sum_{l'\in\mathcal{L}}\exp(S(l';i,j)/\sigma_\ell)}.\end{aligned} \tag{2.12}$$

Taking expectations over marriage surplus with respect to the vector $\boldsymbol{\eta}$ yields the following expected surplus (named *inclusive surplus* in the GEV literature; see Train, 2009):

$$\bar{S}(i,j) \equiv \sigma_\ell \log\sum_k \exp(S(k;i,j)/\sigma_\ell). \tag{2.13}$$

[11] The caveat is that the sum $\phi_m(l_f)+\phi_f(l_f)$ does *not* necessarily provide an implicit representation of the Pareto frontier. It only does so in the case where ϕ_m (ϕ_f) is quasilinear in the private budget $w_i - t_m$ ($w_j - t_f$): in this case, the functions g_m and g_f required to obtain a linear representation of the Pareto frontiers as in (2.6) are linear functions.

2.7 Divorce Decisions

Up to now, household composition was treated as given. However, when the uncertainty is revolved in t_+ (see timeline 1), the couple may decide to break up. Conditionally on the realization of the wage shocks and on temporary shocks $\boldsymbol{\eta}$, spouses are free to compare the optimal household allocation that they can achieve in the coming period to what they can get if each of them were on his/her own. In other words, the new household allocation has to respect the spouses' individual rationality constraints.

The updated state of the couple in t_+ is given by the spouses' new types (i, j) and the vector of temporary match-quality shocks $\boldsymbol{\eta}$. If, once accounted for the temporary shocks $\boldsymbol{\eta}$, the total surplus is not positive for the outermost Pareto frontier $\mathit{\Gamma}(l_f; i, j)$, then the spouses are better off breaking up. Given the logit assumption on $\boldsymbol{\eta}$, the probability of divorce is given by:

$$\begin{aligned} 1 - \alpha(i,j) &\equiv \Pr\left\{ \max_{l_f \in \mathcal{L}} \left(S(l_f; i, j) + \eta_{l_f} \right) < -\kappa \right\} = \\ &= \frac{\exp(-\kappa)}{\exp(-\kappa) + \left(\sum_{l_f} \exp(S(l_f; i, j)/\sigma_\ell) \right)^{\sigma_\ell}} = \frac{1}{1 + \exp(\bar{S}(i,j) + \kappa)}. \end{aligned} \tag{2.14}$$

where the last equality follows from the definition of inclusive surplus (2.13). The probability $\alpha(i, j)$ corresponds to the odds of continuing the current marriage. Finally, the parameter κ stands for the sunk cost of divorce: note that, *ceteris paribus*, a higher κ leads to a higher α.

When divorce cannot be ruled out, only limited commitment devices are feasible: these mechanisms have been widely studied in the economic literature on marriage and risk-sharing[12]. In this model, I consider a particular case: it is assumed that, when uncertainty is resolved, agents are completely free to bargain over a new household allocation: if bargaining fails because of negative surplus, the couple splits. In other words, this is a model of no commitment. The lack of commitment implies that married agents do not succeed in reducing the volatility of consumption as much as they wish. In particular, even small changes in wages will cause the household to shift to a new allocation. On the other hand, if given the choice, risk-averse agents would prefer to commit to a given sharing rule in order to smooth out future labor income shocks.

[12]See Ligon et al. (2002) and Mazzocco (2007) for an exhaustive discussion and an empirical test of limited commitment. More recently, several other papers estimated intertemporal collective models with limited commitment: Voena (2015), Reynoso (2017) and Shephard (2018) are three noteworthy examples; see Chiappori and Mazzocco (2017) for a complete review.

2.8 Value of Marriage

The spouses' Bellman equations recursively characterize the equilibrium marital payoffs for given reservation values $(V_m^0(i), V_f^0(j))$. Consistently with the household problem and the divorce rule described in previous sections, the Bellman equations of married agents can be written as:

$$\begin{aligned} V_m(l_f;i,j) =& v_m(l_f;i,j) + \psi_m(i)\beta\sum_{i'} V_m^0(i')\pi_m(i,i') + \\ & \underbrace{+\,\psi_m(i)\psi_f(j)\frac{\beta}{2}\sum_{i',j'}\left[\gamma_e + \log(\exp(-\kappa) + \exp(\bar{S}(i',j')))\right]\pi_m(i,i')\pi_f(j,j')}_{\text{Husband's continuation value}}. \end{aligned} \tag{2.15}$$

$$\begin{aligned} V_f(l_f;i,j) =& v_f(l_f;i,j) + \psi_f(j)\beta\sum_{j'} V_f^0(j')\pi_f(j,j') + \\ & \underbrace{+\,\psi_m(i)\psi_f(j)\frac{\beta}{2}\sum_{i',j'}\left[\gamma + \log(\exp(-\kappa) + \exp(\bar{S}(i',j')/\sigma))\right]\pi_m(i,i')\pi_f(j,j')}_{\text{Wife's continuation value}}. \end{aligned} \tag{2.16}$$

where γ_e is Euler's constant.

Enforcing the splitting rule (2.10) on the lhs of equations (2.15) and (2.16), one can recover the per-period indirect utilities $v_m(l_f;i,j)$ and $v_f(l_f;i,j)$. The pair $(v_m(l_f;i,j), v_f(l_f;i,j))$ needs to be such that the household allocation lies on the Pareto frontier: hence, substituting v_m and v_f in equation (2.6) ensures that the wife's and husband's payoffs are both feasible and Pareto optimal. Moreover, this also yields a Bellman equation for the surplus function:

$$\begin{aligned} S(l_f;i,j) =& h(l_f,i,j) - \log\left[\exp\left(V_f^0(j) - \psi_f(j)\beta\sum_{j'}V_f^0(j')\pi_f(j,j')\right)^2 + \right. \\ & \left. + \exp\left(V_m^0(i) - \psi_m(j)\beta\sum_{i'}V_m^0(i')\pi_f(i,i')\right)^2\right] + \\ & \underbrace{+\,\psi_m(i)\psi_f(j)\beta\sum_{i',j'}\left[\gamma_e + \log(\exp(-\kappa) + \exp(\bar{S}(i',j')))\right]\pi_m(i,i')\pi_f(j,j')}_{\text{Couple's continuation value}} \end{aligned} \tag{2.17}$$

which yields a system of $|\mathcal{I}| \times |\mathcal{J}| \times |\mathcal{L}|$ equations with as many unknowns, the elements of $(S(l_f;i,j))$[13]. The function $h(l_f;i,j)$ depends on the shape of the Pareto frontier - their

[13] A convenient way of proceeding is actually to derive the corresponding Bellman equation for $\bar{S}$ by using the expression for the inclusive surplus (2.13). For given reservation values (V_m^0, V_f^0), it is possible to solve the system by first computing $\bar{S}$ for couples where at least one spouse has age $\bar{\bar{a}}_g$: these couples have a continuation value equal to zero. Then, it is possible to solve backwards by computing $\bar{S}$ for couples where at least one spouse has age $\bar{\bar{a}}_g - 1$, and so on.

relationship is clarified in appendix A.1 - and, ultimately, on preferences: in this case, it corresponds to the following

$$h(l_f; i, j) = \tilde{\gamma}_1(i, j) + (\gamma_1(i, j) + 1) \log(w_i + l_f w_j) + \gamma_2(l_f; j) + \gamma_3(i, j). \tag{2.18}$$

where $\tilde{\gamma}(i, j)$ is a function of $\gamma_1(i, j)$ (see appendix A.1). By establishing the connection between preferences and the match payoff, the function h has a key role in the determination of the equilibrium marital patterns. I will often refer to h as the *per-period surplus function*.

2.9 Meetings

Search for a partner is costless and singles of different sex meet each other randomly. In each period, the number of meetings between singles of different sex of a given type is given by a *meeting function* $\Lambda(i, j, n_{m,+}, n_{f,+})$. The measures $n_{m,+}$ and $n_{f,+}$ represent the available number of singles by type at time t_+ and are defined over $|\mathcal{I}|$ and $|\mathcal{J}|$ respectively: they will be formally defined in section 2.11, and are endogenously determined at equilibrium. The probability for a single man i of meeting a single woman j and the probability of a single woman j to meet a single man i can be written as the following conditional probabilities:

$$\Lambda_m(i, j) \equiv \Lambda(i, j, n_{m,+}, n_{f,+})/n_{m,+}(i) \tag{2.19}$$

$$\Lambda_f(i, j) \equiv \Lambda(i, j, n_{m,+}, n_{f,+})/n_{f,+}(j). \tag{2.20}$$

The meeting function $\Lambda(i, j, n_{m,+}, n_{f,+})$ needs to respect some theoretical restrictions. The total number of meetings involving types i (or j) cannot exceed $n_{m,+}(i)$ (or $n_{f,+}(j)$)[14]:

$$\sum_j \Lambda(i, j, n_{m,+}, n_{f,+}) \leq n_{m,+}(i) \quad \forall i \tag{2.21}$$

$$\sum_i \Lambda(i, j, n_{m,+}, n_{f,+}) \leq n_{f,+}(j) \quad \forall j \tag{2.22}$$

The specification chosen for Λ is the following:

$$\Lambda(i, j) = \lambda(i, j) \left((n_{m,+}(i))^{-\chi} + (n_{f,+}(j))^{-\chi} \right)^{-1/\chi} \tag{2.23}$$

with $\sum_i \lambda(i, j) \leq 1$ for each j and $\sum_j \lambda(i, j) \leq 1$ for each i. These conditions on λ ensure that constraints (2.21) and (2.22) are respected. In line with the search literature, the number of meetings depends on the availability of singles on each side of the market (Rogerson et al., 2005).

[14] In addition, at the aggregate level, the total number of meetings must not exceed $\min\{N_m, N_f\}$. This additional restriction is implied by (2.21) and (2.22) as long as there is an equal number of male and female singles on the market.

However, with heterogeneity on both sides of the market, the number of meetings between types i and j depend on the specific supplies $n_{m,+}(i)$ and $n_{f,+}(j)$: the two act as inputs in a CES function, where the elasticity of substitution is decreasing in χ[15]. Moreover, $\lambda(i,j)$ acts as a shifter that captures the degree of homophily along observable traits in the meeting structure: the empirical specification of $\lambda(i,j)$ is detailed in section 5.6.

2.10 Marriage Decisions and Value of Singlehood

Upon a meeting, a man and a woman observe each other's type and draw a vector $\boldsymbol{\eta}$. As in equation (2.14), the logit framework yields the following probability of getting married:

$$\begin{aligned} \alpha_0(x,y) &\equiv \Pr\left\{\max_{l_f\in\mathcal{L}}\left(S(l_f;i,j)+\eta_{l_f}\right)>0\right\} \\ &= 1-\frac{1}{1+\exp(\sigma_\ell\bar{S}(i,j))} \end{aligned} \tag{2.24}$$

where α_0 differ from α because of the absence of the sunk cost κ. In other words, if an agent is not interested in pursuing a relationship with his/her date, he/she needs to wait until the next period, but can walk away without having to pay any additional cost. As a consequence, it is easy to show that $\alpha(i,j)>\alpha_0(i,j)$ as long as $\kappa>0$.

It is now possible to derive the value of singlehood, named V_m^0 and V_f^0 for men and women respectively. The per-period utility flow a single agent gets can easily be derived from a much simplified version of the household problem discussed for married couples. The only consumption choice a single agent needs to make is how to spend his total wage on goods q and Q: since he/she lives alone, both goods are private. The presented discounted value of being single also incorporates the expectations about his/her marriage market prospects. The Bellman equations can be written as follows:

$$\begin{aligned} V_m^0(i) =& v_m^0(i)+\beta\psi_m(i)\sum_{i'}V_m^0(i')\pi_m(i,i')di'+ \\ &\underbrace{+\psi_m(i)\frac{\beta}{2}\sum_{i',j'}\left[\gamma_e+\log(1+\exp(\bar{S}(i',j')))\right]\Lambda_m(i',j')\pi_m(i,i')}_{\text{Expected marriage prospects}} \end{aligned} \tag{2.25}$$

$$\begin{aligned} V_f^0(j) =& v_f^0(j)+\beta\psi_f(j)\sum_{j'}V_f^0(j')\pi_f(j,j')+ \\ &\underbrace{+\psi_f(j)\frac{\beta}{2}\sum_{i',j'}\left[\gamma_e+\log(1+\exp(\bar{S}(i',j')))\right]\Lambda_f(i',j')\pi_f(j,j')}_{\text{Expected marriage prospects}}. \end{aligned} \tag{2.26}$$

[15] The specification (2.23) is widely used in demography (Pollak, 1990). When $\chi=1$, the meeting function reduces to the harmonic mean between $n_{m,+}(i)$ and $n_{f,+}(j)$, used for instance by Stevens !!!!.

2.11 Aggregate Stocks

After outlining the behavior of individual agents, it is useful to define aggregate measures to keep track of the number of individuals by type and marital status in the population. First, consider the overall population dynamics: define p_m over $\mathcal{I}$, p_f over $\mathcal{J}$ the marginal PDF of the male and female population characteristics. As detailed in section 2.1, agents may exit the marriage market in any period: e.g., the per-period aggregate outflow of men of type i is given by $(1-\psi_m(i))p_m(i)$. Stationarity demands that the outflow of agents is counterbalanced by an inflow of new agents so that the size and composition of the population do not change. In t_+ in each period, an inflow $\omega_m(i)$ of unmarried men i and $\omega_f(j)$ of unmarried women j enter the market so that p_m and p_f do not change over time[16].

I introduce measures n_m over $\mathcal{I}$, n_f over $\mathcal{J}$ and m over $\mathcal{I} \times \mathcal{J}$ that count male singles, female singles and couples *at the end of the period*, i.e., after the matching phase took place (or, analogously, in t on time-lines 1 and 2, just before uncertainty is resolved). As in any matching model, the *matching outcome* (n_m, n_f, m) must respect the accounting restrictions:

$$p_m(i) = n_m(i) + \sum_j m(i,j) \tag{2.27}$$

$$p_f(j) = n_f(j) + \sum_i m(i,j). \tag{2.28}$$

In t_+, when agents update their types, it is also necessary to update the aggregate distributions. Singles draw their new wages before the "market opening", and they are joined by the inflows of new agents ω_m and ω_f. Hence, the measure of singles of a given type in t_+ is given by:

$$n_{m,+}(i') \equiv \begin{cases} \omega_m(i') + \sum_{i'} \psi_m(i) n_m(i) \pi_m(i,i') & \text{if } a_{i'} > \underline{a}_m \\ \omega_m(i') & \text{if } a_{i'} = \underline{a}_m \end{cases} \tag{2.29}$$

$$n_{f,+}(j') \equiv \begin{cases} \omega_f(j') + \sum_{j'} \psi_f(j) n_m(j) \pi_f(j,j') & \text{if } a_{j'} > \underline{a}_f \\ \omega_f(j') & \text{if } a_{j'} = \underline{a}_f \end{cases} \tag{2.30}$$

Similarly, it is useful to define a measure m_+ that counts married couples of a given type in t_+, right after uncertainty is resolved, but before spouses could make decisions about the

[16] Relaxing this assumption introduces insightful long-run dynamics. For instance, younger cohorts may enter the market with better initial wages: in a competitive environment, this may have sizable implications for older cohorts' matching behavior. While such framework does not seem compatible with a notion of deterministic steady-state equilibrium, it may be helpful to study the relationship between business cycles and marriage markets.

continuation of the match. In other words, the measure m_+ is the distribution of characteristics of the population at risk of divorce in t_+:

$$m_+(i',j') = \sum_{i,j} \psi_m(i)\psi_f(j)m(i,j)\pi_m(i,i')\pi_f(j,j')didj. \tag{2.31}$$

2.12 Law of Motion and Search Equilibrium

The matching outcome (m, n_m, n_f) results from individual matching strategies (α, α_0). The number $m(i,j)$ of couples (i,j) at the end of the period is given by the sum of newlyweds (i,j) and those couples (i,j) that did not divorce after drawing new wages and home productivity shocks. This results in the following law of motion:

$$m(i,j) = \underbrace{\alpha_0(i,j)\Lambda(i,j)}_{MF(i,j)} + \underbrace{\alpha(i,j)m_+(i,j)}_{m_+(i,j)-DF(i,j)}. \tag{2.32}$$

where the first term on the rhs provides a formula for the marriage flow $MF(i,j)$, while the second term implicitly provides a formula for the divorce flow $DF(i,j)$. Introducing the notation $NF(i,j) \equiv MF(i,j) - DF(i,j)$ to define the *net flow* of agents (i,j), the evolution of stocks can also be described concisely as follows:

$$m(i,j) = m_+(i,j) + NF(i,j). \tag{2.33}$$

At the steady-state search equilibrium, agents' matching strategies (α, α_0) must be consistent with the equilibrium payoff structure S. The gains from marriage at equilibrium, described by S depend on both the household technology and the agents' reservation utilities (V_m^0, V_f^0). The latter are endogenous equilibrium objects, in that they depend on the supplies (n_m, n_f) of singles on the market. Given these premises, the steady-state search equilibrium can be defined by combining the key equations outlined in this section.

Definition 2.1. *Consider the search-and-matching model described in this section. A* ***steady-state search equilibrium*** *is given by time-invariant measures of couples and singles* (m, n_m, n_f)*, payoffs* (V_m^0, V_f^0, S) *and strategies* (α_0, α) *so that:*

- *optimal marriage and divorce strategies* (α_0, α) *are linked with surplus* S *through the divorce rule* (2.14) *and the marriage rule* (2.24).
- *the Bellman equation of marital surplus* (2.17) *yields* S *for given reservation utilities* (V_m^0, V_f^0)*;*

- *the Bellman equations of reservation utilities* (2.25) *and* (2.26) *yield* (V_m^0, V_f^0) *for given supplies of singles* (n_m, n_f)*;*

- *if the accounting constraints* (2.27) *and* (2.28) *are enforced, the law of motion* (2.32) *yields the equilibrium aggregate measures* (m, n_m, n_f) *for given matching strategies* (α_0, α)*.*

These equilibrium conditions can be combined to derive a fixed-point operator of type $n = T_{ext}n$ over the support $\mathcal{I} \cup \mathcal{J}$. This fixed-point operator is described in appendix A.3. Recently, Manea (2017) generalized the original proof of existence by Shimer and Smith (2000). It may be possible to extend this proof to a framework with random match quality, although this has not been done in the literature yet. In practice, iteration of the fixed-point operator seems to converge to the same distribution n[17].

2.13 Welfare Measures

The model outlined in this section implicitly provides several measures of welfare. For instance, the expected utility of young individuals entering the marriage market represents the ex-ante expected welfare - conditionally on knowing their initial type i - at the beginning of adulthood. This is nothing more than singles' expected utility right after drawing a new wage and right before going on the marriage market: it can be computed as

$$V_m^{exp}(i) = V_m^0(i) + \frac{1}{2}\sum_j \left[\gamma_e + \log(1 + \exp(\bar{S}(i,j)))\right] \Lambda_m(i,j). \tag{2.34}$$

Fernández and Wong (2017) use ex-ante welfare conditional on the initial endowment of young agents in order to assess the welfare implications of different divorce regimes. After discussing the identification and the estimation of the model, I am able to recover analogous measures of welfare among young individuals.

The distribution of ex-ante welfare matters for two reasons: first, it provides insights on the equality of opportunities among young individuals and how it has evolved over time. Second, by comparing differences across educational groups, it can be used to assess the returns to college in terms of welfare. Chiappori et al. (2017) and Reynoso (2017) measure the *marriage market returns to education* by computing the difference between the expected gains from marriage with a college degree and those without[18]. In this model, disentangling the marriage market

[17] The only caveat is that the introduction of a "relaxation parameter" is needed: details are provided in appendix A.3.

[18] In their frameworks, the choice of the partner takes place right after the end of student's life and before the unfolding of labor and consumption life-cycle dynamics. Hence, quantifying the marriage market returns to education is straightforward.

from the labor market returns to education is more complex: since people marry at different ages and may remarry after a divorce, there is no closed-form solution to compute the marriage market returns to college. However, the model is in principle appropriate to explore the policy implications of differences in marriage prospects on educational choices: further work is needed in this direction.

A more straightforward approach to understand how different subgroups of the population benefit from the marriage market is to look at the marital surplus function (2.17). It is indeed possible to calculate the average surplus produced by the marriage market at equilibrium, either for the entire population or for specific categories. At equilibrium, each match of type (i, j) is associated with a level of marital surplus that depends on the realization of the shocks $\boldsymbol{\eta}$. Hence, I compute the expected realized surplus for both newlyweds and couples that have been married for more than one period. The latter may be observed together at equilibrium in spite of a relatively unfavorable realization of $\boldsymbol{\eta}$, due to the presence of divorce costs.

$$S^{exp}(i,j) = \begin{cases} \mathbb{E}_{\boldsymbol{\eta}} \max\left\{\max_{l_f \in \mathcal{L}} \left[S(l_f; i, j) + \eta_{l_f}\right], 0\right\} & \text{if newlyweds} \\ \mathbb{E}_{\boldsymbol{\eta}} \max\left\{\max_{l_f \in \mathcal{L}} \left[S(l_f; i, j) + \eta_{l_f}\right], -\kappa\right\} & \text{otherwise.} \end{cases} \tag{2.35}$$

Knowing the marriage market outcome (m, n_m, n_f), it is possible to compute the total expected gains from marriage for the whole market. Similarly, it is possible to compute the average expected gains for a specific group: for instance, $\sum_j \frac{m(i,j)}{p_m(i)} S^{exp}(i,j)$ yields the average expected gains for men of type i. Note that a fraction $n_m(i)/p_m(i)$ does not get any marital surplus: hence, the measure depends both on the extensive and the intensive margins of the marital choice, i.e., the choice of whether to marry and the choice of whom to marry.

These measures are used later in section 6.10 and will prove helpful in providing support when trying to understand the mechanisms at work in the model. In addition, they can offer some guidance in terms of which groups may be in need of policy support: if some groups of the population become not only relatively poorer but are also more likely to give up on marriage, then they may incur even larger welfare losses. If these additional losses due to changes in the marriage market outcome are not taken into account, the policy-maker may underestimate the degree of economic inequality.

Nevertheless, only looking at the surplus function does not help assess the monetary costs incurred by households due to changes in the gains from marriage. One way to circumvent this problem is to employ a money metric measure of individual utility that is able to capture the monetary value of the gains from marriage (Chiappori and Meghir, 2014). I intend to extend the analysis in this direction in order to provide a more insightful quantitative assessment of the effects of changing wages on the gains from marriage.

3 Identification

In this section, I discuss the identification of three key objects in the model, the meeting function Λ, the divorce cost κ, and the per-period match surplus h. I informally refer to the "full identification" of the model as the desirable situation where the observed data patterns can only be generated by a unique choice of (Λ, κ, h), and where the primitive parameters of the model can thus be inferred with appropriate data. I show that full identification can be obtained starting from a dataset $(\hat{n}_m, \hat{n}_f, \hat{m}, \hat{\ell}, \widehat{MF}, \widehat{DF})$, where $(\hat{n}_m, \hat{n}_f, \hat{m})$ is the observed marriage market outcome (the "stocks"), $\hat{\ell}$ is the observed vector of labor supply choices, $(\widehat{MF}, \widehat{DF})$ is the observed marital turnover (the gross "flows").

3.1 Matching Strategies

The identification of the match surplus starting from matched data has been exhaustively discussed by Choo and Siow (2006) and Galichon and Salanié (2015). Choo (2015) extends the seminal model by Choo and Siow (2006) to a dynamic framework where people age[19]: also in this case, identification of the gains from marriage relies on the observation of repeated cross-sections of matched data.

Similar identification principles apply to search-and-matching models: information on "stocks", i.e., the number of married and single individuals by type, are still key to achieve the full identification of the model. However, the econometrician needs to address an additional question: are matches between two specific types i and j common (rare) because of a high (low) match surplus or because these types meet with high (low) frequency?

In this section, start by assuming that the meeting function Λ and the divorce cost κ are known to the econometrician. If this is the case, then it is possible to pin down matching strategies (α, α_0) using matched data $(\hat{n}_m, \hat{n}_f, \hat{m})$, starting from the law of motion (2.32) and the following relationship between α and α_0:

$$\alpha_0(i,j) = \frac{\alpha(i,j)}{\tilde{\kappa} + (1-\tilde{\kappa})\alpha(i,j)}. \tag{3.1}$$

where $\tilde{\kappa} = \exp(\kappa)$. The following identification result for $(\alpha(i,j), \alpha_0(i,j))$ applies.

Lemma 3.1. *Denote θ the set of search parameters of the model (Λ, κ) and assume the econometrician observes $(\hat{n}_m, \hat{n}_f, \hat{m})$, where the empirical measures of singles $\hat{n}_m$ and $\hat{n}_f$ respect the*

[19] While the frictionless model of Choo (2015) presents interesting similarities with the model outlined in this paper, one of the main differences is that in Choo's paper the risk of divorce is fully exogenous.

empirical counterparts of the accounting constraints (2.27) and (2.28). Assume that, for each (i, j), the following condition holds:

$$\hat{m}(i,j) < \Lambda(i,j,\hat{n}_{m,+}(i),\hat{n}_{f,+}(j)) + \hat{m}_{+}(i,j). \tag{3.2}$$

Then, for each choice of θ, there exist two unique mappings from the empirical distribution of spouses characteristics $\hat{m}$ defined over $\mathbb{R}_+^{|\mathcal{I}|\times|\mathcal{J}|}$ to the matching strategies $\hat{\alpha}^\theta$ and $\hat{\alpha}_0^\theta$, both in $[0,1]^{|\mathcal{I}|\times|\mathcal{J}|}$.

Proof. Start from the law of motion (2.32), and substitute out $\alpha_0(i,j)$ with (3.1). For each (i,j), $\hat{\alpha}^\theta$ is the one and only solution in the interval $[0,1]$ to the quadratic equation:

$$\begin{aligned}
&-(\tilde{\kappa}-1)\hat{m}_+(i,j)\alpha(i,j)^2+\\
&\quad+\left[(\tilde{\kappa}-1)\hat{m}(i,j)+\Lambda(i,j,\hat{n}_{m,+}(i),\hat{n}_{f,+}(j))+\tilde{\kappa}\hat{m}_+(i,j)\right]\alpha(i,j)+\\
&\quad-\hat{m}(i,j)\tilde{\kappa}=0.
\end{aligned} \tag{3.3}$$

Consider the generic notation for the quadratic equation $ax^2+bx+c=0$. Note that: $a<0$ and $c<0$ as $\tilde{\kappa}>1$ by assumption; $\Delta\equiv b^2-4ac>0$; the axis of symmetry is given by $x=-b/2a>1$. It follows that both solutions take positive values, and that there is at most one solution between $[0,1]$. The latter is between $[0,1]$ if $2a<-b+\sqrt{\Delta}$: squaring both sides of the inequality yields $a+b+c>0$, which holds by assumption (3.2). As long as $\hat{\alpha}^\theta(i,j)\in[0,1]$, it is easy to see from the relationship (3.1) that also $\hat{\alpha}_0^\theta(i,j)\in[0,1]$ regardless of the value of $\tilde{\kappa}$. $\square$

Condition (3.2) implies that, if Λ is misspecified, then there may not exist a set of individual strategies (α,α_0) that rationalize the observed matching outcome $(\hat{n}_m,\hat{n}_f,\hat{m})$. The rhs of condition (3.2) stands for the total number of pairs (i,j) that, in t_+, are considering whether they should spend the next period together. If the number of meetings (i,j) is too low, there may not be a sufficient number of potential matches to rationalize the net flow $NF(i,j)$. In other words, underrating the number of meetings (i,j) will lead $(\hat{\alpha},\hat{\alpha}_0)$ to exceed their upper bounds[20]. The set of conditions (3.2) can thus be used to test whether the prior on the specification chosen for Λ is to reject.

However, we are now left with a major question to address. While conditions (3.2) imply some restrictions on the meeting structure, there may still exist several functions Λ that satisfy

[20] Interestingly, condition (3.2) does not imply any restriction on the cost structure, apart from $\kappa>0$. The proof can be easily extended to the case where the covariance structure of the initial shock differs from the covariance of the following shocks: also in this case condition (3.2) does not depend on either κ or the covariance of the first shock. However, a proper generalization of this result would require to relax the GEV assumption on the home productivity shocks, which would result in a generalization of relationship (3.1). Once relaxed the distributional assumption, one may end up facing restrictions on both Λ and κ.

them. All of these meeting functions would be able to rationalize the observed matching outcome $(\hat{n}_m, \hat{n}_f, \hat{m})$, with the econometrician being unable to distinguish among them. The intuition behind this identification puzzle is the following: a cross-section (or a series of cross-sections) of matched data are only consistent with a unique set of net flows $\widehat{NF}$, as it is clear from the law of motion (2.33). However, there may be several sets of gross flows $(\widehat{MF}, \widehat{DF})$ consistent with the same dataset. This identification issue is addressed in the next section.

3.2 Meeting and Marriage Cost Function

GJR formally discuss this identification problem in a search-and-matching framework without aging and wage shocks. They suggest the use of additional data on gross flows in order to disentangle the structure of meetings from the structure of the surplus. Assume now that the econometrician observes a new layer of data $(\widehat{MF}, \widehat{DF})$. Recall from the law of motion (2.32) that the equations that yield the steady-state marriage and divorce rates are:

$$\alpha_0(i,j) = \frac{MF(i,j)}{\Lambda(i,j)} \tag{3.4}$$

$$1 - \alpha(i,j) = \frac{DF(i,j)}{m_+(i,j)}. \tag{3.5}$$

Relationships (3.4) and (3.5) imply $2 \times |\mathcal{I}| \times |\mathcal{J}|$ restrictions that can be used to achieve full identification of the model. Hence, the number of unknowns in the system implied by (3.4) and (3.5) cannot exceed $2 \times |\mathcal{I}| \times |\mathcal{J}|$. The first $|\mathcal{I}| \times |\mathcal{J}|$ parameters to estimate are the continuation probabilities α for each pair (i, j). The only additional unknown parameter needed to obtain the marriage probabilities α_0 through relationship (3.1) is the cost of divorce κ. Hence, it is necessary to impose a restriction on Λ as it is only possible to identify up to $|\mathcal{I}| \times |\mathcal{J}| - 1$ additional parameters.

The key intuition behind this identification strategy is that both marriage and divorce flows contain information about marital surplus. The structural approach helps establish an explicit relationship between the data and the parameter of interest. Similar empirical strategies have already been used in the matching literature. In the case of marriage markets, Wong (2003), Goussé (2014) and GJR target the rate of arrival of meetings and divorce shocks: the first two papers rely on data on the duration of marriage and singlehood, while the third relies on marriage and divorce rates. In this paper, I use an approach analogous to GJR, although I also exploit the variation in marriage and divorce rates across types to estimate a more general meeting function. Interestingly, Bruze et al. (2015) use a similar strategy to estimate a frictionless model of the marriage market with heterogeneous cost of divorce in terms of both individual types and duration: they exploit the variation in the hazard of divorce with respect to marriage duration. Finally, both Greenwood et al. (2016) and Shephard (2018) assume that the unobserved match-quality is autocorrelated over time: information on marriage duration and divorce can also help with the identification of the parameters of the match-quality distribution.

3.3 Surplus and Household Production Function

Using the identification result from last section, it is possible to infer the cost of divorce and the meeting function: their estimates are named $\hat{\theta} \equiv (\hat{\Lambda}, \hat{\theta})$. Hence, it is possible to back out the matching strategies α and α_0 from the law of motion (2.32), as long as the conditions required by lemma 3.1 are respected. The inclusive surplus $\bar{S}$ can be obtained through the bijection (2.14). Data on labor supply - and in particular knowing the proportion $\hat{\ell}(l_f; i, j)$ of couples (i, j) with l_f hours worked in the data - leads to the identification of the surplus function S over the support $|\mathcal{I}| \times |\mathcal{J}| \times |\mathcal{L}|$ through equation (2.12). The identification of the reservation utilities V_m^0 and V_f^0 follows, provided a normalization of the utility flows for singles, $v_m^0(i)$ and $v_f^0(j)$[21].

Another important remark is that, as long as the wage process (π_m, π_f) and the survival rates (ψ_m, ψ_f) are independent of the marital status, they can be estimated outside of the model. This greatly simplifies the estimation, although it comes at high cost. At the moment, no paper has been successful in estimating a model of marriage market equilibrium with human capital accumulation during the life-cycle, with the only exception of Beauchamp et al. (2018). However, in order to fully understand the relationship between the changing wage structure and marriage market outcomes, this is a necessary step. Several papers have explored this issue outside of the marriage market equilibrium (e.g. Mazzocco, 2007; Blundell et al., 2016), while Shephard (2018) has laid down the basis for empirical work in this direction.

Under these assumptions, it is possible to pin down the per-period match surplus h from the Bellman equation for surplus (2.17), as by now both the surplus and the reservation values are known for given search parameters $\hat{\theta}$. In practice, h is obtained as the residual after subtracting both the current reservation values and the dynamic component (i.e., the continuation value) from the surplus function S.

[21] In the literature on the econometrics of matching models, a normalization of the agents' reservation utilities is usually required as matched data only identify the match gains, i.e., the differential utility produced by the match (Galichon and Salanié, 2015). In search models, an analogous normalization applies to the per-period utility flows of singles.

4 Data

The estimation closely relies on the identification results derived in the previous section. Hence, in order to identify the key primitives of the model - the meeting and the per-period match surplus - two types of data are needed: (i) the standard *matched data*, i.e., cross-sectional data on who is matched with whom, and (ii) panel data to measure the *hazard of marriage* (among singles) and the *hazard of divorce* (among married). In this paper, I use two separate data sources to obtain all the necessary information: the Annual Social and Economic Supplement (ASEC) from the Current Population Survey (CPS) is used as a source of information on the number of singles and married couples by observable characteristics, while the Panel Study of Income Dynamics (PSID) as a source of information on the hazard of marriage and divorce. In this section, I introduce the sample used for estimation and the definition on the main variables; I clarify how I use the two datasets and describe their salient characteristics.

4.1 Sample Selection

The CPS is composed of a series of yearly cross-sections, and observations are assigned individual cross-sectional weights so that the sample is representative of the American population in a given year. From the main CPS dataset, I build two separate samples: in the first, I pool all individuals aged between 20 and 60 observed between 1971 and 1981 (about 409,000 men and 445,000 women); in the second, I pool all individuals in the same age range observed between 2001 and 2011 (about 613,000 men and 664,000 women).

From the main PSID dataset, I only keep observations from the SEO (Survey of Economic Opportunity) and the SRC (Survey Research Center) samples, thus excluding the Immigrant and Latino samples. Since 1997, the survey has been conducted every two years: since in this analysis the PSID is only used to exploit its panel dimension, I only keep odd years in the sample and focus on changes that occur over a two-year period. Also in the case of the PSID, I build two separate samples: the first contains all individuals aged between 20 and 60 between 1971 and 1981 (about 9,800 observations for men and 11,100 for women), and the second all individuals in the same range between 2001 and 2011 (about 12,200 observations for men and 13,300 for women). In the PSID, attrition is low for sampled individuals: this yields a fairly balanced panel. However, temporary non-sample individuals living with the sampled are not followed once they quit the household: this matters when looking at the distribution of divorcees, as it is not always possible to follow the trajectory of one of the two partners after the breakup.

In both samples, I rely on the "relationship-to-head" variable in order to exclude secondary families and same-sex couples. An important remark is in order: the CPS only surveys the civilian noninstitutional population, thus excluding people on duty in the Armed Forces or living in correctional institutions or long-term care facilities. This may explain why the number of observations is higher for women; once statistical weights are implemented, the women-to-men gender ratio is about 0.51, both in the 1970s and in the 2000s.

4.2 Main Variables

- *Conjugal status*: both PSID and CPS respondents are associated with a household identifier and a "relationship-to-head" variable. I identify couples through the presence of an individual who claims to be the head's legal spouse. If a person is head of household and not living with a spouse, I consider him/her to be single. In addition, if he or she is living in a household and is not the head, nor partner of the head, I also consider him/her to be single. As anticipated, members of secondary families (e.g., a child of the head living with his/her partner) are excluded from the sample. In the CPS, information about unmarried cohabiting partners are only available starting from 1995: hence, the empirical analysis focuses on married couples only, and individuals in cohabiting couples are counted as singles[22].
- *Education*: I divide respondents into two categories, those with a college degree and those without. Given the cross-sectional nature of the CPS, education is taken to be the highest diploma achieved at the moment of the survey. Because of this, On the contrary, this problem can be avoided in the PSID: I define education as the highest level achieved along the longitudinal dimension.
- *Hours worked*: in both the CPS and the PSID, the average number of hours worked per week is defined as the total number of hours worked in a year divided by the number of weeks worked in a year. I then build a discrete labor supply variable as follows: agents working less than 7 hours per week on average are considered to be out of the labor force (NW); if they work between 7 and 34 hours, I define them as working part-time (PT); if they work 35 hours or more, I define them as working full-time (FT). The upper bound for part-time workers (34 hours) is consistent with the definition of the Bureau of Labor

[22]Since information on unmarried partners has been available since the earliest wave of the PSID, I plan to conduct robustness checks with a sample taken for the 2000s period where I consider all couples - married and cohabiting - as equal. Lundberg and Pollak (2014) stress that, once cohabitation is taken into account, the gap between college and non-college graduates in the odds of being in a two-adult household is greatly reduced.

Statistics[23].

- *Hourly wage*: in both the CPS and the PSID, hourly wages are obtained by dividing the (deflated) total yearly labor income by the total yearly number of hours worked. It is initially set to zero for those individuals who are out of the labor force. A drawback of the PSID dataset is that information on earnings and labor supply is only available for surveyed heads and partners, but is not available for other members of the household: hence, for some sampled individual-year observations, labor market information is missing, particularly in earlier waves when sampled individuals are young and more likely to live with their parents. The problem of selection due to labor force participation choices is addressed in the estimation phase.

- *Newlyweds*: changes in household composition are only observed in the PSID thanks to its longitudinal panel dimension. Changes in conjugal status occurring between two PSID waves help identify the formation of new couples. When a respondent is single in year $y-2$ and living with a legal spouse in year y, he or she is defined as a "newlywed" in year y. Note that incoming spouses are typically not included in the PSID sample before the marriage occurs.

- *Divorcees*: in a similar way, it is possible to identify divorces in the PSID. If a married couple is observed living together in year y and at least one of the two partners (typically the sampled individual) is observed living alone or with a different spouse in $y+2$, then the couple is flagged as "about to divorce". I do not make a difference between divorce and separation as the legal duties of divorcees are not taken into account in the analysis. This way of identifying dissolving couples allows me to gather information on both spouses' characteristics: as a comparison, datasets containing retrospective information on marital history do not provide detailed information about former partners. In spite of this, since in some cases couples are composed of one followable and one non-followable spouse, it is not always possible to track the trajectories of both after a divorce[24].

[23] I have not tried to use a different definition of part-time yet, although I intend to do so in the future to check whether current findings are consistent.

[24] Note that all individuals belonging to the original 1967 PSID sample are followable: hence, in the early waves of the PSID, the majority of couples is made of two followable individuals. However, couples that formed later (i.e., where an incoming spouse joined a sampled individual) are made of one followable and one non-followable individual.

5 Empirical Specification and Estimation

In this section, I provide details about the estimation method, which is composed of multiple steps. First, I estimate the age and education profiles of hourly wages and the parameters of the $AR(1)$ process for both the CPS and the PSID. The estimation of the wage distribution is performed out of the model. Second, I estimate the marriage surplus jointly with the search parameters (the meeting function and the cost of divorce). Last, starting from estimates obtained at the previous step, I recover the parameters of the production function of the public good (see function (2.2)).

5.1 Wage Levels

In both the CPS and PSID, selection into the labor force prevents me from observing the wage distribution of the entire population. In order to address this issue, I take a control function approach and estimate a standard selection model à la Heckman (1974) for each gender and broad educational group (college graduates and non-college graduates). In the selection equation, I include the number of children, and the ages of the youngest and eldest child as instruments. I subsequently replace missing wages with predicted wages: these are used to assign individuals to wage quantiles, conditionally on their age and education group.

I use the wage distribution obtained with CPS data after estimating the selection model to compute the wage levels used in the following estimation steps. Each individual is assigned the median wage computed within his/her wage quantile, conditionally on his/her age and education. For instance, observations that rank in the top quintile of their age and education group are assigned a wage rate corresponding to the 90th percentile of the group.

It is important to remark that, to be consistent with the model of marriage market and labor supply outlined in previous sections, the wage distribution should be estimated jointly with the other parameters of the model. In this sense, the present work should only be regarded as a first step to extend GJR to include labor force participation choices. In addition, the instruments used to estimate the selection model are far from being ideal: Chiappori et al. (forthcoming), who also opt for an estimation of the age profile of wages outside of the model, suggest the use of policy variation in out-of-work income as an instrument for participation, an approach that could be explored in this framework. As a final remark, note that, in spite of these limitations, I discretize the wage support and only use a limited number of moments from the wage distribution: this should also limit the implications of misrepresenting such distribution.

5.2 Wage Mobility

I have so far described the cross-sectional distribution of wages without imposing any restriction on wage mobility. In order to characterize the degree of mobility implied by the wage process, I follow Bonhomme and Robin (2009) and map the marginal distributions of w_i and $w_{i'}$ into the joint distribution of $(w_i, w_{i'})$ by using a copula. This convenient representation of the $AR(1)$ wage process leaves complete freedom on the way of specifying the marginal distribution of wages, described in the previous paragraph. Call $r_i(h_i, a_i)$ the rank of w_i among agents with human capital h_i and age a_i. The joint CDF of the current wage rank $r_i(h_i, a_i)$ and the future wage rank $r_{i'}(h_{i'}, a_{i'})$ is given by a Plackett's copula $C_m\left(r_i(h_i, a_i), r_{i'}(h_{i'}, a_{i'})|h_i, a_i\right)$ (with $C_f\left(r_j(h_j, a_j), r_{j'}(h_{j'}, a_{j'})|h_j, a_j\right)$ for women). A Plackett's copula is characterized by a single parameter that can be interpreted as a measure of mobility: this one parameter is a monotonically increasing function of the Spearman's rank correlation coefficient (details are provided in appendix A.4). I allow this correlation coefficient to vary with agent's gender, education and age, and denote the vector of coefficients $\rho_m(h_i, a_i)$ and $\rho_f(h_j, a_j)$, for men and women respectively. To estimate these parameters, panel data on wages are needed: hence, after dealing with non-participation as explained in the previous section, I use PSID data to estimate the Sperman's coefficients $\rho_m(h_i, a_i)$ and $\rho_f(h_j, a_j)$ as detailed in Bonhomme and Robin (2009). The results are plotted in figure 5.

This setup implies that the degree of wage mobility faced by agents in the model is effectively summarized by $\rho_m(h_i, a_i)$ and $\rho_f(h_j, a_j)$: for a man of type i, the odds of moving up or down the wage distribution when getting older entirely depend on $\rho_m(h_i, a_i)$. In their analysis of earning mobility in the US, Kopczuk et al. (2010) suggest that rank correlation between periods is indeed a direct and effective measure of wage mobility.

5.3 Agents' Types and Marginal Distributions

The time-invariant human capital endowment, h_i for men and h_j for women, is assumed to correspond to education. I consider two levels of education, college graduates vs non-college graduates. Hence, $h_i, h_j \in \{1, 2\}$, where 2 stands for a college degree. All agents enter the marriage market at age 20, a period corresponds to two years, and all agents quit the market when aged 60: the life-cycle stretches across 21 periods, $a_i, a_j \in \{1, 2, ...21\}$. Finally, for each age and education group, I rank agents according to their wage rates and divide them into wage quantiles: men (women) within the same wage quantile are *ex ante* identical, and are all assigned the same wage rate w_i (w_j), which corresponds to the median wage within the quantile, consistently with what explained in section 5.1. I use 3 quantiles in the estimation phase, and 5 in the simulations and counterfactual exercises.

I assume that the cohort size is constant: hence, the marginal distribution with respect to age is uniform for both men and women. I also assume that the gender ratio is perfectly balanced. This assumes away gradual entry and exit into the marriage market, as well as the potential implications of gender ratio imbalances. While these restrictions could easily be relaxed, they allow me to simplify the analysis and to focus on a smaller number of primitive parameters in the empirical analysis. The only parameter left to estimate is the share of college graduates in the male and female population: I measure it as the proportion of college graduates older than 26-year-old in the CPS. The share of adult college graduates per decade is given in table 3.

If the stationarity assumption were verified in the data, the population would be uniformly distributed with respect to age in the age bracket spanning from 20 to 60, once accounted for exogenous entry and exit[25]. This would be consistent with the assumptions stated in the previous paragraph. However, the stationarity assumption implies that both the size of the US population and its educational composition do not change over time. It is easy to see that these conditions are not verified in the data: in both the 2000s and the 1970s sample, younger individuals tend to be more educated than the older, as a consequence of the steady rise in college attendance. On top of that, in the 1970s sample, younger individuals are more numerous than the older: this is due to the exceptional demographic growth in the Post-war period. These demographic patterns would require to study the out-of-steady dynamics spurred by a growing and increasingly educated population: the changing size and composition of the population may have important implications in marital sorting across cohorts. This challenging issue is beyond the scope of the current paper, and is left for future search.

5.4 Marital Patterns and Hazard Rates

The estimation of the model relies on the observation of the empirical frequencies of couples by type (i, j), male singles by type i and female singles by type j. Hence, as a first step, I compute the raw empirical frequencies from the CPS sample, using the repartition into wage quantiles explained in section 5.1 (I use 3 bins for the estimation). These can be read as a contingency table - men's types on one axis and women's type on the other - and automatically imply some marginal frequencies through the accounting constraints (2.27) and (2.28). However, recall that,

[25] By tracking a cohort of agents born in the same year across CPS waves, it is possible to verify whether the cohort size is constant or is modified by inflows or outflows of people. For young agents, death rates are low; however, immigration, incarceration and active duty in the armed forces in the army do, among other factors, result in non-negligible variation in cohort size across years in the CPS.

in section 5.3, I have already produced estimates of the marginal distributions $\hat{p}_m$ and $\hat{p}_f$ that are consistent with the stationarity assumption. To reconcile marital patterns and marginal distributions, I follow Greenwood et al. (2014) and apply an iterative procedure to obtain what they define as "standardized contingency tables", i.e., standardized empirical frequencies that are, at once, consistent with the required marginals $\hat{p}_m$ and $\hat{p}_f$ and with the matching behavior observed in the data[26]. The joint distribution of characteristics and marital status $(\hat{m}, \hat{n}_m, \hat{n}_f)$ obtained through this standardization technique is used to estimate the model in the next step.

The estimation also requires information on the hazard of marriage and divorce for different groups of the population. These are calculated from the PSID sample.

- Divorce rates for men of type i (women of type j) are calculated as the ratio of men i (women j) divorcing between t and $t+1$ to the number of married men i (women j) in t. Similarly, for couples (i, j), the rate corresponds to the ratio of the number of divorcing couples (i, j) between t and $t+1$ to the number of married couples (i, j) in t.
- Marriage rates for men of type i (women of type j) are calculated as the ratio of men i (women j) getting married between t and $t+1$ to the number of single men i (women j) in t. For couples (i, j), the rate corresponds to the ratio of the number of couples (i, j) getting married between t and $t+1$ to the geometric mean between the number of male singles i and female singles j in t.

In practice, I do not compute the full distribution but only some selected moments (e.g., the rate of divorce for men with a college degree). This allows me to avoid dealing with empty cells due to the small size of the PSID.

5.5 Search Parameters and Marriage Surplus.

The unobserved parameters of the meeting function Λ and the cost of divorce κ are estimated jointly with the vector of matching strategies α. The estimation procedure relies on matching a vector $\hat{\mu}$ of empirical moments calculated from the empirical distribution $(\hat{MF}, \hat{DF})$ to their theoretical counterparts $\mu(\theta, \alpha^\theta)$. The vector $\hat{\mu}$ includes both rates of marriage and divorce conditionally on the agent's gender, education and age.

[26]More explicitly, this technique suggested by Mosteller (1968) consists in transforming a contingency table into a second one that respects the desired marginals while leaving the odds ratio unchanged. In the case of marriage, the transformation does not affect the odds of marrying a type i versus a type i', for each woman j (and vice versa). Details on the computation are provided in appendix A.5.

In practice, I use an estimator of the GMM class and exploit the restrictions implied by the model on the size of the gross flows into and out of marriage. These correspond to equations (3.4) and (3.5), where the matching strategies α and α_0 are replaced by their nonparametric estimators, whose existence is guaranteed by Lemma 3.1. The GMM estimator is given by:

$$\hat{\theta} \equiv \arg\min_{\theta} \sum_{k} \omega_k \left(\mu_k(\theta, \alpha^{\theta}) - \hat{\mu}_k \right) \qquad \text{subject to (3.2) for any } (i,j) \tag{5.1}$$

where ω is a vector of weights such that $\omega_k = 1/Var(\hat{\mu}_k)$. The presence of the constraint (3.2) is required by Lemma 3.1 to ensure that α^{θ} belongs to the set $[0,1]$ and is indeed a probability. Since the number of constraints is large and corresponds to $|\mathcal{I}| \times |\mathcal{J}|$, I add a penalty function to the standard quadratic loss function used as objective. If the penalty function is given enough weight, this results in only small violations of the constraints[27].

Once obtained the estimates of the search parameters $\hat{\theta}$, I compute the corresponding matching strategies $\hat{\alpha}$ and the surplus function $\hat{\hat{S}}$ from the matching rule (2.24). Through equation, I then recover the surplus function $\hat{S}$ - i.e., the match surplus specific to a given labor supply choice l_f - using the odds of choosing l_f for a married couple (i,j) observed in the data. Then, I derive the function $h(l_f; i, j)$ implicitly from the Bellman equation of surplus (2.17): this requires subtracting the continuation value and the reservation values terms, which are by now known terms, from the nonparametric estimate $\hat{S}$ of the surplus function. The intuition is that, once taken into account the dynamic nature of surplus, the per-period match surplus $h(l_f; i, j)$ represents the residual component of the gains from marriage.

A remark is in order concerning the role of the parameter σ_ℓ - i.e., the degree of independence between domestic productivity shocks $\boldsymbol{\eta}$. This parameter weighs the importance of the economic component of the marital surplus, which ultimately depends on the labor supply choice of the wife, as opposed to that part of the marital surplus that only depends on the agents' traits (γ_3 in the per-period match surplus (2.18)). The parameter σ_ℓ is identified through the variation in labor supply behavior conditional on the agents' observable traits and sorting patterns along the same observables: its identification has been widely discussed in the nested logit literature (Train, 2009). However, I have not attempted to estimate σ_ℓ: so far, I have set $\sigma_\ell = 0.7$ to allow for some positive correlation between the shocks $\boldsymbol{\eta}$. There is little if no benchmark in the literature in this regard, although Train (2009) discusses its lower and upper bound ($0 < \sigma_\ell \leq 1$)[28].

[27]This means that α^{θ} may be slightly larger than 1. If the weight of the penalty function is high enough, violations are small, and this does not constitute a problem. Once obtained $\hat{\alpha}$, for those types (i,j) for which the constraint is binding $\hat{\alpha}(i,j)$ is rounded down to 0.995.

[28]While so far my findings have not proved to be particularly sensitive to changes in this parameter, I plan to conduct a more systematic analysis to show that they are indeed robust in this regard. Ultimately, I also plan to estimate σ_ℓ with the other unobserved parameters of the model.

Finally, note that this estimation method exploits a set of restrictions produced by the model and has the advantage of being relatively quick to implement, as it is not necessary to solve for the market equilibrium. Moreover, the estimator is of the GMM class and has well-known properties. In Ciscato (2018), I employ a parallel Markov Chain Monte Carlo method to estimate the model in one step and without having to rely on the full distribution $(\hat{m}, \hat{n}_m, \hat{n}_f)$ but only using some of its moments. This approach is far more time-consuming as it requires to iteratively solve for the equilibrium model. However, it would allow me to estimate the parameters of the domestic production function, of the meeting function, the cost of divorce in one step, and possibly jointly with the wage distribution, if this were made endogenous as suggested several times throughout the paper. It would also allow me to relax some assumptions that are necessary to implement the current GMM method, such as that the shocks $\boldsymbol{\eta}$ are *i.i.d.*.

5.6 Empirical Specification: Meeting Function

The general specification (2.23) chosen for the meeting function Λ contains the unobserved parameters $\lambda(i,j)$ and χ, estimated jointly with the cost of divorce κ through the procedure described in section 5.5. I consider the following specification for the shifter $\lambda(i,j)$, which captures homophily in meetings:

$$\lambda(i,j) = \frac{\tilde{\lambda}(i,j)}{b_m^{\lambda}(h_i,a_i) b_f^{\lambda}(h_j,a_j)} \tag{5.2}$$

$$\sum_j \tilde{\lambda}(i,j)/b_f^{\lambda}(h_j,a_j) = b_m^{\lambda}(h_i,a_i) \tag{5.3}$$

$$\sum_i \tilde{\lambda}(i,j)/b_m^{\lambda}(h_i,a_i) = b_f^{\lambda}(h_j,a_j). \tag{5.4}$$

where

$$\tilde{\lambda}(i,j) = \begin{cases} \lambda_1\{h_i < h_j\} + \lambda_2\{h_i > h_j\} + \lambda_3\{h_i = h_j = 2\} + \lambda_4 d + \lambda_5 d^2 & \text{if } \underline{d} \le d \le \bar{d} \\ 0 & \text{otherwise.} \end{cases} \tag{5.5}$$

with $d \equiv a_m - a_f$. In spite of the heavy notation, this formulation is useful because the constraints on the meeting function (2.21) and (2.22) are always respected[29]. The terms of $\tilde{\lambda}$ have the role of shifting the odds of meetings across types: the first three terms of (5.5) determine the degree of homophily with respect to education, while the last two let the odds of meeting depend on the age distance. On top of this, I impose that meetings do not occur at all if the age distance is too large: in the empirical analysis, I set $\underline{d} = -3$ and $\bar{d} = 7$, i.e., I do

[29] More explicitly, conditions (5.3) and (5.4) allow me to compute a vector b_m^{λ} of size $|\mathcal{I}|$ and a vector b_f^{λ} of size $|\mathcal{J}|$ so that $\sum_i \lambda(i,j) \le 1$ for each j and $\sum_j \lambda(i,j) \le 1$ for each i. The vectors b_m^{λ} and b_f^{λ} are thus functions of the parameters $(\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$.

not allow for meetings between men that are more than 6 years younger than women or more than 14 years older than women (as one period corresponds to two years in the data). This restriction still allows me to consider about 96% of all marriages in the CPS for both the 1970s and the 2000s. The specification is close to the one suggested by Shephard (2018).

5.7 Empirical Specification: Household Production Function

With data on matching behavior and the labor supply of married couples, I have shown how to compute h on each point of its support $\mathcal{I} \times \mathcal{J} \times \mathcal{L}$. We have seen in section 2.8 that the specification of h depends on the agents' utility functions and the production function (2.2): equation (2.18) allows me to establish a connection between the parameters $(\gamma_1, \gamma_2, \gamma_3)$ and the per-period surplus h. Hence, through OLS, I compute estimates $(\hat{\gamma}_1, \hat{\gamma}_2, \hat{\gamma}_3)$ that best fit the vector of residuals $\hat{h}$.

I impose the following restriction on the parameter functions γ_1, $\gamma_2(l_f)$ and γ_3, which characterize the production of the public good Q through function (2.2).

- γ_1, which represents the elasticity of Q with respect to the total joint expenditure $t_m + t_f$, only depends on the spouses' time-invariant human capital (h_i, h_j). In particular, I estimate γ_1 for each combination (h_i, h_j).
- $\gamma_2(l_f)$, which represents the productivity shifter associated with labor supply choice l_f, only depends on the wife's age a_j and human capital h_j. Hence, I estimate γ_2 for each combination (h_j, a_j) and each level l_f, after imposing $\gamma_2(1) = 0$, where $l_f = 1$ corresponds to the wife working full-time.
- γ_3, which is an additional productivity shifter, only depends on the wife's age a_j and human capital h_j and on the husband's a_i and h_i, as well as interactions between these inputs. In particular, γ_3 contains dummies for each combination (h_i, a_i, h_j, a_j) (with a normalization for those pairs s.t. $a_i = a_j$). Hence, while γ_3 can change with age, its trajectory is fully predictable at the moment of the match, since it is not affected by wage shocks.

6 Results

In this section, I start by briefly discussing the estimates of the parameters of the domestic production function of the public good and the meeting function. I subsequently present the fit of the model for the two samples, the 1970s and the 2000s. I then conduct a counterfactual analysis to understand the main forces behind the decline of marriage that occurred between these two periods and discuss the changes in welfare. I conclude with a summary of the main findings and a concise description of the economic mechanisms at play.

6.1 Estimation Results: Public Good

Estimates of the parameter γ_1 are collected in table 1, and suggest that not all families enjoy increasing returns to scale from the joint expenditure $t_m + t_f$ used to produce the public good Q. Interestingly, in the 1970s, the estimate of γ_1 for couples where both spouses are college graduates is not significantly different than 1; however, in the 2000s, these same couples enjoy significant increasing returns to scale. Conversely, couple where no spouse holds a college degree have experienced a drastic decrease: γ_1 used to be significantly greater than 1 in the 1970s, while it is not in the 2000s. Couples where only the wife holds a college degree have also experienced an increase in the productivity of joint expenditure, while couples where the wife does not hold a college degree have experienced a decrease in γ_1.

Estimates of the parameter γ_2 reveal that married women without a college degree that choose to stay at home increase the match surplus more than those with a college degree (see figure 6). However, these gains are lower in the 2000s than in the 1970s: for women aged between 40 and 50 in the 2000s, the benefits of staying at home are not significantly different than zero, regardless of the educational level. Part-time does not seem to produce public benefits, and, on the contrary, it may decrease the match surplus. Also in this case, the shifter γ_2 associated with part-time is lower in the 2000s than in the 1970s. It is possible to conclude that women have higher incentives to spend time on the labor market in the 2000s than they used to in the 1970s: the production of public good Q has become less labor intensive.

6.2 Estimation Results: Meetings and Cost of Divorce

Estimates of the parameters of the meeting function Λ suggest that the marriage market in the 1970s is characterized by a higher segregation with respect to education than in the 2000s. The odds of meetings across educational levels have increased between the two periods, all else constant: this is captured by the increase in the parameters λ_1 and λ_2, displayed in table 2, while the parameter λ_3 has not changed[30]. The high values taken by the estimates of χ suggest

[30] The computation of standard errors has not been carried out yet, and will be necessary to assess whether these changes are statistically significant.

that the supplies of singles $n_{m,+}$ and $n_{f,+}$ are strong complements, and that the meeting function can be well approximated by a Leontief production function. This last result implies that the number of meetings is driven by the short side of the market: if $n_{m,+}(i) > n_{f,+}(j)$, then the number of meetings is proportional to $n_{f,+}(j)$.

The point-estimates for the cost of divorce κ are almost identical between the two periods. Recall that κ is expressed in terms of standard deviations of the shocks η_{l_f}: this means that the estimated cost of divorce corresponds to about 4.3 standard deviations in terms of surplus units, and that marriage is associated with strong commitment[31]. It is important to remark that the complete lack of commitment assumed in this model may cause the estimate of κ to be inflated. In other words, understating the ability of households to reduce consumption volatility by sticking to an agreed sharing rule may result in underestimating the match surplus; if this is the case, the source of commitment is misinterpreted and attributed to high costs of divorce.

6.3 Fit of the Model

The estimated model is able to reproduce some of the key facts observed in the data, and does a good job at reproducing the changes in marital patterns that have occurred between the 1970s and the 2000s. Tables 4 and 5 compare simulated and empirical moments from the distribution of singles' and spouses' characteristics in the cross-section. Table 5 also contains the simulated and empirical hazard rates of marriage and divorce. For the 1970s sample, the predicted share of married men aged between 20 and 60 is 72.25%, as opposed to 69.42% in the data; for the 2000 sample, the predicted share is 58.04%, as opposed to 51.59% in the data. The distance between simulated and empirical moments is similar for women.

The estimated model is also able to approximate the age profile of married individuals: the simulated stock of married agents progressively increases during their 20s and 30s and stabilizes around age 40. The share of married women decreases when they enter their 50s: those who divorce or become widows outnumber those who get married. In the model, spouses die when they turn 62, so this artificially speeds up the process. In spite of this simplistic assumption, the model is still able to capture that the share of married men does not decrease, while the share of married women does: this indicates that men tend to marry younger women. The wage profile of married individuals is also well approximated by the estimated model: table 4 shows that men in the top quintile of the wage distribution are far more likely to get married

[31] Consider a potential couple (i, j) with the systematic part of surplus, $\bar{S}(i, j)$, equal to zero: their odds of getting married are one out of two. However, if the man i and the woman j were already married, the probability that they will file divorce is only equal to 1.4%.

than those at the bottom, both in the simulation and in the data. This "marriage gap" has increased in the 2000s. The estimated model is not able to reproduce the concavity observed for women in the 1970s (i.e., women in the third quintile are the most likely to be married). However, it does predict that, for women, the odds of being married do not increase as much as they do for men along the wage distribution: this is exactly what we observe in the 2000s.

The reason why the model is not always able to replicate all the moments listed in table 4 may be investigated by looking at the mismatch between simulated and empirical moments about marriage and divorce rates (see table 5). The simulations yield lower divorce rates than those observed in the data; these are most likely induced by the high point-estimates for the cost of divorce κ. This results in two discrepancies with the empirical patterns: (i) agents are very selective, thus marriage rates are lower than in the data and the stocks of married agents grow slower; (ii) divorce is rare and the stocks of married agents keep increasing, albeit more slowly, instead of stabilizing. These dynamics are plotted in figures 7 and 8.

6.4 Explaining the Decline of Marriage: Full Decomposition

In order to address the key question of this paper, i.e., to what extent the decline of marriage is accounted for by changes in the wage structure, I perform the following decomposition. The columns of tables 6 and 7 are labeled after the names of the experiments and provide an extensive overview of the decomposition.

a In the first experiment, I simulate a counterfactual equilibrium where all parameters are fixed to their estimated 1970s levels except for the wage distribution, which is assigned its 2000s shape. More precisely, both the wage levels w_i and w_j and the transition matrices π_m and π_f are allowed to take on their 2000s values: in the next section, I will further decompose this step to understand how each of these components matters.

b In the second experiment, I simulate a counterfactual equilibrium where all parameters are fixed to the their estimated 1970s levels except for the shares of college graduates, which are assigned their 2000s values.

c In the third experiment, I let both the wage distribution and the shares of college graduates correspond to what we observe in the 2000s. Both the production function of the public good, the meeting function and the cost of divorce are still fixed to their 1970s levels.

d In the last experiment, I let the meeting function Λ and the cost of divorce κ take on the values indicated by their 2000s point-estimates in table 2. Only the parameters of the production function of the public good, γ_1, γ_2 and γ_3, are still fixed to their 1970s levels: these parameters can account for the residual change.

Different elements of the wage distribution may impact on the marriage market outcome differently. Hence, I run four additional simulations to explore the economic mechanism that establishes the relationship between changes in the structure of labor market earnings and changes in marital patterns. Experiments are once again labeled by letters, consistent with the notation used in tables 8 and 9.

e In experiment (e), I simulate a counterfactual equilibrium where all parameters are fixed to the their estimated 1970s levels except for men's wage levels, which are set to their 2000s values.

f In experiment (f), I simulate a counterfactual equilibrium where all parameters are fixed to the their estimated 1970s levels except for women's wage levels, which are set to their 2000s values. Changes in men's and women's wage levels are plotted in figure 3 and 4.

g In experiment (g), I simulate a counterfactual equilibrium where all parameters are fixed to the their estimated 1970s levels except for the transition matrix π_m, which is allowed to take on its 2000s values. The elements of π_m determine the odds of changing wage quantile for men. Recall from section 5.1 that π_m is generated from an $AR(1)$ process and that the degree of wage mobility is monotonically decreasing in the wage rank correlation between an agent's wage w in period t and w' in $t+1$. Hence, looking at plot 5, it is easy to see that wage mobility among men has unequivocally increased between the 1970s and the 2000s.

h In experiment (h), I simulate a counterfactual equilibrium where all parameters are fixed to the their estimated 1970s levels except for the transition matrix π_f, which is allowed to take on its 2000s values. The elements of π_f determine the odds of changing wage quantile for women. Figure 5 indicates that wage mobility has decreased for women.

6.5 Overall Changes in the Wage Distribution

Between 1970s and 2000s, the share of married men aged between 20 and 60 falls by 14.06 percentage points (i.e., a 19.5% decrease with respect to the initial level). Comparing the marriage market outcomes in the 1970s (column 1) with experiment (a), I conclude that changes in the wage structure can account for about 36% of the decline between the two periods (see table 6). Similar findings can be derived for women, with changes in the wage structure accounting for

35% of the decline. Table 7 shows that divorce rates increase and marriage rates drop: fewer matches generate positive surplus, so the two rates move in opposite directions, which results in fewer married couples in the population.

Plot 9 shows how the number of married agents by gender, age and education changes as a reaction to changes in wages. Changes in the wage structure induce a larger decline in marriage among low-educated men (-7.91% with respect to the 1970s benchmark) than among high-educated men (-3.72%); the decline is more evenly distributed among women: -6.56% for those with a college degree and -6.91% for those without. The share of married men aged between 20 and 30 decreases by 11.10%, and only by 6.48% for those aged between 40 and 50; on the contrary, the decrease is more evenly distributed across age groups for women. The effects of the changing wage structure are heterogeneous across wage quintiles: men in the bottom quintile experience a larger decline in the odds of being married (-7.83%) than those at the middle and the top of the distribution (about -5%). Finally, women in the bottom and the top quintile experience a larger decline (-6.47% and -8.66% respectively) than those in the middle (-1.11%).

Changes in the wage structure result in an increase of the fraction of women working full-time out of those who are married. While the fraction of married women that work part-time stays almost unchanged, there are fewer married women that stay at home. This suggests that changes in wages may erode the gains from marriage coming from household specialization, while joining efforts on the labor market seems to play a bigger role. At this point, however, it is not straightforward to understand why this is the case and why gains from marriage as a whole ultimately decline. Changes in wage mobility and wage levels have been considered jointly so far, and the two may have different implications for the evolution of the gains from marriage.

6.6 Changes in Wage Levels

Experiments (e) and (f) show how changes in wage levels have affected the marriage market outcome, while holding wage mobility fixed. Results are reported in tables 8 and 9. Men's median and bottom wages have decreased, and have done so more for the low-educated; the wage curve at the 90th percentile has become steeper, i.e., wages have decreased for younger individuals and increased for the elder (see figure 3). Column (e) in table 8 shows that the share of married adults decreases by about 6% only due to changes in men's wage levels. The decrease is stronger for the low educated (-7.10%) than for the high educated (-2.46%); it is also stronger for men aged between 20 and 30 (-11.35%) than for those aged between 40 and

50 (-6.48%). The decrease of marriage thus mirrors the uneven decrease in wage levels.

In the same time period, women have experienced a wage increase at the middle and at the top of the wage distribution (see figure 3). These changes induce high-educated women to marry less (-3.43% in column (f), table 6), and to increase their labor supply when married (column (e), table 7). The impact on low-educated women pushes in the same direction, but is weaker.

Experiments (e) and (f) provide insights on the following mechanisms. First, the widespread decrease in men's wages have eroded the gains from marriage: for most couples the husband's earnings constitute the largest share of the household budget, hence declining wages reduce the economic gains from marriage for both one-earner and two-earner couples. The share of married adults declines, particularly among those groups where the wage drop is stronger, i.e., the young and the low educated. Second, the increase in women's wages provide wives with stronger incentives to work and shift gains from marriage from household specialization to joint public good expenditure due to the shrinking gender wage gap; however, women are also more selective as they gain economic independence. As a result, women at the top of the wage distribution are less likely to marry, while those at the middle are more likely to marry (see column (f), table 8). At the bottom of the distribution, wages stay unchanged or slightly decrease between the two periods: hence, women in the bottom wage quintile experience a limited decrease in the odds of being married.

6.7 Changes in Wage Mobility

The last two columns of tables 8 and 9, (g) and (h), consider changes in wage mobility while holding wage levels fixed. This kind of experiment is, to the best of my knowledge, the first of its kind in the literature. My findings show that both changes in men's wage mobility and women's wage mobility have only a very small impact on the marriage market outcome. Men's wage mobility have increased (see figure 5): although numbers are small, column (g) in table 8 suggests that the effect of this increase should have a positive impact on marriage. The explanation is that increased wage mobility makes marriage more relevant due to its insurance motive. However, the small size of the effect may be due to the strength of the commitment induced by the high point-estimates obtained for the cost of divorce κ.

Women's wage mobility is considered in experiment (h): this decrease has nearly no impact on the marriage market outcome. This is an interesting result for the following reason: it indicates that, at the 1970s equilibrium, changes in women's wages almost never cause couples to break up, both because the wife can compensate a wage cut by increasing her domestic time and because the ratio of the wife's earnings to the total household labor income is low. The high cost of divorce still matters in order to explain why adjustments are so limited.

The high cost of divorce also implies that, in all other experiments, most of the adjustments in the share of married across the population go through changes in marriage rates rather than in divorce rates. Since commitment is strong, individuals are extremely careful about selecting their partner: the age of first marriage is thus more sensitive than the duration of first marriage when changes in wage levels are taken into account. This is consistent with young men experiencing a larger marriage decline in the main experiment (a).

6.8 Changes in Schooling

Column (b) in table 6 suggests that the increase in the share of college graduates from the 1970s to the 2000s, which is particularly strong for women, has contributed to both a decline in marriage and changes in assortativeness. In experiment (b), the share of couples where both spouses are college graduates doubles, and high-educated women start "marrying down"; in spite of this, their odds of being married decrease with respect to the 1970s benchmark. In experiment (c), changes in wages are considered jointly with changes in schooling. The interaction between the two changes leads to a further decrease in the share of married adults: these two factors can jointly account for about 58% of the decrease between the 1970s and the 2000s. With respect to experiment (a), changes in schooling partly offset the decrease in marriage for high-educated men.

Changes in the educational composition of the population are interesting because they only affect the match surplus through the competition on the marriage market. Since the increase in the share of college graduates is weaker for men, high-educated women must be less selective. As a result, it becomes more difficult for them to find a valuable match. On the contrary, low-educated women are fewer, and they are ready to match with both high-educated and low-educated men: their odds of being in a marriage relationship increase.

6.9 Changes in Meetings and Household Production

While not the main focus of the analysis, changes in the structure of meetings and in the household production technology are clearly key factors in explaining the decline of marriage. Tables 6 and 7 reveal that changes in the parameters of the meeting function have contributed to the decrease of marriage. Once accounted for changes in wages and schooling, the parameters of Λ and the cost of divorce κ can account for an additional 12% of the decline between the 1970s and the 2000s. Changes in the estimated parameters collected in table 2 suggest that meetings are less assortative with respect to education in the 2000s: this results in both a decline in the number of marriages and in a decrease in the correlation of the spouses' educational levels. Individuals have a clear preference for mating with their peers, particularly in terms of education: if they are less likely to meet potential partners with a similar schooling level, they also end up refusing more matches. However, since search is costly in terms of time, they become slightly more inclined to accept marriages with people that are less alike.

The relevance of changes in household technology, i.e., in the parameters of the production function (2.2) of public good Q, also contribute to the decline of marriage. In particular, they account for a residual 30% decline in the share of married adults (see columns (c) and (2) in table 6). Recall from table 1 that economies of scale have become stronger for couples where the wife holds a college degree, and have decreased for couples where she does not. In addition, plot 6 suggests that the production of Q has become less labor intensive for all types of couples. These changes result in the increased importance of the economic component of the gains from marriage for female college graduates: this leads to a stark increase in the share of married women with a college degree and in their odds of participating to the labor market. In contrast, the decreased importance of both economies of scale and household specialization for women without a college degree explains why they end up marrying less.

6.10 Welfare Analysis

Figure 10 documents the distribution of ex-ante welfare for individuals entering the marriage market at age 20. Between the 1970s and the 2000s, welfare differences across genders have shrunk. Among the low educated this is mainly due to the relatively large decline of men's welfare, while high-educated women have been able to partly catch up. On the other hand, welfare differences across educational groups have increased: is this purely due to increased wage dispersion or does the marriage market play a role in explaining this widening gap?

In table 10, I report changes in the average gains from marriage for the whole population, as well as conditionally on the spouses' education. Interestingly, in the 1970s, both the high and the low educated equally benefit from the surplus generated by the marriage market: on average, individuals without a college degree enjoy almost as much marital surplus as college graduates. However, since the low educated have a lower human wealth, gains from marriage constitute a relatively large share of their welfare.

When the structure of labor market earnings changes (column (a)), the gains from marriage decline overall, with the decline being stronger among the low educated. At the bottom of the men's wage and schooling distribution, welfare decreases for two reasons: first, low-earning men see their human wealth decline; second, they cannot rely on the marriage market as much as they used to do in order to attain a higher level of welfare. On the other hand, most women enjoy an increase in human wealth, although not all of them equally benefit from it. First, real wages increase less - or do not increase at all - at the bottom of the distribution; second, women without a college degree experience a larger decrease in the gains from marriage.

Table 10 also shows that young individuals enjoy lower gains from marriage. In a search context, this is easily understood: some of them may want to wait for the "right" partner. Another reason is that younger individuals earn lower wages: hence, they may prefer to wait until they climb further along the wage curve. In the 2000s, the wage curve is steeper, and gains from marriage for the young decrease, particularly for men, as young women are more likely to marry older partners.

Columns (c), (d) and (2) in table 10 show that, when changes in schooling, in the meeting and domestic production function are taken into account, the gap in the gains from marriage across educational groups progressively widens. In the 2000s, the high educated are able to benefit from relatively higher gains on the marriage market than the low educated (although both groups enjoy less gains than in the past). The gains from marriage of high-educated men are, on average, 34% higher than those of the low educated; similarly, the average gains for high-educated women are 33% higher than those of the low educated.

6.11 Summary and Discussion

The numerous counterfactual experiments described in section 6.4 provide a rich set of results. I summarize the main takeaways below.

- Declining real wages among men erode gains from marriage for both one-earner and two-earner couples. Groups suffering a larger wage decline are those who grow less likely to be married (i.e., the low-educated, the young). Low-earning men are less likely to get married: the marriage market is narrower, and competition for high-earning men is fiercer.
- Increasing real wages among women and the shrinking gender wage gap shift the gains from marriage from household specialization to joint expenditure on public goods. Women gain economic independence and they are more selective in the choice of the partner.

- In both the 1970s and the 2000s, marriage contracts imply strong commitment due to a high cost of divorce. Changes in wage mobility have little impact on the marriage market outcome. Due to the same reason, changes in wage levels have a negative impact on marriage mostly through a decrease in marriage rates rather than an increase in divorce rates.

- The increase in college graduation is higher for women than for men and the college gender gap is reversed. Hence, female college graduates need to start “marrying down”. However, the incentives to sort on wages are stronger: this limits marriage across educational groups.

- In the 2000s, singles with different educational background are more likely to meet. As a result, fewer matches occur, although the fraction of marriages across educational groups is positively affected by this change.

- In the 2000s, couples where the wife holds a college degree benefit from higher economies of scale than in the past. At the same time, women have more incentives to work. These two changes push high-educated women to enter marriage relationships - possibly with high-earning men - in spite of the newly gained economic independence when singles.

- In the 2000s, couples where the wife does not hold a college degree have, overall, fewer incentives to marry than in the past (lower economies of scale, less gains from specialization). Hence, at the bottom of the wage and schooling distribution, individuals lose interest in marriage both due to changes in the wage distribution *and* in the parameters of the domestic production function.

These experiments show that marital patterns change as a result of several forces that often tend to offset each other. Changes in the wage structure play a crucial role in explaining the overall decline, but changes in the other factors also have a non-negligible income on both the share of married individuals, the sorting patterns and the labor supply of women. Consider the case of high-educated vs low-educated women: the first are less likely to marry following changes in wage levels and in the share of college graduates in the population, as discussed above. However, they benefit from stronger incentives to marry due to changes in the domestic production function, and in particular they gain interest in forming two-earner couples. On the contrary, low-educated women are twice affected by unfavorable changes: declining real wages among men affects them only slightly more than their high-educated peers; however, changes in domestic production strongly penalize them. Sorting on wages becomes stronger, but they suffer from increased wage dispersion within their gender group.

Between the 1970s and the 2000s, not only wage inequality has increased, but the marriage market has shifted from an equilibrium where the low and the high educated enjoy, on average, the same level of gains from marriage to an equilibrium where the high educated enjoy substantially more gains. The quantitative results presented in section 6.10 suggest that the marriage market amplifies economic inequality. One missing step is left for future work: in

7 Conclusion

In this paper, I build and estimate an equilibrium model of the marriage markets with search frictions, endogenous divorce, wage mobility and aging. This structural approach allows me to provide a quantitative assessment of the role of changes in the wage structure in explaining changes in the marriage market outcome. The empirical analysis is composed of the following steps: I first estimate the unobserved parameters of the model - the domestic production function, the meeting function and the cost of divorce - for both the 1970s and the 2000s. The estimated model is able to approximate the cross-sectional marital patterns - who is married and with whom - and the divorce and marriage rates observed in the data. I then proceed with a series of experiments where I analyze the role of changes in one primitive parameter of the model holding all other factors constant. I find that changes in the wage structure can explain about 35% of the decline in marriage that occurred between the 1970s and the 2000s, and that they have a stronger impact on the low educated and on the young. I also find that changes in positional inequality play a much more important role than changes in wage mobility. In particular, changes in men's wage inequality and the shrinking gender wage gap are the most important driving forces behind the decline of marriage. Finally, I show that in the 2000s, on top of the increased wage inequality, individuals with a college degree enjoy, on average, substantially more gains than those without: this gap in gains from marriage was instead absent in the 1970s. This result suggests that, as for the 2000s, the marriage market amplifies economic inequality.

The paper presents several innovative aspects, both in the modeling part and in the empirical analysis. It extends the search-and-matching framework of GJR by introducing aging and wage mobility, and represents a first attempt to provide an empirically tractable framework to study marriage along the life-cycle and across cohorts[32]. The setup is potentially suitable for the analysis of a great variety of topics: the determinants of the age of first marriage, gender asymmetries in matching with respect to age and in remarriage trends, and the relationship between marriage and health. In the empirical analysis, I complement existing findings on

[32] To the best of my knowledge, only Shephard (2018) is, at this date, working on this kind of models.

marriage and economic inequality by providing a rich set of results, some of which are new to the literature. The analysis is the first to consider the joint impact of changes in wage inequality, wage mobility and the life-cycle dynamics of labor market earnings on the marriage market outcome. I show that changes in wage inequality between and within gender groups play a bigger role than changes in wage mobility. In section 6.9, I also briefly discuss the implications of changes in the way people meet each other on the marriage market outcome: while more work is needed in this direction, these first findings show that changes in the degree of segregation across educational groups matter in explaining the decline of marriage and the changing sorting patterns.

The paper represents a starting point for further research in this direction. In particular, the analysis abstracts away from human capital investment. Introducing choices such as schooling or dynamic labor supply decisions linked with human capital accumulation is key to understand how agents adjust to changes in labor market conditions. Previous works have stressed the importance of studying the interplay between human capital investment and competitive matching on the marriage market (e.g. Chiappori et al., 2017); other works have extensively discussed the schooling and life-cycle career choices of women outside of an equilibrium framework (e.g. Sheran, 2007; Bronson, 2014). Although this will add an additional layer of complexity, particularly in the estimation phase, the theoretical setup outlined in this paper can bridge these two literatures and provide new insights in this direction.

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A Technical Appendix

A.1 Linearizing the Pareto Frontier

The TU property implies that there exist a cardinal representation of the spouses' preferences so that the Pareto frontier can be characterized as a straight line with slope -1 (see Chiappori and Gugl, 2014). This property is also used in the proof of lemma 2.1. Given the ordinal representation of spouses' utilities given by equation (2.1) and the demand for public good (2.5), it is possible to recover $\mathit{\Gamma}(l_f; i, j)$, i.e., the constant characterizing the linearized Pareto frontier associated with l_f.

$$\begin{aligned}\mathit{\Gamma}(l_f; i, j) &= \exp(\log(w_i - t_m) - \log Q^*(l_f; i, j)) + \exp(\log(l_f w_j - t_f) - \log Q^*(l_f; i, j)) = \\ &= (w_i + l_f w_j - t_m - t_f) Q^*(l_f; i, j) = \\ &= \frac{\gamma_1(i,j)^{\gamma_1(i,j)}}{(1+\gamma_1(i,j))^{1+\gamma_1(i,j)}} (w_i + l_f w_j)^{1+\gamma_1(i,j)} \exp(\gamma_2(l_f; j) + \gamma_3(i,j) + \eta_{l_f}).\end{aligned} \tag{A.1}$$

Note from the expression above how η_{l_f} tilts the Pareto frontier. Moreover, $\mathit{\Gamma}(l_f; i, j)$ is closely related to what is defined in section as the "per-period marital surplus" $h(l_f; i, j)$ corresponds to $\log(\mathit{\Gamma}(l_f; i, j))$.

A.2 Private Consumption and Sharing Rule

The amount of private consumption is jointly determined by the amount of surplus produced by a match and the way it is shared between the spouses. Consider the wife's Bellman equation (2.16): the splitting rule (2.10) tells us that her share of surplus must be exactly one half of the total. This restriction implied by the splitting rule allows me to back out the wife's amount of private consumption. Interestingly, it is possible to write the ratio of the wife's to the private husband's consumption as follows:

$$\frac{w_j - t_f^*(l_f; i, j)}{w_i - t_m^*(l_f; i, j)} = \frac{\exp\big(V_f^0(j) - \beta\psi_f(j) \sum_{j'} V_f^0(j')\pi_f(j, j')\big)^2}{\exp\big(V_m^0(i) - \beta\psi_m(i) \sum_{i'} V_m^0(i')\pi_m(i, i')\big)^2}. \tag{A.2}$$

A.3 Steady-State Equilibrium as a Fixed Point

The steady-state search equilibrium can be thought of as a fixed-point of an operator $n \to T_{ext} n$, with $n = (n_m, n_f)$. First, it is necessary to discretize the sets of types $|\mathcal{I}|$ and $|\mathcal{J}|$, as wage rates are continuous variables in the data. Hence, n is a vector of length $|\mathcal{I}| + |\mathcal{J}|$.

1. Start the iteration with $k = 0$ and a guess for n^k.
2. For given n^k, solve a fixed-point problem T_{int} given by equations (2.17), (2.25) and (2.26), in order to find $V^0 = (V_m^0, V_f^0)$ so that $V^0 = T_{int}V^0$.
3. Update α using (2.24).
4. Substitute the matrix α into the law of motion (2.32) and solve forwards for m.
5. Use the accounting equations (2.27) and (2.28) to compute n^{k+1}.
6. If $\Delta(n^k, n^{k+1}) < \epsilon$, keep n^{k+1}, otherwise set $n^k = \delta n^{k+1} + (1-\delta)n^k$ and restart from step 2.

As anticipated in section 2.12, while there is no theoretical result ensuring existence and uniqueness of the equilibrium, iteration of the fixed-point operator leads to convergence to a vector n^*. Many simulations have brought to me to conclude that convergence to n^* is obtained regardless of the initial points chosen to start the algorithm and for a very broad choice of the numerous primitive parameters. The only caveat is that, at the last step of the algorithm described above, I update the distribution n by taking a convex combination of the last two obtained vectors in the sequence: experience suggests that setting $0 < \delta < 1$ and in particular sufficiently close to 0 (I set it equal to 0.2) allows the algorithm to converge for almost any choice of the primitive parameters.

More theoretical guidance and a proof of existence and, possibly, uniqueness of the equilibrium would help understand the property of the fixed-point operator and could possibly help to design faster solution methods. This is left for future research.

A.4 Plackett's Copula and Transition Matrix

In order to obtain the transition matrices π_m and π_f, I characterize the $AR(1)$ wage process through a copula that links the wage rank of an individual across two consecutive periods. Consider the case of a man i: the joint CDF of his current wage rank $r_i(h_i, a_i)$ and his future wage rank $r_{i'}(h_{i'}, a_{i'})$ is given by the Plackett's copula:

$$C_m(u, v|h_i, a_i) = \frac{1 + \theta(h_i, a_i)(u+v) - [1 + \theta(h_i, a_i)(u+v)^2 - 4\theta(h_i, a_i)(\theta(h_i, a_i) + 1)uv]^{1/2}}{2\theta(h_i, a_i)} \tag{A.3}$$

where the parameter $\theta(h_i, a_i)$ is such that the higher $\theta(h_i, a_i)$, the lower the mobility. In particular, Nelsen (2007, Chapter 5) shows that θ is a monotonically increasing function of the Spearman's rank correlation coefficient. Dropping the arguments (h_i, a_i) for the sake of clarity, the two are related as follows,

$$\rho = \frac{2\theta + \theta^2 - 2(1+\theta)\log(\theta+1)}{\theta^2}. \tag{A.4}$$

A.5 Standardization of Empirical Frequencies

In order to produce a joint distribution of spouses characteristics that is consistent with the stationarity assumption and with the observed matching behavior, I apply the following transformation to the raw empirical frequencies of married and single agents by type. This appendix closely follows Greenwood et al. (2016), which in turns draws from Mosteller (1968) and relies on the solution algorithm of Sinkhorn and Knopp (1967) outlined below.

Call $(m_{raw}, n_{m,raw}, n_{f,raw})$ the empirical frequencies as measured straight from the data: these are associated with the marginals $p_{m,raw}$ and $p_{f,raw}$ through accounting constraints (2.27) and (2.28). However, for my empirical analysis, I choose to work with marginals $\hat{p}_m$ and $\hat{p}_f$, whose estimation is detailed in section 5.3. Starting from $(m_{raw}, n_{m,raw}, n_{f,raw})$, I compute empirical frequencies $(\hat{m}, \hat{n}_m, \hat{n}_f)$ - the "standardize contingency table" - as follows.

1. Start the iteration with $k = 0$ and set $m^k = m_{raw}$, $n_m^k = n_{m,raw}$, $n_f^{k+1} = n_{f,raw}$.
2. Compute the marginal distribution p_m^k using m^k and n_m^k and accounting restriction (2.27).
3. For each man's type i, rescale each element of the contingency table as follows: $m^{k+1}(i,j) = m^k(i,j)(\hat{p}_m(i)/p_m^k(i))$ and $n^{k+1}(i) = n^k(i)(\hat{p}_m(i)/p_m^k(i))$, where $\hat{p}_m$ is the men's marginal distribution that has been imposed.
4. Compute the marginal distribution p_f^{k+1} using m^{k+1} and n_f^{k+1} and accounting restriction (2.28).
5. For each woman's type j, rescale each element of the contingency table as follows: $m^{k+2}(i,j) = m^{k+1}(i,j)(\hat{p}_f(j)/p_f^k(j))$ and $n^{k+2}(j) = n^k(i)(\hat{p}_f(j)/p_f^k(j))$, where $\hat{p}_f$ is the women's marginal distribution that has been imposed.
6. Compute p_m^{k+2} using m^{k+2} and n_m^k: if p_m^{k+2} and $\hat{p}_m$ are close, stop; otherwise repeat from step 2 until convergence.

B Tables

Table 1: Estimates of γ_1 by spouses' education

Parameter (λ_1)	**1971-1981** **(a)**	**2001-2011** **(b)**	**Change** **(b)-(a)**
Husband L, wife L	1.27	0.96	-0.31
	(0.10)	*(0.08)*	
Husband L, wife H	1.32	1.57	0.25
	(0.14)	*(0.09)*	
Husband H, wife L	1.55	1.18	-0.37
	(0.13)	*(0.10)*	
Husband H, wife H	1.02	1.59	0.57
	(0.13)	*(0.10)*	

Notes: the table contains estimates of γ_1, the elasticity of public good Q with respect to the joint expenditure $t_m + t_f$, for different types of couples; L (Low) indicates that the agent does not hold a college degree, while H (High) indicates that he/she does hold a college degree. The first column contains results for the 1970s sample, the second for the 2000s sample, and the third the difference between the two. Standard errors are in parentheses.

Table 2: Estimates of γ_1 by spouses' education

Parameter	**1971-1981** (a)	**2001-2011** (b)	**Change** (b)-(a)
λ_1	-0.1650	0.2539	0.4189
λ_2	-0.1500	0.0419	0.1919
λ_3	0.5034	0.5014	-0.0020
λ_4	-0.0001	0.0009	0.0011
λ_5	-0.0032	0.0045	0.0078
χ	37.6425	39.8686	2.2261
κ	4.3856	4.3792	-0.0065

Notes: the table contains estimates of the parameters of the meeting function Λ, the elasticity of substitution of inputs $(n_{m,+}(i), n_{f,+}(j))$ in the meeting function χ, and the cost of divorce κ. Recall that: λ_1 increases the odds of a woman with a college degree to meet a man without a college degree; λ_2 increases the odds of a man with a college degree to meet a woman without a college degree; λ_3 increases the odds of two college graduates to meet; λ_4 is the coefficient of a linear term in the age distance $a_m - a_f$; λ_5 is the coefficient of a quadratic term in the age distance $a_m - a_f$. Standard errors will be computed in an updated version of the draft: as a reminder, the point-estimates are obtained through a GMM estimator.

Table 3: Summary of parameters estimated or calibrated outside of the model

Parameter	**1971-1981**	**2001-2011**	**Notes**
β	0.9604	0.9604	Calibrated (Voena, 2015; Chiappori et al., 2017)
σ_ℓ	0.7	0.7	Calibrated (see section 5.5)
Share of college graduates (men)	20.84%	30.54%	Estimated (CPS data, see section 5.3)
Share of college graduates (women)	13.03%	31.31%	Estimated (CPS data, see section 5.3)
Wage levels (men and women)	See figure 3		Estimated (CPS data, see section 5.1)
Wage mobility (men and women)	See figure 3		Estimated (PSID data, see section 5.1)

Notes: the table summarizes the parameters that are calibrated or estimated outside of the model. Wage levels and wage mobility are described in separate figures.

Table 4: Fit of the model (1)

	1971-1981 (a)		2001-2011 (b)		Change (b) - (a)	
Moment	**Sim.**	**Data**	**Sim.**	**Data**	**Sim.**	**Data**
% of married						
Men	72.25	69.42	58.04	51.59	-14.21	-17.83
Women	74.66	68.36	60.04	52.85	-14.62	-15.52
% of married by education						
Men (L)	74.10	68.42	57.33	46.61	-16.76	-21.81
Women (L)	75.83	68.56	58.74	49.30	-17.10	-19.25
Men (H)	65.22	73.57	59.65	64.67	-5.57	-8.90
Women (H)	66.84	67.05	62.91	61.41	-3.93	-5.64
% of married by wage quintile						
Men (1st quintile)	59.58	48.83	42.58	28.95	-17.00	-19.88
Women (1st quintile)	73.06	61.18	49.57	39.20	-23.48	-21.98
Men (3rd quintile)	72.45	72.27	52.44	47.44	-20.01	-24.82
Women (3rd quintile)	74.20	73.70	54.50	52.92	-19.69	-20.77
Men (5th quintile)	85.03	87.40	75.11	76.51	-9.92	-10.89
Women (5th quintile)	78.48	66.00	69.75	62.49	-8.74	-3.50
% of married by age						
Men (20-30)	38.34	45.59	18.98	20.36	-19.36	-25.23
Women (20-30)	54.60	57.10	27.67	30.02	-26.93	-27.09
Men (30-40)	76.69	78.69	58.26	56.83	-18.43	-21.86
Women (30-40)	81.77	76.70	66.17	61.00	-15.61	-15.70
Men (40-50)	85.56	82.47	73.81	63.27	-11.75	-19.20
Women (40-50)	87.15	77.09	76.25	62.50	-10.91	-14.59
Men (50-60)	88.39	82.96	81.11	67.33	-7.28	-15.62
Women (50-60)	75.11	67.50	70.09	57.62	-5.02	-9.88

Notes: the table contains moments from the empirical distribution of agents' marital status conditional on their characteristics for both the 1970s and the 2000s. These are compared to the moments obtained by simulating the estimated model. In the last two columns, it is possible to assess the changes observed in the data and those implied by the two simulations. Labels: (L) means non-college graduate; (H) means college graduate; (xx-yy) means from age xx to age yy; (PT) means part-time; (FT) means full-time.

Table 5: Fit of the model (2)

	1971-1981 (a)		2001-2011 (b)		Change (b) - (a)	
Moment	**Data.**	**Sim.**	**Data.**	**Sim.**	**Data.**	**Sim.**
% of couples by education						
L husband, L wife	79.43	75.79	60.27	54.86	-19.16	-20.93
L husband, H wife	1.65	3.57	8.35	10.54	6.71	6.97
H husband, L wife	8.93	11.54	6.75	10.92	-2.18	-0.62
H husband, H wife	9.99	9.10	24.63	23.67	14.64	14.57
% of couples by wife's l_f						
Not working (L)	41.43	48.86	25.96	28.75	-15.47	-20.12
Working PT (L)	20.79	16.48	22.23	17.99	1.44	1.51
Working FT (L)	37.78	34.65	51.81	53.27	14.03	18.61
Not working (H)	34.08	34.95	21.54	20.51	-12.54	-14.45
Working PT (H)	18.29	17.61	17.69	17.29	-0.61	-0.32
Working FT (H)	47.63	47.43	60.78	62.20	13.15	14.77
Marriage rates						
Men	17.18	26.88	11.65	10.98	-5.53	-15.91
Women	18.54	21.52	12.16	10.47	-6.38	-11.05
Men (L)	18.45	27.81	11.36	10.38	-7.09	-17.44
Women (L)	19.41	21.78	11.67	9.44	-7.74	-12.34
Men (H)	13.40	25.18	12.32	12.13	-1.08	-13.05
Women (H)	14.10	20.89	13.36	12.18	-0.74	-8.71
Divorce rates						
All couples	1.69	5.16	2.34	5.05	0.65	-0.11
Men (L)	1.69	5.53	2.61	6.42	0.92	0.89
Women (L)	1.64	5.28	2.45	6.27	0.81	1.00
Men (H)	1.68	4.28	1.75	3.29	0.07	-0.99
Women (H)	2.10	4.73	2.13	3.53	0.03	-1.21

Notes: the table contains moments from the joint empirical frequency of spouses' characteristics, married women's empirical probabilities of choosing a certain level l_f of labor supply and the distribution of empirical probabilities of getting married (for singles) or divorced (for married) for both the 1970s and the 2000s. These are compared to the moments obtained by simulating the estimated model. In the last two columns, it is possible to assess the changes observed in the data and those implied by the two simulations. Labels: (L) means non-college graduate; (H) means college graduate; (xx-yy) means from age xx to age yy; (PT) means part-time; (FT) means full-time.

Table 6: Decomposition of the changes in marriage market outcome (1)

	1970s	**Experiments**				**2000s**
		Wages	**Schooling**	**Wages Schooling**	**Wages Schooling Meetings**	
	(1)	(a)	(b)	(c)	(d)	(2)
% of married						
Men	72.25	67.10	69.51	64.05	62.28	58.04
Women	74.66	69.53	72.00	66.50	64.66	60.04
% of married by education						
Men (L)	74.10	68.24	71.22	64.04	62.04	57.33
Women (L)	75.83	70.59	76.89	70.63	69.27	58.74
Men (H)	65.22	62.79	65.62	64.08	62.82	59.65
Women (H)	66.84	62.46	61.28	57.46	54.54	62.91
% of married by wage quintile						
Men (1st quintile)	59.58	54.92	53.31	48.00	46.31	42.58
Women (1st quintile)	73.06	68.33	70.44	64.50	62.84	49.57
Men (3rd quintile)	72.45	68.87	65.68	60.20	58.36	52.44
Women (3rd quintile)	74.20	73.37	74.03	65.19	63.87	54.50
Men (5th quintile)	85.03	80.60	84.63	79.61	78.07	75.11
Women (5th quintile)	78.48	71.69	72.32	67.39	65.19	69.75
% of married by age						
Men (20-30)	38.34	34.09	34.58	30.04	28.46	18.98
Women (20-30)	54.60	50.84	50.29	45.97	44.01	27.67
Men (30-40)	76.69	70.63	74.19	67.69	65.47	58.26
Women (30-40)	81.77	75.98	79.54	73.18	71.10	66.17
Men (40-50)	85.56	80.02	83.36	77.56	75.83	73.81
Women (40-50)	87.15	81.65	84.74	79.01	77.48	76.25
Men (50-60)	88.39	83.67	85.90	80.91	79.34	81.11
Women (50-60)	75.11	69.65	73.43	67.86	66.06	70.09

Notes: the table contains moments from different simulated economies: column (1) aims to match the 1970s equilibrium; the labels of the column in the middle part of the table ("Experiments") refers to the names of the experiments described in section 6.4; column (2) aims to match the 2000s equilibrium. Each experiment corresponds to a simulated equilibrium where all parameters are fixed to their 1970s levels but those named in the header, which are set to their 2000s levels. The table helps understand which factors contributed the most to changes in the marriage market outcome. Finally, note that the residual difference between column (c) and (2) is only explained by changes in the production function of the public good Q (i.e., due to changes in γ_1, γ_2 and γ_3).

Table 7: Decomposition of the changes in marriage market outcome (2)

	1970s	**Experiments**				**2000s**
		Wages	**Schooling**	**Wages Schooling**	**Wages Schooling Meetings**	
	(1)	**(a)**	**(b)**	**(c)**	**(d)**	**(2)**
% of couples by education						
L husband, L wife	79.43	79.26	65.02	64.67	62.95	60.27
L husband, H wife	1.65	1.13	6.03	4.65	6.11	8.35
H husband, L wife	8.93	9.05	8.31	8.21	10.53	6.75
H husband, H wife	9.99	10.56	20.64	22.47	20.40	24.63
% of couples by wife's l_f						
Not working (L)	41.43	37.25	41.54	37.46	37.65	25.96
Working PT (L)	20.79	21.09	20.75	21.06	21.05	22.23
Working FT (L)	37.78	41.65	37.71	41.48	41.30	51.81
Not working (H)	34.08	30.33	33.31	29.41	28.77	21.54
Working PT (H)	18.29	18.31	18.25	18.25	18.21	17.69
Working FT (H)	47.63	51.37	48.44	52.34	53.01	60.78
Marriage rates						
Men	17.18	14.89	15.97	13.75	12.88	11.65
Women	18.54	15.91	17.18	14.63	13.64	12.16
Men (L)	18.45	15.57	16.52	13.79	12.75	11.36
Women (L)	19.41	16.56	20.11	17.31	16.29	11.67
Men (H)	13.40	12.63	14.85	13.66	13.19	12.32
Women (H)	14.10	12.39	12.55	10.38	9.54	13.36
Divorce rates						
All couples	1.69	2.19	2.01	2.50	2.50	2.34
Men (L)	1.69	2.23	2.04	2.63	2.60	2.61
Women (L)	1.64	2.16	1.87	2.44	2.35	2.45
Men (H)	1.68	2.04	1.95	2.21	2.29	1.75
Women (H)	2.10	2.45	2.41	2.66	2.93	2.13

Notes: the table contains moments from different simulated economies: column (1) aims to match the 1970s equilibrium; the labels of the column in the middle part of the table ("Experiments") refers to the names of the experiments described in section 6.4; column (2) aims to match the 2000s equilibrium. Each experiment corresponds to a simulated equilibrium where all parameters are fixed to their 1970s levels but those named in the header, which are set to their 2000s levels. The table helps understand which factors contributed the most to changes in the marriage market outcome. Finally, note that the residual difference between column (c) and (2) is only explained by changes in the production function of the public good Q (i.e., due to changes in γ_1, γ_2 and γ_3).

Table 8: Changes in wage mobility and wage levels (1)

	1970s	**Experiments**			
		Men's wages	**Women's wages**	**Men's mobility**	**Women's mobility**
	(1)	**(e)**	**(f)**	**(g)**	**(h)**
% of married					
Men	72.25	67.75	71.53	72.38	72.26
Women	74.66	70.20	73.91	74.80	74.67
% of married by education					
Men (L)	74.10	68.83	73.44	74.22	74.11
Women (L)	75.83	71.00	75.31	75.98	75.84
Men (H)	65.22	63.61	64.27	65.42	65.23
Women (H)	66.84	64.86	64.55	66.97	66.85
% of married by wage quintile					
Men (1st quintile)	59.58	54.75	58.85	60.18	59.59
Women (1st quintile)	73.06	68.69	72.07	73.19	73.28
Men (3rd quintile)	72.45	69.72	71.75	72.48	72.46
Women (3rd quintile)	74.20	69.45	77.91	74.34	74.22
Men (5th quintile)	85.03	81.98	84.38	84.71	85.04
Women (5th quintile)	78.48	74.15	76.52	78.65	78.25
% of married by age					
Men (20-30)	38.34	33.99	38.22	38.40	38.36
Women (20-30)	54.60	50.67	54.49	54.68	54.61
Men (30-40)	76.69	71.04	76.12	76.79	76.71
Women (30-40)	81.77	76.44	81.19	81.88	81.79
Men (40-50)	85.56	80.99	84.63	85.70	85.57
Women (40-50)	87.15	82.73	86.11	87.31	87.17
Men (50-60)	88.39	84.97	87.14	88.65	88.40
Women (50-60)	75.11	70.97	73.85	75.35	75.11

Notes: the table contains moments from different simulated economies: column (1) aims to match the 1970s equilibrium; the labels of the column in the middle part of the table ("Experiments") refers to the names of the experiments described in section 6.4. Each experiment corresponds to a simulated equilibrium where all parameters are fixed to their 1970s levels but those named in the header, which are set to their 2000s levels. The table helps understand the impact of changes in each element of the wage distribution on the changing marriage market outcome.

Table 9: Changes in wage mobility and wage levels (2)

	1970s	**Experiments**			
		Men's wages	**Women's wages**	**Men's mobility**	**Women's mobility**
	(1)	**(e)**	**(f)**	**(g)**	**(h)**
% of couples by education					
L husband, L wife	79.43	79.17	79.54	79.42	79.43
L husband, H wife	1.65	1.15	1.63	1.64	1.65
H husband, L wife	8.93	8.80	9.12	8.95	8.93
H husband, H wife	9.99	10.87	9.72	10.00	9.99
% of couples by wife's l_f					
Not working (L)	41.43	38.01	40.66	41.39	41.44
Working PT (L)	20.79	21.08	20.83	20.80	20.79
Working FT (L)	37.78	40.91	38.51	37.82	37.77
Not working (H)	34.08	33.00	31.43	34.04	34.09
Working PT (H)	18.29	18.31	18.30	18.29	18.29
Working FT (H)	47.63	48.69	50.26	47.67	47.62
Marriage rates					
Men	17.18	15.11	16.85	17.25	17.18
Women	18.54	16.18	18.14	18.64	18.55
Men (L)	18.45	15.80	18.11	18.53	18.46
Women (L)	19.41	16.70	19.14	19.52	19.42
Men (H)	13.40	12.85	13.13	13.48	13.40
Women (H)	14.10	13.25	13.22	14.14	14.10
Divorce rates					
All couples	1.69	2.04	1.82	1.67	1.69
Men (L)	1.69	2.08	1.82	1.68	1.69
Women (L)	1.64	2.03	1.75	1.62	1.64
Men (H)	1.68	1.90	1.83	1.64	1.68
Women (H)	2.10	2.17	2.36	2.07	2.10

Notes: the table contains moments from different simulated economies: column (1) aims to match the 1970s equilibrium; the labels of the column in the middle part of the table ("Experiments") refers to the names of the experiments described in section 6.4. Each experiment corresponds to a simulated equilibrium where all parameters are fixed to their 1970s levels but those named in the header, which are set to their 2000s levels. The table helps understand the impact of changes in each element of the wage distribution on the changing marriage market outcome.

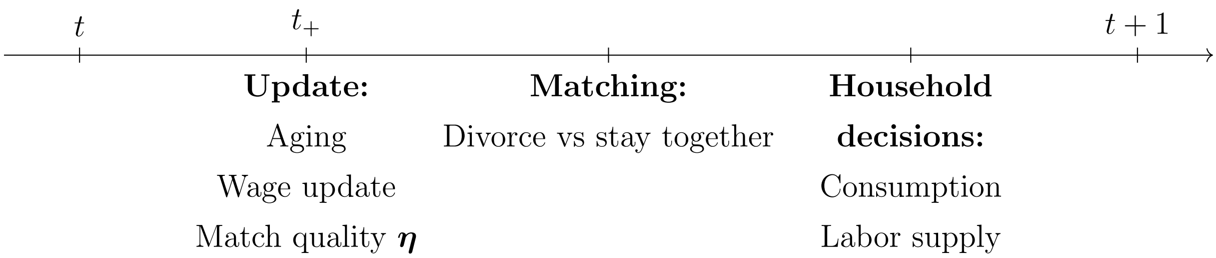
Table 10: Decomposition of the changes in the gains of marriage

	1970s	**Experiments**				**2000s**
		Wages	**Schooling**	**Wages Schooling**	**Wages Schooling Meetings**	
	(1)	**(a)**	**(b)**	**(c)**	**(d)**	**(2)**
Overall	100.00	84.00	92.13	78.62	77.21	73.64
By gender and education						
Men (L)	99.95	82.85	90.77	74.03	73.24	66.58
Men (H)	100.17	88.38	95.24	89.06	86.24	89.70
Women (L)	99.75	83.31	95.40	79.14	79.38	66.72
Women (H)	101.66	88.58	84.97	77.47	72.45	88.83
By gender and age						
Men (20-30)	61.96	49.21	53.14	41.79	40.54	23.36
Men (30-40)	118.70	97.64	111.70	94.74	92.86	83.25
Men (40-50)	104.24	89.13	96.35	84.59	83.70	81.16
Men (50-60)	114.80	98.50	105.51	91.07	89.60	102.14
Women (20-30)	91.61	75.11	79.97	65.71	64.33	37.53
Women (30-40)	120.94	100.83	113.95	97.91	96.30	90.39
Women (40-50)	100.64	86.59	92.74	81.53	80.78	78.22
Women (50-60)	95.96	81.40	90.38	77.00	74.87	91.38

Notes: the first row reports the average gains from marriage overall. The following rows report the average surplus by educational and age categories (see section 2.13). All measures are normalized so that the average gains from marriage in the 1970s are equal to 100%. A full description of the experiments from (a) to (d) can be found in section 6.4.

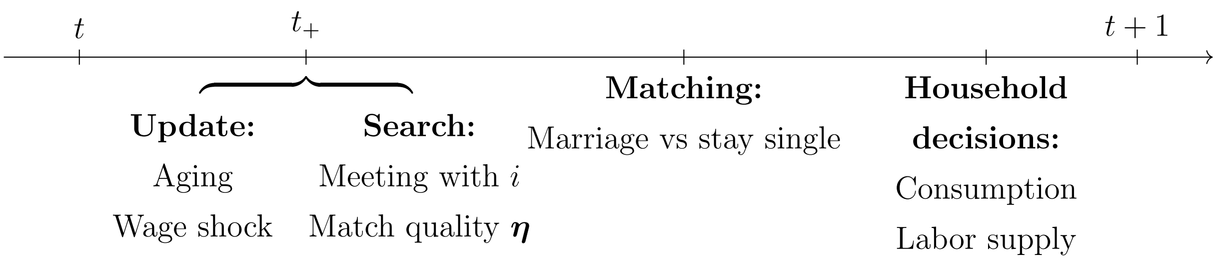
C Figures

Figure 1: Timeline for a man i and a woman j married in t



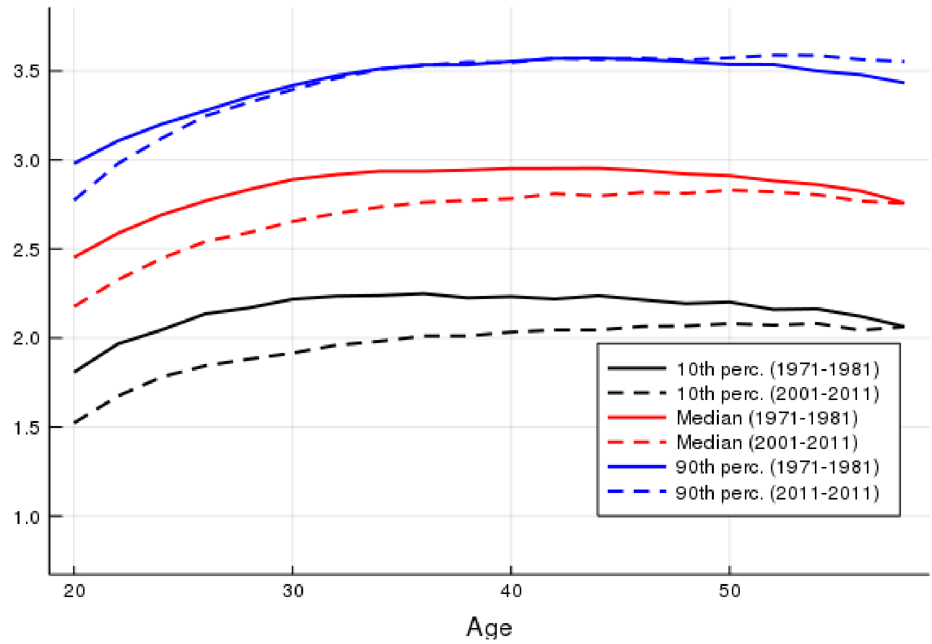
Notes: the figure reproduces the timing of decisions of agents that enter the period as married couples. Uncertainty is resolved at the beginning of the period (t_+): both spouses draw new wages and experience taste shocks $\boldsymbol{\eta}$. Immediately after t_+, couples have sufficient information to decide whether to stay together or divorce. Conditionally on their updated marital status, they make consumption and labor supply decisions.

Figure 2: Timeline for a woman j who is single in t

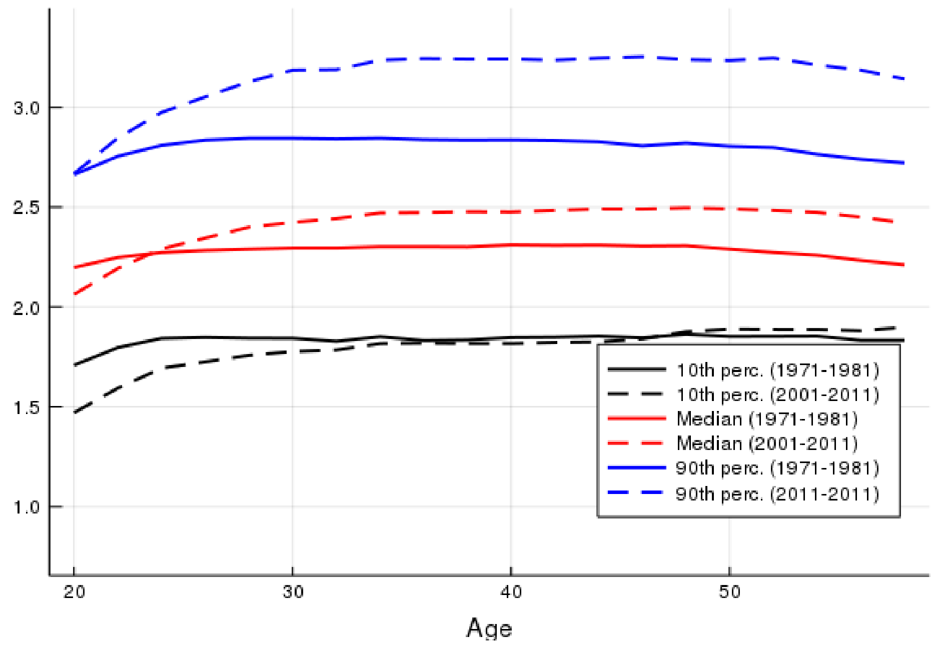


Notes: the figure reproduces the timing of single agents' decisions. Uncertainty is resolved at the beginning of the period (t_+): singles draw a new wage and look for a partner; upon a date, the pair draws a vector $\boldsymbol{\eta}$ which is indicative of match quality. Immediately after t_+, single agents have sufficient information to decide whether to get married (if they have met someone). Conditionally on their updated marital status, they make consumption and labor supply decisions.

Figure 3: Wage levels by gender and age



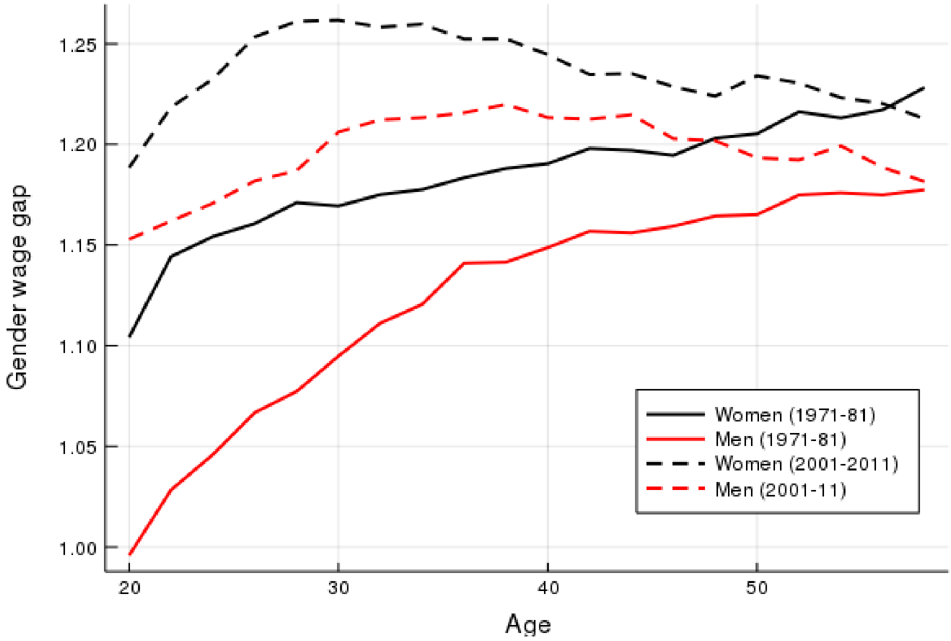
(a) Men



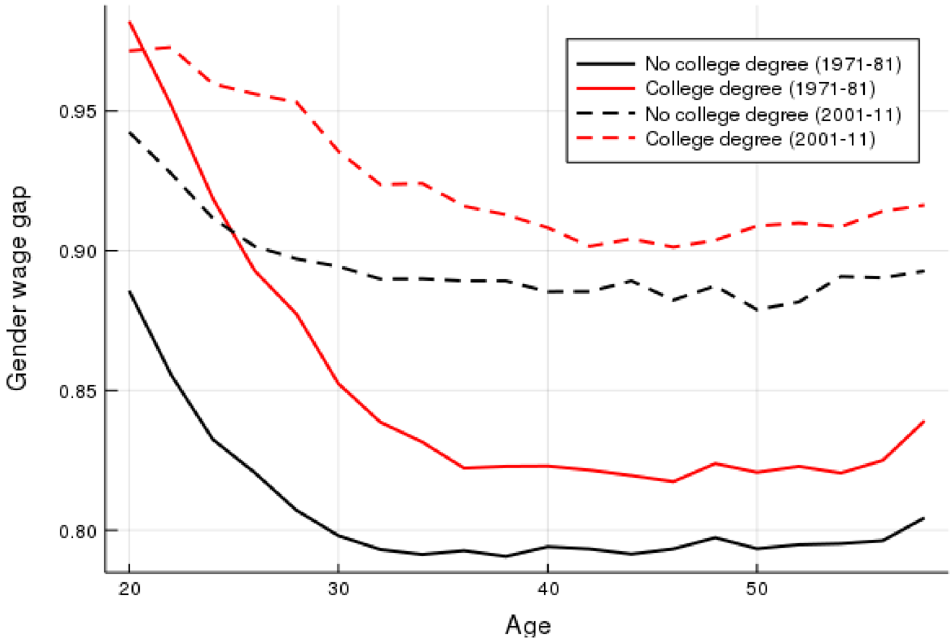
(b) Women

Notes: the plots display wage levels for the 10th (black), 50th (red) and 90th percentile (blue) for both men (on the left) and women (on the right). Solid lines refer to wage levels in the 1970s, while dash lines refer to the 2000s.

Figure 4: College premium and gender wage gap



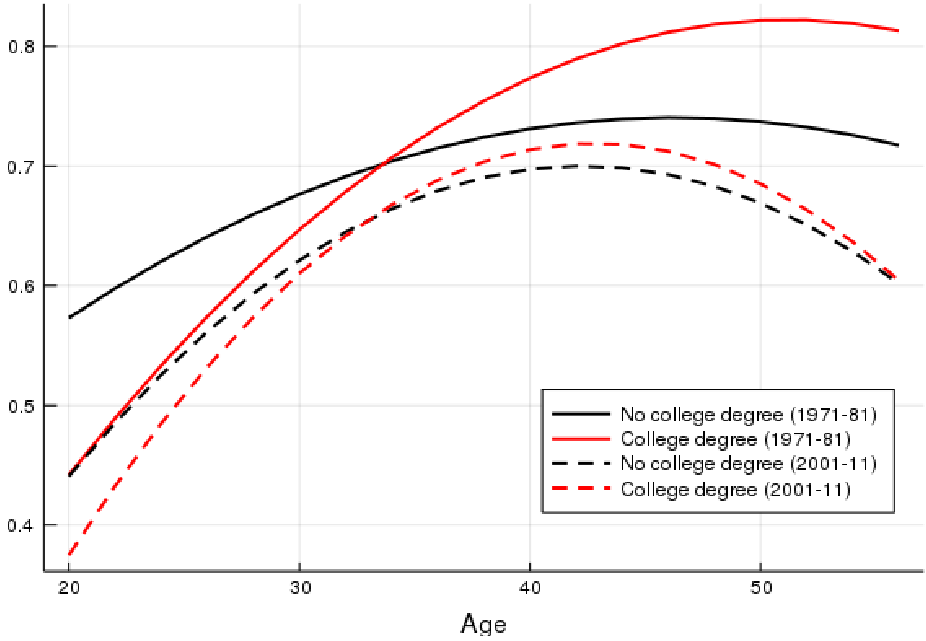
(a) College premium



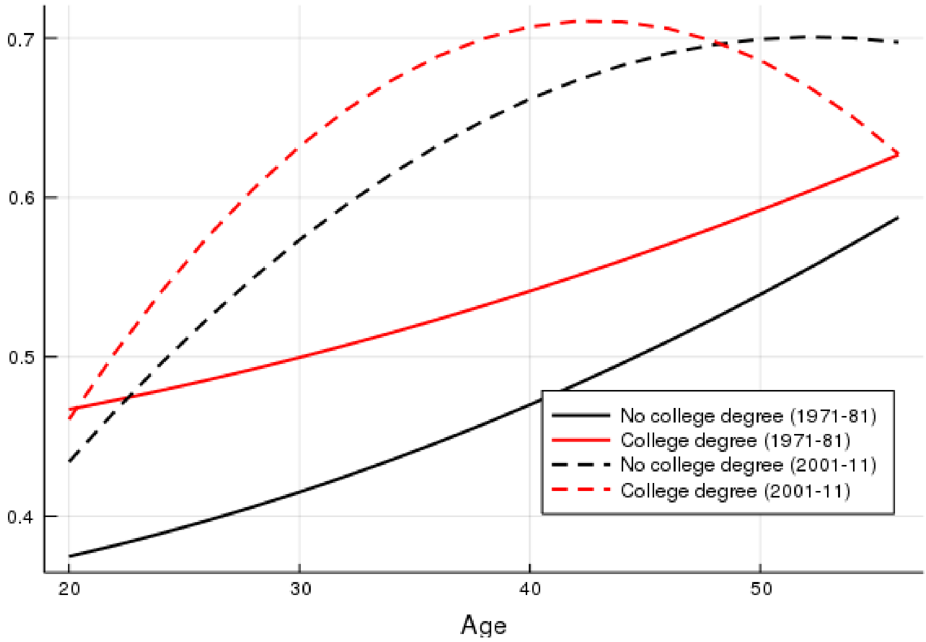
(b) Gender wage gap

Notes: the plots display the college premium (on the right) and the gender wage gap (on the left) measured as ratios between the median wages of each gender and educational group. Solid lines refer to ratios in the 1970s, while dash lines refer to the 2000s.

Figure 5: Changes in wage mobility by gender, age and education



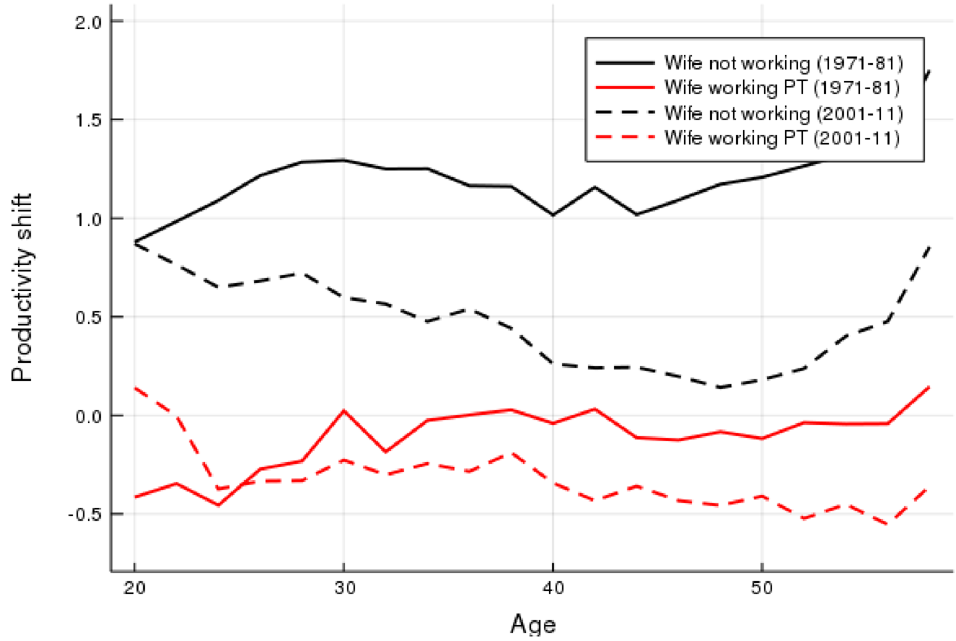
(a) Men



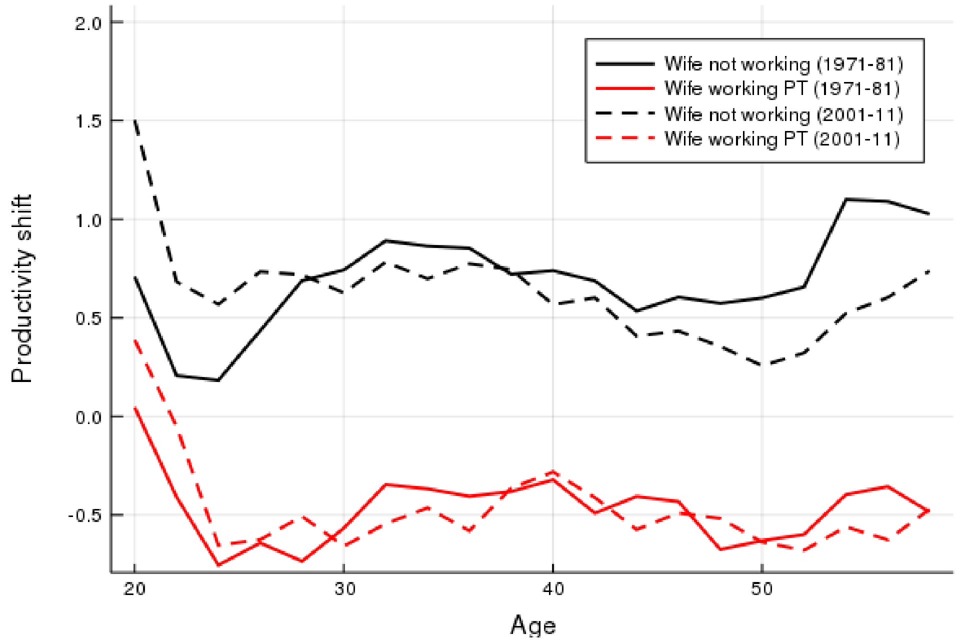
(b) Women

Notes: the plots display the rank correlation between the wage w in period t and the wage w' in period $t+1$: the higher the rank correlation, the lower wage mobility. Solid lines refer to parameter estimates for the 1970s, while dash lines refer to the 2000s.

Figure 6: Estimates of γ_2 by age and education



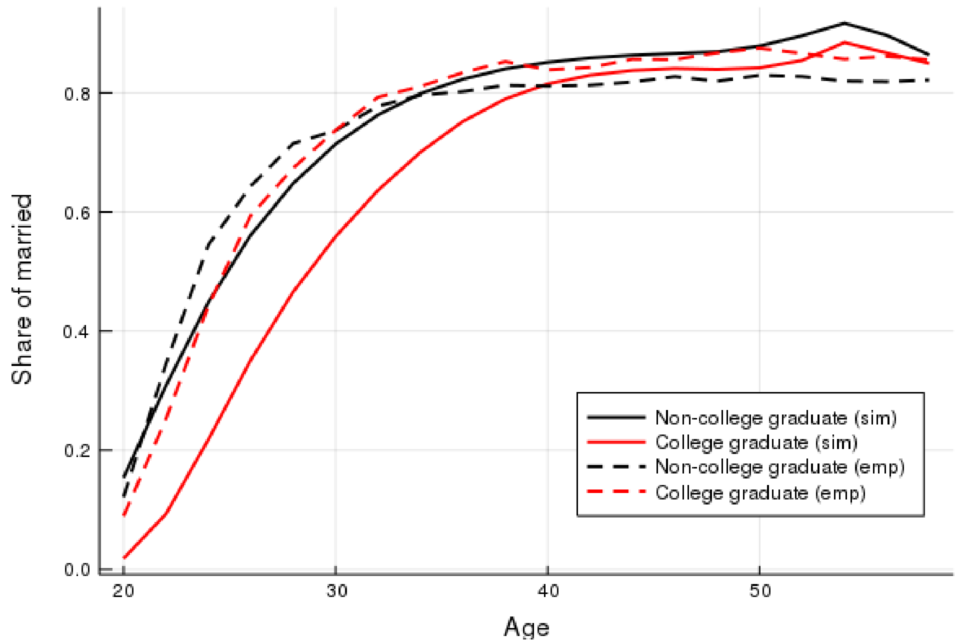
(a) Noncollege graduates



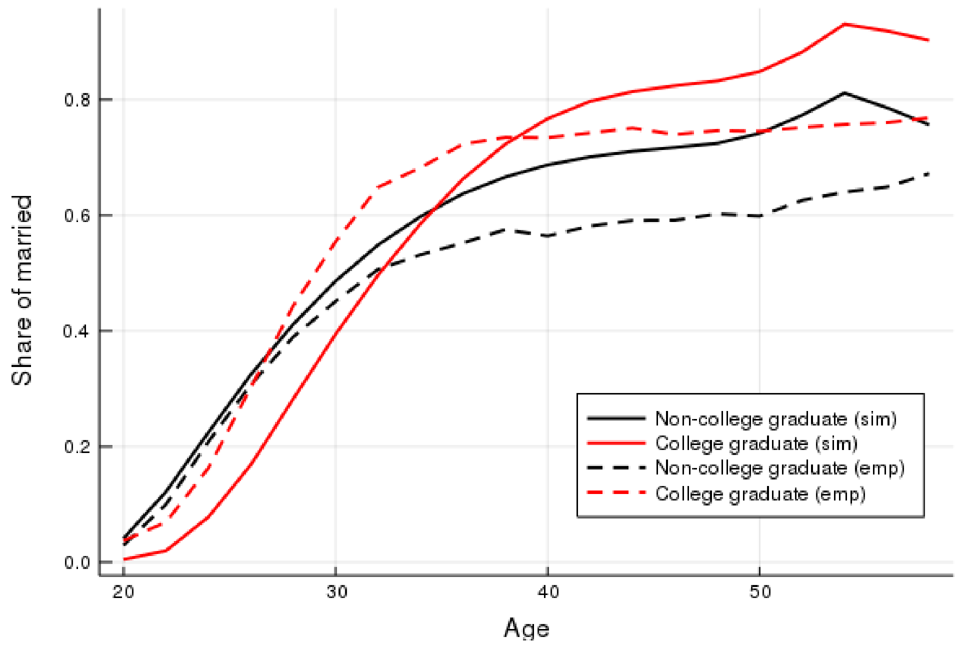
(b) Noncollege graduates

Notes: the plots display estimates of $\gamma_2(l_f)$, the productivity shifter associated with labor supply choice l_f, for women without a college degree (on the left) and with a college degree (on the right). Black indicates inactivity and red part-time; solid lines represent 1970s estimates, and dashed lines 2000s estimates. For each level l_f, $\gamma_2(l_f)$ is allowed to vary by age and education; $\gamma_2(l_f)$ is normalized to zero for married women working full-time. If $\gamma_2(l_f) > 0$, the household benefits from an increase in match surplus with respect to the benchmark (wife working full-time) if option l_f is chosen; if $\gamma_2(l_f) < 0$, the household faces a loss in match surplus.

Figure 7: Fit of the model: share of married men by age and education



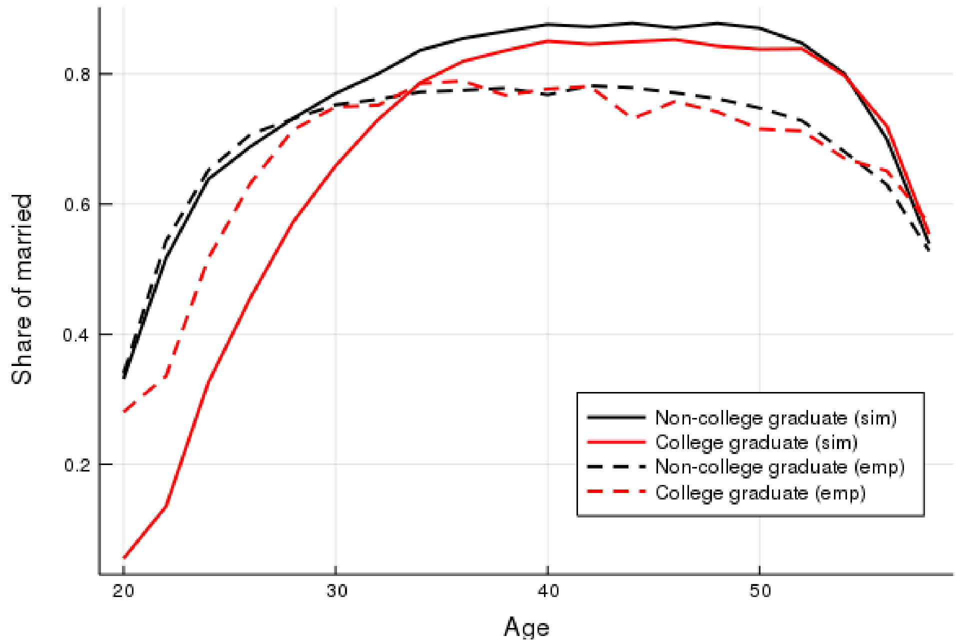
(a) 1970s



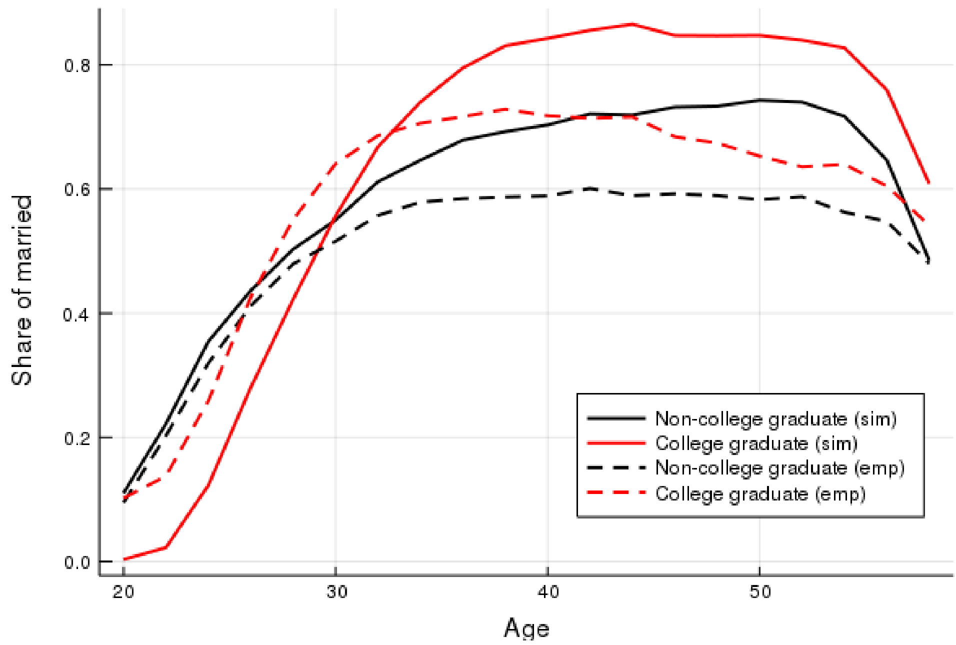
(b) 2000s

Notes: the plots track the life-cycle dynamics of the stocks of married men by educational level. For each plot, black represents non-college graduates, and red college graduates; solid lines correspond to simulated moments, dash lines to empirical moments.

Figure 8: Fit of the model: share of married women by age and education



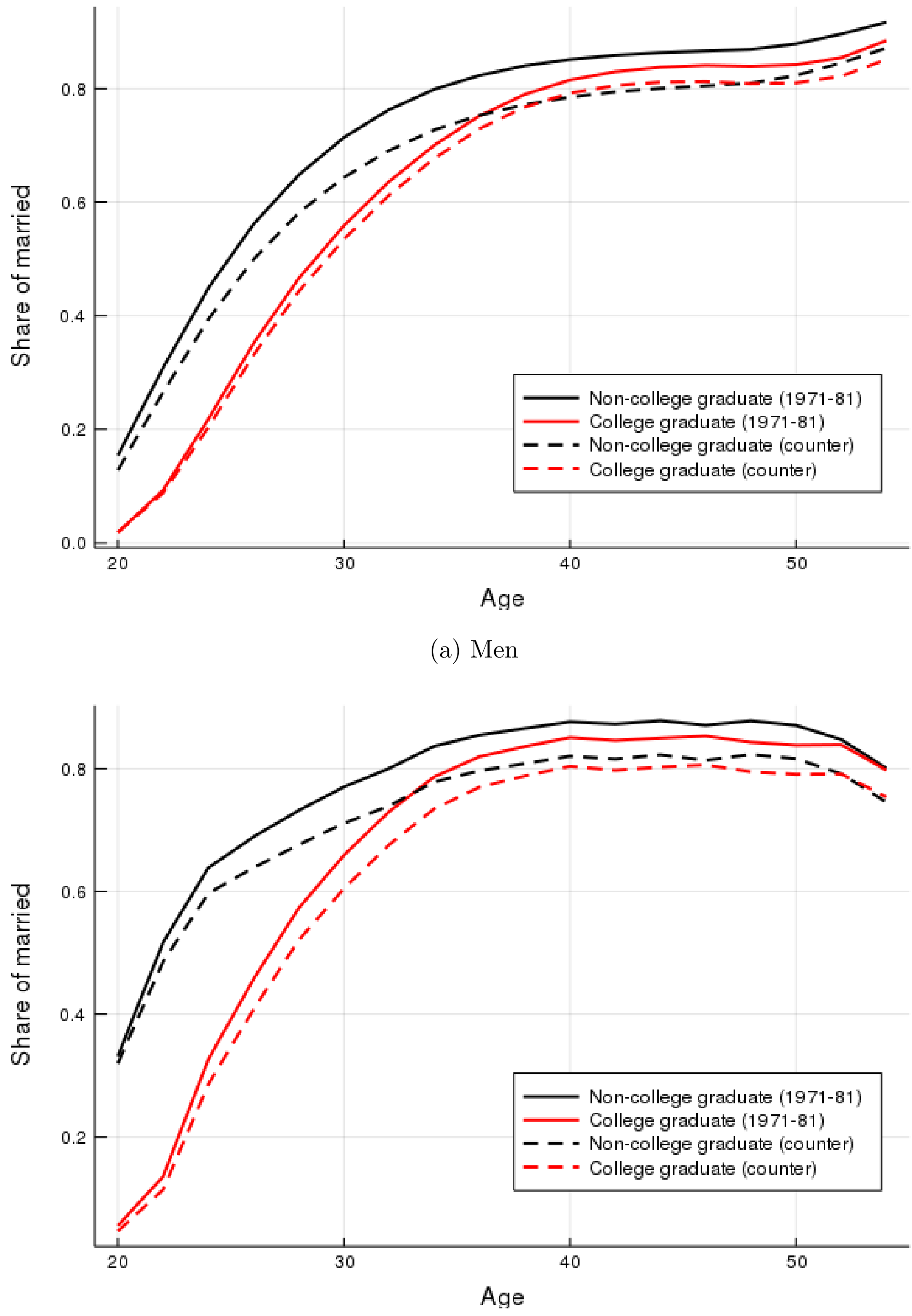
(a) 1970s



(b) 2000s

Notes: the plots track the life-cycle dynamics of the stocks of married men by educational level. For each plot, black represents non-college graduates, and red college graduates; solid lines correspond to simulated moments, dash lines to empirical moments.

Figure 9: Changes in wages: adjustments of the share of married men by age and education

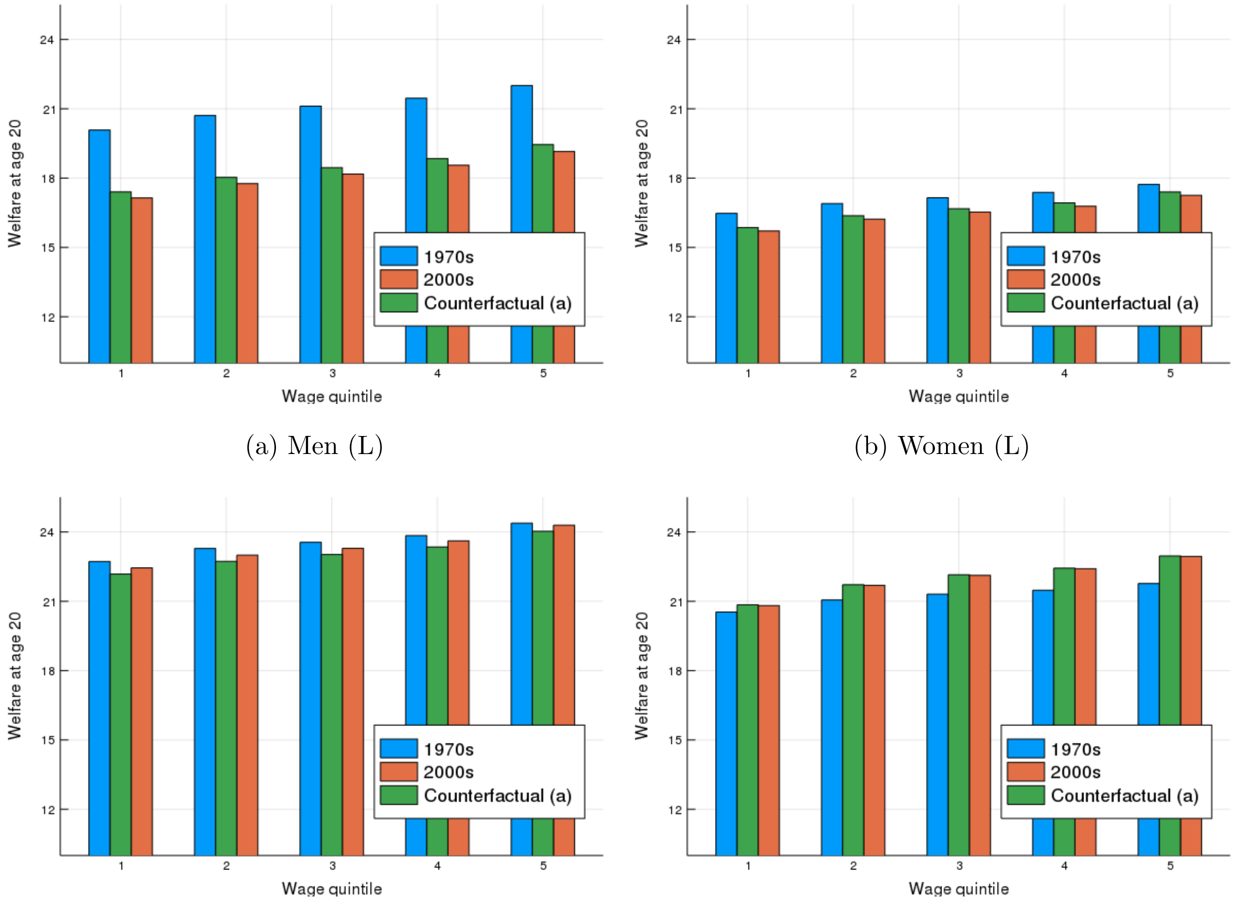


(a) Men

(b) Women

Notes: the plots track the life-cycle dynamics of the stocks of married men by educational level. For each plot, black represents non-college graduates, and red college graduates; solid lines correspond to simulated moments for the 1970s marriage market (column (1) in table 6), while dash lines correspond to simulated moments for a counterfactual equilibrium where all parameters are fixed to the 1970s but the wage distribution, which takes on its 2000s shape (column (a) in table 7).

Figure 10: Changes in wages: adjustments of the share of married men by age and education



(a) Men (L)

(b) Women (L)

(c) Men (H)

(d) Women (H)

Notes: the plots reports the distribution of ex-ante welfare for individuals entering the marriage market at age 20 (see section 2.13). Blue bars correpsond to the distribution of welfare in the 1970s, green bars to the distribution at the counterfactual equilibrium of experiment (a), and orange bars to the distribution in the 2000s. Remember that experiment (a) corresponds to an economy where all primitive parameters are set to their 1970s but the wage distribution (of men and women), which takes on its 2000s shape (see section 6.4).

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