

# The Household Revolution: Childcare, Housework, and Female Labor Force Participation\*

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## Abstract

Throughout the 20th century home production was revolutionized by the introduction of new technologies, from running water to modern appliances, that significantly reduced the time demands of home production. This paper examines whether these changes can explain the important increase in the labor force participation of married women during the 20th century. It contributes to the existing literature by including childcare constraints consistent with U.S. time use data, to examine whether the durable good revolution can also explain the historical increases in the labor force participation rates of married women with children. One of the most remarkable change during the second half of the 20th century is the progressive flattening of the double-peaked pattern that characterized female participation over their life cycle in many industrialized countries.

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# 1 Introduction

Home production has changed dramatically during the course of the 20th century: Labor saving technologies, from running water to modern appliances, have substantially reduced the time demands of home production. In 1890 in the United States only 24% of households had running water and only 8% had electricity; in 1950, these figures were 83% and 94%, respectively. By 1950, a majority of households also had indoor bathrooms and modern appliances such as stoves, electric irons, vacuum cleaners, refrigerators and washing machines.

In an influential paper [Greenwood, Seshadri and Yorukoglu \(2005\)](#) suggest that the household technology revolution played an important role in increasing female labor force participation rates during the 20th century. Like [Greenwood \*et al.\*](#), we take as given both the secular decline in the price of durable goods as well as observed increases in female wages relative to male wages. We have two features missing from their work. First, we include childcare since the bulk of the increase in female labor force participation was due to married women. Childcare can be produced using either primary care time (time spend exclusively with children, like teaching, reading and playing), and secondary childcare time (time spent doing other activities, such as preparing dinner and doing the laundry). Second, we use a life-cycle model in which households live several periods. Consequently, we are able to address not only time series variation in female labor market participation, but also how these patterns differ by age, over time.

While housework is produced using both time and durable goods, childcare is produced using primary and secondary care time. Since housework and childcare are, to some extent, joint products, the household technology revolution leads to potentially interesting interactions between housework and childcare. In particular, labor-saving devices may reduce the amount of time spent doing housework, and so the amount of secondary childcare time. Since children require a fixed amount of childcare services, this reduction in secondary childcare time necessitates an increase in primary childcare time. The net effect of labor-saving devices on female labor market participation is not obvious.

To anchor the model to the data, we use micro data files from the U.S. time use surveys from

1965, 1975, 1985 and 2006. The University of Michigan conducted time-use studies in 1965, 1975, and 1985. The 1965 sample was drawn from a population of urban, mostly employed individuals. Since 2003, the American Time Use Surveys (ATUS) are sponsored by the Bureau of Labor Statistics and conducted by the U.S. Census Bureau. These surveys are therefore not fully comparable. For secondary childcare we rely on the 2006 time use survey. Unfortunately, only one adult in each household is selected to complete the survey. It is therefore impossible to assess the total time spent on household chores or primary and secondary childcare by the household and possible reallocations on time spent doing housework between husband and wife, as a consequence of the durable good revolution.

We re-examine the microdata to obtain information for married women and married men on how much time they spent on primary childcare (where the main activity is childcare), secondary childcare (childcare where the main activity is not childcare), housework and market work. Following World War II, a double peaked pattern arose in the life-cycle pattern of market time by women: the first peak is for women in their early 20s; the second peak, in their 40s. By the 1980s, there was a flattening of this double peak pattern, and by the 1990s, it had disappeared. Between 1965 and 2006, the evidence also points to an overall increase in market work for married women, and a secular decline in the time they spend doing housework.

Bryant (1996) estimated that total housework chores by married women occupied 7.35 hours a day in 1925 and 6.31 in 1968, not a large decline. The U.S. time use survey data from 1965, show that married women (averaged over all age groups) spent a little more than 5 hours **and half a day**<sup>1</sup> on housework (including purchases of goods and services), slightly less than Bryant's but not too far from his estimates. Our data therefore indicates that the decline in housework between 1925 and 1965<sup>2</sup> was important but not as large a decline as suggested by Lebergott (1993), for whom time spent on household chores went from 58 hours a week in 1900 to 18 hours a week in 1975.<sup>3</sup> Our examination of the microdata from the 1975 time use survey shows that in 1975

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<sup>1</sup>Emanuela: Do you mean 5 hours, or half a day. Putting the two together doesn't make sense.

<sup>2</sup>Emanuela: Are you sure of these dates? How do we know anything about housework time in 1925?

<sup>3</sup>Emanuela: Earlier you wrote about the time period 1925 to 1965. Now you're talking about 1975. Is it 1965 or 1975?

married women devoted about 5 hours a day<sup>4</sup> in housework. By 2006, the U.S. time use survey suggest that married women were, overall, spending around three hours a day in housework, a substantial decrease since 1965.

The size of the decline in housework implied by the durable good revolution has been controversial. Many researchers studying time-use data have argued that the effect of the revolution was qualitative and compositional rather than time saving. [Vanek \(1973\)](#) argued that improvements to household technology did not translate into a substantial reduction in housework because households substituted away from paid help, and the standard for hygiene and cleanliness increased (see also [Ramey and Francis, 2005](#); [Mokyr, 2000](#)). Housework went from being hard physical labor to being lighter but time-consuming, with more time spent in activities such as shopping for different types of foods and products, and cooking better meals.

Nonetheless, changes in the nature of housework afforded women greater discretion over the amount of time spent on housework. This allocation of time clearly responded to changes in women's market opportunities and the age of their children: A study by Robinson and Converse (see [Vanek, 1973](#)) reported that in 1965-1966 employed and currently married women with no children devoted 23.4 hours a week to housework while non-employed married women with no children devoted 45.2 hours to housework. This observation suggests that an important part of housework could be reduced, and that the revolution introduced significant flexibility in time use choices. Women with children had a greater incentive to delay exit from the labor market, and to re-enter after their kids entered school. It also made it easier to raise children, increased the quality of time and made it easier to work while raising kids.

The 2006 ATUS survey shows that secondary childcare is an important form of childcare. Married women between the ages of 30 and 35 spent 269 minutes a day in secondary childcare versus 110 minutes of primary child care. Married men in the same age group also devoted a considerable amount of time doing secondary childcare: 169 minutes a day versus 52 minutes a day of primary childcare. Similar results are also found for other industrialized countries using

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<sup>4</sup>Emanuela: 5 hours doesn't seem right to me. 5 hours is 300 minutes. Figure 3 shows that married women spent no more than 300 minutes doing housework. The average couldn't be 300 minutes.

different sources. In Canada in the 1980s, for example, a couple with least one child under the age of five spent 4.1 hours in primary care and 12.3 hours in secondary care (see [Harvey, Marshall and Frederick, 1991](#)).<sup>5</sup>

The model is calibrated to reproduce observed time allocations between housework, market work and primary childcare in the late part of the 20th century and is used to examine the impact on the labor market participation of different cohorts of women of: (1) the decrease in the price of durables, (2) the rise in the relative wage of women, and (3) changes in fertility.

This paper is organized as follows: in Section 2 we examine census data and the micro data from the U.S. time use survey; in Section 3, we describe the model; in Section 4 we discuss the calibration of the model; in Section 5 we examine the results of the simulations. Section 6 concludes.

## **2 Historical Facts: Female Labor Force, Housework and Child-care**

In this section we use data from the U.S. census and from U.S. time use surveys between 1965 and 2006 to examine trends in female labor participation rates and in their use of time. We focus on married women but also examine changes in the contribution of married men to childcare. These surveys allow us to examine the importance of the decline in housework, of the increase in market work, and of changes in the allocation of time for the purpose of childcare – between primary and secondary childcare, and between men and women – in the second half of the 20th century.

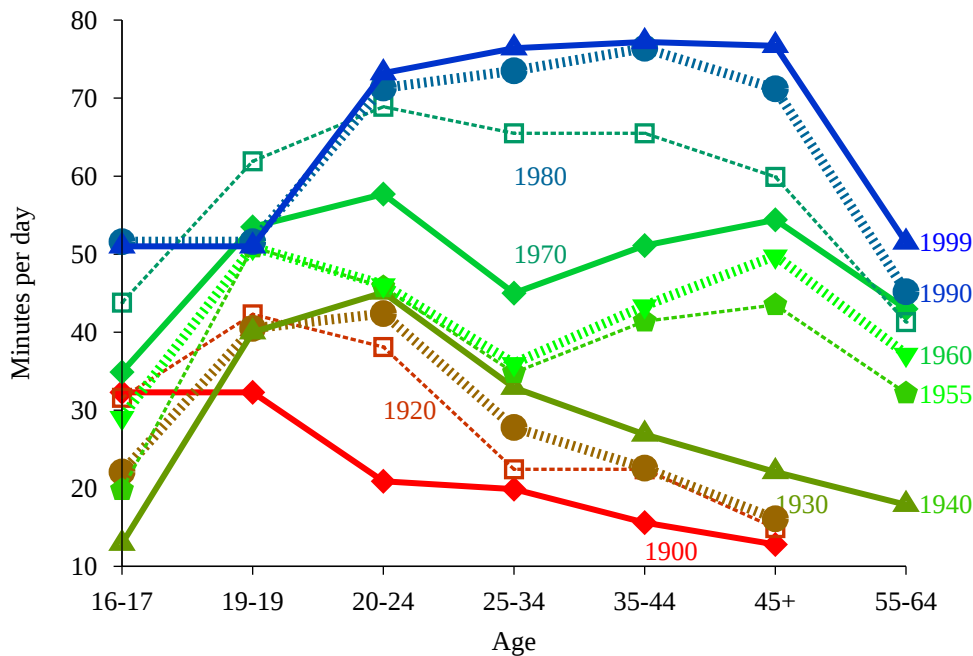
Figure 1 uses information from the U.S. census on female labor force participation rates by age group.<sup>6</sup> It shows that before the Second World War women female participation rates declined after women reached their mid twenties. In 1955 a significant portion of women started to reenter

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<sup>5</sup>Emanuela: We should slice the ATUS data by child age  $< 6$  to make our calculations comparable with the cited Canadian evidence.

<sup>6</sup>Emanuela: Is the U.S. census data on participation rates, or minutes of work per day? If the latter, how do we reconcile the numbers if Figure 1 with those in Figure 2?

Figure 1: Female Labor Force by Age (1900-2000)



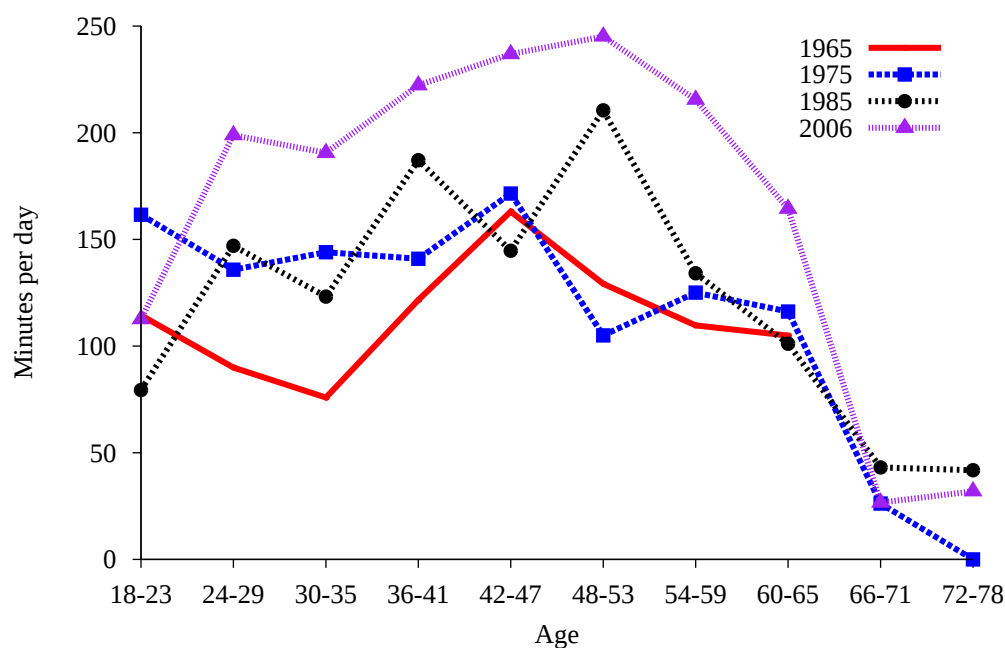
the labor force after their childbearing years. Up until 1970, we observe a double-peaked pattern. By 1980, the double-peaked pattern has flattened out, and has disappeared by 1990. Can the durable good revolution explain women re-entering the labor market after raising children during the 1950s? Can further improvements in home production also explain the flattening of the double peaked pattern?

The disappearance of the double-peaked pattern in the second half of the twentieth century is also visible in the U.S. time use surveys. Figure 2 shows how many minutes per day married women spent on market work. In 1965, married women in the age bracket 24-29 spent 89.97 minutes a day in market work versus the 163.08 minutes spent by married women in the 42-47 age bracket. In 1975, these figures were 135.79 and 171.49 minutes, respectively and in 2006, 198.88 and 236.88 (the figures for 2006 are reported in Table 1<sup>7</sup>). Although the effects of having children on labor market participation have decreased importantly, they have not disappeared.<sup>8</sup> This can be seen by conditioning the time married women spend on market work on whether they have or

<sup>7</sup>Emanuela: Where is the data for Table 1?

<sup>8</sup>Emanuela: I'm not sure I understand the gist of this sentence.

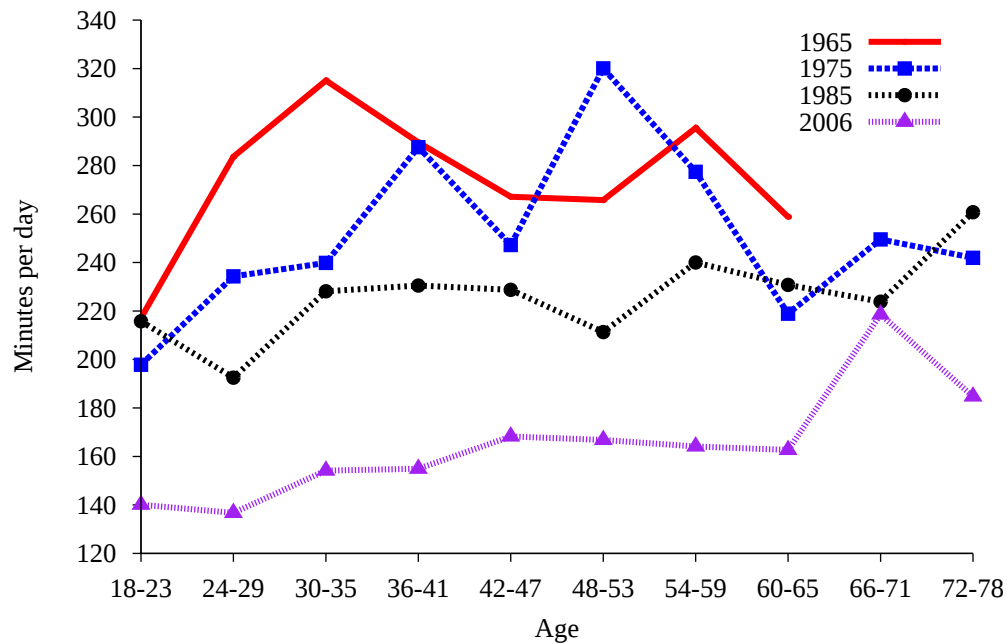
Figure 2: Married Females: Daily Minutes of Work (Time Use Surveys)



not have children. Using the 2006 ATUS survey we find that married women in the age bracket 24-35 with no children worked 285 minutes a day, married women with 1 child below 6 worked 194 minutes a day and married women with 1 child below 6 and 1 child between 6 and 12, worked 104 minutes a day. Single women without children, in the same age bracket, worked 264 minutes a day. This suggests that although married and single women without children worked about the same number of minutes per day, children are still an important constraint with the respect to the time married women spend on market work. Even with the dramatic increases in the female labor force and the flattening of the double-peak pattern, in the late 20th century the presence of children is still associated with less time spent in the labor market. This may also indicate that fertility changes during the second half of the 20th century, and the end of the baby boom, may have had an important role in explaining the flattening of the double-peaked pattern.

Interestingly, the ATUS 2006 survey shows that married men in the age group 24-35 work more the more children they have. Married men 24-35 years old without children work 343.7 minutes; those with one child below 6, 368.4 minutes; and those with one child below 6 and one between 6 and 12, work 411.8 minutes a day (these figures are based on calculations and not reported in our

Figure 3: Married Females: Daily Minutes of Housework (Time Use Surveys)

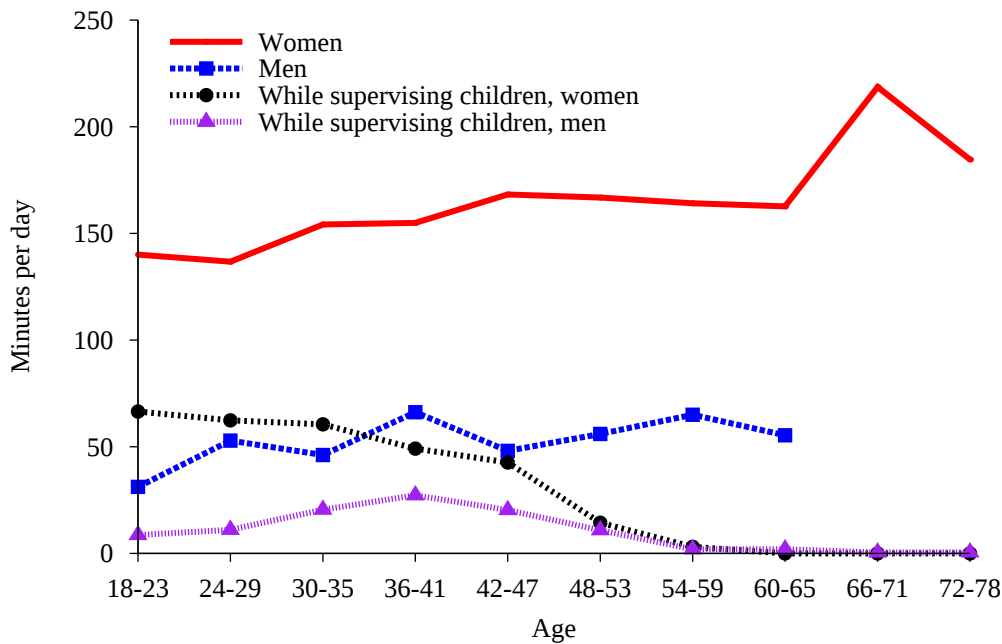


paper).

How much did housework decline? Figure 3 shows important declines in housework between 1965 and 2006. For women in the age group 24-29, housework went from 283.63 minutes a day in 1965 to 136.73 minutes a day in 2006. The decline was similar for other age groups. On average married women were spending 276.79 minutes a day in housework in 1965 versus 163.09 in 2006. The figures do not include time spent purchasing goods. In 1965 married women spent 44.52 minutes a day purchasing goods versus 52.16 minutes in 2006 (see Table 1). These figures are 29.66 and 34.33, respectively for married men. While both men and women have increased their shopping time, this increase is fairly modest.

While housework declined importantly, the supervision of a child required the same number of hours. The household revolution made it easier to raise kids, from cooking to doing the additional washes or even entertaining them, but it did not release the basic time constraint: children needed supervision and someone had to be around. One concern with interpreting the decline in housework as time freed for either leisure or market work is that part of that household care was spent in providing child supervision in the form of secondary care.

Figure 4: Housework and Housework While Supervising Children (2006 ATUS)

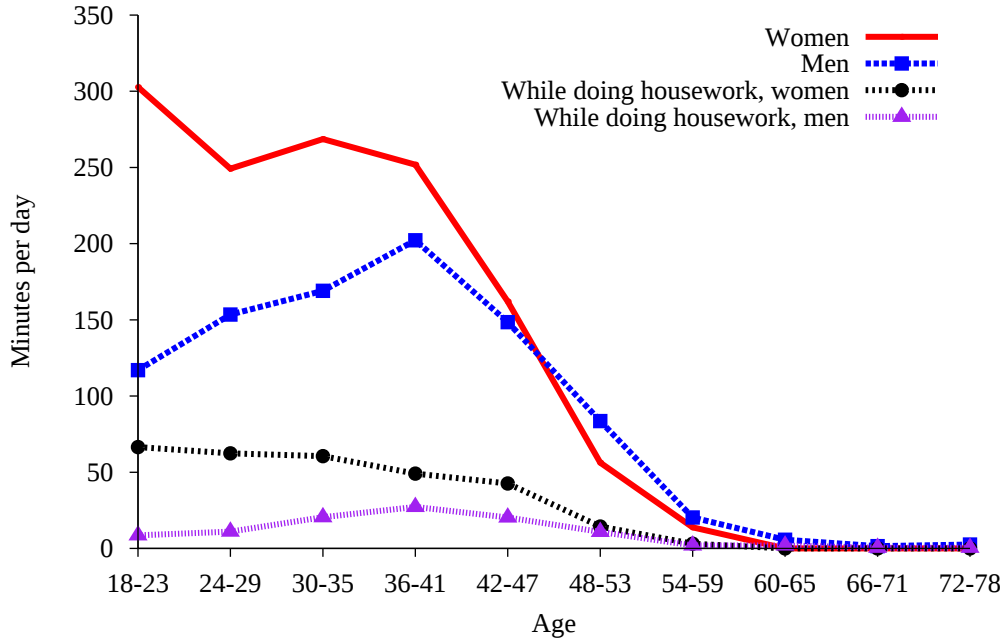


The 2006 survey asks the total time spent providing secondary childcare for all children under 13 (household and non household children). One question is how the large decrease in housework time affected secondary childcare that was done by women while performing housework chores. Figure 4 plots secondary childcare that takes place while doing household chores together with the total time married women and married men spend on household chores in 2006 (this figure does not include time spent purchasing goods and services; see Table 1). Time spent doing household chores is significantly higher than secondary childcare while doing housework for both married women and married men. This seems to suggest that the decline in housework did not substantially change the type of childcare given to children.<sup>9</sup> It could also be that important changes throughout the 20th century changed the type of childcare given to children and that housework ceased to be the most important type of secondary childcare given to children.

Overall, from the 2006 ATUS we learn that adults living in households with children under 6 spent an average of 5.6 hours per day providing secondary childcare – most commonly while doing

<sup>9</sup>Emanuela: I didn't understand this sentence.

Figure 5: Secondary Care and Housework While Supervising Children (2006 ATUS)



leisure activities<sup>10</sup> or household activities (ATUS calculations). Figure 5 shows that secondary childcare while doing housework is a small percentage of total secondary childcare and that men do a considerable amount of secondary childcare. Married women between the age of 30 and 35 spent 268.66 minutes a day, on average, doing secondary childcare; married men, in the same age group, spent 169.08 minutes a day (see Table 1).

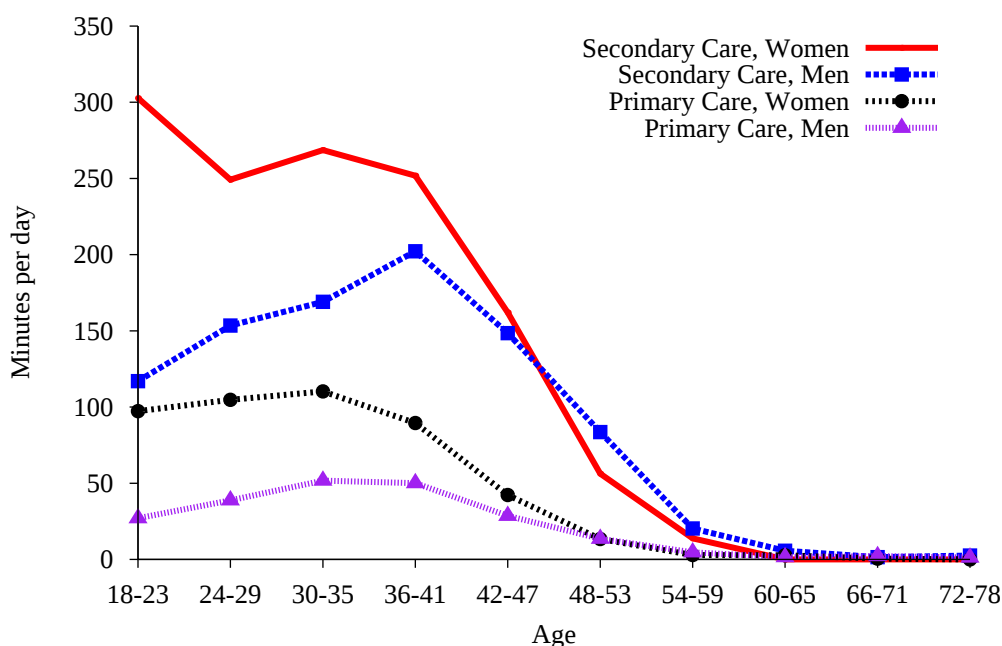
Figure 6 shows that secondary childcare is considerably more important<sup>11</sup> than primary childcare. Men and women spend almost three times more time doing secondary childcare than doing primary childcare, and men are engaged in secondary childcare in a significant way while women remain the main provider of both primary and secondary childcare (see Table 1). For example, in 2006 married women 30 to 35 years old, spent 268.66 in secondary care a day and 110.25 minutes a day in primary care. For married men in the same age group, these figures are 169.08 and 51.67, respectively (see Table 1).

An important change in the composition of secondary childcare may have taken place over

<sup>10</sup>Emanuela: We need a figure to support this observation.

<sup>11</sup>Emanuela: This figure does not actually show that secondary childcare time is more important; it does show that secondary childcare time is much larger than primary childcare time.

Figure 6: Primary and Secondary Care Time (2006 ATUS)



the decades, shifting secondary care while doing housework to secondary care while doing other activities. This shift may have led to an increase in the contribution of men to childcare. Are these the elements that allowed women to join the labor market after having been freed from housework?<sup>12</sup>

Figure 7 shows the evolution of primary childcare over the second half of the 20th century. The micro data do not indicate important changes in the amount of time spent in primary childcare between 1965 and 2006. Figure 8 shows the evolution of secondary childcare while doing housework, for married women. It is unclear how comparable the data are as the amount of secondary childcare while doing housework is especially low for 1985, but is also low for 1965 and 1975.

Overall this information suggests that the durable good revolution affected housework importantly, but it provides only indirect evidence on how these changes affected childcare. Since 1900, given the importance of secondary childcare in the supervision of children, the micro data suggest that the household revolution might have changed the nature of secondary childcare rather than affecting primary childcare – particularly in the last third of the 20th century for which we

<sup>12</sup>Emanuela: This paragraph comes from out of the blue.

Figure 7: Married Females: Daily Minutes of Primary Childcare Time (Time Use Surveys)

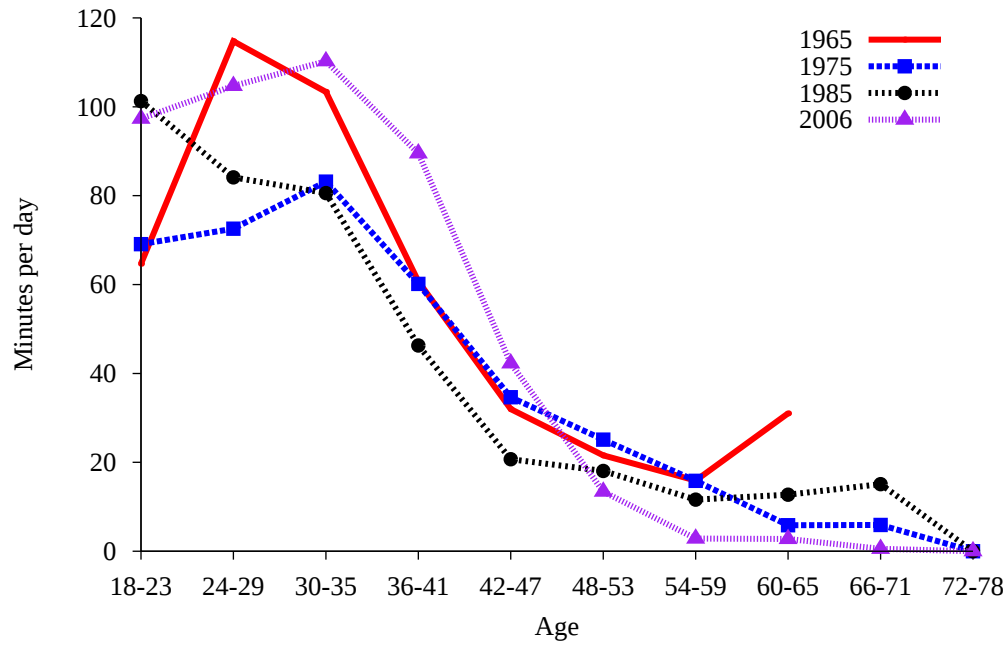


Figure 8: Married Females: Daily Minutes of Secondary Childcare Time (Time Use Surveys)

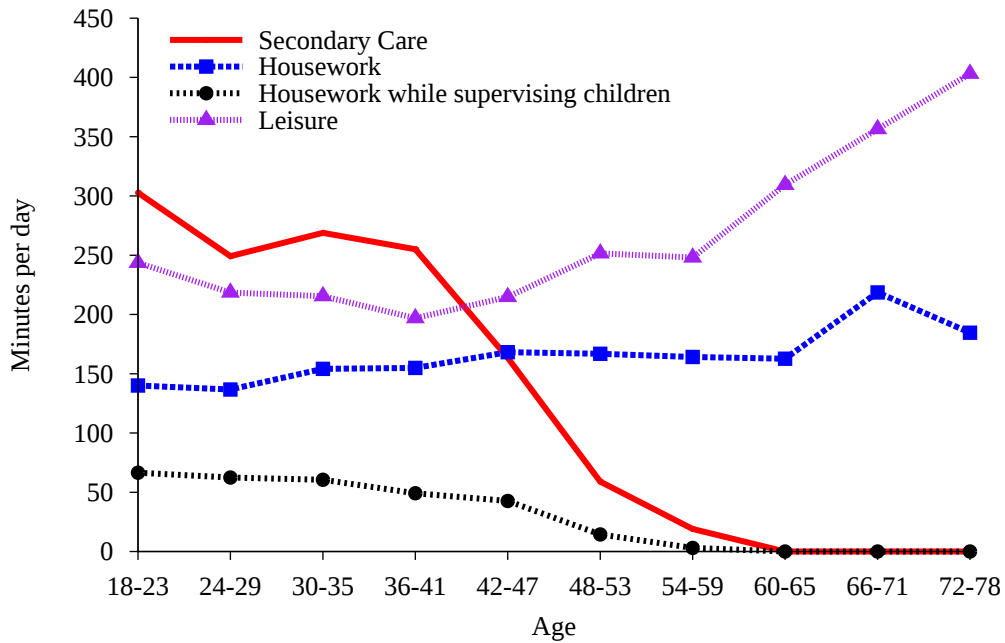
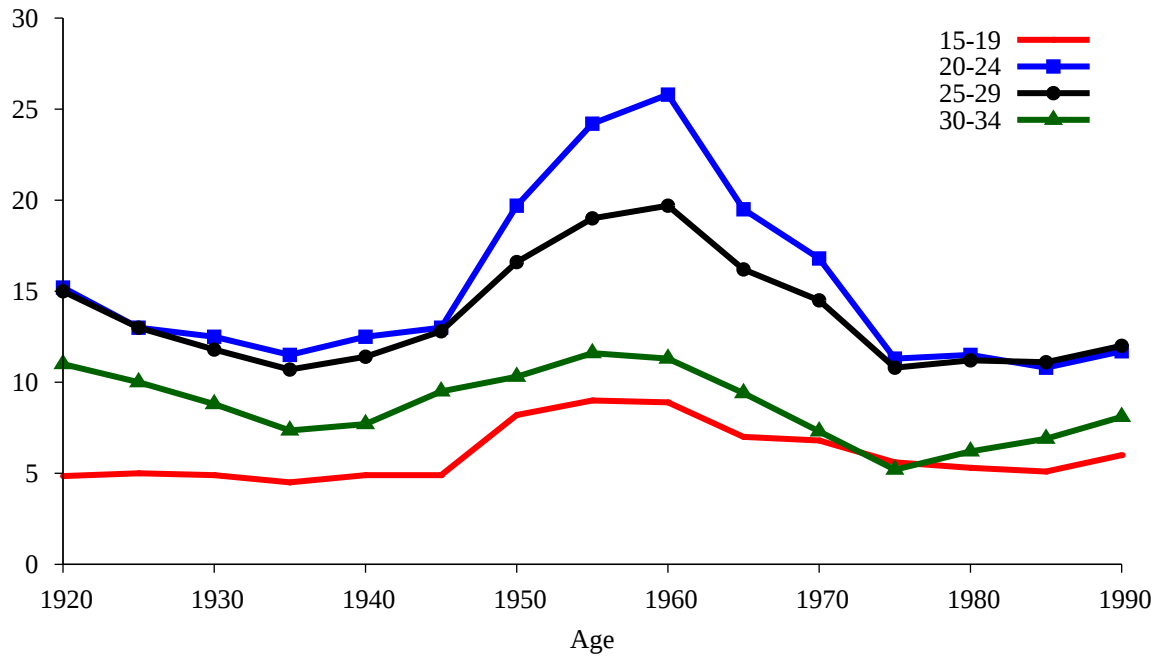


Figure 9: Live Births per 100 Women



have microdata information about time spent on primary and secondary childcare. To the extent that childcare services are increasingly using secondary child-care tie, men have been afforded the opportunity to become more actively involved in the care of their children and at the same time released time from women allowing them to increase their participation to the labor market.

Finally, Figure 9 illustrates the importance of fertility changes throughout the 20th century and particularly during the second half of the century. The sharp increase in fertility rates after World War II, and up until 1960, and their subsequent decline may reflect households' decisions to take advantage of the household revolution by postponing children, having fewer children and/or a shorter spacing between children, the net result of which is to allow married women to work more, on average, in the market. Although this interpretation implies that fertility decisions are endogenous and affected by the durable revolution, this paper will assume that fertility changes are exogenous. We will, however, examine whether these changes contribute to the flattening of the double-peaked pattern observed in the latter part of the 20th century.

### 3 Economic Environment

#### 3.1 Households

The economy is made of overlapping generations and a household comprises a married couple which has one unit of time which they split among market work, housework, secondary care and primary childcare and leisure. We assume that men always work and that the household chooses how much women work. As in [Greenwood \*et al.\*](#), we assume that women earn a fraction of what men earn. A household ‘formed’ at date  $t$  has preferences summarized by

$$\max \sum_{i=0}^{T-1} \beta^i U(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) \quad (1)$$

where  $T$  is the ‘lifetime’ of the household,  $c$  denotes consumption,  $n$  hours of work,  $i$  superscripts refer to the *age* of the household,  $t$  superscripts denote the cohort (that is, the date of formation of the household),  $m$  subscripts pertain to *market* variables,  $h$  subscripts indicate *home work* activities, and  $c$  subscripts signify (*primary*) *childcare*. Thus,  $c_{mt}^i$  is market consumption of a household of cohort  $t$  at age  $i$  (which means this consumption is enjoyed at calendar date  $t + i$ ), and  $n_{ht}^i$  refers to home work hours at age  $i$  of a household of cohort  $t$ . The functional form for  $U$  is:

$$U(c_m, c_h, n_m, n_h, n_c) = \begin{cases} \ln C(c_m, c_h) + \omega \ln(2 - \bar{n} - n_m - n_h - n_c) & \text{if } \gamma = 1 \\ \frac{[C(c_m, c_h)(2 - \bar{n} - n_m - n_h - n_c)^\omega]^{1-\gamma}}{1-\gamma} & \text{if } \gamma \in (0, 1) \cup (1, \infty) \end{cases} \quad (2)$$

where  $C(c_m, c_h)$  is a consumption aggregator:

$$C(c_m, c_h) = \begin{cases} c_m \psi c_h^{1-\psi} & \text{if } \xi = 0 \\ [\psi c_m^\xi + (1 - \psi) c_h^\xi]^{1/\xi} & \text{if } \xi \in (-\infty, 0) \cup (0, 1) \end{cases} \quad (3)$$

Notice that the time endowment of the household is 2 because it includes that of both partners.

Home goods,  $c_{ht}^i$ , are produced by combining durables,  $d_t^i$ , with time,  $n_{ht}^i$ :

$$c_{ht}^i = H(d_t^i, n_{ht}^i) \quad (4)$$

where

$$H(d, n_h) = \begin{cases} d^\eta n_h^{1-\eta} & \text{if } \zeta = 0 \\ \left[ \eta d^\zeta + (1-\eta) n_h^\zeta \right]^{1/\zeta} & \text{if } \zeta \in (-\infty, 0) \cup (0, 1) \end{cases} \quad (5)$$

A key feature of the model is the childcare constraint:

$$c_{ct}^i = G(n_{ct}^i, n_{ht}^i) \quad (6)$$

where

$$c_c = \begin{cases} n_c^\nu n_h^{1-\nu} & \text{if } \varphi = 0 \\ \left[ \nu n_c^\varphi + (1-\nu) n_h^\varphi \right]^{1/\varphi} & \text{if } \varphi \in (-\infty, 0) \cup (0, 1) \end{cases} \quad (7)$$

Childcare is a constraint in that a household of age  $i$  *must* provide total childcare services of  $c_c^i$ ; the household does not directly value the provision of these childcare services. These services, in turn, are produced either with primary childcare time,  $n_c^i$ , or with ‘secondary’ childcare time,  $n_h^i$ . Consequently, when there are children in the household, home work time,  $n_h^i$ , produces two distinct goods: home consumption goods,  $c_h^i$ , and childcare,  $c_c^i$ .

The household’s budget constraint is

$$c_{mt}^i + x_t^i + a_t^{i+1} = \bar{n} w_{t+i} + \phi n_{mt}^i w_{t+i} + r_{t+i} a_t^i \quad (8)$$

where  $x_t^i$  represents investment in durables by a household of cohort  $t$  at age  $i$ ,  $a_t^i$  denotes this household’s beginning-of-period market assets,  $\bar{n}$  is the (fixed) amount of time that the husband works,  $w_{t+i}$  is the real wage,  $\phi$  is the efficiency of the wife relative to the husband, and  $r_{t+i}$  is the gross return on capital.

The law of motion for durables is

$$d_t^i = (1 - \delta_d) d_t^{i-1} + q_{t+i} x_t^i \quad (9)$$

where  $q_{t+i}$  is the state of durables-specific technological change.

The household faces the following boundary conditions:

$$d_t^{-1} = 0, \quad a_t^0 = 0, \quad d_t^T \geq 0, \quad a_t^{T+1} \geq 0 \quad (10)$$

That is, the household starts with no durables and no real assets, and it ends with non-negative holdings of durables and real assets. Notice that the timing with respect to durables implies that durables purchased at age  $i$  are available for use at age  $i$ . This assumption means that durables are available for home production in the first period of the household's life.

The problem of the household is to maximize Eq. (1) subject to Eqs. (4), (6) and (8)–(10), taking as given prices.

### 3.2 Firms

Firms face the usual static problem of maximizing period-by-period profits, viz.

$$\max_{\{K_t, N_t\}} F(K_t, N_t) - \tilde{r}_t K_t - w_t N_t$$

where  $K_t$  is capital,  $N_t$  the labor input,  $\tilde{r}_t$  the real rental rate of capital, and  $w_t$  the real wage. The relationship between  $\tilde{r}_t$ , above, and  $r_t$  in the household's problem is:

$$r_t = \tilde{r}_t + 1 - \delta_k$$

### 3.3 Market Clearing Conditions

Capital market clearing is given by

$$K_t = \sum_{i=0}^{T-1} a_{t-i}^i.$$

On the right-hand side, we need to add up the market assets of all individuals alive at date  $t$ . In reading through this equation, recall that the superscript on  $a$  is the household's age while the subscript denotes its cohort (when it was 'born').

Similarly, labor market clearing is

$$N_t = T \bar{n} + \phi \sum_{i=0}^{T-1} n_{m,t-i}^i.$$

Recall that male labor supply is constant at  $\bar{n}$ .

Finally, goods market clearing is written

$$\sum_{i=0}^{T-1} c_{m,t-i}^i + \sum_{i=0}^{T-1} x_{t-i}^i + K_{t+1} = F(K_t, N_t) + (1 - \delta_k) K_t$$

## 4 Calibration

Functional forms are given by Eqs. (2), (3), (5) and (7). The model's parameters are summarized in Table 1.

To start, a model period is set to 6 years. The reason behind this choice is that the TUS reports the number of children under 6, and the number aged 6-18. So, setting the model period to 6 allows us to line up with the age ranges of children as reported in the TUS. The household 'lives' for 10 periods, or 60 years. In data terms, we are looking at households for which the respondent is aged between 18 and 78.

Perhaps the most problematic parameters are those characterizing the childcare production function,  $\nu$  and  $\varphi$ . The *model* says that for household  $i$ , childcare is

$$c_c^i = [\nu(n_c^i)^\varphi + (1 - \nu)(n_h^i)^\varphi]^{1/\varphi}.$$

Given parameter values for  $\nu$  and  $\varphi$ , and using time data for married women from the 2006 ATUS, the above equation can be used to generate an inferred value for  $c_c^i$ . In principle, we should be using primary care time and housework time for the *household*, not just the wife. Unfortunately, the ATUS only collects time use data for the respondent, not the household. We chose women because they account for the bulk of time spent with children. We 'estimate'  $\nu$  and  $\varphi$  via

$$(\nu, \varphi) = \operatorname{argmin} \left\{ \operatorname{var} \left[ \frac{c_c^i}{\bar{c}_c} \right] \right\}$$

Table 1: Parameter Values

|                               |                                              |         |
|-------------------------------|----------------------------------------------|---------|
| <b>Time</b>                   |                                              |         |
|                               | Length of a period (years)                   | 6       |
|                               | Number of periods of ‘life’                  | 10      |
| <b>Child-care</b>             |                                              |         |
| $\nu$                         | Weight on primary child-care time            | 0.5288  |
| $\phi$                        | CES parameter                                | 0.4907  |
| <b>Market production</b>      |                                              |         |
| $\alpha$                      | Capital’s share                              | 0.3300  |
| $\delta_k$                    | Depreciation rate of market capital (annual) | 0.07    |
| $\phi_{1900}$                 | Relative wage of women in 1900               | 0.4800  |
| $\phi_{1980}$                 | Relative wage of women in 1980               | 0.6000  |
| <b>Utility</b>                |                                              |         |
| $\omega$                      | Weight on leisure in utility function        | 1.5710  |
| $\beta$                       | Discount factor (annual)                     | 0.9845  |
| <b>Consumption aggregator</b> |                                              |         |
| $\psi$                        | Weight on market consumption                 | 0.8121  |
| $\xi$                         | CES parameter                                | −0.2000 |
| <b>Home production</b>        |                                              |         |
| $\eta$                        | Weight on durables                           | 0.5636  |
| $\zeta$                       | CES parameter                                | 0.3500  |
| $\delta_d$                    | Depreciation rate of durables (annual)       | 0.2     |
| $g_q$                         | Change in price of durables                  | −8.3%   |

where  $\bar{c}_c$  is *average* childcare. If the model is correct, then  $c_c^i$  is constant across households, although households may choose different combinations of primary childcare and housework time to satisfy this constraint. Minimizing the variance of  $c_c^i$  simply recognizes that there is no combination of the parameters  $\nu$  and  $\varphi$  that manage to set  $c_c^i$  constant.

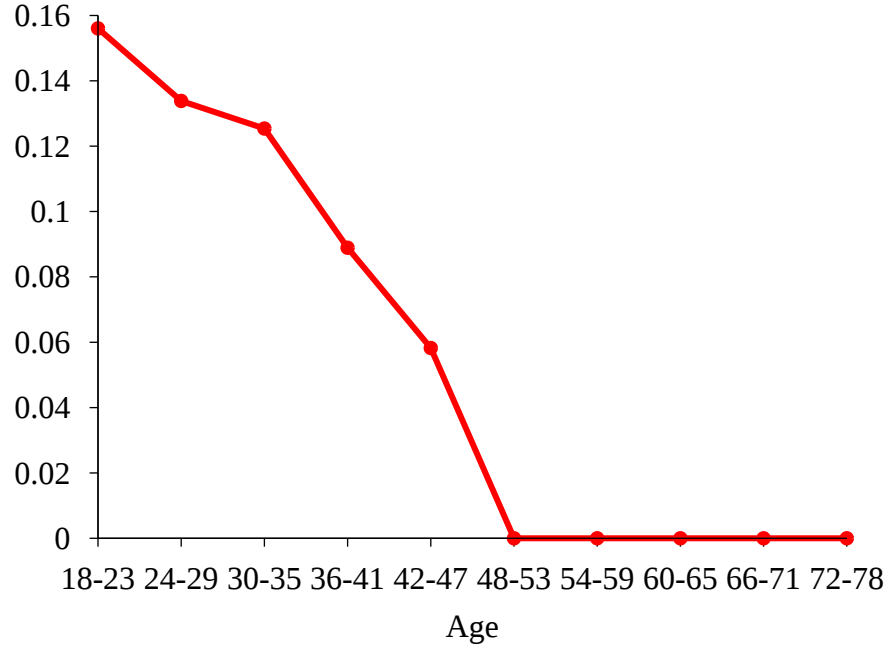
One complication that arises in our estimation procedure is that households differ with regards to the age and number of children. Presumably, a child under the age of 6 has a larger childcare requirement than an older child, and two children under the age of 6 require more childcare than a single child under 6. So, we divide the sample by: the number of children under 6, and the number of children aged 6-18. Average inferred childcare,  $\bar{c}_c$ , is computed for each group. The division by  $\bar{c}_c$  in the variance minimization above renders the childcare requirement unit free so that we can pool households during our estimation.

As reported in Table 1, both  $\nu$  and  $\varphi$  are found to have values of around 0.5. What is most important is that the CES parameter,  $\varphi$ , implies a fair deal of substitutability between primary childcare and housework (secondary childcare) time. In other words, households will find it relatively easy to substitute, say, primary childcare time for housework time in order to satisfy their childcare requirement.

A number of the model's parameters are standard, and hopefully require little discussion. These parameters include:  $\alpha$ , capital's share of income;  $\delta_k$ , the depreciation rate of market capital; and  $\delta_d$ , the depreciation rate of durables. As in Greenwood *et al.* (2005), we calibrate the model to a 1900 steady state and a 1980 steady state. We take the relative wage of women from their work:  $\phi_{1900} = 0.48$  and  $\phi_{1980} = 0.60$ . Also, the price of durables declines at the rate 8.3% per annum, as in Greenwood *et al.*.

The CES parameters for home production,  $\zeta$ , and the consumption aggregator,  $\xi$ , require some discussion. For durables to be labor-saving requires that durables and housework time be fairly substitutable. Hence, we set  $\zeta = 0.35$  which implies more substitutability than Cobb-Douglas. This value for  $\zeta$  is in the range estimated by McGrattan, Rogerson and Wright (1997) and Rupert, Rogerson and Wright (1995). We set  $\xi = -0.2$  which means that market and home consump-

Figure 10: Calibrated Childcare Requirement



tion are less substitutable than in the Cobb-Douglas case. As the price of durables falls, and the household acquires ever more durables, production of the home produced good increases. Making market and home goods complements helps to get an increase in market hours.

Regarding the childcare requirement, we assume that children are in the household for 5 model periods (30 years), corresponding to ages 18 to 47 years in the data. This choice was motivated by the fact that, in the data, older households have few children in their households. We suspect that the relatively small amount of time allocated to primary childcare by older households is provided to grandchildren. We choose the age-specific childcare requirements,  $c_c^i$ , so that the model's 1980 steady state matches primary childcare time from the 1985 TUS. The series for  $c_c^i$  is reported in Figure 10

The remaining parameters are:  $\omega$ , the weight on leisure in utility;  $\beta$ , the discount factor;  $\psi$ , the weight on market consumption in the consumption aggregator; and  $\eta$ , the weight on durables in the home production function. These parameters are chosen to match the following observations:

1. A 5% participation rate for married women in 1900, translated into the fraction of the time endowment based on a 40 hour work week.

2. A 50% participation rate of married women in 1980.
3. An annual real interest rate of 4% in 1900.
4. Average housework time in 1980 of XXX, as it is in the 1985 TUS.

The first two observations are from [Greenwood \*et al.\* \(2005\)](#) while the real interest rate target is a conventional value.

## 5 Results of the Simulations: Steady State Comparison

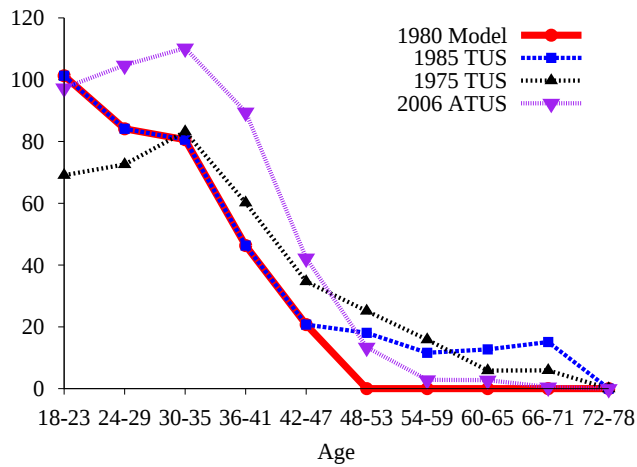
Two different sets of experiments are examined here; the first set assumes no changes in fertility while the second set calculates the changes in childcare requirement that result from changes in fertility during the 20th century. Recall that the childcare requirement is chosen so that the 1980 steady state matches primary childcare time of married women from the 1985 TUS. Also keep in mind that secondary childcare time in the model corresponds to time spent doing housework.

### 5.1 The Durable Good Revolution - No Fertility Changes

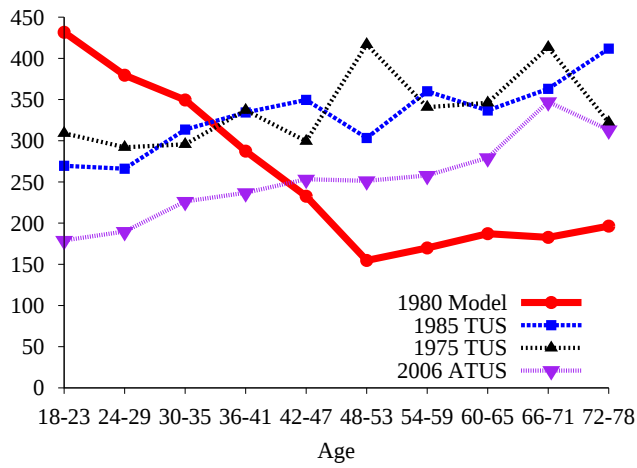
In the first experiment the price of durables declines by 8.3 per cent a year as in [Greenwood \*et al.\* \(2005\)](#), and the relative wage of women matches U.S. data. Results for the 1900 and 1980 steady states are presented in Figure 12. The durable good revolution increases consumption and households total assets. Durable goods increase for all age groups, but more so for older households. Figure 12e shows that in response to the increase in productivity in the durable sector, households decrease the amount of secondary childcare as time spent on housework decreases. As a consequence, they increase primary childcare. We do not have data on primary childcare in 1900 but in 1980 the amount of primary childcare obtained in the simulations is consistent with what observed in the time use data.<sup>13</sup>

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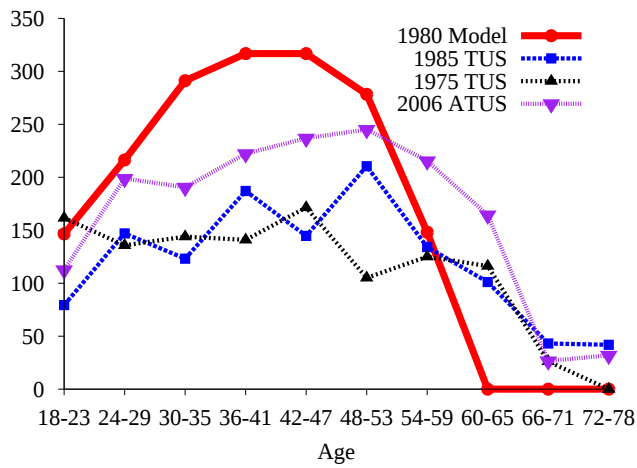
<sup>13</sup>Emanuela: The model matches primary childcare time in 1985 *by construction*.



(a) (Primary) Childcare Time

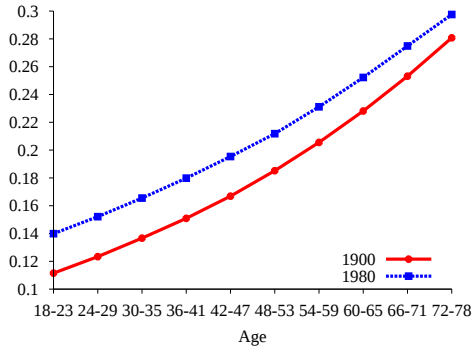


(b) Housework Time

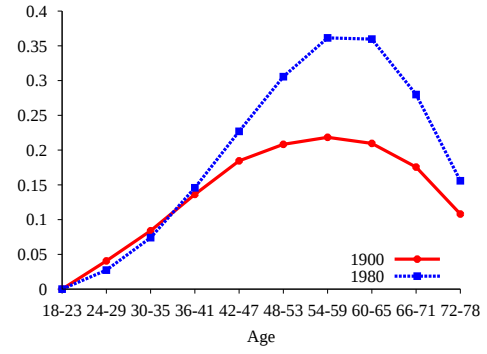


(c) Female Market Time

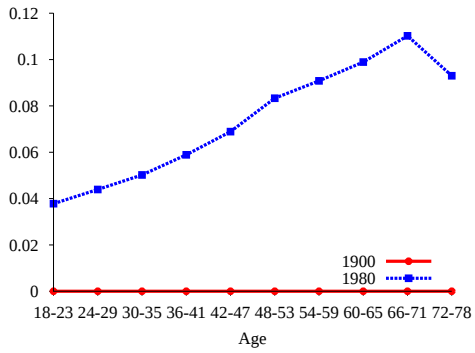
Figure 11: The Model's 1980 Steady State versus the Time Use Surveys



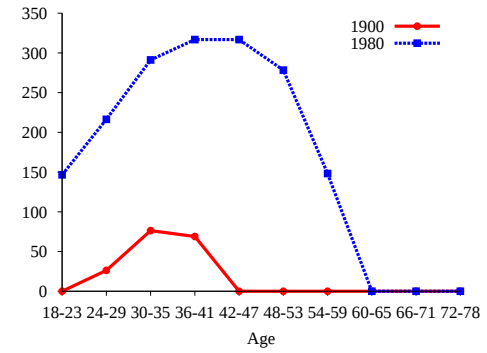
(a) Consumption



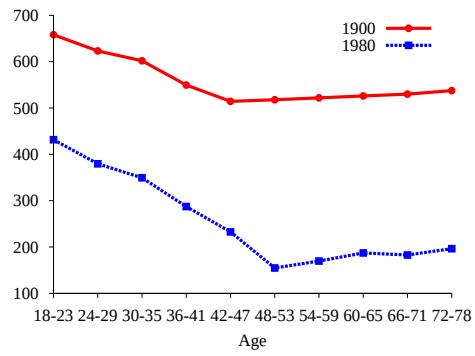
(b) Market Assets



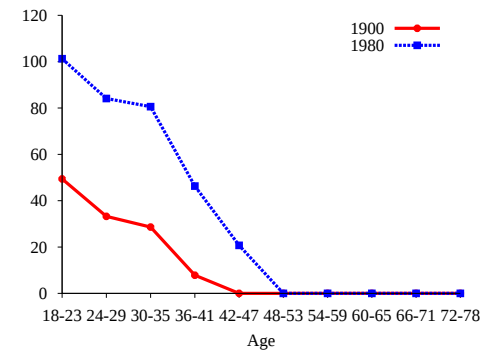
(c) Durables



(d) Female Market Time



(e) Homework Time



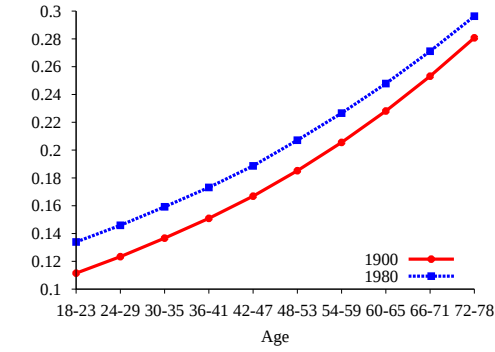
(f) (Primary) childcare Time

Figure 12: Steady State: Baseline 1900 and 1980

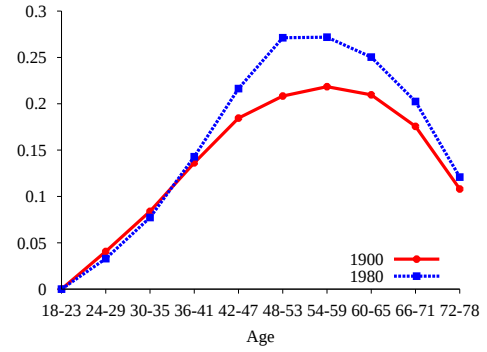
Despite the important increase in primary childcare, from 1900 to 1980, the decrease in housework together with the increase in female relative wage allow women to increase their participation to labor market. These two changes together make female labor market participation overshoot observed labor market participation. In the simulations married women in 1980 work as much as married men do. Female labor participation increases from 5-7 hours a week, on average for the 24-41 age group, in 1900 to about 35 hours a week in 1980. The 1985 time use micro data indicate that married women in the 30 to 35 group work on average 123.19 minutes a day, which is much below 35 hours a week and below the time married men in the same age group spent in market work, which was 357.22 minutes a day. Married women in the 36 to 41 group worked on average 187.13 minutes a day, married men in the same age group worked 323.28 minutes a day. Even in 2006, married women in the 30 to 35 group worked 190.54 minutes a day and in the 36 to 41 group, 222.27 minutes a day. Married men in the same age groups worked 355.56 minutes and 396.83 minutes, respectively. The implications of the durable good revolution as measured by an 8% yearly increase in productivity of the durable sector implies too much market work for the group of women that the microdata suggest were still constrained by childcare and whose participation was much more limited than men's and single women's (without children).

Figure 13 show the same experiment but without the durable good revolution. The only thing that is different in the two steady states is the wage profile of women. In this case, while the number of hours that married women 24 to 36 years old spend in market work is consistent with time use data, after age 36 the decline in market work is rapid and not consistent with time use data which on the contrary show an increase in market work. This decline is due to the wage profile that declines with the age of women. The data however show that in the second half of the century, after children reach a certain age, married women re-enter the labor market and/or increase their participation. The decline in time spent on market work starts with age 48 in the 1965 time use microdata and at 54 in the ATUS 2006 microdata. In this experiment primary childcare is too low, the result of the fact that most childcare is secondary and performed while doing housework.

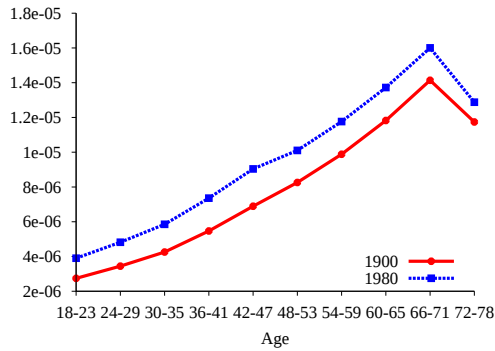
Figure 14 report the experiment with the durable revolution but no change in the female wage



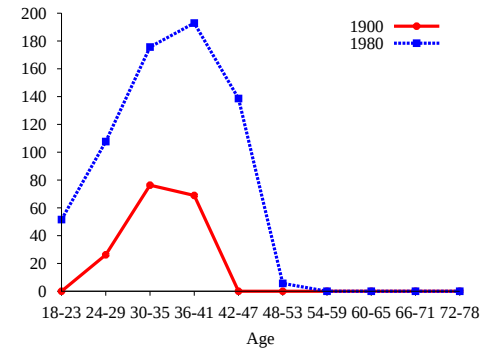
(a) Consumption



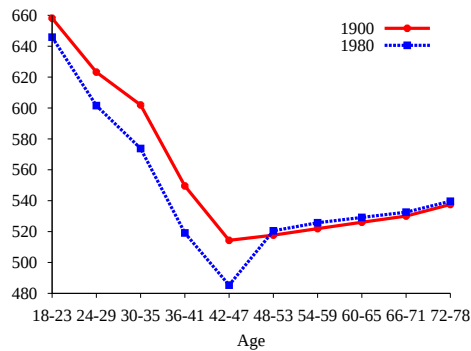
(b) Market Assets



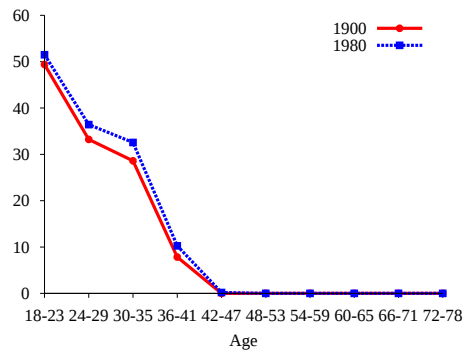
(c) Durables



(d) Female Market Time

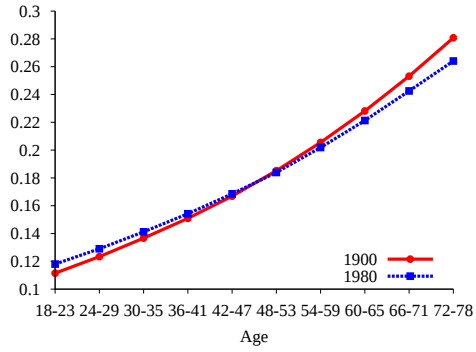


(e) Homework Time

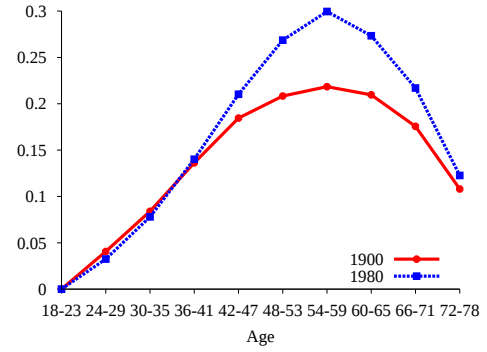


(f) (Primary) Childcare Time

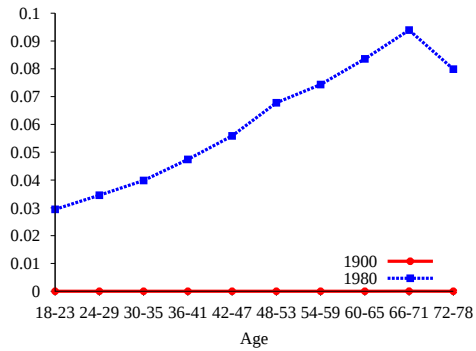
Figure 13: Steady State: No Durable Goods Revolution, 1900 and 1990



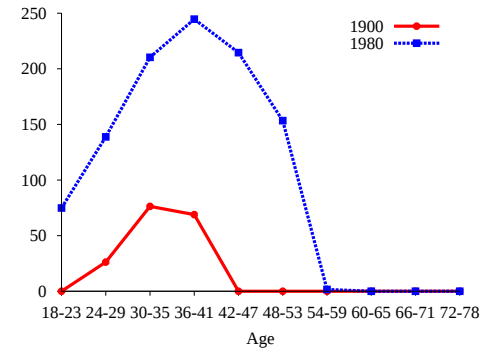
(a) Consumption



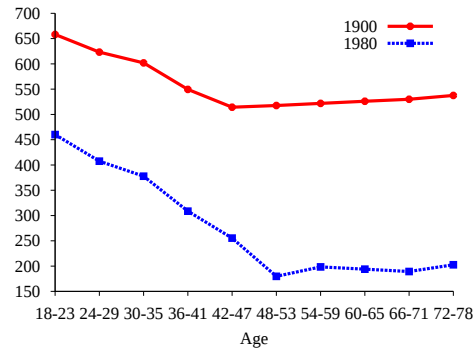
(b) Market Assets



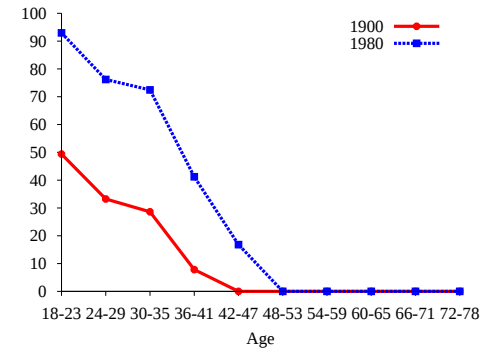
(c) Durables



(d) Female Market Time



(e) Homework Time



(f) (Primary) Childcare Time

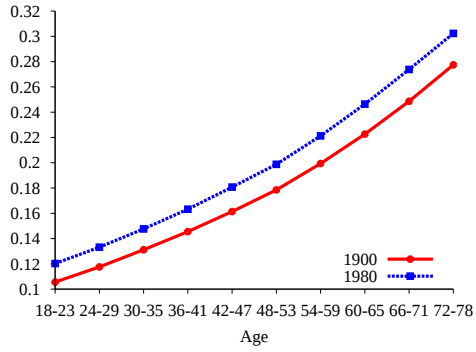
Figure 14: Steady State: No Change in Female Relative Wage, 1900 and 1990

profile. The results for market work are closer to what we observe for the age group 24 to 35, but again market work declines starting age 36 rather than increasing as observed in the data. Primary childcare is consistent with time use survey data. The decrease in market work is explained by the increase in asset holdings as households grow older. These assets provide an alternative source of revenue that reduces the need of market work and increase the demand for leisure.

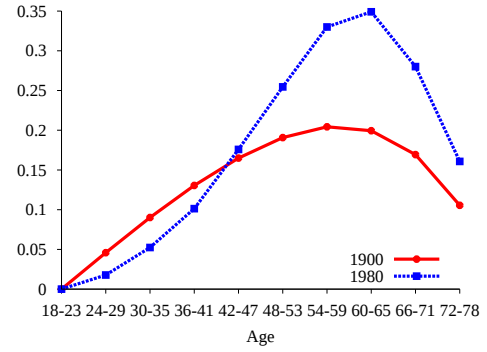
The fourth experiment (see Figure 15), assumes more childcare and the same increase in the productivity of the durable good sector and change in the female wage profile, as in the first experiment. In this case as with the first experiment married women's market work is too high. The fifth experiment (see Figure 16) examines how the result change when primary and secondary childcare are less substitutable. It shows that although primary childcare is higher, market work in 1980 is almost as high as in the first experiment.

Experiment 6, reported in Figure 17, illustrates is the same as the first experiment, but examines the changes that occur over three decades: 1960, 1970 and 1980. Market work and primary childcare increase over the decades. The micro data does not consistently indicate an increase in primary childcare. More importantly, the simulations fail to reproduce the double-peaked pattern found in the data in 1965 and generates too much market work for all three decades.

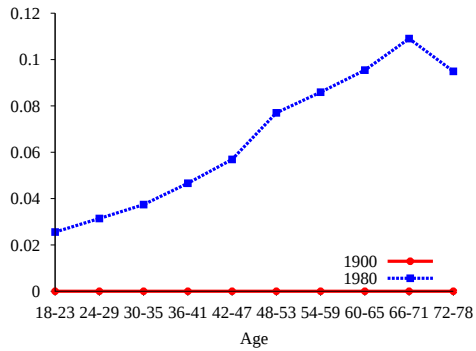
These experiments indicate that the durable good revolution that results from the increased productivity of the durable goods is too powerful when applied to a model where married women have children and the results are compared to the observed participation rates for that group of women. The reduction of housework releases too much time from women's day relatively to what is observed. In addition, childcare, although higher, is not binding and we cannot generate the standard exit and re-entry in the labor market that is observed in the time use data and from census data on female labor participation rates.



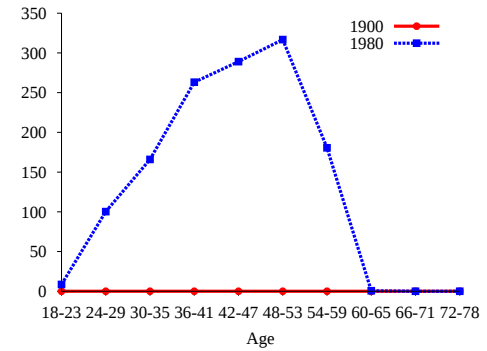
(a) Consumption



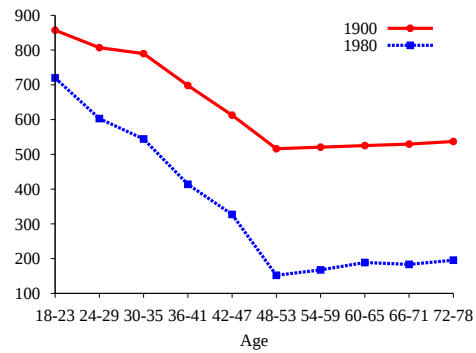
(b) Market Assets



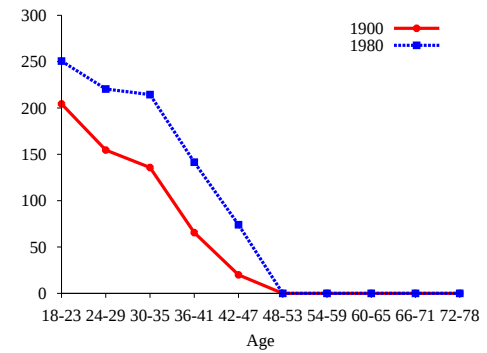
(c) Durables



(d) Female Market Time

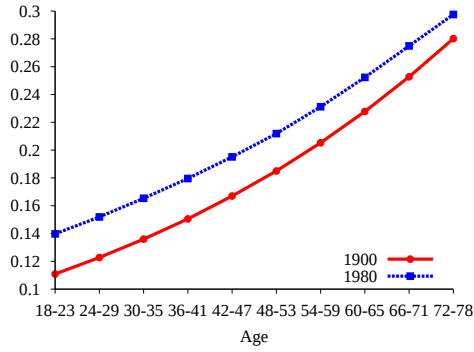


(e) Homework Time

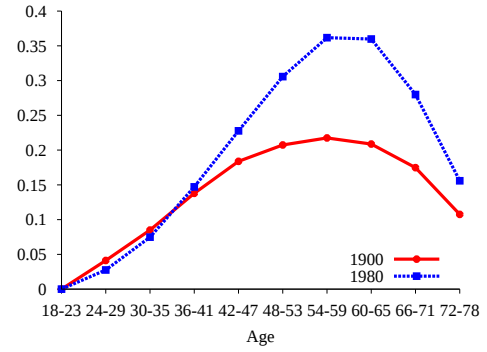


(f) (Primary) Childcare Time

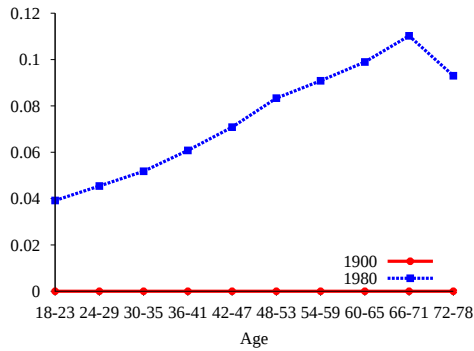
Figure 15: Steady State: Increased Childcare Requirement, 1900 and 1990



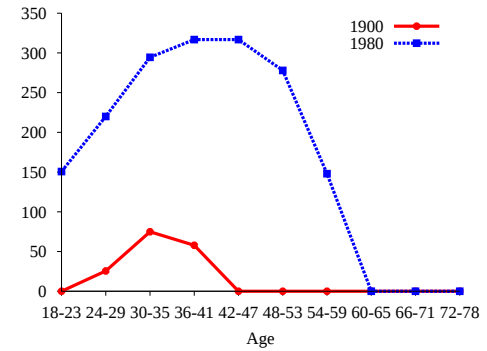
(a) Consumption



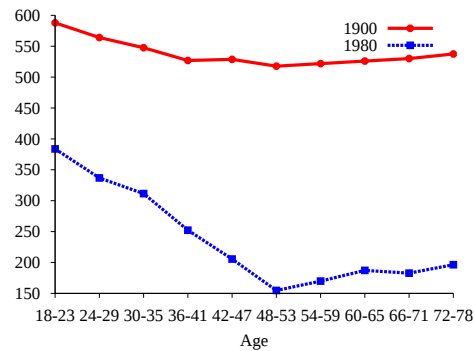
(b) Market Assets



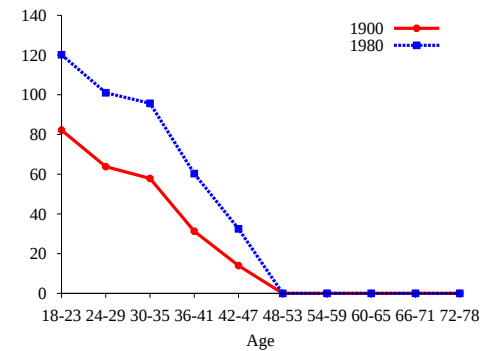
(c) Durables



(d) Female Market Time

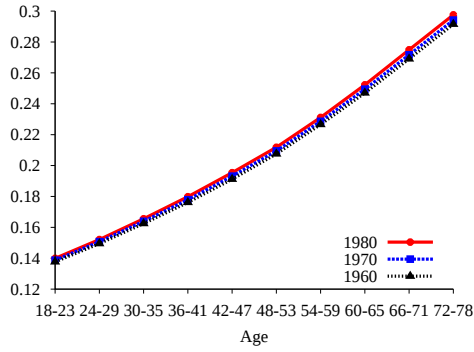


(e) Homework Time

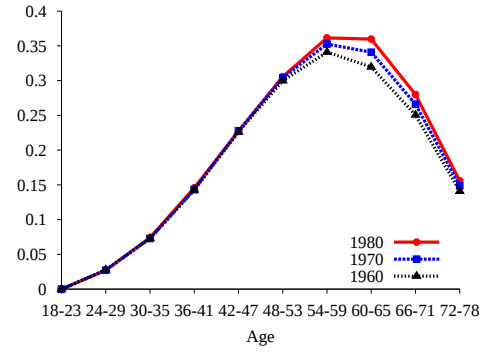


(f) (Primary) Childcare Time

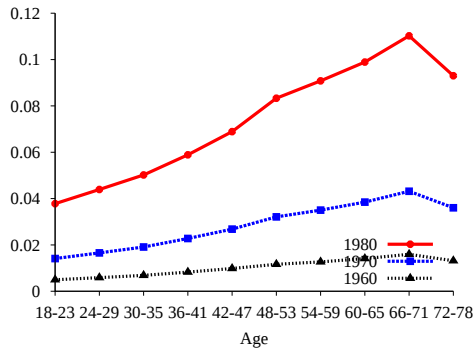
Figure 16: Steady State: Increased Substitutable Requirement, 1900 and 1990



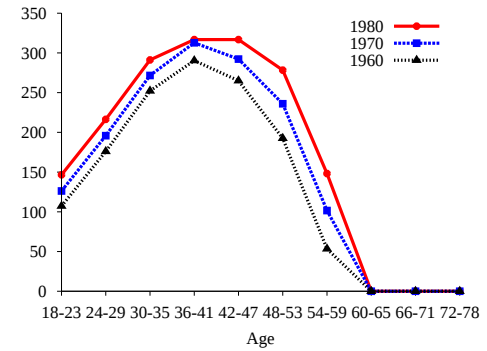
(a) Consumption



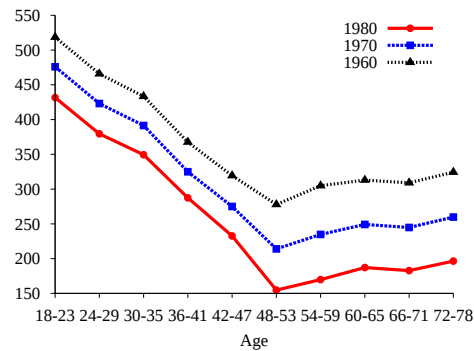
(b) Market Assets



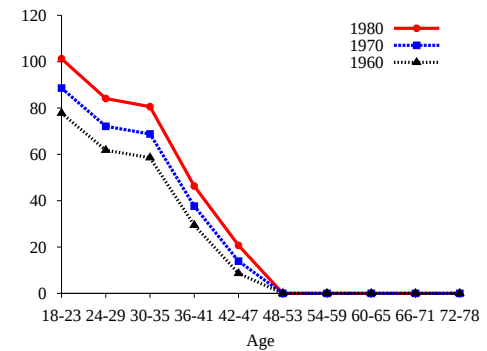
(c) Durables



(d) Female Market Time



(e) Homework Time



(f) (Primary) Childcare Time

Figure 17: 1960, 1970 and 1980 Steady States

## **5.2 The Durable Good Revolution - with Fertility Changes**

## **5.3 Results of the Simulations: Transitional Dynamics**

# **6 Conclusions**

# Technical Appendix

## A Derivation of the Household's Euler Equations

The household's problem can be cast using the language of dynamic programming as

$$\begin{aligned}
 V(a_t^i, d_t^{i-1}; i) \equiv \max & \left\{ U[c_{mt}^i, H(d_t^i, n_{ht}^i), n_{mt}^i, n_{ht}^i, n_{ct}^i] + \beta V(a_t^{i+1}, d_t^i; i+1) \right. \\
 & + \lambda_{1t}^i \left[ \bar{n}w_{t+i} + \phi n_{mt}^i w_{t+i} + r_{t+i}a_t^i + \frac{(1-\delta_d)d_t^{i-1}}{q_{t+i}} - c_{mt}^i - a_t^{i+1} - \frac{d_t^i}{q_{t+i}} \right] \\
 & \left. + \lambda_{2t}^i [G(n_{ct}^i, n_{ht}^i) - c_c^i] \right\} \quad (\text{A.1})
 \end{aligned}$$

First-order conditions:

$$c_{mt}^i : \quad U_1(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) = \lambda_{1t}^i \quad (\text{A.2a})$$

$$\begin{aligned}
 n_{ht}^i : \quad & U_2(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) H_2(d_t^i, n_{ht}^i) + U_3(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) \\
 & + \lambda_{2t}^i G_2(n_{ct}^i, n_{ht}^i) = 0 \quad (\text{A.2b})
 \end{aligned}$$

$$n_{mt}^i : \quad U_3(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) + \lambda_{1t}^i \phi w_{t+i} = 0 \quad (\text{A.2c})$$

$$n_{ct}^i : \quad U_5(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) + \lambda_{2t}^i G_1(n_{ct}^i, n_{ht}^i) = 0 \quad (\text{A.2d})$$

$$a_t^{i+1} : \quad \beta V_1(a_t^{i+1}, d_t^i; i+1) = \lambda_{1t}^i \quad (\text{A.2e})$$

$$d_t^i : \quad U_2(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) H_1(d_t^i, n_{ht}^i) + \beta V_2(a_t^{i+1}, d_t^i; i+1) = \frac{\lambda_{1t}^i}{q_{t+i}} \quad (\text{A.2f})$$

Envelope theorem:

$$a_t^i : \quad V_1(a_t^i, d_t^{i-1}; i) = \lambda_{1t}^i r_{t+i} \quad (\text{A.2g})$$

$$d_t^{i-1} : \quad V_2(a_t^i, d_t^{i-1}; i) = \lambda_{1t}^i \frac{1-\delta_d}{q_{t+i}} \quad (\text{A.2h})$$

Eliminate partials of  $V$  and  $\lambda_{1t}^i$ :

$$U_3(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) + \phi w_{t+i} U_1(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) = 0 \quad (\text{A.3a})$$

$$U_1(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) = \beta U_1(c_{mt}^{i+1}, c_{ht}^{i+1}, n_{mt}^{i+1}, n_{ht}^{i+1}, n_{ct}^{i+1}) r_{t+i+1} \quad (\text{A.3b})$$

$$\begin{aligned} \frac{U_1(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i)}{q_{t+i}} = & U_2(c_{mt}^i, c_{ht}^i, n_{mt}^i, n_{ht}^i, n_{ct}^i) H_1(d_t^i, n_{ht}^i) \\ & + \beta \frac{(1 - \delta_d) U_1(c_{mt}^{i+1}, c_{ht}^{i+1}, n_{mt}^{i+1}, n_{ht}^{i+1}, n_{ct}^{i+1})}{q_{t+i+1}} \end{aligned} \quad (\text{A.3c})$$

## References

- Bryant, W. Keith (1996). "A Comparison of the Household Work of Married Females: The Mid-1920s and the late 1960s," *Family and Consumer Sciences Journal*, 24 (4): 358–384.
- Greenwood, Jeremy, Ananth Seshadri and Mehmet Yorukoglu (2005). "Engines of Liberation," *Review of Economic Studies*, 72 (1): 109–133.
- Harvey, Andrew S., Katherine Marshall and Judith A. Frederick (1991). *Where Does Time Go?*, Ottawa: Statistics Canada.
- Lebergott, Stanley (1993). *Persuing Happiness: American Consumers in the Twentieth Century*, Princeton, N.J.: Princeton University Press.
- McGrattan, Ellen R., Richard Rogerson and Randall Wright (1997). "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy," *International Economic Review*, 38 (2): 267–290.
- Mokyr, Joel (2000). "Why Was There More Work for Mother? Technological Change and the Household, 1880-1930," *Journal of Economic History*, 60 (1): 1–40.
- Ramey, Valerie A. and Neville Francis (2005). "A Century of Work and Leisure," Working Paper 12264, National Bureau of Economic Research.
- Rupert, Peter, Richard Rogerson and Randall Wright (1995). "Estimating Substitution Elasticities in Household Production Models," *Economic Theory*, 6 (1): 179–93.
- Vanek, Joann (1973). *Keeping Busy: Time Spent in Housework, United States, 1920–1970*, Ph.D. thesis, The University of Michigan.