

Divorce, Remarriage, and Fertility with On-the-Marriage Search

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PRELIMINARY AND INCOMPLETE

Abstract

Even with falling divorce rates, between 30 and 40 percent of new marriages end in divorce. Recent divorcees – especially men but increasingly also women – tend to remarry very quickly. To the extent that marriage provides consumption insurance, and security to undertake costly investments such as raising children, the phenomenon of divorce and rapid remarriage prompts re-examination of the gains to marriage in terms of risk sharing. This paper explores marriage and divorce when individuals can engage in on-the-marriage search. Introducing on-the-marriage search allows us to match the rapid remarriage rates seen in US microdata as well as to explore the connections between infidelity, divorce, and remarriage that have attracted much attention in the sociology literature. In a second-best contracting world, the ability to search on the marriage (OTMS) has ambiguous and potentially important implications for the marriage as a consumption smoothing device and as a platform for making investments in children. We find that allowing for OTMS has variable effects on the first and second moments of consumption for different parts of the population, with women slightly worse off and men slightly better off when OTMS is allowed. Perhaps counterintuitively, OTMS also has a positive effect on fertility because it increases the attractiveness of having children for men in mediocre marriages.

1 Introduction

Although the divorce rate has been falling in recent years, especially among the college-educated population, the experience of divorce and re-partnering is still very prevalent in modern marriage markets. 1% of all women aged 15 and over – unconditional on being married – divorce during a given year.¹ A somewhat under-explored fact in the economics literature on marriage is that divorcees, especially men but increasingly also women, remarry very quickly. By the first anniversary of a divorce, 11% of divorcees have re-partnered. After five years over a third have remarried, and after fifteen years

¹National Health Statistics Reports, Number 49, March 22 2012.

the remarriage rate is over 80%.² Of all marriages, up to 36% consist of a previously married spouse.³ This is not a recent phenomenon. In fact, five year remarriage rates are even higher for each decade going back to the 1950s.⁴ This paper shows that standard models of marriage have trouble matching the remarkably high, and especially the very rapid, rates of remarriage seen in the data, and that introducing on-the-marriage search to the standard framework yields a richer and more predictive model of marriage over the life cycle. At a first pass, on-the-marriage search allows the hazard rate of remarriage following divorce generated by the model to match the time-variant pattern seen in the data. We show that it also yields various secondary implications for how individuals sort in marriage markets and how much insurance marriage can provide.

We introduce on-the-marriage search to the framework of dynamic joint household maximization with imperfectly transferable utility and endogenous fertility developed by Mazzocco et al. (2014) and Voena (2012). This allows a spouse to actively seek an outside option to the current marriage, which has implications for the evolution of the division of surplus within a marriage and potentially for fertility choices and the welfare of children within the household. Ligon et al. (2002) show that the efficient renegotiation of the contract requires altering the division of surplus as little as possible. On-the-marriage search allows for more frequent and more drastic renegotiations, potentially lowering the gains to marriage and altering consumption patterns during marriage and across marital transitions. Searching on the marriage may also reduce the expected returns to marriage by creating conflict within the couple or reasons other than to do with consumption smoothing. Conversely, however, in a world of limited commitment, the option to continue searching while married could also increase the gains to marriage by giving spouses in bad marriages exit strategies that do not involve long periods of singlehood. With limited commitment in marriage contracts renegotiation happens as income and marriage quality shocks are realized. In order to allow for search behaviour that is necessarily detrimental to one's partner, the household maximization process is noncooperative – a departure from the literature.

We estimate this model using indirect inference. The model with on-the-marriage search predicts remarriage rates better than the standard model, which underpredicts remarriage in the few years following divorce and overpredicts it among individuals who have been divorced for a long time. This has implications for consumption smoothing over the lifetime, and for the expenditures on children.

This paper is closely related to literatures on dynamic joint household decision making, and assortative matching in the presence of frictions. Mazzocco et al. (2014) show that labor supply and savings decisions of couples are codependent and therefore cannot be fully explained by individual characteristics. The authors present a joint decision-making framework within which partners' individual decisions can be competitive as well as cooperative and in which the insurance value of marriage is decreased by either

²National Survey of Family Growth, 2006-2011 cycles, Center for Disease Control.

³US Census Bureau, Survey of Income and Program Participation, 1996 panel, Wave 2.

⁴Note that earlier decades have smaller divorce cohorts, and so represent smaller total number of divorcees.

partner’s ability to leave. We borrow this framework into which we add both endogenous fertility and the ability to search on the marriage.⁵ We find that on the marriage search (OTMS) has a variety of interesting implications. First, it is a normal “good”, especially for men, and consequently increases with effective income. This means that happier marriages do not necessarily experience lower levels of OTMS despite the fact that OTMS lowers marriage quality over time. As well, OTMS increases the relatively utility weight of the husband in marital bargaining since husbands engage in more search and so have higher outside options on average. As well, it appears to increase fertility relative to a world in which individuals face the same income processes and preferences but cannot search while married by decreasing men’s commitments to their families.

The rest of the paper is organized as follows. Section 2 presents the empirical motivation and Section 3 the theoretical framework of the model. Section 4 describes the data and measurement issues. Section 5 outlines further assumptions needed to necessitate numerical simulation and Section 6 discusses estimation issues. Results are presented in Section 7 and Section 8 concludes.

2 Empirical Motivation

The high divorce rate is widely recognized, but less attention has been paid to the phenomenon of remarriage. Remarriage is common: cross-sectionally, one-third of all marriages are remarriages for at least one spouse. Remarriage happens quickly: around half of divorcees remarry within five years (and over 80% remarry eventually).⁶ Hazard rates of remarriage are initially high following divorce, and fall quickly with the tenure of divorcehood. This section presents evidence from several sources to build the case that mate search is plausibly concurrent with ongoing relationships (on-the-marriage search), and that successful matching is the likely cause of marital dissolutions that are immediately followed by a new relationship. Following the Beckerian view of the household, we are primarily interested in household-to-household transitions: separations and cohabitations rather than legal divorce and marriage.

Rapid transitioning to the next partnership

To avoid problems associated with panel surveys such as attrition, inconsistent reporting of partners, and changes in partner identification tags, we focus on retrospective marriage histories reported in the National Survey of Family Growth (NSFG) collected by the Center for Disease Control and the Survey of Income and Program Participation (SIPP) collected by the Census Bureau. Demographers generally prefer retrospective survey

⁵Shimer and Smith (2000) and Smith (2006) study the conditions under which partners match assortatively in the presence of search frictions. Burdett and Coles (1999) show that under full commitment and without the possibility of divorce, search frictions lead to positive assortative matching within discrete castes, even when the distributions of partner quality are continuous. Burdett and Coles (2001) show that this can lead to inefficiencies in human capital investment.

⁶These facts are consistent for the SIPP 1996, 2001, 2004, and 2008 cycles, and the NSFG 2006-2010 and 2011-2013 cycles.

data to calculate marriage statistics (see Ratcliffe et al. (2008)), but respondents may find it more difficult to recall changes in living arrangements than formal marital proceedings (Manning and Smock (2005)).

Formal marriage and divorce are subject to a variety of laws and processes that impede quick transitions. Some states impose waiting periods following the finalization of divorce proceedings during which remarriage is prohibited, but more commonly there is a waiting period built into divorce proceedings⁷ – and divorce litigation itself may take some time even in the absence of legally mandated waiting periods. With this in mind, a high hazard rate of remarriage following divorce may only reflect on-the-marriage search to the extent that partners search for a new spouse after they have separated but before legal proceedings have been finalized. Figure 1 shows hazard rates of formal remarriage following either divorce or separation (precisely defined below). Note that the remarriage hazard rate is rising steeply in the initial years following separation – when divorce proceedings are presumably still underway for some couples – and that the hazard rate following divorce starts out higher and either increases modestly or decreases in the initial years following the divorce.

Formal marriage is clearly subject to legal and logistical frictions. Moreover, the Beckerian conception of a household is not limited to legal marriages; long term cohabitations between romantic partners are very much within the scope of our interest. To measure transitions between households in a way that obviates measurement concerns associated with legal delays and includes informal living arrangements, we focus on the period between separation from one partner and cohabitation with another.

Figure 2 shows hazard rates of cohabitation following a separation in the NSFG (cohabitation dates are not reported in the SIPP). A separation is defined as the month in which the respondent stops living with the former partner, while a cohabitation begins in the month in which the respondent begins living in the same household as the person who eventually becomes the next marriage partner.⁸ The framing of the survey question ensures that (a) the respondent is moving on to a new partner rather than returning to the old one; and (b) the new relationship is a long term, serious partnership, rather than a transitional living arrangement.⁹ The hazard rate of cohabitation following a separation is high in the two to three years following a separation, and steeply declining afterwards.

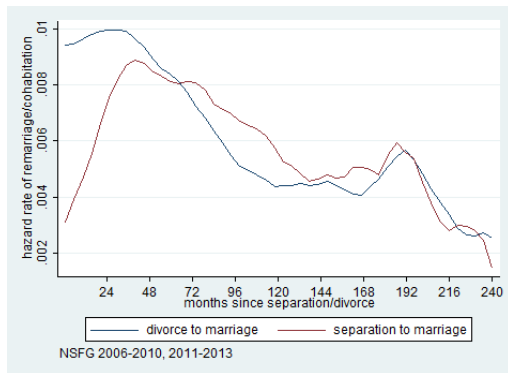
Strikingly, over 5% of respondents (of either gender) report fewer than six months between separating with one long term partner and initiating cohabitation with the next. Given potential welfare consequences, this suggests a role for on-the-marriage search in life-cycle models of marriage with limited commitment.

⁷<https://secure.ssa.gov/poms.nsf/lnx/0200305165>

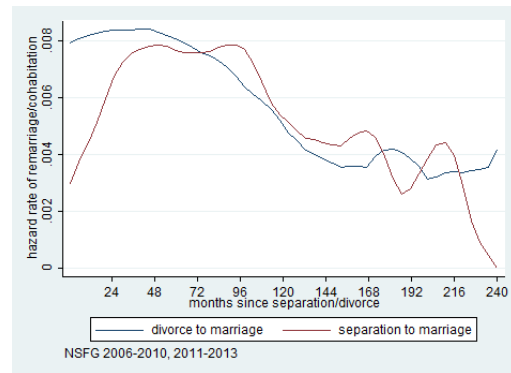
⁸There are missing data for men in both the remarriage and cohabitation variables. Thus, a portion of cohabitation dates are imputed. See Appendix A for details.

⁹Cohabitations that do not result in marriage are not recorded. This could include temporary cohabitations from which the separator moves on, and permanent cohabitations wherein the new partners never formally remarry. If anything, this restriction implies that our estimates will understate the actual degree of relationship-to-relationship transitioning in the data.

Figure 1: Formal remarriage hazard rates, by months since separation/divorce, for women and men



(a) Women: raw



(b) Men: raw

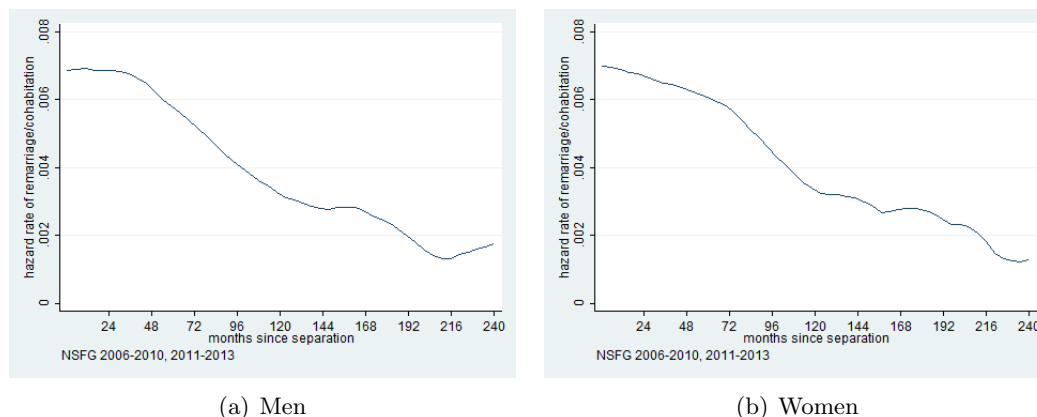


(c) Women: smooth



(d) Men: smooth

Figure 2: Hazard rates of cohabitation with next marriage partner, by months since separation, for women and men (missing cohabitation dates imputed – see appendix A for details)



Direct evidence of on-the-marriage search

This paper argues that on-the-marriage search can explain the remarkably high – and remarkably quick – remarriage and cohabitation patterns among divorcees. This mechanism has empirical backing. The National Survey of Families and Households (NSFH) and the General Social Survey (GSS) contain pertinent information in support of this mechanism discussed below. Literatures in sociology and anthropology associate infidelity with marital dissolution, and a literature in social psychology investigates the practice of ‘mate-poaching’, which we consider to be an alternative framing of on-the-marriage search.

Wave 3 of the NSFH reports that 8% of separated or divorced women and 16% of men admit to having been romantically involved with another party immediately prior to the dissolution of the marriage. Correspondingly, 47% of women and 41% of men report that the former spouse was extramaritally involved. Respondents are likely hesitant to admit their own infidelity, and particularly zealous in accusing the estranged spouse, so neither set of numbers can be taken at face value. South and Lloyd (1995) argue that these represent plausible upper and lower bounds on romantic infidelity associated with divorce, using wave 1 of the survey (which reports rates of similar magnitude). There is a negative correlation between reporting one’s own infidelity and reporting that of the spouse.

The GSS (pooled 1972-2010 samples) reports whether sexual infidelity has ever been committed against the spouse. Among ever married respondents, 14% of women and 20% report committing infidelity against their spouse at some point during the marriage.¹⁰

¹⁰97% of all eligible respondents answer the question. The numbers are comparable to the study of Mark et al. (2011), who find 19% of women and 23% of men to have cheated.

Of those currently married, 10% of women and 18% of men report infidelity, while among divorced or separated individuals, 26% of women and 41% of men admit to it. Although the selection bias in the latter group is evident, it suggests infidelity as a leading cause of divorce and further demonstrates its prevalence.

These data sources demonstrate the prevalence of extramarital affairs, particularly those leading to marital dissolution. They provide evidence in support of an established literature relating infidelity to divorce: Betzig (1989) identifies infidelity (alternatively, adultery) as the primary cause of divorce in 150 cultures, including the United States, and a review by Kitson et al. (1985) on research investigating the cause of American divorces finds that nearly every study reviewed reports extramarital affairs as a leading cause of divorce.

Infidelity – even to the extent that it leads to divorce – it is not identical to on-the-marriage search. The former may be purely recreational, reflecting capricious sexual behaviour rather than a deliberate search for a new long term partner. The literature in social psychology on ‘mate-poaching’ provides more direct evidence for on-the-marriage search. Schmitt et al. (2004) reports that 63% of North American men and 52% of women have “attempted to poach [a partner] for long-term mating” who was “already in a relationship” (p 567). Of these, 77% of men and 80% of women report success. Likewise, 72% of men and 75% of women report having been the object of a poaching attempt, with respective success rates of 52% and 48%. Although the sample size is large (greater than 4000), the respondents are mainly undergraduate students. These numbers should be taken as suggestive, rather than representative of the US population (as are the data sources on infidelity mentioned above). Foster et al. (2014), Davies et al. (2007), and Schmitt and Buss (2001) report broadly similar findings, without the emphasis on long term partnerships.

Remarriage and infidelity are quantitatively major and indispensable to a complete picture of the marriage institution as a whole. Common intuition, direct evidence, and a broad collection of research points to on-the-marriage search as the crucial mechanism connecting these phenomena. The following section develops a model of on-the-marriage search in a non-cooperative life cycle model of marriage.

3 Model

The model introduces on-the-marriage search to the framework of Mazzocco et al. (2014) and Voena (2012) with stochastic aging and an endogenous fertility decision. The goal of the model is to capture patterns of divorce and remarriage behaviour observed in US data and to study the implications of this behavior for adult welfare and for expenditures on children.

Setting

Time is discrete and agents live for a known number of life cycle stages T through which they age stochastically. Agents supply labor inelastically and are subject to stochastic

income shocks. Single women and couples can choose their fertility. Single and married agents also choose the intensity of which to search on the marriage market. Upon meeting agents decide optimally whether to marry or not. Marriage allows individuals to pool income risk and so acts as insurance. Married agents behave noncooperatively and are unable to permanently commit not to search, and not to leave the marriage. Income is transferable within the household subject to an imperfect transfer technology. Due to this technology and the fact that utility functions are concave, utility is imperfectly transferable.

Participation in the marriage market requires a positive level of search intensity. In general, the cost of search effort can be expressed in consumption or utility terms, depending on the form of the utility function. We treat search as being costless in terms of consumption but generating a gender-specific utility cost (or benefit) ψ_g , which is further described below.

Agents

Characterize agents by vector x , which consists of gender $g \in \{m, f\}$, age group, marital status, marriage quality ξ , number of children γ , the marriage contract Λ (explained below), and income k . Individuals age stochastically, transitioning between seven age categories – five working and two retirement age categories – and for computational tractability couples always age together. Income is subject to i.i.d. stochastic shocks, while marriage quality is subject to autocorrelated shocks (that also depend on search behaviour, as explained below). Measures M of men and F of women inelastically supply one unit of labor each period and receive income, which they spend on consumption c . They also expend search intensity s at zero consumption cost but constant utility cost ψ^g , $g = m, f$.

Per-period utility is logarithmic in consumption. Concavity yields risk aversion which is necessary for marriage to provide insurance value. In addition to risk pooling, marriage provides economies of scale in utility. The equivalence scale multiplies the consumption of married agents and decreases as the marriage contract becomes more unequal as in Voena (2012). While married, partners also share the costs of children.

Single agents spend income on consumption, on their children, and optimally choose search intensity in the marriage market. Married agents face a two-stage optimization process. First the income of both partners is pooled, the costs of current children are deducted, and the remainder is allocated across partners by the household planner. This is a joint utility maximization with Pareto weight λ given to the man and $1 - \lambda$ given to the woman. Normalize the weight on the man's utility as $\Lambda = \frac{\lambda}{1-\lambda}$. Each partner receives a share of pooled income (minus childcare costs $C(\gamma)$) which is spent on individual consumption – so that $c_t^f + c_t^m = k_t^f + k_t^m - C(\gamma)$ – and proceeds to maximize the individual value function in the second step by choosing search intensity.

This two-step process is a departure from the previous literature on dynamic life cycle modeling of households with imperfect commitment, wherein the household planner solves the household allocation completely with no second individual stage. Two stages are necessary in the present setting because an increase in search intensity necessarily

benefits one partner at the other's expense; the household planner would spend nothing on search intensity if it chose the complete allocation in a full commitment environment, and although this prediction no longer holds exactly in a limited commitment environment, the household planner is unlikely to choose a sufficient level of search to match the levels of infidelity observed in the data. As well, we believe it is intuitive to treat extra-marital search as fundamentally non-cooperative.

Timing

At the beginning of period t married agents receive an innovation to their current match quality match quality ξ . Single and married agents then match to a potential partner of the same age category and comparability $\hat{\xi}$, income \hat{k} and children $\hat{\gamma}$ or fail to match with a certain probability depending on last period's search intensity. A matched agent observes income from the previous period k_{t-1}^i for herself, k_{t-1}^{-i} for her partner (if the partner exists), and k_{t-1}^j for her new potential match, and forms expectations over current income k_t^i , k_t^{-i} , and k_t^j that inform her marriage decision.

After marital status is decided, agents realize the stochastic income shock.¹¹ They then choose whether or not to have a new baby (increasing γ) and pay the upkeep costs of their previous stock of children, plus the new child if applicable. Single agents spend the the remainder of income on consumption, while married agents receive their shares of household income in the first stage of the the two-stage household maximization process described above. Next agents choose search intensity s_t (for marrieds, this is the second part of the two-stage process), which determines the probability of matching in the following period $t + 1$. Finally utility is realized and agents proceed to period $t + 1$.

Search and Matching

In period $t - 1$ agents make a search decision that determines their likelihood of matching with a new potential partner in period t . Exerting search intensity entails a constant marginal cost of ψ^g units of utility, $g \in \{m, f\}$. For married agents, search intensity also affects the distribution from which next period marriage quality ξ is drawn, as described in more detail below. Agents match randomly to another agent in the same age group. In a given period an agent may or may not find a match. A woman f who matches to a man m in period t proposes to him if she improves her expected lifetime utility by marrying him, given her current situation. If this marriage also increases expected lifetime utility for man m , the couple weds. Note that f and m may each have an

¹¹The marital decision occurs before the stochastic income shock so that there is an insurance value to marriage; since partners' shocks are uncorrelated marriage allows agents to pool risk. Consider a married couple in period T . If agents know their income with certainty, neither will accept a marriage contract that gives an allowance less than their own income. Both spouses consume their own income and there is no insurance value to marriage. Anticipating this, a married agent in period $T - 1$ will not accept a contract yielding personal allowance less than own income since there is no possibility of future risk pooling to compensate for sacrifice in consumption. By backward iteration it is clear that there is no insurance value to marriage in such a formulation. With the marriage contract negotiated before the realization of income shocks, there is insurance value to marriage in any period, including period T .

existing spouse, or may be single. The decision to leave one's current spouse for a new partner is explained in more detail in the following subsection.

In a given period an agent who has invested in search activity s at the end of the previous period meets a new potential mate with probability $\phi(ms)s$ where $\phi < .5$ and ϕ can differ by marital status. For marrieds, we assume only one partner at a time meets a potential new spouse even in the case where both spouses search simultaneously; however, a spouse's likelihood of meeting a new spouse does not depend on the current partner's search intensity. If woman f who has invested in search finds a match, the probability that she matches to a man of type x^m is proportional to the fraction of men of that type in the population in the same age group who search. The man's type x^m is comprised of his age category, income, and marital and family status. Woman f cares only about his income, and his willingness to propose to her (the latter of which depends on his wife's income, the number of children he has, and the quality of his current marriage if he is married). Woman f is an acceptable spouse to some set of men $x \in \mathcal{J}$: that is, men in this set will leave their current situation and marry her. Call such men viable matches for woman f . The probability of meeting a viable match is $\rho(s, x, ms) \equiv \phi(ms)sPr[x^m \in \mathcal{J}|x^f]$ where s again is the search activity in the previous period. This probability is endogenously determined in equilibrium.¹²

Renegotiation

Marriage is a mutually voluntary union from which either partner can divorce unilaterally. Since surplus from marriage is divided according to the marriage contract Λ , agent i may prefer to divorce given this contract but prefer to stay married given a contract $\Lambda' \neq \Lambda$. If partner i prefers to become single or to leave the current marriage for another one, this prompts a renegotiation of the marriage contract. In this case, partner i 's incentive compatibility constraint is violated and i makes a credible threat to leave the marriage. The household planner increases the Pareto weight of the reluctant partner i to the point that this partner is indifferent between remaining in the current marriage and taking the outside option.¹³ The new contract is given by Λ' .¹⁴ Now if the other

¹²In principle, the likelihood of matching by an individual of a given gender should depend on the total shares of men and women who are searching in a period. For instance, if men search harder or more often than women, then women should have a higher likelihood of matching, as is commonly assumed in the labor matching literature, e.g. Pissarides (2000). In practice, this makes the estimation of marriage market equilibrium quite difficult. Since in equilibrium almost all singles and relatively few marrieds search, we simplify the analysis by assuming that equal numbers of men and women search. Differences in the likelihood of matching still depend on individual characteristics but not on aggregate differences in behavior by gender.

¹³Ligon, Thomas, and Worrall (2002) show that efficient renegotiation requires changing the Pareto weights as little as possible. Intuitively, risk averse agents prefer smaller variation in consumption over time.

¹⁴If it is the man's incentive compatibility that is violated, $\Lambda' > \Lambda$, and vice versa. Note that it is possible that such a contract does not exist. Consider a man m whose relative Pareto weight is arbitrarily large, meaning the household planner allocates to him all of his own and his wife's earned income, $k^m + k^f - C(\gamma)$. This man will leave the current marriage for one that allocates him consumption $c^m > k^m + k^f - C(\gamma)$. In a case such as this there is no contract that will satisfy the reluctant partner,

partner $-i$ still prefers the current marriage under the renegotiated contract Λ' to their own outside option, the marriage contract is successfully renegotiated to Λ' . Otherwise, no contract can satisfy both partners simultaneously and the couple divorces, each taking their best outside option.

Renegotiation requires the preferred outside option to be viable. Consider two couples A and B with marriage contracts Λ_A and Λ_B to which all partners prefer the current marriage to singlehood. In period t woman f^A and man m^B match, and prefer to marry each other rather than to stay in their current partnerships at the current contracts. Their match prompts a renegotiation in both marriages, so that either is indifferent between entering the new marriage and remaining in their current marriage under the new contracts $\Lambda'_A < \Lambda_A$ and $\Lambda'_B > \Lambda_B$ respectively. Four cases are now possible:

- if neither unmatched spouse m^A and f^B finds the new contract acceptable then both current marriages dissolve and the new marriage between f^A and m^B is formed;
- if m^A finds renegotiated contract Λ'_A acceptable but f^B finds contract Λ'_B unacceptable, marriage A is renegotiated successfully to Λ'_A and the tentative match between f^A and m^B disappears; therefore m^B cannot credibly threaten to leave marriage B , so the original contract Λ_B stands and the marriage continues as before;
- if f^B finds the renegotiated contract acceptable but Λ^A does not, the outcome is analogous to the previous;
- if unmatched spouses m^A and f^B each find the new contracts acceptable then both marriages are tentatively renegotiated; this implies that the new union between f^A and m^B is not viable, meaning neither can make a credible threat to leave, and both existing marriages continue at their original contracts Λ_A and Λ_B .

From the perspective of any individual i , a match with new potential partner j is only significant if j cannot successfully renegotiate his current marriage. Denote such a match j as a viable match.

3.1 Fertility

Single women and married couples can opt have children at any point in the life cycle. Having a child yields an immediate utility benefit given by B_c . Households with integer number γ of children bare costs of $C(\gamma)$, the functional forms of which are introduced in section 5. Once a mother gives birth to a child, she bears the cost of that child each period for the remainder of her life. While married, couples share the cost of the children, both their own and any children from the mother's previous marriages. If the father leaves, either to become single or to join a new woman in marriage, he no longer pays any of the direct costs to the children; however, as part of the divorce settlement, he

who initiates divorce.

leaves a part of his earning potential to the mother to cover his share of the continuing costs, as described in section 5. Women can have up to two children either with the same or with different men, or alone; men are not limited in how many children they can father except by their partners' completed fertility.

Value Functions

Consider a single individual i of gender g in period $t < T$ with current income k_t^i , which has just been realized and children γ_t^i . The income shock is realized after matching happens, so agent i 's marital status in period t is given; i does not get a chance to match to a potential partner j until period $t + 1$. Having already rejected any previous spouse or potential partner met in the current period, or having failed to meet a willing partner, i optimizes subject to the budget constraint $c_t^i = k_t^i$. Recall that x_t^i denotes the vector of characteristics of agent i in period t . Time preference is given by β . Let $V^{g,0}(x_t^i)$ denote the value of being single and $V^{g,1}(x_t^i, x_t^j, \xi_t, \Lambda_t)$ the value of being married to a partner with characteristics x_t^j , with additional state variables ξ_t (current marriage quality) and Λ_t (the current marriage contract). γ is treated as an individual-level variable of the wife.

The value for a single agent i is given by

$$\begin{aligned} V^{g,0}(x_t^i) = & \max_{c_t^i, s_t^i, \gamma_t^i \in \{\gamma_{t-1}^i, \bar{\gamma}\}} u(c_t^i) + \psi^i s_t^i + B_c \times (\gamma_t^i - \gamma_{t-1}^i) \\ & + \beta \rho(s_t^i, x_t^i) \mathbb{E}[V^g(x_{t+1}^i, \hat{x}_{t+1}^j, \hat{\xi}_{t+1}, \bar{\Lambda})] \\ & + \beta(1 - \rho(s_t^i, x_t^i)) \mathbb{E}[V^{g,0}(x_{t+1}^i)] \\ \text{s.t. } & c_t^i \leq k_t^i - C(\gamma_t^i) \end{aligned} \quad (1)$$

where $\bar{\gamma}$ is zero for men and two for women. $V^g(x^i, x^j, \xi_t, \Lambda_t) = \max\{V^{g,1}(x^f, x^m, \xi_t, \Lambda_t), V^{g,0}(x^f)\}$, indicating that upon being matched to a viable partner, individual i chooses the maximum of the value of marrying and the value of remaining single. With probability $1 - \rho(s_t^i, x_t^i)$, i does not meet a willing partner in the next period. In this case i expects to receive the value of being single with beliefs over next period's income k_{t+1}^i informed by current income k_t^i and a known distribution of shocks. With probability $\rho(s_t^i, x_t^i)$, i meets a viable partner next period and decides between marrying and staying single. The expected value of the former depends on expectations over both i 's incomes next period and those of potential spouse j . The marriage contract of a newly wed couple is fixed at $\hat{\Lambda} = 1$ – a partnership with equal Pareto weights on either partner.

Now consider an agent i married to spouse j , after marital decisions have been made and income shocks have been realized. These partners have decided at the beginning of period t to be together, either staying in an existing marriage (after realizing ξ_t^i and having the chance to encounter new partners) or having just wed. When that decision was made – before income shocks were realized – it must have been optimal for both partners to choose the marriage rather than the best outside option, based on the realization of ξ_t and expectations over k_t^i, k_t^j informed by last period's incomes. At the end of the period t , period t incomes have been realized, one partner may receive

a consumption level lower than the value of own income post-divorce, which would be the level consumed while single. The future insurance value of marriage may partially or fully compensate that partner for the low consumption value. In the former case, this partner would prefer to be single, but the specification of timing means that agents cannot renegotiate or divorce until period $t + 1$. This means that both of the following incentive compatibility constraints must hold at the beginning of period $t + 1$:

$$IC_{t+1}^m : \mathbb{E}[V^{m,1}(x_{t+1}^m, x_{t+1}^f, \xi_{t+1}, \Lambda_t)] \geq \mathbb{E}[V^{m,outside}(x_{t+1}^m)] \quad (2)$$

$$IC_{t+1}^f : \mathbb{E}[V^{f,1}(x_{t+1}^f, x_{t+1}^m, \xi_{t+1}, \Lambda_{t+1})] \geq \mathbb{E}[V^{f,outside}(x_{t+1}^f)] \quad (3)$$

where expectations are taken over individual incomes k and $V^{g,outside}$ is the best available outside option to spouse g depending on whether she has met a viable new mate (someone who will marry her at $\Lambda = a1$) or not, in which case $V^{g,outside} = V^{g,0}$. Violation of either incentive compatibility constraint prompts renegotiation as described above.

Household Optimization

Joint household optimization is a multi-stage process. In the collective optimization stage the household planner maximizes a Pareto-weighted sum of both partners' value functions by allocating the total pooled income between the two of them and choosing fertility (0 or 1 new babies) in the period. Then in the individual optimization stage each partner consumes the value of personally allocated income, and chooses search intensity so as to maximize the individual value function. Since the preference structure each individual is known to the household planner – and the contract is known to both partners – the problem can be solved by backward iteration, with the household planner anticipating each spouse's individual optimization after receiving personal consumption c_t^i .

The household planner's problem is as follows:

$$\begin{aligned} \max_{c_t^f, c_t^m, \gamma_t^f \in \{\gamma_{t-1}^f, \bar{\gamma}\}} & V^{f,1}(x_t^f, x_t^m, \xi_t, \Lambda_t) + \Lambda_t V^{f,1}(x_t^m, x_t^f, \xi_t, \Lambda_t) \\ \text{s.t.} & c_t^f + c_t^m = k_t^f + k_t^m - C(\gamma_t) \end{aligned} \quad (4)$$

where individual value functions are given by (for spouse i with partner j):

$$\begin{aligned} V^{i,1}(x_t^i, x_t^j, \xi_t, \Lambda_t) = & \max_{s_t^i} u(\nu(\xi_t, \Lambda_t)c^{i*}) + \psi^i s_t^i + B_c \times (\gamma_t^f - \gamma_{t-1}^f) \\ & + \beta(1 - \rho^i)(1 - \rho^j)\mathbb{E}[V^i(x_{t+1}^i, x_{t+1}^j, \xi_{t+1}, \Lambda_{t+1})] \\ & + \beta\rho^i(1 - \rho^j)\mathbb{E}[\max\{V^i(x_{t+1}^i, x_{t+1}^j, \xi_{t+1}, \Lambda_{t+1}), V^{i,1}(x_{t+1}^i, \hat{x}_{t+1}^j, \hat{\xi}, \bar{\Lambda})\}] \\ & + \beta(1 - \rho^i)\rho^j\mathbb{E}[V^i(x_{t+1}^i, x_{t+1}^j, \xi_{t+1}, \Lambda_{t+1})] \\ & + \beta\rho^i\rho^j\frac{1}{2}\mathbb{E}\left[\max\{V^i(x_{t+1}^i, x_{t+1}^j, \xi_{t+1}, \Lambda_{t+1}), V^i(x_{t+1}^i, \hat{x}_{t+1}^j, \hat{\xi}_{t+1}, \bar{\Lambda})\} \right. \\ & \left. + V^{i,1}(x_{t+1}^i, x_{t+1}^j, \xi_{t+1}, \Lambda_{t+1})\right] \end{aligned} \quad (5)$$

where $\nu(\cdot)$ gives economies of scale for marriage.¹⁵ Expected value for the subsequent period $t + 1$ is determined as follows. If neither partner matches then next period each can expect a value $V^i(\cdot)$, which is the maximum payoff of either staying current marriage following realizations of the partners' incomes, or singlehood. Shocks realized this period may also prompt a renegotiation next period, so $\Lambda_t \neq \Lambda_{t+1}$ in general. If i matches and the partner j does not, i receives the maximum of $V^i(\cdot)$ and the value of the marriage formed by accepting the match.¹⁶ If the partner j matches but i does not, then i chooses between remaining in the current marriage with a renegotiated contract Λ' and becoming single, where Λ' is either (1) the current contract, if the partner's incentive compatibility holds even after meeting a potential new spouse (one willing to wed her at $\bar{\Lambda}$); or (2) if the partner's incentive compatibility is violated upon meeting the match, the contract that makes the partner indifferent between staying in the current marriage and accepting the new match.

To make computation of the model feasible we assume that two married partners cannot match simultaneously, though the probability of matching does not depend on the spouse's search behavior (which is feasible so long as individual match probabilities are less than 50%).

Note that as the length of a time period becomes short the probability of spouses matching simultaneously approaches zero; since matching probabilities are small, this assumption is not generally restrictive.

Equilibrium

An equilibrium consists of optimal marriage decisions defined over the set of partner types; optimal renegotiation rules defined over partner types, contracts, and relationship qualities; and optimal search decisions given partner types, marriage characteristics, the distribution of searchers, and marriage and renegotiation rules. Because incomes are exogenously given and there is no saving, equilibrium simply means that the choices to search and to accept or reject matched partners given the matching probabilities returns these same match probabilities. We accomplish this by looping over the household problem and resulting economy multiple times for each set of parameters until the match probabilities generated by individual search choices converge to a fixed point. Because of search externalities, there may be multiple search equilibria. Specifically, in our context couples play a non-cooperative game over searching each period which may have multiple or no pure-strategy equilibria (we rule out mixed strategies computationally). To resolve the issue, we assume that when multiple equilibria in a couple's game arise (or no solution arises), they both search. Intuitively, this is like assuming that once a couple has committed to search he experiences the utility payoff from his activity and cannot "unsearch". In practice, the effect of search externalizes on search behavior is

¹⁵The function $\nu(\Lambda)$ is maximized for $\Lambda = 1$ and is globally concave. This equivalence scale is explained further in Section 5.

¹⁶In the event that the current marriage is renegotiated successfully, partner i will remain in the current marriage under a new contract that yields the same value as that of accepting the match.

relatively small since we use a binary search decision and at least one partner typically has a dominant strategy to search.

4 Data

We estimate the model on the 2004 and 2008 cycles of the Survey of Income and Program Participation (SIPP) covering the years 2003-2013, and the remarriage data taken or imputed from the NSFG. The SIPP contains panel data on the income, demographic characteristics, and marital status of individuals over a period of up to five years, with corresponding data on the spouse (if present). All variables are reported at the monthly level and observations are collapsed into six-month intervals for the purpose of this study. We focus only on adult singles and couples of ages 18 to 65. The data contain 1,448,085 household-quarters with 156,194 individuals – many of whom share a household. Summary statistics are reported in Table 1.

A divorce takes place if the spouse disappears from the household and marital status changes, or if the identification code for the spouse changes. In the latter case the reference person has divorced and remarried within a single quarter. This counts as a remarriage. A remarriage also occurs if the reference person obtains a new spouse – with a new identification code – after some quarters of singlehood; so a reconciliation of a marriage following a separation is not counted as a remarriage. Note that by “marriage” we also include cohabitation.¹⁷

Although the model is estimated using the SIPP and NSFG data, we also use the 1980-2011 waves of the PSID to examine longer run trends in remarriage since we can observe individuals after their divorces over a much longer time-frame. We use the PSID, however, only for out-of-sample predictions and not to estimate the model. Since the PSID corresponds to a more distant time period (the average year of the sample being 1994), these comparisons should be taken as suggestive, especially given the continuing increase in the incidence of cohabitation compared to marriage since the 1980s among U.S. households (Stevenson and Wolfers (2007)).

5 Estimation Assumptions and Parameterization

The nature of the model economy is as follows. Unique individuals are born into the economy at in the youngest age category, corresponding to age 18. They work until they reach the sixth age category, approximately around age 65. At birth they are single, and are randomly assigned gender and starting earning ability so as to match the mean and standard deviation of the distributions of young earners found in the SIPP. They proceed to choose search intensity, and which partner to marry. Once married, individuals continue to search for new potential partners, making search decisions that affect the likelihood of making a match next period. After retirement agents receive

¹⁷Following a divorce the SIPP continues to track the reference person, but the spouse disappears. This occludes comparison of remarriage rates of spouses following a divorce.

Table 1: Summary Statistics, SIPP 2004, 2008 cycles.

	Variable	women			men		
		Obs.	Mean	Std. Dev.	Obs .	Mean	Std. Dev.
All	quarterly income	996891	5285	7321	939526	9663	12261
	marital status	998883	.515	.500	941549	.547	.497
	children present	998883		.552	.497	.471	.499
	divorces observed	7281	-	-	6308	-	-
Married	quarterly income	514875	6232	7940	514934	12545	14044
	marital status	513195	1	0	513587	1	0
	divorces observed	7281	-	-	6308	-	-
Single	quarterly income	484008	5449	6578	426615	6188	8467
	marital status	583696	0	0	425939	0	0
	weddings observed	9962	-	-	9672	-	-

a fixed share of their previous income, living until they have aged out of the seventh and last age category, which in our simulated economy always occurs before age 130. A model period is six months.

In the simulation, the household of each reference individual is fully characterized in period t by:

- age category $t \in \{1, \dots, 7\}$,
- income $k_t \in \{k^1, k^2, \dots, k^K\}$,
- partner's income $k'_t \in \{k^1, k^2, \dots, k^K\}$,
- search intensity $s_{t-1} \in \{0, 1\}$,
- partner's search intensity $s'_{t-1} \in \{0, 1\}$,
- marriage quality ξ
- and the marriage contract $\Lambda_t \in \{0, \Lambda^1, \Lambda^2, \dots, \Lambda^N\}$ (with $\lambda^1 > 0$ and $\lambda^N < 1$).

We make the standard assumption that individuals marry only in their own age group, and then the couple shares the same realization of stochastic aging shocks. This assumption is necessary to solve the model recursively but allows for the possibility that partners have different ages measured in years. Grid sizes are set as $K = 12$ and $N = 11$, with $k^1 = \$6000$ and increasing by a factor of 1.25 to $\$87,000$ (biannual net income) $\Lambda \in \{.25, .30, \dots, .70, .75\}$.

Numerical estimation requires specifying functional forms for utility and matching functions and for the evolution of income and match quality. They are described below.

Utility

Utility functions take the same form across genders and are logarithmic in consumption (so that the utility weighting and consumption shares are the same) with separable disutility in search intensity. Utility of a single individual of gender g is then given by:

$$u^g(c, s, \gamma_{new}) = \ln(c) + \psi^g s + B_c \gamma_{new} \quad (6)$$

where ψ^g , which can be greater or less than zero, is the marginal utility to search effort and γ_{new} is a new child, added to the stock of previous children. The benefits or costs of search effort is in utility rather than pecuniary terms, as in Pissarides (2000).

In order to capture complementarity in income types we introduce an equivalence scale following Voena (2012) which acts as a multiplier on utility for married households. In a given period a married individual of gender g receives utility according to:

$$u^g(c, \Lambda, \xi) = \ln[c\nu(\Lambda, \xi)] + \psi^g s + \kappa(\xi) + B_c \gamma_{new}$$

$$\nu(\Lambda, \xi) = \nu_0(\xi) [\lambda^{\nu_1} + (1 - \lambda)^{\nu_1}]^{\frac{1}{\nu_1}}$$

where $\nu_0(\xi) \in \mathbb{R}^+$ and $\nu_1 \in [-\infty, 1]$ and $\frac{\partial \nu_0}{\partial \xi} > 0$.

The bracketed component describes inequality preferences. When $\nu_1 = 1$, spouses have no aversion to inequality and the expression is equal to one. As ν_1 approaches $-\infty$ the expression converges to the minimum of $\{\lambda_t, 1 - \lambda_t\}$ ¹⁸, giving each partner an extreme aversion to an unequal contract. The parameter $\nu_0(\xi)$ normalizes the inequality multiplier compared to the utility function for singles and depends on marriage quality. When marriage quality is high, couples are better able to convert their individual incomes into household output. ξ also generates a non-pecuniary return to marriage κ which is independent of consumption.

Matching

Define the probability of finding a viable match of type x^j as $\varrho(s, x^i, x^j, ms)$ for an individual characterized by x^i with marital status ms . As previously described, this probability necessarily depends on i 's type, since j must endogenously choose to marry i . We assume that the search decision is binary, that is, $s \in \{0, 1\}$. Conditional on meeting a viable partner, the probability that this person is of type x^j is simply proportional to that type's frequency in the population. The probability of meeting a viable match of type x^j is then given by $\varrho(s, x^i, x^j, ms) = I(s = 1)\rho(s, x^i, ms)g(x^j)$, where $I(\cdot)$ is the indicator function and $g(\cdot) = \{m(\cdot), f(\cdot)\}$ is the probability density function of men's or women's types.

In general, we assume that singles and married searchers may match at different rates since being married may reduce the return to search effectiveness. Thus, $\rho(s, x^i, 0) \neq \rho(s, x^i, 1)$ for $ms = 0$ and $ms = 1$. Specifically, we let there be a "marriage penalty" in search effectiveness $\hat{\phi}$ such that $\rho(s, x^i, 1) = \hat{\phi}\rho(s, x^i, 0)$

¹⁸Recall that $\lambda = \frac{\Lambda}{\Lambda+1}$.

Fertility

We set the immediate utility benefit of having a new baby to

$$B_c = c_0 + c_1 \times age$$

while the cost of children is given by

$$C(\gamma) = \gamma \times (\zeta_0 + \zeta_1(k^f + k^m))$$

Although the benefit of having a new child accrues immediately, it can be thought of as the present value of a stream of utility benefits from children which do not depend on subsequent marital decisions or income realizations. Following divorce, single mothers bare all the direct costs of children (and $k^m = 0$ by assumption). However, when a couple with children divorces, the husband dedicates a 25% share of his income stream to the wife for each child, so that his earning ability falls from k^m to $k^m - \gamma$ while the wife's increases from k^f to $k^f + \gamma$. This is a computationally feasible way to introduce child support following divorce in a way that also allows us to capture men's preferences for their own biological children. That is, men prefer to match with women who have not already completed their fertility because only *new* children generate utility payoffs while children from the wife's previous marriage still generate financial responsibilities.

Income process

Incomes (which are net of taxes and child support) take one of the discrete values $k_t \in \{k^1, k^2, \dots, k^K\}$. Each period earning ability is updated according to the exogenous process:

$$\ln(k_{t+1}) = \ln(k_t) + \ln(\varepsilon_t)$$

where

$$\varepsilon \sim N(\mu, \sigma^2)$$

and

$$\mu = b_0 + b_1 age\ cat + b_2 age\ cat^2 + b_{man}.$$

The income process is identical across genders except for the constant trend b_{man} . Once individuals reach age category 6, they retire and cease to experience income shocks. They continue to receive 70% of their retirement-age income until death.

Marriage quality

Individuals make marriage and divorce decisions after observing the comparability their current partner, or any potential new partner, in the current period. Marriage quality evolves according to the following Markov process:

$$\begin{array}{rcc}
 & & t \\
 & & p_{stay}(\xi, s_f, s_m) \quad p_{plus}(s_f, s_m) \quad 0 \\
 t + 1 & p_{minus}(s_f, s_m) & p_{stay}(\xi, s_f, s_m) \quad p_{plus}(s_f, s_m) \\
 & 0 & p_{minus}(s_f, s_m) \quad p_{stay}(\xi, s_f, s_m)
 \end{array}$$

where p_{stay} gives the probability of staying at the same quality level, and p_{plus} and p_{minus} are defined analogously. These probabilities depend on the search behaviour of either partner. In particular, the probabilities are given by:

$$\begin{aligned} p_{plus}(s_f, s_m) &= .1 - \iota(s_f, s_m) \\ p_{minus}(s_f, s_m) &= .1 + \iota(s_f, s_m) \\ p_{stay}(\xi, s_f, s_m) &= 1.0 - p_{minus}(s_f, s_m) - p_{plus}(s_f, s_m) \end{aligned}$$

where $\iota(s_f, s_m) = e_f s_f + e_m s_m + e_b \times s_f \times s_m$. The e s capture the costs of infidelity to the current marriage to the wife searching, the husband searching, and the interaction effect of both searching at once. In general, we expect that OTMS by either partner will raise the likelihood that marriage quality falls in a subsequent period ($\frac{\partial \iota}{\partial s} > 0$) as suggested by, among others, Previti and Amato (2004); that is, that OTMS is a cause as well as a consequence of poor marriage quality.

To keep the model tractable, marriage quality ξ takes three values with $\xi = 1$ being the lowest quality marriage and $\xi = 3$ being the highest. Since ξ affects the couple's ability to convert their resources into consumption and provides additional "happiness" that is independent of consumption, we assume that $\nu_0(1) = \nu_0(2) - \delta_\xi$ and $\nu(3) = \nu_0(2) + \delta_\xi$ and that $\kappa(1) = \kappa(2) - \delta_\kappa$ and $\kappa(3) = \kappa(2) + \delta_\kappa$. $\nu_0(2)$, δ_ξ , $\kappa(2)$ and δ_κ are estimated as part of the model. The reason for allowing ξ to affect marriage payoffs in two ways is to capture the degree of income effect generated for couples by good quality marriages, which may be important for on-the-marriage search decisions. κ does not generate an income effect since it is a quasi-linear utility term.

6 Estimation

We estimate the model using indirect inference. Numerical simulation yields a distribution of marital status, fertility, and income, whose moments are compared to those of the SIPP. The parameters listed in Table 2 vary so as to minimize the sum of the squared percentage deviations between the moments generated by the model and those found in the data. The moments to match are:

- remarriage shares following divorce at six month intervals, up to three years (six moments),
- the marriage hazard rate for all single individuals,
- the divorce hazard rate,
- the share of households married,
- the share of husbands/wives who search (two moments),
- the share of divorces following infidelity,

- the shares of women who have had children before age 25, 30, 35 and 40 (4 moments)
- the shares of married and single female-headed households with children (2 moments)
- correlation between spouses' individual incomes
- correlation between per-capita adult household income and fertility
- mean and standard deviation of private incomes (net of child support) by men/women under/over 40 (eight moments),
- mean of private incomes (net of child support) by men/women by marital status (four moments), and

for a total of 32 moments. They identify the 21 parameters described in the previous section.

The correlation of incomes between partners demonstrates the effect of on-the-marriage search on positive assortative matching. Comparable theoretical frameworks are Mazzocco et al. (2014) and Burdett and Coles (2001). Correlation between a partner's income share and consumption share in the marriage will reveal the extent to which on-the-marriage search affects division of marriage surplus. The shares of husbands (23%) and wives (12%) who cheat, and the share of divorces due to infidelity are rough consensus estimates from sociology literature based on data from the General Social Survey and other smaller studies (Wiederman (1997)) and allow us to estimate the utility and marital quality returns from OTMS. The remarriage rates, calculated from NSFG, are also important for identifying the role of OTMS and the matching "technology" for single and married agents. Fertility moments allow us to identify the costs and benefits of children; conditional on the matching technology they also have important implications for divorce and remarriage. Finally, the mean and standard deviation of personal incomes at different ages provides a parsimonious basis for capturing the risk sharing of model agents to operate to a reasonable extent given real income distributions.

For each set of parameters, we run the model several times to achieve a marriage market equilibrium in which search and matching choices generate are consistent with, and re-generate, the distribution of searchers. After simulation of the model economy with one set of parameters yields a certain measure of distance from the moments, a new set of parameters is chosen according to the Nelder-Mead method. This process continues until the moments of the simulation are sufficiently close to those in the data (an average squared deviation of no more than 2% across the moments) or until the error will not fall any further. This yields a final set of parameters whose plausibility should speak to the validity of the model.

7 Results

In this section we explore the our model’s ability to predict remarriage rates and contrast it with a model without on-the-marriage-search (OTMS). We then examine its predictions with respect to a few stylized facts from the marriage literature in economics and sociology, and conclude by examining its implications for insurance – specifically whether or not consumption smoothing is greater in a model with or without OTMS – and for expenditures on children. Ex-ante, the answer to the question of whether OTMS reduces insurance is not obvious. Searching on the marriage implies a lack of commitment beyond the standard dynamic incomplete contracts model of divorce and, in our framework, is the outcome of a non-cooperative game played by spouses. On the other hand, OTMS can increase the option value of a marriage since spouses do not have to stop searching once partnered. As well, if the weaker spouse in a faltering relationship can engage in OTMS relatively costlessly, then he or she may be able to protect him or herself from a divorce shock.

7.1 Parameters and fit

Table 2 reports the parameter estimates from our benchmark model and table 3 reports some selected moments (the full table of fit is available upon request). At least to a first pass, the estimated are reasonable. Men have higher earning ability on average than women ($b_{man} > 0$), making them on average the stronger partner in marriage. This is reflected in an average value of the utility weight to the husband of .53 in the model. This weight is lower than the weight of around .55 to .60 typically found in the literature (e.g. Voena (2012), Knowles (2013)) which may reflect the fact that the model is estimated using quite recent data, and the position of the wife in marriage may continually be improving in response to changing gender norms (Knowles (2013)). The ability of higher-earning men to dominate in their marriages is limited by the fact that couples are relatively inequality-averse ($\nu_1 = .880$ where $\nu_1 = 1$ implies no inequality-aversion.) Marriage quality manifests mainly through the ability of couples to transform utility into income: the (negative) non-pecuniary gain to marriage is actually quite small, implying that increasing the quality of a marriages generates a positive income effect, which informs the results presented below. As expected, searching on the marriage increases the likelihood that marital quality declines, and the effect is reinforced if both spouses search at the same time. Finally, the direct utility benefit of search are positive for men, who derive a small net enjoyment from searching but are larger and negative for women who therefore do not enjoy search.¹⁹

Fertility yields very large direct benefits – given log utility, at the mean six month private net consumption of \$12000 for a woman without children, having a baby increases utility by the equivalent of \$1,560,000 of additional consumption for one period – and, in neither the model with our with OTMS, do these benefits vary with age. Costs of

¹⁹Since enjoyment of search is likely to be quite idiosyncratic, and these differences are likely to swamp gender effects, a more realistic distribution of costs would allow for gender-specific means and variances. Unfortunately this is not computationally feasible.

Table 2: Estimated parameters: Benchmark Model

Estimate	Parameter	Description
-.260	ψ^f	search cost/benefit for women
.106	ψ^m	search cost/benefit for men
.123	ϕ	arrival rate of matches for single searchers
.041	$\hat{\phi}\phi$	arrival rate of matches for married searchers
.149	e_f	cost to ξ of the wife searching
.083	e_m	cost to ξ of the husband searching
.029	e_b	interaction cost of both searching
.914	b_0	constant in income process
.0201	b_1	coef. on <i>age cat</i> in income process
-.000082	b_2	coef. on <i>age cat</i> ² in income process
0.104	b_{man}	male dummy in income process
.306	σ	standard deviation of income shock
$\gamma(561 + .083(k_f + k_m))$	$C(\gamma)$	per-period cost of children
$4.87 - .00126age\ cat$	BC	utility benefit of a new child
0.880	ν_1	aversion to unequal contracts (1 = no aversion)
1.13	$\nu_0(2)$	multiplier on utility for couples with $\xi = 1$
1.55	$\nu_0(2)$	multiplier on utility for couples with $\xi = 2$
1.98	$\nu_0(3)$	multiplier on utility for couples with $\xi = 3$
-.365	$\kappa(1)$	non-pecuniary gain to marriage for couples with $\xi = 1$
-.143	$\kappa(2)$	non-pecuniary gain to marriage for couples with $\xi = 2$
.085	$\kappa(3)$	non-pecuniary gain to marriage for couples with $\xi = 3$

children in the benchmark model with OTMS are, to a first pass, quite reasonable, increasing with at a rate of \$8 for every \$100 earned by the adults above a base of about \$600 semi-annually. This provides us some confidence in the expenditure calculations for children reported in the final section.

To gain some insight into the performance of our model and the contribution of OTMS, table 4 presents estimates from a “standard” limited commitment marriage model in which we shut down OTMS (and set the parameters governing the arrival rate of external matches for marrieds, and the effect of OTMS on ξ , to zero.) In general, the estimates of the two models are not extremely different. Two exceptions are the much lower estimated costs per child in the alternative model without OTMS, which in general are not very precisely estimated; and the much lower value of ν_1 (.67), producing strong complementary of consumption in marriage. The latter, along with large variance in κ and ν_0 by ξ is required to produce divorce in the model without OTMS, since otherwise couples can always renegotiate to a contract that improves both partners’ outcomes relative to being single.

Next, Figure 3 shows the differences between the two models that arise with respect to the remarriage rates. The top left panel shows remarriage hazards over three years (six model periods) plotted against the same remarriage hazards from the SIPP. The top right panel shows the cumulative remarriage hazard over 12 years plotted against the remarriage CDF from the PSID. The bottom panels show the twelve-year cumulative remarriage rates disaggregated by gender. Pooling across gender, it is obvious that the model without OTMS underpredicts the “intercept”: the share of individuals who

Table 3: Selected moments: Benchmark model with OTMS

Target Description	Target	Model
share of wives who cheat during a marriage	.12	.10
share of husbands who cheat during a marriage	.23	.19
share of divorces following infidelity	.32	.26
unconditional 6-month marriage rate	.0214	.0198
cross sectional share of married agents	.542	.594
unconditional six-month divorce rate	.0132	.0125
correlation of spouse incomes	.125	.089
first birth by 25	.45	.40
first birth by 35	.80	.76
marriages with children	.65	.58
single women with children	.35	.39
correlation of lag k and births	-.031	-.002

are unmarried for one quarter or less before re-paring. The model without OTMS understates the share of early remarriages within six months by approximately eight percentage points or 50%. Remarriage rates then gradually catch up: ten years post-separation, the model without OTMS overshoots the share of remarried individuals by about 15 percentage points (30%).

Disaggregating by gender in the bottom part of the figure, we see that the benchmark model with OTMS is able to capture fairly well the faster remarriage rates of men compared to women (keeping in mind that this is not targeted in the simulation.) The overshooting of remarriage rates at long durations in the model without OTMS is concentrated among women:²⁰ This is mainly due to the fertility process: married and divorced women are more likely than never-married women to have children in the household. Men are less willing to marry women who previously have children by other men, both because it limits their own fertility and because the new wife’s children impose costs (quite mitigated in the model without OTMS). The fact that women with children have a harder time remarrying than men or women without children is well-documented (e.g. Becker et al. (1977)). In the model, the share of women who are remarried after three years the average time to remarriage is 3.4 years compared to 4.2 for women without children.²¹

Finally, OTMS has implications for sorting over the life cycle. Figure 4 plots the

²⁰Even using the individual weights, the gender difference in remarriage is somewhat exaggerated in the PSID due to the fact that single women who do not remarry are more likely to be heads of households than single men, and therefore to be present in the “heads and wives” sample. In the weighted SIPP sample, after three years, 39.1% of newly separated women have remarried compared to 42.6% of men.

²¹The difference also arises because men search more on the marriage than women. In the model, however, child support costs deter men with children from divorcing and the costs of children yield negative income effects that deter search. Married men without children actually search twice as much on the marriage as men with children.

Table 4: Estimated parameters: Model without OTMS

Estimate	Parameter	Description
-.232	ψ^f	search cost/benefit for women
.085	ψ^m	search cost/benefit for men
.246	ϕ	arrival rate of matches for single searchers
n/a	$\hat{\phi}\phi$	arrival rate of matches for married searchers
n/a	e_f	cost to ξ of the wife searching
n/a	e_m	cost to ξ of the husband searching
n/a	e_b	interaction cost of both searching
.980	b_0	constant in income process
.0104	b_1	coef. on <i>age cat</i> in income process
-.000077	b_2	coef. on <i>age cat</i> ² in income process
0.065	b_{man}	male dummy in income process
.332	σ	standard deviation of income shock
$\gamma(22.8 + .0671(k_f + k_m))$	$C(\gamma)$	per-period cost of children
$4.49 - .00916age\ cat$	BC	utility benefit of a new child
0.673	ν_1	aversion to unequal contracts (1 = no aversion)
1.73	$\nu_0(2)$	multiplier on utility for couples with $\xi = 1$
2.30	$\nu_0(2)$	multiplier on utility for couples with $\xi = 2$
2.87	$\nu_0(3)$	multiplier on utility for couples with $\xi = 3$
-.471	$\kappa(1)$	non-pecuniary gain to marriage for couples with $\xi = 1$
-.290	$\kappa(2)$	non-pecuniary gain to marriage for couples with $\xi = 2$
-.110	$\kappa(3)$	non-pecuniary gain to marriage for couples with $\xi = 3$

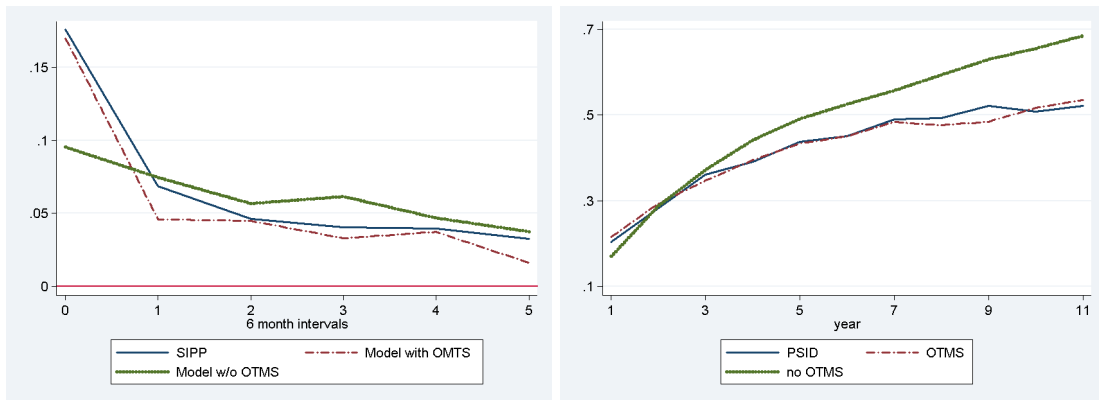
average correlation of spousal private incomes by age of the husband.²² The estimated correlation is modestly too low in both models. In the model with OTMS, however, the correlation of spousal incomes increases over the life cycle since couples can pair up early and then eventually leave to settle with a more suitable spouse in terms of income (allowing for an efficient egalitarian marriage contract to be supported). Searching on the marriage should therefore leads to more assortative mating over time, consistent with the modest trend observed in the data. This is less obviously true in a model without OTMS since young spouses may prefer to remain single until they meet a partner with the same earning potential. Sorting over the life cycle is likely to lead to greater (unobservable) compatibility over time but not necessarily greater matching on incomes. Figure 4 bears out this conjecture.

7.2 “Cheating”, marriage quality and income

In the context of our model, “cheating” or “infidelity” constitutes successful OTMS – that is, OTMS that results in a pairing with another individual, which in turn may or may not trigger a renegotiation of the current marital contract or a separation from the current spouse. Figure 5 plots the relationship between marriage quality and OTMS by wives and husbands. Unsurprisingly, men engage in OTMS more than women, with about 1.8% on average searching successfully (i.e. “cheating”) in a six-month model period. Since the meet rate is about 11%, our model predicts that about 30% of married

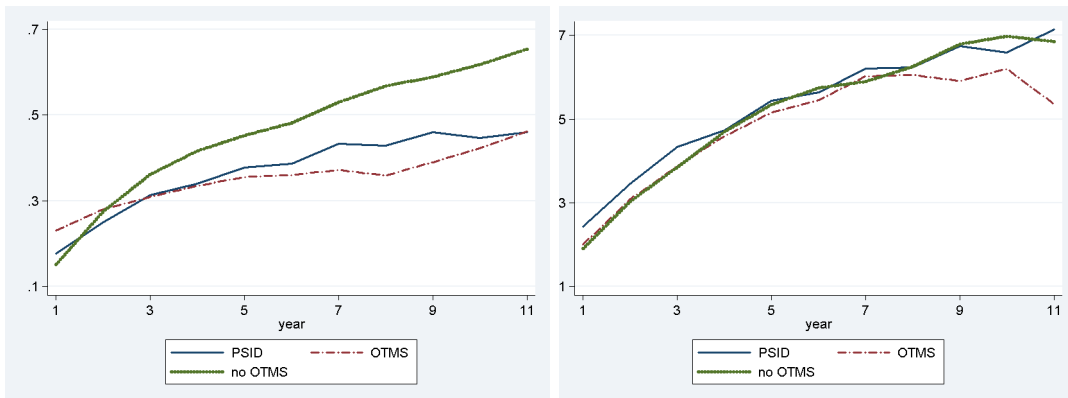
²²The correlations of private income are taken from the SIPP and may partly pick up a cohort effect.

Figure 3: Remarriage rates with and without OTMS



(a) both genders: in-sample prediction

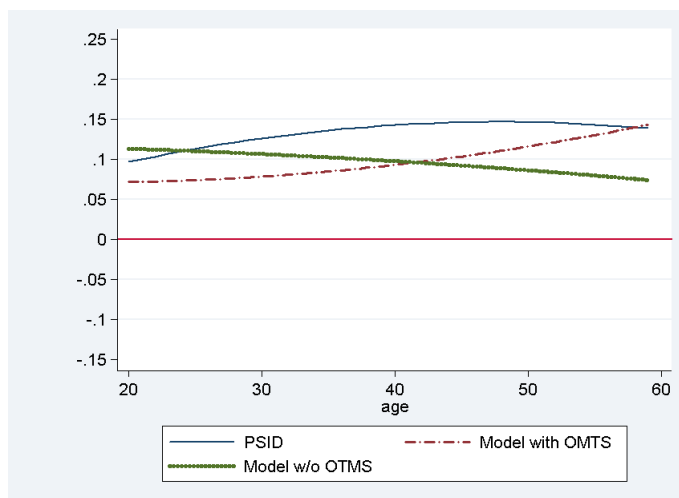
(b) both genders: out-of-sample prediction



(c) women

(d) men

Figure 4: Assortative mating by spouses' private incomes over the life cycle



men engage in OTMS on average and about 20% of married women. More surprisingly, OTMS is U-shaped in marriage quality for both genders. The fact that OTMS increases in match quality for the highest quality marriages is due to a combination of three factors. First, there is the income effect from good-quality marriages that allows men to engage in search as a costly activity (where the cost is future marriage quality). The second factor is the non-cooperative nature of searching on the marriage. Women search when their husbands search, even though it is (marginally) costly to them, since as their husband's search raises the likelihood of a divorce or renegotiation against their interests, it also raises their own incentive to search. This factor is important: if we shut down husbands' ability to search on the marriage, wives' search rates fall to close to zero. Finally, as shown below, both average match quality and OTMS are increasing in the husband's personal income since high income men are less likely to tolerate low-quality marriages.

Table 5 explores the relationship between OTMS, marital quality, and spouses' personal incomes. We divide men and women into three earning categories: low (1), medium (2), and high (3), grouped by sex-specific tercile. The upper entries report the average marital quality of the couples (on a scale of one to three). The lower bolded entries show the rate of husband's infidelity. Again, we see that OTMS is increasing in both husband's income (down the rows) and wife's income (across the columns), consistent with an income effect of search. Average marriage quality is also increasing strongly in husband's income, though at a decreasing rate, and not consistently in wife's income. The happiest marriages are those between a medium-earning husband and a low-earning wife. Since much of the return to marriage is in economies of scale consumption, high-earning couples (and low-earning couples with few outside options) are willing to tolerate more personality conflict (non-pecuniary costs) in order to reap high consumption returns.

Figure 6 shows the divorce rates resulting in the model with OTMS by marriage

Figure 5: OTMS by marriage quality ξ

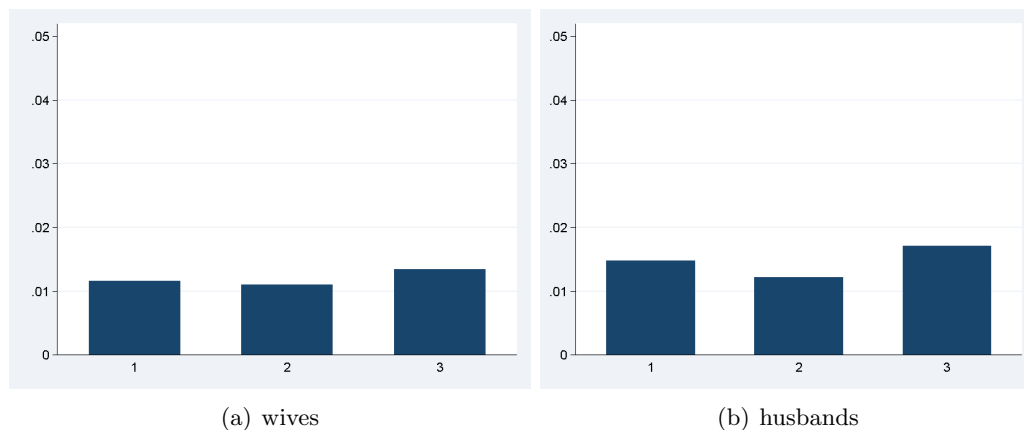


Table 5: Search and income

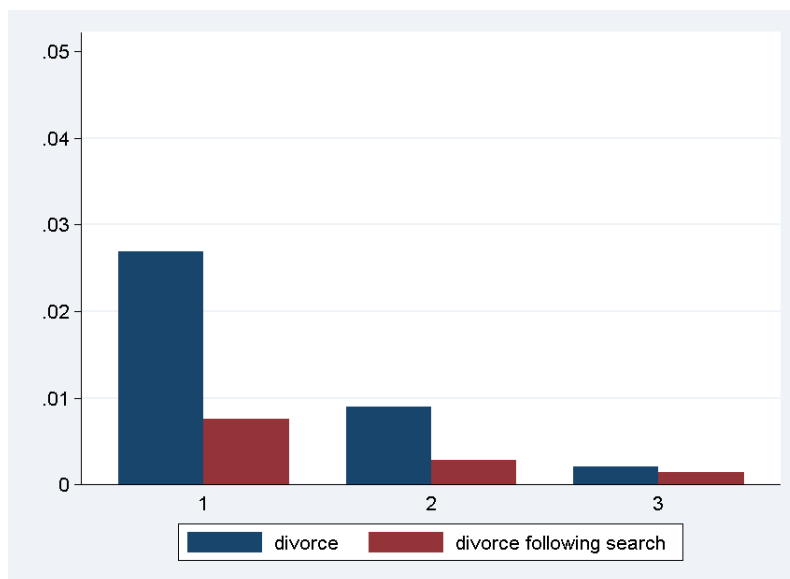
	Wife's k		
	0.889	1.062	1.051
Husband's	0.008	0.008	0.023
k	2.113	1.923	1.708
	0.005	0.009	0.035
	1.680	1.613	1.690
	0.005	0.011	0.052

quality. Consistent with the previous evidence in this section, divorce is highest for marriages with low exogenous match quality. These marriages tend to end with both partners leaving to singlehood. By contrast, about half of divorce from the highest quality marriages ($\xi=3$) occurs when one partner makes a successful match outside the marriage.

7.3 OTMS and consumption smoothing

Finally, in this section we explore the implications of the model for consumption smoothing and for expenditures on children over the life cycle. To start, table 6 reports means and variances of consumption between the two models, expressed relative to the mean consumption of men in each model. In the model with OTMS, consumption variance is typically lower since returns to marriage are much lower on average. Finding a suitable match (i.e. one that can sustain an egalitarian marriage contract) is very important to consumption in the model without OTMS; those left single experience much lower effective consumption leading to large inequality across households and across the life cycle.

Figure 6: Divorce by marital quality with and without OTMS



In the benchmark model, by contrast, the differences in consumption that arise across marital status are more modest and divorce has a smaller effect on consumption. On the other hand, gender differences in consumption are larger in the benchmark model with OTMS.

While instructive, the results don't isolate the direct effect of OTMS on outcomes. Table 7 does so focussing on both adult and child consumption (specifically expenditures on own and children's consumption). Specifically, it reports the mean and variance of spending per adult and per child and the share of adult women with at least one child in the model calibrated with OTMS and in the model calibrated to OTMS but in which OTMS is simply shut down.²³ Quite counterintuitively, we see that shutting down OTMS in the calibrated OTMS model reduces the fertility rate. It also reduces the expenditure on children, because now single women are more likely to have children relative to married women. One mechanism through which this surprising result works is the marriage contract: the average utility weighting of the husband in marriage falls from .53 to .52 when OTMS is shut down; if men have stronger preferences for children than their wives on average, then increasing the power of wives' preferences in household optimization will reduce fertility. Another reason may be that men are less enthusiastic about having children when they cannot search on the marriage since it is less easy for them to leave their families if the marriage turns sour. We leave exploring the implications of marital commitment for fertility in more detail for future work.

²³The expenditure calculation is on the first 36 model periods (18 years) after the first child is born.

Table 6: Mean and variance of per-period consumption

Consumption	mean	variance
Men		
with on-the-marriage search	1.00	.752
without on-the-marriage search	1.00	.804
Women		
with on-the-marriage search	.875	.576
without on-the-marriage search	.955	.774
Single		
with on-the-marriage search	.643	.485
without on-the-marriage search	.341	.319
Married		
with on-the-marriage search	1.185	.704
without on-the-marriage search	1.215	.788

Table 7: Expenditure on children

	Consumption	Expenditure per child	fertility rate
Benchmark (OTMS)	14995.53	2345.12	.538
	(10867.38)	(1204.27)	(.498)
Shutting down OTMS	16034.33	2056.35	.233
	(12032.42)	(1215.68)	(.422)

8 Conclusion

[tba]

9 Appendix A: Imputation of cohabitation dates for males in the NSFG

To our knowledge, the National Survey of Family Growth (NSFG) is unique in reporting retrospective cohabitation histories. However, the male survey suffers from missing data. This section describes how we impute cohabitation histories for men.

The NSFG contains redundant questions on marital histories. One series of questions reports century month of marriage with each formal spouse the respondent has ever had, as well as the date that cohabitation was initiated with this person.²⁴ Another series of questions reports only century month of marriage. In the female sample, all variables have high response rates and the two marriage variables agree with each other.²⁵ In the male sample, one marriage variable has a high response rate, while the other marriage variable and the cohabitation variable have low response rates. Dates of marriage agree for the observations containing non-missing values for both marriage variables.²⁶

Our approach is as follows. Since we observe full marriage histories for men in one of the redundant marriage variables, we fill in missing cohabitation dates by assuming that cohabitation preceded marriage by 16 months. This is the average length of time between cohabitation and marriage for second marriages of the men for whom we observe both remarriage and its preceding cohabitation.

Rates of formal remarriage in the NSFG match those from the SIPP and PSID retrospective marital history topical modules.²⁷

Note that although hazard rates for men and women follow a similar qualitative pattern – falling steeply in separation tenure – the rates for men are much lower than for women, while formal remarriage rates for men are higher (referring back to Figure 1). This is due to missing data in the male portion of the NSFG. This explanation can be confirmed by examining a series of redundant questions on the month and year of formal remarriages contained in both the male and female surveys. Century month of the n th marriage is reported in two separate variables, and century month of the n th premarital cohabitation is reported once (except for the first cohabitation, which is reported twice – but since the first cohabitation does not follow a divorce, it cannot be used to calculate partner-to-partner transitions).

Figure 3 shows a comparison of hazard rates for the imputed variable versus an alternative approach: assigning the reported date of marriage to observations for which cohabitation dates are missing. Since the female sample contains few missing cohabitation dates for women, the plot is similar. In the male sample, assigning marriage dates

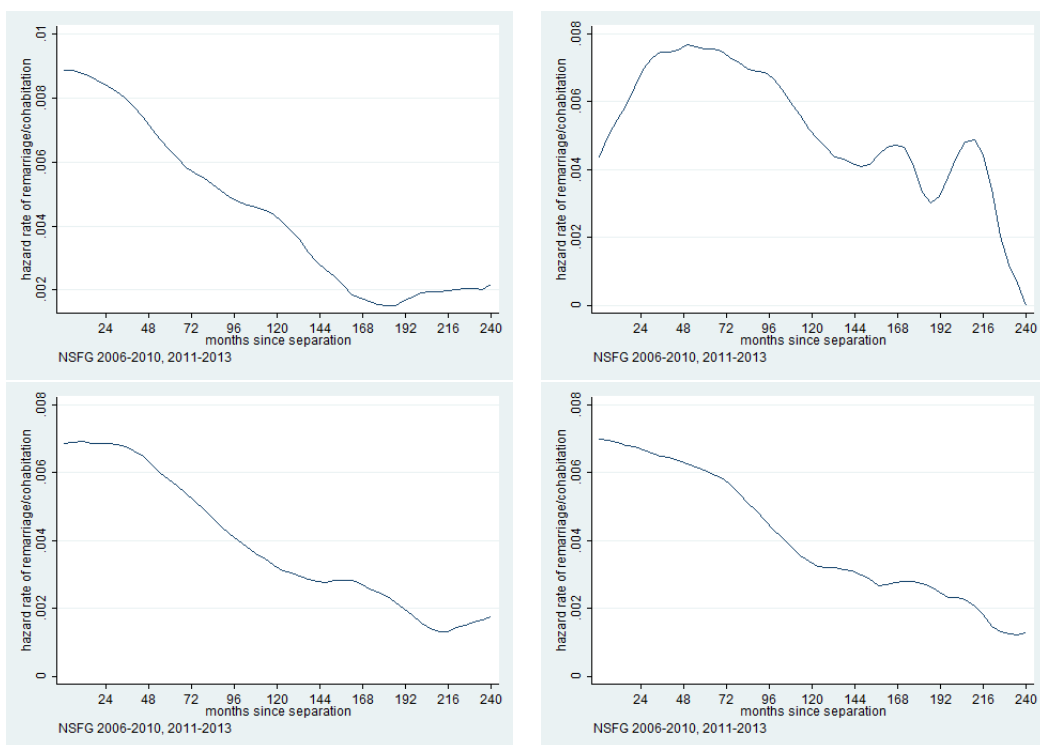
²⁴Century month is given by the number of months following the birth of Christ, and so contains the month and year of an event in a single number. For example, January 2000 is given by 24001 in century months, while February 2000 is given by 24002.

²⁵In the small minority of observations for which the reported dates are not identical, they are within a few months of each other.

²⁶There is also a redundant question on century month of first cohabitation, but not for subsequent cohabitations. Since we are interested in remarriage, the date of first cohabitation is not of direct interest, but it is worthwhile to note that dates of first cohabitation agree for the observations reporting both variables.

²⁷The 1996 cycle of the SIPP reports month and year of remarriage, while future cycles suppress month due to privacy concerns. The PSID reports both month and year from 1985 to 2013.

Figure 7: Hazard rates of cohabitation with next marriage partner, by months since separation, for women and men (imputed on bottom)



to observations with missing cohabitation dates is ineffective, since most cohabitation dates are missing.

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