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? The stationarity, since the mid 1970s, of married-men's average weekly hours of paid labor suggests that the inclusion of bargaining between spouses is essential for understanding the labor supply trends of married women. This paper develops and calibrates to US time-use survey data a simple macro-style model of marital bargaining, where the allocations depend on equilibrium marriage and divorce rates. The results suggest that failure to account for bargaining would exaggerate by roughly 100% the effect of the closing of the gender gap in wages on the labor supply of married women. With respect to average paid labor of married couples, the prediction error from ignoring bargaining would be on the order of 5 hours per week. The model without bargaining also exaggerates the impact on the decline of marriage resulting from the declining price of home equipment, from tax reform and from the closing of the gender gap.

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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 median 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 bargaining, and thus are ill-suited to study questions of intra-household allocation. This paper asks whether both the decline of marriage and the rise in married-women's labor supply observed in the US over the period 1975-2003 could have been caused in large part by the closing of the gender gap in wages.[1] 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). 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 and wealth of the

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[1]The beginning and end points of the analysis are fixed by the availability of time-use survey data to measure home production time.

married household remain constant. 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.

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) 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. Since the main predictions of bargaining models for labor supply are based on the allocation of leisure, this result suggests that it would be unwise to make inferences from labor supply without accounting for home-production time.

A sensible rationalization of 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 Greenwood, Seshadri, and Yorukoglu (2005). 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(b) 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.

It is possible of course that married men's non-working time is nevertheless declining relative to that of their wives, if home-production time for married couples is accounted for. In this paper I show, using American surveys of household time use, that the problem 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. 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, and explain it on the basis of social norms.

The argument developed here proceeds in two stages; first a model of marriage and allocations is developed. This combines a marriage-equilibrium process similar to that of Chade and Ventura (2005) with intra-household bargaining as in McElroy and Horney (1981), and a home-production technology in the spirit of Greenwood, Seshadri, and Yorukoglu (2005).

At first, the analysis is based on inferences made from special cases of the model. Thus we establish that the iso-leisure pattern is easily explained by the impact of relative wages on bargaining position, and hence without reference to social norms. We also show that neither the tax reform

nor the home technology stories can fully account for the rise in married-women's labor supply, because they operate largely as income effects, and hence cannot account for the rise in the wife's leisure-expenditure share of household income. Finally, we show that while the impact of wage levels on marriage rates depends on the nature of the home-production technology, the convergence of relative wages can reduce marriage rates even when the home inputs consist only of time, a case that makes marriage rates independent of wage levels. While the model developed here is very stylized, these basic insights are clearly characteristic 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.

These inferences leave open the essentially quantitative questions: does intra-household bargaining change our understanding of the shifts in marriage rates, aggregate labor, and the labor supply of married women? To answer these questions, the model is equipped with a standard CES home-production technology, logarithmic preferences, and a stochastic process for marriage quality. Values for wages, non-labor income and tax rates are fed in from survey data. The model is then calibrated to match time allocations and marriage rates for 1975 and 2003. This benchmark version of the model is then compared with its "unitary" version, in which the bargaining solution is 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.

From the point of view of matching the iso-leisure fact, the key feature of the model developed here is that the bargaining position of the spouses depends on the marriage-market 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 27% decline in this ratio, in response to the shrinking of the gender gap in wages. However in the equilibrium with bargaining, the rise in the relative wage causes married couples to allocate a higher leisure share to the wives, offsetting the higher price of female leisure. The most important force is the closing of the gender gap in wages, which generates a 7-hour increase in the wife's paid labor. This is more than simply a reallocation between husband and wife; the average labor supply of married couples increases by 2.5 weekly hours, about 40% of the increase observed since the 1970s.

The model also explains a decline in the marriage rates of single women from 9.1% to 6.4% per year; about 60% of the total decline in marriage over the period 1975-2003. Income and wage growth on its own can explain 50% of the observed decline in the marriage rate, while convergence of wages accounts for 20%.

The quantitative results also take into account two other topical sources of change: improvement in home productivity over time and changes to the marginal tax schedule due to fiscal reforms over the period. Greenwood and Guner (2004) explain the marriage decline over the longer period since

1945 as the result of a continuous decline in the cost of running a household, relative to the mean wage. They identify two forces driving this change: the rise in average wages, and the decline in the price of home equipment. In the current paper, we find that the fall in the equipment price generates only a 2-hour increase, about 20% of the total change in married women's labor supply. This is because we use the time allocation of single-person households to identify the role of home equipment; since the time allocated to home production by singles has not declined very much over time, this limits the role of the price decline of home equipment.

The impact of tax reform on married-women's labor supply has been widely studied; the marginal tax schedule has flattened considerably since the 1970s, and this appears to have had significant effects on married-women's labor supply, as documented by Eissa (1995). A seminal paper, Prescott (2004) conjectures that this accounts for the rise in female labor supply after 1986. In the current paper, the quantitative experiments suggest that effects of tax reform alone could have accounted for roughly 20% of the rise in married-women's labor supply, consistent with the finding of Kaygusuz (2010), and about 26% of the rise in average labor supply of married couples.

How important is bargaining for explaining these trends in labor and marriage? The results show that bargaining sharply reduces the role of wage growth in the decline in marriage. When bargaining in the model is shut down, income and wage growth alone can account for the entire decline in marriage rates since 1975. The effects of the equipment-price trend or the tax reforms on marriage rates are relatively small in the benchmark model; ; the former reduces marriage rates by 2%, while the effect of the tax reform is to increase marriage rates very slightly, by about 4%. However when the bargaining between spouses is shut down, these effects are transformed; equipment prices drive marriage rates down 2 percentage points, and taxes by 1.6 points. It is much easier to explain marriage decline without bargaining, but the sources of change appear to be quite different.

In regards to labor supply, the model without bargaining is far more responsive to the relative wage trend; not only do wive's paid hours increase by an additional 10 hours per week, but average hours of married couples increases by an additional 2.5 hours , about 50% of the total increase observed since 1975.

These results suggest that it is potentially misleading to abstract from bargaining, even at the most aggregate level. It is to be expected that bargaining would be critical for understanding the impact of changes in relative wages, though the size of these effects on labor supply by sex has never been measured. However the role of bargaining turns out to be quite large even with respect to the effects of taxation and economic growth on marriage and labor supply. Even the impact of growth on aggregate labor turns out to be sensitive to the bargaining assumption.

The model in the current paper can be seen as a simplified version of the marriage-market models of Greenwood, Guner, and Knowles (2000) and Greenwood, Guner, and Knowles (2003), but there the focus is on heterogeneity in matching and fertility decisions, which limits the analysis to one or two marriage opportunities per lifetime. An infinite horizon model with many matching

and fertility opportunities has been developed by Kennes and Knowles (2008), but that model abstracts from the time-allocation problem of married households. Another paper that spells out the implications of the collective model at the macro level is Lise and Seitz (2005), who find that accounting for trends in intra-household inequality substantially reduces the apparent increase in consumption inequality over the last 30 years.

2 Trends in Time Allocation

For distinguishing different versions of the household model the response of total work time, including unpaid work, to changes in relative wages of men and women is more useful than that of paid working time. What is missing from the standard macro data sets therefore are numbers for then changes in unpaid work. The goal of this section is to document patterns in non-working time by studying these changes. The strategy is to use the CPS 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 mean paid work hours for married couples in these data sets are very similar over the years to the numbers in the CPS.

2.1 Paid-Labor Supply Trends: CPS

Figure 1, 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. [2]

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, 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(b) 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(c) shows that, over the next 28 years, average hours rose steadily to 29.3 in 2000, an increase of nearly 18% .

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

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 unpaid work hours, which are presumably from 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 representative source of 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. 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 2(c) shows that while non-working time remained constant over the 1975-2003 period, there was a small reallocation of this time from leisure activities to personal care for wives and

from personal care to leisure activities for husbands. Thus married women's relative time spent in leisure activities does fall, but non-working time does not. Could this be driven by the increase in women's paid work? This would be hard to reconcile with the three hour decline in men's personal care time, given that their paid time declined less than 5%. Indeed, when the sample is censored to exclude the top percentile of market labor, the table shows no trend in men's market labor, but the fall of personal care time remains unchanged. As Biddle and Hamermesh (1990) find that the elasticity of sleep time with respect to paid work hours is significantly negative, and sleep is the main component of personal care time, the reallocation of non-working time for women appears to have the wrong sign for their rise in personal care to be driven by rising labor force participation of wives. Hence, it appears that this is indeed a relabeling or reallocation of non-working time.

Finally, 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 alloca-
tions, 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 of the Pareto weights in which the weights depend on the
value of leaving the marriage. Finally, we work out these values by computing the equilibrium
marriage rates depend on full income by marital status. A simple example of the model is then
fully worked out to show how the main features determine labor supply.

The main non-standard simplification is that home goods appear as a minimum-consumption
constraint, and do not enter the utility function. A more standard approach would be to treat home
goods as arguments in the utility function. This feature is motivated by simplicity, as it allows
the model to be calibrated in separate chunks. It is a simple way of matching the fact that there
is virtually no fall in average home hours over the period 1975-2003, by marital status; indeed for
single men, home hours rose slightly, while for couples the rise in husband's hours nearly offsets the
decline in that of the wives.

3.1   Household Structure

There is a large population with equal numbers of two sexes $i \in \{H, W\}$, 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 household earnings.

Each agent i has a time endowment of one unit of time, 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.[3] The time constraint for each spouse i is:

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

The consumption expenditure of a single household is c_i^S, while that of married couples is
the sum over public consumption c^P and private consumption $c_H^M + c_W^M$. For singles, there is no
distinction between private and public consumption.

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[3]The empirical analysis reported in Table 4 shows that unpaid job-related time is an important component of
unpaid work, and that the average of this across sex-marital subsamples is proportional to paid working hours.

There is a home good that 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. Married couples are constrained to produce a minimum level g^M of the home good, while for singles the constraint is g_i^S.

Preferences of individuals over consumption and leisure are represented by the discounted sum:

$$\sum_{j=0}^{\infty} \beta^j \left[u_i^m \left(c_{t+j}^P, c_{i,t+j}, l_{i,t+j} \right) + J_{i,t+j}^M \varepsilon_{i,t+j} \right]$$

where m indicates marital status and $J_{i,t+j}^M$ is an indicator for marriage. The period utility function $u_i^m \left(c^P, c_i, l_i \right)$, depends on household consumption of a public good c^P, the private consumption c_i of person i, non-working time l_i.

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 in the Married Household

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 agent i.

Since home goods do not enter the utility function, the home-production constraint always binds:

$$G(e_q, h_H, h_W) = g^m \tag{1}$$

Since the allocation does not affect continuation values, conditional on μ_i, we can write the efficient allocation as the solution to a static problem. Noting that $\mu_W + \mu_H = 1$, we have set $\mu_H = \mu$, so that $\mu_W = 1 - \mu$. Given μ, The married household maximizes:

$$\{\mu u(c_P, c_H, l_H) + (1 - \mu) u(c_P, c_W, l_W)\}$$

subject to the budget constraint:

$$c_P + c_H + c_W + pe_q + T(Y_M^T) \leq Y_M^T$$

, where taxable income $Y_M^T \equiv w_W n_W + w_H n_H + y_M^{nl}$, to the home-production constraint (1), and to the time constraints, as well as the usual non-negativity constraints on consumption and leisure.

Let the multiplier on the budget constraint be λ. Suppose that we take the marginal and average tax rates, T^M and T^A, respectively, as given. The optimality conditions are

$$\mu u_c (c_P, c_H, l_H) = \lambda$$
$$\mu u_l (c_P, c_H, l_H) = \lambda w_H \frac{1 - T^M}{1 + t_n}$$

for the husband and

$$(1 - \mu) u_c (c_P, c_W, l_W) = \lambda$$
$$(1 - \mu) u_l (c_P, c_W, l_W) = \lambda w_W \frac{1 - T^M}{1 + t_n}$$

for the wife. With respect to the public good, the optimality condition is:

$$u_P (c_P, c_i, l_i) = \lambda$$

3.3.1   Leisure Allocations

The first-order conditions imply the marginal utility of leisure is inversely proportional to the relative wage, holding μ constant:

$$\frac{u_{lH}}{u_{lW}} = \frac{w_H}{w_W} \frac{\mu}{1 - \mu}$$

. Hence when the relative wage increases, then concavity of the utility function implies relative leisure must fall. This is the theoretical motivation of this paper. To make this into a quantitative statement, we need only specify a utility function. With log utility, relative leisure is itself inversely proportional to the relative wage,

$$\frac{l_W}{l_H} = \frac{w_H}{w_W} \frac{1 - \mu}{\mu}$$

. Blau and Kahn (1997) report that the average wages of women working full time rose, as a fraction of men's, from 0.60 to 0.76 over the period 1975 to 1995. If the weight μ remained constant, then the relative leisure $\tilde{l} = \frac{l_W}{l_H}$ for average wife should have decreased by 18%:

$$\frac{\tilde{l}(0.76)}{\tilde{l}(0.6)} = \frac{0.6}{0.76} = 0.82$$

If instead each agent had additively separable CES utility:

$$u (c_i, l_i) = \frac{c_i^{1-\sigma} - 1}{1 - \sigma} + \delta \frac{l_i^{1-\sigma} - 1}{1 - \sigma}$$

, the first-order condition for relative leisure would be similar:

$$\frac{l_W}{l_H} = \left[\frac{w_H}{w_W} \frac{1 - \mu}{\mu} \right]^{1/\sigma}$$

. With $\sigma > 1$, as is usually assumed in the macro literature, the result is that the wage elasticity of relative leisure is reduced from 1 to $1/\sigma$. Setting $\sigma = 2$, the prediction is that married women's leisure should have declined 9.5%, relative of that of their husbands, an effect on the order of 6 hours. Therefore generalizing the utility function to the CRRA class, as used in the macro literature, does not make the iso-leisure problem go away. 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. Since women's wages are rising relative to men's the tax story is inadequate because it does not supply an offsetting effect to prevent women's leisure from falling.

With log utility, it is easy to see that if the solution is interior, then labor income is invariant to μ. This is very useful for future results. Using the budget constraint, we can define full income as

$$Y_M^F = \left(\frac{w_W (1 - h_W) + w_H (1 - h_H)}{1 + t_n} + y_M^{nl} - k_M \right) \left(1 - T^A \right)$$

, where $k_M = \frac{p}{1-T^A} e_q$ is the effective cost of equipment. The optimal consumption expenditure, net of taxes, with log utility is given by

$$x_c = \frac{1}{1 + \delta \frac{1-T^A}{1-T^M}} Y_M^F$$

, and the optimal leisure expenditure by

$$\hat{w}_H^M l_H + \hat{w}_W^M l_W = \frac{\delta}{1 + \delta \frac{1-T^A}{1-T^M}} Y_M^F$$

, where $\hat{w}_i^M = \frac{1-T^M}{1-t_n}$. The distortion induced by the progressiveness of the tax is $\frac{1-T^A}{1-T^M}$, which is increasing in income. With a linear tax rate, this ratio equals one and we are left with the familiar constant-expenditure-share property.

We can write the *indirect* utility (conditional on full income Y_M^F) from marriage each period, as:

$$U_i^M \left(Y_M^F, w_i \right) + (1 - \phi + \delta) \ln \mu_i + \varepsilon$$

, where

$$\begin{aligned} U_i^M \left(Y_M^F, \hat{w}_i \right) &= (1 + \delta) \ln \left[\frac{1}{1 + \delta \frac{1-T^A}{1-T^M}} Y_M^F \right] - \delta \ln \hat{w}_i^M + K_M \\ K_M &= \phi \ln \phi + (1 - \phi) \ln (1 - \phi) + \delta \ln \delta \end{aligned}$$

The analogous results for CES utility are shown in the appendix.

3.4 Single-Person Households

For single people of sex i with non-labor income y_i^{nl}, the household problem is

$$\max_{n,h,e_q} \left\{ u\left(w_i n_i + y_i^{nl} - pe_q - T\left(w_i n_i + y_i^{nl}\right), 1 - n_i(1 + t_n) - h_i\right) + \lambda\left[G\left(e_q, h_i\right) - g\right]\right\}$$

Holding the tax rates constant, we can define full income from the solution to the home production problem:

$$Y_i^S = \left[y_i^{nl} + \frac{w_i}{1 + t_n}(1 - h_i)\right]\left(1 - T^A\right) - pe_q$$

The single household chooses l_i, c_i, n_i, h_i, e_q to maximize the utility function $u(c_i, l_i)$ subject to the budget constraint

$$c_i = w_i n_i + y_i^{nl} - pe_q - T\left(w_i n_i + y_i^{nl}\right)$$

, the home production constraint $G(e_q, h_i) = g$, and the time constraint

$$
\begin{aligned}
l_i &= 1 - n_i(1 + t_n) - h_i \\
n_i &= \frac{1 - l_i - h_i}{1 + t_n}
\end{aligned}
$$

, where the time cost of work equals t_n.

Setting the average tax rate to T^A, the budget constraint, in terms of leisure and home time, the budget constraint is:

$$c_i = \left(w_i \frac{1 - l_i - h_i}{1 + t_n} + y_i^{nl}\right)\left(1 - T^A\right) - pe_q$$

With log utility the expenditure share of leisure depends on the wedge between marginal and average tax rates:

$$\frac{w_i}{1 + t_n} l_i = Y_i^S(p, w_i; h_i, e_q) \frac{\delta}{\frac{1 - T^M}{1 - T^A} + \delta}$$

, where Y_i^S is the full income of singles:

$$Y_i^S \equiv \left(w_i \frac{1 - h_i}{1 + t_n} + y_i^{nl}\right)\left(1 - T^A\right) - pe_q$$

When marginal and average rates are equal, expenditure share becomes the familiar constant $\frac{\delta}{1+\delta}$.

The indirect utility is

$$U_i^S(w_i, Y_i^s) = (1 + \delta)\ln Y_i^s - (1 + \delta)\ln\left(\frac{1 - T^M}{1 - T^A} + \delta\right) + \ln\frac{1 - T^M}{1 - T^A} - \delta\ln\frac{w_i}{1 + t_n} + \delta\ln\delta$$

The analogous results for CES utility are shown in the appendix.

3.5 Determination of μ

Our theory of μ is that it is a function 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. The Egalitarian solution is also more elastic than the Nash solution, which reduces the distance from the unitary assumption required for the calibration to match the iso-leisure fact.

Let $U_i^M \left(Y_M^F, \hat{w}_i, \mu_i \right) + \varepsilon$ 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 CDF of ε; this is the distribution from which quality is drawn for new matches. Let $F \left(\varepsilon' | \varepsilon \right)$ represent the conditional distribution for ongoing matches.

Standard arguments show that there exist thresholds $\left(\varepsilon^M, \varepsilon^D \right)$ 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

$$V_i^M \left(\mu_i, \varepsilon \right) = U_i^M \left(\mu_i, w, Y \right) \quad + \int_{\varepsilon^D} \varepsilon' F \left(\varepsilon', \varepsilon \right) d\varepsilon'$$
$$+ \beta \left[F \left(\varepsilon^D | \varepsilon \right) \left(V_i^S - d_c \right) + \left(1 - F \left(\varepsilon^D | \varepsilon \right) \right) V_i^M \left(\mu_i', w\varepsilon \right) \right] \quad (2)$$

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

$$V_i^S = U_i^S + \beta \left[\Phi \left(\varepsilon^M \right) V_i^S + \int_{\varepsilon^M} V_i^M \left(\mu_i, \varepsilon \right) d\Phi \left(\varepsilon \right) \right] \quad (3)$$

Define the gains from marriage, relative to divorce, as

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

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.

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 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.

The Egalitarian solution is defined as the μ that equalizes the gains from marriage. Hence μ^E solves:

$$W_H^D \left(\mu^E, \varepsilon \right) = W_W^D \left(1 - \mu^E, \varepsilon \right)$$

.

3.5.1 Example

Consider the log example where the indirect utilities of married and single people are as in the previous examples. Suppose that there are no divorce costs, and that ε is iid; the gains from marriage are then equal to the difference in indirect utility. With the egalitarian solution,

$$\mu_H = \frac{1}{1 + \widetilde{q}^a \widetilde{y}^b}$$

, where

$$\widetilde{y} = \frac{Y_W^s}{Y_H^s}, \widetilde{q} = \frac{q_W}{q_H}, a = \frac{\delta}{1 - \phi + \delta} \text{ and } b = \frac{1 + \delta}{1 - \phi + \delta}$$

.

. This says that the bargaining position of spouse j is summarized by the product of her relative taste for single life and her relative full income as a single. Notice that ε does not enter; this is because with the Egalitarian solution, factors that are common to both spouses drop out of the determination of μ. [4]

Relative leisure is a function of the Pareto weight μ, which depends on the relative wage through the ratio of full incomes when single. For the Egalitarian case, relative leisure is given by:

$$\widetilde{l} = \frac{1 - \mu}{\mu} \frac{1}{\widetilde{w}} = \widetilde{q}^a \frac{\widetilde{y}^b}{\widetilde{w}}$$

. Hence the elasticity of relative leisure with respect to the relative wage is:

$$\frac{\partial \ln}{\partial \ln \widetilde{w}} \widetilde{l} = \frac{\partial}{\partial \ln \widetilde{w}} \left[\ln \frac{\widetilde{y}^b}{\widetilde{w}} \right] = b \frac{\partial \ln \widetilde{y}}{\partial \ln \widetilde{w}} - 1 \tag{4}$$

This implies the elasticity of relative leisure with respect to the relative wage can be positive or negative. The model can therefore match the iso-leisure fact when $b = 1$.

3.6 Marriage-market 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 the marriage market.

Definition. A *recursive equilibrium* of the marriage market with progressive tax functions $T_i(y)$ and a given bargaining solution concept $B(W_H, W_W)$, consists of a pair of thresholds $\{\varepsilon^M, \varepsilon^D\}$, a Pareto weight μ, and for each household type $i \in \{M, SW, SM\}$, tax rates $\{T_i^M, T_i^A\}$ and value functions $\{V_i^M(\mu_i, \varepsilon), V_i^S\}$ such that:

---

[4] Note also that an increase in the tax penalty on wive's earnings causes μ to increase, because otherwise the increase in wive's leisure would increase her gains from marriage, violating the principle that equilibrium gains from marriage are determined by the relative utility of single life, which is unaffected by the tax.

1. The value functions solve the Bellman equations (**??**,3) 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: $\mu = B(W_H, W_W)$, where W_i represents the gain of spouse i from marriage, relative to divorce.

4. The optimal allocations generate, for each household type i, a level of taxable household income y_i such that $T'_i(y_i) = T^M_i$, and $T_i(y_i) = y_i T^A_i$

3.7 Comparative Statics of Marriage: A Special Case

To compute the marriage/divorce thresholds, we define the minimum value $\underline{\mu}^M_{-i}(\varepsilon)$ as the Pareto weight that leaves a single agent of sex i indifferent between marriage and single life: $W_i\left(\underline{\mu}^M_i, \varepsilon\right) = 0$. Similarly we can define $\underline{\mu}^D_i(\varepsilon)$ 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 $\underline{\mu}^M_i(\varepsilon)$ then we can find ε^M by solving $\underline{\mu}^M_W(\varepsilon^M) + \underline{\mu}^M_H(\varepsilon^M) = 1$. The divorce threshold ε^D is computed in a similar way. Of course if ε is iid then $\varepsilon^D = \varepsilon^M - 2d_c$. There are two reasons therefore in the model, why divorce rates are lower than $1 - \pi^M$; positive divorce costs, and persistence of ε.

In this section we consider a simplified version of the model in which all of these functions can be derived explicitly. The simplifications consist of assuming egalitarian bargaining with log utility, that marriage quality ε is iid, and that the divorce costs are zero. With these assumptions, we can solve the model easily because the dynamic components to the gains from marriage are equal for husband and wife, and so cancel out in the bargaining solution..

What matters then is the effect of marriage on flow utilities. Excluding the marital share and the match quality, this is:

$$
\begin{aligned}
\Delta_i &= U^M_i - U^s_i \\
&= K_{MS} + (1 + \delta) \ln \frac{Y^M}{Y^S_i} - \ln q_i - \delta \ln\left(1 - \tau^i\right)
\end{aligned}
$$

where $K_{MS} = \phi \ln \phi + (1 - \phi) \ln(1 - \phi)$. The minimum Pareto weight $\underline{\mu}_i$ is therefore:

$$
a = \frac{\delta}{1 - \phi + \delta} \, and \, b = \frac{1 + \delta}{1 - \phi + \delta}
$$

$$
\underline{\mu}_i = K \left(\frac{Y^M}{Y^S_i}\right)^{p_1} q_i^{p_0} \varepsilon^{-p_0}
$$

where $K = \exp\left(\frac{K_{MS}}{1-\phi+\delta}\right)$, $p_0 = \frac{\delta}{1-\phi+\delta}$, and $p_1 = \frac{1+\delta}{1-\phi+\delta}$. At the marriage threshold ε^M, it must be that $\underline{\mu}_W\left(\varepsilon^M\right) + \underline{\mu}_H\left(\varepsilon^M\right) = 1$. This implies that the marriage threshold is given by

$$\varepsilon^M = K^{\frac{1}{p_0}} \left[\frac{\left(Y_M^S\right)^{p_1} q_M^{p_0} + \left(Y_W^S\right)^{p_1} q_W^{p_0}}{\left(Y^M\right)^{p_1}}\right]^{1/p_0}$$

.If the joy of single life were equal across sexes, then threshold would proportional to it:

$$\varepsilon^M = K^{\frac{1}{p_0}} q \left[\frac{\left(Y_M^S\right)^{p_1} + \left(Y_W^S\right)^{p_1}}{\left(Y^M\right)^{p_1}}\right]^{1/p_0}$$

. This implies the higher is the income of singles, the lower the marriage rate. The effect of ϕ is to reduce the elasticity of marriage rates to relative income. When $\phi = 0$ we see that what matters for the marriage threshold is the ratio of income when single to income when married:

$$\varepsilon^M = K^{\frac{1}{p_0}} q \left[\frac{Y_M^S + Y_W^S}{Y^M}\right]^{1/p_0}$$

, where the elasticity is determined by $1/p_0 = \frac{1+\delta}{\delta} > 1$.

How do assumptions about home production determine the effect of wages on marriage rates? Suppose that $\phi = 0$ and that full income is composed of wage income, net of a fixed cost $\psi > 0$ of running a household and let the female wage be a given fraction α of the male wage.

Since the marriage rate is increasing in the ratio of income while married to income as singles, it is increasing in ψ :

$$\frac{Y^M}{Y_M^S + Y_W^S} = \frac{w_M(1+\alpha) - \psi}{w_M(1+\alpha) - 2\psi}$$

Furthermore, as average wages increase, marriage rates will also fall:

$$\frac{\partial}{\partial w_M}\left(\frac{Y^M}{Y_M^S + Y_W^S}\right) = \frac{1}{(w_M(1+\alpha) - 2\psi)}\left[1 - \frac{w_M(1+\alpha) - \psi}{w_M(1+\alpha) - 2\psi}\right] < 0$$

This is effect is central to the explanation by Greenwood and Guner (2004) of the decline of marriage since WW2.

Now suppose that the fixed cost is actually a time cost, and that it doesn't matter which spouse does the work. If $\psi < 1$ and the wife's time is cheaper at the margin than the husband's, we can write

$$\frac{Y^M}{Y_M^S + Y_W^S} = \frac{1 + \alpha(1-\psi)}{(1-\psi)(1+\alpha)} > 1$$

In this world, wage growth has no effect on marriage rates. What about a rise in α?

$$\frac{\partial}{\partial \alpha}\left(\frac{Y^M}{Y_M^S + Y_W^S}\right) = \frac{1}{1+\alpha}\left[1 - \frac{1 + \alpha(1-\psi)}{(1-\psi)(1+\alpha)}\right] < 0$$

So the closing of the gender gap in wages reduces marriage rates, even in a world where average wages have no effect. The size of this effect is unknown, but will be larger, relative to the effect of average wages, the easier it is to substitute equipment for time in the home-production function.

4   Home Technology

We assume a home production technology that is Cobb-Douglas in equipment and labor. Letting H be the labor input, and e_q the flow of equipment services, the technology is represented as

$$G\left(H, e_q\right) = e_q^{1-\theta} H^{\theta}$$

We would like a specification for technology that allows for zero inputs of labor, so that both singles and married can be modeled as operating the same technology. We represent this with a specification for the effective labor input of married couples that is CES in the individual inputs, and allows for changes in relative productivity:

$$H\left(h_W, h_H\right) = \left[z_W h_W^{1-\rho} + z_H h_H^{1-\rho}\right]^{1/(1-\rho)}$$

For singles of sex $i \in \{W, H\}$, effective labor input is $H\left(h_i, 0\right) = z_i h_i$.

The following results are easily demonstrated.

Lemma 2 *The optimal homework time of singles of sex i is*

$$h_i^S\left(w_i, p\right) = \frac{g_i^S}{z_i}\left[\frac{p}{w_i}\frac{\theta}{1-\theta}\right]^{1-\theta}$$

Lemma 3 *The cost of home production for singles is*

$$w_i h_i + p e_q = \left(g_i^S / z\right)\left[w_i^{\theta} p^{1-\theta}\right] k_S$$

, where $k_S = \left(\frac{\theta}{1-\theta}\right)^{1-\theta} + \left(\frac{1-\theta}{\theta}\right)^{\theta}$.

If we define a conversion factor A_m between male and female labor then the married results are particularly simple. Let

$$A_M \equiv \left(\frac{w_H}{w_W}\frac{z_W}{z_H}\right)^{-\rho}$$

Lemma 4 *For married couples, the optimal ratio of working time is given by*

$$\frac{h_W}{h_H} = \left(\frac{w_H}{w_W}\frac{z_W}{z_H}\right)^{\rho}$$

Then we can write $H = \kappa_M h_H$, where

$$\kappa_M = \left[z_W A_M^{1-\rho} + z_H\right]^{1/(1-\rho)}$$

the unit cost of H is therefore

$$\widehat{\omega} = \frac{w_W A_M h_H + w_H h_H}{\kappa_M h_H} = \frac{w_W A_M + w_H}{\kappa_M}$$

. This is useful because now we can write the results for married couples using the solution for singles . The Lagrangian for the married couple's problem is:

$$L = \widehat{\omega}H + pe_q + \lambda^M \left[g^M - e_q^{1-\theta}H^\theta \right]$$

.

Therefore the optimal aggregated home time H is given by

$$H(\widehat{\omega}, p) = g^M \left[\frac{p}{\widehat{\omega}} \frac{\theta}{1-\theta} \right]^{1-\theta}$$

. This implies

Lemma 5 *The optimal home labor time of the husband is*

$$h_H = \frac{H}{\kappa_M} = \frac{g^M}{\kappa_M} \left[\frac{p}{\widehat{\omega}} \frac{\theta}{1-\theta} \right]^{1-\theta} = \frac{g^M}{\kappa_M} \left[\frac{p}{\widehat{\omega}} \frac{\theta}{1-\theta} \right]^{1-\theta}$$

and that of the wife is

$$h_W = A_M h_H = g^M \frac{A_M}{\kappa_M} \left[\frac{p}{\widehat{\omega}} \frac{\theta}{1-\theta} \right]^{1-\theta}$$

.

The input demands are linear in the home constraint, but the relation to wages and the equipment price is quite complicated. The model therefore implies the following relations of parameters to observables:

1. The elasticity of home-work hours of singles to wages is $1 - \theta$

$$\frac{\partial}{\partial \log w} \log h_i^*(w_i, p) = 1 - \theta$$

2. The elasticity of the husband-wife work ratio to the wage ratio is ρ

$$\frac{\partial}{\partial \log w} \log \frac{h_W}{h_H} = \rho$$

5 Computation

The model's solution is computed using a standard numerical strategy. Given tax rates, wages and technology parameters, it is easy to solve the model directly for the optimal home-production decisions, as outlined above, and these in turn imply the full income by household type. Given preference parameters and the Pareto weight μ, it would be easy to compute the allocations of leisure and consumption of married household if the tax rates were constant. Unfortunately, with progressive taxation, the tax rate depends on the labor income of the household, and hence on

the leisure allocations. This 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 Pareto weight μ depends on the continuation values of married versus single, which in turn depend on the marriage and divorce thresholds $\left(\varepsilon^M, \varepsilon^D\right)$. The solution strategy is to solve for 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. This means that under the hypothesis that they describe marriage and divorce in the future, they are generated by the optimal marriage/divorce decisions today. The approximations to the value functions are then updated by recomputing the value of marriage at the new values of $\left(\varepsilon^M, \varepsilon^D\right)$. This procedure converges monotonically in the euclidean norm to a fixed point for $\left(\varepsilon^M, \varepsilon^D\right)$. At the fixed point, all of the equilibrium conditions hold, by construction. This procedure is explained in more detail in the appendix.

6   Understanding the Trends in Paid Work

We now calibrate the model with two different parameter sets: one to match statistics from 1975 and one to match statistics from 2003. We will refer to the pair of parameterizations collectively as the "benchmark" model, and will use it to answer the questions posed in the introduction.

The overall calibration of the model can be divided into three phases. First there is the calibration of the home technology, then the preferences over leisure, and finally the marriage-market equilibrium. Due to the separability between leisure and home-production allocations in the model, the home-technology phase does not require information about preferences or marriage-market equilibria. These parameters are therefore set to make the model match statistical targets concerning time spent in home production by family type. The calibrated technology converts wage observations into measures of full income y by household type, net of home production costs. This in turn allows us to compute the share of spending on leisure for each household member; the total spending implies a value for the preference parameter δ. In the case of married couples, the ratio of leisure spending on each spouse reveals the required value of the husband's Pareto weight μ required to match the leisure allocation. In this way we arrive finally at the indirect utility flow for each type of household.

That leaves the marriage-market calibration. We shall require the model's equilibrium to match some measures of flows in and out of marriage, as well as the relative leisure l_W/l_H.

6.1   Reconciliation of time-use survey to CPS Hours

The calibration targets for married-couple's hours are taken from Table 4, discussed previously. Since the object of the analysis is to analyze the trends in paid hours in the CPS data, the first

step is to reconcile paid work hours in the time-use data with those in the 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 reallocation rule is proportional; where the time surveys report an excess of paid hours, the fraction allocated to unpaid work equals the ratio of unpaid to paid work. These adjustments are mostly quite small, except that paid work is 3.5 hours too high for husbands in 1975 in the time-use surveys, and 4 hours too for single men in 2003. The table also breaks down unpaid work into two categories: home production, and work-related time, which involves commuting and unpaid time at work, such as meals. The hours in this table will now be used to calibrate the model.

6.2 Home Technology

To calibrate the home technology, consider the expenditure share of home equipment. 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. [5] The target for the model is an expenditure share equal to 5.0%. This is used to pin down $\theta = 0.924$, the labor share in home technology.

We saw earlier that the home-production technology implies that the elasticity of the husband-wife work ratio to the wage ratio is ρ, which we set by using cross-sectional data (assuming away marital assortment on z). We showed above that the elasticity of the husband-wife work ratio to the wage ratio equals ρ. This cannot be estimated directly on the 2003 time-use data because there is only one time-use questionnaire per household. However since the survey is linked to the CPS, we can impute the spouse's home labor by projecting home labor time in the ATUS on the CPS variables. Using this imputed measure of the spouse's home labor, the estimated elasticity is $\rho = 0.86$ when controlling for employment status of the spouses and age. As a robustness check, we can carry out a direct estimation on the 1985 survey, which has a small, non-representative husband-wife component with reports of home hours for both spouses. The parameter estimate turns out to be $\rho = 0.83$. When not controlling for employment status, the elasticity estimate falls, but only 0.77. The estimates are so close, there is hardly a need to choose between them, so we take the central estimate and set $\rho = 0.83$. The full results tables for these regression exercises are shown in Table A2.

The parameter values for the home technology are summarized in Table 5. We normalize $z_H = 1$ in both years. Given the values for (θ, ρ, z_H), we set z_W in each period to match the husband-wife work ratio h_W/h_H. The remaining technological parameters are the home-production levels. These

---

[5]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.

are set so that the model matches the home time averages for 1975 and 2003. For married couples the values $g_{1975}^M = 41.98$ and $g_{2003}^M = 12.78$ solve the inversion of the home constraint:

$$g_t^M = \widehat{h}_{Wt} K^\theta \left(\frac{1-\theta}{\theta} \left(\frac{w_{Wt} + w_{Ht} A_{Mt}}{p_t} \right) \right)^{1-\theta}$$

. Similarly for single men, the levels are $g_{1975}^H = 0.085$ and $g_{2003}^H = 0.115$, while for single women, we get $g_{1975}^W = 0.289$ and $g_{2003}^W = 0.199$. This rise in g^H allows the exercise to account for the failure of h_M^S to fall over time as a shift in tastes for housework on the part of single men.

The match between targets and model results for this parameter set is shown in Table 6. The only mismatch occurs for the home-equipment share of consumption expenditure, which in the model increases slightly, from 4.1% to 4.3%, while in the data it declines slightly, from 5.6% to 4.6%. Further work is needed to clarify the reasons for the mis-match, but given the small share $1 - \theta$ of equipment in production, resolving this is unlikely to affect the results qualitatively.

This technology implies that a household incurs a fixed cost largely in terms of labor time. In Greenwood and Guner (2004), households are subject to a non-substitutable pecuniary fixed cost that is set to 13% of the male wage in 1950, in addition to whatever home production takes place. This implies considerable economic gains from marriage. According to the BLS, real compensation per hour worked roughly doubled between 1950 and 1975, which would suggest a fixed cost for singles of 6.5% of the real wage in 1975, while for married household it would be 13%.[6]

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.

For each household type, the wage plus the average hours spent on home production, is used to compute the cost of home production, given the parameters of the home production function, ρ, θ, z_F. This is done on the basis of the net wage, which equals the gross wage, less the cost of working t_n. This cost in turn equals the average time spent in unpaid work-related activities, as reported in Table 5 for the two calibration years, 1975 and 2003, which implies $t_n = 0.18$ in 1975 and 0.11 in 2003.[7]

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

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[6]The series is title Nonfarm Business Sector: Real Compensation Per Hour (COMPRNFB), and is available at the FRED data bank of the St,. Louis Fed. The URL is http://research.stlouisfed.org/fred2/series/COMPRNFB/

[7]As unpaid hours data is not available from the CPS, it is not possible to report an annual series.

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 or by exclusion from the sample of the older population, which is likely to have a particularly high share of non-labor income.

Full income Y of the household is set equal to the sum of the wage and non-labor income for the head, and where present, the spouse, less the cost of home production and the fixed cost of households, as represented by the parameter ξ.

The tax function is taken from Guner, Kaygusuz, and Ventura (2008). This is a two-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 1970 and 2000 to IRS data on average tax rates by income of the household and filing type. [8] 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 short-run phenomenon, following on from an equally short run-up in tax rates in the 1970s.

6.3 Preferences

From 1975 to 2003, the expenditure share of leisure declined for married couples. To match this, we turn to separable CES preferences; for each spouse i in a marriage, utility is given by:

$$u(c_P, c_i, l_i) = \phi \frac{c_P^{1-\sigma} - 1}{1 - \sigma} + (1 - \phi) \frac{c_i^{1-\sigma} - 1}{1 - \sigma} + \delta \frac{l_i^{1-\sigma} - 1}{1 - \sigma}$$

. Under these preferences, the expenditure share of leisure for married couples is given by

$$\frac{w_W l_W + w_H l_H}{Y_M^T (1 - T^A) - pe_q} = \delta^{1/\sigma} \frac{B(\mu)}{A(\mu)}$$

, where

$$A(\mu) \equiv \phi^{1/\sigma} + \left[(1 - \mu)^{1/\sigma} + \mu^{1/\sigma} \right] (1 - \phi)^{1/\sigma}$$

$$B(\mu) \equiv \left(\frac{1 + t_n}{1 - T^M} \right)^{1/\sigma} \left[w_W^{1-1/\sigma} (1 - \mu)^{1/\sigma} + w_H^{1-1/\sigma} \mu^{1/\sigma} \right]$$

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[8] 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

, and T^M and T^A are the marginal and average tax rates, respectively. As we saw earlier, given σ, the Pareto weights μ are pinned down by the observed leisure ratios and wages:

$$\mu = \frac{1}{1 + \frac{w_W}{w_H}(l_W/l_H)^\sigma}$$

With $\phi = 0.5$ set arbitrarily, it requires $\sigma = 0.79$ and $\delta = 1.24$ to match the expenditure share of leisure each year.

Non-working time is significantly higher in the data for singles than for married people; on average, singles get 70 hours of weekly non-working time, compared to as low as 60 hours for married men in 2003. To ensure that the model matches the leisure share of expenditure for each household type in *each* year, we adjust the ratio of non-labor income to full labor income for the single households, and then offset the effect on utility so that this adjustment cannot affect marriage/divorce decisions. The actual and adjusted ratios are reported below in Table 7. By construction therefore, the calibrated model will match the time allocations of singles and leisure-expenditure shares of married.

6.4 Bargaining and the marriage-market

For any given year, the aggregate output of the marriage-market model consists of marriage rates π^M, divorce rates π^D, and the relative leisure l_W/l_H. The marriage-market calibration involves setting some parameters arbitrarily and then setting the remaining free parameters so that the model output matches the empirical analogs.

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. This ensures that the hazard rates are consistent with the population fractions. The resulting estimates are:

	1975	2003
π^M	0.0929	0.0458
π^D	0.0249	0.0178

.

The free parameters of the marriage model are set so that the steady states of the model match the marriages rates for both years, the divorce rate for 1975 , and the relative leisure of spouses: 1.03 for 1975 and 1.02 for 2003. The parameters in question are the joy of single life (q_m, q_f),the divorce cost d_c, and the weight α the model puts on the bargaining solution versus a fixed Pareto weight. We compute for a given marriage both the egalitarian solution μ^E and a "fixed" Pareto weight μ^F that is allowed to change only if required for a marriage with positive surplus to form or continue, as in models of limited commitment, such as Thomas and Worrall (1988). The husband's pareto weight is thus given by the sum: $\mu = \alpha\mu^E + (1 - \alpha)\mu^F$. The value of μ^F is set to 0.588, the average of that required for matching relative leisure in each of the calibration years, so this

procedure yields a natural measure α of the distance from the unitary model required to match the statistical targets.

The other parameters, whose values are fixed arbitrarily, are the share of public goods in utility, set to $\phi = 0.1$ σ_ε the standard deviation of marriage quality ε, set to 1.0, .and the persistence ρ of match quality, set to 0.95. The high persistence is required to allow divorce rates to fall when marriage rates rise.

7 Results

The calibration procedure results in a tight fit between model and data for the two years, as is easily seen in Table 9, which reports the marriage and divorce rates and the allocations of leisure and paid work across household types. The parameters that generated this are shown in Table 8. The most interesting of course is the weight $\alpha = 0.361$ that the model puts on the bargaining solution, which shows that the calibration requires a sharp deviation from the unitary model assumption.

Figure 5 compares the time series in the data with a synthetic-trend prediction from the model. The synthetic trend combines inputs from time series data, such as wages, equipment prices and non-labor income, with piecewise linear trends for inputs whose values are only available at a few points in time, such as tax-rate coefficients, which are based on the work of Kaygusuz (2010), and the home-productivity parameters, which are generated in the Benchmark model for 1975 and 2003. The model is solved for time-allocations in each year, conditional on these exogenous variables. The results in panel (a) shows that the synthetic and empirical trends for paid weekly hours of married couples are roughly in sync; deviations are naturally smallest at the endpoints and largest in the middle years, a pattern that is echoed in panel (b), where the deviations appear larger for the single-women households. The overall changes are of course accurately reflected by the calibration, while the deviations, driven in part by the arbitrary interpolation of the forcing variables, are without consequence for the exercises in comparing steady states that follow.

7.1 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 variables and parameters are fixed at the values for the 1975 benchmark, except for the variables that particular experiment is concerned with; these variables are set to their values in the 2003 benchmark.

Each column for Table 10 reports the values for 2003 that would have held had the variable in the column title been the only change between the two periods. The net change in the outcome of a given row between 1975 and the experiment column is therefore a measure of the importance of the variables in question for explaining time-allocation trends. To assess the importance of bargaining and home production for the result, the experiments are repeated in Tables 10(b) and 10(c); in

Table 10(b), the pareto weight μ is held constant, and in Table 10(c), the home-production inputs are held constant. In the Relative Wage experiment, the husband's wage is held constant at the 1975 level, and the wife's raised so that the wage ratio is the same as in 2003. In the equipment price experiment, the price drops from the 1975 value to the 2003 value. In the Income Tax column, the parameters governing the taxes paid by married and single are replaced by those for 2003. In the Wage and Income Growth experiment, the relative wage is held constant at the 1975 ratio, but the observed growth of hourly compensation is imposed, so that the husband's wage matches the 2003 value, while the wife's is lower. Non-labor income is set to match the observed increase in non-labor income from the CPS.

In all three tables the first column of results, labelled 1975, is identical, and represents the benchmark calibration for that year. In Table 10(a) the column labelled '2003' similarly indicates the benchmark calibration for that year, while in the following tables, it represents the effect of holding either the Pareto weight (Table 10(b)) or the home-time allocation (Table 10(c)) constant, evaluated at the benchmark's parameter values for 2003 . Comparing across these three tables, the '2003' columns reveal that abstracting from bargaining is a much more serious problem than abstracting from home production. In Table 10(b), women's labor supply soars to more than 10 hours above the Benchmark level of 23.2 hours, while in Table 10(c), holding home-time constant is shown to have an impact on the order of 15 minutes on weekly paid hours. Since the reasons for the impact of bargaining have been discussed in the theory section, it suffices to note that despite the fact that the calibrated model allows for a much more articulated model, and a much larger set of driving forces, the impact of bargaining is of the same order of magnitude as in the rough calculations made earlier with the simplified example.

7.2 Explaining The Trends in Married-Couple's Time Allocations

On its own, the rise in women's relative wage can explain 77% of the increase in married-women's labor supply, a shift of more than 7 hours weekly, and wage growth (holding the relative wage constant) can explain 52%, a shift of 4.8 hours. By contrast, the decline of the equipment price accounts for 33% of the increase in married-women's labor supply, and tax reform can account for 26%. All four of these potential explanations turned out to be quantitatively important, and qualitatively consistent with the work of Jones, Manuelli, and McGrattan (2003) in the first case, Greenwood and Guner (2004) in the next two, and with respect to taxes, Eissa (1995) and the rapidly growing literature summarized in Kaygusuz (2010).

In light of the fact that Greenwood and Guner (2004) assume away the leisure margin, it is interesting to note that the calibration implies that of the 4-hour decline in married-women's home hours generated by the declining equipment price, only about 15% is lost to a rise in leisure (comparable to working costs , which consume about 11% of the liberated time). However the equipment price fall causes husband's home production time to fall by more than an hour, instead of increasing as in the data, which results in a 7 hour discrepancy relative to 2003. So the rise in

husband's hours is working to limit the role of the equipment price in the calibration.

7.3   How important is bargaining?

In Table 10, the columns labelled '2003' allow us to compare the unitary and collective versions of the model, so as to measure the impact of bargaining on the results at the macro level. Its quite clear from comparing the two tables that the impact of bargaining on the wife's labor supply is by far the greatest in the analysis of relative wages. Paid work for the wife rises nearly 9 hours more than in the benchmark, so the impact of relative wages accounts for almost all (90%) of the discrepancy between the unitary and the bargaining version of the model.

In the simple examples, it was shown that a stable relative-leisure ratio was consistent with a model where bargaining offset the impact of the change in the relative wage. The results for non-working time in Table 10(a) show that the story is not so simple in the calibrated model; the ratio of wife's to husband's non-working time actually falls from 1.03 to 0.93 in response to the rise in the wife's wage. Table 10(b) shows that this decline would have been much larger in the unitary version of the model, so bargaining clearly has a large bite here, but it is not enough to explain the stability of the relative-leisure ratio. Table 10(a) shows that the ratio tends to be driven up by economic growth, which on its own would have driven relative leisure up to 1.10. It is clear from Table 10(b) that this effect mostly operates through bargaining, as the ratio here falls to 1.05. This is the result of concavity of the utility function, which implies that growth has a stronger effect on the welfare of single women than on that of single men. [9] As with the relative wage, the key is the elasticity of the pareto weight to the outside option.

Even at the most aggregate level, intra-household bargaining appears to play a significant role. The first row of Table 12, derived from Table 10(a), shows that the average paid-labor supply of married people rises in the benchmark model from 24.1 weekly hours to 29.5. The experiment columns show that the relative wages,. the equipment price and the income tax reform seem to be equally important on their own, each generate an increase of roughly 2.5 hours. However the middle rows, based on Table 10(b), shows that with a constant Pareto weight, paid work per couple rises by 5 additional hours, all of which is driven by the response to relative wages. The unitary version of the model as we saw already gets this wrong in terms of relative work hours, but here we learn that it also gets the average work hours seriously wrong, which has strong implications for per-capita hours, as Figure 1 made clear.

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[9]The CPS results in Table 7 imply non-labor income fell from 13.7% of labor income to 8.4% for single women on average, while it remained constant for single men at 8.3% . Therefore the growth result is not driven by disparities in the growth rates as these have an opposing effect.

7.4 Explaining the Decline of Marriage

Over the period 1975-2003, the annual marriage rate per single women fell from 9% to 4.5%. The divorce rate per marriage also fell, from 2% to 1.8%. Can the model's experiments shed light on the causes of the marriage-rate decline? Column 2 of Table 11 shows that the model can explain a decline from 9.1% to 6.4% per year; about 60% of the total decline in marriage. Three elements in the calibration are required for this; a high persistence of marriage quality ($\rho = 0.95$), a low share of public goods in marriage ($\phi = 0.1$) and high fixed cost of establishing a household ($x = 0.15$). The first row shows that income and wage growth on its own can explain 50% of the observed decline in the marriage rate.

Convergence of the relative wage explains about 20% of the total decline in marriage in the model; this is obviously much less important than growth, but far more important than the effects of the equipment-price trend or the tax reforms; the former reduces marriage rates by 2%, while the effect of the tax reform is to increase marriage rates very slightly, by about 4%. In Greenwood and Guner (2004), the fall in equipment price plays a more important role in the decline of marriage than it does here. The difference may well be due to the time period considered; they analyze events since 1945, while the analysis here begins in 1975. As we saw earlier, the relative stability in the home hours of single persons over the later period limits the role that can be assigned to technology-based arguments such as the price trend.

The middle rows show the impact on marriage rates of the same changes when the bargaining is shut down (μ is constant). The marriage rate in the benchmark model falls an additional 1.6 percentage points, down to 4.8%. The impact of the equipment-price trend and the tax reforms are now much larger; the former drives the marriage rate down a further two percentage points to 7.1%, while the latter, now causes the marriages rate to fall 2 points, instead of gaining a half point.

The model appears to have no problem accounting for the decline in divorce rates; with high persistence, the quality of married couples is higher when marriage rates fall, so the divorce risk is correspondingly lower.

Abstracting from bargaining therefore not only increases the apparent instability of marriage[10], but also severely distorts the marriage-decline story, giving a spuriously high importance to tax reform and the equipment price trend and making each of these causes look more important than the effect of wage convergence.

7.5 Discussion

The bargaining model proposed here relies on a bargaining solution with divorce threat-points, but the same argument could apply to other bargaining models, provided that the bargaining positions

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[10]Recall that what is meant by 'constant μ' here allows the Pareto weight to shift if required to ensure efficient marriage or separations. Therefore the effect of fixing μ does not in itself cause inefficient marital outcomes.

of the spouses are increasing in their own wages. 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 (2008), which argues that by adding utility for children to the model, and the assumption that the costs of children are largely in terms of the parent's time, the model can replicate the rise in single women's fertility and the decline of married people's share of births.

8   Conclusion

Standard explanations of rising female labor supply have strong implications for husband's time allocations that have not been explored. In particular, both the closing of the gender wage gap and rising home productivity imply that the leisure of husbands should be increasing strongly relative to that of wives. Time-use data in the US suggest that this is not so, and this is consistent with other work which argues that relative leisure around the world is independent of relative wages. 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 analysis also identified a new mechanism for explaining marriage decline, through the closing of the gender gap in wages. While the calibrated model suggests economic growth is the main cause of the decline in marriage rates over the period 1970-2003, the effect of relative wage convergence generates about 20% of decline in the model.

Are macro-economists mistaken in ignoring bargaining between spouses? Quantitatively, the impact of allowing for household bargaining turned out to be very large at the level of labor supply by sex, on the order of 10 weekly hours, nearly 30% of married-men's (paid) labor supply. Even at the most aggregate level, the over-prediction of per-capita labor supply resulting from re-allocation of leisure was significant, amounting to about 2 weekly hours, or 40% of the change since 1975. Of the four exogenous shocks studied here, the importance of bargaining effects turned out to be at

least as large as those driven by the time allocated to home production in all except for the case of the equipment price trend. This suggests that household bargaining, which is the subject of a mere handful of macro papers, may be at least as important for understanding labor supply as home production, which has been a major topic in macro for twenty years. Abstracting from bargaining was also seen to distort the analysis of the marriage-rate decline, exaggerating particularly the role of the equipment-price trend.

The integration of marriage and home-production into a model of intra-household allocation was essential for the insights presented here. Since singles are likely to transit into marriage, the effect of higher wages on the allocation of leisure cannot be determined without taking into account the effect on the value of being single, relative to married, which is determined in the marriage-market equilibrium. The labor supply of married men, which has been largely neglected because of the very stability we analyze here,therefore turns out to be informative about the types of model, and ultimately, the types of explanations, that can account for the trends in married-women's labor supply and in marriage rates.

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Years	Sample		Weekly Hours	Per-Capita
1962-66	Women	Single	24.22	
		Married	11.79	25.24
	Men	Single	25.71	
		Married	39.44	
1967-75	Women	Single	22.54	
		Married	13.76	25.37
	Men	Single	24.52	
		Married	38.60	
1976-85	Women	Single	23.07	
		Married	16.73	25.45
	Men	Single	25.13	
		Married	35.74	
1986-96	Women	Single	24.89	
		Married	21.36	27.69
	Men	Single	27.20	
		Married	36.20	
1997-2001	Women	Single	25.95	
		Married	23.47	29.01
	Men	Single	28.22	
		Married	37.30	
2002-2006	Women	Single	24.67	
		Married	22.97	27.84
	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
	Less than 12	1.08	1.02	1.08	1.01
Years of	12 Years	1.06	1.14	1.03	1.06
Education	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	21.42	27.47	26.30	15.51	14.31	38.73	35.23
Job-Related	3.72	3.86	4.86	4.73	2.72	2.58	6.48	6.34
Home Production	24.27	23.05	9.82	10.13	34.27	35.10	11.49	12.29
Total Work	47.23	48.33	42.15	41.16	52.49	51.98	56.7	53.86
Non-Working Hours	70.77	69.67	75.85	76.84	65.51	66.02	61.3	64.14
Time-Survey Freq.	250		149		719		671	
CPS Population Share	12.12		13.87		37.78		36.23	
1985								
Paid Work	24.17	24.36	29.02	26.30	18.24	18.97	36.26	36.02
Job-Related	4.62	4.38	5.3	4.73	3.23	3.41	6.21	6.48
Home Production	21.01	20.92	12.13	12.93	32.82	32.35	15.29	15.36
Total Work	49.8	49.67	46.45	43.97	54.28	54.74	57.76	57.86
Non-Working Hours	68.2	68.33	71.55	74.03	63.72	63.26	60.24	60.14
Time-Survey Freq.	719		559		1158		990	
CPS Population Share	16.51		18.02		33.47		31.99	
2003								
Paid Work	24.83	24.59	30.28	26.40	22.54	23.05	38.87	35.94
Job-Related	2.64	2.70	3.68	2.90	2.08	2.54	4.1	3.95
Home Production	20.53	20.64	11.88	12.97	30.74	30.45	16.59	17.47
Total Work	47.99	47.93	45.83	42.28	55.35	56.03	59.57	57.36
Non-Working Hours	70.01	70.07	72.17	75.72	62.65	61.97	58.43	60.64
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.

Value		Parameter
1975	2003	
0.115	0.081	Home Production single male g^H
0.215	0.289	Home Production single female g^{SW}
42.145	16.191	Home Production married g^M
1.752	1.256	Womens Home Productivity z_W
0.924		Home-Labor share of output θ
0.83		Substitutability of spouse's home labor ρ

Table 5: *Technology parameters for benchmark Model*

Weekly Hours in Home Production

1975		2003		
Model	Data	Model	Data	
35.1	35.1	30.45	30.45	wifes home time
12.29	12.29	17.47	17.47	husbands home time
24.75	24.75	22.29	22.29	single womens home time
11.67	11.67	14.67	14.67	single mens home time
0.04072	0.056	0.04271	0.046	equipment share

Table 6: *Home production model results and empirical targets.*

Household type	1975			2003		
	Leisure/Y	Non-LabInc/Y_FL		Leisure/Y	Non-LabInc/Y_FL	
		CPS	Model		CPS	Model
Married	68.1%	4.6%		63.5%	7.3%	
Single Male	71.9%	8.3%	12.5%	71.3%	8.3%	30.1%
Single Female	76.0%	13.7%	26.5%	72.9%	8.4%	27.2%

Table 7 : Expenditure share of leisure and Non-Labor Income as a fraction of full earnings. Computed from CPS. Income in model is adjusted so that model matches expenditure share of leisure by household type.

Value	Parameter
Calibrated parameters	
0.84	female/male joy of single life
2.3	level of joy of single life
1.2	divorce cost
0.36	weight on Egalitarian solution
Normalized parameters	
1	std. deviation of marriage quality
1.817	leisure utility: delta
0.1	public goods share of utility

Table 8: *Benchmark-Model parameter set*

1975		2003		Statistic
Data	Model	Data	Model	
0.093	0.093	0.046	0.064	marriage rate
0.025	0.025	0.018	0.015	divorce rate
1.029	1.031	1.022	1.016	non-working time: wife/husband
66.02	65.58	61.97	61.66	non working time: wives
64.14	63.63	60.64	60.68	non working time: husbands
14.30	14.18	23.05	23.23	paid working time: wives
35.23	35.03	35.94	35.79	paid working time: husbands
67.98	67.98	68.41	68.41	non working time: single women
75.29	75.29	74.03	74.03	non working time: single men
21.42	21.37	24.59	24.55	paid working time: single women
26.30	26.29	26.40	26.37	paid working time: single men

Table 9: *Empirical targets and results for benchmark calibration.*

Variable	Benchmark Model		Experiments			
	1975	**2003**	**Relative Wage**	**Equip. Price**	**Income Tax**	**Wage and Income Growth**
paid working time: wives	13.748	23.164	20.965	16.568	16.200	13.970
paid working time: husbands	34.612	35.836	32.114	36.701	37.204	37.808
non-working time: wife/husband	1.030	1.018	0.929	1.057	1.036	1.099
home-production time: wives	35.100	30.450	32.003	31.240	34.978	34.272
home-production time: husbands	12.290	17.470	14.063	10.939	12.247	12.000
non working time: wives	66.041	61.738	60.651	66.597	63.319	66.653
non working time: husbands	64.104	60.637	65.309	62.998	61.105	60.638

Table 10 (a): Benchmark Results; *Computational Experiments in Benchmark model,.*

Variable	Benchmark Model		Experiments			
	1975	**2003**	**Relative Wage**	**Equip. Price**	**Income Tax**	**Wage and Income Growth**
paid working time: wives	13.748	36.566	29.134	16.626	15.489	15.538
paid working time: husbands	34.6116	31.843	27.408	36.643	37.447	37.168
non-working time: wife/husband	1.0302	0.720	0.720	1.055	1.055	1.056
home-production time: wives	35.1	30.443	32.003	31.240	34.978	34.272
home-production time: husbands	12.29	17.466	14.063	10.939	12.247	12.000
non working time: wives	66.0414	46.869	51.012	66.529	64.158	64.801
non working time: husbands	64.1037	65.073	70.862	63.066	60.818	61.392

Table 10(b): *Computational experiments with Pareto weight held constant.*

Variable	Benchmark Model		Experiments			
	1975	**2003**	**Relative Wage**	**Equip. Price**	**Income Tax**	**Wage and Income Growth**
paid working time: wives	13.748	22.577	18.497	15.857	16.103	13.109
paid working time: husbands	34.6116	40.439	33.671	36.758	37.173	37.727
non-working time: wife/husband	1.0302	0.951	0.927	1.033	1.036	1.106
home-production time: wives	35.1	35.100	35.100	35.100	35.100	35.100
home-production time: husbands	12.29	12.290	12.290	12.290	12.290	12.290
non working time: wives	66.0414	57.745	60.489	63.603	63.313	66.846
non working time: husbands	64.1037	60.702	65.232	61.589	61.099	60.446

Table 10(c) *Computational experiments with home production held constant.*

Variable	Benchmark Model		Experiments				Outcomes held constant
	1975	**2003**	**Relative Wage**	**Equipment Price**	**Income Tax**	**Wage and Income Growth**	
marriage rate	0.091	0.064	0.084	0.090	0.096	0.068	
divorce rate	0.026	0.015	0.023	0.025	0.025	0.018	
marriage rate	0.091	0.048	0.079	0.071	0.076	0.056	Pareto Weight
divorce rate	0.026	0.016	0.024	0.026	0.026	0.018	
marriage rate	0.091	0.063	0.084	0.090	0.096	0.068	Home Time
divorce rate	0.026	0.015	0.023	0.025	0.025	0.018	

Table 11: **Marriage and Divorce Rates:** *in Benchmark and in Computational Experiments.*

Statistic	Benchmark Model		Experiments				Outcomes held constant
	1975	**2003**	**Relative Wage**	**Equip. Price**	**Income Tax**	**Wage and Income Growth**	
Average Paid Hours		29.50	26.54	26.63	26.70	25.89	
Share of Total Change		1.00	0.44	0.46	0.47	0.32	
Average Paid Hours	24.18	34.20	28.27	26.63	26.47	26.35	Pareto Weight
Share of Total Change		1.88	0.77	0.46	0.43	0.41	
Average Paid Hours		31.51	26.08	26.31	26.64	25.42	Home Time
Share of Total Change		1.38	0.36	0.40	0.46	0.23	

Table 12: *Average paid work hours of Married Couples*
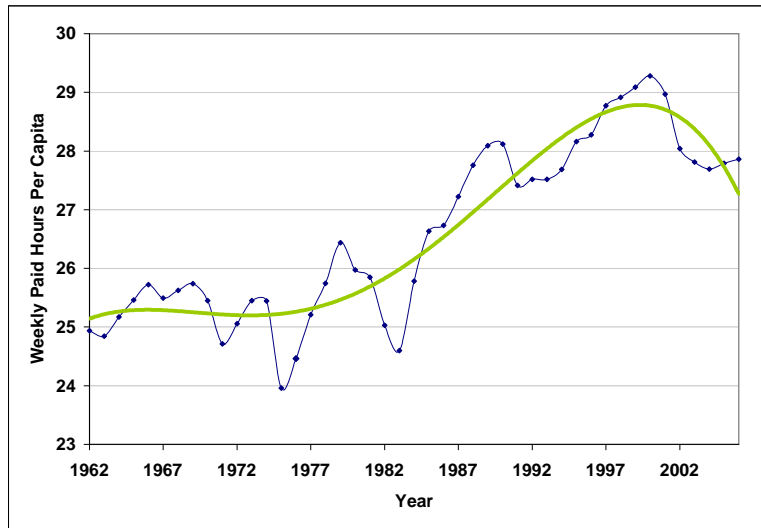
Figure 1(a): *Per-capita hours in the March CPS.* Based on author's computations from reported hours worked in previous week by persons aged 18-65. With fitted quartic trend line.
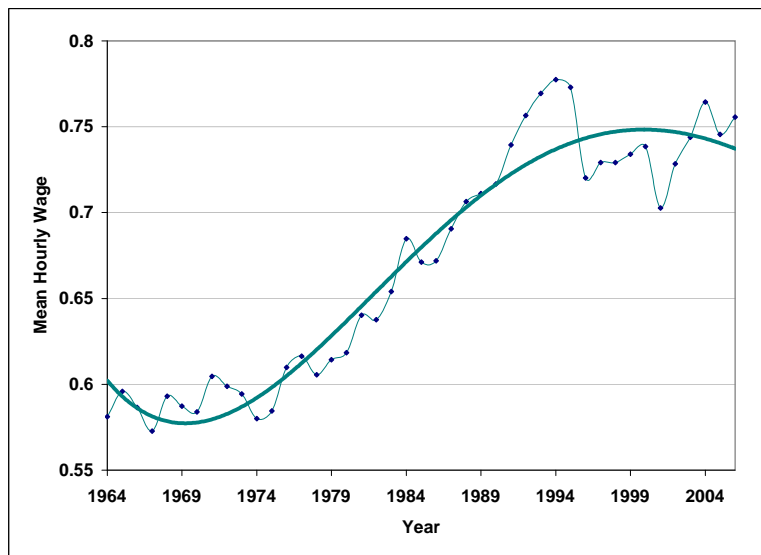

Figure 1(b): *Ratio of Mean Wages of Men to those of Women.* Author's computations from the March CPS for population 18-65 years old working 10 hours or more weekly at paid employment
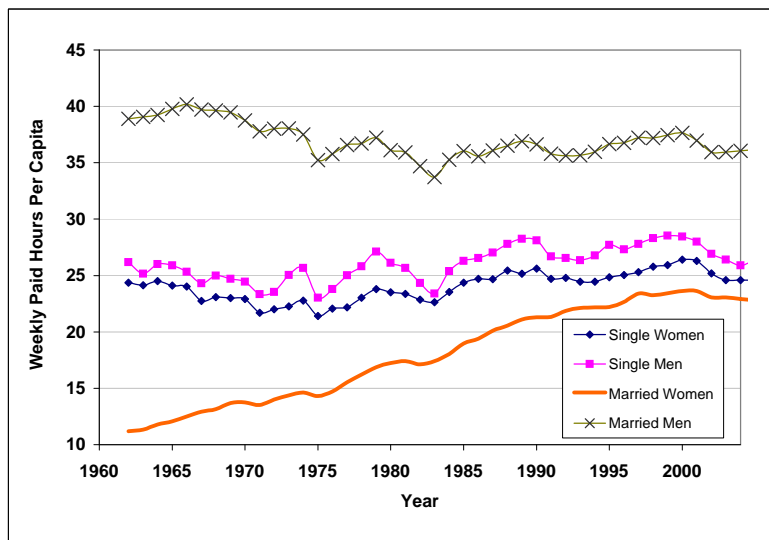

Figure 1(c): *Per-capita hours by sex and marital status.* Based on author's computations from March CPS, persons aged 18-65
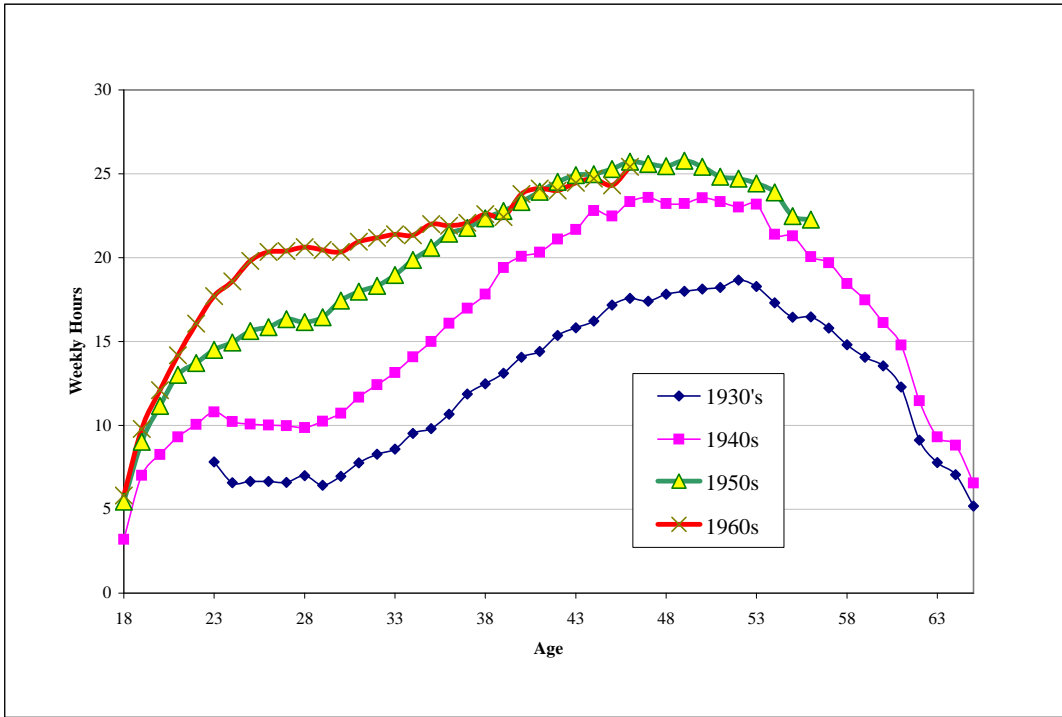
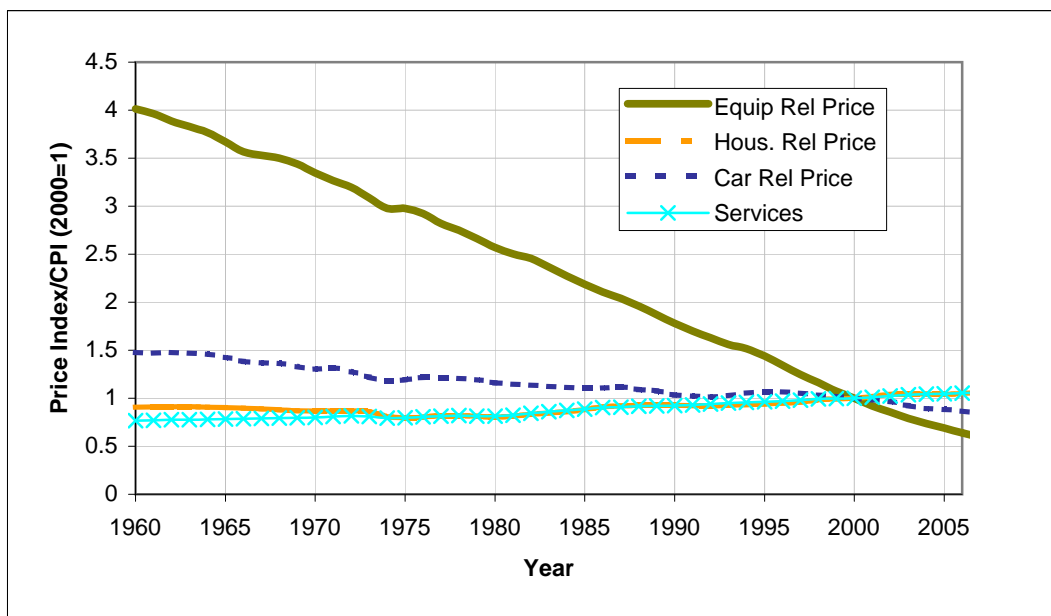Figure 2a: Weekly Paid Hours of Married Women by Birth Cohort in the March CPS
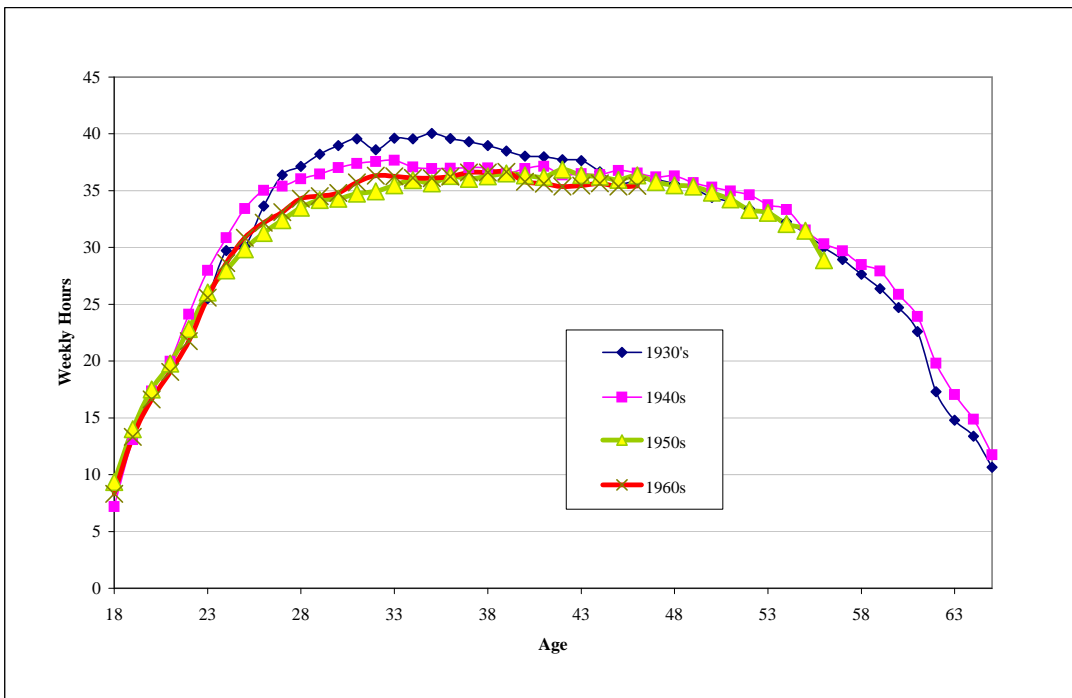
Figure 2b: Weekly Paid Hours of Married Men by Birth Cohort in the March CPS
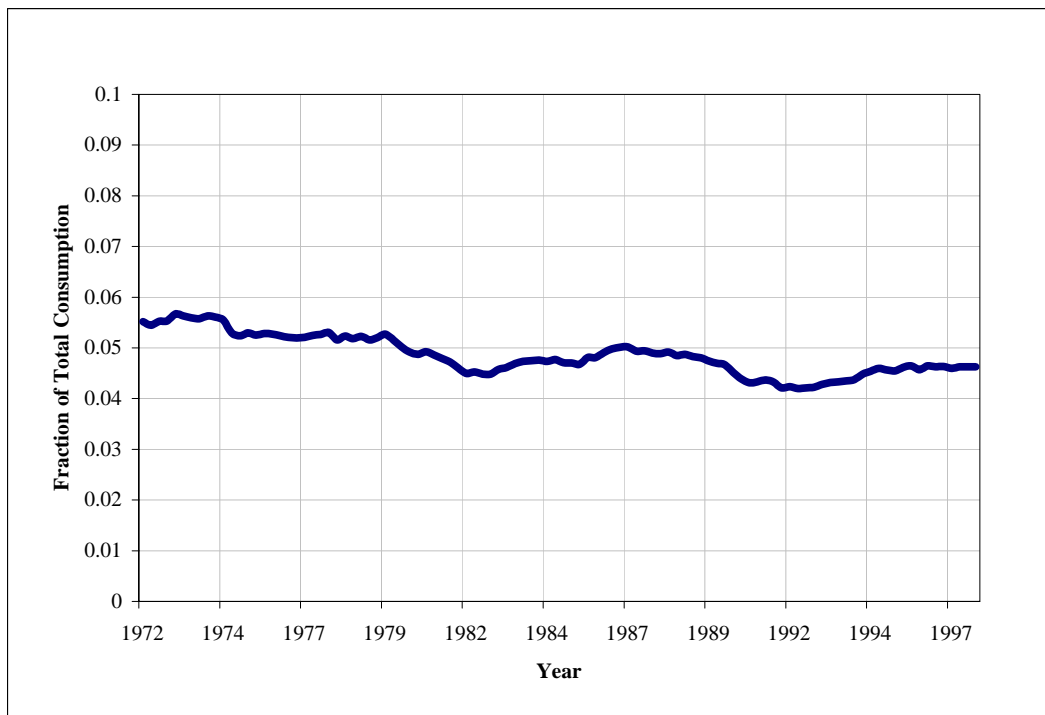
Figure 4(a): *Spending share of Home Equipment in the NIPA* , 1972-1997. Source: BEA Table
2.3.3. Real Personal Consumption Expenditures by Major Type of Product, Quantity Indexes

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
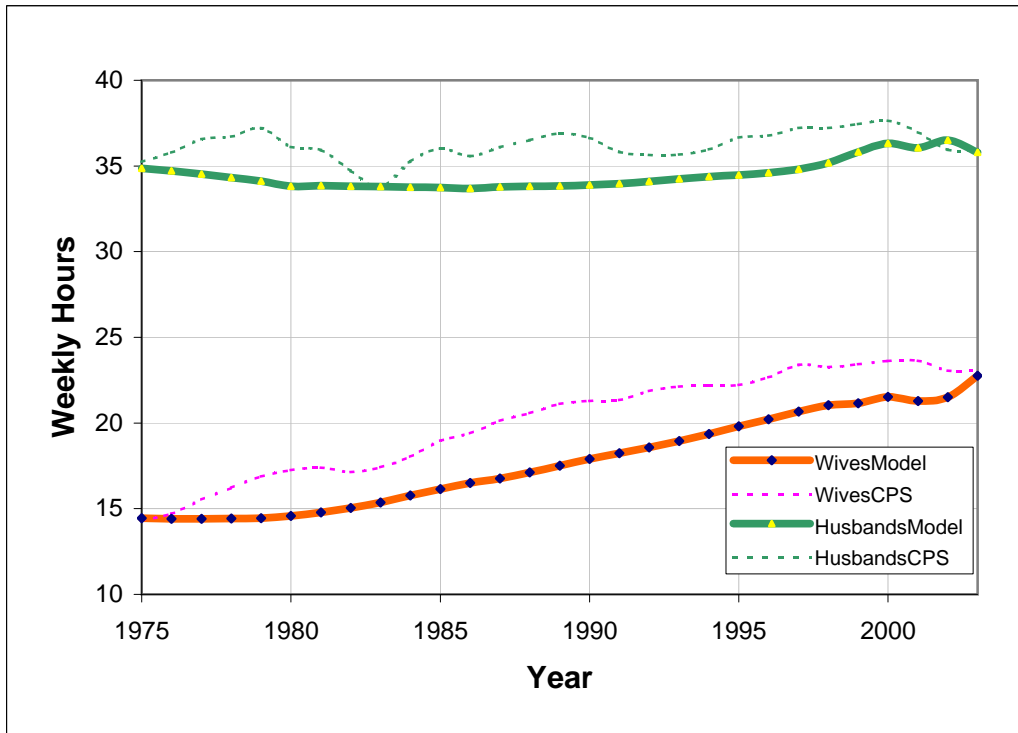
Figure 5(a): *Predicted and Actual Paid work of Married Couples.* Dashed lines from March CPS; thick lines from Benchmark model fitted with piecewise-linear trends
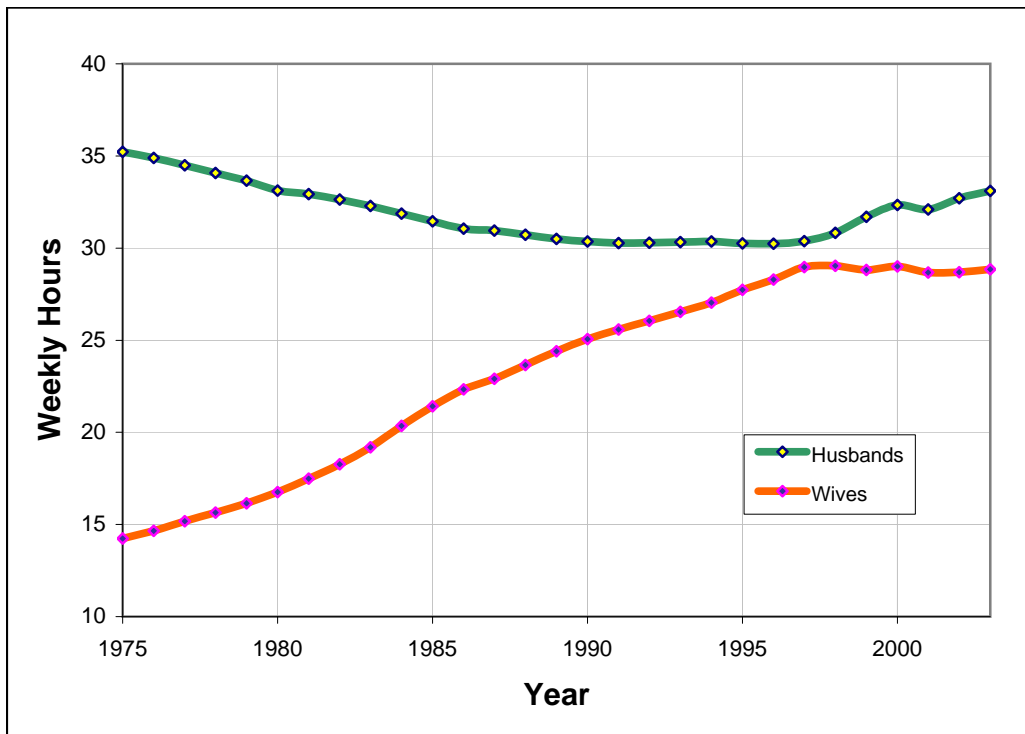
Figure 5(b): *Predicted Paid work of Married Couples with Cohort-Specific Pareto Weights.*