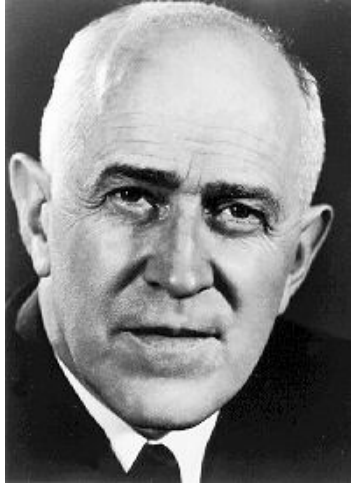# Economie d'avant garde

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MARRIAGE AND DIVORCE SINCE WORLD WAR II:
ANALYZING THE ROLE OF TECHNOLOGICAL PROGRESS ON THE
FORMATION OF HOUSEHOLDS

by

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Marriage and Divorce since World War II: Analyzing the Role of Technological Progress on the Formation of Households

Jeremy Greenwood and Nezih Guner

Abstract

Since World War II there has been: (i) a rise in the fraction of time that married households allocate to market work, (ii) an increase in the rate of divorce, and (iii) a decline in the rate of marriage. What can explain this? It is argued here that technological progress in the household sector has saved on the need for labor at home. This makes it more feasible for singles to maintain their own home, and for married women to work. To address this question, a search model of marriage and divorce is developed. Household production benefits from labor-saving technological progress.

Keywords: Marriage, Divorce, Hours Worked, Household Production, Technological Progress

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Updates: http://www.econ.rochester.edu/Faculty/GreenwoodPapers/manddww2.pdf

1 Introduction

Consider the following two facts that have helped reshape U.S. households over the last 50 years:

1. A smaller proportion of the adult population is now married compared with 50 years ago – Figure 1.[1] Eighty-two percent of the female population in 1950 was married (out of non-widows between the ages of 18 and 64). By 2000 this had declined to 62 percent. Adults now spend a smaller fraction of their lives married.[2] In 1950 females spent about 88 percent of their life married as compared with 60 percent in 1995. Underlying these facts are two factors.

    (a) Between 1950 and 1990, the divorce rate doubled from 11 to 23 divorces per 1,000 married women (between the ages of 18 to 64) – Figure 2.

    (b) At the same time, the marriage rate declined. Exactly how much is somewhat sensitive to the particular age group used for the calculations.[3] In 1950 there were 211 marriages per 1,000 unmarried women as compared with just 82 in 2000 (again, out of non-widows between the ages of 18 to 64).

2. The amount of time allocated to market work by married households has increased

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[1] Sources: (1) The marital status of the population is reported in the U.S. Census Bureau publications *Marital Status and Living Arrangements* (March 1950 to March 1998) and *America's Families and Living Arrangements* (March 1999 to March 2000). (2) The fraction of life spent married is from Schoen (1983) and Schoen and Standish (2001). (3) The divorce and marriage rates shown in Figure 2 are contained in Clarke (1995a,b).

[2] The fraction of time spent married is calculated as follows: First, data on life expectancy, e, and the fractions of total life spent as never married, n, married, m, and divorced, d are collected from Schoen (1983) and Schoen and Standish (2001). This data covers each year between 1950 and 1980, and the years 1983, 1988, and 1995. Second, on the basis of these numbers, the figures presented in Figure 1 are then calculated as

$$\frac{em}{en - 18 + em + ed}.$$

[3] The basic problem is that data is not available for marriages by age group. Data is available on the number of unmarried women by age group. Hence, the marriage rate for a particular age group is computed as the total number of marriages divided by the total number of unmarried women in the given age group.
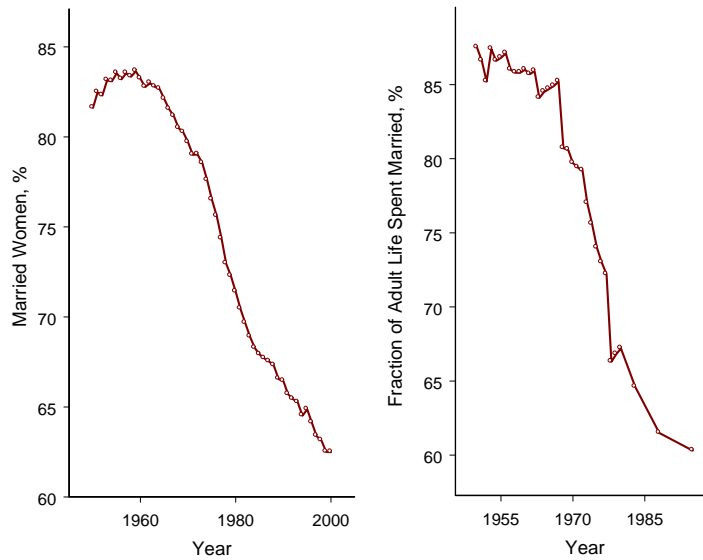
Figure 1: Marriage, 1950-2000.

markedly over the postwar period – see Figure 3.[4]   This is mainly due to a rise in labor-force participation by married females. In particular,

(a) In 1950 a married household in the 24-to-54-year-old age group spent 25.5 hours per week per person working in the market. This compared with 31.3 hours per week in a single household. Thus, singles worked more in the market on average than did married couples. At the time, only 23.7 percent of married women worked, compared with 78 percent of single ones.

(b) By the year 1990 labor effort expended per person by married households had risen to 33.5 hours per week. This exceeded the 30.6 hours spent by a single household. Almost as many married females were participating in the labor market (71 percent) as single ones (80 percent).

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[4] Source: Simple tabulations based on data extracted from IPMUS-USA, Minnesota Population Center, University of Minnesota. See Section 6.1.2 for more detail.
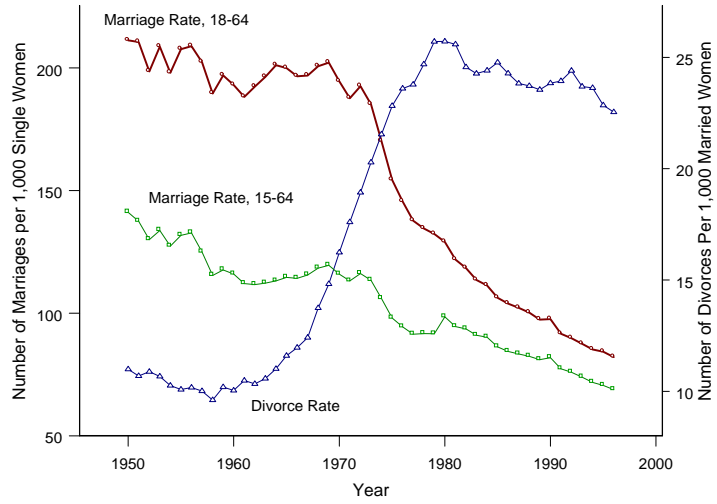
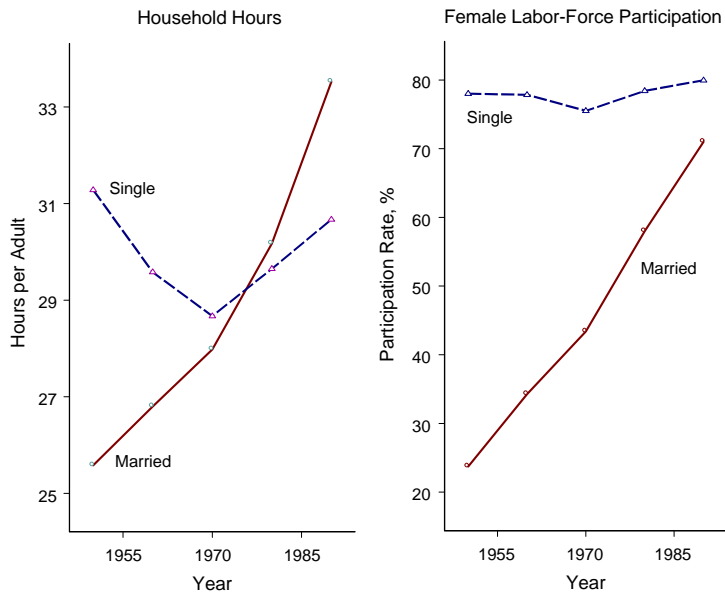Figure 2: Rates of Marriage and Divorce, 1950-2000.

Figure 3: Household Hours Worked and Female Labor-Force Participation, 1950-1990.

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What economic factors can explain these facts? The idea here is that technological progress played a major role in inducing these changes.[5] Two hundred years ago the U.S. was largely a rural economy. The household was the basic production unit, with the family producing a large fraction of what it consumed. At the time, most marriages were arranged by the parents of young adults. Key considerations were whether or not the potential groom would be a good provider, and the bride a good housekeeper.[6] Over time more and more household goods and services could be purchased outside the home, such as packaged foods and ready-made clothes. Additionally capital goods, ranging from washing machines to microwave ovens, were brought into the home greatly reducing the time needed to maintain a household.[7] This had two effects. First, it allowed all adults, both married and single, to devote more time to market activities and less to household production. Second, it lowered the economic incentives to get married by reducing the benefits of the traditional specialization of women at housework, and of men at market work. The reduction of the economic benefits of marriage allowed the modern criteria of mutual attraction between mates to come to the fore, a trend "from economics to romance" in the words of Ogburn and Nimkoff (1955).

To model this idea formally, a Becker (1965) - cum - Reid (1934) model of household production is embedded into a Mortensen (1988) style spouse-search model. Three key ingredients are injected into this framework. First, there are economies of scale in household consumption and production. Second, it is assumed that purchased household inputs and

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[5] The impact of technological progress on household formation was addressed some time ago in a classic and prescient book by Ogburn and Nimkoff (1955). The book analyzes the impact of technological progress on family size, marriage and divorce, and female labor-force participation, among other things.

[6] Ogburn and Nimkoff (1955, pp. 40-41) quote Godey's *The Lady's Book* in 1831 as writing "No sensible man ever thought a beautiful wife was worth as much as one that could make good pudding" or in 1832 as stating "Among our industrious fore-fathers it was a fixed maxim that a young lady should never be permitted to marry until she had spun for herself a set of body, bed and table linen. From this custom all unmarried women are called spinsters in legal proceedings."

[7] Greenwood, Seshadri and Yorukoglu (2005, Section 1.2) and Greenwood, Seshadri and Vandenbroucke (2005, Section V.A) present evidence that technological advance occurred in the household sector over the course of the last century. The latter paper argues that the impact of this technological progress started to gather steam at the start of the baby boom. This is relevant for the analysis in Section 7.

labor are substitutes in household production. Third, it is presumed that nonmarket goods exhibit stronger diminishing marginal utility than market goods. Some theoretical results are established for this framework. The economies of scale in household consumption and production provide an economic motive for marriage.[8] It pays for a couple to pool their resources together. Now, suppose that the price of purchased household inputs declines over time. Labor will be displaced from the home, given that household inputs and labor are substitutes in household production. Furthermore, if there is stronger diminishing marginal utility in nonmarket goods vis à vis market goods then married households will allocate a smaller fraction of their spending on the inputs for household production than will single households. As a consequence, single households gain the most from a decline in the price of purchased household inputs. Thus, a fall in the price of purchased household inputs causes the relative benefits of single life to increase. Singles searching for a spouse will become pickier. For those currently married, the value of a divorce will rise, because the value of becoming single is higher. Thus, the theoretical analysis suggests that the framework developed has promise for explaining the observed rise in the number of single households, together with the increase in hours worked by married ones.

To gauge the quantitative potential of the framework, the model is solved numerically. The model's predictions for the time paths of labor-force participation and vital statistics are compared with the U.S. data. It is found that the developed framework can potentially explain a substantial portion of the rise in divorce, the fall in marriage, and the increase in married female labor-force participation that occurred during the later half of the twentieth century. At the outset it will be stated, though, that the goal of the analysis is not to simulate an all-inclusive model of household formation and labor-force participation. Rather, the idea here is to see whether or not the simple mechanisms put forth have the potential quantitative power to explain the postwar observations on household formation and labor-

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[8] Love provides an additional motivation for marriage in the model. The interaction between monetary and non-monetary incentives to get married is also analyzed by Fernandez, Guner and Knowles (2005). In their framework a higher level of inequality generates a higher degree of marital sorting. This occurs because the economic costs of marrying down increase for the rich. They also present empirical evidence supporting this prediction.

force participation. This is done without regard to the many other possible explanations for the same set of facts – some of which could be embedded into a more general version of the developed framework. Theory, by its essence, is a process of abstraction. Therefore, some factors that may be important for understanding the phenomena under study have been left out of the analysis, both for purposes of clarity and tractability.

For example, the tremendous amount of technological progress in contraception that occurred over the last century greatly reduced the risk out-of-wedlock sexual relationships. It seems very likely that this provided impetus for a fall in marriage and a rise in divorce. Interestingly, the fraction of the population that is married did not show monotonic decline over the course of the entire 20th century. It actually increased during the baby boom years. This resulted in a hump-shaped time path for marriage during the last century. It might be hard for a theory based on improvements in contraception, alone, to explain this. As will be argued in detail later on, however, the current theory has the potential to do so. The liberalization of divorce laws in the 1970s is often thought of as being a prime candidate for causing the rise in divorce. The adoption of no-fault unilateral divorce laws by many states in the 1970s coincides well with the rise of divorce rate during the same period. However, the empirical evidence on the effect of divorce laws is controversial. While Friedberg (1998) reports that the move to unilateral divorce can account as much as about 17 percent of the rise in divorce rates between 1968 and 1988, a more recent study by Wolfers (2003) finds that unilateral divorce laws explain very little of the rise in divorce rates. Furthermore, except for a spike associated with World War II, the rate of divorce rose more or less continuously over the last century from about 4 per 1,000 women in 1900, to about 10 in 1941 (a doubling), to about 23 today (another doubling). [In fact, Ogburn and Nimkoff (1955) write about the trend.] So, there seems to be room in the literature for the explanation proposed here that technological advance in the household sector contributed to the rise in divorce and the decline in marriage.

2   The Economic Environment

The economy is populated by a continuum of people with unit mass. Individuals have finite lives, in the sense of Yaari (1965). Specifically, at the beginning of each period an individual faces the constant probability of dying, δ. Thus, δ people die each period. The individuals who have passed on are replaced by a newly-borne generation of exactly the same size. There are two types of individuals: those who are single and those who are married. Each individual is endowed with one unit of time, which can be divided between market and nonmarket work. A unit of market work pays the wage rate, w. At the beginning of each period singles participate in a marriage market, assuming that they have survived. Each single is randomly paired up with someone else. The prospective couple then draws a certain level of suitability or quality, b, from a fixed distribution. The question facing a single is: should s/he marry, or wait until a better match comes along. For a married couple match quality evolves over time, according to some fixed distribution. For simplicity, assume that married couples die together at the start of a period with probability δ. If they survive then they must decide whether or not to remain married. After the marriage and divorce decisions, individuals enter the labor market. A single agent must decide how much of his one unit of time to devote to market work. A married couple must determine how much of their two units of time to spend in the labor force. For simplicity, it is assumed that there are no assets markets. Hence, there is no borrowing or lending, etc., in the economy. Last, as will become clear, there are no matching externalities present in the model. The aggregate state of the marriage market will not influence household's decision making.

2.1   Production

Start with production. Two types of goods are produced, market and nonmarket ones.

2.1.1 Household Production

Suppose that nonmarket goods, n, are made in line with the following household production function:

$$n = [\theta d^\kappa + (1 - \theta)h^\kappa]^{1/\kappa}, \text{ for } 0 < \kappa < 1, \tag{1}$$

where d denotes purchases of household inputs, and h is the amount of time spent on housework.[9]   Let purchased household inputs sell at price p, measured in terms of time. The idea here is that over time p will drop. Specifically, let p fall monotonically to some lower bound $\underline{p} > 0$. In response households will substitute out of using labor toward using more purchased inputs. Note that it has been assumed that purchased inputs and time are more substitutable in production than Cobb-Douglas; i.e., $\kappa > 0$. Hence, as p declines, household production will become more goods intensive and less labor intensive.[10]   Examples of labor-saving household inputs abound: disposable diapers, frozen foods, microwave ovens, washing machines, and tupperware.

2.1.2 Market Production

The production of market goods is done in line with the constant-returns-to-scale production technology

$$\mathbf{y} = w\mathbf{l}, \tag{2}$$

where $\mathbf{y}$ is aggregate output and $\mathbf{l}$ is aggregate employment. Given the linear form for the aggregate production function, w will represent the real wage rate in equilibrium. Real wages will grow over time. In particular, suppose that w increases monotonically to some finite upper bound $\overline{w}$. There is no physical or, as mentioned, financial capital in the economy. Market output y is used for two purposes: viz, direct consumption and as an input into household production. Specifically, one unit of output can be used to produce one unit of

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[9] For some uses of household production theory in macroeconomics see Benhabib, Rogerson and Wright (1991), Gomme, Kydland and Rupert (2001), Greenwood and Hercowitz (1991), and Parente, Rogerson and Wright (2000), and Rios-Rull (1993).

[10] Krusell, Ohanian, Rios-Rull and Violante (2000) employ this notion of labor-shedding technological progress in their study of the post-1974 rise in the skill premium.

final consumption or $1/p$ units of household inputs. Thus, the economy's resource constraint reads

$$\mathbf{c} + p\mathbf{d} = \mathbf{y},$$

where $\mathbf{c}$ and $\mathbf{d}$ represent aggregate consumption and purchases of household inputs, respectively.

2.2 Tastes

Singles: Let the momentary utility function for a single read

$$U^s(c, n) = \alpha \ln(c - \mathfrak{c}) + (1 - \alpha)n^\zeta/\zeta, \text{ with } 0 < \alpha < 1, 0 \leq \mathfrak{c} < 1, \zeta < 0.$$

Here c and n denote the person's consumption of market and nonmarket goods, respectively. The constant $\mathfrak{c}$ represents a fixed cost associated with maintaining a household.[11] [12] This represents the first of two sources of scale economies in household consumption. If a single dies he realizes a utility level of zero in the afterlife, an innocuous normalization. Note that leisure has been excluded from the tastes. This is in line with the Beckerian (1965, p. 504) theory of household production since "although the social philosopher might have to define precisely the concept of leisure, the economist can reach all his traditional results as well as many more without introducing it at all." The idea here is that often all one cares about is time spent in the market versus at home, and the above framework will capture this through the production side of things. Additionally, observe that a separable form for the utility function is chosen, as is conventional in macroeconomics. This minimizes the role placed on home production.[13]

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[11] See footnote 14 for more detail.

[12] The fixed cost is presumed to be the same for both single and married households. This is for theoretical convenience, only. Casual empiricism suggests that it should be smaller for single households. Footnote 25 reports some results for the quantitative analysis where this assumption is relaxed. Also, one might expect that there are some fixed costs for home goods too. Some results for this case are also discussed in Footnote 25.

[13] The framework is closer to the home production setup used by Greenwood and Hercowitz (1991) as opposed to the Benhabib, Rogerson and Wright (1991) one. The separable consumption setup without

Married Individuals: Tastes for a married individual are given by

$$U^m(c, n) + b = \alpha \ln((c - \mathfrak{c})/2^\phi) + (1 - \alpha)(n/2^\phi)^\zeta/\zeta + b, \text{ with } \zeta < 0 < \phi < 1,$$

where c and n represent the *household's* consumption of market and nonmarket goods. To determine an individual's consumption, $c - \mathfrak{c}$ and n are divided by the household equivalence scale, 2^ϕ, to get consumptions per member, $(c - \mathfrak{c})/2^\phi$ and $n/2^\phi$. Since $0 < \phi < 1$, this implies that it is less expensive to provide the second member of the household with consumption than it is the first. This is the second source of economies of scale in consumption. Note that the utility function for nonmarket goods is more concave than the ln function; i.e., $\zeta < 0$. The importance of this restriction will become clear as the theory is developed. This constraint is *not* imposed in the quantitative analysis. Therefore, the data will speak to the sign and magnitude of ζ. Observe that the bliss from a match, b, can be negative. Finally, if a married couple die they realize a zero-utility level thereafter.

2.3 Match Quality

Recall that when singles meet they draw a match quality, b. Suppose that b is normally distributed so that

$$b \sim N(\mu_s, \sigma_s^2),$$

where μ_s and σ_s^2 are the mean and variance of the single distribution. Let the cumulative distribution function that singles draw from be represented by $S(b)$. Likewise, each period a married couple draws a new value for the match quality variable, b. Suppose that last period the couple had a match quality of b_{-1}. Now, assume that b evolves according to the following autoregressive process:

$$b = (1 - \rho)\mu_m + \rho b_{-1} + \sigma_m \sqrt{1 - \rho^2}\xi, \text{ with } \xi \sim N(0, 1).$$

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leisure is just a special case of the nonseparable consumption setup with leisure. In fact, the former can be nested in latter. Therefore, quantitatively speaking, the model can only perform *better* when adopting nonseparable tastes and allowing for leisure, because the estimation routine will pick the parameter values that maximize the fit. In practice, though, a lack of substitution in tastes can often be compensated for changing the degree of complementarity/substitutability in production. Without a time series on leisure per se (as opposed to nonmarket time) the value of including it seems minimal. Indeed, the models of Benhabib, Rogerson and Wright (1991) and Greenwood and Hercowitz (1991) produce very similar results.

Here μ_m and σ_m^2 denote the long-run mean and variance for the process b. The parameter ρ is the coefficient of autocorrelation. Write the (conditional) cumulative distribution function that married couples draw from as $M(b|b_{-1})$.

3 Household Decision Making

How will a single agent divide his or her time between market and nonmarket work? When will he or she choose to get married? Likewise, how will a married couple split their time between market work and housework? When will they choose to divorce? To answer these questions, let $V(b)$ denote the expected lifetime utility for an individual who is currently in a marriage with match quality b. Similarly, W will represent the expected lifetime utility for an agent who is single today. Imagine that two singles meet and draw a match quality of b. They will choose to marry if $V(b) \geq W$ and to remain single if $V(b) < W$. Likewise, consider a married couple with match quality b. They will pick to remain married when $V(b) \geq W$ and choose to divorce if $V(b) < W$. Thus, the marriage and divorce decisions are summarized by Table 1. Note that given the absence of asset markets, b will be the only state variable at the individual level that is relevant for determining expected lifetime utility. At the aggregate level, prices and wages will also matter. Recall that wages are rising over time, and that prices are falling. Thus, W and V are functions of time. Given this, W' and V' will denote the value functions for single and married lives that obtain next period; i.e., the prime symbol connotes these functions' dependence on time. So, how are the functions $V(b)$ and W determined? This question will be addressed next.

TABLE 1: MARRIAGE AND DIVORCE DECISIONS

	Single				*Married*		
Marry		*if*	$V(b) \geq W$	Remain Married	*if*	$V(b) \geq W$	
Remain Single	*if*	$V(b) < W$		Divorce		*if*	$V(b) < W$

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3.1 Singles

The dynamic programming problem for a single agent appears as

$$W = \max_{c,n,d,h}\{U^s(c,n) + \beta \int \max[V'(b'), W']dS(b')\}, \tag{P1}$$

subject to

$$c = w(1-h) - wpd, \tag{3}$$

and (1).[14]   The discount factor β reflects the probability of dying. That is, if $\widetilde{\beta}$ is the person's subjective discount factor then $\beta = (1-\delta)\widetilde{\beta}$. Observe that while the individual is single today, the agent picks married or single life next period to maximize welfare, as the term $\max[V'(b'), W']$ in (P1) makes clear. Since $S(b)$ is some fixed distribution, the aggregate state of the marriage market does not impact on the individual's decision making.

3.2 Couples

The dynamic programming problem for a married couple reads

$$V(b) = \max_{c,n,d,h}\{U^m(c,n) + b + \beta \int \max[V'(b'), W']dM(b'|b)\}, \tag{P2}$$

subject to

$$c = w(2-h) - wpd, \tag{4}$$

and (1). Problem (P2) is similar in structure to problem (P1) with three differences: (i) the utility function for married agents differs from single agents due to scale effects in household consumption; (ii) a married couple realizes bliss from marriage and this is autocorrelated over time; (iii) the couple has two units of time to allocate between market and nonmarket work. Again, note that while an individual is married today, the agent chooses married or single

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[14]   It can now be seen that the constant $\mathfrak{c}$ does represent a fixed cost associated with maintaining a household. Write U^s as $U^s(\widetilde{c}, n)$, where $\widetilde{c}$ denotes the consumption of market goods by a single household. Let $\mathfrak{c}$ denote the fixed cost of maintaining a household. The household's budget constraint will now appear as $\widetilde{c} = w(1-h) - wpd - \mathfrak{c}$. Rewrite the budget constraint as $\widetilde{c} + \mathfrak{c} = w(1-h) - wpd$. Next, define $c = \widetilde{c} + \mathfrak{c}$ so that $\widetilde{c} = c - \mathfrak{c}$. Use this to substitute out for $\widetilde{c}$ in U^s and the above budget constraint. This setting has transformed into the one presented in the text.

life next period to maximize welfare.[15]   Last, the aggregate state of the marriage market does not impinge on the couple's decision making, because $M(b'|b)$ is a fixed distribution.

4   Equilibrium

Formulating an equilibrium to the above economy is surprisingly simple. First, given the linear market production function (2), there is no need to determine the equilibrium wage, w. Second, since there are no financial markets, there is no interaction between households other than through the marriage market. As far as consumption and production are concerned, each household is an island unto themselves. Also, there are no matching externalities in the model. Each single is matched with a potential mate each period. This pair then draws a quality for the match, b, from the fixed distribution $S(b)$. Likewise, the b for a couple evolves according to the fixed distribution $M(b'|b)$. Hence, household decision making is not influenced by the aggregate state of the marriage market. Therefore, characterizing an equilibrium for the economy amounts to solving the programming problems (P1) and (P2). Thus, it is easy to establish that an equilibrium for the above economy both exists and is unique.[16]

4.1   Vital Statistics

Computing vital statistics for the economy is a relatively straightforward task. Suppose that the economy exits the previous period with the (non-normalized) distribution $\mathbf{M}_{-1}(b_{-1})$ over match quality for married agents. The fractions of agents who were married and single last

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[15] The structure of problems (P1) and (P2) is similar to the typical search/work problem – see Hansen and Imrohoroglu (1992), Jovanovic (1987), and Wright and Loberg (1987) for some examples, or Rogerson, Shimer and Wright (2004) for a recent survey.

[16] In a nutshell the argument is as follows: Recall that $\lim_{t\to\infty} p_t = \underline{p}$ and $\lim_{t\to\infty} w_t = \overline{w}$. It is easy to deduce that a pair of unique steady-state value functions, W^* and V^*, exist that will solve the dynamic programming problems (P1) and (P2). To see this note that (P1) and (P2) define an operator $(W, V) = \mathbf{T}(W', V')$. By standard arguments, it can be readily deduced that the operator $\mathbf{T}$ is a contraction mapping on the space of continuous bounded functions with norm $||W, V|| = \sup |W| + \sup |V|$. Working backwards in time from the steady state it is also easy to see that the value functions W and V will exist and be unique at each stage of the recursion.

period, m_{-1} and s_{-1}, are therefore given by $m_{-1} = \int d\mathbf{M}_{-1}(b_{-1})$ and $s_{-1} = 1 - \int d\mathbf{M}_{-1}(b_{-1})$. Now, at the beginning of the current period the fraction δ of populace dies. These people are replaced by newly-borne single agents. All agents will then take a draw, b, for their match quality. After this, they will make their marriage and divorce decisions in line with Table 1. Define the set of match quality shocks for which it is in an individual's best interest to live in a married household, or $\mathcal{M}$, by

$$\mathcal{M} = \{b : V(b) \geq W\}.$$

The current-period distribution over match quality for married agents, or $\mathbf{M}(b)$, will then read[17]

$$\mathbf{M}(b) = (1 - \delta) \int_{\mathcal{M} \cap [-\infty, b]} \int dM(\widetilde{b}|b_{-1}) d\mathbf{M}_{-1}(b_{-1}) + [s_{-1} + \delta m_{-1}] \int_{\mathcal{M} \cap [-\infty, b]} dS(\widetilde{b}). \quad (5)$$

Therefore, the fractions of agents who are married and single in current period, m and s, are given by $m = \int d\mathbf{M}(b)$ and $s = 1 - \int d\mathbf{M}(b)$. The fraction of people getting married in the current period is $[s_{-1} + \delta m_{-1}] \int_{\mathcal{M}} dS(\widetilde{b})$, while the proportion going through a divorce is given by $(1 - \delta) \int_{\mathcal{M}^c} \int dM(\widetilde{b}|b_{-1}) d\mathbf{M}_{-1}(b_{-1})$, where $\mathcal{M}^c$ is the complement of $\mathcal{M}$.

5 Qualitative Analysis

It is now time to entertain the following two questions, at least at a theoretical level:

1. How does technological progress affect the amount of time spent on housework?

2. How does technological progress affect the economic return from married versus single life?

Before answering these two questions, it may pay to take stock of the key features of the model and to discuss the role that they play in the subsequent analysis.

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[17] Note that when a single agent dies he is replaced by another single agent. This explains why there is no term reflecting the probability of dying multiplying s_{-1} in the formula for $\mathbf{M}(b)$.

- *Household Equivalence Scale*, $0 < \phi < 1$. This provides an economic incentive for marriage. If a two-person household can live more economically than a single-person household then there are gains from marriage.

- *Purchased Household Inputs-Housework Substitutability in Home Production*, $0 < \kappa < 1$. Suppose that over time the price of purchased household inputs declines. The higher the degree of substitutability between purchased inputs and housework the bigger will be the labor-saving impact of technological progress on home production.

- *Strong Diminishing Marginal Utility for Nonmarket Goods*, $\zeta < 0$. Married couples will consume more of all goods than singles do. If the utility function for nonmarket goods is more concave than the one for market goods then married couples will allocate a higher fraction of their spending (as compared with singles) to market goods, c, relative to the inputs into home production, d and h.

- *Fixed Cost of Household Maintenance*, $\mathfrak{c} \geq 0$. This gives another economic incentive for marriage. Moreover, at low levels of income households will have limited resources to allocate for market consumption, after meeting the fixed cost of household maintenance. This will force poorer households, or singles, to devote a higher fraction of their time to market work relative to richer households, or married couples.

- *Marital Bliss*, b. This creates a noneconomic incentive for marriage.

- *The Probability of Dying*, $0 < \delta < 1$. This proves useful in the quantitative analysis. It increases the fraction of people who are single, ceteris paribus.

The task is now to establish that the features outlined above do indeed play their assigned roles.

5.1 The Time-Allocation Problem

The Problem: To this end, consider the time-allocation problem that faces a household of size, z. It is static in nature and appears as

$$I(z, p, w) = \max_{c,n,h,d}\{\alpha \ln(\frac{c - \mathfrak{c}}{z^\phi}) + (1 - \alpha)(\frac{n}{z^\phi})^\varsigma/\varsigma\}, \tag{P3}$$

subject to

$$c - \mathfrak{c} = w(z - h) - wpd - \mathfrak{c}, \tag{6}$$

and

$$n = [\theta d^\kappa + (1 - \theta)h^\kappa]^{1/\kappa}.$$

Observe that versions of problem (P3) are embedded into (P1) and (P2), a fact that can be seen by setting $z = 1$ and $z = 2$.

The Solution: By using the constraints for n and $c - \mathfrak{c}$ in the objective function (P3), and then maximizing with respect to d and h, the following two first-order conditions are obtained:

$$\frac{\alpha}{c - \mathfrak{c}}wp = (1 - \alpha)z^{-\phi\varsigma}[\theta d^\kappa + (1 - \theta)h^\kappa]^{\varsigma/\kappa - 1}\theta d^{\kappa - 1}, \tag{7}$$

and

$$\frac{\alpha w}{c - \mathfrak{c}} = (1 - \alpha)z^{-\phi\varsigma}[\theta d^\kappa + (1 - \theta)h^\kappa]^{\varsigma/\kappa - 1}(1 - \theta)h^{\kappa - 1}. \tag{8}$$

These two first-order conditions have standard interpretations. For instance, the left-hand side of (7) represents the marginal cost of an extra unit of purchased household inputs, d. The marginal unit of purchased household inputs costs wp in terms of forgone market consumption. Since an extra unit of market consumption has a utility value of $\alpha/(c - \mathfrak{c})$ this leads to a sacrifice of $[\alpha/(c - \mathfrak{c})]wp$ in terms of forgone utility. Likewise, the right-hand side of this equation gives the marginal benefit of an extra unit of purchased household inputs. These extra goods will increase household production by $[\theta d^\kappa + (1 - \theta)h^\kappa]^{1/\kappa - 1}\theta d^{\kappa - 1}$. The marginal utility of nonmarket goods is $(1 - \alpha)z^{-\phi\varsigma}(n)^{\varsigma - 1}$. Thus, the marginal benefit of an extra unit of purchased household inputs is $(1 - \alpha)z^{-\phi\varsigma}(n)^{\varsigma - 1} \times [\theta d^\kappa + (1 - \theta)h^\kappa]^{1/\kappa - 1}\theta d^{\kappa - 1}$, which is the right-hand side of (7). The two first-order conditions (7) and (8), in conjunction with the budget constraint (6), determine a solution for c, d and h.

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5.2 Results

Everything is now set up to address the two questions poised at the start of this section.

5.2.1 Technological Progress and Time Allocations

So, how does technological progress affect the amount of time allocated to homework? First, a fall in the price of purchased household inputs, p, leads to a reduction in the amount of housework, h, and a rise in the amount of market work, $z - h$. When the price of purchased household inputs drops households move away from using labor in household production toward using goods (given the assumption that production exhibits more substitutability than Cobb-Douglas or that $\kappa > 0$). Second, a rise in wages, w, leads to an increase in the amount of housework, h, done. At low levels of income, the marginal utility of market goods is high due to the fixed cost of household maintenance, $\mathfrak{c}$. Thus, people devote a lot of time to laboring in the market. As wages increase the fixed cost for household maintenance bites less and people relax their work effort in market. Proposition 1 formalizes all of this.

Proposition 1 *Housework, h, is:*
(i) increasing in the price of household commodities, p;
(ii) decreasing in the fixed cost of household maintenance, $\mathfrak{c}$;
(iii) increasing in real wages, w (when $\mathfrak{c} > 0$).

Proof. See the Appendix. ■

Remark *Real wages, w, will have no effect on time allocations in the absence of a fixed cost for household maintenance, c; i.e., when $c = 0$. To see this, substitute (6) into (7) and (8) and note that the first-order conditions depend on c/w. Thus, as the economy develops the impact of wages on housework will vanish, since $c/w \longrightarrow 0$ as $w \longrightarrow \infty$.*

5.2.2 Household Size and Allocations

Can anything be said about the allocations, (c, d, h), within a two-person household vis à vis a one-person household? The lemma below provides the answer, where the superscripts m and s are attached to the allocations for married and single households. Before proceeding,

it will be noted that the lemma is a key step along the road to proving that a fall in the price for purchased household inputs reduces the utility differential between married and single life, when holding fixed the amount of marital bliss. It shows that a married household spends less on purchased household inputs, relative to market consumption (over and above the fixed cost of household maintenance), than does a single one. Likewise, the corollary to the lemma is instrumental for establishing that a rise in wages reduces the economic benefit from marriage. It proves that a married household consumes more market goods than a single household does.

Lemma 1 *The allocations in married and single households have the following relationships:*
(i) $(c^m - \mathfrak{c}) > [(2 - \mathfrak{c}/w)/(1 - \mathfrak{c}/w)](c^s - \mathfrak{c})$;
(ii) $d^m < [(2 - \mathfrak{c}/w)/(1 - \mathfrak{c}/w)]d^s$;
(iii) $h^m < [(2 - \mathfrak{c}/w)/(1 - \mathfrak{c}/w)]h^s$.
The above relationships hold with equality when $\zeta = 0$.

Proof. Again, see the Appendix. ■

Corollary *Married households consume more market goods than do single households:*
(i) $(c^m - \mathfrak{c})/2^\phi > (c^s - \mathfrak{c})$;
(ii) $c^m > c^s$.
The above relationships hold even when $\mathfrak{c} = \zeta = 0$.

Proof. See Appendix. ■

Now, note that a married household has $2 - \mathfrak{c}/w$ units of disposable time, after netting out the fixed cost of household maintenance, to spend on various things. A single household has $1 - \mathfrak{c}/w$ units of disposable time. Lemma 1 states that a married household will spend a larger fraction of their adjusted time endowment on the consumption of market goods than will a single household. The lemma also implies that married households spend less than single households do on household inputs, relative to market goods. That is, $pd^m/(c^m - \mathfrak{c}) < pd^s/(c^s - \mathfrak{c})$ and $wh^m/(c^m - \mathfrak{c}) < wh^s/(c^s - \mathfrak{c})$ so that $[pd^m + wh^m]/(c^m - \mathfrak{c}) < [pd^s + wh^s]/(c^s - \mathfrak{c})$, at least when $\zeta < 0$. When nonmarket goods exhibit strong diminishing marginal utility, bigger households will favor (relative to the consumption patterns of smaller

ones) the use of market consumption for their larger adjusted endowment of time. Part (i) of the corollary states that after paying the fixed cost of household maintenance, market consumption per person is effectively higher in a married household than a single one. Also, married households spend more in total on market goods than do single households.

5.2.3 Technological Progress and the Economic Benefits of Married versus Single Life

Last, how does technological progress affect the utility differential between married and single life (holding fixed the amount of marital bliss)? To address this, let u^m denote the level of momentary utility realized from married life, sans marital bliss, and u^s represent the level of utility realized from single life. From problem (P3) it is apparent that $u^m = I(2, p, w)$ and $u^s = I(1, p, w)$.

Proposition 2 *The utility differential between married and single life (sans marital bliss), $u^m - u^s$, is:*
(i) increasing in the price of purchased household inputs, p;
(ii) decreasing in real wages, w (when $\mathfrak{c} > 0$).

Proof. The first part of the proposition can be established by applying the envelope theorem to problem (P3). It can be calculated that

$$\frac{d(u^m - u^s)}{dp} = -\alpha w \left[\frac{d^m}{c^m - \mathfrak{c}} - \frac{d^s}{c^s - \mathfrak{c}} \right] > 0, \tag{9}$$

where the sign of the above expression follows from Lemma 1(i, ii). To prove the second part of the lemma, note that

$$
\begin{aligned}
\frac{d(u^m - u^s)}{dw} &= \alpha \left[\frac{2 - h^m - p d^m}{c^m - \mathfrak{c}} - \frac{1 - h^s - p d^s}{c^s - \mathfrak{c}} \right] \\
&= \frac{\alpha}{w} \left[\frac{c^m}{c^m - \mathfrak{c}} - \frac{c^s}{c^s - \mathfrak{c}} \right] = \frac{\alpha}{w} \left[\frac{1}{1 - \mathfrak{c}/c^m} - \frac{1}{1 - \mathfrak{c}/c^s} \right] < 0, \tag{10}
\end{aligned}
$$

where the sign of the above expression derives from the fact that $c^m > c^s$, or part (ii) of the corollary to Lemma 1. ■

Thus, technological advance in the form of either a falling price for purchased household inputs or rising real wages reduces the economic gain from marriage. A fall in the price of

purchased household inputs leads to a substitution away from the use of labor in household production toward the use of purchased household inputs. Single households use labor-saving products the most intensively, so they realize the greatest gain [i.e., $d^m/(c^m - \mathfrak{c}) < d^s/(c^s - \mathfrak{c})$ in (9)].[18] The assumption of strong diminishing marginal utility for nonmarket goods ($\zeta < 0$) is important for the result that a drop in the price of purchased household inputs will reduce the economic return to marriage. Suppose that $\zeta = 0$. Then, prices will have no impact on the utility differential between married and single life, because $d^m/(c^m - \mathfrak{c}) = d^s/(c^s - \mathfrak{c})$ by Lemma 1. The presence of a fixed cost is not important for obtaining the desired result, since the lemma still holds when $\mathfrak{c} = 0$. To take stock of the situation so far, a decline in the price of household products will lead to a decrease in housework by Proposition 1. It also causes a reduction in the economic return to marriage by Proposition 2. Therefore, a decline in the price of purchased household inputs has the potential for explaining Observations 1 and 2 made in the Introduction.

As wages increase, the fixed cost for household maintenance matters less. The fixed cost for household maintenance bites the most for single households [i.e., $\mathfrak{c}/c^m < \mathfrak{c}/c^s$ in (10)]. Therefore, single households benefit the most from a rise in wages. From (10) it is immediate that a change in wages will have no impact in the absence of a fixed cost ($\mathfrak{c} = 0$) on the utility differential between married and single life. Also, note this result does not depend upon the assumption of strong diminishing marginal utility of nonmarket goods since the Corollary to Lemma 1 holds even when $\zeta = 0$. Now, recall from Proposition 1 that an increase in wages will cause housework to rise. Therefore, a rise in real wages, alone, *cannot* account for both Observations 1 and 2.

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[18] While Proposition is very suggestive, given the general nature of the adopted setup it is hard to say much concrete about the impact of technological progress on marriage and divorce, per se. To do so requires either restricting the theoretical setup or numerically simulating the model. The latter is done in the next section. The former strategy is pursued in the Appendix. It can be shown that a one-period decline in the price for purchased household inputs leads to a one-period drop in the rate of marriage and a one-period increase in the divorce rate. By specializing the stochastic structure of the model further, it can be established that a steady-state decline in the price for purchased household inputs leads to a fall in the steady-state fraction of the population that is married.

5.2.4 The Economic Value of Marriage

What is the economic value of married life? One way to measure this is to compute the required income, or compensation, that is necessary to make a single person as well off as a married one with no bliss ($b = 0$). This can be done by solving the following expenditure problem:

$$E(p, w, u^m) = \min_{\tilde{c}^s, \tilde{d}^s, \tilde{h}^s} \{\tilde{c}^s + pw\tilde{d}^s + w\tilde{h}^s\}, \tag{P4}$$

subject to (1) and

$$\mu \ln(\tilde{c}^s - \mathfrak{c}) + (1 - \mu)(\tilde{n}^s)^\zeta / \zeta = u^m. \tag{11}$$

Equation (11) states that the momentary utility level realized by a single agent must equal that of a married one with no bliss, or u^m. Hence, problem (P4) finds the minimum level of expenditure that makes a single person as well off as a married one. A consumption-based measure of the economic benefits from marriage is then given by

$$\ln\left[\frac{E(p, w, u^m)}{w}\right],$$

where w is the value of a single agent's time endowment. The solution to the expenditure problem is surprisingly simple and natural.

Lemma 2 *The compensating differential between married and single life is given by*

$$\ln[E(p, w, u^m)/w] = \ln[2^{1-\phi} + (1 - 1/2^\phi)\mathfrak{c}/w].$$

Proof. See the Appendix, one more time. ∎

The result is very appealing and the underlying intuition straightforward. For expositional purposes, temporarily set $\mathfrak{c} = 0$. On the one hand, a married household has twice the time endowment of a single one. On the other hand, a married household must provide consumption to twice as many members. On net, due to economies of scale in household consumption, a married household realizes $2^{1-\phi}$ ($= 2/2^\phi$) as much consumption as a single one. Now, when $\mathfrak{c} > 0$ an adjustment must be made for the presence of the fixed cost of household maintenance. This reduces a single's consumption by $\mathfrak{c}$ but a married's one by only $\mathfrak{c}/2^\phi$, so that the difference is $(1 - 1/2^\phi)\mathfrak{c}$. Note that the income needed to make a single person as

well off as a married one is not a function of the price of purchased household inputs; one just needs to scale up a single's income by the constant fraction $2^{1-\phi} + (1 - 1/2^\phi)\mathfrak{c}/w$. It is a function of the wage rate, though. At higher wage rates the fixed cost bites less. Finally, Lemma 2 establishes that there is an economic incentive for marriage provided that there is some form of economies of scale in consumption or production; i.e., whenever either $\mathfrak{c} > 0$ or $\phi < 1$.

It may seem a bit puzzling that a fall in price reduces the utility differential between married and single life, $u^m - u^s$, but has no impact on the compensating differential between these two situations, $\ln[2^{1-\phi} + (1 - 1/2^\phi)\mathfrak{c}/w]$. Suppose that one makes the compensation outlined by (P4). Then, married and single households will use labor-saving products in the same intensity, in the sense that $d^m/(c^m - \mathfrak{c}) = d^s/(c^s - \mathfrak{c})$ – see the proof of Lemma 2. This implies that any further change in price will have no impact on the utility differential, $u^m - u^s$, as can readily be seen from (9). Thus, for price changes the compensation only has to be done once; that is, once the compensation has been made, a subsequent price change affects married and single households commensurately. This suggests that for tracking over time the impact of technological progress on the utility differential from marriage the compensating differential is not a perfect measure.

6   Quantitative Analysis

The Household's Dynamic Programming Problems – A Restatement: Given the static nature of the household's time allocation problem (P3), note that the dynamic programming problems for single and married households (P1) and (P2) can be rewritten as

$$W = I(1, p, w) + \beta \int \max[V'(b'), W']dS(b'),$$

and

$$V(b) = I(2, p, w) + b + \beta \int \max[V'(b'), W']dM(b'|b).$$

Here $I(z, p, w)$ gives the maximal level of momentary utility that a z-person household can obtain, given that the price of purchased household inputs is p and that the wage

rate is w. The fact that for a household of a particular size, z, it is possible to calculate their current level of utility, $I(z, p, w)$, without regard to their marriage/divorce decision is very useful. Given a sequence of prices and wages, $\{p_t, w_t\}_t^\infty$, it possible to compute from (P3) the associated sequence of momentary utilities for single and married households, $\{I(1, p_t, w_t), I(2, p_t, w_t)\}_t^\infty$.

6.1 Matching the Model with the Data

In order to simulate the model, numbers must be selected for the various parameters. Except for five of the parameters, almost nothing is known about appropriate values. Additionally, time series for prices and wages need to be inputted into the simulation. Values for the model's parameters will be assigned either on the basis of a priori information or they will be estimated.

6.1.1 A priori information

Take the model period to be one year. In line with convention, say following Kydland and Prescott (1982), set the subjective discount factor at 0.96. The discount factor used in decision making must reflect the individual's probability of survival, $1 - \delta$. A person's life expectancy is $1/\delta$. Thus, if (marriageable) life expectancy for an adult is taken to be 47 years then $1/\delta = 47$. Therefore, set $\beta = 0.096 \times (1 - 1/47)$. Next, let $\phi = 0.77$. This is in line with the O.E.C.D.'s household equivalence scale that treats the second adult in a family as consuming an additional 0.7 times the amount of the first adult. Hence, the parameter ϕ solves $1/2^\phi = 1/(1.0 + 0.7)$. A series for wages can be constructed from the U.S. data. To do this, divide disposable income by hours worked to obtain a measure of compensation per hour.[19] The use of disposable income should (partially) take into account the changes in taxes (and transfers payments) that occurred over this time period. Between 1950 and 2000 compensation per hour worked rose 3.0 times. Thus, the analysis simply presumes

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[19] Specifically, take the series for Disposable Personal Income from the National Income and Product Accounts and divide it through by Hours Worked by Full-Time and Part-Time Employees, both available from the Bureau of Economic Analysis, U.S. Department of Commerce.

that wages rise at $100 \times \ln(3.0)/50 = 2.2$ percent per year. Last, the household production function is characterized by two parameters, viz κ and θ. These have been estimated by McGrattan, Rogerson and Wright (1997). Their numbers are used here.[20]

6.1.2 Estimation

The rest of the parameters will be calibrated/estimated. First, a set of data targets is picked. These targets summarize the data along five dimensions: the time allocations for both married and single households, the fraction of the population married, the divorce rate, and the marriage rate. Second, the parameter values in question are then chosen to maximize the model's fit with respect to these data targets. Specifically, for this section, define $\widetilde{d}_t^j$ to be the j-th data target for period t. Let λ be the vector of parameters to be estimated. The model will yield a prediction for the j-th data target as a function of these parameters and time, denoted by $d_t^j = D^j(\lambda, t)$. The estimation procedure solves

$$\min_{\lambda} \sum_{j=1}^{5} \{ \sum_{t \in \mathcal{T}} I_t^j \omega_t^j [\widetilde{d}_t^j - D^j(\lambda, t)]^2 / [\sum_{t \in \mathcal{T}} I_t^j] \}, \tag{P5}$$

where $I_t^j \in \{0, 1\}$ is an indicator function returning a value of 1 if there is an observation at date t, ω_t^j gives the weight assigned to the target, and $\mathcal{T} \equiv \{1950, 1960, \cdots, 2000\}$. Unlike the theory, the estimation does *not* restrict $\mathfrak{c} \geq 0$ or $\zeta < 0$; the data will decide the magnitudes and signs of these parameter.

It's interesting to compare this strategy for picking parameter values with the conventional one employed in business cycle analysis, discussed in Cooley and Prescott (1995). Business cycle analysis models short-run fluctuations around a *stationary* mean. Hence, parameter values are typically picked so that the model matches up with some relevant long-run averages from the data. In contrast, the current analysis focuses on long-run changes in a *nonstationary* world. The strong trends observed in the data speak to the degree of curvature in tastes and technologies. Thus, the information contained in these trends should be

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[20] The important parameter is the elasticity of substitution between goods and time in production, $1/(1 - \kappa)$. Chang and Schorfheide (2003) also find that goods and time are substitutes in the household production function. Their estimate is not far off from McGrattan et al.'s (1997).

used to estimate parameter values. This is allowed by letting data targets at different points in time enter into (P5). A discussion of the 10 parameters to be estimated and the 16 data targets used to identify them will now follow.

Household Technology Parameters – Time Allocations Obtaining a price series for purchased household inputs is somewhat problematic. So, a time path of the form $p_t = p_{1950} \times e^{-\gamma(t-1950)}$ will be estimated here, where γ is the rate of decline in the time-price for purchased household inputs and p_{1950} is the initial price. The fixed cost for household maintenance, $\mathfrak{c}$, plays an important role in controlling the initial level of market work expended by singles relative to married households. Nothing is known about its value, so it will also have to be estimated. Thus, three household technology parameters will be estimated: $\mathfrak{c}$, p_{1950}, and γ.

To match the model up with the data on time allocations, note that the fraction of time spent by a married household on market work, l^m, is given by $l^m = (2 - h^m)/2$. Likewise, the fraction of time spent by a single household working in the market is $l^s = 1 - h^s$. Now, note that l^m and l^s can be written as functions of the parameters to be estimated, namely $\mathfrak{c}$, p_{1950}, and γ. They are also functions of time, t, and the taste parameters α and ζ. Thus, write $l_t^m = L^m(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta; t,)$ and $l_t^s = L^s(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta; t)$.

To calculate the analogous numbers for the U.S. data, assume that there are 112 non-sleeping hours in a week. Following the footsteps of McGrattan and Rogerson (1998), weekly hours per married and single households can be calculated using U.S. Census Data. For each decennial year between 1950 and 1990 the Census provides hours per week in following intervals: 1-14, 15-29, 30-34, 35-39, 40, 41-48, 49-59, and more than 60 hours. Let E_i denote the number of people that report hours in a particular interval i, E_R represent the total number of people reporting hours, E stand for the total number of people employed, and N be the total population. Then, the fraction of total nonsleeping time allocated to the market is calculated as

$$(7.5E_{1-14} + 22E_{15-29} + 32E_{30-34} + 37E_{35-39} + 40E_{40} + 44.5E_{41-48} + 42E_{49-59} + 62.5E_{60+})\frac{1}{E_R}\frac{E}{N}\frac{1}{112}.$$

This fraction is computed by marital status for all males and females between ages 24 and 54. The fractions of total household time allocated to the market by married households, $\widetilde{l^m}$, and by single households, $\widetilde{l^s}$, are then calculated as the averages across male and female hours. Thus, an observation for $\widetilde{l_t^m}$ and $\widetilde{l_t^s}$ is obtained for each decade t between 1950 and 1990, inclusive.

Now, to operationalize the above in (P5) let $\widetilde{d_t^1} \equiv \widetilde{l^m}$, $D^1(\lambda, t) \equiv L^m(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta; t,)$, $\widetilde{d_t^2} \equiv \widetilde{l^s}$, and $D^2(\lambda, t) \equiv L^s(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta; t,)$ for $t = 1950, 1960, \cdots, 1990$. Also, set $\omega_t^1/2$ and $\omega_t^2/2$ to be the fractions of married and single females in the time-t population of women. (Note that $\omega_t^1 + \omega_t^2 = 2$, the number of data targets for the time allocations.) The theory developed suggests that the parameters $\mathfrak{c}$, p_{1950}, and γ will be important for determining the time paths for hours worked. As a practical matter, it turns out that the time paths for hours worked largely identify the magnitudes of $\mathfrak{c}$, p_{1950}, and γ – note that, as was mentioned earlier, the matching parameters, $\mu_s, \sigma_s, \mu_m, \sigma_m$, and ρ, don't even enter into the $L^m(\cdot)$ and $L^s(\cdot)$ functions.

Taste and Matching Parameters – Vital Statistics   There are seven taste and matching parameters that need to be estimated; namely, α, ζ, μ_s, σ_s, μ_m, σ_m, and ρ. Parameter α determines the weight of market goods in the utility function, while the parameter ζ controls the degree of concavity in the utility function for nonmarket goods. The more concave this utility function is the faster households will move away from nonmarket goods toward market goods as income rises. Hence, this parameter plays an important role in determining how the relative benefits of married versus single life respond to technological progress. The idea here is that information on the trend in vital statistics is important for determining the value of ζ. The remaining six matching parameters govern the noneconomic aspects of marriage – again recall that $L^m(\cdot)$ and $L^s(\cdot)$ are not functions of the matching parameters.

These seven parameters impinge heavily on the model's predictions concerning vital statistics. Here, the data is targeted along three dimensions for two years, 1950 and 2000: the fraction of the population married, the divorce rate, and the marriage rate. So,

let $\widetilde{m}^j_{1950}$ and $\widetilde{m}^j_{2000}$ denote the data targets along the j-th dimension for the years 1950 and 2000. Correspondingly, permit $m^j_{1950} = M^j(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta, \mu_s, \sigma_s, \mu_m, \sigma_m, \rho; 1950)$ and $m^j_{2000} = M^j(\mathfrak{c}, p_{1950}, \alpha, \zeta, \mu_s, \sigma_s, \mu_m, \sigma_m, \rho; 2000)$ to represent the model's steady-state output along the j-th dimension for the years 1950 and 2000. Hence, in (P5) set $\widetilde{d}^{j+2}_t \equiv \widetilde{m}^j_t$, $D^{j+2}(\lambda, t) \equiv M^j(\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta, \mu_s, \sigma_s, \mu_m, \sigma_m, \rho; t)$ and $\omega^{j+2}_t = 1$, for $j = 1, 2, 3$ and $t = 1950$ and 2000. (Again, note that $\omega^3_t + \omega^4_t + \omega^5_t = 3$, the number of data targets for the vital statistics.)

To summarize, the parameter vector $\lambda \equiv (\mathfrak{c}, p_{1950}, \gamma, \alpha, \zeta, \mu_s, \sigma_s, \mu_m, \sigma_m, \rho)$ is estimated so that model matches the data on five dimensions: the time allocations for married households, the time allocations for single households, the fraction of the population married, the divorce rate, and the marriage rate. This involves 16 observations from the U.S. data.[21] Due to the heavy time costs of simulating the full model, the parameter α was arbitrarily restricted to lie in a 21-point discrete set $\mathcal{A} = \{0.2, \cdots, 0.278, \cdots, 0.4\}$.[22] The parameter values obtained from the above procedure for matching the model with the data are presented in

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[21] The estimation procedure employed is similar to one used by Andolfatto and MacDonald (1998). Given the paucity of observations there is little point in adding an error structure to the estimation.

[22] This set contains the value of α calibrated by Greenwood and Hercowitz (1991) for a business cycle model that includes household production and does not put leisure into the utility function. It also contains the value suggested by Cooley and Prescott (1995) for the standard real business cycle model. The results obtained are not that sensitive to the choice of α. Hence, this restriction is not that severe. Also, the spacing between the points in $\mathcal{A}$ is not linear. The set is refined over 3 successive iterations so that the points are clustered the closest around the optimal solution $\alpha = 0.278$.

Table 2.

<div align="center">TABLE 2: PARAMETER VALUES</div>

Category	Parameter Values	Criteria
Tastes	$\beta = 0.960 \times (1 - \delta)$, $\phi = 0.766$,	a priori information
	$\alpha = 0.278$, $\zeta = -1.845$	estimated – vital statistics
Technology	$\mathfrak{c} = 0.131$,	estimated – hours data
	$\theta = 0.206$, $\kappa = 0.189$	a priori information
Life span	$1/\delta = 47$	a priori information
Shocks	$\mu_s = -4.195$, $\sigma_s^2 = 8.002$,	estimated – vital statistics
	$\mu_m = 0.562$, $\sigma_m^2 = 0.698$, $\rho = 0.897$	
Prices	$p_{1950} = 10.759$, $\gamma = 0.060$,	estimated – hours data
	$p_t = p_{1950} \times e^{-\gamma \times (t-1950)}$ for $t = 1951, ..., 2000$	
Wages	$w_{1950} = 1.00$,	normalization
	$w_t = w_{1950} \times e^{0.022 \times (t-1950)}$ for $t = 1951, ..., 2000$	a priori information

6.2 Results

Visualize the economy in 1950. Wages are low and the price for purchased household inputs is high, at least relative to 2000. Over time wages grow and the price for purchased household inputs falls. The time paths for wages and prices inputted into the analysis are shown in Figure 4. As can be seen, in the U.S. data wages increase 3.0 times over the time period in question. Prices are estimated to decline by a factor of 20. This seems large, but it is merely the result of compounding a 6.0 percent annual decline over a 50-year period. Can these two facts help to explain the decline in marriage and the rise in divorce over the last 50 years? This is the question asked here.

6.2.1 Household Hours

The time path for household hours that arises from the model is shown in Figure 5. It mimics the U.S. data reasonably well. In particular, the model matches very well the sharp
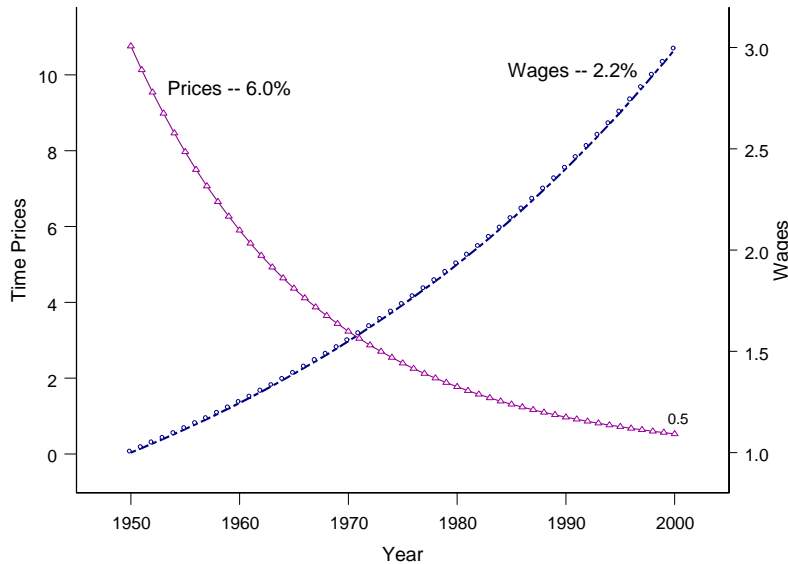
Figure 4: Wages and Prices, 1950-2000 – Model Inputs.

increase in the fraction of time devoted to market work by married households. This is due to the declining price for purchased household inputs. The estimation procedure picks a 6.0 percent annual rate of price decline. This looks reasonable.[23] Purchased household inputs and housework are substitutes in household production. As the price of purchased household inputs declines, households substitute away from using labor at home toward using goods. The model has trouble mimicking the enigmatic U-shaped pattern for single households – still, note the presence of an attenuated U, though. It does a reasonable job at predicting the rise in participation from 1970 on.[24] Observe that in 1950 married households

[23] For instance, the Gordon quality-adjusted time price index for air conditioners, clothes dryers, dishwashers, microwaves, refrigerators, TVs, VCRs, and washing machines fell at 10 percent a year over the postwar period.

[24] The estimation scheme weights marrieds and singles by their prevalence in the population. Instead re-estimate the household technology parameters, holding fixed the tastes and matching parameters (except for ζ), just using the hours data for singles from 1970 on. Doing this results in $\mathfrak{c} = 0.051$, $p_{1950} = 0.8836$, and $\gamma = 0.021$. The model then fits this rising portion of single hours nearly perfectly – it still can't get the U shape, though. The fit for married labor supply is a little worse, but not bad. The predictions for vital statistics are very close to the ones currently obtained, when $\zeta = -3.5$. Note that a higher value for ζ is

devoted a smaller fraction of their time to market work than did single ones, both in the data and model. In the model this derives from the fixed cost of household maintenance.[25]

This forces low-income households to work more than high-income ones. In the model the low-income households are singles. As wages rise this effect disappears. By 1990 in the U.S. married households worked more than singles ones did. This is surprising since married households are much more likely to have children. In the model, they work about the same. Perhaps, in the real world, more productive individuals are also more desirable on the marriage market. Indeed, Cornwell and Rupert (1997) provide evidence that this is the case. Such a marriage-selection effect is missing in the model.

6.2.2 Vital Statistics

Now, the model starts off from an initial steady state that resembles the U.S. in 1950 and converges to a final one looking like the U.S. in 2000. In 1950 about 81.6 percent of the female population was married (out of non-widows who were between the ages of 18 to 64). There were 10.6 divorces per 1,000 married females, and 211 marriages. According to Schoen (1983) marriages lasted about 30 years in 1950. In 2000 the picture was quite different. Only

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picked to compensate for the lower rate of price decline, γ. For predicting the targets presented in Table 3, the results never differ by more than an absolute value of 0.02, relative to the baseline model – the difference is usually much smaller. Alternatively, one could use the whole series for singles hours. A U-shaped pattern emerges with some worsening of fit elsewhere. The overall fit for the model isn't noticeably better for either of these two estimation schemes.

[25] Suppose that married and single households have different fixed costs, $\mathfrak{m}$ and $\mathfrak{s}$. Re-estimating the model, holding fixed the taste and matching parameters (except for ζ), results in $\mathfrak{m} = 0.1585$, $\mathfrak{s} = 0.1366$, $p_{1950} = 15.116$, and $\gamma = 0.068$. Not surprisingly, the fixed cost for married households is bigger than the one for singles. The fit for married female labor supply is now slightly better, while the one for singles is about the same. More or less the same predictions for the vital statistics are obtained (when $\zeta = -1.845$ and the other taste and matching parameters are held fixed). The results for the targets presented in Table 3 never differ by more than an absolute value of 0.004, relative to the baseline model.

One could also add a fixed cost for household maintenance expressed in terms of nonmarket goods; i.e., rewrite the nonmarket goods part of the utility function as $(1 - \alpha)[(n - \mathfrak{n})/z^\phi]^\varsigma/\varsigma$, where $\mathfrak{n}$ is the fixed cost and $z = 1, 2$ is household size. A re-estimation of the household technology parameters for the model (holding fixed the other parameter values) established that this version of the model matched the hours worked data about as well as the benchmark model. At the old taste and matching parameter values, there are too many marriages in 1950. This is because the incentives to get married are now even higher. On this, the estimation scheme also picks a larger value for $\mathfrak{c}$ ($= 0.1463$) in the presence $\mathfrak{n}$ ($= 0.0919$) to keep singles working in market. The taste and matching parameters can be jiggled however so that this version of the model gives about as good (or bad) results as before.
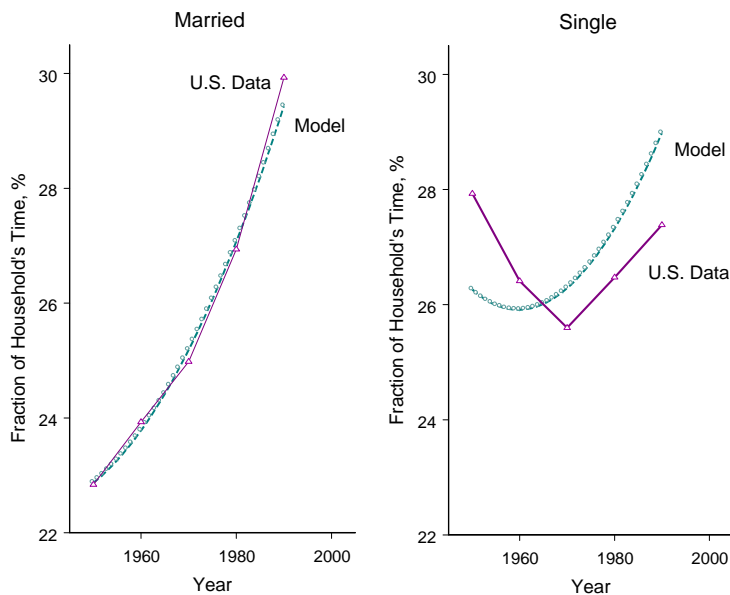
Figure 5: Household Hours, 1950-1990 – U.S. Data and Model.

62.5 percent of females were married. The divorce rate had risen to 23 divorces by 1995, and the marriage rate had declined to about 80 marriages.[26]   Finally, the average duration of marriages was about 20 to 24 years.[27]   Table 3 shows the model's performance along these dimensions. Note that singles face a distribution with a low mean and a high variance, while married people face a distribution that has relatively a high mean, low variance, and high autocorrelation – see Table 2. This has two effects. First, it encourages singles to wait a while until a good match comes along. Second, it generates the long durations of marriages observed in the data.

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[26] Divorce and marriage statistics from the National Center for Health Statistics are not available after 1996.

[27] There are not any recent estimates for the duration of marriages. Schoen and Standish (2001) estimate that the duration of marriages to be about 24 years in 1995, while Espenshade (1985) estimates it to be 22.5 years for white females and 14.6 for black females over the period 1975-1980.

The steady-state duration of marriages in the model is given by

$$d_m = \frac{1}{1 - \pi_{mm}(1 - \delta)},$$

where π_{mm} is the probability of a married agent remaining married next period.

31

	1950		2000	
	Model	Data	Model	Data
Fraction married	0.818	0.816	0.678	0.625
Probability of divorce	0.011	0.011	0.026	0.023
Probability of marriage	0.131	0.211	0.094	0.082
Duration of marriages	31.31	29.63	21.47	20-24

The fraction of the population that is married declines with the passage of time in the model. Figure 6 compares results obtained from the model with the U.S. data. The model can explain 14 percentage points of the observed 19 percentage point decline in the number of married females. This seems reasonable since other things went on in the world, such as a rise in the number of people going to college, a decline in fertility, etc. Observe that the utility differential between married and single life declines over time.[28] [29] This occurs for two reasons. First, recall that the utility function for nonmarket goods is more concave than the one for market goods. Thus, high-income households (married couples) spend less on household inputs relative to market consumption than do low-income household (singles). As a consequence, a fall in the price of purchased household inputs has a bigger impact on singles vis à vis married couples. Second, as wages rise the importance of the fixed cost for household maintenance disappears. This is more important for single households than married ones. Finally, many couples choose to live together but not marry. The framework can be thought of as modelling couples living together. The fraction of females living with a male fell by 16 percentage points between 1960 and 2000.[30] From this angle, the model

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[28] In line with the discussion surrounding Lemma 2 the compensating differential needed to make a single as well off as a married person only falls from 20.7 percent to 17.7. This small decline is due to the fact that the fixed cost, $\mathfrak{c}$, is only a small fraction of the value of a single's time endowment, w.

[29] Cho and Siow (2003) estimate a non-transferable utility model of the U.S. marriage market. Their estimates show that the gains to marriage for young adults fell sharply between 1971 and 1981.

[30] The fraction of females living with a male is defined to be the fraction of females who are married plus the fraction of females who are unmarried living with a male. The size of this latter group is tabulated using
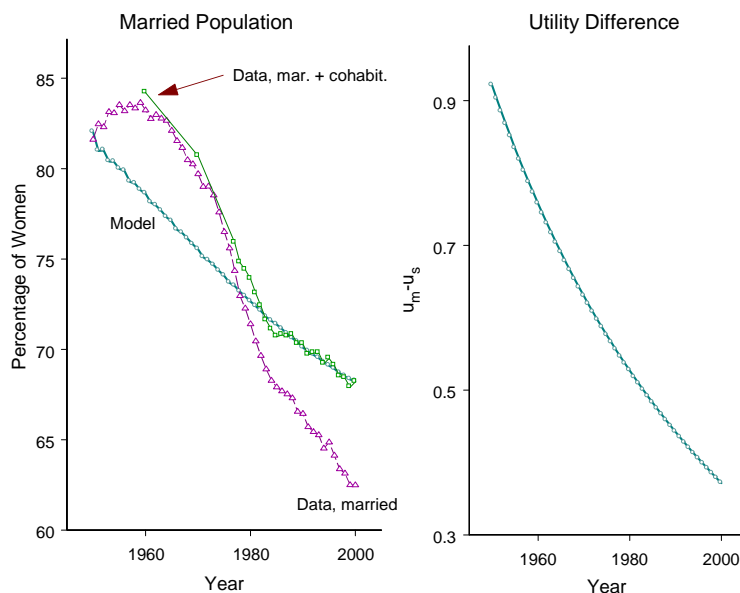
Figure 6: The Decline in Marriage, 1950-2000 – U.S. Data and Model.

captures about 88 percent of the decline between 1950 and 2000.[31] Interestingly, the model seems to do well predicting the number of marriages for the first half of the sample, and the number of cohabitations for the later.

Underlying the decline in the fraction of the U.S. population that is married is a rise in the divorce rate and a decline in the rate of marriage. This is true for the model too, as can be seen in Figure 7. In the model divorces rise from 11 to 26, per 1,000 married women. This compares with 11 to 23 in the data. Marriages, in the model, fall from about 131 to 94 per 1,000 unmarried women. In the data they dropped from 141 to 69 or from 211 to 82, depending on the measure preferred. Thus, by either measure, the drop in marriages in the model is a little anemic. Again, it is not surprising that the model does not do well in this regard. Some important factors have been left out, such as the rise in education that surely

the Census Bureau's 'posslq' household variable – persons of the opposite sex living together. This variable unfortunately also includes people who aren't partners. Still, it probably is a good proxy for the number of cohabitations.

[31] Note that the number of unmarried couples living together before 1960 would have been small and can be safely ignored.
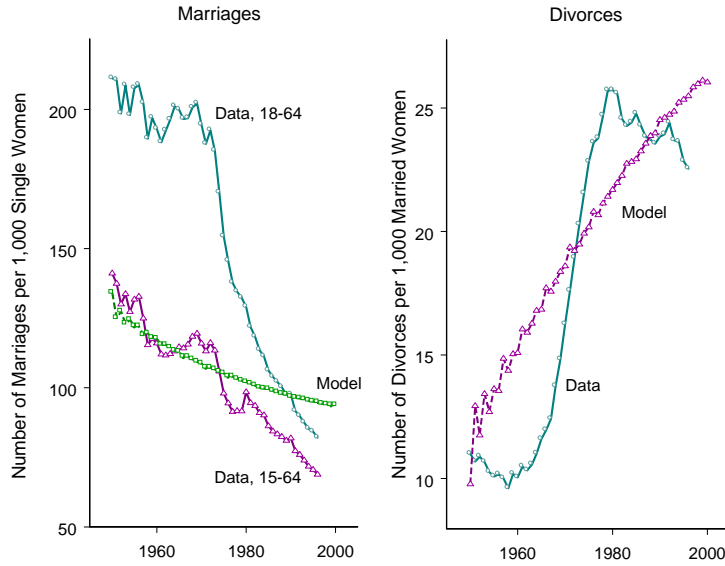
33

Figure 7: Rates of Marriage and Divorce, 1950-1996 – U.S. Data and Model

must be associated with the delay in first marriages, or a narrowing in the gender gap that may have promoted female labor-force participation and made single life a more desirable option for females.[32]   Last, in the data the duration of a marriage was 30 years in 1950. By 2000 this had declined to 20 years. The model does well in this regard. It predicts that duration of a marriage was 31 years in 1950 and 21 years in 2000.[33]

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[32] Regalia and Rios-Rull (2001) show that the decline in the gender gap played a significant role in the rise of single households during the 1970-1990 period.

[33] Recall that the estimation strategy uses information on the trends in labor supply and vitals statistics over the entire sample to identify the key parameters $\mathfrak{c}$, γ, and ζ. To check for the robustness of this strategy, the model was partially re-estimated (over the $\mathfrak{c}$, γ, p_{1950}, and ζ parameters) to fit the 1950 to 1970 subperiod. In particular, for $\mathfrak{c} = 0.1459$, $\gamma = 0.068$, $p_{1950} = 16.219$, and $\zeta = -1.7$, the model did a good job matching labor supply and vital statistics for the subperiod. Using these estimates the model's predictions for the year 2000 were then generated. They are surprisingly close to the benchmark model. The results for 1950 are: fraction married, 0.827; probability of divorce, 0.010; probability of marriage, 0.135; duration of marriages, 32.20. For 2000 the corresponding figures are 0.675, 0.026, 0.093, and 21.33.

7   1920-2000: A Proposed Extension

The effects of technological progress on the formation of households were beginning to per-colate before World War II. How are these effects manifested in data? Can the model be modified to address them?

7.1   The Marriage Data

Figure 8 plots the proportion of the female population that was married from 1880 to 2000.[34] About 72 percent of the population was married in 1900, as opposed to 62 percent in 2000. So, 10 percentage points less women were married at the end of the 20th century relative to the beginning. Observe that the number of marriages shows a ∩-shaped pattern roughly coinciding with the baby boom years. This pattern is not as dramatic as it seems at first glance. The population was much younger at the turn of the last century than it is today. Women aged 18 to 30 made up 44 percent of the population in 1900. Now, they account for 26 percent. Young women are much less likely to be married than older ones. Figure 8 also shows the fraction of the female population that are married after making a correction for the shift in the age distribution.[35]   First, note that much more females were married at the

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[34] The facts reported in this Section are based on tabulations from data obtained from the U.S. Census, downloaded from IPUMS-USA, Minnesota Population Center, University of Minnesota.

[35] The adjustment is done using the typical method employed by demographers. Let p denote the total female population at a point in time. Suppose that this population is made up of I age groups. Define p_i to represent the number of women in the i-th age group and allow m_i to proxy for the number of these women who are married. The fraction of married females in the total population is then given by

$$f = \sum_{i=1}^{I} \frac{m_i}{p_i} \frac{p_i}{p}.$$

Hence, f depends both on the age composition of the population (or the p_i/p terms) and on the fraction of each age group who is married (or the m_i/p_i terms). Now, for any year t define an age-adjusted measure by

$$\widehat{f_t} = \sum_{i=1}^{I} \frac{m_{i,t}}{p_{i,t}} \frac{p_{i,2000}}{p_{2000}}.$$

Thus, $\widehat{f_t}$ calculates the fraction of women that would be married if the age composition of 2000 was in effect at time t.
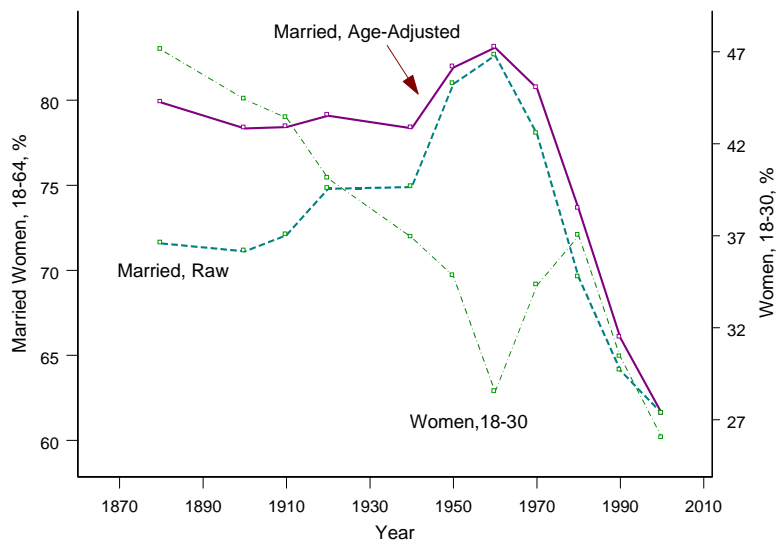
Figure 8: Marriage, 1880-2000.

beginning of the century as opposed to the end, about 17 percentage points more. Second, the hump is still there, but it is much less pronounced. What can account for this hump-shaped pattern in marriage? Specifically, why did the number of marriages rise between 1940 and 1960, and subsequently decline?

7.2 Living Arrangements of Young Adults

At the beginning of the 20th century the vast majority of never-married young females (close to 80 percent) lived as dependents with their parents. A substantial fraction lived in households as non-relatives; viz, boarders, servants, etc. Almost none lived in their own household, however. The fraction of young stand-alone households made up by singles has become much more prevalent over time. It has risen from close to zero at the turn of the last century to about 50 percent today, as Figure 9 illustrates.[36]   Additionally, Figure 9 plots

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[36] In Figure 9 an independent single female is defined to be a never-married woman who is either the head of a household, or the friend or partner of a householder. The curve labeled 'single, on own' graphs this group relative to all single females. The curve marked 'married' shows the number of married females
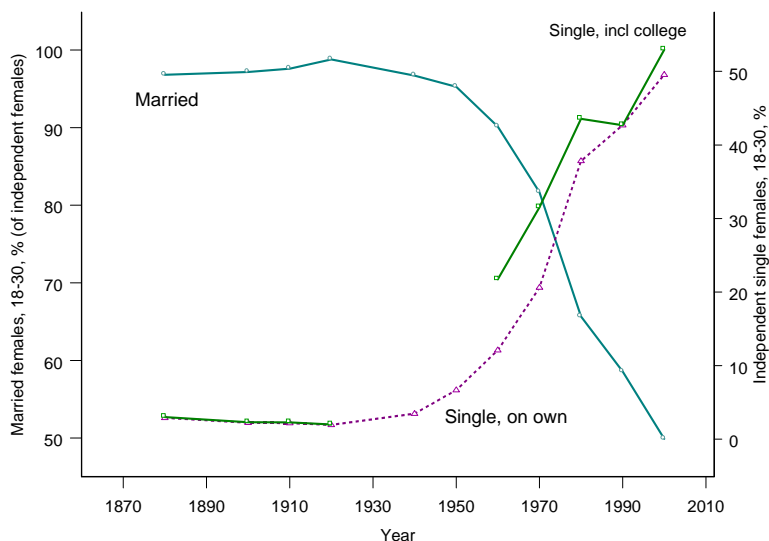
Figure 9: Living Arrangements for Young Women, 1880-2000.

the proportion of young households made up by married couples. As can be seen, it fell from nearly 100 percent at the turn of the last century to less than 50 percent today. Interestingly, this plot shows a monotonic decline from roughly 1910 on; the hump has disappeared.

7.3 Returning to the Hypothesis

The idea here is that technological progress in the household sector made it feasible to establish smaller and smaller households. In the initial stages of development technological advance made it easier for a young adult to leave his or her parent's home and marry. As household technology progressed further it became viable for young adults to leave home and remain single. Therefore, the move by young adults from large to two-person households coincided with an increase in marriages while the subsequent shift toward one-person households was associated with a decline. This hypothesis is consistent with the decline in the fraction of total young households made up by married ones that was shown in Figure

relative to the number of married plus independent single ones. The plots are restricted to women in the 18-to-30 age group.

9.

7.3.1 Altering the Setup

To gauge whether or not this hypothesis has promise consider the following simple extension of the model. Let there now be three types of individuals: singles living at home with their families (dubbed young adults), singles living in their own homes, and married couples living in their own households. Suppose that a young adult living with his family receives a momentary utility of $H(w,p) - x$. Here $H(w,p)$ gives the economic benefit from living at home, as a function of the underlying state of the economy (w,p). The variable x represents the psychic disutility from living at home (versus alone) so to speak. It is distributed across the population according to the distribution function X. Each single starts adulthood living at home with their families and must make a decision about whether or not to leave his family's home. Assume that a young adult leaves home single and then looks for a mate. Once departed, he can never return. Also presume that a family realizes no benefit from a child staying at home. The rest of the setup remains the same as before. The analysis will focus on steady states.

The criteria underlying a young adult's decision about whether or not to move out is summarized below.

<p align="center">Table 4: Decision to leave home</p>

Leave Home	*if*	$W(w,p) \geq [H(w,p) - x]/[1 - \beta(1 - \delta)]$
Remain Home	*if*	$W(w,p) < [H(w,p) - x]/[1 - \beta(1 - \delta)]$

A young adult will leave home when the benefit from independent single life, $W(w,p)$, exceeds the benefit from living with his family, $[H(w,p) - x]/[1 - \beta(1 - \delta)]$. Now, define x^* by the equation

$$W(w,p) = [H(w,p) - x^*]/[1 - \beta(1 - \delta)].$$

Clearly, a young person will leave home when $x \geq x^*$, and will stay there when $x < x^*$. The number of people deciding to live at home will be given by $X(x^*)$. Now, consider

an increase in wages or a fall in the prices. These will lead to reductions in the number of young adults living at home so long as the benefits of independent single life rise more than the benefits of a dependent one; i.e., so long as $W_1(w, p) > H_1(w, p)/[1 - \beta(1 - \delta)]$ or $W_2(w, p) < H_2(w, p)/[1 - \beta(1 - \delta)]$. The considerations ensuring this are likely to be parallel to those outlined in the Section 5, as will be seen.

Note that problems (P1) and (P2) remain the same as before, since the decision to leave home is irreversible and because a married couple realizes no utility from a child living at home. In a steady state the equation specifying the type distribution for marriages will appear as

$$\mathbf{M}(b) = (1 - \delta) \int_{\mathcal{M} \cap [0,b]} \int dM(\widetilde{b}|b_{-1}) d\mathbf{M}_{-1}(b_{-1}) + \{(1 - \delta)s + \delta[1 - X(x^*)]\} \int_{\mathcal{M} \cap [0,b]} dS(\widetilde{b}),$$

with

$$\int dM(b) + s + X(x^*) = 1, \qquad \text{[cf. (5)]}.$$

Therefore, a huge virtue of this setup is that it involves little modification to the original formulation.

7.3.2   An Example

Does the above setup have promise for extending the earlier analysis to the pre-World War II period? To address this question, the model's potential will be demonstrated using a simple example. The example will focus on three years, to wit 1920, 1950 and 2000. For each year the model's steady state will be computed. The output from the model will then be compared with the stylized facts discussed in Sections 7.1 and 7.2. It should be emphasized that given the simplicity of the setup, the example is intended only as an illustration; it should not be viewed as a serious data-fitting exercise.

For the taste and technological parameters, take the values presented in Table 2 with two changes. Presumably the price for purchased household inputs fell faster earlier in the last century than later on. So, allow the price to fall at the constant rate γ_{1920} prior to 1950. Additionally, the fixed cost for household formation will be allowed to differ for

this subperiod as well. Denote this by $\mathfrak{c}_{1920}$. The above setup changes the pool of singles that are available on the marriage market. So, new matching parameters will be selected. These values will apply for the whole 1920 to 2000 period. Something must be specified for the economic benefit that a young adult derives from staying at home with his parents, $H(w, p)$. Simply suppose that each family has two kids and set $H(w, p) = I(4, p, w)$. That is, each period a young adult who stays at home realizes the maximal level of momentary utility that would arise in a household with four wage earners. [One could just as easily set $H(w, p) = \vartheta I(4, p, w)$ for some $\vartheta \in (0, 1)$. The essential requirement is that the economic benefit of living in a large household should decline over time relative to a small one.] Last, the distribution X governing the disutility from living at home with one's parents will be represented by a discrete distribution that approximates (over a range covering the three steady-state values for x^*) a normal distribution with a mean and variance denoted by μ_x and σ_x^2. Given the primitive nature of the example, the parameters values are selected so that the model's steady states display some features of interest, discussed below. The parameter values selected are presented in Table 5.

TABLE 5: NEW PARAMETER VALUES – EXAMPLE

Household Production	$\mathfrak{c}_{1920} = 0.161$, $\gamma_{1920} = 0.172$
Shocks	$\mu_s = -3.75$, $\sigma_s^2 = 8$
	$\mu_m = 0.6$, $\sigma_m^2 = 0.9$, $\rho = 0.7$
Utility of Living at Home	$H(w, p) = I(4, p, w)$
Disutility of Living at Home	$\mu_x = 1.999$, $\sigma_x^2 = 2.794$

In the model 63.8 percent of single women work in 1920, the same number as in the data for women between the ages of 18 and 64 – see Table 6. Likewise, only 7.8 percent of married women work in 1920, again the same as is observed in the data. By construction, the model still generates the hours-worked predictions shown in Figure 5 for the period 1950-1990.[37]

This transpires because the hours-worked decisions are functions solely of the taste and

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[37] Prior to 1950 it is not possible to obtain hours-worked data for married and single females. Thus, for

technology parameters, and these haven't been changed for the 1950 to 2000 period. Table 7 presents the results for some vital statistics.[38]   The statistics for the U.S. data apply to women in the 18-to-64 age group (as in Table 3). The numbers have also been adjusted for the shift in U.S. age distribution, which was discussed earlier. First, as can be seen, the model replicates quite nicely the stylized facts for the fraction of females who are married. In particular, the model duplicates the ∩-shaped pattern displayed in the data.[39]   Second, it also does a reasonable job predicting the decline in the proportion of single females that live at home with their parents. Third, analogously, it mimics well the rise in fraction of single females that live alone. All in all, it looks like an extension of the framework that models the decision of a young adult to leave home has promise for explaining the trends in vital statistics that are observed in the U.S. data.

TABLE 6: PARTICIPATION RATES – 1920

	Model	Data
Married	0.078	0.078
Single	0.638	0.638

1920 labor-force participation rates are used instead. This is done by heroically assuming that the work week is fixed at 40 hours and that there are 112 nonsleeping hours in a week. It is also assumed that all males work a 40 hour week. Denote the rates of participations for married and single females by f_{1920}^m and f_{1920}^s. Then, for the model f_{1920}^m and f_{1920}^s can be obtained from hours worked, h_{1920}^m and h_{1920}^s, by using the formulae

$$\frac{2 - h_{1920}^m}{2} = \frac{40 + 40 \times f_{1920}^s}{2 \times 112} \text{ and } 1 - h_{1920}^s = \frac{40 + 40 \times f_{1920}^s}{2 \times 112}.$$

[38] The numbers in Table 7 for the U.S. data derive as follows: First, the counts for the fractions of females who are married, m, are taken from the data displayed in Figure 8. Second, in the model only never-married females live at home. Suppose that this is true in the data as well. Then, $X(x^*)$ is simply the fraction of females who are single, never-married, and live at home. Third, $s = 1 - m - X(x^*)$. All numbers in the table refer to women in the 18-to-64 age group and have been adjusted to control for shifts in the age distribution of the population (in the manner discussed in Footnote 35).

[39] An improvement in fitting the numbers for 2000 can be obtained at the sacrifice of a diminution in the left-hand side of the hump.

	1920		1950		2000	
	Model	Data	Model	Data	Model	Data
Married – m	0.791	0.791	0.813	0.819	0.722	0.616
Single, Living at Home – $X(x^*)$	0.186	0.185	0.126	0.125	0.109	0.109
Single, Living Alone – s	0.023	0.024	0.061	0.056	0.169	0.275

7.3.3 Discussion

The proposed extension of the benchmark model is minimalist, to say the least. It is easy to identify areas of the analysis that warrant further work. At the heart of the above extension is a young adult's decision to leave home. Perhaps one could allow for a young adult to search for a mate while at home. Three options would then arise: stay at home, leave home married, and leave home single. Doing this will be important for matching the rates of marriage that are observed in the data.[40]   In the earlier part of the last century most females got engaged before they left home. Therefore, the model cannot hope to match the observed rates of marriage at early dates if marriagability is restricted to the small pool of single females living alone. Additionally, should searching for a mate while living in your parent's home be as efficient as searching for one when you live alone? Modelling the utility that a young adult receives while at home is another area where the framework could be improved. Do transfers flow from young adults to parents, or vice versa? The answer to this will depend upon how parents care about their kids, how children feel about their parents, and their mode of interaction.

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[40] Since marriage and divorce rates are not available by age, it is not possible to calculate age-adjusted rates for these data. The marriage rate could be very sensitive to age adjustment.

8 Conclusions

The fraction of adult females who are married has dropped by roughly 20 percentage points since World War II. Females now spend a much smaller part of their adult life married than 50 years ago. Associated with this has been a rise in the divorce rate and a decline in the rate of marriage. At the same time, hours worked by married households rose considerably. This was driven by a large increase in labor-force participation by married females.

An explanation of these facts is offered here. The story told focuses on technological progress in both the household and market sectors. The idea is that investment-specific technological progress in the household sector reduced the need to use labor at home. This simultaneously allowed women to enter the labor force and eroded the economic incentives for marriage. The analysis blends together a search model of marriage and divorce with a model of household production. The economic incentives for marriage derive from economies of scale in household production. These are whittled away overtime for two reasons. First, rising wages make it easier to meet or exceed the fixed cost for household maintenance. This reduces the need to marry to make ends meet. Second, a falling price for labor-saving household inputs has a bigger impact on single vis à vis married households, since the former devote a larger share of their spending to these products due to a high rate of diminishing marginal utility for nonmarket consumption. These two effects increase the (relative) value of single life.[41]

So, where can the analysis go from here? Technological progress in the home and market may affect the pattern of matching in society. There is some evidence that the degree of assortative mating in the U.S. has increased since 1940.[42] Extensions of the model may be able to capture this. Suppose that individuals differ in their labor market productivities.

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[41] The economic forces that reduce the relative benefit of single versus married life may also have affected other living arrangements, such as the incentives of the elderly to live with their kids. Between 1970 and 1990 the fraction of widows living alone rose from 52.1 to 64.2 percent. Bethencourt and Rios-Rull (2004) argue that the rise in the relative income of elderly widows can account for a significant part of the rise in the number of elderly widows living alone between 1970 and 1990.

[42] See Lam (1997) for some facts on the correlation of income levels across partners and Mare (2000) for education.

Assume that married males devote all of their time to market work while married females split their time between market work and household work. Now, when choosing a potential mate their earnings on the labor market will be a consideration. This will matter less at early stages of economic development, since married women will do little market work due to the large amount of time spent in household production. As women start to work more in the market, due to technological progress, it will begin to matter more. As an economy advances and the benefits from economies of scale in household consumption diminish, earnings potential along with marital bliss will become more important criteria when choosing a mate. The degree of assortative mating will increase. Additionally, such an analysis would likely imply that the drop in the marriage rate should be biggest for those individuals in lower income groups, since the relative benefits from marriage will fall the most for them. Indeed, there is some evidence suggesting that this has been the case.[43]

9   Appendix

9.1   Proofs

As a prelude to the proofs of the lemmas and propositions, combine (7) and (8) to obtain

$$d = [\frac{(1-\theta)p}{\theta}]^{1/(\kappa-1)}h \equiv R(p)h. \tag{12}$$

Using this in (6) then gives

$$c - \mathfrak{c} = w[(z - \frac{\mathfrak{c}}{w}) - h] - wpd = w[(z - \frac{\mathfrak{c}}{w}) - h] - wpR(p)h. \tag{13}$$

Finally, by substituting (12) and (13) into (8) a single equation can be obtained in one unknown, namely h:

$$\alpha[\theta R(p)^{\kappa} + (1-\theta)]^{1-\zeta/\kappa}h^{1-\zeta} = (1-\alpha)(1-\theta)z^{-\phi\zeta}[(z - \frac{\mathfrak{c}}{w}) - h - pR(p)h]. \tag{14}$$

The solution is portrayed in Figure 10. It is easy to deduce that the left-hand side of (14) is increasing in h, since $\zeta < 0$. It is trivial to see that the right-hand side is decreasing in h.

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[43] See Wallace (2000) who finds that the decline in the marriage rate is inversely related to the level of education.
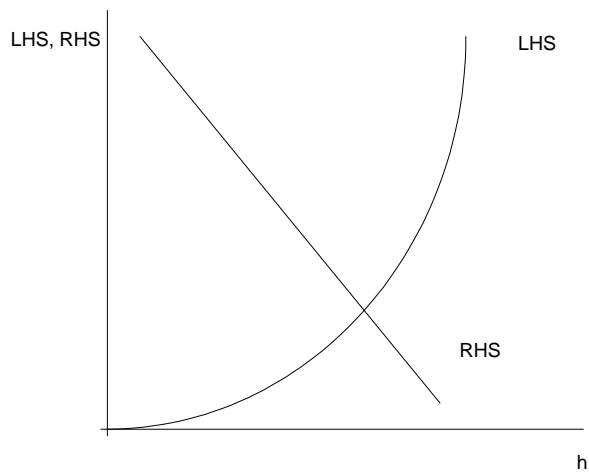
Figure 10: The Determination of h.

Proof of Proposition 1. On (i), observe that both $R(p) = \{[(1-\theta)/\theta]p\}^{1/(\kappa-1)}$ and $pR(p)$ are decreasing in p, since $0 < \kappa < 1$. Therefore, the right-hand side of (14) falls with a drop in p, as $-pR(p)$ is increasing in p. Thus, the RHS curve in Figure 10 will shift down when p declines. The left-hand side increases with a reduction in p because $R(p)^\kappa$ is decreasing in p. Hence, the LHS curve shifts up. As a consequence, h unambiguously drops. For (ii) and (iii), note that w and $\mathfrak{c}$ only enter into (14) in the form $\mathfrak{c}/w$. It's trivial to see that the right-hand side of (14) is decreasing in $\mathfrak{c}/w$, while the left-hand side is not a function of $\mathfrak{c}/w$. Therefore, an increase in $\mathfrak{c}/w$ will cause h to fall. The desired results follow immediately. ■

What is the relationship between the size of a household, on the one hand, and the amount of time allocated to housework and spending on goods, on the other hand? One would expect housework, h, to rise when size, z, increases because the total endowment of time has risen. This is true. A more interesting question is whether or not housework rises by a factor more or less than the proportionate increase in household size. On the one hand, given that the utility function for nonmarket goods is more concave than the one for market goods, the household has a preference for diverting extra resources into market consumption.

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This suggests that housework will increase less than proportionately with size. On the other hand, at higher levels of income the fixed cost for household maintenance will matter less. This propones that housework will rise more than proportionately with size. While the result turns out to be ambiguous, a useful upper bound on the response of housework to household size can be derived. This is presented in Lemma 3, which is an important step toward proving Proposition 2. Using this upper bound, it can be shown that married households spend less than single households do on the inputs into household production, d and h, at least relative to market consumption, $c - \mathfrak{c}$.

Lemma 3 *A rise in z by a factor of $\lambda > 1$ leads to an increase in h by a factor strictly less than $\rho = (\lambda z - \mathfrak{c}/w)/(z - \mathfrak{c}/w)$. When $\zeta = 0$ (ln utility for nonmarket goods) a magnification in z by a factor of $\lambda > 1$ will cause h to expand by exactly a factor of ρ.*

Proof. Rewrite equation (14) as

$$\alpha[\theta R(p)^\kappa + (1 - \theta)]^{1 - \zeta/\kappa} h^{-\zeta} h + (1 - \alpha)(1 - \theta)(1 + pR(p))z^{-\phi\zeta} h$$
$$= (1 - \alpha)(1 - \theta)z^{-\phi\zeta}(z - \mathfrak{c}/w).$$

If z increases by factor $\lambda > 1$ then $z - \mathfrak{c}/w$ rises by the factor $\rho \equiv (\lambda z - \mathfrak{c}/w)/(z - \mathfrak{c}/w) > \lambda$. Now, the right-hand side rises by the factor $\lambda^{-\phi\zeta}\rho$. Observe that if h rises by the factor ρ then the left-hand side will increase by more than the factor $\lambda^{-\phi\zeta}\rho$, because $\rho^{-\zeta} > \lambda^{-\phi\zeta}$ when $\zeta < 0$ and $0 < \phi < 1$. Therefore, to restore equality between the left-hand and right-hand sides of the above equation, h must rise by less than the factor ρ. The first part of the lemma has been established. Last, suppose that $\zeta = 0$. In this case, (14) reduces to

$$h = \frac{(1 - \alpha)(1 - \theta)(z - \mathfrak{c}/w)}{\alpha[\theta R(p)^\kappa + (1 - \theta)] + (1 - \alpha)(1 - \theta)(1 + pR(p))}. \tag{15}$$

The second part of the lemma follows immediately. ∎

In line with the intuition presented above on the relationship between household size and allocations, suppose that $\mathfrak{c} = 0$. In this case, $\rho = \lambda$. Thus, larger households will devote proportionately less of their time to housework than smaller ones, since an increase in household size by a factor $\lambda > 1$ will lead to a rise in h by a factor less than $\rho = \lambda$. Next,

suppose that $\zeta = 0$ and $\mathfrak{c} > 0$, so that both market goods and nonmarket goods have ln utility. If z increases by a factor of λ then h will rise by exactly the factor $(\lambda z - \mathfrak{c}/w)/(z - \mathfrak{c}/w) > \lambda$. Now, larger households spend proportionately more of their time on housework relative to smaller ones. This lemma will now be use in the proof of Lemma 1.

Proof of Lemma 1.   First, result (iii) is immediate from Lemma (3). Second, it is easy to see that (ii) is implied by equation (12) and result (iii). By using (ii) and (iii), in conjunction with equation (13), result (i) can be obtained. Last, the situation for $\zeta = 0$ is readily handled by using the closed-form solution (15). ∎

Proof of Corollary.   From Lemma 1, note that when $\zeta \leq 0$ it transpires that $(c^m - \mathfrak{c}) \geq 2(c^s - \mathfrak{c})$, since $[(2 - \mathfrak{c}/w)/(1 - \mathfrak{c}/w)] \geq 2$. Thus, $(c^m - \mathfrak{c})/2^\phi \geq 2^{1-\phi}(c^s - \mathfrak{c}) > (c^s - \mathfrak{c})$. Part (ii) of the corollary follows trivially. ∎

Proof of Lemma 2.   The solution to the expenditure problem (P4) is once again characterized by (8) and (12) for $z = 1$, in conjunction with (11). Now, suppose that $c^m - \mathfrak{c}$, d^m, and h^m satisfy the married time-allocation problem or (P3) when $z = 2$. Then, it is easy to show that $\widetilde{c}^s - \mathfrak{c} = (c^m - \mathfrak{c})/2^\phi$, $\widetilde{d}^s = d^m/2^\phi$, and $\widetilde{h}^s = h^m/2^\phi$ satisfy the expenditure problem. Given this, it follows that $\widetilde{c}^s + pw\widetilde{d}^s + w\widetilde{h}^s = [(c^m - \mathfrak{c}) + pwd^m + wh^m]/2^\phi + \mathfrak{c} = (2w - \mathfrak{c})/2^\phi + \mathfrak{c}$. The desired result obtains. ∎

9.2   The Impact of Technological Progress on Marriage and Divorce

The impact of technological progress on marriage and divorce will now be addressed. To this end, note that by standard arguments [Stokey and Lucas with Prescott (1989, chaps. 4 and 9)] it can be shown that the married value function V is strictly increasing in b. Thus, there is a unique value for b, or threshold t, that solves the equation $V(b) = W$. Furthermore, $V(b) \gtreqless W$ as $b \gtreqless t$. This allows the dynamic programming problems (P1) and (P2) to be rewritten more simply as

$$W = u^s + \beta \int^{t'} W' dS(b') + \beta \int_{t'} V'(b') dS(b'),$$

and

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$$V(b) = u^m + b + \beta \int^{t'} W' dM(b'|b) + \beta \int_{t'} V'(b') dM(b'|b),$$

where again $u^s = I(1, p, w)$ and $u^m = I(2, p, w)$.

It is now easy to show that a purely temporary decrease in the price for purchased household inputs ($dp < 0$ with $dp' = dp'' = \cdots = 0$) will make individuals choosier about their mates.

Lemma 4 *A temporary one-shot decline in the price for purchased household inputs, p, will cause the threshold, t , to rise.*

Proof. The above equations imply

$$
\begin{aligned}
t = \ & u^s - u^m + \beta \int^{t'} W' dS(b') + \beta \int_{t'} V'(b') dS(b') \\
& - \beta \int^{t'} W' dM(b'|b) - \beta \int_{t'} V'(b') dM(b'|b).
\end{aligned}
$$

Now note that W', V' and t' are unaffected by a purely temporary price decrease. Therefore,

$$\frac{dt}{dp} = \frac{d(u^s - u^m)}{dp} < 0,$$

by Proposition 2. Thus, a temporary decline in price will cause the threshold, t, to rise. ∎
Since all individuals become more pickier about their mates, the rate of marriage will suffer a one period fall and the rate of divorce endure a one period increase.

To say much more, it looks like either some additional structure needs to be imposed on the framework, or that the model needs to be simulated numerically. The latter strategy is pursued in Section 6. Following the first strategy, the stochastic structure of the model will be simplified in way that is commonly done with search models – for example, see Wright and Loberg (1987).

Assumption *Let the stochastic structure governing match quality be specified as follows: (i) For single agents the cumulative distribution function S has bounded support with upper bound $\bar{b}$;*

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(ii) For married agents let b evolve in line with

$$b' = \begin{cases} = b, & \text{with } \Pr(\pi), \\ = \underline{b}, & \text{with } \Pr(1 - \pi), \end{cases}$$

where $\underline{b} < [U^s(w, \bar{p}) - U^m(w, \bar{p})]$ with $\bar{p}$ representing the upper bound on the price for household products. The lower bound $\underline{b}$ is constructed so that it is never optimal to marry given this match quality.

Given this, the dynamic programming problems for single and married agents, in a stationary equilibrium, will appear as

$$W = u^s + \beta \int_t V(b)dS(b) + \beta W S(t), \tag{16}$$

and

$$V(b) = u^m + b + \pi\beta V(b) + (1 - \pi)\beta W. \tag{17}$$

Lemma 5 *A decrease in the price for purchased household inputs, p, causes the steady-state threshold level of match quality, t, to rise.*

Proof. An equation characterizing the threshold, t, will be derived. To this end, first rewrite (17) as

$$V(b) = \frac{u^m + b + (1 - \pi)\beta W}{1 - \beta\pi}.$$

Now, use this in (16) to obtain an equation defining W:

$$[1 - \beta\pi - \beta^2(1 - \pi) - \beta S(t)(1 - \beta)]W = (1 - \beta\pi)u^s + \beta \int_t (u^m + b)dS(b).$$

Note that (17) can also be evaluated at $b = t$ to get $W = [u^m + t]/(1 - \beta)$. This allows the above equation to be converted into a condition specifying t. Specifically, solving out for W gives

$$[\frac{1 - \beta\pi - \beta^2(1 - \pi)}{1 - \beta} - \beta S(t)](u^m + t) = (1 - \beta\pi)u^s + \beta \int_t (u^m + b)dS(b),$$

which can be rearranged to read[44]

$$[1 + \beta(1 - \pi) - \beta S(t)](u^m + t) = (1 - \beta\pi)u^s + \beta \int_t (u^m + b)dS(b).$$

This equation determines t. Integrating by parts the right-hand side of the above condition yields

$$[1 + \beta(1 - \pi) - \beta S(t)](u^m + t) = (1 - \beta\pi)u^s + \beta u^m[1 - S(t)] + \beta\bar{b} - \beta t S(t) - \beta \int_t^{\bar{b}} S(b)db,$$

which can be rewritten as

$$[1 + \beta(1 - \pi)]t = (1 - \beta\pi)(u^s - u^m) + \beta\bar{b} - \beta \int_t^{\bar{b}} S(b)db.$$

Finally, differentiate the above equation to get

$$\frac{dt}{dp} = \frac{(1 - \beta\pi)}{1 + \beta(1 - \pi) - \beta S(t)} \frac{d(u^s - u^m)}{dp} < 0,$$

where the sign follows from Proposition 2. Hence, a decrease in price, p, will increase t. ∎

So, how will a decrease in the steady-state price for purchased household inputs, p, affect the number of people who are married in a steady state? To answer this, let χ represent the steady-state fraction of people who are married and s denote the density function that is associated with S. The fraction of people who are married in a steady state is determined by the equation

$$\chi = (1 - \chi)[1 - S(t)] + \chi(1 - \pi),$$

so that

$$\chi = \frac{1 - S(t)}{1 + \pi - S(t)}.$$

From this it is immediate that

$$\frac{d\chi}{dp} = \frac{-\pi}{[1 + \pi - S(t)]^2} s(t) \frac{dt}{dp} > 0,$$

by Lemma 5. Thus, a fall in price will lead to a decrease in the fraction of the population that is married.

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[44] Note that $1 - \beta\pi - \beta^2(1 - \pi) = (1 - \beta)[1 + \beta(1 - \pi)]$.

References

Andolfatto, David and MacDonald, Glenn M. "Technology Diffusion and Aggregate Dynamics." *Review of Economic Dynamics*, April 1998, *1*(2), 338-370.

Becker, Gary S. "A Theory of the Allocation of Time." *Economic Journal*, September 1965, *75*(299), 493-517.

Benhabib, Jess; Rogerson, Richard and Wright, Randall. "Homework in Macroeconomics: Household Production and Aggregate Fluctuations." *Journal of Political Economy*, December 1991, *99*(6), 1166-1187.

Bethencourt, Carlos and Rios-Rull, Jose-Victor. "On the Living Arrangements of Elderly Widows." Working Paper #21, CAERP, 2004.

Chang, Yongsung and Frank Schorfheide. "Labor-supply Shifts and Economic Fluctuations." *Journal of Monetary Economics*, November 2003, *50*(8), 1751-1768.

Cho, Eugene and Aloysius Siow. "Who Marries Whom and Why." Mimeo, University of Toronto, 2003, *Journal of Political Economy*, forthcoming.

Clarke, Sally C. "Advance Report of Final Divorce Statistics, 1989 and 1990." *Monthly Vital Statistics Reports,* March 1995a, *43* (8 suppl.). Hyattsville, Maryland: National Center for Health Statistics.

Clarke, Sally C. "Advance Report of Final Marriage Statistics, 1989 and 1990." *Monthly Vital Statistics Reports,* July 1995b, *43* (12 suppl.). Hyattsville, Maryland: National Center for Health Statistics.

Cooley, Thomas F. and Prescott, Edward C. "Economic Growth and Business Cycles." In Thomas F. Cooley, Editor, *Frontiers of Business Cycle Research.* Princeton: Princeton University Press, 1995,1-38.

Cornwell, Christopher and Rupert, Peter. "Unobservable Individual Effects, Marriage and the Earnings of Young Men." *Economic Inquiry*, April 1997, *35*(2), 285-94.

Espenshade, Thomas J. "Marriage Trends in America: Estimates, Implications,and Underlying Causes." *Population and Development Review*, *11*(2), 193-245.

Fernandez, Raquel; Guner, Nezih and Knowles, John. "Love and Money: A Theoretical and Empirical Analysis of Household Sorting and Inequality." *Quarterly Journal of Economics*, February 2005, *120*(1), 273-344.

Friedberg, Leora. "Did Unilateral Divorce Raise Divorce Rates? Evidence from Panel Data." *American Economic Review*, June 1998, *88*(3): 608-627.

Gomme, Paul; Kydland, Finn E. and Rupert, Peter. "Home Production Meets Time-to-Build." *Journal of Political Economy*, October 2001, *109*(5), 1115-1131.

Greenwood, Jeremy and Hercowitz, Zvi. "The Allocation of Capital and Time Over the Business Cycle." *Journal of Political Economy*, December 1991, *99*(6), 1188-1214.

Greenwood, Jeremy; Seshadri, Ananth and Vandenbroucke, Guillaume. "The Baby Boom and Baby Bust." *American Economic Review*, March 2005, *95*(1), 183-207.

Greenwood, Jeremy; Seshadri, Ananth and Yorukoglu, Mehmet. "Engines of Liberation." *Review of Economic Studies*, January 2005, *71*(1), 109-133.

Hansen, Gary D. and Imrohoroglu, Ayse, "The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard." *Journal of Political Economy*, February 1992, *100*(1),118–142.

Jovanovic, Boyan, "Work, Rest and Search: Unemployment, Turnover, and the Cycle." *Journal of Labor Economics*, April 1987, *5*(2), 131–148.

Krusell, Per; Ohanian, Lee; Rios-Rull, Jose-Victor and Violante, Giovanni. "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis." *Econometrica,* September 2000, *68*(5), 1029-1053.

Kydland, Finn E., and Prescott, Edward C., "Time to Build and Aggregate Fluctuations." *Econometrica*, November 1982, *50*(6): 1345-1370.

Lam, David. "Demographic Variables and Income Inequality." In Mark R. Rosenzweig and Oded Stark, Editors, *Handbook of Population and Family Economics*. Amsterdam: Elsevier Science B.V., 1997, 1015-1059.

Mare, Robert D. "Assortative Mating, Intergenerational Mobility, and Educational Inequality." CCPR-004-00, UCLA, 2000.

McGrattan, Ellen R.; Rogerson, Richard and Wright, Randall. "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy." *International Economic Review*, May 1997, *38* (2), 267-290.

McGrattan, Ellen R. and Rogerson, Richard. "Changes in Hours Worked Since 1950." *Quarterly Review*, Winter 1998, 2-19.

Mortensen, Dale T. "Matching: Finding a Partner for Life or Otherwise." *American Journal of Sociology*, 1988, *94* (suppl.), S215-S240.

Ogburn, William F. and Nimkoff, Meyer F. *Technology and the Changing Family.* Boston: Houghton Mifflin Company, 1955.

Parente, Stephen L.; Rogerson, Richard and Wright, Randall. "Homework in Development Economics: Household Production and the Wealth of Nations," *Journal of Political Economy*, August 2000, *108*(4), 680-687.

Regalia, Fernando and Rios-Rull, Jose-Victor. "What Accounts for the Increase in the Number of Single Households?" Mimeo, University of Pennsylvania, 2001.

Reid, Margaret G. *Economics of Household Production.* New York: John Wiley & Sons, Inc., 1934.

Rios-Rull, Jose-Victor. "Working in the Market, Working at Home, and the Acquisition of Skills: A General-Equilibrium Approach." *American Economic Review*, September 1993, *83*(4), 893-907.

Rogerson, Richard; Shimer, Robert and Wright, Randall. "Search-Theoretic Models of the Labor Market: A Survey." Working Paper 10655, National Bureau of Economic Research, 2004.

Schoen, Robert. *United States Marital Status Life Tables for the Period 1910-1975 and Cohorts Born 1888-1945.* Washington, D.C.: National Technical Information Service (available from), 1983.

Schoen, Robert and Standish, Nicola. "The Retrenchment of Marriage: Results from Marital Status Life Tables for the United States, 1995." *Population and Development Review,* September 2001, *27*, 553-563.

Stokey, Nancy L. and Lucas, Robert E. Jr. with Prescott, Edward C. *Recursive Methods in Economic Dynamics.* Cambridge: Harvard University Press, 1989.

Yaari, Menahem, E. "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer." *Review of Economic Studies*, April 1965, *32*(2), 137-150.

Wallace, Geoffrey L. "An Assessment of Several Explanations for the Decline in Marriage." Mimeo, La Follette School of Public Affairs, University of Wisconsin, 2000.

Wolfers, Justin. "Did Unilateral Divorce Laws Raise Divorce Rates? A Reconciliation and New Results." Working Paper # 10014, NBER, 2003.

Wright, Randall and Loberg, Janine. "Unemployment Insurance, Taxes, and Unemployment." *Canadian Journal of Economics*, February 1987, *20*(1), 36-54.