Why are Married Men Working So Much? Relative Wages, Labor Supply and the Decline of Marriage.

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Abstract

Are macro-economists mistaken in ignoring bargaining between spouses? This paper argues that models of intra-household allocation could be useful for understanding aggregate labor supply trends in the US since the 1970s. A simple calculation suggests that with standard preferences, the unitary model predicts a 19% decline in married-male labor supply in response to the narrowing of the gender gap in wages since the 1970s. However married-men's paid labor remained stationary over the period from the mid 1970s to the recession of 2001. This paper develops and calibrates to US time-use survey data a model of marital bargaining in which time allocations are determined jointly with equilibrium marriage and divorce rates. The results suggest that bargaining effects raised married men's labor supply by about 2.1 weekly hours over the period, and reduced that of married women by 2.7 hours. While relative wage growth can account for all of the increase in married women's hours over the period, the decline in marriage rates over the same period appears to be unrelated to wages; most of the marital decline is due to forces outside the model, although the declining price of labor-saving home equipment appears to play a significant role.

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1 Introduction

The economic position of women appears to have improved significantly relative to that of men over the last forty years, as reflected in higher wages and stronger career prospects. Figure 1(a), for instance, shows that the mean wages for workers with more than 10 average weekly hours converged strongly over the period 1975-2001. As Becker (1988) has pointed out, this is a likely explanation for the decline in marriage rates over the same period, as convergence in market wages reduces the gains from marriage. Furthermore, to the extent that such changes improve the bargaining position of women, they are likely to have shifted the allocations within marriage in favor of the wife.

Neither of these potential impacts of wage convergence have been extensively studied at the aggregate level, largely because macro models of the household tend to ignore questions of intra-household allocation.[1] This paper asks whether extending a standard macro model to include bargaining between spouses can enrich our understanding of the rise in married-women's labor supply observed in the US over the period 1975-2003. The implications for aggregate labor supply and the decline of marriage are also examined. The analysis relies on a simple model of equilibrium bargaining between spouses that is both tractable and compatible with the highly aggregated models used in macroeconomics.

While the evidence for reallocations in response to improved outside options is quite strong at the micro level, macroeconomic models with households usually abstract from such effects by assuming that the household acts as an economic agent with a stable utility function. At the level of the micro data on labor supply, this "unitary" assumption has been shown repeatedly to be inferior to an approach that allows allocations within the marriage to depend on the economic position outside the marriage. For instance, Chiappori, Fortin, and Lacroix (2002) find that the data rejects the unitary model in favor of the "collective model with distribution factors", which is essentially an empirical implementation of bargaining between spouses, in the tradition of McElroy and Horney (1981). Empirical support for inter-temporal implications of this model was provided by Mazzocco (2007). The comparative neglect of inter-spouse bargaining by macro-economists is all the more surprising considering the central role of bargaining in the labor-search literature, and the obvious parallels between employment and marriage relationships, as discussed in Burdett and Coles (1999).

From the point of view of empirical analysis, an important advantage of employment relationships is that wages and output are in principle observable, while the utility allocation between spouses in a marriage is not. The standard practice in the collective-model literature has been to study paid labor time as a proxy for intra-household allocations; the implicit assumption has been that paid labor is negatively related to leisure, and that an improvement in the outside option of the wife will result in an increase in her leisure, and hence a decline in her paid labor. A well-recognized problem with this approach is that it is only valid if the relative prices faced by the married household , as well as its wealth, are invariant to the forces underlying the changes in the outside options. Hence the collective-model literature is limited to the study of effects that leave these unchanged, such as local variations in divorce laws and in sex ratios of singles. Analysis of changes in relative wages therefore requires a more structural approach which can account for income and substitution effects of wages.[2]

[1] For a recent exception, see Lise and Seitz (2011), who find that accounting for trends in intra-household inequality substantially reduces the apparent increase in consumption inequality over the last 30 years.

[2] Browning and Gortz (2006) find that variation in wife's leisure across Danish households is positively correlated with her consumption expenditures, supporting the hypothesis of bargaining over that of preference heterogeneity. This also rationalizes the use of leisure as a proxy for relative welfare in the household.

The assumption that time outside of paid work equals leisure time is also unsuitable for historical comparisons of leisure allocations, because it ignores the time married people spend in household chores. Indeed Greenwood, Seshadri, and Yorukoglu (2005) [GSY hereafter] have argued that rising labor productivity at home accounts for roughly half of the increase in married-women's labor supply since 1945, as the time required to accomplish the chores has diminished, due to the decline in prices of labor-saving home equipment. Over the 1975-2003 period, NIPA deflators show that in 2003 the price of home equipment relative to consumption prices stood at about 25% of the 1975 level. Since the main predictions of bargaining models for labor supply are based on the allocation of leisure, this suggests that it may be misleading to make inferences from labor supply without accounting for home-production time.

A sensible rationalization of the macro-economist's neglect of intra-household bargaining might be that the aggregate effects of reallocation are likely to be small. Jones, Manuelli, and McGrattan (2003) have shown that a standard unitary household model with home production can explain the rise in married women's labor supply since 1950 in response to either the trend in the female-male wage ratio or in response to rising productivity at home, as in GSY. In both cases, they find that calibration to US data implies that married men's labor supply should have fallen, by somewhere between 5-8 hours weekly. However Figure 1(c) shows that married men's weekly paid work hours, after a significant decline in the 1960s, remained essentially stationary over the 1972-2001 period while women's relative wages were rising. This suggests that the shortcomings of the unitary model may be significant at the macro level. This of course has direct implications for aggregate labor supply, which increased by roughly 20% over the same period.[3]

In this paper I show, using American surveys of household time use, that the problem of relative leisure is robust to accounting for home production. While total working time of married people, both men and women has increased since 1975, the ratio of husband's non-working time to that of the wife is roughly constant over the period. This is supported by similar findings by Bech-Moen (2006) for the US and Norway. Slicing the data more finely to account for heterogeneity in education, age or female labor force participation exacerbates the problem: the relative leisure of wives actually increased in most of the sub-categories, declining only among couples over age 50. Indeed, Burda, Hamermesh, and Weil (2007), noting that the leisure ratio is independent of relative wages across a wide range of countries, despite disparities in relative wages, call this the "iso-leisure" pattern, which they explain on the basis of social norms.

The argument developed here proceeds in two stages; first a model of marriage and allocations is developed; the model is equipped with a standard Cobb-Douglas home-production technology, CRRA preferences, and a stochastic process for marriage quality. The marriage-equilibrium concept is similar to that of Chade and Ventura (2005) but allows for intra-household bargaining as in McElroy and Horney (1981). From the point of view of matching the iso-leisure fact, the key feature of the model is that the bargaining position of the spouses depends on the marriage-matching equilibrium, which is in turn a function of the relative wage. This feature is essential for reconciling the standard macro model with the main empirical result, that the ratio of married women's non-working time to that of husbands was stationary over the period 1975-2003. Without bargaining, the model predicts a 12% decline in this ratio, in response to the shrinking of the gender gap in wages. Given a level of married leisure of roughly 61 weekly hours per capita in 1975, that translates into a 7 hour decrease in married-men's working time. The model shows that the stationary leisure ratio can be easily explained by the impact of relative wages on bargaining position, and hence without reference to social norms. While the model is very stylized, this basic insight is clearly characteristic

[3] Prescott (2004) conjectures that the rise in per-capita hours was driven by tax reforms that flattened the marginal tax schedule. However the estimates of Guner, Kaygusuz, and Ventura (2012) and Kaygusuz (2010) suggest that the reforms of the 1980s had been largely eroded by the year 2000.

of the broad class of models used in macro-economics; the most important assumption being that household utility is within the CES class and separable across goods.

In the second stage, the paper proposes answers to the essentially quantitative questions raised above: how much does intra-household bargaining change the model's responses of labor supply and marriage rates to relative wages, taxes, equipment prices or other shocks to the economic environment? The model is first calibrated to match time allocations for 1975 and 2003 so as to permit an accounting-style decomposition of the changes over time. Values for wages, non-labor income and tax rates are fed in from survey data. We allow preferences and technology to be specific to each household type/year; the paper shows how the parameters are identified explicitly from the moments of the data, so the model matches the time-allocation statistics and identifies shifts in technology and preferences. We then calibrate the marriage-matching process to observed marriage and divorce rates, allowing the value of single life to shift over time so as to match the marriage rates, but keeping constant the relative joy of single life.

This benchmark version of the model is then compared with the "unitary" version, in which the Pareto weights on the spouses are held constant, to make it comparable to the standard macro approach. Finally, the model is subjected to a series of computational experiments in which all variables but one are kept at their 1975 levels; these experiments are carried out in both the unitary and bargaining versions of the model.

With regards to explaining the rise in wife's paid labor, the most important force is the closing of the gender gap in wages, as in Jones, Manuelli, and McGrattan (2003). This is more than simply a reallocation between husband and wife; the average labor supply of married couples increases by more than 6 weekly hours. However bargaining turns out to have little effect on per-capita hours, justifying the neglect of bargaining in models at the highest level of aggregation. With rigid Pareto weights, the error in the predicted per-capita hours is 0.8 hours, about 12% of the increase observed since the 1970s.

In contrast to GSY, improvements in the home-production technology or the decline of home-equipment prices seem to have little impact on female labor supply. This is because accounting for the cost of husband's time in home production reduces the measured equipment share in the home production technology to the point that diminishing marginal returns preclude any major impact of labor-saving equipment on time allocation. In the benchmark model, the declining equipment price frees up 1.2 hours of the wife's time from home production, but most of this is absorbed into higher leisure. These two features, absent in GSY, plus the fact that the current paper is focused on a later period in time, would appear to explain the divergence from their results.

Regarding the decline in the marriage rates of single women since the 1970s, the main message from the calibration is that is has little to do with wages or bargaining. The main factor in the decline appears to be the shift in preferences implied by the calibration of the time-allocation problem; this makes singles better off relative to married, and single women better off relative to single men. Each of these effects are easily shown to reduce marriage rates, and together they explain about a third of the observed decline. Home equipment prices play an important role too, accounting for 16% of the marriage decline, as labor-saving equipment plays a more important role for single households than married. This effect is significantly smaller than in Greenwood and Guner (2009), but the current paper abstracts from an important feature of their model, the existence of fixed costs of household formation. Bargaining plays a relatively minor role, in accounting for marriage decline, magnifying the impact of the preference changes by about 4%.

Relative to the large literature on female labor supply and intra-household allocation, the main theoretical contributions of this paper are 1) to put the model into an equilibrium context, where the outside options are determined endogenously, and 2) to develop a simple version of the model that relates directly to the models used in macroeconomics. These features mean that allocations between married couples can be related thorough the model to data on marriage and on the time-use decisions of single-person households; this disciplines the values of the outside options in the calibration. A recent paper in which marriage and intra-household outcomes are modeled as jointly determined is Choo, Seitz, and Siow (2008); they analyse female labor supply but, in the absence of a bargaining model are limited to the consideration of distribution factors, like the sex ratio. The model in the current paper can be seen as extending the two-period marriage-market models of Greenwood, Guner, and Knowles (2000) and Greenwood, Guner, and Knowles (2003), where the analysis is limited by wage heterogeneity to one or two marriage opportunities per lifetime.

It is important to stress that the extreme simplicity of my approach precludes direct comparison with life-cycle models of the trends in female labor supply. Attanasio, Low, and Sanchez-Marcos (2008) (ALS hereafter), for instance, use a lifecycle model to consider the role of returns to experience and the costs of child-raising; they abstract however from intra-household allocation and marriage decisions, taking the arrival of children and the marital status of women as exogenous in order to focus on selection into the labor force. They find that convergence in wages can account only for the increased participation of non-mothers; a decline in child-care costs (relative to the female wage) is more effective in account for increased work of mothers. The current paper does not model children, making child-care irrelevant, while ALS fixes the timing and quantity of children, making child-care essential for working mothers. Both approaches are abstractions; since working women can delay fertility, the truth must lie somewhere in between. My model also abstracts from other important features in ALS model, such as age and the intensive/extensive margin distinction; the results of this paper suggest that it would be useful to extend the lifecycle approach to allow for marriage decisions and bargaining between spouses.

2 Trends in Time Allocation

Standard macro data sets lack systematic information on unpaid work; this turns out to be critical for distinguishing different versions of the household model, which hinges on the response of total work time, including unpaid work, to changes in relative prices. The goal of this section is to document patterns in non-working time by studying these changes. The strategy is to use the March CPS the standard source of macro labor-time data, to document the trends in paid labor and relative wages and show that the trends are driven by the behavior of married people. Since unpaid work time is not documented in the CPS, we then turn to time-use surveys and show that the relative leisure ratio has been stationary over the 1975-2003 period,

2.1 Paid-Labor Supply Trends: CPS

Figure 1(c), which shows the labor-supply trend by sex and marital status, the trend in relative wages, and the per-capita hours trend, is based on the March Supplement of the CPS, from 1962 to 2006. To filter out the role of cyclical fluctuations, Table 1 averages the data over several years. The population is restricted to civilians age 18 to 65, a standard definition of working-age adulthood. Younger people are likely to be constrained by compulsory schooling, and older people by mandatory retirement, social security rules, and disabilities. The weekly hours variable is the reported hours worked last week.[4]

For married women it is clear that average weekly hours of paid labor increased steadily, from an average of 11.8 in the 1962-66 period to 22.97 in 1994-2001. For single women, there is no trend, hours fluctuate between 22 and 26 over these periods. For single men, the pattern is similar,

[4]Similar results obtain if instead we multiply usual weekly hours by number of weeks worked.

a stationary series that fluctuates between 24 and 28 weekly hours. For married men, hours are essentially constant at 36 from 1976-2003.

The wage trend shown in Figure 1(a) is computed by dividing annual earnings by annualized hours worked, as given by the hours worked last week response. To avoid noise from people with low hours, the sample for this calculation is restricted to people who worked at least 10 hours.

Average hours worked per person in 1971 was 24.7, slightly lower than in 1962. Figure 1(b) shows that, over the next 28 years, average hours rose steadily to 29.3 in 2000, an increase of nearly 18% .

To compare the lifecycle and cohort effects, Figure 2 shows age-hours profiles for 10-year birth cohorts of married men and women. Those for women rise significantly with each successive cohort; by 3 hours at age 30 when we move from the 1930s to the 1940s cohorts, by an additional 7 hours to the 1950s cohort, and by another 3 hours from the 1950s to the 1960s cohort. In contrast, the age-hours profiles of married men are essentially identical over all cohorts. This also means that there is no question here of substitution of labor time across the lifecycle in response to changes in married women's roles: the shape of the men's profiles do not change systematically as we move across cohorts.

It may be interesting to explore the possibility that the lack of trend in husband's hours is driven by conflicting trends between households where the wife works and those where she doesn't, or by a rise in household where the wife works. In the appendix, Figure A1 shows that for wives aged less than 50 years, husband's hours are stationary after 1974 for both household types. In all cases, husbands work more in households where the wife is also working. For households where the wife is older than 50, there is decline in husband's hours until 1984 for households where the wife is not working, and stationarity thereafter. The stationarity of husband's paid working hours therefore holds even when age and labor force status are accounted for, except that, for the oldest group, the stationary period starts somewhat later.

Another possibility is that paid work hours are fixed by custom at a rigid number, such as 40 hours per week. Figure A2(a) shows that indeed at all age groups, the median in the 1990s is 40, and for men older than 25, the 25th percentile is also close to 40. However the model implies that if this constraint is binding, the household can respond by adjusting home work hours, which are presumably free from the institutional rigidities that operate in the work place.

2.2 Non-Working time: The Time-Use Surveys

To track trends in unpaid work and hence non-working time, we follow the existing literature in relying on a collection of cross-sectional time-use surveys beginning in 1965 and culminating in the first wave of the American Time Use Survey in 2003. These appear to be the only source of representative data on home production time apart from cooking and cleaning, notably child care and shopping time, as well as unpaid work time and leisure activities. This is important because it is well-known (see Gershuny and Robinson (1988)) that married-couple's allocation of home-production time has shifted since the 1960s, with husbands apparently bearing a larger share of house work than in the past.

Because of inconsistent design over the years, comparison of variables from the time-use surveys requires standardization of activities into broader categories. Results for this type of exercise are reported by Robinson and Godbey (1997) and Aguiar and Hurst (2007); from the regression methods of the latter, for instance, we learn that, over the period 1965-2003, leisure for men increased by roughly 6 to 9 hours per week (driven by a decline in market work hours) and for women by roughly 4 to 8 hours per week. Robinson and Godbey (1997) also finds that women's total work declined over the 1965-1985 period.

For the purposes of the current paper, however, a closer look at the data is warranted for three reasons. First, while the existing results concern the population as a whole, we need to examine the time allocation of married people. Second, the results reported in previous papers concern trends since 1965, with little information on the period that is critical for the analysis here, 1975 to the end of the 1990s. The 1965 survey is not in fact representative, as the representative component consists of a small (n=1200) sample that restricts attention to people living in cities of population 30,000 to 280,000. Finally, while the labor literature analyses trends in leisure, defined as time in specified non-work activities such as attending social functions or watching TV, in the macro literature it is standard to divide discretionary time into paid work, home-production and non-working time.

Of the 168 hours available each week, it is assumed that the minimum time required for sleep and personal care is 50 hours, which turns out to be the first percentile in the pooled data for 1965, 1975, 1985 and 2003. The exact number assigned to this minimum time is without consequence for the analysis. The important point is that time spent in sleep and personal care includes a discretionary component, as documented by Biddle and Hamermesh (1990). This paper assumes discretionary time is allocated between paid work and unpaid work; the residual is taken to be non-working time. The variables making up each of these categories are taken from the definitions of Aguiar and Hurst (2007).

Table 2(a) reports the time allocation of married people aged 18-65 according to these surveys. The table shows that working time did decline over the longer period since 1965, but all of this decline was before the period of interest begins in 1975. Since then the working time of both married men and women has increased, due to a rise in unpaid work for men and in paid work for women. The main point however is that while non-working time has declined slightly for both husbands and wives since 1975, the ratio of married women's non-working time to that of married men has remained stable; 1.073 in 1975, 1.073 in 2003. Even after accounting for unpaid working time therefore, married women's non-working time is not responding relative wages in the way predicted by the unitary model.

Part (b) of the table shows that unpaid working time is composed largely of time spent cooking and cleaning in the case of the women; while this component has increased 50% for men, it was still only 3.33 hours weekly on average in 2003, compared to 14.9 hours for wives. Commuting and Job-related time declined for both men and women, even though time in paid work did not. The 2.5 hour decline for men in time spent in Job-related was largely offset by small increases in other categories. One category that increased for both men and women was child care (excluding time spent playing with children); the effect is small however relative to the other changes, so it does not appear worth worrying how time spent in this category might be mis-measured. Overall, men in 2003 were spending two more hours in "Other home production" per week, and one more in "Cooking and Other Indoor Chores" than in 1975. The lack of trend in relative non-working time therefore is robust to how we treat child-care time.

Table 3 shows that conditioning on observables such as age, education and labor force status does not explain the stationarity of relative non-working time. The relative wages of the sub-samples are shown in Table 3(a), which gives the female/male wage ratios for people working 10 hours more per week. For the 25-54 age group, the ratio of mean wages rises from 0.6 in the 1967-74 period to 0.76 in the 1995-2000 period. For the 55-65 age group, the wage ratio is the same in both periods. For those with less than a bachelor's degree (BA), the ratio evolves from 0.6 to 0.76; for those with a BA or more , the trend is weaker, from 0.66 to 0.72, falling back to 0.69 in the 2000-2006 period. Table 3(b) shows that, over the 1975-2003 period, only one group of husbands gets an increase in relative non-working time; those with educational attainment equal to 12 years, the equivalent to a high-school diploma. The wife's relative non-working time falls in this case from 1.14 to 1.06. For all other groups, wife's relative non-working time increases or stays constant. Most significantly, when the sample is restricted to spouses who are working, the wife's relative non-working time increases from 0.97 to 1.04. The effect appears to be strongest among younger couples; the increase for married people aged 25-55 is from 0.94 to 1.04. Among the 55-70 age group the rise in wife's relative non-working time is much weaker, from 1.01 to 1.06, which may be due to the fact that the wage change is much smaller for this group as shown in Table 3, from 0.66 to 0.69. Far from accounting for the failure of husband's non-working time to rise, the observables seem to exacerbate the issue by revealing that in fact it is the wife's relative non-working time that is increasing within most groups.

Could it be that there is a rigidity, perhaps due to social norms, that restricts married couples from freely adjusting non-working time? It is generally difficult to examine this in the time-use surveys because they sample individuals, rather than households. However in 1985, the sample includes 531 married couples. Figure A2(b) shows the husband-wife ratios of nonworking time for this sample. While it is clear that the distribution is centered around one, considerable dispersion exists. A similar result for Australia, Germany and the US is obtained by Burda, Hamermesh, and Weil (2007). While analyzing the source of this dispersion is outside the scope of the current paper, it seems to indicate that there is no lack of flexibility in the allocation of non-working time.

3 A Model of Marriage and Labor Supply

This section describes a simple equilibrium marriage model. We first work out the efficient allocations, taking as given the Pareto weight the household puts on each spouse. Holding these weights fixed corresponds to the standard unitary model used in macroeconomics. We then extend the model by nesting a bargaining theory in which the Pareto weights depend on the value of leaving the marriage. Finally, we work out how the equilibrium weights depend on full income by marital status for all household types. A simple example of the model is then fully worked out to show how the main features determine labor supply.

3.1 Household Structure

There is a large population comprised of two sexes $i \in \{H, W\}$ in equal numbers, who are otherwise *ex ante* identical and live through an infinite succession of discrete periods. At the beginning of each period, people are either married or single. Married people learn their realization of a match-quality shock ε, choose allocations, 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. This shock has an unconditional distribution Φ; realizations are independent across pairings, but may be persistent within. Let the conditional distribution be $F(\varepsilon', \varepsilon)$. The cost of divorce is $d_c \geq 0$.

All people who enter the period as singles are randomly paired with a single of the opposite sex. The new pairs then learn their match quality ε, choose allocations 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 market goods.

Each agent i has a one-unit time endowment, which is allocated across three competing uses: leisure l_i, work outside the household, n_i and home work h_i. There is a time cost t_n per unit of outside work. The time constraint for each agent i is:

$$l_i + n_i (1 + t_n) + h_i = 1$$

. Agents derive utility from leisure l_i, as well as the consumption of a market good c and a home good g. We assume a CES utility function:

$$u(c,l,g)=\frac{\sigma_c}{1-\sigma_1}c^{1-\sigma_1}+\frac{\sigma_l}{1-\sigma_1}l^{1-\sigma_1}+\frac{\sigma_g}{1-\sigma_1}g^{1-\sigma_1}$$

. Preferences of individuals over infinite streams of utility are represented by the discounted sum:

$$E_0\left(\sum_{t=0}^{\infty}\beta^j\left[u(c_t,l_t,g_t)+J_{i,t}^M\varepsilon_{i,t}\right]\right)$$

where m indicates marital status and $J_{i,t}^M$ is an indicator equal to one if the agent is in a married household at the end of period t.

The home good is produced using inputs of housework time (h_H,h_W) from each spouse, as well as a flow of home equipment e_q, according to a production function $G(e_q,h_H,h_W)$. In order to allow both singles and married to be modeled as operating the same technology, we assume the effective labor input of married couples is CES in the individual inputs:

$$h(h_W,h_H)=\left[\eta_0 h_W^{1-\eta_1}+(1-\eta_0)\,h_H^{1-\eta_1}\right]^{1/(1-\eta_1)}$$

Let the effective time input be h and the goods input be e_q. The home-production function is

$$G(h,e_q)=z\left[e_q^{1-\theta}\right]h^{\theta}$$

.

3.2 Markets, Prices and Taxation

A unit of outside labor n_i by a worker of sex i produces w_i units of a consumption good, which is consumed within the period. Both the wage $\widetilde{w}_i$ and the work cost t_n are parameters which evolve exogenously. Households also have some endowed non-labor income, equal to y_M^{nl} for married couples and y_i^{nl}, $i\in\{H,W\}$ for singles. Income is taxed according to a progressive tax schedule that distinguishes between married and single households. The tax bill of a household of type i with gross (taxable) income Y_i is given by $T_i(Y_i)$. The household buys home equipment e_q at price p_q per unit.

3.3 Efficient Allocations

We show in the appendix how to write the decision rules as functions of the average and marginal tax rates, which we denote T^A,T^M, respectively. Of course these expressions only give the optimal decisions when evaluated at the correct tax rates, but this is easily resolved through iteration on the tax rates, using the tax function $T(Y^T)$ to update the tax rates, given the decision rules.

3.3.1 Singles

The indirect utility flow of a single-person household with wage w is:

$$u_S=max_{c,l,g,h,e}\left\{u(c,l,G(h,e_q))\right\}$$

subject to

$$c+wl+T\left(Y^T\right)=w(1-h)+y-p_e e_q$$

where w is the wage, $p_e$the price of equipment and y the non-labor income of the household. Taxable income is:

$$Y^T = w(1-l-h)+y$$

The reduced-form demand functions, which depend on the budget-constraint multiplier λ are:

$$[c,l,g] = \left[\left(\frac{\sigma_c}{\lambda}\right)^{1/\sigma_1}, \left(\frac{\sigma_l}{\lambda w^M}\right)^{1/\sigma_1}, \left(\frac{\sigma_g}{\lambda D^M}\right)^{1/\sigma_1}\right]$$

, where D^M is the effective marginal price of home goods, as derived in the Appendix, and $w^M = w\left(1-T^M\right)$ is the effective marginal wage for the single type. The full income of the household is

$$Y^F = D^A\left(\frac{\sigma_g}{\lambda D^M}\right)^{1/\sigma_1} + \left(\frac{\sigma_c}{\lambda}\right)^{1/\sigma_1} + w^A\left(\frac{\sigma_l}{\lambda w^M}\right)^{1/\sigma_1}$$

, where D^A is the unit cost of home production. The solution for the budget multiplier λ is given in the appendix.

We also find that the equipment share of home-production costs is:

$$\frac{p_e e_q}{w^A h + p_e e_q} = \frac{\tau(1-\theta)}{\theta+\tau(1-\theta)}$$

, where $\tau \equiv \frac{1-T^M}{1-T^A}$ represents the progressivity of taxes, and $w^A = w\left(1-T^A\right)$ is the effective unit cost of leisure. Of course the tax rates and hence the effective wages will depend on the household type through the taxable income, and hence the marginal and average prices of home goods will too.

3.3.2 Married Households

The married household is assumed to maximize a welfare function consisting of a weighted sum of the welfare of each spouse $i \in \{H, W\}$, corresponding to the husband and wife. The state of a marriage is given by the quality shock ε.There is no commitment, so the decisions made by a new marriage are the same as those of an existing marriage in the same state. Since allocations are assumed to be efficient, we can represent them as the solution to the household planner's problem where μ_i is the Pareto weight on spouse i in the planner's objective function.

Since we assume utility is separable in the home good, and that spouses each get the same utility from the home good, we can let the total utility flow from the home good be $v\left(G\left(H\left(h_M, h_W\right), e_q\right)\right)$.

The couple chooses the husband's allocation (c_M, l_M, h_M) and the wife's allocation (c_F, l_F, h_F) and home equipment e_q to maximize

$$v\left(G\left(H\left(h_M, h_W\right), e_q\right)\right) + \mu_M u^M\left(c_M, l_M\right) + \mu_W u_W^W\left(c_W, l_W\right)$$

subject to

$$c_M + w_M l_M + c_F + w_W l_W + T\left(Y^T\right) = w_M\left(1-h_M\right) + w_W\left(1-h_W\right) - p_e e_q$$

and the time constraints for each spouse:

$$h_M + l_M \leq 1$$

where Y^T represents taxable income:

$$Y^T = w_M (1 - l_M - h_M) + w_W (1 - l_W - h_W) + y$$

. If we take as given the marginal wages w_M^M, w_W^M of the husband and wife, respectively, and let λ represent the budget-constraint multiplier, we can write the reduced-form demand functions as

$$[c_i, l_i, g] = \left[\left(\frac{\mu_i \sigma_c}{\lambda} \right)^{1/\sigma_1}, \left(\frac{\mu_i \sigma_l}{\lambda w_i^M} \right)^{1/\sigma_1}, \left(\frac{\sigma_g}{\lambda D^M} \right)^{1/\sigma_1} \right]$$

. The home-production inputs end being all proportional to the demand for home goods:

$$[h_M, h_W, e_q] = \left[\frac{g}{x_g}, \frac{x_w g}{x_g}, \frac{x_e g}{x_g} \right]$$

, so the unit price of the home good is independent of the output level. The expressions for the optimal values of the ratios $x_g \equiv g/h_M$, $x_e = e/h_M$, and $x_w = h_W/h_M$ are given in the appendix. Note the tight relationship of the wage ratio to the ratio of wife's time to that of the husband, which will be useful for choosing a value for η_1:

$$h_W = x_w h_M = \left(\frac{w_M}{w_W} \frac{\eta_0}{1 - \eta_0} \right)^{1/\eta_1} h_M \tag{1}$$

The equipment share of expenditure is given by:

$$\frac{p_e x_e}{w_M^A + w_W^A x_w + p_e x_e} = \frac{\hat{\tau} (1 - \theta)}{\theta + \hat{\tau} (1 - \theta)} \tag{2}$$

, where $\hat{\tau}$, by analogy with the expression for singles, represents the effective progressivity of taxation of married couples (derived in the Appendix). These explicit solutions for all the decisions rules will be very useful for providing a transparent identification scheme in the calibration section.

3.3.3 Implications for relative leisure

The first-order conditions for the spouses' leisure imply that if the Pareto weights are constant, then the ratio of marginal utilities for leisure will be proportional to the relative wage:

$$\frac{u_l^M (c_M, l_M, g)}{u_l^W (c_W, l_W, g)} = \frac{w_M}{w_W} \frac{1 - \mu}{\mu}$$

. In macro models, an assumption of separability between the leisure and consumption arguments is required in order to explain the absence of long-run trends in hours worked per capita. This implies that as the wage ratio $\frac{w_M}{w_W}$ has fallen over time, the ratio of marginal utilities must have fallen too, concavity of the utility function leisure implies that husband's leisure should rise relative to that of the wives. Using the CES specification above, the prediction can be made quantitative. The efficient leisure ratio is given by:

$$\frac{l_W}{l_H} = \left[\frac{w_M}{w_W} \frac{\mu_W}{\mu_M} \right]^{1/\sigma}$$

.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 we follow Attanasio, Low, and Sanchez-Marcos (2008) in setting $\sigma = 1.5$, the prediction is that married women's leisure should have declined 12.4% relative of that of their husbands, an effect on the order of 7 hours. Note that these implications are independent of the tax function and the home-production technology. With joint taxation, the relative wage of husband and wife is unaffected, so any increase in wife's labor supply induced by changes in the tax schedule should leave the leisure ratio unchanged.

3.4 Determination of the Pareto weights

Our theory of the Pareto weights is that they are functions of the gains from marriage, relative to divorce, as in a wide range of papers from McElroy and Horney (1981) to Chiappori, Fortin, and Lacroix (2002) to Greenwood, Guner, and Knowles (2003). We will consider the Egalitarian bargaining solution, because for special cases it renders the model tractable, so that we can solve for equilibrium allocations and marriage decisions.[5] In the case of a linear Pareto frontier, for instance with fully transferable utility, a standard assumption in the labor-matching literature, the Egalitarian solution is equivalent to the Nash bargaining solution with equal weights.

In what follows we consider a stationary environment; relative wages are constant, so the only source of divorces is random variation in match quality; as spouses will agree on the states of the world in which divorce is preferable, commitment is not an issue in this environment.[6]

Let $U_i^M\left(\mu_i, Y^M\right) + \varepsilon$ represents the indirect utility flow to agent i from a marriage where μ_i is the Pareto weight on agent i, and ε is the current realization of a random variable representing the quality of the marriage. Let V_i^M indicate the value to a person of sex i of being married and V_i^S that of being single. Let Φ represent the unconditional CDF of ε; this is the distribution from which the match-quality realization is drawn for new matches. Let $F\left(\varepsilon'|\varepsilon\right)$ represent the conditional distribution for on-going matches.

Standard arguments show that there exist thresholds $\varepsilon^M, \varepsilon^D$ such that marriage occurs only if $\varepsilon > \varepsilon^M$ and divorce only if $\varepsilon < \varepsilon^D$. If we take μ_i' as fixed, the value to spouse i of being in the marriage is

$$V_i^M\left(\mu_i, \varepsilon\right) = U_i^M\left(\mu_i, Y^M\right) + \varepsilon ... \\ ... + \beta\left[F\left(\varepsilon^D|\varepsilon\right)\left(V_i^S - d_c\right) + \left(1 - F\left(\varepsilon^D|\varepsilon\right)\right) EV_i^M\left(\mu_i', \varepsilon'\right)\right] \tag{3}$$

Similarly, for singles, let the indirect utility flow be U_i^S, so that we can write the value of being single as:

$$V_i^S = U_i^S + \beta\left[\Phi\left(\varepsilon^M\right) V_i^S + \int_{\varepsilon^M} V_i^M\left(\mu_i', \varepsilon'\right) d\Phi\left(\varepsilon\right)\right] \tag{4}$$

Define the gains from marriage, relative to divorce, as

$$W_i^D\left(\mu_i, \varepsilon\right) = V_i^M\left(\mu_i, \varepsilon\right) - V_i^S - d_c$$

where the divorce cost $2d_c$ is assumed to be paid equally by each spouse.

Definition 1 *A bargaining solution $B\left(W_H, W_W\right)$ is a mapping from a pair of functions $W_H^D\left(\right), W_W^D\left(\right)$ to a Pareto weight μ on spouse H. The weight on spouse W is given by 1-μ.*

Notice that this definition allows B to map on to any Pareto-optimal allocation. The main restriction relative to the set of all possible bargaining solutions, is that solutions depend only on

[5] The Egalitarian solution, while it lacks the scale invariance of the standard Nash solution, is more intuitive; indeed Kalai (1977) argues that this solution implements a Rawlsian approach to justice.

[6] The computational methods we use can be extended to the case of wage trends with perfect foresight, provided we assume full commitment at the time of marriage, but the solutions are difficult to characterize analytically.

the gains from marriage. This is quite standard in the literature on household labor supply, and is consistent with the result of Chiappori, Fortin, and Lacroix (2002) and others who find that labor supply of married couples responds to variables ("distribution factors") that affect the value of single life, such as divorce rules, or the sex ratio of singles.

It is useful to contrast two common examples. The “Egalitarian” solution μ^E is defined as the value of μ that equalizes the gains from marriage. Hence μ^E solves:

$$\frac{W_M^D\left(\mu^E,\varepsilon\right)}{W_W^D\left(1-\mu^E,\varepsilon\right)}=1$$

. A nice feature of this concept is that it is easy to solve because they symmetry implies terms that are common to both sides drop out. The Nash solution by contrast takes into account both the gains and the curvature of the Pareto frontier, i.e. the marginal cost of transferring utility. The FOC for the Nash solution μ^N, with equal bargaining power, is

$$\frac{W_M^D\left(\mu^N,\varepsilon\right)}{W_W^D\left(1-\mu^N,\varepsilon\right)}=-\frac{\partial W_M^D\left(\mu^N,\varepsilon\right)/\partial\mu}{\partial W_W^D\left(1-\mu^N,\varepsilon\right)/\partial\mu}$$

With concave utility, the right-hand side is declining in μ^N ; this reduces the elasticity of the Nash solution with respect to gains from marriage. It turns out that while the Nash solution is insufficiently elastic to fully account for the stability of relative leisure, the Egalitarian solution is too elastic. In the quantitative analysis we will therefore rely on a convex combination of the two solutions to generate Pareto-optimal allocations.

3.5 Matching Equilibrium

The marriage threshold ε^M sets the marriage surplus to zero, relative to single life. Similarly the divorce threshold ε^D sets the marriage surplus to zero, relative to divorce. The wedge between the two is a function of the divorce cost d_c. These two thresholds define the market-clearing conditions in a stationary marriage-market equilibrium.

Definition. A *stationary recursive equilibrium* of the matching market with progressive tax functions $T_i(\cdot)$ and bargaining solution $B\left(W_H,W_W\right)$, consists of a pair of thresholds $\left\{\varepsilon^M,\varepsilon^D\right\}$, a Pareto weight μ, and for each household type $i\in\{M,S_W,S_H\}$, allocations, tax rates $\left\{T_i^M,T_i^A\right\}$ and value functions $\left\{V_i^M\left(\mu_i,\varepsilon\right),V_i^S\right\}$ such that:

1. The value functions solve the Bellman equations (3,4) for men and women, given the prices $\{w,y,p_q\}$ and thresholds
2. The threshold ε^M sets to zero the gains from marriage, relative to remaining single, while ε^D sets to zero the gains from marriage, relative to divorce .
3. The allocations implied by the Pareto weight μ equal those generated by the bargaining solution: $\mu=B\left(W_H^D,W_W^D\right)$, where W_i represents the gain of spouse i from marriage, relative to divorce.
4. The allocations generate, for each household type i, a level of taxable household income Y_i^T such that $T_i'\left(Y_i^T\right)=T_i^M$, and $T_i\left(Y_i^T\right)/Y_i^T=T_i^A$.

3.6 Computation

The model's solution is computed using a standard numerical strategy. With progressive taxation, the tax rate depends on the labor income of the household, and hence on the leisure allocations. The time-allocation problem is therefore solved by guessing the labor income (and hence the tax rate), solving for the leisure allocation, and updating the guess until we have guessed the correct labor income, given μ. Thus the static components of the model are easily solved.

The solution strategy for the dynamic equilibrium in the marriage market is to solve for the Egalitarian value of μ, given guesses on $\left(\varepsilon^M, \varepsilon^D\right)$ and associated approximations for the values V_i^M of being married, as functions of ε.

Given these value-function approximations, we search over the unit simplex in R^2 to find a pair $\left(\varepsilon^M, \varepsilon^D\right)$ of stationary marriage and divorce rates. To compute the marriage/divorce thresholds, we define the minimum weight $\underline{\mu}_i^M(\varepsilon)$ as the Pareto weight that leaves a single agent of sex i indifferent between marriage and single life: $W_i\left(\underline{\mu}_i^M, \varepsilon\right) = 0$. Similarly we can define $\underline{\mu}_i^D(\varepsilon)$ as the value that leaves a married agent of sex i indifferent between marriage and divorce. The surplus equals the sum of the gains $W_j(\mu_j, \varepsilon)$, so if we can compute $\underline{\mu}_i^M(\varepsilon)$ then we can find ε^M by solving $\underline{\mu}_W^M\left(\varepsilon^M\right) + \underline{\mu}_H^M\left(\varepsilon^M\right) = 1$. The divorce threshold ε^D is computed in a similar way. Of course if ε is iid then $\varepsilon^D = \varepsilon^M - 2d_c$.

At the threshold values $\left(\varepsilon^M, \varepsilon^D\right)$, the surplus is zero, so all Pareto-optimal bargaining solutions imply the same value of μ. Taking the future as given, we can easily compute the Egalitarian solution by equating the gains from marriage; this gives the threshold value of ε:

$$\varepsilon^M = -W_M\left(\mu^E\right) = -W_W\left(\mu^E\right)$$

The Pareto weight μ depends on the continuation values of married versus single, which in turn depend on the marriage and divorce thresholds $\varepsilon^M, \varepsilon^D$. The procedure is identical for the divorce threshold. Indeed for the case of iid marriage quality, it is easy to see that $\varepsilon^D = \varepsilon^M - 2d_C$.

Once we know the thresholds, we can use the Bellman equations (3) to compute the bargaining solution for any ϵ in $\left[\epsilon^D, \epsilon^M\right]$. The approximations to the value functions are then updated by splining the value of marriage for each spouse on a grid over $\left[\epsilon^D, \epsilon^M\right]$.

This procedure converges monotonically in the Euclidean norm to a fixed point for $\varepsilon^M, \varepsilon^D$. At the fixed point, all of the equilibrium conditions hold, by construction.

As discussed earlier, the Nash equilibrium yields a Pareto weight that depends on the marriage quality. If this is persistent then the average marriage quality, and hence the allocations, will be functions of the marriage (and divorce) rates. Even with iid quality, the non-linearity of the decision rules may cause the average of the decisions to differ from the decisions of the average householders of each type. With the solutions in hand, there are at least one potential reason why it may be important to base statistics from the model on simulations. The statistics reported below are therefore based on simulations of the model.

4 Calibration

The calibration is in two stages; first we choose parameters for the time allocation problem to match time-use statistics and the NIPA equipment share of consumption, then in the second stage for the marriage-matching problem, we choose parameters to match marriage and the wife-husband leisure ratio for the two years.

4.1 Reconciliation of time-use survey to CPS Hours

We first deal with two problems in the time-use data: 1) discrepancies in paid hours with the March CPS, 2) the presence of variation at business-cycle frequencies. We also break down unpaid work into two categories: home production, and work-related time, which involves commuting and unpaid time at work, such as meal-times.

The March CPS is the standard macro data series for hours worked, so the exercise is more useful to macro-economists if it conforms to this series. Since business-cycle variation is outside the scope of the paper, we reconcile paid work hours in the time-use data with the 1975 and 2003 values from a 20 year moving average of paid hours from the March CPS. Table 4 shows how this is done. For each sex-marital -status group, the table lists under 'Time-Survey' the values for weekly hours of paid and unpaid work for the years 1975 and 2003. The next column, 'Adjusted to CPS', lists the paid weekly hours from the CPS. The other hours numbers in this column reflect the reallocation of the deviation in paid hours to home work and non-working time. The adjustment to the time-use data consists of setting paid time equal to the averaged CPS level for the year, and then increasing the work-related time in proportion to the adjustment to paid work time. Home hours are then reduced by the same factor, so as to minimize the impact of the adjustments on leisure hours.

It turns out that the paid-work variable in the time-use data is a better match to the smoothed CPS time series than to the raw data. The time-use averages are shown along with the adjustments in Table 4. The end result is that the larger changes are confined to singles; reductions in paid work for single men of a bout two hours in 1975 and three hours in 2003, and a two-hour increase for single women in 1975. In terms of leisure, the only change exceeding one hour is a 2.45 hours increase for single men in 2003, about 3%. For married couples there is one correction to paid work that exceeds one hour, a reduction in husband's paid hours from 38.87 to 36.62 for 2003. Qualitatively however relative leisure remains essentially constant, the wife/husband ratio exhibiting a very small decline from 1.05 to 1.047.

4.2 Income and Taxes

From the March CPS, we have labor income and total personal income for the whole sample in every year. The wage is computed as the ratio of labor income to hours worked and averaged each year over the population aged 18-65 of each sex. This results in the estimates reported in Table A4 in the appendix and imply a growth of real wages of 19% over the period. Non-wage compensation, which is excluded from the CPS measure, also grew rapidly over the period. According to Meisenheimer (May 2005), analysis of the National Compensation Survey reveals that total compensation per hour in the nonfarm business sector actually grew 32% between 1979 and 2003, the excess over reported wage growth being due to a 55% growth in benefits.

We take non-labor income to be the excess of total personal income over reported labor income. The mean estimates, reported in Table A4 in the appendix, in terms of ratios to mean full labor income,i.e. the sum of the observed wages, are on the order of 4% for married and 6% for singles. In aggregate, macro economists usually find non-labor income to be about a third of GDP. Supposing our population to be representative of the economy as a whole this would lead us to expect non-labor income to average about 10% of full income, so the CPS measurements appear to be quite low. This may be explained by mis-measurement (eg omission of non-realized capital income) or by exclusion from the sample of the retired population, which is likely to have a particularly high share of non-labor income.

The tax function is taken from Guner, Kaygusuz, and Ventura (2012). This is a three-parameter function:

$$T(y) = (\alpha_0 + \alpha_1 \ln (y/\bar{y}))$$

, where the average tax rate for the household with average income $\bar{y}$ equals α_0 and the marginal tax rate $\alpha_0 + \alpha_1$. The function is fitted for the years 1970 and 2000 to IRS data on average tax rates by income of the household and filing type (married or single).[7] For married couples in 1970 the coefficients are $(0.096, 0.0814)$ and in 2000 $(0.1023, 0.0733)$, while for singles they are $(0.1597, 0.0857)$ in 1970 and $(0.1547, 0.0497)$ in 2000. The tax functions are normalized by average household income in each year. Note that the marginal tax rate for the married household with average income is roughly 0.18 in both 1970 and 2000, reflecting the fact that the decline of marginal tax rates so often discussed in the literature on female labor supply was a short-run phenomenon, at least in regards to married couples. Marginal tax rates for singles did decline, from 0.25 to 0.2 at the average income. The tax functions are shown in Figure 3(b).

4.3 Technology Parameters

We use equation (1) to set the substitutability parameter η_1 for married-couples' home labor to match the change in the home-production time ratio:

$$\eta_1 = \frac{log\left(\frac{w_M}{w_W}\right)_{2003} - log\left(\frac{w_M}{w_W}\right)_{1975}}{log\left(\frac{h_W}{h_M}\right)_{2003} - log\left(\frac{h_W}{h_M}\right)_{1975}}$$

This yields a value of $\eta_1 = 0.33$, which implies a high elasticity of substitution between the labor of husband and wife. An interesting implication of this value is that the fact that wives spend much more time than husbands in home production is entirely explained by the wage differential; the productivity parameter value $\eta_0 = 0.475$, which implies roughly equal productivity of spouses at home, is required in order to generate the observed home-labor ratios. Of course if the model were to be expanded to allow for other factors that might have cause the home hours ratio to fall over time, then the elasticity estimate would be considerably reduced.

An important advantage of the Cobb-Douglas production function relative to a more general specification is that it provides a clean way to calibrate the role of equipment, as represented by the parameter θ. From the NIPA we have observations on a related quantity, the share of home equipment in total NIPA consumption expenditure. The NIPA series for equipment and furniture spending, as shown in Figure 4(a), appears to fluctuate between 4 and 6 per cent of total consumption. Part (b) of the diagram, shows that the price index for equipment has been falling rapidly relative to the CPI. [8]

Since total spending on NIPA consumption goods equals net income in our model, lets call this Y^N , which equals observed income net of taxes. Let total spending on the home good be S^G , and spending on home equipment be S^E. We now set the parameter θ so that the model will match the observation on $S^E/Y^N \equiv X^{EY}$. Similarly, let the equipment share of production spending be $\frac{S^E}{S^G} \equiv X^{EG}$

[7] I am grateful to Remzi Kayusz for supplying the 1970 coefficients. The historical data is available for 1916-1999 at the IRS web Statistics on Income web site:
http://www.irs.gov/taxstats/article/0,,id=223808,00.html

[8] Note in the figure that the relative prices of goods that might be part of a broader definition of home equipment, such as cars, services or even housing, have been quite stable when compared to the price of home equipment, which justifies calibrating to spending on the narrow NIPA definition.

We can infer X^{EG} from X^{EY} :

$$X^{EY} = \frac{S^E}{Y^N} = \frac{S^E}{S^G}\frac{S^G}{Y^N} = X^{EG}X^{GN}$$

so we can replicate the observed X^{EG} by setting

$$\theta = \frac{\left(1 - X^{EG}\right)\hat{\tau}}{\left(1 - X^{EG}\right)\hat{\tau} + X^{EG}}$$

, where $\hat{\tau}$ is the effective progressivity of the tax schedule for married couples, as defined in the appendix. A similar procedure is applied to singles.

We assume work costs are proportional to time spent working, and for each year set τ to match the ratio of unpaid work-related time to paid work time, averaged over all household types.

4.4 Preference Parameters

We set the utility curvature parameter σ_1 to 1.5, the same value taken by Attanasio, Low, and Sanchez-Marcos (2008) to represent a happy medium of existing practices. With the technology parameters in place we can infer the amount of consumption of the home good from the data on home hours, as well as the effective prices of the home good. For each household type we set the parameters $\sigma_C, \sigma_l, \sigma_g$ so that the model exactly matches the average hours spent on home production, leisure and paid work. For singles, we can express expenditure on each good as a share of consumption expenditure:

$$X^{HC} = \frac{w^A h + p_e e_q}{c} = \left(\frac{\sigma_g}{D\sigma_c}\right)^{1/\sigma_1} \frac{w^A + p_e x_e}{x_g}$$

, where the proportions $x_e = e_q/h_M$ and $x_g = h_M/g$ are derived in the Appendix.

Assuming we can observe X^{HC}, then we can infer the ratio of preference weights as:

$$\frac{\sigma_g}{\sigma_c} = \left(X^{HC}\frac{x_g}{w^A + p_e x_e}\right)^{\sigma_1} D^M$$

Of course we can do the same for the leisure-expenditure ratio X^{LC},

$$X^{LC} = \frac{w^A l}{c} = \frac{w^A\left(\frac{\sigma_l}{w^M}\right)^{1/\sigma_1}}{(\sigma_c)^{1/\sigma_1}}$$

from which we infer the ratio:

$$\frac{\sigma_l}{\sigma_c} = \left(\frac{X^{LC}}{w^A}\right)^{\sigma_1} w^M$$

.

Imposing that the weights sum to 1 then results in values for each utility-weight parameter.

4.5 Results: Parameter Values

The statistical targets that were used to choose the parameter values are shown in Table 5(a) . In addition to the 26 targets shown there, the work-related time from Table 4 was used to set the values of the work costs, for a total of 28 targets. However the procedure described above uses the leisure expenditure shares, not the actual leisure times; leisure times of married couples are therefore not pinned down, leaving 26 targets.

The resulting parameter values are shown in Table 6(a). It is clear that the calibration implies a limited role for equipment: the home-output elasticity with respect to labor input is around 90% for all household types, leaving only 10% for equipment. This means that doubling the amount of home equipment purchased would increase home output by only 7%. Even for single men in the 1970s, who appear to be more reliant on equipment, with an 80% labor share, doubling equipment would result in home output increasing by less than 15%. The reason θ turns out so low is that the cost of the labor inputs is so high; for married couples, accounting for the cost of the husband's time significantly reduces the apparent role of equipment.

In regards to preferences, we see another reason limiting the impact of home technology: the utility weight on home goods is very small, in the 3-7% range. This implies relatively low expenditure shares; wealth effects will be largely absorbed by the other goods, such as leisure, with expenditure shares on the order of 2/3. In Greenwood, Seshadri, and Yorukoglu (2005) for example, technical change increases married women's paid labor by "liberating" women from home production; however that paper abstracts from both husband's time input and the leisure margin, implying larger effects on paid labor than would obtain in the current paper.

Another interesting implication of the time allocation data is that the utility weight on leisure has decreased over time; this is implied by the observation that expenditure shares on leisure have decreased since 1975. While all 3 types seem to care less now about leisure, the decline is by far the greatest for married couples; this comes from the fall in the leisure share of spending over time. The leisure decline observed here is of course consistent with leisure having increased over the much longer run, documented in Aguiar and Hurst (2007), who analyze per capita trends since 1965, and Greenwood and Vandenbroucke (2005), who argue leisure declining since the 19th century. Per-capita leisure also increases here because the composition of the population has shifted from low-leisure types (married households) to high-leisure types (singles).

Finally, the model implies that the decline of marriage is unrelated to wages or income; the sum of the utility of a single man and a single woman increases by 0.27, about 4%, from 1975 to 2003, so that singles are indeed better off , but that of married couples increases by 0.36 (about 5%), so marriage rates would have increased slightly if left to these influences alone.

4.6 Bargaining and the marriage equilibrium

In this section we calibrate the model so that it yields the correct values for the marriage rates, the divorce rate and the Pareto weights μ for two calibration years: 1975 and 2003. The stochastic process for ϵ is arbitrarily fixed to an iid standard normal with mean zero and variance $\sigma = 2$.

We impose that μ is the weighted sum of two bargaining solutions. Let ω be the weight on the Egalitarian bargaining solution and $(1 - \omega)$ the weight on the Nash solution.[9]

Three parameter values are held constant over the two calibration dates: the relative joy of being single q_W/q_M, the divorce cost d_C, and the weight ω on the Egalitarian bargaining solution. The level, as represented by q_W is allowed to vary to help match the change in marriage rates over time. This means here are five free parameter values to set.

For any given year, the aggregate output of the marriage-market model consists of marriage rate π^M , divorce rate π^D, and the relative leisure l_W/l_H. Because official estimates of the empirical marriage and divorce hazard rates not available after 1995, these are computed instead from the annual transitions in the distribution marital status in the March CPS according to a simple procedure described in the appendix, starting from the fraction of women already married by age 18. This ensures that the hazard rates are consistent with the population fractions.

[9] Recall that this is to get the required elasticity of relative leisure, holding constant the relative joy of single life q_W/q_M. An alternative strategy would be to go with one bargaining solution and back out the variation in q_W/q_M.

There are therefore 6 potential targets. Since there are only 5 parameters in the loop, we drop one of the targets, the divorce rate for 2003. Matching this would require higher persistence in ϵ to allow divorce rates to fall when marriage rates rise. Since persistence makes the model more difficult to compute, it is natural to begin by abstracting from this feature. The initial conditions for the simulation consists of the fraction of women married by age 18 and a vector of marriage quality, assumed to be above the threshold, for these women. In practice, the mass of these women is so small that they make little difference for the quantitative results.

The targets for this calibration are shown in Table 5(b) and the resulting parameters in Table 6(b). They imply that women get more direct utility from single life than men do; $q_W/q_M = 1.25$; this is needed to explain why wives get roughly the same leisure as husbands despite having higher pecuniary gains from marriage due to having lower wages. The estimates also imply that single life was a better deal in 1975 than in 2003; as the first stage of the calibration delivers an increase in the economic gains from marriage, a decline in the joy of single life $[q_w, q_M]$ is imposed to match the decline of the marriage rate. The results is a marriage rate of 8.5% in 1975 for the benchmark model, compared to a target of 9.3%, and 4.4% in 1975, compared to a target of 4.6%. The magnitude of the decline is therefore very similar in the model (48%) and the data (51%).

The calibrated divorce cost is fairly high; 5.29 is equivalent to four years of full income for married couples in 1975, 2.6 years in 2003. This is related to the dispersion in the marriage shock; less dispersion would imply a lower divorce cost to match the data, since very bad shocks would be less frequent. Higher persistence would also reduce calibrated divorce costs, as married quality would be higher on average than under the unconditional process. This would also help deal with the non-targeted divorce rate, which increases in the model, while it declines in the data, although this could be easily be fixed by indexing the divorce cost to income.

The model puts 40% weight on the Egalitarian and 60% on the Nash solution. This comes from matching the elasticity of the wife/husband leisure ratio, given that we have imposed that there is no shift in the relative utility from single life. The role of the Nash solution is to reduce the elasticity of μ wrt relative wages. It also turns out that under the Nash solution the Pareto weight is a declining function of ϵ, because men's gains increase with ϵ relative to women's gains from marriage; for low ϵ the main component of gains is the pecuniary gain, which is larger for women, while for large values the main component is marriage quality, which is assumed to be equal. Therefore there is a potential for changes in the marriage rates to affect allocations through μ.

5 Experiments

The goal of the experiments is to measure the relative importance for marriage and paid labor hours of the historically-changing variables that we take as exogenous, such as wages, the equipment price and the effective tax rate of working wives. The idea is that for each experiment, all parameters are fixed at the values for the 1975 benchmark, except for the parameter that the particular experiment is concerned with, which is set to its value in the 2003 benchmark. The main results are reported in Table 7, which explicitly explores the role of bargaining in generating responses to changes in relative wages and to changes in preferences, which turn out to be the two main forces at work in the model. Columns (1) and (7) show the benchmark outcomes for 2003 and 1975, respectively; the other columns correspond to experiments. Those experiments where bargaining does not play an important role are shown in Table 8.

Column (6) in Table 7 shows that without bargaining, the effect of wage convergence is to drive down the wife/husband leisure ratio from 1.05 in 1975 to 0.93 in 2005. In Column (3) however, we see that the response of the Pareto weight through bargaining brings the ratio back up to 1.02, and Column (2) shows that shifting preferences return it the rest of the way to the old ratio, while Column (5) shows the effect of preference shifting is entirely through the implications for bargaining. In other words, the preference shifts affect relative leisure only through improving the position of single women relative to single men. Bargaining is therefore playing the critical role in maintaining the leisure ratio, allowing the improved position of single women to offset the direct impact of relative wages on the married allocation.

Column (3) shows that the rise in wife's working hours was due entirely to the rise in relative wages; this can account, on its own, for all of the 8 hour increase. In fact, Column (6) shows that the impact of relative wages is considerably higher in the absence of bargaining; the wife's labor supply would have risen by an additional 3.5 hours, an error equal to about 44% of the observed increase. A similar result applies to the change in preferences, which would have generated an additional 1.7 hours with rigid Pareto weights, an effect that is entirely offset by the impact, via bargaining, of the implied welfare gain of single women relative to single men.

The stability of men's hours on the other hand appears to be due to the conflicting effects of preferences and relative wages. First Column (6) in Table 7 shows that, with rigid Pareto weights, the rise in the wife's relative wages would have driven husband's working hours down from 37.63 to 30.61, very much as we predicted from the back-of-the envelope computation in the theoretical section. Allowing for bargaining, Column (3) shows that the effect of the relative wage is much less severe, and results in the husband's working 32.70 hours weekly. The static part of the calibration told us that in the preferences of married couples consumption had gained in importance at the expense of leisure. Column (2) shows that on its own this would have increased husband's working hours by more than 4 hours, to 42.32. However Table 8 shows that this effect is largely offset in turn by wage and income growth, which on its own results in a 3-hour decline. Finally, recall that preferences shifting on its own would also have increased with wife-husband leisure ratio; this effect, due to single women being made better off relative to single men, would have added 1.1 hours to men's work hours. Bargaining is therefore an important component of the story, raising husband's labor supply by about 3.2 hours relative to the unitary model, but there are also large effects that do not operate through bargaining.

We saw that husband's home-work hours rose by 5.87 hours over the period; Column (3) in Table 7 indicates that 3 hours can be attributed to the shift in the relative wage, and Column (2) that two hours were due to the preference shift away from leisure. Columns(5) and (6) show that these effects are independent of bargaining, which is to be expected, as the theoretical model showed that the home production decisions are independent of the Pareto weights.

For wives' home hours, the big picture is a 5.1 hour decline; Column (3) shows that on its own, the declining gender wage gap would have caused a much larger decline, more than 10 hours, but this is offset in part by the effects of the preference shift (+6 hours), shown in Column (2), and a smaller effect (1.8 hours) of income and wage growth, as shown in Table 8.

Table 8 shows that there are some effects of equipment price on home-work hours of married women (about 1.3 hours) and men (about half an hour). This translates into a gain in wive's paid work of about a half hour; as one might have guessed from the preference estimates, most of the impact is soaked up by a increase in the wife's leisure time.

Marriage rates decline by about 50% in the benchmark models, but the only force inside the model that contributes to this is the decline of equipment price; Table 8 shows that on its own this drives the marriage rate down to 7.8% annually; hence this accounts for 17% of the decline.[10] The residual decline is attributed by the calibration to the decline in the joy of single life, as explained

[10]The size of this effect could be increased by imposing a fixed cost of household formation, as in Greenwood and Guner (2009).

in Section 4 above. In Table 8, we see that changes in marriage rates, driven by a rise in the level of q, hurt women more than men, as the relative leisure of wives declines to 1.04 from the 1975 benchmark of 1.06. This effect is small however so marriage rates do not appear to have a strong impact on allocations within married couples.

In summary, the experiments showed that bargaining is playing a quantitatively first-order role in the analysis of relative leisure and paid labor supply. The main message regarding marriage decline is that wage changes appear to have little to with it, at least not through the channels available in the current model, but that declining equipment prices may play an important role.

5.1 Annual Trends

So far the analysis has been confined to a comparison of two years, 1975 and 2003. Now suppose instead we consider year-by-year comparisons of the model with the data over this period. The method is to compute the decision rules for each year using the same routine that was used for calibration, but to allow parameters that correspond to observables, such as wage and income parameters, to vary so as to match the observations for the year in question, while those that cannot be derived from observables each year, such as home technology or utility parameters, are set as weighted averages of the benchmark values from 1975 and 2003. This ensures that the model matches the data for 1975 and 2003; the question is how well it does in the intervening years. The annual data, as in the calibration, consists of 20-year moving averages from the March CPS. This exercise is not entirely coherent; we are assuming each year that the bargaining outcome of the newly married is computed as if the current conditions were to persist forever, even though we allow unforeseen changes each year; hence the importance of using moving averages to smooth out the transitory variations.

The role of bargaining can be seen by comparing the results from an alternative trend computation, using the same parameters but with the Pareto weights fixed at the 1975 values.

The results of this procedure are shown in Figure 5. In panel (a) we see that for married-women's labor supply, the model line stays in contact with the data line except for the period 1976-1984, where it lies slightly below, by about one hour. The line corresponding to the fixed Pareto weight on the other hand parts company with the data line about 1983; the prediction error is already two hours by 1985, and continues to grow to 2003. For men's labor supply, on the other hand, the model with the fixed Pareto weight does better the benchmark for the first 10 years, staying closer to the data line, which falls by slightly more than an hour over this period. Over the 1985-2003 period however, the data remains stationary at just under 37 hours weekly, while the Fixed-weight line continues its steady decline down to 34 weekly hours. The benchmark line fluctuates around the data line, the gap peaking at roughly one hour above in 1983, and a half-hour below in 1997. Overall then we can say that the fixed-weight model does slightly better than the benchmark model over the 1975-85 period, but significantly worse after that.

Given that flexible Pareto weights play such an important role in matching labor supply over time, a useful next step for future research would be to compare the predictions of different types of bargaining models against the data. One basic question would be the role of commitment; can we assume that Pareto weights are fixed for the duration of the marriage, or do we need to allow the weights to vary within the marriage as well? Consider a simulation in which the trend is computed for a population in which the weights are fixed for each marriage cohort but allowed to vary between cohorts. In each new marriage, the allocation corresponds to the bargaining outcome from the trend computation described earlier. The marriages from each year are carried over the following year, subject to the observed divorce rates, and new marriages formed at the observed marriage rates, as summarized in Figure 3.

In Figure 6 we show the results of this simulation with cohort-specific weights, and compare them to the Benchmark trend results. Not surprisingly given the low rates of marriage and divorce in the data, the cohort-specific line resembles that for fixed Pareto weights; married-men's paid labor lies everywhere below that in the benchmark model, and married-women's lies everywhere above. The effect of allowing variation between marriage cohorts shows up as a significant reduction of the prediction error; by the year 2000 for instance, the two-hour error for wive's paid labor in the fixed weight case in Figure 5(a) has been reduced to one hour. A similar pattern holds for married-men's paid labor. The exercise suggests therefore that a model of full commitment can account for about half of the deviation between the data and the fixed-weight model.

6 Discussion

The emphasis on bargaining in this paper should not be taken too literally; it is intended as a short-hand for any mapping from outside options to the division of surplus, as in the micro-empirical literature on "collective" models of the household. The household model proposed here relies on a bargaining solution with divorce threat-points, but the same argument could apply to other models of intra-household allocation, provided that the the division of surplus is allowed to depend monotonically on some measure of the relative value of disagreement that is increasing in own wages. Whether the actual determination occurs through bargaining, auctions, judicial decisions or shifting social norms would seem to be without consequence for the basic argument.

It should also be noted that there are two strong empirical justifications for divorce threat-points. First, data about the lives of singles, such as labor supply, wages and marriage rates, can be used, in combination with a suitable model of single life, to estimate the threat-points. In this paper, these threat-points are determined in the marriage-market equilibrium, as remarriage plays an important role in the value of being single. Second, the estimation results of Chiappori, Fortin, and Lacroix (2002) at the micro level imply that household labor supply is better described by a bargaining model with divorce threat-points than one with non-cooperative marriage as a threat-point.

The model is simple enough that it is easily extended to accommodate concerns outside the scope of the current paper. According to Ventura and Bachrach (2000), the fraction of child births accounted for by unmarried women has increased from 10 per cent in 1970 to nearly 35 per cent today. This suggests a big part of the marriage trend may be due to child costs falling for single women relative to married women. This trend may be due to pecuniary factors, such as welfare transfers to single mothers, or to non-pecuniary, such as a decline in the stigma associated with single motherhood. These ideas are pursued in a related paper in progress, Kennes and Knowles (2011), which argues the advent of more efficient birth control can explain the rise in single women's fertility and the decline of marriage rates.

Because the current model is so abstract, the estimated effects presented above should be seen as provisional. Even a simple change like adding fixed costs of household formation could increase the importance of wage changes for explaining the decline of marriage. It would be interesting to see whether the addition of dynamics in the form of fertility, savings or human-capital investments affect the interpretations presented here, but while it is clear that some of the results will change, the size of the bargaining effects suggests that bargaining will remain an important part of explaining time-allocation shifts over the last 40 years.

The integration of marriage and home-production into a model of intra-household allocation was essential for the insights presented here. However the main message regarding the decline of marriage was that it appeared not be directly driven by changes in wages or technology. Marriage rates in the US declined at a time of unprecedented prosperity and while women's wages were increasing relative to men's. It is tempting therefore to link the increased attractiveness of single life implied by these developments to the decline of marriage. The method of the current paper, by calibrating to data on time-allocation of both married and single households, suggested that wage/technological explanations had a relatively minor impact; in terms of the model, shifting preferences turned out to play the leading role. These changes in preferences should be interpreted as proxies for influences outside the model; the result therefore implies that more structure is required in the model to isolate potential sources of the decline in marriage rates.

One might ask why married men's working time declined in the period 1950-1975; the results of the wage-growth experiment in Table 8 suggest that we can expect labor-supply decline to accompany economic growth, and that bargaining has little to say about this effect. There are two further reasons that distinguish the 1950s and 1960s from the period studied here: 1) the gender wage gap was not declining, and 2) divorce was costly and rare, so the outside options were likely to have been less relevant to married couples.

A more relevant concern might be the elasticity of substitution of the spouses time in the home production function. Recall that this was calibrated by matching the decline in the wive's homework relative to that of the husbands. A more sophisticated approach might consider the possibility of technical change that made husband's time more productive at home. An example of this early in the 20th century would be the invention of substitutes for mother's milk in nursing infants, as in Albanesi and Olivetti (2006). The impact of other examples, such as the advent of home-laundry machines, as in Greenwood, Seshadri, and Yorukoglu (2005) are probably still too early to explain the transition since the 1970s. Such forces, if found to be quantitatively significant in the 1970s, would reduce the calibrated wage-elasticity of labor supply, and thus weaken the impact of the relative wage on the home allocations, but the importance of bargaining would remain, as this inferred from the leisure ratios, independently of the home technology.

The model may also have interesting implications for tax reform. This did not have a major impact in the experiments because there was not much change in the tax schedules, at least for married couples, over the 1975-2003 period; the flattening of the tax schedule discussed by Prescott (2004) occurred in the 1980s, and appears to have vanished by the end of the 1990s. It remains to be seen therefore how a change in the progressivity of taxes might affect aggregate labor supply, and hence tax revenues. Because single women are poorer than single men, a more progressive tax system would shift bargaining power to wives, reducing their labor supply relative to that of husbands. A deeper question that the model would be suitable for is to examine the impact of joint versus individual taxation of married couples, in the spirit of Chade and Ventura (2005).

7 Conclusion

The central point that motivated this paper is that the absence of a strong relation between wages and relative leisure of spouses is far from being an indicator that bargaining may be safely ignored; to the contrary, in the context of Neoclassical models, this is a compelling indicator of the importance of household bargaining.

Standard explanations of rising female labor supply have strong implications for husband's time allocations that have not been explored in the previous literature; the exception is Jones, Manuelli, and McGrattan (2003), who predict that husband's labor time should decline significantly. Time-use data in the US suggest that this did not happen over the 1975-2003 period when the gender gap in wages was closing. This paper showed that allowing for bargaining between spouses is a simple way to reconcile the trends in time allocation with the usual driving forces proposed in the literature. The size of the effects measured in the current paper suggests that it would be useful for macroeconomics to examine more closely the mechanism by which such inter-spousal allocations actually occur.

Are macro-economists mistaken in ignoring bargaining between spouses? The results indicate that the modeling of bargaining should not be a priority for all macroeconomic questions. Bargaining in the model has little to add to the analysis of events whose impacts on the value of single life are similar for both sexes. Even for events like shifts in relative wages, which do have strong implications for bargaining, the effects on husbands are nearly offset by those on wives, so that bargaining could be ignored in the analysis of per-capita labor supply, at least as a first pass.

Where bargaining appears essential is in the analysis of the response of sex-specific behavior, such as married-men's labor supply, to changes that affect the relative value of single life. We saw that the errors from the "unitary" version of the model were large relative to those of the bargaining model. The implications for future research are not limited to the shocks analyzed here. The impact of improved birth control, the decline of stigmatization of divorce, or the advent of affirmative action in employment are also likely to have raised the value of single life more for women than for men. In the light of the current results, it would be rash to interpret the impact of such changes on married-women's labor supply or on marriage rates without considering the implications for bargaining; small or insignificant labor-supply effects for instance may mask large welfare effects for married women.

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Years	Sample		Weekly Hours	Per-Capita Hours
1962-66	Women	Single	24.22	25.24
		Married	11.79	
	Men	Single	25.71	
		Married	39.44	
1967-75	Women	Single	22.54	25.37
		Married	13.76	
	Men	Single	24.52	
		Married	38.60	
1976-85	Women	Single	23.07	25.45
		Married	16.73	
	Men	Single	25.13	
		Married	35.74	
1986-96	Women	Single	24.89	27.69
		Married	21.36	
	Men	Single	27.20	
		Married	36.20	
1997-2001	Women	Single	25.95	29.01
		Married	23.47	
	Men	Single	28.22	
		Married	37.30	
2002-2006	Women	Single	24.67	27.84
		Married	22.97	
	Men	Single	26.52	
		Married	36.01	

Table 1: *Trends in Paid Hours Per Capita, March CPS ages 18-65*

Variables	1965		1975		1985		2003	
	Wives	**Husbands**	**Wives**	**Husbands**	**Wives**	**Husbands**	**Wives**	**Husbands**
Discretionary Time	118	118	118	118	118	118	118	118
Paid Work	11.54	42.07	14.8	38.17	17.6	35.51	21.82	38.2
Unpaid Work	45.28	19.4	36.79	17.91	35.6	21.32	32.32	20.29
Total Working Time	56.82	61.47	51.59	56.08	53.2	56.83	54.14	58.49
Non-Working Time	61.18	56.53	66.41	61.92	64.8	61.17	63.86	59.51
Sample Size	739	696	697	655	1122	966	4116	3774

Table 2(a). *Time allocation of married couples*. Author's computations from married people aged 18-65 in time-use surveys. Observations with more than 4 weekly hours unaccounted for excluded.

Variables	1975		2003	
	Wives	**Husbands**	**Wives**	**Husbands**
Commute+Job-Related	2.71	6.54	2.02	4.06
Cooking and Indoor Chores	21.31	1.98	14.86	3.33
Shopping	6.18	3.8	6.55	4.24
Other Home Production	2.36	4.53	4.06	7.01
Child Care	4.23	1.06	4.83	1.65
Total Unpaid Work	36.79	17.91	32.32	20.29

Table 2(b) *Composition of Unpaid Work* . Author's computations from married people aged 18-65 in time-use surveys.

Variables	1975		2003	
	Wives	**Husbands**	**Wives**	**Husbands**
"Leisure 1"	34.5	33.07	32.43	35.51
Net Personal Care	25.4	23.31	24.44	20.12
Other Non-Working Time	6.51	5.54	6.99	3.88
Total Non-Working Time	66.41	61.92	63.86	59.51

Table 2(c) *Composition of Non-Working Time.* Author's computations from married people aged 18-65 in time-use surveys. "Leisure 1" refers to variable defined in Aguiar & Hurst (2006).

Age	Years 62-66	67-74	75-84	85-94	95-00	2000-06
18-24	0.83	0.81	0.84	0.92	0.91	0.90
25-54	0.59	0.60	0.63	0.74	0.76	0.75
55-56	0.65	0.65	0.60	0.64	0.63	0.66
Education						
< HS	0.59	0.58	0.61	0.71	0.74	0.75
HS	0.61	0.61	0.64	0.73	0.76	0.76
College	0.58	0.60	0.66	0.75	0.76	0.75
BA	0.64	0.66	0.66	0.73	0.72	0.69

Table 3(a): *Female-Male Wage Ratios by Age and Education*. Author's computations from the CPS population of people aged 18-65 who worked at least 10 hours weekly on average.

Subsample		Wife-Husband Ratios of Non-Working Time 1965	1975	1985	2003
Years of Education	Less than 12	1.08	1.02	1.08	1.01
	12 Years	1.06	1.14	1.03	1.06
	13-15 years	1.20	0.98	1.03	1.08
	16 or more	1.01	1.07	1.11	1.10
Working		0.89	0.97	1.01	1.04
Age	25-55	0.83	0.94	1.03	1.04
	55-70	1.12	1.01	0.95	1.06

Table 3(b): *Non-Working Time of Married People*. Author's Computations from the time-use surveys.

Weekly Hours	Singles				Married			
	Women		Men		Women		Men	
	Time-Survey	Adjusted to CPS	Time-Survey	Adjusted to CPS	Time-Survey	Adjusted to CPS	Time-Survey	Adjusted to CPS
				1975				
Paid Work	19.24	21.26	27.47	25.55	15.51	15.08	38.73	38.01
Job-Related	3.72	4.11	4.86	4.52	2.72	2.64	6.48	6.36
Home Production	24.27	21.72	9.82	10.51	34.27	35.25	11.49	11.70
Total Work	47.23	47.09	42.15	40.58	52.50	52.97	56.70	56.07
Non-Working Hours	70.77	70.91	75.85	77.42	65.51	65.03	61.3	61.93
Total	118	118	118	118	118	118	118	118
Time-Survey Freq.	250		149		719		671	
CPS Population Share	12.12		13.87		37.78		36.23	
				2003				
Paid Work	24.83	24.09	30.28	26.90	22.54	23.05	38.87	36.62
Job-Related	2.64	2.56	3.68	3.27	2.08	2.13	4.1	3.86
Home Production	20.53	21.14	11.88	13.21	30.74	30.04	16.59	17.55
Total Work	48.00	47.79	45.84	43.38	55.36	55.22	59.56	58.03
Non-Working Hours	70.01	70.21	72.17	74.62	62.65	62.78	58.43	59.97
Total	118	118	118	118	118	118	118	118
Time-Survey Freq.	3347		2405		4238		3912	
CPS Population Share	19.55		20.94		30.34		29.17	

Table 4: *Reconciliation of Working Hours from Time-Use Surveys to CPS Paid Work Time.* Averages weighted by CPS population distribution. Adjustment includes reallocating paid work hours to, or from, unpaid work and non-work to match CPS paid hours.

Statistic	1975		2003	
	Data	Model	Data	Model
Wives HP home time	35.23	35.15	30.03	29.99
Husbands home time	11.7	11.68	17.55	17.53
single womens home time	21.72	21.77	21.14	21.14
single mens home time	10.5	10.5	13.21	13.25
equipment share	0.056	0.056	0.046	0.046
Wives leisure	65.05	64.91	62.78	62.7
Husbands leisure	61.93	61.79	59.97	59.89
single womens leisure	70.91	71.08	70.21	70.2
single mens leisure	77.42	77.4	74.63	74.87
Wives paid work	15.08	15.23	23.06	22.88
Husbands paid work	38.01	37.8	36.62	36.68
single womens paid work	21.26	21.34	24.09	24.09
single mens paid work	25.55	25.55	26.9	27.01

Table 5 (a) Time-allocation results

Statistic	1975		2003	
	Data	Model	Data	Model
Marriage Rate	0.0929	0.0854	0.0458	0.0442
Divorce Rate	0.0249	0.0241	0.0178	0.0352
Wife/Husband Leisure Ratio	1.0505	1.0553	1.0469	1.0423

Table 5(b) Marriage-market calibration results.

Type	Year	Theta	Utility Weights		
			Consumption	Home Good	Leisure
Married	1975	0.898	0.260	0.051	0.689
	2003	0.919	0.323	0.070	0.607
Single Men	1975	0.817	0.224	0.026	0.750
	2003	0.879	0.254	0.038	0.709
Single Women	1975	0.906	0.193	0.072	0.735
	2003	0.928	0.213	0.072	0.715
Work Costs	1975	0.178	Substitutability of Home Labor		0.475
	2003	0.106			

Table 6(a) Values of Time-Allocation parameters

Parameter	Value
Joy of single life: women/men	1.25
Men's joy of single life 1975	0.83
Men's joy of single life 2003	0.71
Divorce Cost	5.29
Weight on Egalitarian Solution	0.38

Table 6(b) Values of marital matching parameters

Statistic		Bench2003	Flexible Pareto Weight		Rigid Pareto Weight			Bench1975
			Preferences	Relative Wage	2003	Preferences	Relative Wage	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Marriage rate		0.040	0.064	0.102	0.04	0.07	0.10	0.09
Divorce Rate		0.037	0.029	0.021	0.04	0.03	0.02	0.02
Wife/husband leisure ratio		1.04	1.12	1.02	0.93	1.06	0.93	1.06
Paid work	Wives	22.94	15.04	23.22	26.42	16.67	25.90	14.97
	Husbands	36.52	43.40	32.70	33.82	42.32	30.61	37.63
	Single women	24.09	23.13	21.29	24.09	23.13	21.29	21.34
	Single men	27.01	27.67	25.26	27.01	27.67	25.26	25.55
Home work	Wives	30.02	41.05	24.72	30.02	41.05	24.72	35.15
	Husbands	17.55	13.64	14.45	17.55	13.64	14.45	11.68
	Single women	21.14	21.60	21.70	21.14	21.60	21.70	21.77
	Single men	13.25	13.07	10.54	13.25	13.07	10.54	10.50
Leisure	Wives	62.49	58.69	65.26	58.64	56.77	62.10	64.63
	Husbands	59.93	52.49	64.30	62.92	53.76	66.75	61.24
	Single women	70.20	69.14	71.22	70.20	69.14	71.22	71.08
	Single men	74.87	72.33	77.69	74.87	72.33	77.69	77.40

Table 7: *Main results with flexible and rigid Pareto weights*. The case with rigid Pareto weight imposes the mapping from marriage quality to Pareto weight that is derived from the 1975 Benchmark calibration.

Statistic		Experiments					
		Equipment Price	Income and Wage Growth	Tax Schedule	Technology	q level	Work Costs
Marriage rate		0.078	0.110	0.091	0.104	0.031	0.107
Divorce Rate		0.025	0.020	0.023	0.025	0.049	0.025
Wife/husband leisure ratio		1.056	1.039	1.055	1.064	1.045	1.061
Paid work	Wives	15.58	11.62	15.02	14.71	15.28	15.43
	Husbands	37.56	34.3	37.64	37.8	37.42	39.94
	Single women	21.51	20.99	22.07	21.34	21.34	22.75
	Single men	25.66	23.76	26.19	25.55	25.55	27.06
Home work	Wives	33.87	36.54	35.1	35.15	35.15	35.23
	Husbands	11.25	12.14	11.66	11.68	11.68	11.7
	Single women	21.04	21.72	21.55	21.77	21.77	21.74
	Single men	9.763	10.59	10.38	10.5	10.5	10.49
Leisure	Wives	65.18	67.19	64.62	64.93	64.26	65.12
	Husbands	61.74	64.7	61.23	61.04	61.48	61.35
	Single women	71.62	71.55	70.44	71.08	71.08	71.09
	Single men	78.01	79.41	76.76	77.4	77.4	77.57

Table 8: *Other results with flexible Pareto weights*.

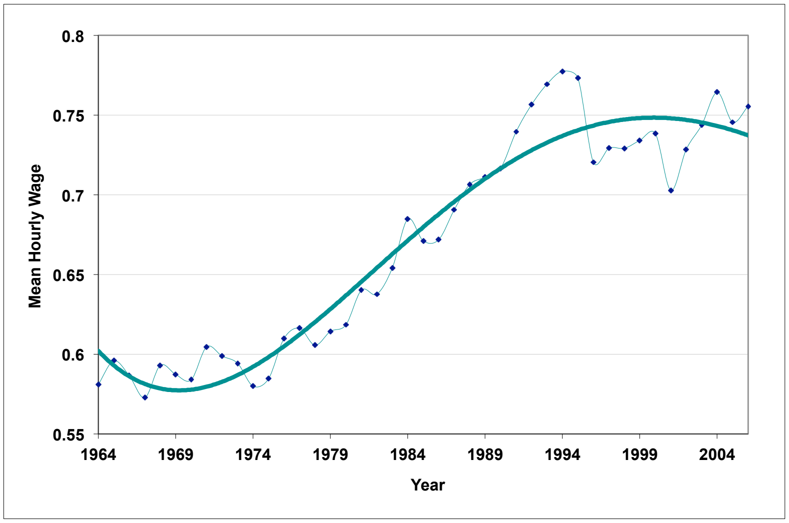

Figure 1(a): *Ratio of Mean Wages of Women to those of Men.* Author's computations from the March CPS for population 18-65 years old working 10 hours or more weekly at paid employment

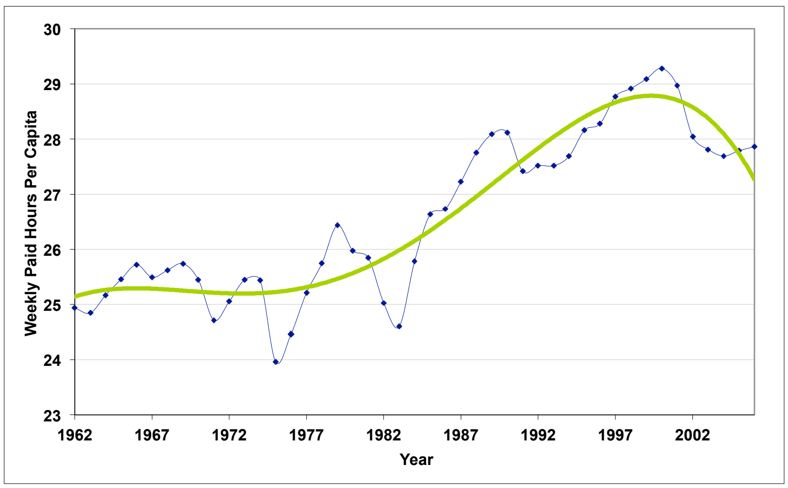

Figure 1(b): *Per-capita hours in the March CPS.* Based on author's computations from reported hours worked in previous week by persons aged 18-65. With fitted quartic trend line.

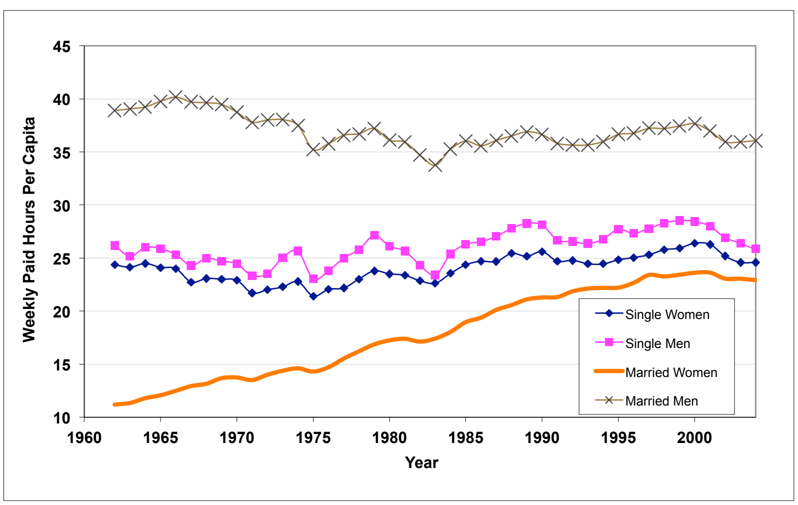

Figure 1(c): *Per-capita hours by sex and marital status.* Based on author's computations from March CPS, persons aged 18-65

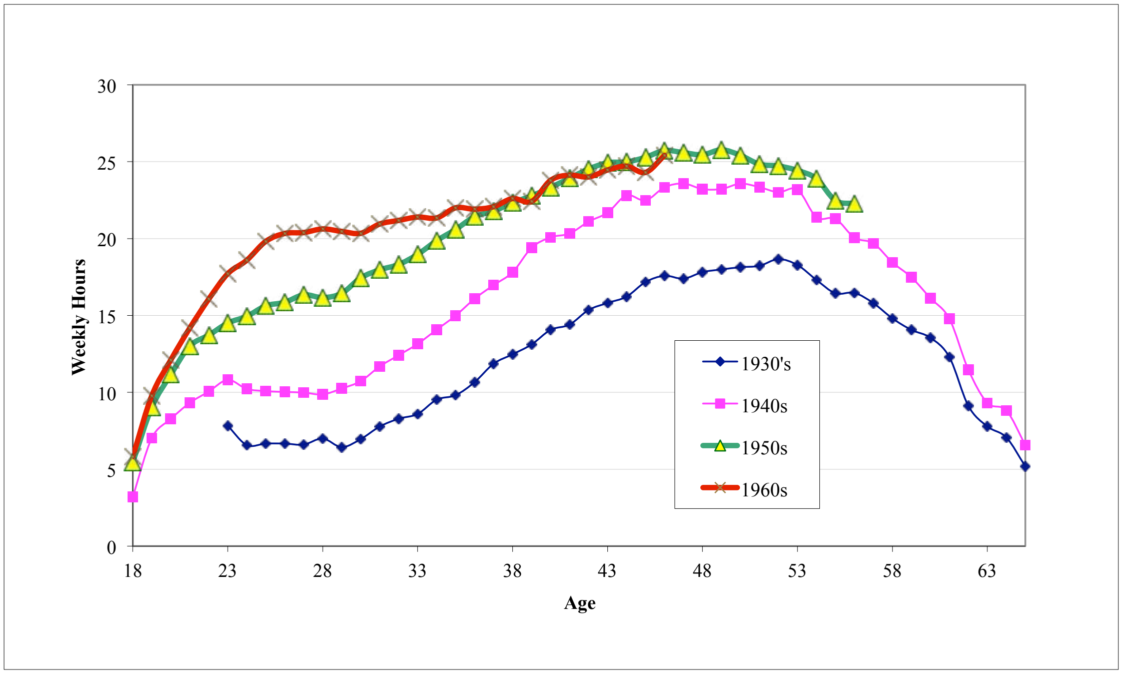

Figure 2a: Weekly Paid Hours of Married Women by Birth Cohort in the March CPS

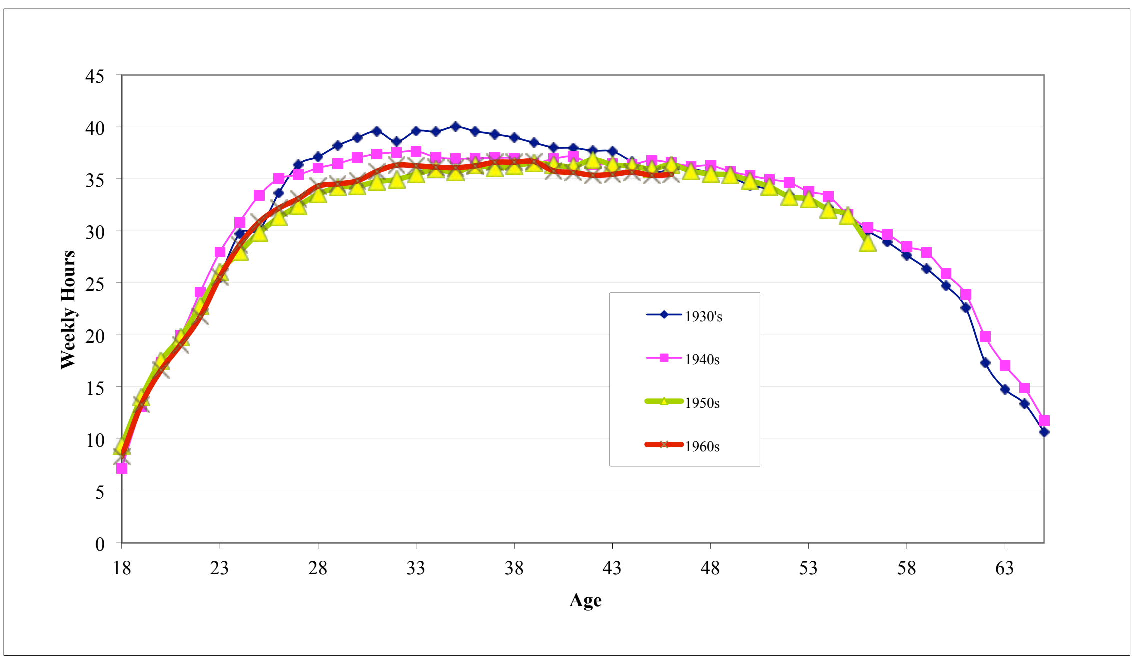

Figure 2b: Weekly Paid Hours of Married Men by Birth Cohort in the March CPS

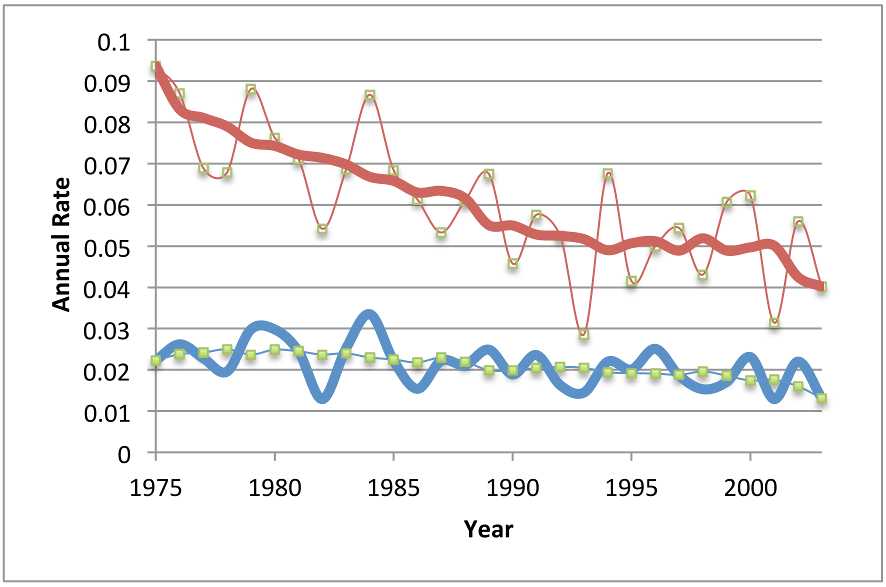

Figure 3(a): *Marriage and divorce rates*. Per single woman aged 18-65, as imputed from March CPS.

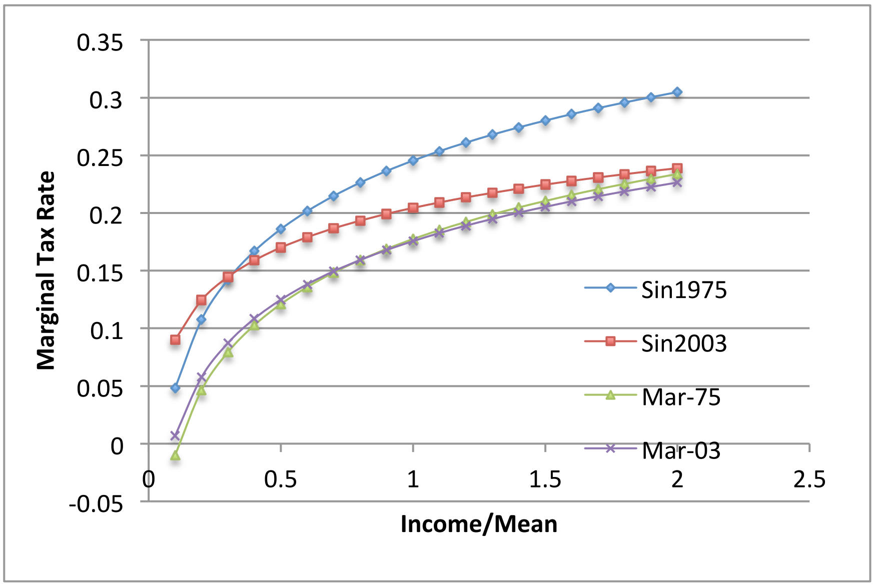

Figure 3(b): *Marginal Tax Rates*. Imputed from IRS Summary Data.

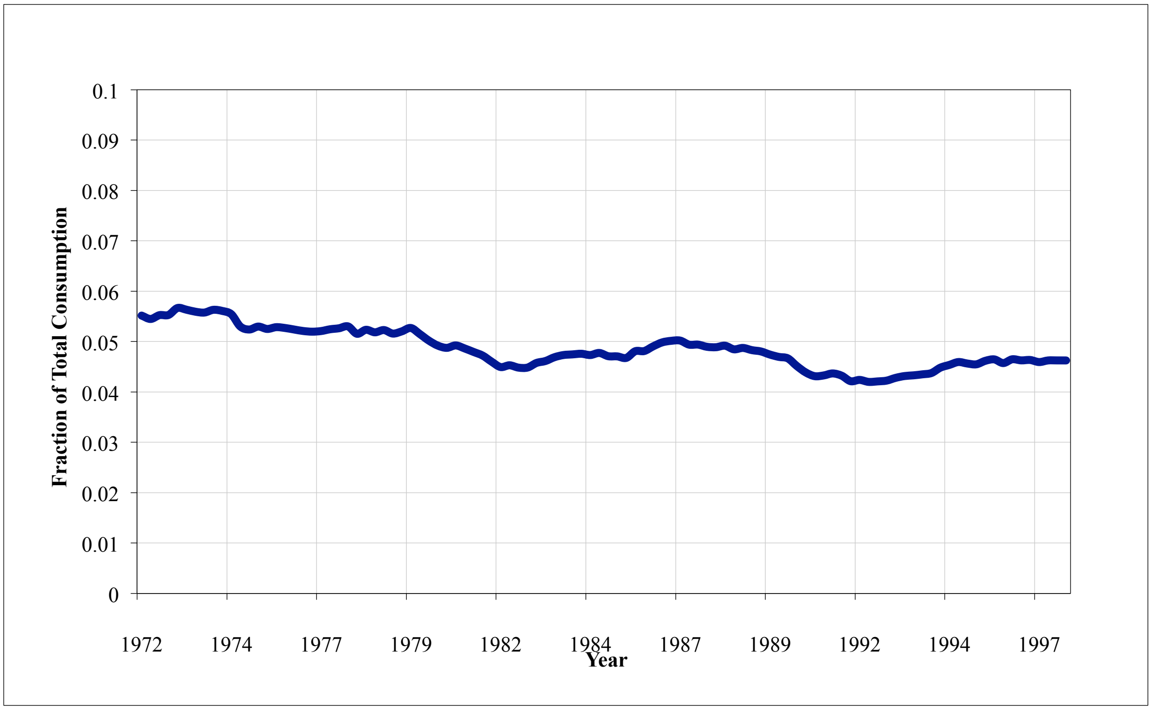

Figure 4(a): *Spending share of Home Equipment in the NIPA*, 1972-1997. Source: BEA Table 2.3.3. Real Personal Consumption Expenditures by Major Type of Product, Quantity Indexes

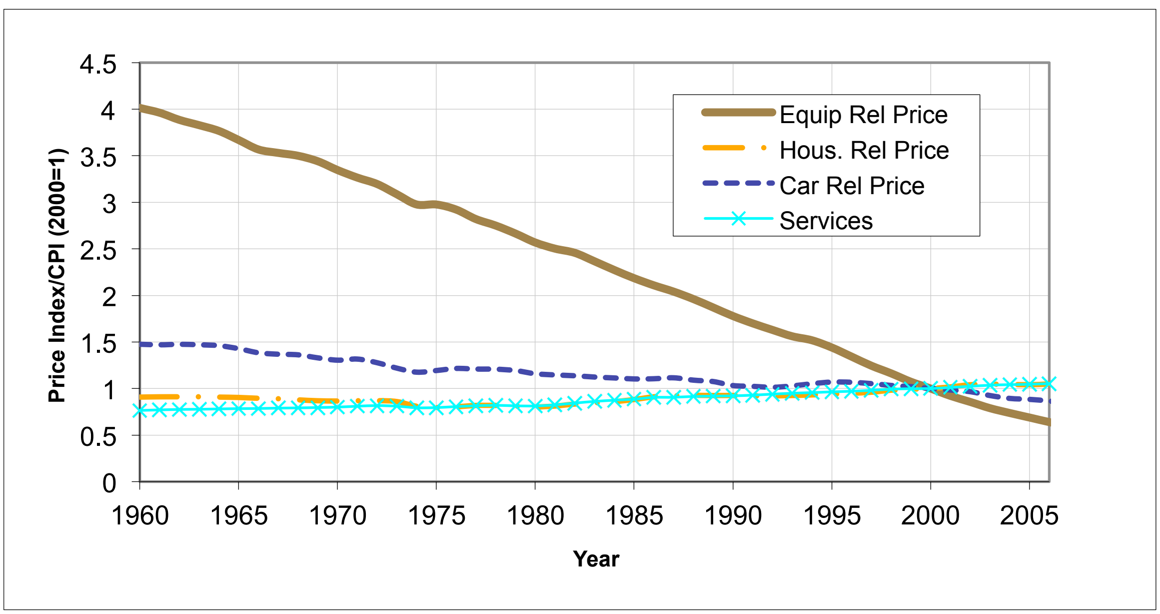

Figure 4(b): *Relative Price of Home Equipment and Furniture. Source:* BEA Table 2.3.4. Price Indexes for Personal Consumption Expenditures by Major Type of Product . http://www.bea.gov/bea/dn/nipaweb

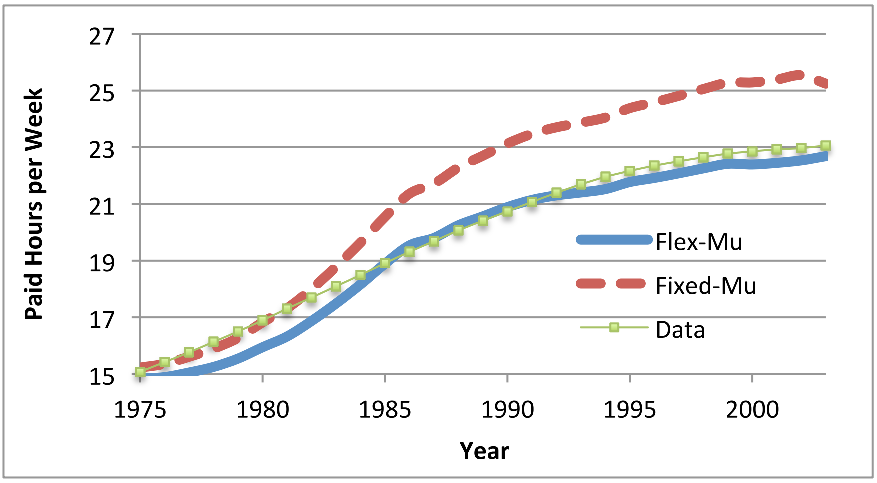

Figure 5(a): Married Women's Paid-Labor Supply with fixed and flexible pareto weights.

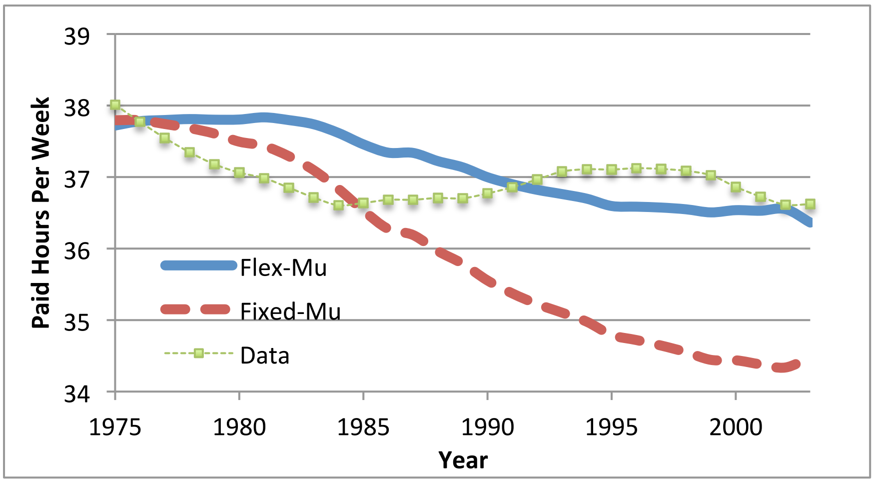

Figure 5(b): Married Men's Paid-Labor Supply with fixed and flexible pareto weights.

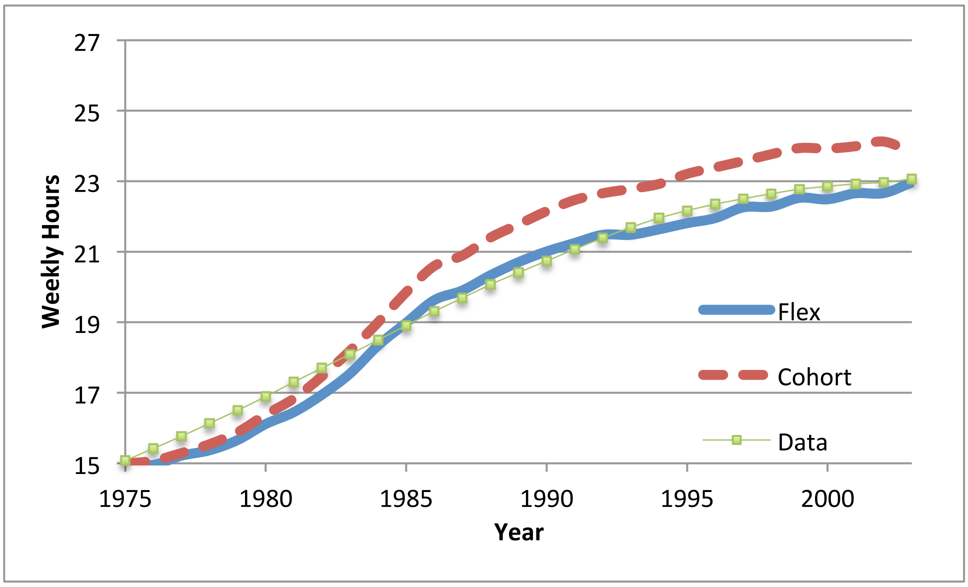

Figure 6(a): Wives' paid labor hours, with cohort-specific Pareto weights (dashed) versus flexible weights (solid), compared to data (boxed line).

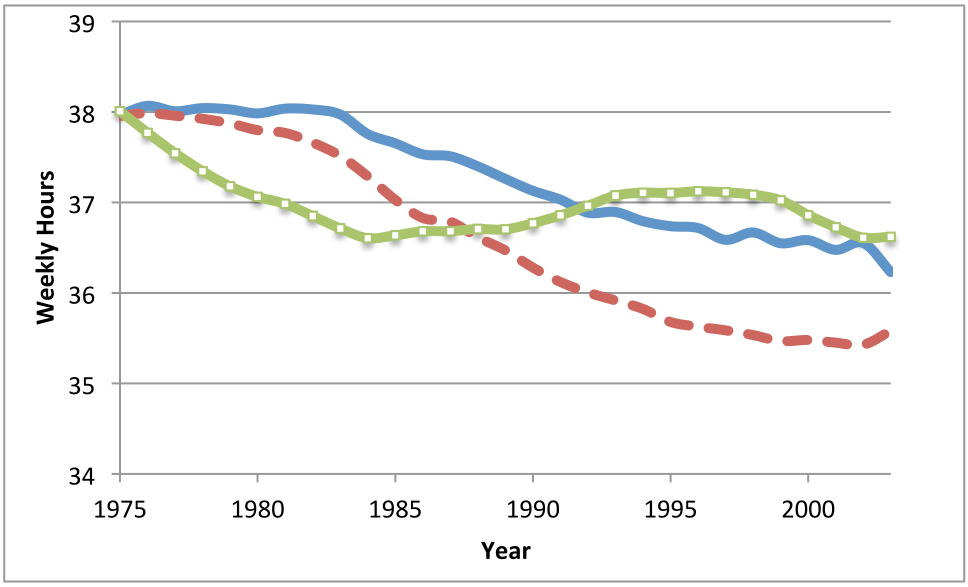

Figure 6(b): Husband's paid labor hours, with cohort-specific Pareto weights (dashed) versus flexible weights (solid), compared to data (boxed line).