Why are Married Men Working So Much?*

John Knowles†

University of Pennsylvania

First Version: July, 2005

Abstract

I show that a simple bargaining model of married couple's leisure-time and housework allocations can explain an interesting trend that has hitherto gone unnoticed: a decline in the leisure of husbands relative to their wives. The model implies that if women find single life sufficiently attractive, then the closing of the gender gap in wages leads to a decline in husband's leisure. Calibration to US data shows that trends in family size and home productivity both play significant roles in explaining wive's labor-supply trends, but that bargaining effects substantially reduce the wage-elasticity of married women's employment.

JEL Codes: E130, J120, J160, J200, J220

JEL Keywords: General Aggregative Models: Neoclassical;Time Allocation and Labor Supply;Economics of Gender; Marriage; Marital Dissolution;

*I am grateful to Iourii Manovskii , Guido Menzio, Andrew Postlewaite, Victor Rios-Rull, Larry Samuelson, Raul Santaeulalia-Llopis and Gustavo Ventura for helpful discussions, and to Jeremy Greenwood, Nezih Guner and seminar participants at the NBER 2005 Summer Institute, Iowa State, Laval University and the University of Pennsylvania for constructive comments.

†Department of Economics, 3718 Locust Walk. jknowles@econ.sas.upenn.edu

1 Introduction

It is well-known that leisure of the average US adult has been increasing over the last 30 years. A recent paper by Aguiar and Hurst (2005) confirms this trend, which is also the subject of an influential book by.Robinson and Godbey (1997). This trend does not imply of course that leisure is increasing for all groups, and a lively literature has grown up around the question of why some groups, in the words of Hochschild (1997), appear to face a 'time bind'.[1]

This paper argues that this trend of increasing leisure does not hold for an economically significant portion of the labor force: men married to women under the age of 50. Indeed for the men of this group whose wives work in the market, leisure time has actually been decreasing. But regardless of the trend in absolute leisure, what is really interesting for macro economists is that there has been a significant decline in the husband's leisure *relative* to that of their wives.

This anomalous trend is interesting both for its implications for aggregate labor supply and for what it suggests about decision-making within families. Over the last 35 years, the average weekly time married women spend in paid employment has doubled. Two plausible explanations of this change are that women's wages have increased relative to those of men, and that rising productivity in household work has allowed married women to devote more time to market work. A number of recent papers explore these and related hypotheses, including Jones, Manuelli, and McGrattan (2003), which finds in favor of rising female wages and Greenwood, Seshadri, and Yorukoglu (2003), which claims that rising productivity at home is largely responsible.[2]

[1]For a review of the 'time-bind' literature see Jacobs and Gerson (2004). Other recent papers on the leisure trend include Greenwood and Vandenbroucke (2005), who document the trend over the past 200 years, and Ramey and Francis (2005), who argue that the long-run trend is a statistical artifact.

[2]These papers actually consider the trend over a longer period; since 1950 in the first case, and since 1900 in the second.

In the context of a standard unitary model of the household, both explanations imply that the leisure of husbands should be increasing, relative to that of their wives. For instance, Jones, Manuelli, and McGrattan (2003) find that the labor supply of husbands should have fallen by 5-10 hours weekly. We show that these predictions are indeed corroborated, but only for husbands of women over the age of 50. The share of the labor force accounted for by the younger households is obviously very large, hence their anomalous behavior suggests something important is missing from our theories of aggregate labor supply. This paper argues that the missing element is a consideration of how changes in the macro-economic environment affect the allocation of resources between spouses: the decline in husband's relative leisure suggests that the bargaining position of women has been improving over time.

Consider the optimal allocation from the point of view of the individual spouses in a marriage, who collectively make decisions that are Pareto-optimal. The allocation can be interpreted as that of a benevolent household planner maximizing a weighted sum of the utility of each spouse, for some given pair of Pareto weights. The unitary model essentially assumes that the weight of the spouse in the household planner's problem is invariant over time. We show that in the case of log utility, all that is required to match the observed trend in relative leisure is that the weight accorded to the husband's utility decline by 15% from the 1970s to the 1990s, rather than staying constant as in the unitary model.[3]

To explain such movements in the wife's share of household utility, we extend the unitary model by incorporating a simple model of bargaining between spouses. We assume that when negotiations break down, the result is divorce, so that the equilibrium allocation of married couples depends on the gains from marriage, as in the seminal paper of McElroy and Horney (1981). Relying on a standard solution

[3]This conclusion is independent of trends in home production time because we model home production as a constraint; trends in productivity at home affect the location of the pareto frontier but have no direct effect on the utility allocation.

concept, that the spouses split the marital surplus equally, we can solve explicitly for.the leisure allocation. We find that husband's leisure is decreasing in the wife's wage, whenever the attractiveness of single life is sufficiently high for women relative to men. If this condition fails, then husband's leisure will increase when the wife's wage increases.

The paper then extends the analysis to consider corner solutions in which the wife does no market work. Most of the trend in married-women's labor supply is due to the rise in labor-force participation rates; in the 1970s, we find that about 40% of wives aged 25-45 did no market work over a 3-year period; that dropped to 12% by the 1990s. Both in the 1970s and the 1990s, we observe that women who are not working spend about 40% more time on housework than do working women and get about 20% more leisure. In the context of our model, these facts suggest that fixed costs of employment prevent women with relatively low optimal market hours from working outside the home, thus netting them extra leisure. We show that the mapping from bargaining equilibria to the Pareto weight at a corner solution can be very different from that at an interior solution, even with identical outside options. This implies that the husband's weight in the household utility function will decline even when the bargaining position is constant, another strike against the unitary model.

By calibrating a version of the model with heterogeneity in the required amount of home inputs, we can apply the basic theory to comparing explanations of the trend in married women's labor supply. In addition to the two explanations alluded to above, we also allow for an exogenous decline in family size. We force the model to match the relative leisure, marriage rates and wive's employment rates in each period, so that we can use computational experiments to decompose the sources of the changes in leisure and labor supply.

The results imply that the wage trend on its own explains the entire increase in wife's relative leisure; this means husbands are working harder because their bargaining position in the household has eroded over time. On the other hand, the trend in married women's employment is due in roughly equal measure to each explanation, though the wage trend dominates slightly. The substitution effect of the wage trend on wife's labor is offset by the effect on her leisure. On the other hand, the rise in productivity at home resulting from the price trend has no such offsetting effect, so that despite a comparatively small effect on full income, the price trend accounts for 36 per cent of the trend in wive's employment.

The model also has implications for the decline in marriage over the last 30 years, the subject of a number of other equilibrium analyses, including Greenwood, Guner, and Knowles (2003), Regalia and Ríos-Rull (1999), Caucutt, Guner, and Knowles (2002). More recently, Greenwood and Guner (2004) have argued that rising wages and home productivity can explain nearly 90% of the decline in the fraction of adult life women spend married. We show that a rise in female wages can cause marriage rates to rise or fall, depending on the extent to which women prefer married to single life. According to our calibrated model, the rise in female wages is more important than rising home productivity for explaining the decline in marriage rates.[4]

The basic labor-supply analysis developed here is in the vein of the household-bargaining literature deriving from Manser and Brown (1980) and McElroy and Horney (1981). Such bargaining models are special cases of the 'collective' model theory of the household developed by Chiappori (1988), in which testable restrictions are derived on the basis of separable utility and Pareto efficiency alone. Chiappori, Fortin, and Lacroix (2002), who show that correlations between divorce laws and married women's labor supply across states are consistent with the predictions of the collective model. The current paper differs from the previous literature in that it imposes a simple solution concept which allows for explicit solutions for labor supply and other household decisions, permitting comparative statics with respect to wages, rather

[4] Greenwood and Guner (2004) consider a wage trend in a model with no sexes. In our analysis, the husband's wage is roughly constant over time, so that the trend in wife's relative wage is roughly equivalent to the trend in the average wage.

than limiting the analysis to 'distribution' factors that shift the outcome without affecting the household budget.

The marriage-market equilibirum analysis of our model can also be seen as a simplification of Greenwood, Guner, and Knowles (2003), which computes equilibrium marriage rates and married-couple allocations in an environment with bargaining and idiosyncratic match-quality shocks. Other papers on the equilibrium analysis of marriage and female labor supply also appear to be limited to computational results, as in Caucutt, Guner, and Knowles (2002) and Regalia and Ríos-Rull (1999).[5]. On the other hand, analytical results are obtained by Chiappori and Weiss (2000) and Chade and Ventura (2004), who develop simple equilibrium-marriage models comparable to the current paper. Their concerns are very different however; the former focuses on optimal contracts, the latter on search behavior. Neither model allows for labor-supply decisions, and assumes instead that the gains from marriage are exogenous. Theoretically, the key difference is that utility in the first of these papers is assumed to be perfectly transferable, and in the latter non-transferable, while in our model utility is partially transferable, via the allocation of leisure and private consumption.

A simultaneous paper, Bech-Moen (2006) shows that the leisure trend also holds in Norwegian data, and shows that a bargaining model can explain trends in leisure and market hours in both countries as the result of wage convergence alone. That paper relies on a Nash-bargaining solution concept, and hence relies more on numerical analysis, and does not consider the possibility of corner solutions or the implications of trends in home technology or marriage rates. The current paper by contrast makes the point that while the trend in wages *could* explain labor supply trends, in fact

[5]Regalia and Ríos-Rull (1999) reports that, as in this paper, one can infer from US data that women have a higher intrinsic enjoyment of single life. They infer this from the fact that women tend to marry men higher in the wage distribution, and that higher wages are associated among women with lower marriage rates, but among men with higher rates. Along with the current paper, this suggests that both cross-sectional and time-series support this view that women need marriage less than men do.

other trends, such as in home technology, are equally important.

The rest of the paper is divided into seven parts: an empirical analysis in Section 2, followed by an analysis of the unitary model in section 3, then an analysis of the allocation of leisure in the bargaining model of the household. Section 5 integrates home production into the model. Section 6 presents the quantitative implications when the model is calibrated to US data. The conclusion contains a summary of the results.

2 Trends in Time Allocation

In this section we document trends in the working time for married-couple households in the U.S. The main variables of interest are the market labor time and time spent in housework of each spouse. The sum of these is taken to be total working time, and the remainder of total discretionary time as free time or leisure.

2.1 Dedicated Time-Use Surveys

We begin with a look at a series of time-use surveys carried out in the US between 1965 and 2003. Valuable analyses of these data sets include Robinson and Godbey (1997) and Aguiar and Hurst (2005). The latter also includes includes access to a compilation of the data on which this first part of the analysis is based. It is important to note these data are at the individual level; no information on spouses or other family members is collected, beyond their mere existence. Furthermore, for 1993, marital status is not available, while for 2003 the survey was extensively redesigned, causing comparability issues, particularly with respect to child care, that are discussed in Aguiar and Hurst (2005). For these reasons, the following analysis excludes 1993 and treats the 2003 wave with some skepticism.

There are 168 hours in a week, allocated over a myriad of activities listed in these surveys. In the spirit of Robinson and Godbey (1997), these activities can be

	Year	N	Leisure Concept* 0	1	2	3
Wives	1965	157	22.48	22.71	91.69	96.15
	1975	190	25.25	25.97	98.22	102.90
	1985	469	28.05	28.66	100.85	106.47
	2003	2087	24.58	26.14	98.33	106.94
Husbands	1965	404	31.36	32.41	102.63	104.09
	1975	377	31.56	31.89	102.66	104.57
	1985	568	31.30	31.92	102.19	104.15
	2003	2306	28.48	30.23	98.92	102.95

*Based on (Aguiar and Hurst, 2005).

Table 1: Alternative Leisure Concepts for Married Working People aged 25-45 in U.S. time-use surveys.

aggregated up into broader categories such as Personal Care, Market Work, Home Work, and Leisure. Of course the concept of leisure is ambiguous; it is not clear for instance how to classify time with children. For this reason, the analysis considers a range of leisure concepts, as defined in Aguiar and Hurst (2005). These consist of summations of time spent in activities deemed to be leisure, starting from Leisure 0 which is limited to the obvious activities: TV, movies, hobbies etc. Leisure 1 adds time spent playing with children, Leisure 2 adds personal care and sleep time to Leisure 1, and Leisure 3 adds child-care time to Leisure 2.

The trends for these leisure concepts are shown in Table 1 for married people aged 25-45. It is clear that for each concept, the wife's leisure is rising over time, but the husband's is essentially stationary, and by the last wave is actually falling.

What sort of activities account for the change in relative leisure? We do not have access to the full set of leisure variables in these surveys, but we can consider some of the most important. Consider time spent watching TV, in sport or exercise and in civic activities. For the case of high-school dropouts, these activities accounted for 80% of men's Leisure 0 in 1965 and 50% of women's.

Table 2 shows that for wives without a diploma, time watching TV increased from

	Year	Leisure Activities					
		TV	Meals	Exercise	Civic	Garden/Pet	Child Play
Wives	1965	6.64	6.73	0.86	0.99	0.39	0.23
	1975	10.44	6.99	0.92	3.00	0.25	0.72
	1985	11.90	7.17	1.99	2.31	0.57	0.61
	2003	11.02	8.41	1.83	2.24	1.28	1.56
Husbands	1965	13.64	8.35	2.11	2.15	0.21	1.05
	1975	15.59	8.43	2.33	2.35	0.22	0.32
	1985	14.79	7.45	3.20	1.59	0.63	0.61
	2003	14.38	8.43	2.89	2.20	1.99	1.75

Table 2: Leisure activities of married working couples where wife is aged 25-45. Data from U.S. time-use surveys.

8 hours in 1965 to 17 hours in 1985, a gain of about 5 hours relative to their husbands. For college-educated wives, TV time increased by about 5.5 hours, resulting in a 30% gain relative to the husband's TV time. Wives also gained an hour and a half of time spent eating. Trends in TV and eating time therefore account for a dominant share of the relative leisure trend. Apart from time gardening or with pets, the other activities also show large gains for wives relative to their husbands, but account for much less time over all. Thus the leisure trends reflect, to a large extent, a trend in time watching TV, which is quite plausibly leisure. The only leisure activity in the table that has grown more for husbands than for their wives is gardening; unlike TV watching, this is something many households pay others to do, which certainly weakens the case for considering this as leisure.

While these surveys represent the most serious attempts we have to measure time-allocation at any one calendar year, they suffer from some serious defects for understanding trends in married-couple time allocations. Because of the individual nature of the time-use surveys, we cannot condition on spouse characteristics, such as whether the spouse is working. Furthermore, the surveys are spread far apart in time, making trends harder to measure, and carried out by different agencies with different methods and variable definitions. Finally, the surveys only measure time allocation in one day; they do not distinguish between people who happened to be off work that day and those who are not regularly employed.

2.2 The Panel Study of Income Dynamics

To remedy the shortcomings of the time-use surveys, we now turn to household data: the 1969-1997 waves of the PSID, excluding those years in which housework variables were not collected, such as 1975 and 1982. Little of the analysis reported here exploits the panel nature of the study; the PSID is used because it is the only annual cross-sectional dataset in the U.S. that includes a measure of housework.

Our full sample consists of all wives (or "wives") between the ages of 25 and 80 who report time spent in market labor and house work for both spouses. The sample size grows over time, from 1018 households in 1969, to 3052 in 1997. This results in a total number of annual observations equal to 69,762.To ensure that the sample is representative, all statistics are weighted using the household's cross-sectional weight for each year. We also repeat the exercise for single men and single women, as the model has implications for their time allocations.

The housework variable is the response to the question: "About how much time does your (wife/"WIFE") spend on housework in an average week? I mean time spent cooking, cleaning, and doing other work around the house." A similar question is asked for husbands. This is not an ideal instrument in many ways, particularly as the interpretation of housework may vary across sexes, and over time.

We take weekly hours worked in each category to be the annual numbers reported, divided by 52. In order to ensure that extreme values of hours do not distort the results, we top-code both market hours and housework hours at 90 hours weekly; this affects only the top percentile in each case.

The analysis focuses on the portion of the sample consisting of women and single men aged between 25 and 45 and the husbands of these women. We further restrict the sample to "working households", by which we mean married households where the wife works 10 hours or more outside the home, and single households where the head works 25 hours or more outside the home. Summary statistics are shown in Table 4, which reports housework and market hours, as well as family size for married and single households. The table shows that the average wife's time in market work increased over the period, from 30 hours weekly to 33.6, and that housework hours fell from 25 hours to 17. Total working time for women declined by four hours. For married men, housework hours increased from three to 7.6 weekly, while market hours stayed constant. The relative leisure of the husband declined from 118% of the wife's leisure time, to 96%.Relative home work time of the husbands increased from 12 percent to 43 percent.[6]

For singles, Table 3 implies that leisure of both men and women is increasing over time, and by roughly the same amounts: six hours weekly. Therefore the trend among married people does not reflect some tendency towards less leisure of men. For housework however we do see a similar trend of more time devoted by men, less by women.

Note that the wives in this latter sample are comparable to those of the time-use sample analyzed in the previous section, so we should pause for a minute to consider the degree of concordance between the two data sources. Whereas wives in the PSID work 55 hours weekly in the 70s, they work 60 hours in 1975 according to the time-use survey, excluding child care, a discrepancy of about 10% of total working time. The PSID says they worked 30 hours in the market and 25 hours at home, compared to 32 and 23 in the time-use survey. Thus the source of the discrepancy in work hours appears to be that the PSID excludes commuting and other work-related time. Considering how primitive is the PSID approach to time allocation, it is remarkable that the results should be so similar to that of the specialized surveys. The PSID does seem to understate men's home hours, but since the trends are quite similar, it

[6] In Table A-2 of the appendix, we show that the pattern is qualitatively similar when non-working women are included in the sample, although the relative leisure trend is somewhat weaker.

Years	N/Year	Home	Market Core	Market Total*	Total Working	Leisure*	Family Size	Number of Kids
				Married Men, Wife aged 25-45				
1969-1975	228	3.18	43.02	50.02	53.20	44.80	4.20	1.92
1978-1983	735	6.80	42.50	49.50	56.30	41.70	3.67	1.48
1988-1997	1903	7.57	43.04	50.04	57.61	40.39	3.53	1.38
				Married Women, aged 25-45				
1969-1975	228	25.43	29.68	34.68	60.11	37.89	4.20	1.92
1978-1983	735	22.00	30.88	35.88	57.88	40.12	3.67	1.48
1988-1997	1903	17.49	33.66	38.66	56.15	41.85	3.53	1.38
				Single Men aged 25-45				
1969-1975	42	5.75	43.97	50.97	56.72	41.28	1.38	0.21
1978-1983	232	8.23	42.14	49.14	50.37	47.63	1.35	0.23
1988-1997	557	7.91	43.29	50.29	51.21	46.80	1.35	0.21
				Single Women aged 25-45				
1969-1975	72	13.74	37.94	42.94	56.68	41.32	2.39	1.09
1978-1983	264	12.78	39.01	44.01	51.79	46.21	2.04	0.79
1988-1997	659	10.96	39.77	44.77	50.73	47.27	1.97	0.77

**Married sample where wife worked at least 10 hours per week. Singles sample where head worked at least 25 hours per week. "Market total" is Market Core plus an allowance for commuting and work-related time: 7 hours for men, 5 for women. Leisure equals 98 hours minus Total Working hours.*

Table 3: Hours worked, earnings and family size in PSID for "working" households where wife or head is aged 25-45 years.

Age	Drop Out	High-School	College
25-34	17.44%	11.61%	6.60%
35-44	11.60%	13.65%	16.10%
45-54	6.61%	2.84%	5.80%
55-65	-12.29%	-9.33%	-4.61%

Table 4: Percent decline in husband's relative leisure in households where the wife spends 25 hours or more weekly in paid market work.

seems safe to ignore this level effect.

To ensure that other demographic changes over the same period are not driving the finding of the trends in time allocation, we turn to Table 4 shows for households where the wife works 10 hours weekly or more, the size of the decline in husband's relative leisure. When the wife is between 35 and 44 years old this ranges from 12% when the wife did not complete high school to 16% for college-educated wives. The change is uniformly smaller when the wife is aged between 45 and 54 years old: for drop-outs the change in relative leisure is 7%, and only 3% for high-school graduates. For the youngest group, where the wife is aged 25-34, the relative leisure of the husband fell by 17% in the case of dropouts, 12% for high-school graduates, and 7% for college-educated women. Conditioning on education and age therefore only strengthens the trend towards lower relative leisure for husbands. It is clearly not 'explained' by the significant education trends among women over the same period.

The lack of a positive trend in husband's leisure may seem to be inconsistent with the widely-reported negative trend in men's market hours. The results reported here do not concern all men however, only those married to women under age 45. For older men and for singles, we clearly saw that leisure was increasing over time. Also the decline in leisure is driven partly by an increase in home hours, which is not considered in papers that focus on market work, such as McGrattan and Rogerson (2004).For our purposes the important point is that the decline in relative leisure of the husband is large and is confirmed by both types of survey.

3 A Simple Unitary Model

In the analysis that follows we concentrate upon the households of women aged 25-45; we ignore the younger and older groups because their time allocations are likely linked to education and retirement decisions, respectively, which are outside the scope of this paper. We will consider first the question of why the allocation of leisure did not increase in favor of husbands, and then ask why the house-work time of husbands should have increased, while that of their wives declined so dramatically.

Suppose that preferences of individuals are represented by the following utility function:

$$\widetilde{u}\left(c^h, c_i, l_i\right) = \phi \ln c^h + (1-\phi)\ln c_i + \delta \ln l_i$$

where c^h is household consumption (a public good), c_i is the private consumption of person i, l_i is her leisure and ϕ is a constant.[7]

The unitary household is assumed to maximize a household utility function consisting of a weighted sum of the utility of each spouse. We represent this by assigning to the husband a Pareto-weight μ_i in the household utility function.

There is also a home good that is produced using inputs of housework time (h_i, h_j), as well as a flow of appliances, k, according to a production function G. Married couples are constrained to produce a minimum level of the home good. Since home goods do not enter the utility function, this constraint always binds:

$$\underline{g}^m = G\left(k, h_i, h_j\right)$$

[7]The distinction between the two types of consumption plays no role in the current section, but will be relevant later in the paper.

Each person i has a time endowment of one unit of time, which is allocated across three competing uses: leisure l_i, market work, n_i and housework h_i. There is a fixed cost of working that is proportional to the wage; we express this as a fraction τ_i^e of the time endowment. Let's assume that the optimum has both spouses working. The time constraint for each spouse i is:

$$l_i + n_i + h_i + \tau_i^e = 1$$

A person of sex i gets wage w_i per unit of market labor The household buys home appliances k at price p per unit, so the budget constraint of the household is given by

$$c^h + c_i + c_j + w_i l_i + w_j l_j = I\left(h_i, h_j, k | w_i, w_j, p\right)$$

where

$$I\left(h_i, h_j, k | w_i, w_j, p\right) = \left(w_i + w_j\right)\left(1 - \tau_i^e\right) - w_i h_i - w_j h_j - pk$$

Suppose that the household's optimal allocation is on the interior of the choice set. Then we can represent this as the solution to a two-stage problem; first maximize full income through the choice of h_i, h_j, k, and then maximize the household utility function via the allocation of leisure and consumption.

Define full income as the solution to the income maximization problem:

$$Y^m\left(w, p\right) = \max_{h_i, h_j, k}\left\{I\left(h_i, h_j, k | w_i, w_j\right)\right\}$$

subject to the above constraints.

Let $\left(h_i^*, h_j^*, k^*\right)$ represent the solution to this problem, so that

$$Y^m\left(w, p\right) = I\left(h_i^*, h_j^*, k^* | w_i, w_j\right)$$

. Now the optimal leisure choice solves this sub-problem:

$$\max_{l_i, l_j}\left\{\phi \ln c^h + (1-\phi)\left[\mu_i \ln c_i + (1-\mu_i)\ln c_j\right] + \delta\left[\mu_i \ln l_i + (1-\mu_i)\ln l_j\right]\right\} \qquad (1)$$

subject to:

$$c^h + c_i + c_j + w_i l_i + w_j l_j < Y^m(w, p)$$

Since the solution is interior by assumption, the optimal decisions are:

$$\begin{aligned} c^h &= \frac{\phi}{1+\delta} Y^m(w, p) \\ c_i &= \mu_i \frac{1-\phi}{1+\delta} Y^m(w, p) \\ l_i &= \frac{\mu_i}{w_i} \frac{\delta}{1+\delta} Y^m(w, p) \end{aligned} \tag{2}$$

This is an instance of the well-known result that expenditure shares are constant with Cobb-Douglas preferences.[8]

3.1 Relative Leisure in the Unitary Household

The model says that the leisure of the spouses is related by

$$l_j / l_i = \frac{1 - \mu_i(\widetilde{w})}{\widetilde{w} \mu_i(\widetilde{w})} = \widetilde{l}(\widetilde{w}) \tag{3}$$

Blau and Kahn (1997) report that the average wages of women working full time rose, as a fraction of men's, from 0.60 to 0.76 over the period 1975 to 1995. If the weight μ_i remained constant, then wife's relative leisure $\widetilde{l}$ should have decreased by 20%:

$$\frac{\widetilde{l}(0.76)}{\widetilde{l}(0.6)} = \frac{1/0.76}{1/0.6} = 0.80$$

. If there were no change in wife's leisure, then, taking average leisure in 1970 to be 40 hours per week each as per Robinson and Godbey (1997), then husband's leisure should have increased by about 10 hours.

For older husbands, those married to women aged 55 or older, we do in fact observe a decline of this order in market hours. However for younger men, the predicted

[8]In the appendix we deal with the corner-solution case where wives do not work outside the home. The solution requires that we consider the technology for home production, which we defer until later in the paper. Since the focus of the paper is the change in the allocations of households where the wives are working, we defer all discussion of this case to the end.

decline is so large relative to any observed trend in the data that it seems unlikely that tweaking the preferences or adding home production are going to solve the problem. The results of Jones, Manuelli, and McGrattan (2003) corroborate this conjecture for both wage-based explanations of the rise in women's market hours.

In this model it is easy to solve for the Pareto weight given the observed leisure and relative wages. We observed in Table 3 that husband's leisure was 1.2 times that of working wives in the 1970s. Setting $\widetilde{w} = 0.60$, and inverting the optimality condition for leisure gives us

$$\mu_i^{1970} = \frac{1}{1 + \widetilde{w}_{1970}\widetilde{l}_{1970}} = \frac{1}{1 + 0.60/1.2} = 0.67$$

, implying that husbands are getting a larger share of the utility in the marriage.

How do the results change when we plug in the changes in wages and relative leisure? We observed that husband's leisure equalled that of working wives in the 1990s, while the relative wage of wives increased to 0.76:

$$\mu_i^{1990} = \frac{1}{1 + \widetilde{w}_{1990}\widetilde{l}_{1990}} = \frac{1}{1 + 0.76} = 0.57$$

So the Pareto weight of the husband would have to fall by 15% in order to explain the change in leisure allocation of households where the wife was working 10 or more hours outside of the home.

To understand aggregate trends in household labor supply therefore requires a theory of these weights. In what follows, we will rely on bargaining models, in which the solution depends on the gains from marriage. Since the motivation for considering a bargaining model involves the observation that husband's leisure is not increasing, it is essential to consider the conditions under which an increase in the wife's wage causes men's leisure to fall.

Proposition 1 *If the following condition is satisfied, then for wife's relative leisure to rise when the wife's wage increases requires that*

$$\frac{d}{d\widetilde{w}} \ln \widetilde{l}\,(\widetilde{w}) > 0 \Leftrightarrow -\frac{d\mu_i}{d\widetilde{w}} \frac{1}{(1-\mu_i)\,\mu_i} > \frac{1}{\widetilde{w}} \tag{4}$$

So the more responsive is the wife's share to her wage, the more likely it is that husband's leisure declines when her wage rises. To see under what conditions this might happen, we now consider a simple theory of the Pareto weight μ_j.[9]

4 The Allocation of the Marital Surplus

In this section, we consider a marriage in which the total surplus is positive and which chooses allocations that are Pareto-optimal. We also assume that all Pareto-optimal allocations are interior; later in the paper we will relax this assumption to consider wife's labor-force participation. Under these conditions, the allocation can be represented as a Pareto weight μ_i for, say, the husband. This is because the solution of the household problem in the unitary model is a point on the frontier, and any point on the Pareto frontier can be generated as the solution to the household problem for some weight μ_i.

Therefore the allocation of the surplus between the two spouses is equivalent to the choice of the Pareto weights μ_j in the couple's problem. To understand how these might evolve over time, in response to trends in relative wages or in non-market productivity, we turn to bargaining models of the married couple. We restrict attention to solution concepts that map the gains from marriage of each spouse onto a point on the Pareto frontier. This is the key assumption of the paper. There is a long tradition of models using this approach in the literature on intra-household allocations, beginning with Manser and Brown (1980) and McElroy and Horney (1981).

Despite such a long tradition, the microfoundations of this approach to marriage decisions are not clear; we don't know the details of plausible non-cooperative games that give rise to the co-operative bargaining solutions that are the basis of the literature. We therefore consider this topic to be outside the bounds of the current

[9]Note that if this condition is satisfied, then the spouses's leisure will be increasing in her own wage, because of the symmetry of the problem.

paper. Nevertheless, it may be instructive to consider two possible interpretations of the assumption that the allocation is a mapping from the gains from marriage onto the Pareto frontier. Lets start by taking the assumption literally. Consider a sequential-offer bargaining game. If the bargaining procedure allowed people to make take-it-or-leave-it offers, then the proposer's dominant strategy would be to offer the potential spouse an allocation that gave her only slightly more utility than she would get outside the marriage. It would be rational for the spouse to accept. If the proposer were selected by a coin flip, then the law of large numbers would lead to equal sharing of the marital surplus on average.

This suggests an "egalitarian" solution concept, in which the marital surplus is split equally between the spouses. When utility is perfectly transferable, which is not the case here, this is equivalent to the Nash solution, which maximizes the product of the gains from marriage. The advantage of the egalitarian solution is that it is analytically tractable, as well as simple and plausible.[10]

More generally, we might consider the possibility that the marriage allocation depends on a process of repeated rounds of alternating offers that my result in agreement, in perpetual disagreement or in an exogenous termination that results in both partners becoming single.When negotiations are subject to some risk of this breakdown, then the equilibrium allocation depends on the utility of being single. In this case, the allocations will respond to forces that shift the values of being single, although the exact form of the dependence will be sensitive to variations of the bargaining process and to the solution concept employed..Therefore it is reasonable to expect at least qualitatively, that allocations will depend on the gains from marriage in the way outlined below.

This egalitarian solution is illustrated in Figure 1. The diagram plots the attainable allocations in the space of the indirect utilities of husband and wife. The

[10]To preserve tractability, it is critical that each spouse get exactly half of the surplus; this causes any utility term that is equal for both spouses to drop out of the problem.

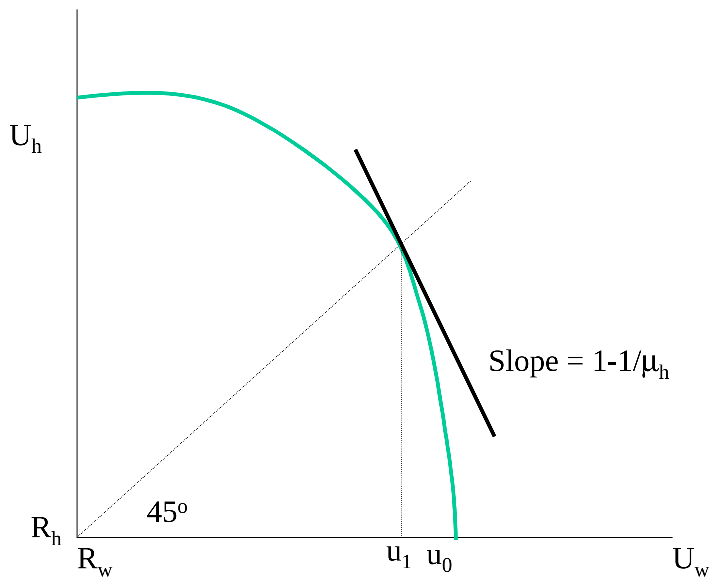

Figure 1: The Pareto frontier for a married couple at an interior solution.

curved line represents the Pareto frontier, the tangent line the indifference curve of a household planner who puts weight μ_h on the husband's utility. The origin represents the reservation utilities of the spouses. The fact that tangency occurs along the 45 degree ray from the origin indicates that the planner views the egalitarian solution as optimal. Obviously we can trace out the entire Pareto frontier by varying μ_h. In what follows, we propose a theory of movements of μ_h over time based on this requirement that the Egalitarian solution solve the planner's problem indexed by μ_h.

4.1 A Model of Marriage

We begin by outlining a simple equilibrium marriage model. We proceed by first working out the equilibrium leisure allocations, taking the marriage rate as given; in the appendix we work out how the equilibrium marriage rates depend on full income by marital status.

We assume there is a very large marriage population with equal number of both sexes, that people live forever and that time is divided into discrete periods. People of a given sex are identical. At the beginning of each period, people are either married or single. Married people learn their realization of a match-quality shock ε, and then choose whether to stay together or to divorce. If they divorce, they must then wait until the next period to meet a new potential spouse. All people who entered the period as singles are then randomly paired with a single of the opposite sex. The new pairs then learn their match quality and decide whether to marry. After the marriage decisions, all married couples choose their time allocations over market and house work, and get utility from leisure, match quality and consumption of household earnings.

We assume that divorce and marriage are costless, and that the process for match quality is independent of marital status. Finally, we require that wages and the quality of single life do not change over time.

4.1.1 Single People

Suppose that when people are single they get some additional utility q_i which is sex-specific; the preferences of individuals are given by:

$$\widetilde{u}\left(c_i, l_i, q_i\right) = \ln c_i + \delta \ln l_i + \delta \ln q_i$$

, where l_i is the fraction of time devoted to leisure and $\delta \ln q_i$ is the joy from being single. Let τ^e be the cost of going to work, expressed as a fraction of the total time endowment, which we normalize to one. A single person of sex i faces budget and home-production constraints given by:

$$\begin{aligned} c + w_i l_i &\leq w_i\left(1 - h_i - \tau^e\right) - pk = I^S\left(h_i, k | w_i\right) \\ G\left(k, h_i\right) &\geq \underline{g}^s \end{aligned}$$

Define full income as the solution to the income maximization problem:

$$Y^s\left(p, w_i\right) = \max_{h_i, k_i} I^S\left(h_i, k | p, w_i\right)$$

subject to

$$G(k, h_i) \geq \underline{g}^s$$

Optimal decisions are given by

$$\begin{aligned} c_i &= \frac{1}{1+\delta} Y^s(p, w_i) \\ l_i &= \frac{\delta}{1+\delta} \frac{Y^s(p, w_i)}{w_i} \end{aligned}$$

The flow utility from being single is given by the indirect utility function:

$$U_i^s(p, w_i, q_i) = K_S + (1+\delta) \ln Y^s(p, w_i) - \delta \ln w_i + \delta \ln q_i$$

where $K_S = \delta \ln \delta - (1+\delta) \ln (1+\delta)$.

4.2 The Gains from Marriage

Suppose that married couples are optimally at some interior solution. Let $\widetilde{U}_i^M(\mu_i)$ represent the indirect utility function of person i being married:

$$\begin{aligned} \widetilde{U}_i^M(\mu_i, \varepsilon) &= \phi \ln \frac{\phi}{1+\delta} Y^m(w, p) + (1-\phi) \ln \left(\mu_i \frac{1-\phi}{1+\delta} Y^m(w, p) \right) \\ &\quad + \delta \ln \left(\frac{\mu_i}{w_i} \frac{\delta}{1+\delta} Y^m(w, p) \right) + \delta \ln \varepsilon \\ &= K_M + (1+\delta) \ln Y^m(w, p) - \delta \ln w_i + (1 - \phi + \delta) \ln \mu_i + \delta \ln \varepsilon \end{aligned}$$

, where K_M is given by

$$K_M = \phi \ln \phi + (1-\phi) \ln (1-\phi) + K_S$$

It is convenient to break out the Pareto weight from the flow utility:

$$\widetilde{U}_i^M(\mu_i, \varepsilon) = U_i^M + (1 - \phi + \delta) \ln \mu_i + \delta \ln \varepsilon$$

where

$$U_i^M = K_M + (1+\delta) \ln Y^m(w, p) - \delta \ln w_i$$

The difference in flow utilities, excluding the marital share and the match quality, is

$$\begin{aligned} \Delta_i (p, w_i, q_i) &= U_i^M - U_i^s \\ &= K_{MS} + (1+\delta) \ln \frac{Y^m (w, p)}{Y^s (p, w_i)} - \delta \ln q_i \end{aligned}$$

where

$$K_{MS} = K_M - K_S = \phi \ln \phi + (1-\phi) \ln (1-\phi)$$

We show in the appendix that there is a unique equilibrium marriage rate equal to the probability that the match quality exceeds ε^M, where this marriage threshold is given by:

$$\varepsilon^M = K \left[\left(\frac{Y_i^s}{Y^m} \right)^{p_1} q_i^{p_0} + \left(\frac{Y_j^s}{Y^m} \right)^{p_1} q_j^{p_0} \right]^{1/p_0} \tag{5}$$

. In this expression, K, $p_{0,}$ and p_1 are positive constants whose values depend on ϕ and δ. What matters for marriage rates, according to this expression, is a weighted average of the income of singles relative to the income of married couples. The income-ratio of sex j is more important than that of sex i to the extent that $q_j > q_{i.}$ This means that if sex j needs marriage less, then the marriage rate is more dependent on her income than on that of sex i. In terms of the gender gap, a trend towards equality could cause marriage rates to rise or fall, depending on the extent to which the low-wage sex enjoys single life more than the high-wage sex.

4.3 The Egalitarian solution

Suppose that spouses agree to split the gains from marriage evenly. This implies that the Pareto weight μ_i solves

$$W_i (w, q, \varepsilon | \mu_i) = W_j (w, q, \varepsilon | 1 - \mu_i)$$

, where $W_i (w, q, \varepsilon | \mu_i)$ is the gain from marriage for a person of sex i given that he has Pareto weight μ_i in the household utility function.. We call this the Egalitarian solution; it is also known as the "split the surplus rule".

We show in the appendix that the Egalitarian solution equates the gains in flow utility from marriage. If the household is at an interior solution, then this implies:

$$\Delta_i(p, w_i, q_i) + (1-\phi+\delta)\ln\mu_i = \Delta_j(p, w_i, q_i) + (1-\phi+\delta)\ln(1-\mu_i)$$

. Solving this condition yields the equilibrium allocation, which we represent, in accordance with Figure 1, by the husband's Pareto weight:

$$\mu_i(\widetilde{y}, \widetilde{q}, \varepsilon) = \frac{1}{1+\widetilde{q}^a\widetilde{y}^b}$$

, where $\widetilde{y} = \frac{Y_j^s(p,w_j)}{Y_i^s(p,w_i)}$, $\widetilde{q} = \frac{q_j}{q_i}$ and $a = \frac{\delta}{1-\phi+\delta}$ and $b = \frac{1+\delta}{1-\phi+\delta}$.

. This says that the bargaining position of spouse j is summarized by the product of her relative taste for single life and her relative full income as a single. Notice that ε does not enter; this is because with the egalitarian solution, factors that are common to both spouses drop out of the determination of μ_i.

The Pareto weight depends on the relative wage through the ratio of full incomes when single:

$$\frac{d\mu_i}{d\widetilde{w}} = \frac{-b\widetilde{q}^a\widetilde{y}^{b-1}}{(1+\widetilde{q}^a\widetilde{y}^b)^2}\frac{d\widetilde{y}}{d\widetilde{w}}$$

Therefore the leisure of spouse i will fall in response to a rise in $\widetilde{y}$ when the following condition is satisfied:

$$\frac{b\widetilde{q}^a\widetilde{y}^{b-1}}{(1+\widetilde{q}^a\widetilde{y}^b)^2}\frac{d\widetilde{y}}{d\widetilde{w}} > \frac{1}{\widetilde{w}} \tag{6}$$

Since the left-hand side is increasing in $\widetilde{q}$, we are more likely to see this condition hold when women are well off as singles, whether. because $\widetilde{q}$ is high or $\widetilde{y}$ is high. Also, an increase in $\widetilde{w}$ is likely to increase the left-hand side, because, as we argue below, the ratio $\widetilde{y}$ is likely to be increasing in $\widetilde{w}$. Since it lowers the right hand side, this condition is more likely to hold for high $\widetilde{w}$. Only when women's wages are sufficiently low, or the non-pecuniary quality of single life sufficiently poor for women, will the closing of the gender gap in wages cause wife's leisure to fall, as predicted by the unitary model; otherwise their leisure will increase, consistent with what we saw in the empirical section. For the model to be consistent with the increase in husband's relative leisure observed among older couples requires only that we assume that among older people, the prospect of single life is relatively more attractive for men. This does not seem implausible.

By way of contrast with the equilibrium condition for marriage, the size of the effect of economic trends on the leisure allocation is a function of the size of the response of the ratio of single's wages.

4.4 Numerical Example

We have extended the unitary model of household labor supply by incorporating a theory of the intra-household allocation that depends on two additional parameters, ϕ and $\widetilde{q}$, that are inherently unobservable. In this section we show that these parameter values can be inferred, together with δ, from a few simple leisure statistics: leisure's expenditure share of full income, the relative leisure of spouses at a given time, and the elasticity of relative leisure with respect to the relative full income of singles.

We can write the leisure ratio as

$$\widetilde{l} = l_j / l_i = \frac{1}{\widetilde{w}} \widetilde{q}^a \left[\widetilde{y} \left(\widetilde{w} \right) \right]^b$$

If $\widetilde{q}$ stays constant over time, and $\widetilde{y}$ equals $\widetilde{w}$, then the elasticity of relative leisure with respect to $\widetilde{w}$ is given by $b - 1$:

$$\frac{d}{d \ln \widetilde{w}} \ln \widetilde{l} \left(\widetilde{w} \right) = \frac{d}{d \ln \widetilde{w}} \left[(b-1) \ln \widetilde{w} + a \ln \widetilde{q} \right]$$

This means we can pin down some basic parameters with some simple empirical observations. First, we can recover μ from the relative leisure, as above. Then to get δ, we consider leisure cost of married people as a share of their full incomes, $Y^m(w, p)$:

$$\frac{w_i}{Y^m(w, p)} \frac{l_i}{\mu_i} = \frac{\delta}{1 + \delta}$$

. Since we observe wages, then under the assumption that spending on household equipment is a negligible fraction of income, we get

$$Y^m(w,p) \simeq w_i(1-h_i) + w_j(1-h_j)$$

So δ solves:

$$\frac{1}{[(1-h_i)+\widetilde{w}(1-h_j)]}\frac{l_i}{\mu_i} = \frac{\delta}{1+\delta}$$

. Plugging in numbers for the 1970s, $h_i = 0.04, \widetilde{w} = 0.61, h_j = 0.26, l_i = 0.45$ and $\mu_i = 0.67$, we get

$$\frac{\delta}{1+\delta} = 0.48 \Rightarrow \delta = 0.92$$

We began by taking μ as given from the observation on relative leisure. Once δ is fixed however, μ is a non-linear function of ϕ and $\widetilde{q}$. With δ fixed by the levels of leisure, ϕ is identified by the change in relative leisure in response to the change in $\widetilde{w}$. From the 70s to the 90s, the relative wage increased 25% and relative leisure 17%, so the elasticity ξ is 0.68. The elasticity of relative leisure to the change in wages, maintaining the assumption that $\widetilde{w} = \widetilde{y}$, is given by

$$\begin{aligned} \xi &= 0.68 = b - 1 = \frac{\phi}{1-\phi+\delta} \\ \Rightarrow & \phi = \frac{\xi}{1+\xi}(1+\delta) = 0.77 \end{aligned}$$

This says that most consumption in the marriage is public consumption. We now have values for a and b :

$$\begin{aligned} a &= \frac{\delta}{1-\phi+\delta} = 0.8 \\ b &= \frac{1+\delta}{1-\phi+\delta} = 1.67 \end{aligned}$$

so$\widetilde{y}_{70}^b = 0.44$.We can now return to our first result, that $\mu = 0.67$ in the 1970s, to pin down $\widetilde{q}$.

$$\begin{aligned} \mu_i^{70s} &= 0.67 = \frac{1}{1+\widetilde{q}^a\widetilde{y}_{70}^b} \\ &\Rightarrow \widetilde{q} = 1.23^{1/1.23} = 1.18 \end{aligned}$$

This implies that women need marriage somewhat less than men do, for a given level of wages. If we had included in the model conventional assumptions about women's gain from having children in marriage, or from a greater psychic payoff of marriage, that would only strengthen this result, in the sense that to the extent that the non-pecuniary benefits in marriage accrue more to women than to men, the higher $\widetilde{q}$ implied by the fact that the leisure differential between men and women is so much smaller than the income ratio of singles, $\widetilde{y}$ .Note also, from equation (5), that $\widetilde{q} > 1$ implies that convergence of women's wages may cause marriage rates to fall.

Since this solution is for the special case where $\widetilde{w} = \widetilde{y}$, the more important point is that all of the apparently free parameters in the model are in fact pinned down by the data, once the home techonology is given. However the analysis so far has ignored the trends in time allocated to home production. Incorporating home production into the model will give us not only a theory of the time married couples spend in housework, it will also give us a theory of $\widetilde{y}$.When we calibrate the full model to US data, it will still be true, as demonstrated in the above example, that there is a unique set of parameters that matches the data on leisure and work, conditional on the technology.

5 Home Production

It is clear from the analysis of households with working wives that in the unitary model we can make some predictions about leisure without a theory of home production. However in the bargaining model, the leisure decisions of married couples depend on the levels of full income of singles, and hence a theory of home production is needed even before making predictions concerning leisure, let alone housework time.. Furthermore, if the wife does not work in the market, then the time constraint implies that the wife's leisure is directly determined by her housework time. Therefore we now expand the analysis to explicitly model the decisions concerning housework.

If the technology for production of the home good were constant over time, then we could subsume it into the parameters $(\phi, \widetilde{q})$ .However the NIPA deflator for home equipment and furnishings has fallen by 50% relative to the GDP deflator since the 1970s.[11] Furthermore, according to Bils (2004), the NIPA durables prices are based on severe underestimation of technology improvement, so that a more realistic estimate of the price trend would on the order of a further 50% decline over the period. As Greenwood and Guner (2004) point out, this price trend, by raising productivity of home labor, could affect both the attractiveness of single life and the opportunity cost of market labor. In our model, the effects on the allocation of leisure and on marriage rates will depend on whether the full income of single men rises by more or less than that of single women, and on whether a weighted average of the full income of singles rises by more or less than that of married people.

5.1 Technology

We now turn to the determination of full income. Recall from the discussion of the unitary model that this can be written as the solution to the following problem of the married couple:

$$Y^m(w,p) = \max_{h_i,h_j,k} \{I(h_i,h_j,k|w_i,w_j)\}$$

subject to

$$\underline{g}^m = G^m(k,h_i,h_j)$$

Lets start from the assumption that the married-couples technology is separable between capital and some homothetic aggregate $H(h_i,h_j)$ of the spouse's home time. Then the first-order conditions imply that the ratio of housework times at the optimum is independent of the price p :

$$\frac{w_i}{w_j} = \frac{H_1}{H_2}$$

[11] The prices series are drawn from NIPA data on the BLS web page: http://www.bea.gov/beahome.html. The price of home durables is taken as the ratio of the price index for home durables and furniture to the GDP deflator.

Year	1965		1975		1985	
Wife Employed?	No	Yes	No	Yes	No	Yes
Sample Size	324	157	239	190	269	468
Total Market	0.82	40.31	1.23	37.37	1.13	32.67
Total Work at Home	43.58	29.28	37.82	23.07	36.4	24.66
Total Working Time	44.4	69.59	39.05	60.44	37.54	57.33
Leisure	51.22	29.43	55.21	35.31	53.56	38.49
Child Care*	10.11	4.03	7.83	3.94	8.68	4.84
Remainder	32.52	22.48	36.64	25.25	36.49	28.04

Table 5: Housework and Leisure of Wives in U.S. time-use surveys compiled by Aguiar and Hurst(2005).

This would preclude the trend in appliance prices explaining the rapid rise in ratio $\frac{h_i}{h_j}$ that we documented in the empirical section. For a decline in p to match observed rise in $\frac{h_i}{h_j}$ requires that k be more complementary with h_i than with h_j.We therefore assume a CES production function that allows for sex bias in the technology:

$$G(k, h_i, h_j) = \left[z_i k^{\theta_i} h_i^{1-\theta_i} + z_j k^{\theta j} h_j^{1-\theta_j}\right]^{\eta}$$

, where the equipment shares θ and the total factor productivity z may differ by sex. The parameter η reflects returns to scale in home production, a potential benefit of marriage.

5.2 The Extensive Margin

It is well-known that most of the change in female labor supply over the period under consideration is due to the movement of wives into the labor force, rather than an increase of the hours of working wives. In this section we ask how to reconcile this phenomenon with the model.

Table 5 shows the home hours and leisure for wives in the time-use surveys reported in Table 3. The main features are that in all periods women who are not working outside the home have roughly 50% more leisure and 50% more hours of housework than those who do work outside the home. The decline in home production hours over time appears to be about 33% for both groups. Women who do not work in the market also spend more time in child care, but these patterns hold roughly for both measures of leisure, before and after childcare, even in 2003 which reflects the new definitions of childcare.

In terms of the model, because households where the wives do not work are at a corner solution, we cannot separate the leisure allocation from the home-hours allocation. So we cannot infer from the fact that these women get more leisure that they have lower wages or higher values outside the marriage. If these were indeed the primary reason that these households were at the corners, it is not clear why this should lead to them spending so much more time in home production.

Therefore the major challenge for the model is to explain this differential in home hours. A simple way to do this is to allow for heterogeneity in the home-production constraint. Suppose that some households require a much higher level of the home good in order to operate. Then these households would, at an interior solution, allocate much less of the wife's time to market labor.

We show in the appendix that, when the wife's market labor is zero, the optimal choice of (h_i, k) solves this unconstrained problem:

$$V^C(\mu_i, w_i) = \max_{h_i,k} \{[1 + \mu_i \delta] \ln I^c(h_i, k|w_i) + (1 - \mu_i)\, \delta \ln l_j(h_i, k)\}$$

subject to

$$I^c(h_i, k|w_i) = w_i - h_i w_i - pk$$

The Pareto frontier implied by the solutions to this problem give rise to a different mapping from bargaining solutions to the Pareto weight μ_i than the case of interior solutions. Perhaps the easiest way to understand this is to consider the household choosing between two different problems, one where the wife works, and one where the wife does not. This is illustrated in Figure 2, which adds to the previous graph, Figure 1, a second Pareto frontier representing the case where the wife does not work, and hence the household does not pay the fixed cost for market entry of the wife.

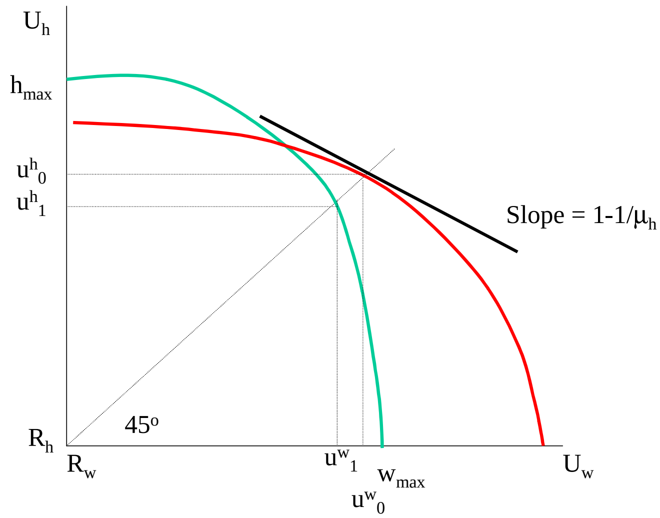

Figure 2: Pareto frontier for corner solution, where wife does not work in the market.

This second frontier is lower at the vertical axis under the assumption that the wife would optimally work in the market if her leisure were not valued by the planner; therefore the gap on the vertical axis represents the wife's earnings foregone. It is also further to the right on the horizontal axis, under the assumption that the wife would not optimally work in the market if the planner put zero weight on the husband's utility; therefore the gap on the horizontal axis represents the savings for the couple that does not incur the fixed cost. Obviously this implies the slope of the tangent will be different than in the case where the wife works. The figure illustrates the particular case where the wife does not work, because, along the 45 degree line, the second frontier lies further out than the original one where the wife works.

To implement this idea, we assume that married couples differ in the amount of home good they are required to produce.[12] This may be thought of as heterogeneity in types that are unobservable in the data. For consistency with the marriage equilibrium analysis, we could imagine that marriage occurs strictly within these types.

[12]Note that we are assuming this heterogeneity is not expressed in single households; only in married couples.

In terms of the constraint, we generalize by allowing for effects of family size n_k and unobservable type γ :

$$G(k, h_i, h_j) \geq \underline{g}^m(n_k, \gamma)$$

Since we cannot distinguish these types when single, we assume a fixed distribution over the housework-types, and denote the CDF by Γ.

6 Calibration

The objective of this section is to learn how much of the trends in market work, housework and leisure time of married couples can be attributed to each of the competing explanations, holding constant all other features of the environment, including the relative attractiveness of single life.. We will calibrate the model the model to match the data for the 1970s and the 1990s, and then use this benchmark model to determine the quantitative impact of each explanation in isolation. To achieve this, we compare this calibrated benchmark to restricted versions of the model, in which we allow only for one of these trends at a time: the relative wage, the home-equipment price or family size.

The calibration strategy involves parametrizing four objects: the home goods constraint $\underline{g}^m(n_k, \gamma)$ as a function of family size, the home-production technology $G(k, h_i, h_j)$, the utility function, and the distribution $\Gamma(\gamma)$ that governs heterogeneity in the the home-goods constraint of married couples.

We assume the production of the home good is given by the CES function $G(k, h_i, h_j)$ described above with z_j normalized to one. This leaves as free parameters $(\theta_i, \theta_j, z_i, \eta)$. To parametrize the home constraint on family composition. We assume this is given by

$$\begin{aligned}
\underline{g}^m(n_k, \gamma) &= \gamma\left(\alpha_m + \alpha_{nk} n_k^{\alpha_2}\right) \\
\underline{g_i}^s(n_k) &= \alpha_{si} + \alpha_{nk} n_k^{\alpha_2}
\end{aligned}$$

. The distribution $\Gamma(\gamma)$ is assumed to be log-normal with parameters (μ_g, σ_g).

For the benchmark model, we assume that the relative wage $\widetilde{w}$ evolves from 0.61 in the 1970s to 0.76 in the 1990s, to match the observations in Blau and Kahn (2000)[13]. Following the adjusted NIPA series documented in the previous section, we set the price p of home capital k, to decline from 1.0 to 0.23. The distribution of match quality $F(\varepsilon)$ is assumed to be log-normal with parameters $(\mu_\varepsilon, \sigma_\varepsilon)$.

We set some of the parameters directly from the summary statistics from the PSID sample by estimating an OLS equation of home hours on demographics. The analysis is reported in the appendix. The coefficients of interest are the partial effects of demographic differences on total housework time. These partial effects are: single male, single female, parent , and parent of more than one kid. Together these yield values for the family composition parameters $(\alpha_{si}, \alpha_{sj}, \alpha_{nk}, \alpha_2)$. The married-couple parameter α_m is normalized to two, then men's wage in 1970 to one, and the home-equipment price in 1970 to one.

The remaining thirteen parameters are set by requiring the model to match the targets listed in Table 6, which also shows the corresponding statistics obtained by the model. For the 1970s and the 1990s, the targets include the home-production and leisure time of married couples where the wife is also working in the market, as well as the fraction of wives working. In addition, the procedure targets the home-production time of non-working wives in the 1970s. The fraction of adult life married is computed from Schoen and Standish (2001). Along every dimension, the fit between data and benchmark model is very close: the average deviation of the model statistics from the empirical targets is on the order of 1%.

The actual parameters that give rise to this benchmark are shown in the Appendix. The most notable features of the home technology are that the share of

[13]The observed wage change is likely to include the effects of selectivity and investment, as pointed out by many recent papers on the gender gap, including Blau and Kahn (2004) and Mulligan and Rubinstein (2005). This seems like a promising angle for future research with this model.

Targets	Data	Bench
Home Production		
Wife Working, 1970s		
Wife	0.26	0.25
Husband	0.03	0.03
Wife Not Working, 1970s		
Wife	0.43	0.43
Wife Working, 1990s		
Wife	0.17	0.18
Husband	0.07	0.08
Leisure when wife is working		
Wife, 1970s	0.40	0.41
Husband, 1970s	0.45	0.44
H/W Ratio, 1990s	0.96	0.96
Fraction of Wives Working, 1970s	0.45	0.45
Fraction of Wives Working, 1990s	0.85	0.85
Fraction of Adult Life Married, 1970s	0.85	0.85
Fraction of Adult Life Married,1990s	0.55	0.55

Table 6: Calibration targets for benchmark model

equipment is twice as high in men's home production as in women's, and that husband's total factor productivity at home is about 85% that of the wives. The parameters also imply returns to scale in home production on the order of 1.3, a significant source of gains from marriage. The utility parameters imply another source of gains from marriage: the share of public goods in utility of married couples is about 60 per cent. Finally, as suggested in the earlier analysis, the model implies women would have enjoyed single life more than men, or at least needed marriage less, had they been able to earn similar wages.

We now turn to the actual explanation of the trends in relative leisure, home hours and wife's labor-force participation. Table 8 shows the results for the Benchmark model and the three experiments. Each of the explanatory trends accounts for roughly a third of the increase in wive's employment, though the wage trend is slightly more important and the family-size trend slightly less. The price and family-size trends however cause husband's relative leisure to increase; so it is clear that the decline in husband's relative leisure is strictly due to the wage trend. And what then explains the decline in wife's home hours from 0.26 of her time endowment to 0.17? This again is almost entirely due to the trend in the relative wage, which on its own accounts for more than 60% of the decline in wife's home time, and 80% of the positive trend in husband's home time.

To summarize, it appears that for understanding the trend in working hours of married women, net of the decline in family size, both relative wages and the trend in home technology are equally important. However the trend in relative leisure is all due to the trend in wages. This is because the wage trend causes a large rise in women's full income as single; an increase of 25% over the 1970s, while the price trend causes a relatively slight change that is stronger for men than for women. This is also reflected in the change in the husband's Pareto weight, which mainly decreases due to the wage trend.

There is a composition effect in the results, reflected in the fact that the price

			Experiments		
			1	2	3
	Data	Bench	Wage Trend Only	Price Trend Only	Family Trend Only
Employment Rate of Wives	0.85	0.85	0.61	0.60	0.58
Husband's Pareto Weight		0.56	0.56	0.64	0.63
Married Leisure in 1990's					
Wife	0.43	0.44	0.43	0.41	0.42
Husband	0.41	0.42	0.42	0.44	0.44
H/W Ratio	0.95	0.96	0.98	1.08	1.04
Home Hours in 1990s					
Wife	0.17	0.18	0.21	0.24	0.24
Husband	0.08	0.08	0.07	0.04	0.03
Market Labor in 1990's					
Wife	0.35	0.29	0.27	0.25	0.24
Husband	0.44	0.43	0.44	0.45	0.46
Full Income 90s/70s ratio					
Married	-	1.09	1.07	1.00	1.01
Single Women	-	1.31	1.25	1.01	1.04
Single Men	-	1.03	1.00	1.02	1.02
Marriage Rate in 1990s	0.55	0.55	0.73	0.78	0.77

Table 7: Comparison of results for the benchmark model and experiments

trend appears to have surprisingly little effect on the full income of married couples; indeed the table shows no change. This however is an illusion:, the wives entered the labor force had higher housework than the wives who were already working in the 1970s. The trends in prices and wages both draw into the labor force wives with high values of the housework constraint, so that the average housework of working wives tends to rise.

One final point about the results; the model implies a theory of the decline in marriage rates that is consistent with the actual empirical trend. The idea, implied in equation (5), is that marriage rates decline when the full income of singles rises relative to that of married. This could happen either through the price trend or the closing of the gender gap. This ratio climbs 20%, according to the model, from the 1970s to the 1990s. It is interesting therefore to compare the results for the wage and price trends in Table 8. It appears that the trend in home-equipment prices causes a decline from 85% to 78%, while the wage trend alone plays a larger role, causing marriage rates to fall to 73%. Obviously the model is not designed to explore the various possible causes of marriage trends, however it is interesting because we saw earlier that the wage trend only has a negative effect on marriage rates when the low-wage sex needs marriage less than the high-wage sex does.

7 Conclusion

This paper had three closely-related goals. The first was to determine whether aggregate trends in the time allocation of married couples actually fit the pattern implied by a stylized version of the unitary-household models generally used in macroeconomics. The second goal was to explore the implications of generalizing the unitary model in the simplest possible way into a model of individual people who make up the married couple. The third goal was to use the model to assess the relative importance of different potential explanations of the trends in the time allocation of married couples.

We used two independent sources of time use data to show that the leisure of husbands of women aged 25-45 was declining relative to that of their wives, and that their housework time was increasing. Since it is well-known that standard models of aggregate labor supply imply that husbands relative leisure should increase when women's hours of market labor increase, this fact suggests that macroeconomists need a more realistic model of household behavior. The second finding of this paper is that what is needed is a simple bargaining model. By calibrating the model to match US data, we found that the closing of the gender gap in wages explains virtually all of the leisure trend and about half of the housework trend. To answer the question with which this paper began, the reason married men are working so much is that the husband's bargaining position is eroding in response to the rise in women's wages.

This paper does not claim to have definitively measured the importance of the various reasons for the trend in women's market work; indeed we made many drastic simplifications in the interest of clarity. The significance of the quantitative results is that, while it is convenient and reasonable for macro economists to abstract from the interactions of individuals in a household, even a very crude step towards accounting for these interactions can significantly improve the performance of macro-economic models. Had the predictions of the unitary model been correct, the labor supply of married men in our sample would have fallen significantly since the 1970s, implying a large impact on aggregate labor. Our model says this did not happen because higher wages made it easier for women to walk away from marriage. We conclude that bargaining models of the household can provide a clearer and richer understanding of macroeconomics.

References

Aguiar, M., and E. Hurst (2005): "Measuring Trends in Leisure: Evidence from Five Decades of Time Use Surveys," Mimeo.

Bech-Moen, O. C. (2006): "Gender DIfferences in Market and Home Hours," Mimeo.

Bils, M. (2004): "Measuring Growth from Better and Better Goods," NBER Working Papers.

Blau, F. D., and L. M. Kahn (1997): "Swimming Upstream: Trends in the Gender-Wage Differential in the 1980s," *Journal of Labor Economics*, 15(1, pt. 12), 1–42.

Blau, F. D., and L. M. Kahn (2000): "Gender Differences in Pay," *Journal of Economic Perspectives*, 14(4), 75–99.

——— (2004): "The US Gender Pay Gap in the 1990s: Slowing Convergence," NBER Working Papers.

Caucutt, E. M., N. Guner, and J. Knowles (2002): "Why Do Women Wait? Matching, Wage Inequality, and the Incentives to Fertility Delay," *Review of Economic Dynamics*, 5(4), 815–855.

Chade, H., and G. Ventura (2004): "Income Taxation and Marital Decisions," *Review of Economic Dynamics*, p. forthcoming.

Chiappori, P., and Y. Weiss (2000): "An Equilibrium Analysis of Divorce," Discussion paper, University of Chicago.

Chiappori, P.-A. (1988): "Rational Household Labor Supply," *Econometrica*, 56(1), 63–90.

Chiappori, P.-A., B. Fortin, and G. Lacroix (2002): "Marriage Market, Divorce Legislation and Household Labor Supply," *Journal of Political Economy*, 110(1), 37–72.

Greenwood, J., and N. Guner (2004): "Marriage and Divorce Since World War II: Analyzing the Role of Technological Progress on the Formation of Households," Discussion paper, NBER.

Greenwood, J., N. Guner, and J. Knowles (2003): "More on Marriage, Fertility and the Distribution of Income," *International Economic Review*, 44(3), 827–862.

Greenwood, J., A. Seshadri, and M. Yorukoglu (2003): "Engines of Liberation," University of Rochester - Center for Economic Research (RCER), RCER Working Papers.

Greenwood, J., and G. Vandenbroucke (2005): "Hours Worked: Long-run Trends," Economie D'avant Garde, Research Report No. 10. University of Rochester.

Hochschild, A. R. (1997): *The Time Bind : When Work Becomes Home and Home Becomes Work*. Metropolitan Books, New York, NY.

Jacobs, J. A., and K. Gerson (2004): *The Time Divide*. Harvard University Press, Cambridge, MA.

Jones, L. E., R. E. Manuelli, and E. R. McGrattan (2003): "Why are married women working so much?," Federal Reserve Bank of Minneapolis, Staff Report: 317.

Manser, M., and M. Brown (1980): "Marriage and Household Decision Making: A Bargaining Analysis," *International Economic Review*, 21, 31–44.

McElroy, M., and M.-H. Horney (1981): "Nash-Bargained Household Decisions: Towards a Generalization of the Theory of Demand," *International Economic Review*, 36, 333–349.

McGrattan, E. R., and R. Rogerson (2004): "Changes in Hours Worked, 1950-2000," *Federal Reserve Bank of Minneapolis Quarterly Review*, 28, 14–33.

Mulligan, C. B., and Y. Rubinstein (2005): "Selection, Investment, and Women's Relative Wages Since 1975," Discussion paper.

Ramey, V. A., and N. Francis (2005): "A Century of Work and Leisure," Mimeo, University of California, San Diego.

Regalia, F., and J.-V. Ríos-Rull (1999): "What Accounts for the Increase in Single Households and the Stability in Fertility?," Barcelona, Spain: Universitat Pompeu Fabra, Department of Economics, Working Paper No. 1999.

Robinson, J. P., and G. Godbey (1997): *Time for Life*. The Pennsylvania State University Press, University Park, PA.

Schoen, R., and N. Standish (2001): "The Retrenchment of Marriage: Results from Marital Status Life Tables for the United States, 1995," *Population and Development Review*, 27, 553–563.

A Appendix

A.1 Empirical Tables

Table A-1 shows the trend towards increased leisure that has been discussed in many previous papers. Based on the Aguiar-Hurst extract of the US time surveys, it shows averages for the sample of non-retired people aged 21-65. As discussed in the text, the child-care definitions changed in 2003, partially obscuring the leisure trend. Over

Variables	1965		1975		1985		1993*	
	Women	Men	Women	Men	Women	Men	Women	Men
Sample Size	1050	866	937	778	1839	1483	1708	1433
Total Hours Per Week	168	168	168	168	168	168	168	168
Sleeping	55.1	54.4	59.0	56.2	56.0	55.0	58.6	57.1
Eating	7.9	8.3	8.0	9.0	7.7	8.0	7.4	7.6
Other Personal Care	9.5	7.7	7.7	7.0	10.1	8.7	8.2	7.2
Total Personal Care	72.5	70.3	74.7	72.2	73.8	71.6	74.1	71.9
Discretionary Time	95.5	97.7	93.3	95.8	94.2	96.4	93.9	96.1
Market Work	16.8	41.8	16.8	39.1	21.3	36.3	24.6	36.2
Commute+Work-Related	3.2	9.3	2.9	6.5	3.8	6.2	2.6	3.9
Total Market	20.0	51.1	19.8	45.8	25.2	42.6	27.2	40.2
Cooking and Indoor Chores	24.5	1.9	20.4	2.0	15.7	3.8	13.3	2.8
Shopping	7.1	4.6	5.7	3.7	7.0	4.6	6.1	4.1
Other Home Production	2.5	2.8	2.2	3.9	2.5	4.5	2.2	4.3
Total Work at Home	26.9	4.7	22.5	5.9	18.2	8.2	15.4	7.1
Total Working Time	54.5	60.6	48.6	55.8	51.1	56.2	49.5	52.2
Leisure	**41.0**	**37.1**	**44.8**	**40.1**	**43.0**	**40.2**	**44.4**	**44.0**
Child Care*	5.4	0.9	4.3	1.2	3.9	1.0	3.3	0.7
Remainder	29.8	30.6	33.1	33.3	33.4	34.6	34.8	37.0

Ages 25-65 Non-Retired

Table 8: Trends in time use for non-retired people aged 21-65

the entire period, leisure including child care increased about 12% for women and 20% for men. Up to 1993, the increase in leisure net of child care was about 16% for women and 13% for men.

Table A2 is the analog to Table 4 in the text for a wider sample that includes wives who are not working. The table shows that the average wife's time in market work doubled over the period, from 12 hours weekly to 25, and that housework hours fell from 34 hours to 21. Total working time for women declined slightly more than an hour, from 47.8 hours to 46.5. For married men, housework hours increased from two to seven weekly, while market hours declined from 44 to 41. For this broad sample, the relative leisure of the husband declined from 100% of the wife's leisure time, to 94%. The table also implies that the relative housework time of the wives fell sharply, by nearly 8 hours, while that of the husbands rose by about 4.5 hours.

The next table shows the determination of partial effects by estimation of a regression equation of (log) total home hours on PSID data. These effects are used to

Years	N/Year	Home	Market	Total	Leisure*
		Married Men, Wife aged 25-45			
1969-1975	746	2.14	44.14	47.45	50.55
1978-1983	1634	6.25	41.89	49.05	48.96
1988-1997	3333	7.45	41.63	49.78	48.22
		Married Women, aged 25-45			
1969-1975	578	34.57	12.04	47.79	50.21
1978-1983	1299	28.37	18.03	47.14	50.86
1988-1997	2709	20.99	25.08	46.45	51.55

Table 9: Trends in PSID for Married Couples where wife is aged 25-45

calibrate the family-size function in the benchmark version of the model.

We attempt to measure the various effects associated with the trend in housework hours by running an OLS regression in which the dependent variable is the log of the sum of the housework hours of both head and spouse for married couples, and of the housework hours of the head for singles. The table reports the results when the excluded group is married with zero kids. Four specifications are reported, the simplest of which shows that single males spend 50% less time than married in housework, and single women about 85% less, while parents of one child spend 43% more time in housework. Additional children appear to increase housework time by 13% each. This result suggests that people are including at least some portion of childcare in their responses to the questions about housework.

Specification 2 shows that the estimates are robust to controlling for education of the head. In the last two specifications, the estimates suggest that home hours fell about 18% for married couples, 5% for single women, and actually rose 7% for single men. This latter effect disappears after adding controls for labor-force status of the head. By contrast, controlling for labor force status causes the 1990's effect to converge to about -11% for both married and single women.

To summarize, we see that for households where wives are under age 55, the

Variable	Specification			
	1	2	3	4
Intercept	2.980	3.133	3.246	3.199
	(0.008)	(0.010)	(0.012)	(0.013)
Single Male	-1.073	-1.091	-1.138	-1.024
	(0.010)	(0.009)	(0.021)	(0.021)
Single Female	-0.846	-0.857	-0.797	-0.699
	(0.008)	(0.008)	(0.017)	(0.017)
Parent	0.308	0.300	0.304	0.296
	(0.011)	(0.011)	(0.010)	(0.010)
Number of Kids	0.134	0.126	0.114	0.088
	(0.004)	(0.004)	(0.004)	(0.004)
After 1990	.	.	-0.175	-0.109
	.	.	(0.009)	(0.009)
Single Male After 1990	.	.	0.072	-0.008
	.	.	(0.023)	(0.022)
Single Female After 1990	.	.	-0.052	-0.119
	.	.	(0.019)	(0.019)
High-School Graduate	.	-0.137	-0.115	-0.073
	.	(0.008)	(0.008)	(0.008)
Attended College	.	-0.280	-0.258	-0.204
	.	(0.009)	(0.009)	(0.009)
Works Full Time*	.	.	.	-0.160
	.	.	.	(0.007)
Does Not Work*	.	.	.	0.218
	.	.	.	(0.009)
Age 25-34	-0.182	-0.167	-0.164	-0.141
	(0.009)	(0.009)	(0.009)	(0.008)
Age 35-44	-0.195	-0.169	-0.152	-0.126
	0.009	0.0089	0.0089	0.0088
R-Squared	0.483	0.492	0.498	0.518
N	49176	49176	49176	49176

Table 10: Estimated coefficients for log of total weekly housework hours.

shift in the allocation of the leisure away from the husband is somewhat stronger after controlling for age, education and full-time employment. By way of contrast, consider the households where the wife was aged between 55 and 65. In that slightly older group, men's leisure actually increased relative to the wife's, by about 5% for college-educated wives, and by 10% for the others.

A.2 Equilibrium in the Marriage Market

Under the assumptions that there is no commitment and that match quality is iid both over time and across pairings, there is no dynamic component to the gains from marriage. Marriage is the efficient outcome if and only if the flow gains are positive. Since this condition need hold only at the optimal allocation between spouses, however, we cannot just add up the individual gains at some arbitrary allocation. Instead we define the minimum Pareto weight $\underline{\mu}_i$ that makes marriage acceptable to person i.Marriage is the efficient outcome if and only the minimum weights sum to less than one.

The minimum Pareto weight $\underline{\mu}_i$ is the solution to the following equation:

$$\begin{aligned} 0 &= \Delta_i\left(p, w_i, q_i\right) + (1-\phi+\delta)\ln\underline{\mu}_i + \delta\ln\varepsilon \\ \Rightarrow &\ \ln\underline{\mu}_i = -\frac{\Delta_i\left(p, w_i, q_i\right) + \delta\ln\varepsilon}{1-\phi+\delta} \\ \Rightarrow &\ \underline{\mu}_i = K\left(\frac{Y_i^s}{Y^m}\right)^{p_1} q_i^{p_0}\varepsilon^{-p_0} \end{aligned}$$

where

$$K_{MS} = K_M - K_S = \phi\ln\phi + (1-\phi)\ln(1-\phi)$$

and

$$\begin{aligned} K &= \exp\left(\frac{K_{MS}}{1-\phi+\delta}\right) \\ p_0 &= \frac{\delta}{1-\phi+\delta} \\ p_1 &= \frac{1+\delta}{1-\phi+\delta} \end{aligned}$$

Marriage is efficient is and only if:

$$\underline{\mu}_i + \underline{\mu}_j \leq 1$$

Under the assumption that μ is not a function of ε, we can define the threshold marriage quality ε^M as the lowest value of match quality for which marriage is the efficient outcome:

$$\begin{aligned} 1 &= K\left(\frac{Y_i^s}{Y^m}\right)^{p_1} q_i^{p_0}\varepsilon^{-p_0} + K\left(\frac{Y_j^s}{Y^m}\right)^{p_1} q_j^{p_0}\varepsilon^{-p_0} \\ &\Rightarrow \varepsilon^M = K^{\frac{1}{p_0}}\left[\left(\frac{Y_i^s}{Y^m}\right)^{p_1} q_i^{p_0} + \left(\frac{Y_j^s}{Y^m}\right)^{p_1} q_j^{p_0}\right]^{1/p_0} \end{aligned}$$

Therefore the equilibrium marriage rate is given by

$$\Pr\left(\varepsilon > \varepsilon^M\right) = 1 - F\left(\varepsilon^M\right)$$

, where

$$\varepsilon^M = K^{\frac{1}{p_0}}\left[\left(\frac{Y_i^s}{Y^m}\right)^{p_1} q_i^{p_0} + \left(\frac{Y_j^s}{Y^m}\right)^{p_1} q_j^{p_0}\right]^{1/p_0}$$

A.3 Determination of the Pareto Weights

Proposition 2 *Under the egalitarian solution, the Pareto weight of spouse j in the household utility function is given by*

$$\mu_j = \frac{\widetilde{qy}^{\frac{1+\delta}{\delta}}}{1+\widetilde{qy}^{\frac{1+\delta}{\delta}}}$$

Proof. The solution equates the gains from marriage:

$$W_i\left(\varepsilon|\mu_i\right) = W_j\left(\varepsilon|\mu_j\right)$$

The gains from marriage are given by

$$W_i\left(\varepsilon|\mu_i\right) = \widetilde{U}_i^M\left(\varepsilon,\mu_i\right) - U_i^S$$

Given the expression (**??**) for $W_i\left(\varepsilon\right)$, this implies

$$\begin{aligned}
& \delta\ln\mu_i - (1+\delta)\ln Y_i^s - \delta\ln q_i \\
= \; & \delta\ln\left(1-\mu_i\right) - (1+\delta)\ln Y_j^s - \delta\ln q_j \\
\Rightarrow \; & \delta\ln\frac{\mu_i}{1-\mu_i} = (1+\delta)\ln\frac{Y_i^s}{Y_j^s} - \delta\ln\frac{q_i}{q_j} \\
\Rightarrow \; & \frac{\mu_i}{1-\mu_i} = \left(\frac{q_i}{q_j}\right)\left(\frac{Y_i^s}{Y_j^s}\right)^{\frac{1+\delta}{\delta}} \\
\Rightarrow \; & \mu_i = \frac{\frac{q_i}{q_j}\left(\frac{Y_i^s}{Y_j^s}\right)^{\frac{1+\delta}{\delta}}}{1+\frac{q_i}{q_j}\left(\frac{Y_i^s}{Y_j^s}\right)^{\frac{1+\delta}{\delta}}}
\end{aligned}$$

The result follows by symmetry. ■

A.4 Wage Elasticity of Leisure

Using the fact that leisure depends on the relative wage both directly and via the Pareto weight, we show the response of relative leisure to a change in the relative

$$\widetilde{l}\left(\widetilde{w}\right) = \frac{1-\mu_i\left(\widetilde{w}\right)}{\widetilde{w}\mu_i\left(\widetilde{w}\right)}$$

$$\begin{aligned}\widetilde{l}'(\widetilde{w}) &> 0 \Leftrightarrow \frac{d}{d\widetilde{w}} \ln \frac{1-\mu_i(\widetilde{w})}{\widetilde{w}\mu_i(\widetilde{w})} > 0 \\ &= \frac{d}{d\widetilde{w}} [\ln(1-\mu_i)] - \frac{d}{d\widetilde{w}} \ln \mu_i - \frac{d}{d\widetilde{w}} \ln \widetilde{w} \\ &= -\left(\frac{1}{(1-\mu_i)\mu_i}\right) \frac{d\mu_i}{d\widetilde{w}} - \frac{1}{\widetilde{w}}\end{aligned}$$

A.5 Labor-Force Participation

In the body of the paper, we have assumed that the wife labor supply to the market is greater than zero. This is what permits us to separate the leisure allocation from home production in the maximization problem. In this section we show that if the wife's optimal market labor is zero, then a decline in the price of home goods will cause the relative leisure of the husband to fall.

We proceed, as before, by solving the problem given full income, and then solving for full income. If the wife is not working for a wage, the definition of full income $I^c(w_i, k)$ for a constrained couple is now as shown on the rhs of the following budget constraint:

$$c^h + c_i + c_j + w_i l_i = w_i - h_i w_i - pk = I^c(h_i, k|w_i)$$

Given (h_i, k) therefore we know how much income the household can allocate between leisure and consumption. Using the fact that the wife's leisure is determined by h_i, k through the home-production constraint, this sub-problem can be written as:

$$\max_{l_i, c^h, c_i, c_j} \left\{\phi \ln c^h + (1-\phi)[\mu_i \ln c_i + (1-\mu_i)\ln c_j] + \delta\mu_i \ln l_i\right\}$$

subject to the above budget constraint.

It is clear that the optimal expenditures are:

$$
\begin{aligned}
c^h &= \frac{\phi}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right) \\
c_i &= \mu_i \frac{1-\phi}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right) && (7) \\
c_j &= \left(1-\mu_i\right) \frac{1-\phi}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right) && (8) \\
l_i &= \frac{\mu_i}{w_i} \frac{\delta}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right)
\end{aligned}
$$

The husband's utility is given by

$$
\begin{aligned}
u_i\left(\mu_i, k\right) &= (1-\phi)\ln\left[\mu_i \frac{1-\phi}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right)\right] + \phi \ln\left[\frac{\phi}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right)\right] \\
&\quad + \delta \ln\left[\frac{\mu_i}{w_i}\frac{\delta}{1+\mu_i\delta} I^c\left(h_i, k|w_i\right)\right] \\
&= (1+\delta)\ln I^c\left(h_i, k|w_i\right) + (1-\phi+\delta)\ln\mu_i + K_i
\end{aligned}
$$

where $K_i = (1-\phi)\ln(1-\phi) + \phi\ln\phi + \delta\ln\delta - \delta\ln w_i - \left(1+\mu_i\delta\right)\ln\left(1+\mu_i\delta\right).$

The home-production constraint implies that wife's leisure is a function of home durables k :

$$
g_m = \left[\left(z_i\left(h_i\right)^{1-\theta_i} k^{\theta_i}\right)^\eta + \left(z_j\left(1-l_j\right)^{1-\theta_j} k^{\theta_j}\right)^\eta\right]^{1/\eta}
$$

$$
\begin{aligned}
h_j\left(h_i, k\right) &= \left[\left(\frac{g_m}{z_j k^{\theta_j}}\right)^\eta - \left(\frac{z_i}{z_j}\left(h_i^{1-\theta_i} k^{\theta_i-\theta_j}\right)\right)^\eta\right]^{\frac{1}{\left(1-\theta_j\right)\eta}} \\
\frac{\partial}{\partial h_i} h_j\left(h_i, k\right) &= \frac{1-\theta_i}{1-\theta_j}\frac{A}{h_i}\left(\frac{z_i}{z_j}\left(h_i^{1-\theta_i} k^{\theta_i-\theta_j}\right)\right)^\eta \\
\frac{\partial}{\partial k} h_j\left(h_i, k\right) &= \frac{1}{1-\theta_j}\frac{A}{k}\left[-\theta_j\left(\frac{g_m}{z_j k^{\theta_j}}\right)^\eta - \left(\theta_i-\theta_j\right)\left(\frac{z_i}{z_j}\left(h_i^{1-\theta_i} k^{\theta_i-\theta_j}\right)\right)^\eta\right] \\
A &= \left[\left(\frac{g_m}{z_j k^{\theta_j}}\right)^\eta - \left(\frac{z_i}{z_j}\left(h_i^{1-\theta_i} k^{\theta_i-\theta_j}\right)\right)^\eta\right]^{\frac{1}{\left(1-\theta_j\right)\eta}-1}
\end{aligned}
$$

We see the utility that the wife gets, conditional on $I^c\left(h_i, k|w_i\right)$ and μ_i:

$$
\begin{aligned}
u_j\left(\mu_i, k\right) &= (1-\phi)\ln\left(1-\mu_i\right) + \ln I^c\left(h_i, k|w_i\right) + \delta\ln l_j\left(h_i, k\right) + K_j \\
K_j &= (1-\phi)\ln\frac{1-\phi}{1+\mu_i\delta} + \phi\ln\frac{\phi}{1+\mu_i\delta}
\end{aligned}
$$

The optimal choice of (h_i, k) solves this unconstrained problem:

$$V^C(\mu_i, w_i) = \max_{h_i,k} \{[1 + \mu_i\delta] \ln I^c(h_i, k|w_i) + (1 - \mu_i)\delta \ln l_j(h_i, k)\}$$

subject to

$$I^c(h_i, k|w_i) = w_i - h_i w_i - pk$$

The first-order conditions for this problem are:

$$\begin{aligned} \frac{dV}{dk} &= -\frac{[1 + \mu_i\delta]\, p}{I^c(h_i, k|w_i)} + \frac{(1 - \mu_i)}{l_j(h_i, k)} \frac{\partial}{\partial k} l_j(h_i, k) \geq 0 \\ \frac{dV}{dh_i} &= -\frac{[1 + \mu_i\delta]\, w_i}{I^c(h_i, k|w_i)} + \frac{(1 - \mu_i)}{l_j(h_i, k)} \delta \frac{\partial}{\partial h_i} l_j(h_i, k) \geq 0 \end{aligned}$$

$$\begin{aligned} \frac{\partial}{\partial h_i} l_j(h_i, k) &= \frac{1 - \theta_i}{1 - \theta_j} \left[\frac{g_m}{z_j k^{\theta_j}} - \frac{z_i}{z_j} \left(h_i^{1-\theta_i} k^{\theta_i - \theta_j}\right)\right]^{\frac{\theta_j}{1-\theta_j}} \frac{z_i}{z_j} \left(h_i^{-\theta_i} k^{\theta_i - \theta_j}\right) \\ \frac{\partial}{\partial k} l_j(h_i, k) &= \frac{1}{1 - \theta_j} \left[\frac{g_m}{z_j k^{\theta_j}} - \frac{z_i}{z_j} \left(h_i^{1-\theta_i} k^{\theta_i - \theta_j}\right)\right]^{\frac{\theta_j}{1-\theta_j}} \\ &\quad \times \left[\theta_j \frac{g_m}{z_j} k^{-1-\theta_j} - (\theta_i - \theta_j) \frac{z_i}{z_j} \left(h_i^{1-\theta_i} k^{\theta_i - \theta_j - 1}\right)\right] \end{aligned}$$

Is the problem concave? As k gets larger, $I^c(\mu_i, k)$ declines, making the first term more negative. The second term declines, so the FOC is decreasing.

$$\frac{d^2 V}{dk^2} = -\frac{[1 + \mu_i\delta]\, p^2}{I^c(\mu_i, k)} - \frac{(1 - \mu_i)(b - 1)\delta abk^{b-2}}{l_j} + \frac{(1 - \mu_i)\delta}{l_j^2} \left(abk^{b-1}\right)^2 \geq 0$$

A.6 Calibrated Parameters

These are the parameters of the benchmark calibration referred to in the table. Note that the family-size parameters are set using the regression results above; so they are held fixed when the model is matched to the targets.

Parameters	Benchmark Model
Utility parameters	
Women's utility of being single, relative to men's	1.29
Utility weight of leisure	1.18
Share of public goods in consumption	0.61
Employment fixed cost, as fraction of time endowment	0.10
Home Technology	
Required home goods per adult equivalent	0.07
Men's Durables Share	0.08
Women's Durables Share	0.04
Men's Relative TFP	0.84
Returns to Scale	1.23
Family Size	
Adult equivalents per child	1.07
Curvature of family size	0.48
Reduction for Single Man	0.90
Reduction for Single Woman	0.74
Distribution of g-factor for married	
Mean	0.33
Standard Deviation	0.24
Distribution of match quality	
Mean	0.45
Standard Deviation	0.49

Table 11: Parameters for the Benchmark Model