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

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Abstract

Over the twentieth century, the amount of time that married women devoted to working in the market increased dramatically. This paper explores the implications for the allocation of womens' time stemming from: (1) the durable goods revolution associated with the introduction of new technologies, from running water to modern appliances, that significantly reduced the time demands of home production; (2) the increase in the relative wage of women, from roughly 50% to over 80%; and (3) changes in childcare requirements associated with changes in fertility patterns. To do so, we construct a life-cycle model with home production and childcare constraints. The parameters of the childcare production function are chosen to match micro evidence from U.S. time use data. We find that the increase in the relative wage of women is the most important explanation of the increase in married womens' market work time over the twentieth century. Increases in relative wages and decreases in fertility can also explain a large part of the observed decrease in housework. The model finds that the declining price of durable goods has an appreciable effect only since 1980.

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1 Introduction

Over the past century or so, the allocation of womens' time has changed markedly. These changes manifest themselves in several ways:

1. *Market hours:* Between 1900 and 1980, the participation rate of married women (including women with a domestic partner) increased from 5.6% to 51%; over the same period, single women increased their participation from 43.5% to 61.5%. Between 1950 and 1990, market hours worked by married women shows a large increase while that of single women is nearly constant.
2. *Housework:* On this dimension, there is considerable disagreement in the literature. [Lebergott \(1993\)](#) argues that hours spent by women on housework fell from 58 hours per week in 1900 to 18 hours in 1975, a decline of 68%. [Bryant \(1996\)](#) reports that between the mid-1920s and mid-1960s, the decline in the number of hours of housework by married women was only 14%. [Ramey and Francis \(2009\)](#), building on the work of [Ramey \(2009\)](#), calculate that the decline from 1900 and 1975 was 31%; from 1900 to 2005, they find that women spent 35% less time on home production with most of this decline occurring after 1965. According to [Ramey and Francis \(2009\)](#), the decline between 1965 and 2005 is 87 minutes per day; [Aguiar and Hurst \(2007\)](#) report a decline of 108 minutes per day from 1965 to 2003.¹ While the magnitude may be in doubt, there is a consensus that women are spending less time on housework.
3. *Childcare:* We need to distinguish between two different sorts of childcare time: primary childcare which is time spent exclusively with a child, such as reading, playing, or taking him/her to the doctor; and secondary childcare which is time during which children are under parental supervision, but the parent is engaged in some other primary activity, like housework (for example, doing laundry, preparing dinner, shopping for groceries), leisure, or other activities. U.S. time use surveys from 1965 through 2006 show that the amount of time that married women spent on primary childcare has not changed very much. There is less known about the secular pattern of secondary childcare time. The best source for the U.S. is the 2006 American Time Use Survey (ATUS). This micro data source distinguishes between two types of childcare time: According to the 2006 ATUS, the typical married woman aged 30 to 35 spends 110 minutes a day on primary childcare and 357 minutes doing secondary childcare,

¹[Ramey and Francis \(2009\)](#) and [Aguiar and Hurst \(2007\)](#) define housework in somewhat different ways. For example, [Ramey and Francis](#) classify childcare as home production.

of which 120 minutes is while doing housework.² The message to take away is that married women spend a considerable amount of time taking care of children; see also [Aguiar and Hurst \(2007\)](#).

4. *Life-cycle patterns:* While the macroeconomics literature has focused on the behavior of aggregate labor inputs, there are also interesting life-cycle patterns. Prior to World War II, female labor force participation rates peaked around age 20; see [Figure 1](#). Following World War II, a double peak pattern arose. The first peak still occurred around age 20; a second peak arose around age 45. However, by 1980, this double peak pattern had almost vanished, and by the last decade of the twentieth century it had disappeared. Female participation rates now rise sharply to around age 20, are flat-to-rising until age 45, then decline.

In this paper, we construct a dynamic general equilibrium model à la Becker to address the changes in womens' allocation of time. The model includes a number of features that arise from the observations above; they are:

1. *Home production:* The technological improvements in the home sector over the past 120 years are nothing short of remarkable. In 1890, only 24% of U.S. households had running water and 8% had electricity; by 1950, 83% had running water and 94% had electricity. These changes were accompanied by several innovations: By 1950, a majority of households had indoor bathrooms and modern appliances like stoves, electric irons, vacuum cleaners, refrigerators, and washing machines. Improvements over the last half of the twentieth century include clothes dryers, freezers and microwave ovens. Furthermore, these modern conveniences have become cheaper over time, particularly when expressed relative to average female wages. Since many of these household innovations are labor-saving devices, it seems natural to think that their introduction freed up womens' time from the drudgery of housework to other activities, including market work. Observations like these motivated [Greenwood, Seshadri and Yorukoglu \(2005\)](#) to analyze the effects of the durable goods revolution on how women allocate their time between market and housework. Our model builds on their work by also including a home sector with durables serving as a (potentially) labor-saving devices.
2. *The relative wage of women:* Circa 1900, the average married woman earned roughly half that earned by the average married man; by 2000, the ratio was over 80%, with a large portion of that increase occurring since 1980. [Jones, McGrattan and Manuelli](#)

²Similar results are also found for other industrialized countries using different sources. In Canada in the 1980s, for example, a couple with least one child under the age of five spent 4.1 hours a day in primary care and 12.3 hours in secondary care; see [Harvey, Marshall and Frederick \(1991\)](#).

(2003) find that these observed changes in the earnings gap of women are the most successful explanation of the increase in the hours of market work by married women between 1950 and 1990. [Attanasio, Low and Sanchez-Marcos \(2008\)](#) also find an important role for the smaller female earnings gap. Like these earlier works, our model includes the observed increases in the relative wages of women.

3. *Childcare*: As discussed above – and in more detail in Section 2 – the time commitment associated with child rearing are substantial. In our model, childcare takes two inputs: primary childcare time, and a combination of secondary childcare time and paid daycare services. Fertility decisions are not modeled; instead, fertility and the associated childcare requirements are imposed exogenously. Calibration of the childcare production function runs into two difficulties. First, the ATUS includes no information on the time that a child spends in daycare or in the care of relatives or family friends. Second, there are no estimates of the elasticity of substitution between primary childcare time and the secondary input. These limitations are handled as follows. Given the number and ages of children, it is assumed that all women must deliver the same level of childcare services; what differs is *how* they deliver those services. As a first step, we consider only non-working women who presumably have no need for daycare. The parameters of the childcare production function (the weight on primary childcare time and the elasticity of substitution between the primary and secondary inputs) are then obtained by fitting these parameters to a childcare isoquant, given the different choices of primary and secondary childcare time as reported in the 2006 ATUS (handling the additional complication that children of different ages have different childcare requirements, and women have different numbers of children). This exercise then gives the childcare requirement (conditional on the ages and number of children) that must be satisfied. Observed fertility is then used to compute the life-cycle pattern of childcare requirements of the typical woman by cohort. In solving the model, women have the choice of how to satisfy their childcare requirement, whether through primary childcare time, secondary childcare time, or daycare services.

Like many papers in the literature, we focus on married women since they are the prime drivers of the increase in female market work. A further reason to concentrate on married women is that most children are born and raised by married women, not singles.

In the literature, few (if any) papers have treated childcare separately from home production. This seems surprising since, as [Aguiar and Hurst \(2007\)](#) note, “There are certain elements of child rearing for which market goods and parental time are not good substitutes. This proposition is supported by the fact that hardly anyone uses market substitutes to

raise their children completely. For this reason, we feel it appropriate to analyze childcare separately.” Put differently, the elasticity of substitution between market goods and childcare is not comparable to the elasticity of substitution between durables and hours in the home production function. While [Attanasio *et al.* \(2008\)](#) find that introducing children and childcare costs are important determinants of women’s labor market decisions, they measure childcare as a monetary cost that women must pay in order to work. In other words, they do not examine the time constraints implied by childcare, nor how much time women devote to this activity.

Recent empirical evidence suggests that childcare constraints limited the impact of the household revolution. [Dinkelman \(2011\)](#) examined the impact of rural household electrification on employment in South Africa and finds that the impact of changes in household technology on market work is larger for women in their 30s and 40s, and is less important in areas with a higher percentage of young children. [Cardia \(2012\)](#) finds that electric stoves in the U.S. significantly increased labor force participation rates of married women with school age children, but not the participation of married women with pre-school children.

Modeling home production and childcare as separate activities is important because of the interactions between the two. As reported in [Section 2](#), nearly a third of secondary childcare time is conducted while doing housework. A reduction in housework time has two effects: the direct effect of reducing home production, and the indirect effect of reducing secondary childcare time. This shortfall can be made up by increasing some combination of primary childcare time, leisure (the other component of secondary childcare time in our model), or daycare. So, unlike [Greenwood *et al.* \(2005\)](#), the effects on time spent in the market of introducing labor saving devices into the home production sector are far from straightforward. The same holds true for changes in the relative wages of women. Absent childcare, an increase in the relative wage will likely reduce both housework and leisure time. With childcare, these reductions in housework and leisure must be offset by increased primary childcare time or purchased daycare services in order to continue satisfying the childcare constraint.

The model is calibrated in part to observations from the 2006 ATUS. We then use the model to examine the allocation of time to market work, housework, primary childcare, secondary childcare, and leisure. It makes predictions not only for aggregates, but also the life-cycle patterns of time use, and is evaluated on both these dimensions. Simulations of the model include the secular decline in the relative price of durables, the increase in the relative wage of women, and childcare costs and fertility. We evaluate the role played by each of these elements. The simulations reveal that the durable goods revolution had little impact on the allocation of married women’s time to market hours and housework early in

the twentieth century. The most significant driving forces are changes in the relative wage and fertility (and its associated impact on childcare requirements). Between 1920 and the late 1960s, these two elements together lead to a 65% increase in market work, and replicate observed market work for 1950 as reported in [Jones *et al.* \(2003\)](#). These two factors also explain half of the decline in housework time, 7% compared to the 14% fall reported by [Bryant \(1996\)](#). At the beginning of the twentieth century and during the baby boom, the model predicts less housework time than is observed, a phenomenon that we suspect can be attributed to omitting some of the extra housework costs associated with raising children (extra laundry, meals, cleaning and shopping). At the beginning of the century, where the mismatch is more pronounced, changes in reproductive technology and the invention of infant formula may account for part of the difference; see [Albanesi and Olivetti \(2007\)](#). Looking at the technological innovations in home production from a different perspective, they show that improvements in reproductive medicine and baby formula also had important effects on female participation rates early in the twentieth century. Changes in relative wages and fertility rates may also explain the decline in market work after World War II. It is only after 1980 that further decreases in the price of durables, together with the rapid rise in the relative wage of women, contributes to explaining observed changes in market work and housework.

This paper is related to a number of other works in the literature. While the literature on the impact of technological improvements in the household sector on the allocation of time to housework is large, particularly in sociology, few papers have addressed this issue in the context of a quantitative general equilibrium model. Our modeling of the durable goods revolution owes an intellectual debt to the seminal work of [Greenwood *et al.* \(2005\)](#). They found that in a model with home production, the observed decline in the price of durables can explain a large fraction of the increase in the labor force participation of women. [Greenwood *et al.*](#) calibrated their model to data on the decline in the housework time of women reported by [Lebergott \(1993\)](#). A number of authors have suggested that the improvements in home production as embodied in durable goods have led to a more modest decline in women's housework time than reported by [Lebergott](#). The arguments, as put forth by [Vanek \(1973\)](#) and [Mokyr \(2000\)](#), are that the durable goods revolution entailed a substitution away from paid help or market services, and that the standard for hygiene and cleanliness increased.

Recently, [Jones *et al.* \(2003\)](#) cast doubt on the ability of the durable goods revolution to explain the increase in female labor force participation. In [Greenwood *et al.* \(2005\)](#), labor is indivisible: a woman must choose whether or not to participate in the labor market.³ [Jones](#)

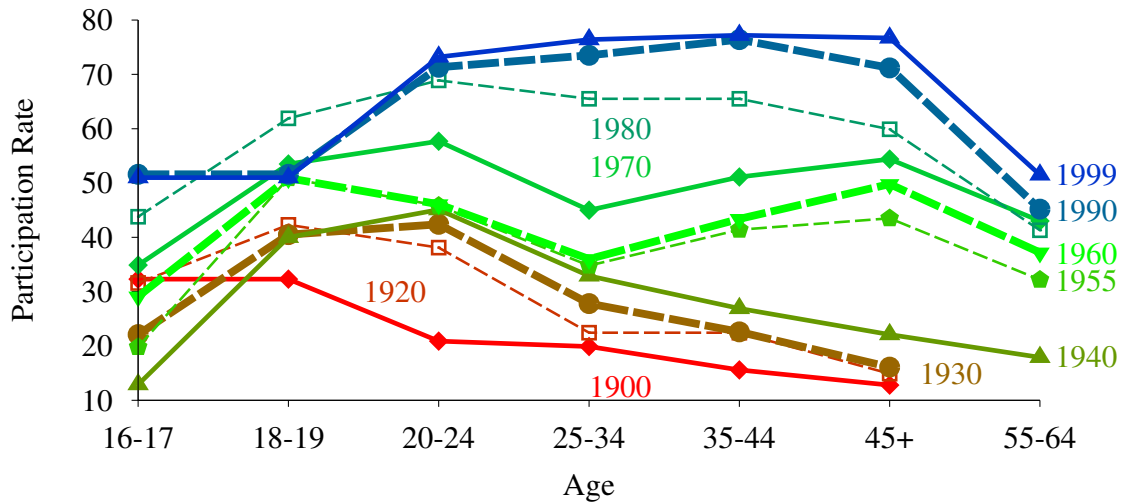
³[Greenwood *et al.* \(2005\)](#) consider a version of their model with divisible labor and divisible durable goods. They find that their results continue to hold in this environment.

et al. point out that with divisible labor, a declining price of durables increases market hours of work only if market and home goods are complements in utility while the empirical evidence is that these goods are substitutes in utility; see [McGrattan, Rogerson and Wright \(1997\)](#), [Rupert, Rogerson and Wright \(2000\)](#). [Jones et al.](#) show that for the declining price of durables to reproduce the increase in market hours between 1950 and 1990 requires that market and home goods be complements in utility and that the home consumption be an inferior good. They find that the observed changes in the male-female earnings gap is the most successful explanation for the increased market hours of married women.

Finally, our paper is related to [Attanasio et al. \(2008\)](#) who used an overlapping generations model to assess different explanations for the observed increase in the labor supply of mothers, focusing on the behavior of the 1940s and 1950s cohorts. They find that the observed increase in the relative wage of women along with a decrease in childcare costs can explain the large increases in female market work time in the latter part of the twentieth century, as well as the limited role of increases in the return to experience. [Attanasio et al.](#) include neither home production nor housework since they focus on the increase in female market hours in the last few decades of the twentieth century, after most of the technological improvements in the home sector have taken place. While other papers have looked at the role of the changing gender gap in earnings, their use of an overlapping generations structure is recent. As discussed above, the chief difference between [Attanasio et al.](#) and our paper is that they treat childcare as a kind of tax on womens' market activity while we explicitly model the time required for childcare, allowing women to substitute between primary childcare and secondary inputs. Another difference between [Attanasio et al.](#) and the current paper is that we examine trends over the twentieth century while they look at the end of the twentieth century.

The remainder of the 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. Solving the model is difficult owing to the number of potentially non-binding constraints; see [Section 5](#). In [Section 6](#) we examine the results of the simulations. While the benchmark calibration restricts market and home goods to be complements in utility, [Section 7](#) explores the implications of assuming that these goods are substitutes in utility. For an empirically plausible elasticity, the model finds essentially no role for the durable goods revolution to affect the allocation of womens' time. [Section 8](#) concludes.

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



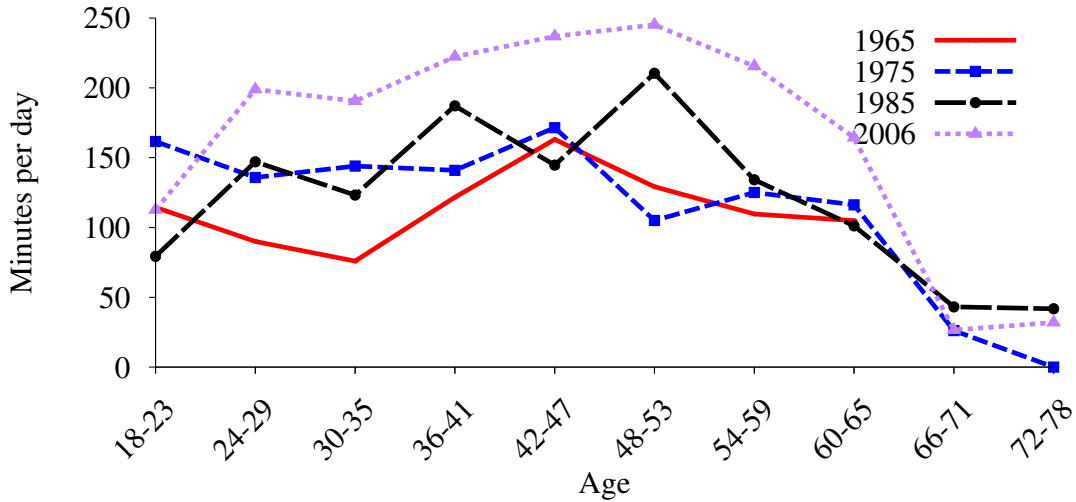
2 Historical Facts: Female Labor Force, Housework and Childcare

In this section we use data from the U.S. time use surveys and U.S. Census to examine trends in married women's market work, housework, childcare and leisure. The term married woman is used as a shorthand to include not only married women but also women with a domestic partner.

Figure 1 uses information from the U.S. census on female labor force participation rates by age group. It shows that before World War II, female participation rates declined after women reached their mid-twenties. In 1955 a significant portion of women started to reenter the labor force after their childbearing years. Up until 1970, there is a double-peaked in the life-cycle pattern of labor force participation, with one peak in women's early 20s and the other in their 40s. The double-peaked pattern flattened out by 1980, and disappeared by 1990.

The Census data are on *participation rates* and may overstate the increase in the number *hours* spent on market work by treating equally part time and full time work. However, the disappearance of the double-peaked pattern in the second half of the twentieth century, even if less pronounced, is also visible in the U.S. time use surveys which report the time women spend on market work. Figure 2 reports the observed changes in the allocation of time of married women to market work over the second half of the twentieth century. The data come from the 1965, 1975 and 1985 Time Use Surveys (TUS) and the 2006 American Time Use Survey (ATUS). Figure 2 also suggests that in the 1960s, children significantly affected the amount of time that married women spent working in the market, and that this effect has

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



since diminished. In 1965, married women in the age bracket 24-29 spent 89.97 minutes a day in market work versus 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).

Figure 3 shows marked declines in housework between 1965 and 2006. For women in the age group 24-29, housework fell steadily from 283.63 minutes a day in 1965 to 136.73 minutes 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. While housework declined sharply after 1965, in principle, the supervision of a child required the same number of hours.⁴ One concern with interpreting the decline in housework as time freed for either leisure or market work is that part of housework time was spent in providing child supervision in the form of secondary care. Unfortunately we do not have information about secondary childcare in the first half of the century, and the information we have from the Time Use Surveys prior to 2003 cannot be compared to the information collected in the more recent ATUS.

Since 2003 the ATUS has collected information about time spent during which a respondent had a household child under 13 in “his/her care” but is doing something else as a primary activity. The child need not be in the same room.⁵ In addition, if the respondent reports providing both primary and secondary childcare, the time is attributed to primary

⁴It is possible that with less time spent on housework, childcare standards increased and more time is now spent supervising children than in the first half of the century.

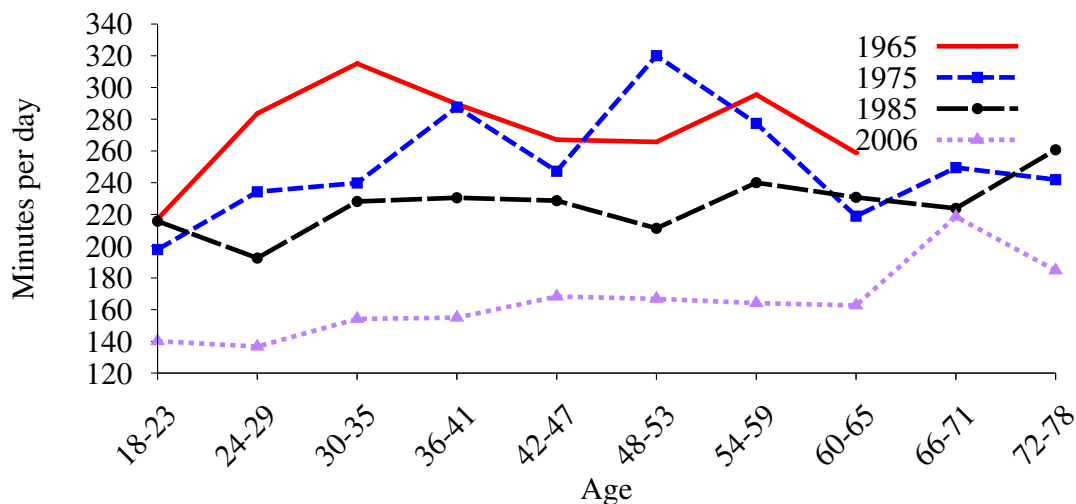
⁵The time individuals spend providing secondary childcare to household children is restricted to the time between when the first household member under the age of 13 woke up and the last household child under 13 went to bed. It is also restricted to times when the respondent was awake.

Table 1: From the 2006 ATUS: Married Women Allocation of Time

| Age | Observations | Personal Care | Leisure | Market Work | Housework | Housework (broad) |
|-------|--------------|---------------|---------|-------------|-----------|-------------------|
| 18-23 | 71 | 620.75 | 243.51 | 112.64 | 140.09 | 159.01 |
| 24-29 | 321 | 571.50 | 218.52 | 198.88 | 136.73 | 163.55 |
| 30-35 | 605 | 552.74 | 215.41 | 190.54 | 154.17 | 185.5 |
| 36-41 | 644 | 545.59 | 196.85 | 222.27 | 154.92 | 187.48 |
| 42-47 | 579 | 551.23 | 214.77 | 236.88 | 168.23 | 197.42 |
| 48-53 | 407 | 551.13 | 251.52 | 245.13 | 166.80 | 193.54 |
| 54-59 | 320 | 568.04 | 248.10 | 215.52 | 164.13 | 193.08 |
| 60-65 | 224 | 556.86 | 309.43 | 164.39 | 162.67 | 186.54 |
| 66-71 | 163 | 579.61 | 356.40 | 26.60 | 218.56 | 245.14 |
| 72-78 | 113 | 577.36 | 403.07 | 31.92 | 184.73 | 208.77 |
| 18-78 | 3447 | 559.94 | 248.08 | 191.75 | 163.09 | 191.31 |

| Age | Observations | Primary Childcare | Secondary Childcare | Secondary Childcare (with housework) | Secondary Childcare (with broad housework) | Secondary Childcare (with leisure) |
|-------|--------------|----------------------|------------------------|---|---|--|
| 18-23 | 71 | 97.30 | 377.00 | 101.00 | 108.50 | 140.70 |
| 24-29 | 321 | 104.72 | 302.23 | 87.64 | 103.12 | 92.54 |
| 30-35 | 605 | 110.20 | 357.30 | 103.96 | 120.62 | 107.27 |
| 36-41 | 644 | 89.53 | 309.47 | 84.19 | 97.65 | 82.63 |
| 42-47 | 579 | 42.27 | 172.81 | 53.10 | 58.63 | 53.20 |
| 48-53 | 407 | 13.41 | 49.40 | 16.16 | 17.91 | 13.25 |
| 54-59 | 320 | 2.86 | 15.60 | 4.41 | 5.00 | 3.62 |
| 60-65 | 224 | 2.75 | 5.11 | 0.84 | 0.89 | 2.21 |
| 66-71 | 163 | 0.52 | 4.64 | 0.97 | 0.97 | 1.85 |
| 72-78 | 113 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 18-78 | 3447 | 49.15 | 166.47 | 47.9 | 139.53 | 49.38 |

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



care only. The responses from the ATUS are not directly comparable to earlier TUS since when respondents reported that they were engaged in secondary childcare, they were then asked “what else were you doing?” and so respondents may have under-reported passive supervision of children. The recent time use surveys (ATUS) give much higher estimates of secondary childcare than previous time use surveys, suggesting that the question asked captured different notions of secondary childcare, with less passive child supervision captured in the earlier surveys.⁶ For these reasons our figures report secondary childcare only for the 2006 survey but primary childcare for all four surveys. For both primary and secondary childcare,⁷ we use only information about the respondent’s own child/children and/or their spouse’s child/children.

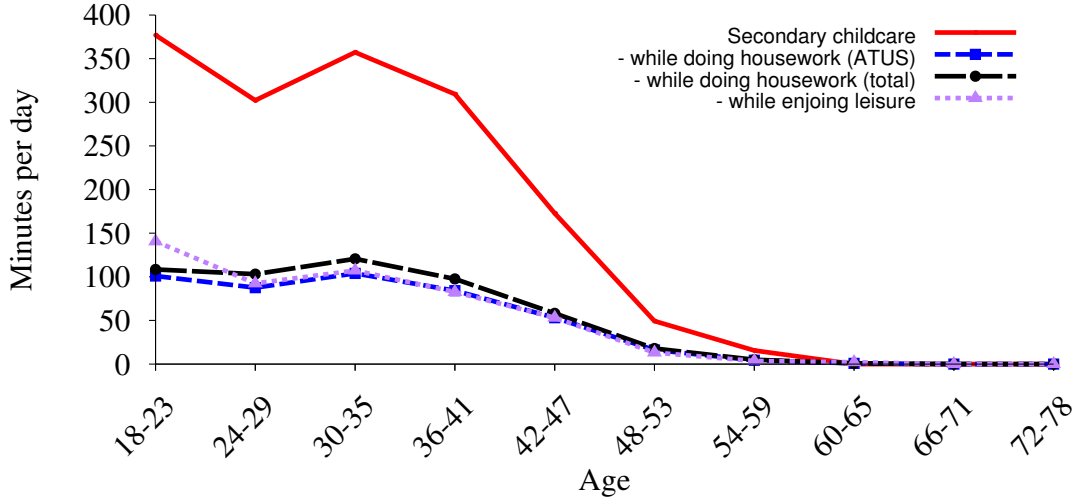
Table 1 reports for 2006 how many minutes per day married women spent on personal care, leisure, market work, housework, primary and secondary childcare.⁸ It shows shows

⁶Allard, Bianchi, Stewart and Wright (2007) describe the different measures of secondary childcare used in the surveys. They also compare the data from the 2003-2004 ATUS on primary and secondary childcare with the 2000 National Survey of Parents (NSP) conducted by the Survey Center at the University of Maryland. This is the most recent time-diary study that collects data on secondary activities. The NSP information about primary childcare is remarkably close to the information obtained from the 2003-2004 ATUS, but for secondary childcare the NSP reports much lower figures. Again, the difference is the more passive notion of childcare used in ATUS which aims at capturing the idea that the respondents may be doing something else, in a different room, not with the child, but nearby, with the knowledge of what the child is doing and capable of intervening if necessary. For primary childcare, however, the notion used in the different surveys provides very similar estimates.

⁷For secondary childcare we use the information under the flag `trthh_ln`

⁸The ATUS codes for personal care are: `tutiercode1=01`, for leisure: `tutiercode1==12`, for market work: `work (tutier1code=05) + travel to work (tutier1code=18 + tutier2code=05)`, for housework: `household activities (tutier1code=02): total housework housework + consumer purchases (tutier1code = 07, tutier2code=01+02+03)+ travel to make purchases (tutier1code=18, tutier2code=07)+ phone calls (tutier1code=16, tutier2code=01, tutier3code=04)`, for primary childcare: `household chil-`

Figure 4: Secondary Care Time (2006 ATUS)



that married women spend almost three times more time giving secondary childcare than doing primary childcare.

Figure 3 plots the total time married women spent on household chores in 2006 and Figure 4 the time spent doing housework while providing secondary childcare. Two measures of housework are used: one includes standard activities (code 02), while “total housework” also includes time spent purchasing groceries, food and gas, including time spent traveling and making phone calls related to purchases of consumption goods (see Table 1). These figures show that a considerable fraction of secondary childcare is done while mothers do household chores, particularly for married women younger than 41 and confirm the importance of the link between housework and childcare.

Figure 4 also shows secondary childcare while enjoying leisure. Both types of secondary childcare (joint with housework and with leisure) are of similar magnitude, each about a third of total secondary childcare. The other third of secondary childcare, which is not included as part of secondary childcare in our model and simulations, was done when the primary activity was some other activity such as grooming, eating a meal, or studying.⁹ The large share of secondary childcare used to satisfy the childcare requirement suggest that the link between housework and childcare might have been even more important earlier on in the century, when housework was more time intensive.

Figure 5 shows the evolution of primary childcare over the second half of the twentieth

dren tutier1code=03, (tutier2code=01 + tutier2code=02 + tutier2code=03)+ nonhousehold children tutier1code=04, (tutier2code=01+ tutier2code=02+ tutier2code=03) + travel (tutier1code=18, tutier2code=03, tutier3code=01) + (tutier1code=18, tutier2code=04 , tutier3code=01).

⁹For example, in the 2006 ATUS survey a woman between the ages of 30 and 35 spent 39.84 minutes per day supervising the kids while eating a meal, and 26.88 minutes while the primary activity was traveling.

Figure 5: Married Females: Daily Minutes of Primary Childcare Time (Time Use Surveys)

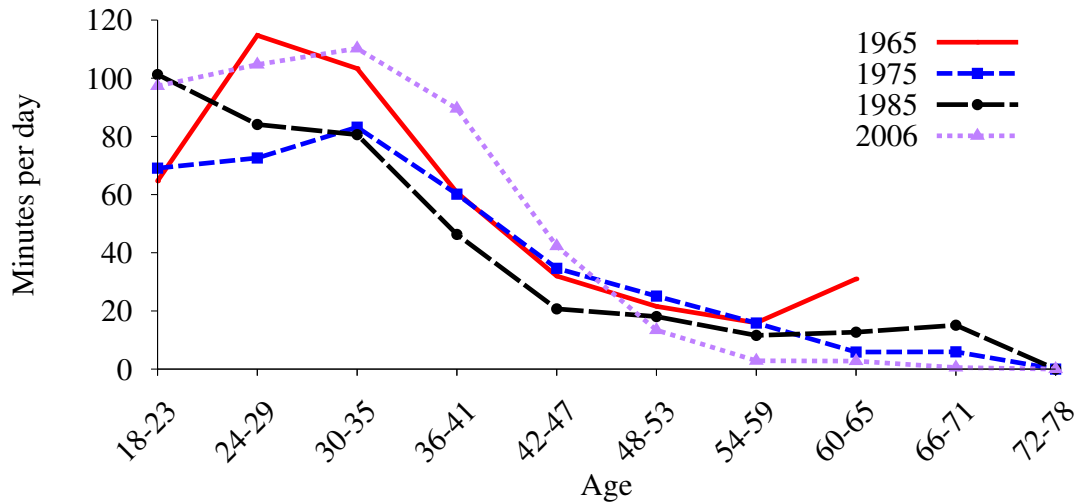
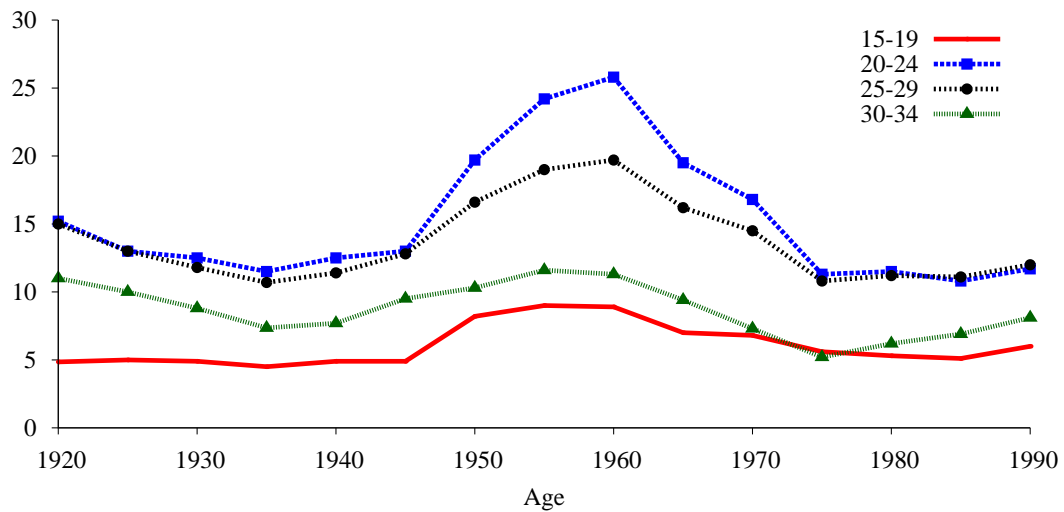


Figure 6: Live Births per 100 Women



century. The micro data do not reveal large changes in the amount of time spent on primary childcare between 1965 and 2006. However, if we exclude 1965 when childcare requirements were higher because of the baby boom, there is an increase in the time married women spend providing primary childcare to their children, about 40 minutes more a day in 2006 than in 1985 and 1975; a similar trend is reported in [Aguiar and Hurst \(2007\)](#).

Finally, Figure 6 illustrates the importance of fertility changes throughout the twentieth century and particularly during the second half of the century. We will examine whether these changes contributed to the flattening of the double-peaked pattern in womens' market work observed in the latter part of the twentieth century.

To recap, the evidence shows that there has been an increase in primary childcare time over the second half of the twentieth century. Secondary childcare time is much larger

than primary childcare time, and roughly equal fractions of secondary childcare is done while performing housework tasks and while enjoying leisure. While we have no evidence regarding secondary childcare over the entire twentieth century, the information from the second half of the twentieth century suggests that the household revolution might have had its first impact on the allocation of time between different types of childcare (primary versus secondary) and within types of secondary childcare (leisure versus housework).

3 Economic Environment

3.1 Households

The economy is populated by overlapping generations of households. Each household within a generation is identical and is comprised of a married couple which splits its time among market work, housework, secondary care and primary childcare and leisure. While men always work a fixed number of hours, the household chooses how much women work. As in [Greenwood *et al.* \(2005\)](#), women earn a fraction of what men earn. A household ‘formed’ at date t has preferences summarized by

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

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, and h subscripts indicate *home work* activities. 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:

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

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

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

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:

$$c_{ct}^i \leq G(n_{pt}^i, n_{ht}^i, \ell_t^i, s_t^i) \quad (6)$$

where

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

where n_p is *primary* childcare time, n_s is *secondary* childcare time, and s is purchased daycare services. Secondary childcare time and daycare are assumed to be perfect substitutes. Secondary childcare is a fraction of leisure time, ℓ , and housework time, n_h :

$$n_s = \theta_\ell \ell + \theta_h n_h. \quad (8)$$

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_p^i , or with secondary childcare time, n_s^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

$$c_{mt}^i + q_{t+i}x_t^i + p_{t+i}s_t^i + a_t^{i+1} = \bar{n}w_{t+i} + \phi_t^i n_{mt}^i w_{t+i} + r_{t+i}a_t^i \quad (9)$$

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, ϕ_t^i is the efficiency of the wife relative to the husband, r_{t+i} is the gross return on capital, q_{t+i} is the price of durables and p_{t+i} is the price of daycare. It is assumed that the price of daycare is a fraction ρ of the wife's wage: $p_{t+i} = \rho \phi_t^i w_{t+i}$.

The household faces a constraint on the *wife's* time,

$$n_{mt}^i + n_{ht}^i + n_{pt}^i + \ell_t^i = \tilde{T} \quad (10)$$

where \tilde{T} is the time endowment. Notice that secondary childcare time does not appear in the time constraint since it is a byproduct of leisure and housework time.

There are a number of non-negativity constraints in the model. The important ones are on the allocations of time and purchases of daycare services. As well, a woman cannot work more than a ‘standard’ work week. These constraints are:

$$0 \leq n_{mt}^i \leq \bar{n}, \quad n_{ht}^i \geq 0, \quad n_{pt}^i \geq 0, \quad \ell_t^i \geq 0, \quad s_t^i \geq 0. \quad (11)$$

The law of motion for durables is

$$d_t^i = (1 - \delta_d)d_t^{i-1} + x_t^i. \quad (12)$$

The household faces the following boundary conditions:

$$d_t^{-1} = 0, \quad a_t^0 = 0, \quad d_t^T \geq 0, \quad a_t^{T+1} \geq 0 \quad (13)$$

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 (9)–(13), 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

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

The right-hand side adds 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

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

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

Finally, goods market clearing is written

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

4 Calibration

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

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 6-12. 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.

A number of the model's parameters are standard, and hopefully require little discussion. These parameters include: α , capital's share of income; δ_k , the depreciation rate of market capital; and δ_d , the depreciation rate of durables. The depreciation rates are consistent with results reported in Gomme and Rupert (2007). The initial price of durables, q_{1900} is chosen so that in 2006, the durables-output ratio is around 0.325 – a value that is consistent with the data; again, see Gomme and Rupert (2007). The price of durables declines at the rate 8.3% per annum, as in Greenwood *et al.*. Time spent working by men, \bar{n} , is 320 minutes per day (a 7.5 hour work day, 5 days a week). \bar{n} is also the maximum amount of time that a woman can work in the market.

Perhaps the most problematic parameters are those characterizing the childcare production function, ν and φ . The *model* says that for household i , childcare is

$$c_c^i = [\nu(n_p^i)^\varphi + (1 - \nu)(n_s^i + s^i)^\varphi]^{1/\varphi}.$$

In order to estimate the parameters of the childcare production function, we assume

Table 2: Parameter Values

| | | |
|-------------------------------|--|---------|
| Time | | |
| | Length of a period (years) | 6 |
| | Number of periods of 'life' | 10 |
| \tilde{T} | Time endowment (minutes per day) | 680 |
| Market production | | |
| α | Capital's share | 0.33 |
| δ_k | Depreciation rate of market capital (annual) | 0.07 |
| Utility | | |
| ω | Weight on leisure in utility function | 0.6354 |
| β | Discount factor (annual) | 0.9821 |
| Consumption aggregator | | |
| ψ | Weight on market consumption | 0.7450 |
| ξ | CES parameter | -0.3 |
| Home production | | |
| η | Weight on durables | 0.4590 |
| ζ | CES parameter | 0.35 |
| δ_d | Depreciation rate of durables (annual) | 0.2 |
| q_{1900} | Initial price of durables, 1900 | 13 |
| g_q | Change in price of durables | -8.3% |
| Childcare | | |
| ν | Weight on primary childcare time | 0.58347 |
| φ | CES parameter | 0.75715 |
| θ_ℓ | | 0.6 |
| θ_h | | 0.8 |
| ρ | cost of childcare as a fraction of wages | 0.5 |

Table 3: Childcare Production Function Estimates

| Parameter | Estimate | Standard Error |
|-----------|-----------|----------------|
| p_{01} | 159.74207 | 6.79635 |
| p_{02} | 171.81351 | 8.98634 |
| p_{10} | 213.92775 | 5.86796 |
| p_{11} | 239.36241 | 7.27665 |
| p_{12} | 235.77827 | 11.40349 |
| p_{20} | 256.11998 | 6.80167 |
| p_{21} | 251.56954 | 11.23365 |
| p_{22} | 229.29934 | 21.86333 |
| ν | 0.58347 | 0.01497 |
| φ | 0.75715 | 0.04515 |

that non-working married women use no daycare services. For such women, the estimating equation is of the form

$$0 = - \sum_{j=0,1,2} \sum_{\substack{j'=0,1,2 \\ j \neq j'}} p_{jj'} I_{jj'} + [\nu(n_p^i)^\varphi + (1 - \nu)(n_s^i)^\varphi]^{1/\varphi} + \epsilon_i$$

where $I_{jj'}$ is an indicator function equal to 1 if the woman has j children under the age of 6 and j' children aged 6 to 12.¹⁰ $p_{jj'}$ gives the childcare required if the number of children is given by the ordered pair, (j, j') . The parameters to be estimated are the $p_{jj'}$ s, ν and φ . Conceptually, the values of ν and φ trace out different childcare isoquants while the $p_{jj'}$ s index different isoquants.

The parameter estimates are summarized in Table 3. All of the parameters are fairly tightly estimated. What is most important is that the CES parameter, φ , implies a fair deal of substitutability between primary and secondary childcare. In other words, households will find it relatively easy to substitute, say, from primary to secondary childcare in order to satisfy their childcare requirement.

The childcare requirements, $p_{jj'}$, can now be used to calculate the amount of daycare working women have to provide to their children to ensure that the childcare requirements are met.¹¹

Going from the estimates of the $p_{jj'}$ s to the childcare requirement for a ‘typical’ woman in a particular cohort is somewhat involved. First, fertility data is available at five year intervals

¹⁰In the ATUS, very few women have more than 2 children under the age of 6, or more than 2 children aged 6 to 12.

¹¹In principle, we should be using primary and secondary childcare time for the household, not just the wife. Unfortunately, as discussed earlier, the ATUS only collects time use data for the respondent, not the household.

from 1920 through 1995. For dates prior to 1920, the 1920 observation is repeated; for dates after 1995, the 1995 observation is repeated. The fertility data is available for the following age groups: 20–24, 25–29, 30–34 and 35–39. It is assumed that woman over the age of 40 do not give birth; as an empirical matter, their fertility rate is extremely low. This data is converted to annual using spline interpolation. Second, the fertility data is used to compute the number of newborns for each year, for each possible age of a woman; it is assumed that all woman in the same age group have the same fertility. Third, use the newborn data to figure out the number of children under the age of 6, at 6 year intervals. The same data, offset by 6 years, gives the number of children aged 6 to 12. Fourth, these ‘child profiles’ are adjusted to match the ATUS. The reason for this adjustment is that the fertility data is for all woman while from the ATUS we are interested in only married women. Finally, use the childcare requirement estimates, $p_{jj'}$, to compute the childcare requirement for each household cohort. Since a representative woman of a particular cohort will, in general, not have an integer number of children, it is necessary to interpolate the childcare requirement.

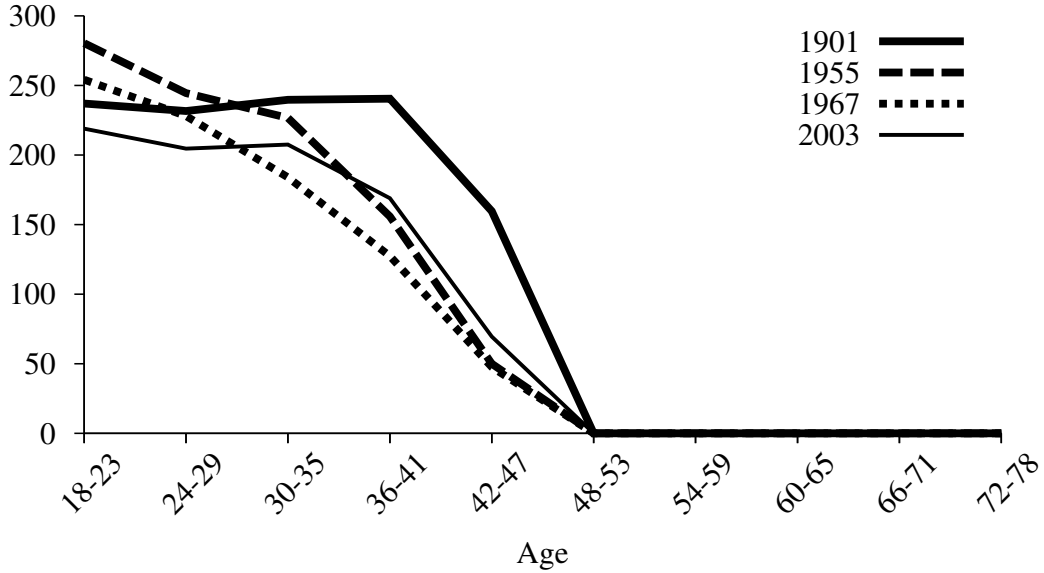
Figure 7 presents the childcare requirement profile for the 1901, 1955, 1967 and 2003 cohorts. Early in the twentieth century, the childcare requirement was fairly flat until the typical woman reached her mid-30s, falling off fairly shortly thereafter. The 1955 cohort which gave birth to the baby boom generation saw a higher childcare requirement early in the life-cycle, but this requirement fell off fairly smoothly with age. By the end of the twentieth century, the typical childcare requirements of a woman early in her life-cycle had fallen, but were reasonably flat to her early-30s. One may well ask why the sharp increase in births associated with the baby boom – see Figure 6 – does not manifest itself in a sharper increase in childcare requirements for the 1955 cohort. The answer lies in the childcare requirement estimates in Table 3. Having two children under the age of 6, for example, does not double the childcare requirement, it increases it by 20%. In other words, the incremental effect of an additional child on the childcare requirement is relatively small once a woman already has a child.

Recall from Eq. (8) that secondary childcare time, n_s^i , is the sum of a fraction θ_ℓ of leisure time and a fraction θ_h of housework time. It is assumed that these fractions are constant: they do not vary with the age of the woman, nor with the age or number of children. The fractions are taken to roughly match observations from the ATUS data and are as reported in Table 2.

The parameter ρ is the cost of daycare as a fraction of a woman’s wage. Its value is obtained as the ratio of average female domestic worker earnings to average female earnings, measured in the late twentieth century.

For durables to be labor-saving, durables and housework time have to be fairly substi-

Figure 7: Childcare Requirement Profiles by Cohort

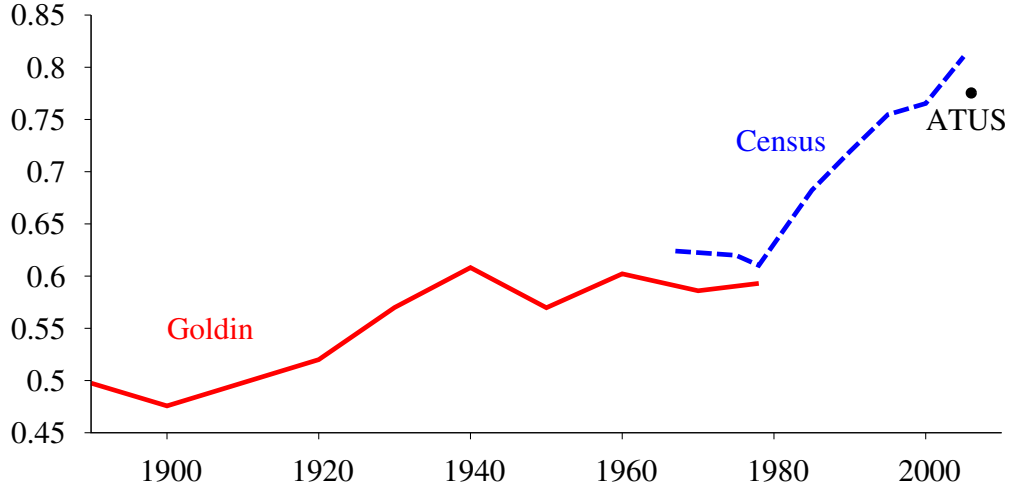


tutable. Hence we set the CES elasticity of substitutions in the home production $\zeta = 0.35$ which implies more substitutability than Cobb-Douglas. This value for ζ is in the range estimated by McGrattan *et al.* (1997) and Rupert, Rogerson and Wright (1995). Consider, instead, the setup in Greenwood *et al.* (2005). There, market time is indivisible, hours and durables are perfect complements (the home production function is Leontief), durables are indivisible, and by assumption, adopting the latest vintage of durables increases the productivity of housework time in a labor-embodied fashion. As the price of durables falls, a household eventually adopts the newest vintage of durables. While their model is quite suitable for analyzing the household durable adoption decision, our model is more appropriate for comparing the allocation of time between market work, housework, childcare and leisure.

The elasticity of substitution between market and home goods plays an important role in the analysis. As Jones *et al.* (2003) show, when market and home goods are good substitutes, improvements in home technologies induces a decrease in market hours; only when the two goods are highly complementary will market hours increase. Empirical evidence in McGrattan *et al.* (1997) and Rupert *et al.* (1995) suggest, instead, that home and market goods are substitutes, which implies that improvements in home technologies will decrease female market hours. As in Jones *et al.* (2003) we assume complementarity between the two goods so that improvements in home technology generate a positive effect on female market work. While Jones *et al.* (2003) set $\xi = -0.75$, which implies an elasticity of substitution between home and market goods equal to 0.57, we assume slightly more substitutability by setting $\xi = -0.3$ (an elasticity of 0.74).

The data for the earning gap for the period from 1900 to 1980 included, come from Goldin

Figure 8: Earning Gap: Female to Male Earnings



(1990) and for the period between 1985 to 2005, from various issues of the Census Statistical Abstracts. Both definitions use median full time earnings for white women and men. As Figure 8 shows, the earning gap increases sharply after 1980, similar increases are also found in Jones *et al.* (2003) and Attanasio *et al.* (2008).

The time endowment, \tilde{T} , requires some discussion. In the business cycle literature, the usual practice is to set the time endowment to discretionary time: total time less sleeping and personal grooming. In the business cycle model, this discretionary time is then split between working and leisure. Since there are no time series on aggregate leisure, the business cycle literature is not particularly interested in leisure per se. However, as shown in Table 1, what the business cycle researcher calls leisure is, in fact, a mix of many activities, only a small portion of which is leisure. If we took the total time endowment (1440 minutes per day), subtracted off personal care (from the ATUS, about 560 minutes per day), and matched the profiles for market work, housework and primary childcare time, then the model would predict far too much leisure time since, on average, women spend about 200 minutes per day on other activities. For the model, it is important to get leisure right since it is one of the inputs to secondary childcare. In order for the model to have a chance at matching the observed life-cycle profiles, we treat this ‘extra’ 200 minutes per day as non-discretionary time. Alternatively, we can compute \tilde{T} as the sum of average market time, housework time, primary childcare time, and leisure. Doing so gives a value of about 680 for \tilde{T} . Keep in mind that defining discretionary time in this fashion simply gives the model an opportunity to get average time allocations right, not the life-cycle patterns.

The remaining parameters are: ω , the weight on leisure in utility; β , the discount factor; ψ , the weight on market consumption in the consumption aggregator; and η , the weight on

durables in the home production function. These parameters are chosen to roughly match the following observations:

1. From the 2006 ATUS, married women worked, on average, 198.28 minutes per day.
2. From the 1965 U.S. TUS, married women worked, on average, 113.6 minutes per day.
3. An annual real interest rate of 4%.
4. From the 2006 ATUS, married women on average performed 192.02 minutes of housework.

5 Solving the Model

There are a number of features in the model that make it difficult to solve using standard techniques, meaning solving sets of non-linear Euler equations and constraints. First, the fact that secondary childcare time and daycare services are perfect substitutes means that the non-negativity constraint on daycare sometimes binds. Second, there is sufficient substitutability between primary childcare time and secondary childcare that the non-negativity constraint on primary childcare time sometimes binds. These two problems are exacerbated by the fact that secondary childcare time is a ‘cast off’ of other activities, namely housework time and leisure. Third, the substitutability between durables and housework time mean that the non-negativity constraint on housework time may also bind. Finally, the inequality constraint on childcare may bind, particularly later in a woman’s life-cycle when secondary childcare time may be more than sufficient to satisfy this constraint.

While a number of approaches were taken to solving the model, in the end a brute force maximization of lifetime utility subject to the various constraints and non-negativity constraints did the trick, with one modification: the Euler equations for asset and durables accumulation were included among the constraints.¹² In a sense, including these Euler equations amounts to blending a straight maximization of lifetime utility with solving Euler equations. The reason for including these Euler equations is that while the solution algorithm performed well in finding solutions for ‘static’ variables (‘well’ in the sense that these variables fit their relevant Euler equations), the same could not be said for the ‘dynamic’ variables.

Simulating the model proceeds as follows. First, conjecture a path for the capital-labor ratio. The capital-labor ratio then gives the path for the real wage and return to capital. Second, solve the household’s problem for each cohort. That is, given the path for factor prices, maximize each household’s lifetime utility, subject to its constraints. Third, compute

¹²The actual optimization code (with inequality constraints) is due to [Schittkowski \(1985/86\)](#).

what the model implies for the path of the capital-labor ratio. If this computed path is sufficiently close to that conjectured, stop; otherwise, update the conjecture for the path of the capital-labor ratio and repeat the steps above.

Finally, we construct artificial time use surveys in exactly the same way that they are for the U.S. Specifically, we do not present the life-cycle profile for some cohort. Instead, we build up a model-based time use survey that corresponds to a snapshot of the time allocations of the generations that are alive at the time of the survey.

6 Results of the Simulations

The base case simulation incorporates the historical patterns in the earnings gap, the price of durables, and fertility (and so childcare requirements). The following counter-factual experiments are also conducted: (1) eliminate the effects of changes in the home productivity by keeping the price of durables at their 1900 level; (2) keep the relative wage of women fixed at its 1900 level; (3) maintain fertility, and so childcare requirements, at their 1900 level; and (4) eliminate the childcare requirement.

The model is evaluated in two ways. First, Figures 9–11 ask how well the model performs with regards to the life-cycle profiles for the allocation of time as reported in various U.S. time use surveys. Second, Figures 12 and 13 examine the model’s ability to mimic the observed behavior of aggregate time allocations.

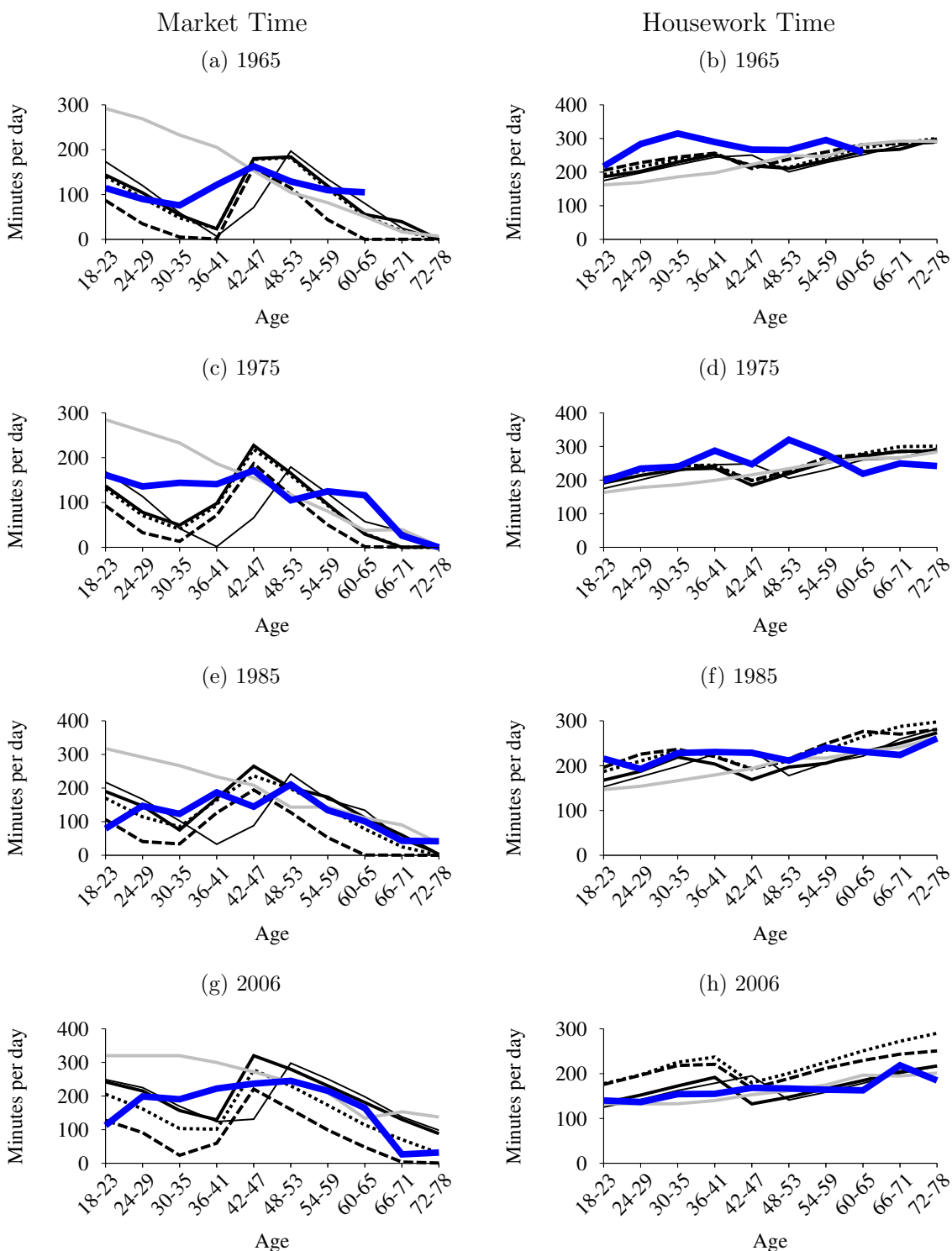
A final experiment, reported in Figure 14, consider the aggregate effects of a 25% reduction in the cost of childcare.

6.1 Life-cycle Patterns

Benchmark Model

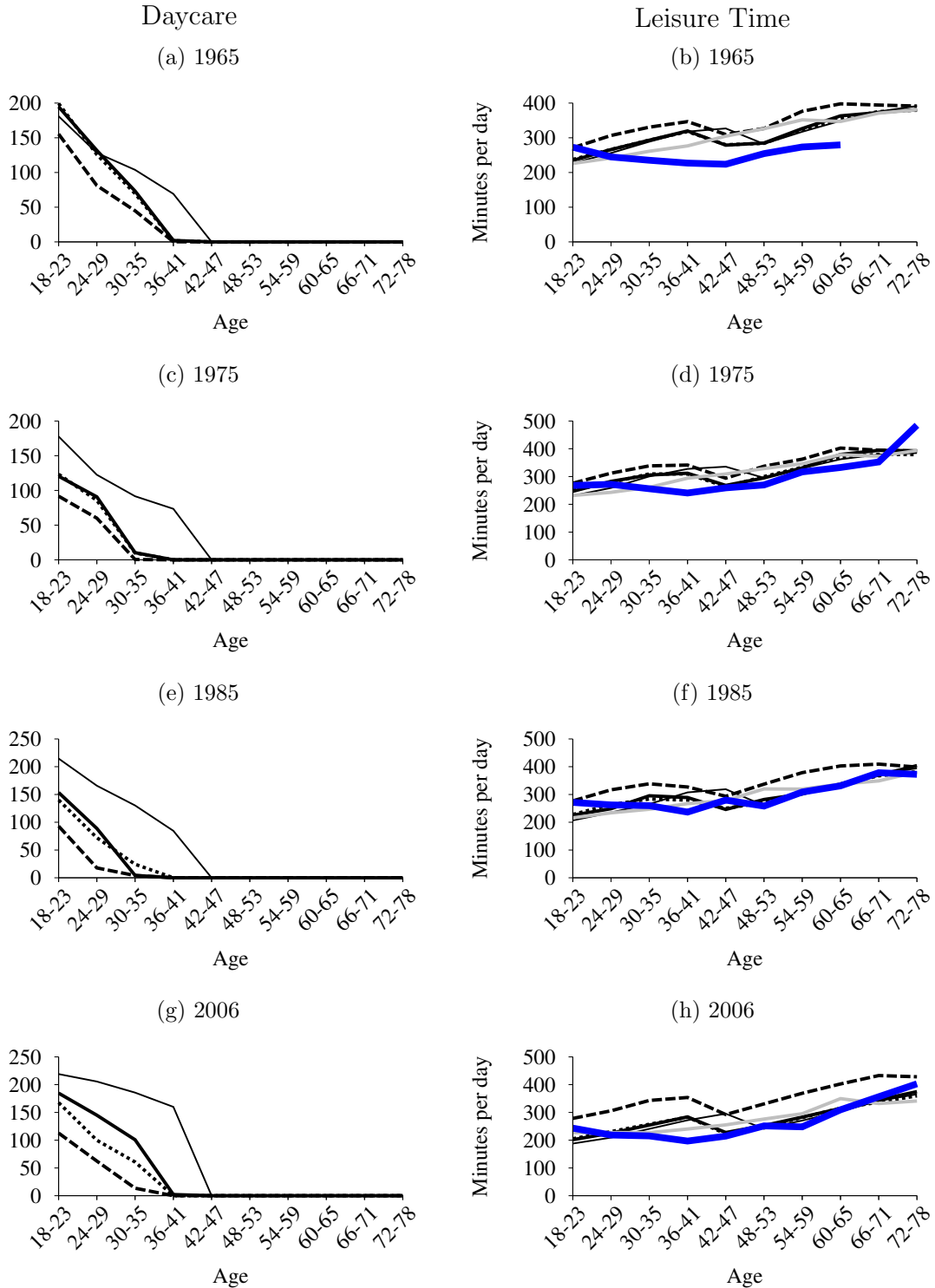
Data and model simulations for market work are presented in the left-hand panels of Figure 9. In 1965, the data exhibits a double peak pattern to married womens’ work time, starting high, dropping off in a woman’s early-30s, rising again in her 40s, then declining again. The model exaggerates the double peak pattern, under-predicting market time in a woman’s 30s, and over-predicting in her mid-40s to mid-50s. While the 1975 TUS shows a flattening of this double peak pattern, the model continues to show a definite double peak. Consequently, the model under-predicts market time early in a woman’s life-cycle, then again over-predicts in her mid-40s to mid-50s. The 1985 and 2006 surveys display a hump-shaped pattern. For these years, the model continues to predict a double peak pattern, although there is a flattening of the peak and trough.

Figure 9: Simulations: Market Work and Housework



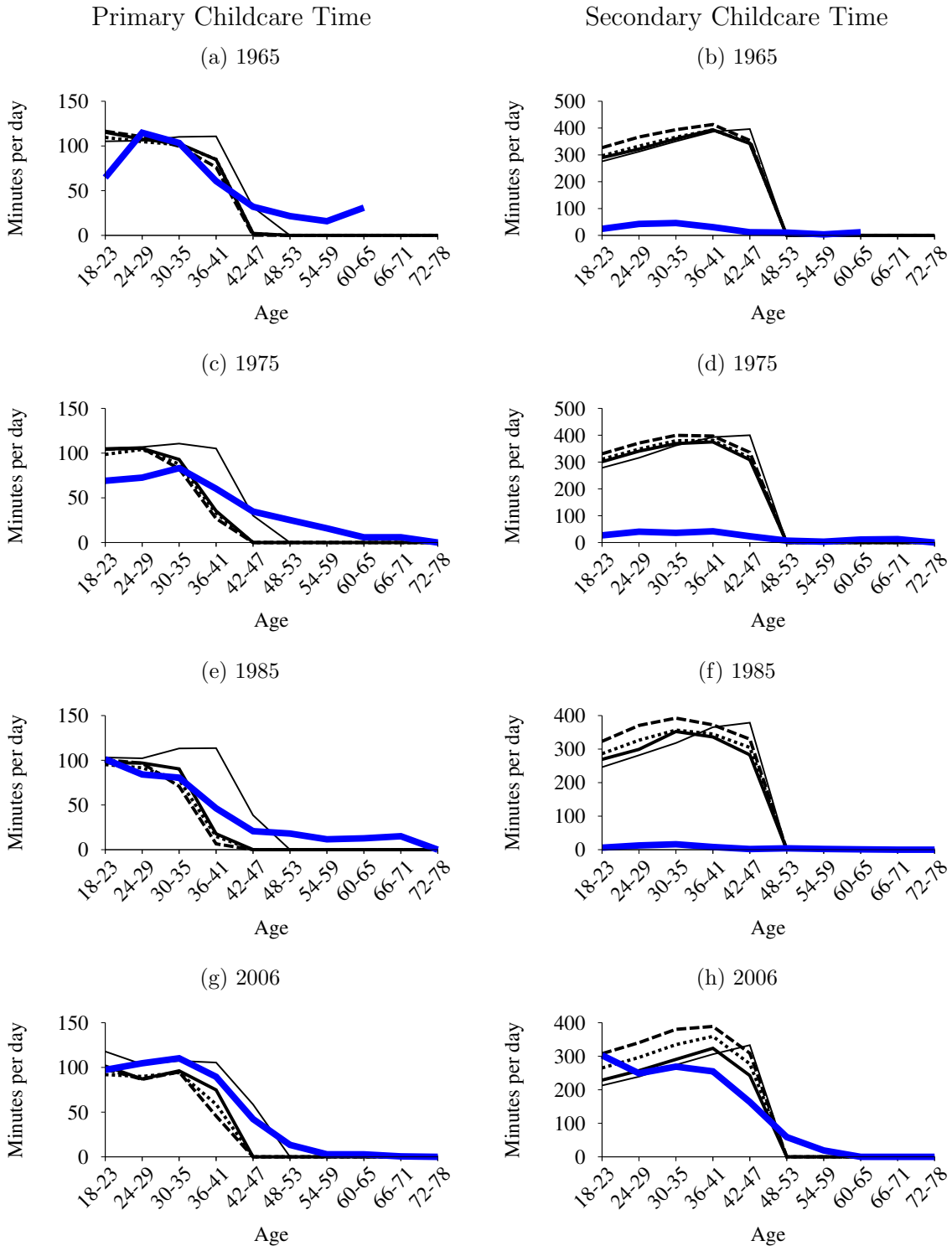
Legend: (1) heavy, blue solid line: U.S. Time Use Survey data (various years); (2) black solid line: benchmark model; (3) black dashed line: 1900 relative wage; (4) black dotted line: 1900 price of durables; (5) thin black line: 1900 childcare requirements; (6) gray solid line: no childcare.

Figure 10: Simulations: Leisure and Daycare



Legend: (1) heavy, blue solid line: U.S. Time Use Survey data (various years); (2) black solid line: benchmark model; (3) black dashed line: 1900 relative wage; (4) black dotted line: 1900 price of durables; (5) thin black line: 1900 childcare requirements; (6) Gray solid line: no childcare.

Figure 11: Simulations: Primary and Secondary Childcare



Legend: (1) heavy, blue solid line: U.S. Time Use Survey data (various years); (2) black solid line: benchmark model; (3) black dashed line: 1900 relative wage; (4) black dotted line: 1900 price of durables; (5) thin black line: 1900 childcare requirements; (6) Gray solid line: no childcare.

One might speculate that one reason why the model over-predicts market time for the youngest group of women (18 to 23) is because of time spent on education. For 2006, the model predicts around 250 minutes compared to 112.64 in the data. It turns out that married women in this age group devote a mere 23 minutes per day to education. There are a number of anomalies concerning this age group that cannot be understood within the context of our model. As reported in Table 1, this age group spends substantially more time on personal care than the 24 to 29 age group: 620 minutes compared to 571. The younger age group also spends more time on leisure (243 minutes versus 218) than the next older age group. A further issue is that the number of women in this youngest age group is much smaller than the other age groups.¹³

The model under-predicts market time of women between the ages of 24 and 35, and over-predicts for those aged 42 to 47. One potential explanation for these discrepancies is that we have abstracted from human capital accumulation, and just as importantly human capital depreciation when a woman is temporarily out of the market. Were these elements included, women may find it preferable to maintain their attachment to the market in order to maintain their salary, and so juggling their childcare responsibilities. Modeling human capital in this way would, we expect, boost the model's predictions for market time early in a woman's life-cycle (where the benchmark model under-predicts). It may also imply less market time for women in their early 40s since some of these women would have experienced sizable depreciation in their human capital during their childbearing years.

With regards to the model's under-prediction for market hours of women aged 24 to 35, it is possible that we have overstated childcare costs. For example, a significant number of women receive family help; see [Cardia and Ng \(2003\)](#). Using the 1992 release of the Health and Retirement Survey, they find that 42.5% of households with at least one child and grandchild spent more than 100 hours per year caring for grandchildren. Other data sources likewise indicate that there are non-trivial intergenerational transfers of time. Using the National Longitudinal Survey of Labor Market Experience, [Presser \(1989\)](#) finds that grandmothers are the most common (23.9%) type of care for preschool children, averaging 27.1 hours per week.

Over the four surveys, housework time is flat-to-rising over the life-cycle; see the right-hand side of Figure 9. The model also generates flat-to-rising profiles. In 1965, the model under-predicts the data throughout. For 1975 and 1985, the model under-predicts housework time for women in their late 30s to late 50s, then over-predicts later in the life-cycle. Overall,

¹³This youngest age group spends 93.4 minutes per day on secondary childcare while watching television compared to 52.7 minutes for the next oldest age group. The younger age group only spends 23 minutes per day on education while the next age group spends 74.

the model's prediction is closer to the data for the 1985 survey. The calibration procedure ensures that the model roughly matches average housework time. However, the model over-predicts women's housework time through their 30s, then under-predicts for their 40s to mid-50s.

For leisure, the data exhibits a flat-to-rising profile; see the left-hand side of Figure 10. The model mimics this flat-to-rising pattern. However, for 1965, the model over-predicts leisure time across the life-cycle. The degree of over-prediction for leisure is smaller for the 1975, 1985 and 2006 surveys. For 2006, the model noticeably over-predicts leisure time for women in their 30s; the same is true of the 1975 survey.

A plausible explanation for the mismatch between the model and data with respect to both housework and leisure time is that we have assumed that having children does not lead to more housework, like more laundry, meal preparation, cleaning and shopping. Since the mismatch is most pronounced when fertility is at its highest, in 1965, this may be an important omission. To get some idea of the how much housework can be attributed to children, we made a number of calculations from the 2006 ATUS. Consider women aged 25 to 35. A typical married woman in this age group with no children under the age of 6 spent 125.3 minutes per day on housework; those with one child under the age of 6 spent 147.6 minutes; and those with two children under the age of 6 spent 185.7 minutes. These are sizable increases in housework time, and we suspect that including these costs in our model would improve its predictions for housework and leisure time, even though it may further decrease the amount of time allocated to market work.

In the data, primary childcare tends to start off high, then drops off gradually starting in a woman's late 30s; see the left-hand side of Figure 11. The model displays a similar pattern. Throughout, the model misses the amount of primary childcare time starting in a woman's 40s, principally because we assumed that by that age, children no longer require childcare (in part because they are sufficiently old, and in part because relatively few women have children past their mid-30s). For 1965 and 1975, the model over-predicts the amount of time spent on primary childcare for young women. The model's predictions for 1985 and 2006 are a pretty good match for the data.

For secondary childcare, we focus on the 2006 survey since it seems to have better measured secondary childcare time. It is probably not too surprising that the overall life-cycle pattern for secondary childcare looks similar to that of primary childcare: it starts high, then gradually falls off; see the right-hand side of Figure 11. The model exhibits a similar pattern although it under-predicts early in the life-cycle and over-predicts for women in their 30s. These misses on secondary childcare time are a direct consequence of not matching exactly the patterns of its constituent components, leisure and housework time.

The model also makes predictions for daycare use; see the left-hand side of Figure 10. The model predicts that the heaviest use is early in a woman’s life-cycle, and that daycare drops off fairly quickly. In fact use of daycare goes to zero *before* the childcare constraint does; so does primary childcare time. What is happening is that by the time woman reaches her early 40s, there is more than sufficient secondary childcare time to satisfy the childcare constraint. This prediction follows from the assumptions that secondary childcare time and daycare are perfect substitutes, and that secondary childcare time is a good substitute for primary childcare time.

To summarize, the benchmark model does a decent job of accounting for the life-cycle pattern of market work time by married women over the four U.S. time use surveys. The model does well in capturing the flat-to-rising life-cycle profiles for housework time, although it tends to underpredict for 1965 and 1975. In the data, leisure is likewise flat-to-rising; again, the benchmark model captures this pattern although it once more underpredicts for 1965. The model does well in mimicing the observed life-cycle pattern to primary childcare which starts off high, then gradually falls off. The story for secondary childcare follows largely from that for housework and leisure time which is to say that the model exhibits a similar pattern to that seen in the data. Overall, it is times when fertility – and so childcare requirements – are high that the model tends to underpredict the patterns seen in the data.

The Importance of Childcare

To assess the importance of childcare on the model’s predictions for the life-cycle allocations of time, we re-solve the model using the benchmark parameter values except that the childcare constraint is zero. This parameterization stands in as our version of Greenwood *et al.* (2005). With respect to the predictions for housework and leisure time, there is little to choose between the benchmark model and the model without childcare; see the right-hand panels of Figures 9 and 10. However, the model without childcare predicts that women allocate a lot of time to working in the market early in their life-cycles, then gradually reduce this time as they age; see the left-hand side of Figure 9. Intuitively, without childcare, there is an incentive for women to work early in their life-cycle in order to save and accumulate assets; later in their life-cycles, women live off the returns to these assets and reduce the amount of time devoted to market work. This pattern is quite unlike the data. Recall that 1965 is characterized by a double peak life-cycle pattern. Over time, this double peak has flattened; the 1985 and 2006 surveys reveal a hump-shaped pattern to market time. These observations indicate that modeling childcare is important for understanding the life-cycle allocation of married womens’ time to market activity.

Counter-factuals

Figures 9–11 report three counter-factual experiments. The first asks what the second half of the twentieth century would have looked like without the durable goods revolution. We simulate this scenario by keeping the price of durables at their 1900 level. Without these labor-saving durables, housework time would be larger. In order to allocate more time to housework, married women need to reduce the amount of time devoted to other activities. While there is little change in leisure, market work is predicted to fall across the life-cycle. Owing principally to the increase in housework, secondary childcare time rises. Due to their substitutability with secondary childcare time, primary childcare time and daycare both fall. All of these effects tend to be small *except* for 2006.

The second experiment keeps the relative wage of women at its 1900 level. Not surprisingly, women substitute out of market work into other activities, chiefly housework and leisure. Owing to these increases in leisure and housework time, secondary childcare time rises. This latter increase leads to marked declines in both primary childcare time and daycare, again owing to their substitutability with secondary childcare time. Overall, the effects of lowering the relative wage of women is quite sizable, particularly in 2006 when the relative wage is much higher than the other survey years; see Figure 8.

The final experiment imposes the 1900 childcare requirement throughout the twentieth century. As reported in Figure 7, the principal effect of this change is to boost the childcare requirement of older women (between their mid-30s and mid-40s) since early in the twentieth century, women had more children and later into life. It is, then, not surprising that the effects of this experiment manifest themselves chiefly among women in their mid-30s to mid-40s. The model predicts that these middle aged women will spend less time working in the market, more time doing housework and enjoying leisure (and so more time on secondary childcare time). Primary childcare time and use of daycare by middle aged women are both much higher than under the benchmark calibration.

Overall, these experiments indicate sizable effects associated with fertility (as reflected in changes in childcare requirements), particularly among middle aged women; larger effects over the entire life-cycle due to the increase in the relative wage of women; and fairly modest effects of the durable goods revolution, especially prior to the 2006 survey.

6.2 Aggregate Trends

Figure 12 eschews the life-cycle patterns in favor of a more aggregated view of the model's results. Specifically, Figure 12 presents aggregated time allocations over roughly the past century. The chief goal here is to get a different perspective on the factors behind the changes

in the allocations of womens' time. To this end, the same counter-factual experiments are included in this figure.

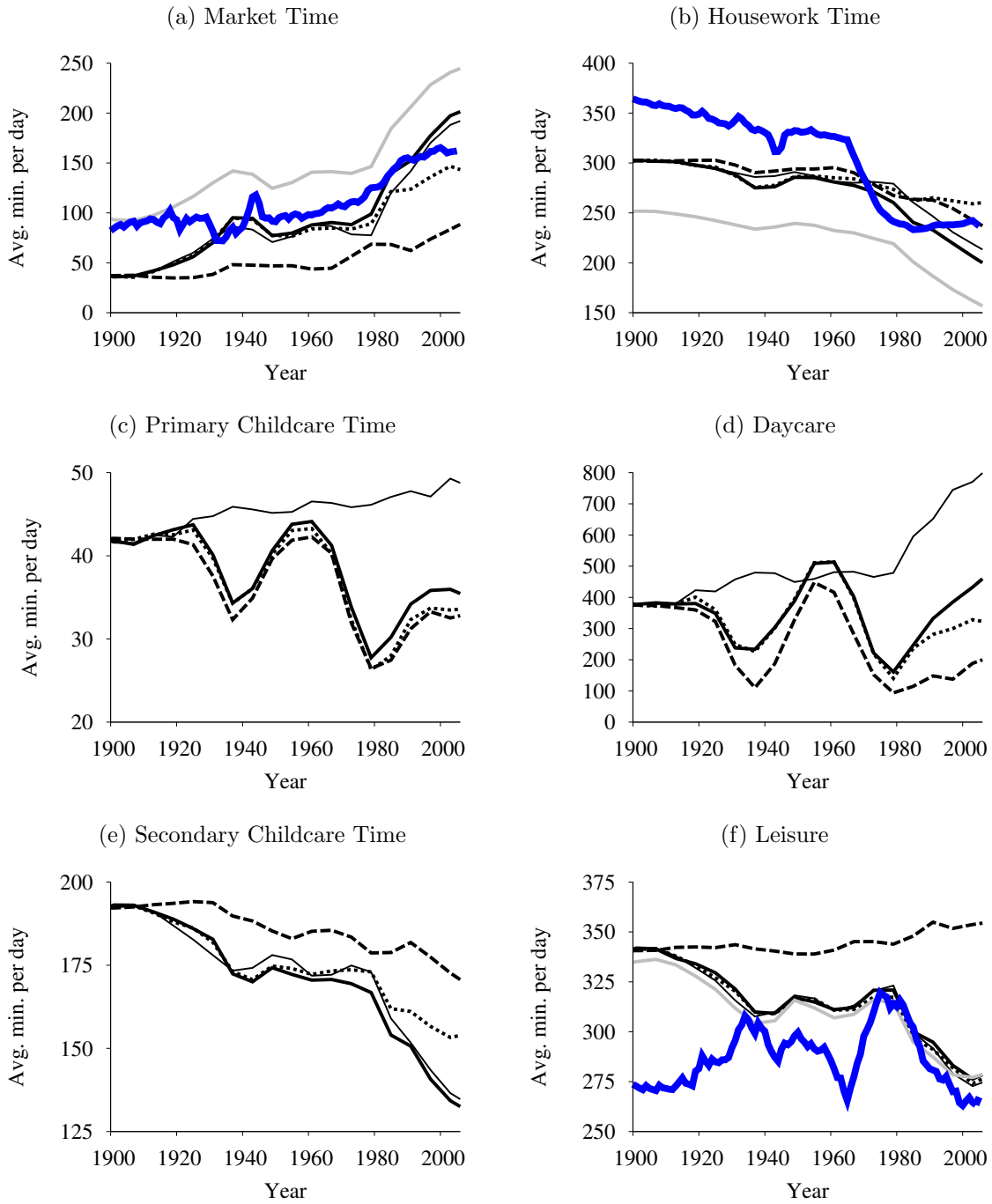
To start, Figure 12a shows that the benchmark model predicts a marked increase in the amount of time women spend working in the market, from an average of 35.9 minutes per day around 1900 to 197.4 minutes in 2003. The effect of the change in the relative wage of women can be evaluated by keeping the relative wage at its 1900 level throughout. Doing so, average market time rises from 37.2 minutes per day to 830.5.¹⁴ The difference between the benchmark model's predicted increase (161.5 minutes) and that predicted when the relative wage is constant (46.3 minutes) gives the effect of the change in the relative wage of women. Specifically, the change in the relative wage accounts for just over 70% ($= \frac{161.5-46.3}{161.5}$) of the benchmark model's increase in market time. Next, shutting down the change in the price of durables, the model predicts a rise in market time from 36.4 minutes to 146.8, or a change of 110.3. In other words, the durable goods revolution explains roughly 30% ($= \frac{161.5-110.3}{161.5}$) of the rise in market time in the benchmark model. Finally, maintaining the 1900 childcare requirements throughout results in a rise in market time from 36.1 minutes to 188.2. Thus, changes in childcare account for a scant 6% ($= \frac{161.5-152.1}{161.5}$) of the rise in womens' market time.

While the previous paragraph focuses on overall changes, there are clearly differential effects over time. In particular, while the change in childcare has a small effect when looking at the entire sample, the effect circa 1980 is substantially larger – the simulation holding childcare at its 1900 level shows a fairly large deviation from the benchmark simulation. Performing an exercise similar as above, except stopping in 1979, one would conclude that 50.1% of the change in married womens' market work time is attributable to changes in the relative wage of women, 16.3% to changes in the price of durables, and 34.0% to changes in fertility (childcare). In other words, circa 1980, the contribution of childcare is substantially larger than in 2003. These calculations also point to the important effects of the rapid increase in the relative wage of women since 1980: Around 1980, the contribution of the relative wage is around 50%; by 2003, its contribution has risen to over 70%.

The story is much the same absent childcare requirements. Without childcare, the model predicts that from 1901 to 2003, market time increases by 147.8 minutes per day. Holding the relative wage of women fixed at its 1900 level, market time would have risen by 42.0 minutes. Again, the difference, 105.8 minutes, gives the contribution of changes in the relative wage: 71.5%. Holding the price of durables at its 1900 level, market time would have increased by

¹⁴In the model, women know the entire path of their relative wage. Consequently, for 1900, there is a slight difference between imposing the 1900 relative wage throughout as opposed to the actual historical relative wage.

Figure 12: Historical Trends



Legend: (1) heavy, blue solid line: Ramey and Francis data; (2) black solid line: benchmark model; (3) black dashed line: 1900 relative wage; (4) black dotted line: 1900 price of durables; (5) thin black line: 1900 childcare requirements; (6) gray solid line: no childcare.

100.8 minutes. Thus, the durable goods revolution accounts for 31.8% ($= \frac{147.8-100.8}{147.8}$) of the total change in market time.

Figure 12a also plots data on U.S. market time as reported in Ramey and Francis (2009). Unfortunately, there are significant conceptual differences between the data in Ramey and Francis and our model. In particular, Ramey and Francis include *all* women, not just married women; and they include women aged 14 or older whereas we have only included women 18 or older. Nonetheless, the Ramey and Francis data is arguably the best available data over such a long time span. According to Ramey and Francis, market time of the typical woman roughly doubled between 1900 and 2005; the benchmark model predicts a five fold increase. One can speculate what Ramey and Francis would have recorded if they had focused on married women. In the first half of the twentieth century, it was not common for married women to work.¹⁵ Ramey provided us with more detailed data for market hours, leisure and housework in the 1920s; this information is reported in Table 4. Market hours for married women are much lower than reported by Ramey and Francis (and plotted in Figure 12) where both married and single women are included. In the 1920s non-farm country married women worked between 40 and 50 minutes a day (depending on the study); married women living in towns or cities, about 30 minutes. For the 1920s, our benchmark model says that married women worked about 40 minutes per day – remarkably close to the numbers reported in Table 4. Thus, when the model is lined up with data for married women – Table 4 for the 1920s and U.S. time-use surveys since 1965 – it captures the observed historical changes in work time.

The aggregate effects of housework time are summarized in Figure 12b. So that the model data is more comparable with the Ramey and Francis (2009) data, housework time here is defined to include both housework and primary childcare time. The benchmark model predicts a decline in housework time of 96.4 minutes per day (from 302.8 to 206.3), or a 31.9% decline which is quite close to the 35% decline reported in Ramey and Francis. Between the mid-1920s and late-1960s, Bryant (1996) reports a 14% decline in housework time; over this period, the model can account for 7%, or half. If the relative wage of women stayed at its 1900 level, the model predicts that housework time would decline by 59.4 minutes. Consequently, the observed increase in female relative wages accounts for 38.5% ($= \frac{96.4-38.5}{96.4}$) of the decline in housework time. On the other hand, holding the price of durables at their 1900 level

¹⁵In fact, there were institutional barriers to women working. A 1931 survey conducted by The National Education Association revealed that 77% of the reporting cities did not hire married women as teachers, and 63% dismissed teachers upon marrying; see Baxandall, Gordon and Reverby (1995) and also Blau, Ferber and Winkler (2002) and Goldin (1990). According to U.S. census data, in 1900, 57% of women 15 years or older were married and 31% were single (the bulk of the remainder were widowed). The employment rate for married women (aged 16 or older) was 5.6% while the corresponding single rate was 45.9%.

Table 4: Time-use of Married Women in the 1920s

| Time use (minutes per day) | Category | Homemaking (including care of family members | Care of family members | Work | Leisure |
|--|--|---|------------------------------|-------|---------|
| Study: Wilson (1929, 1930). Period: 1926–1927 in Oregon | Married homemakers - farm | 442.3 | 32.6 | 104.6 | 204.0 |
| | Married homemakers - country | 470.6 | 42.9 | 51.4 | 225.4 |
| | Married homemakers - towns nonfarm | 441.4 | 55.7 | 28.3 | 261.4 |
| Study: USDA (1944). Period: 1924–28, 1930–31 | Farm homemakers | 443.1 | 33.4 | 81.4 | 240.0 |
| | Nonfarm rural homemakers | 441.4 | 40.7 | 38.6 | 270.0 |
| | College-educated urban homemakers, cities < 100,000 | 426.0 | 88.3 | 18.0 | 312.0 |
| | College-educated urban homemakers, cities > 100,000 | 405.4 | 81.4 | 18.9 | 323.1 |

Source: data supplied by Valerie Ramey

leads to a 43.5 minute decline in housework, or 54.9% ($= \frac{96.4-43.5}{96.4}$) of the total. Maintaining the same childcare requirement throughout leads to a 82.5 minute decline in housework, or 14.4% ($= \frac{96.4-82.5}{96.4}$) of the total decline. In terms of housework time, the model finds that the durable goods revolution was the largest contributor, followed by changes in the relative wage of women.¹⁶

Leisure time is recorded in Figure 12f. The benchmark calibration implies a fall of 65.0 minutes, from 341.4 in 1901 to 276.3 in 2003, or a drop of 23.5%. In contrast, Ramey and Francis record a more modest decline of 2%.¹⁷ For the model, almost all of the decline in leisure time can be attributed to increases in the relative wages of women. Absent these increases, the model predicts a slight increase of 13.1 minutes in leisure which implies that changes in relative wages explain essentially all of the change in leisure. By way of contrast, shutting down either the fall in the price of durables or changes in childcare result in declines in leisure of 66.8 and 69.6 minutes respectively, meaning that these changes account for virtually none of the change in leisure time.

In terms of childcare, given the results for housework time and leisure, it should not be a surprise that the model attributes most of its predicted decline in secondary childcare time (58.4 minutes according to the benchmark model) to increases in the relative wage of women (66.6%) with a lesser contribution by the durable goods revolution (32.4%). It is perhaps surprising that changes in childcare requirements account for only 2.7% of the decline in secondary childcare time.

For primary childcare time, the benchmark model generates a decline of 5.8 minutes. The small size of this decline is due, in part, to averaging over all women. Recall that of the 10 age groupings, only 5 have a positive childcare requirement, and of these the model predicts that only the first 4 actually allocate time to primary childcare. As a result, the average fall of 5.8 minutes corresponds to 14.5 minutes per day for those women who actually allocate time to primary childcare. Absent changes in the relative wages of women, primary childcare time would have fallen by 9.6 minutes. Shutting down the fall in the price of durables, primary childcare time would have fallen by 8.4 minutes. On the other hand, imposing the 1900 childcare requirement throughout would have required an extra 7.7 minutes of primary childcare time in 2003.

Use of daycare services rises by 1% under the benchmark calibration. Were womens' relative wages unchanged from their 1900 values, the model sees a 49.2% decline in the use of daycare. A more modest 12.5% fall in daycare results if the price of durables remains at

¹⁶The story is largely the same if childcare time is excluded from "housework" time. In this case, changes in the relative wages of women account for 45.7% of the total decline in housework time while the durable goods revolution explains 60.4%.

¹⁷In Ramey and Francis (2009), leisure is for women aged 25 to 54.

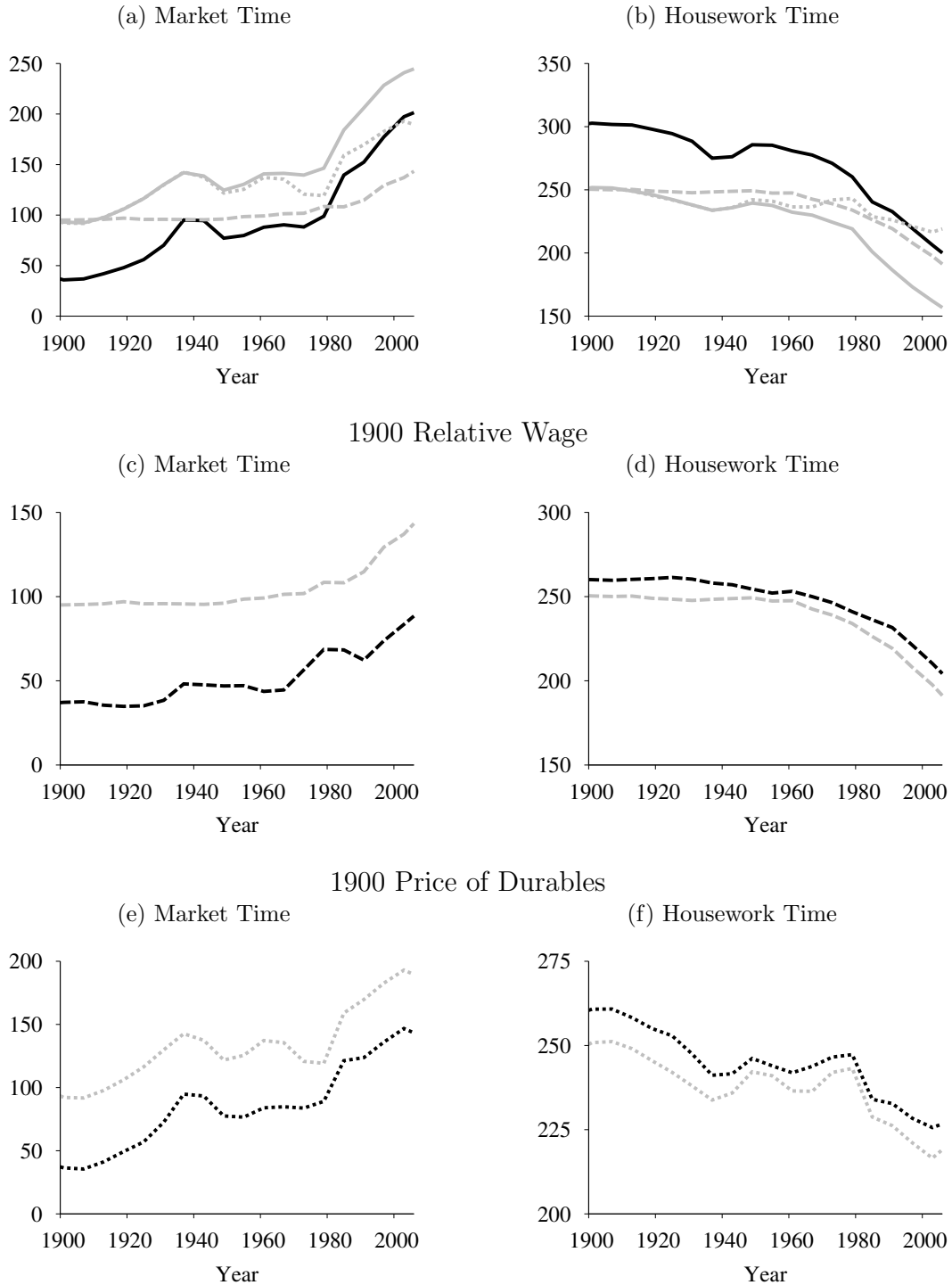
its 1900 level. Finally, if childcare requirements remained at their 1900 level, use of daycare would rise by 104% by 2003.

Figure 12a also shows that the effects of childcare (fertility) on market time were mostly strongly felt between the late 1930s and late 1950s, and 1970–2003 (especially the 1970s). Durable goods only started having an appreciable effect on market time starting around 1950, with the impact of durables then growing over time. The influence of changes in the relative wages of women are felt almost throughout the twentieth century. Changes in the relative wage had a sizable effect from the mid-1930s to mid-1940s, and more recently since 1980 when the relative wage of women rose precipitously.

Figure 12b tell a similar story for housework time as for market time. The model has problems reproducing the aggregate pattern to housework in two periods: early in the twentieth century, and during the baby boom following World War II. Both periods correspond to time of high fertility. We suspect that these discrepancies may reflect extra housework time directly attributable to children that have been omitted from our model, such as extra laundry and food preparation. The mismatch early in the twentieth century is not surprising. If we compare the numbers for leisure and housework for the first few decades of the century to those in Table 4, which refer to married women only, we see that married women devote more time to housework than married and single women together and less time to leisure. Therefore, the mismatch between our simulations and the data is even greater than that reported in Figure 12b during the first part of the century. Albanesi and Olivetti (2007) suggest that progress in medical technologies, obstetric practices, and infant formula was fundamental to reducing time spent in home production early in the twentieth century. Notice that during this period and the baby boom, there is a corresponding mismatch with regards to leisure time. To perform better, the model would have to capture the reallocation of extra housework time from leisure, not market time.

The model can also be used to assess the importance of childcare on the allocation of married womens' time. Figures 12a and 12b and Figure 13 show that absent the childcare constraint, in 2003 women would have worked 43.5 more minutes per day in the market, and reduced by about 44.3 minutes per day their housework time. These predictions accord well with evidence from the 2006 ATUS. For example, relative to a woman without children, a married woman aged 30 – 35 with at least one child under the age of six works 60.7 fewer minutes in the market and spends 55 more minutes on housework. Looking over the twentieth century, childcare has an impact on changes in the time women spend on market work. The benchmark calibration predicts a rise in market work from 35.9 minutes per day in 1901 to 197.4 in 2003 – a six-fold increase. Without childcare, the model predicts a rise from 93.1 minutes per day in 1901 to 240.8 in 2003, or roughly a 2.5 times larger.

Figure 13: Comparison: With and Without Childcare
Benchmark Model



Legend: (1) black solid line: benchmark model; (2) black dashed line: 1900 relative wage; (3) black dotted line: 1900 price of durables; (4) gray solid line: no childcare; (5) gray dashed line: no childcare, 1900 relative wage; (6) gray dotted line: no childcare, 1900 price of durables;

Figures 13c and 13d present simulations of the model that hold the relative wage at its 1900 value. These figures show that even with the decline in the price of durables, the version of the model without childcare predicts almost no change in either market time or housework time over most of the twentieth century. In contrast, running the model holding the price of durables at its 1900 value shows a sizable increase in time allocated to the market, as well as a decline in housework time; see Figures 13e and 13f. In other words, according to our model, changes in the relative wage of women are essential to account for changes in both market and housework time early in the twentieth century.

Figures 13c and 13d show that if relative wages are held at their 1900 level, changes in the price of durables have little effect on either market or housework time until the late 1970s. Figure 13c shows that changes in childcare (owing to changes in fertility) had substantial impacts on market time, particularly around 1940 and 1980. These effects would likely be larger if the additional housework attributable directly to children were included.

Figures 13e and 13f illustrate the importance of changes in the relative wages of women. The increase in married women's market time in the 1930s and early 1940s is due to a combination of a decrease in fertility (see Figure 13c) and increases in the earnings of women (as reflected by the increase in both simulations in Figure 13e). Comparing across Figures 13c and 13e suggests that the increase in market work in the 1970s is chiefly due to lower childcare requirements: in both figures, the simulations with childcare show increases in market work while those without childcare show almost no change in market time. Finally, Figure 13f shows a substantial decline in housework time even when there is no change in the price of durables. This decline shows up early in the twentieth century (to roughly 1940), then late in the twentieth century (starting around 1980). Figure 13d indicates that a large part of the decline after 1980s was due to higher relative wages of women.

Our results thus far can be summarized as follows:

1. During the first half of the twentieth century, increasing relative wages of women were the most important driver behind the rise in married women's market time. Improvements in household technologies had little effect on either market or housework time.
2. The increase in market time just prior to World War II can be attributed to higher relative wages, not changes in fertility (compare the with and without childcare scenarios in Figure 13a; the increase in market work is roughly the same).
3. Changes in fertility, and so childcare, and a steady relative wage explain the behavior of market work in the post-World War II period, up to 1980.

4. After 1980, changes in market and housework time were driven by both increases in the relative wage and decreases in the price of durables.

6.3 Cheaper Daycare

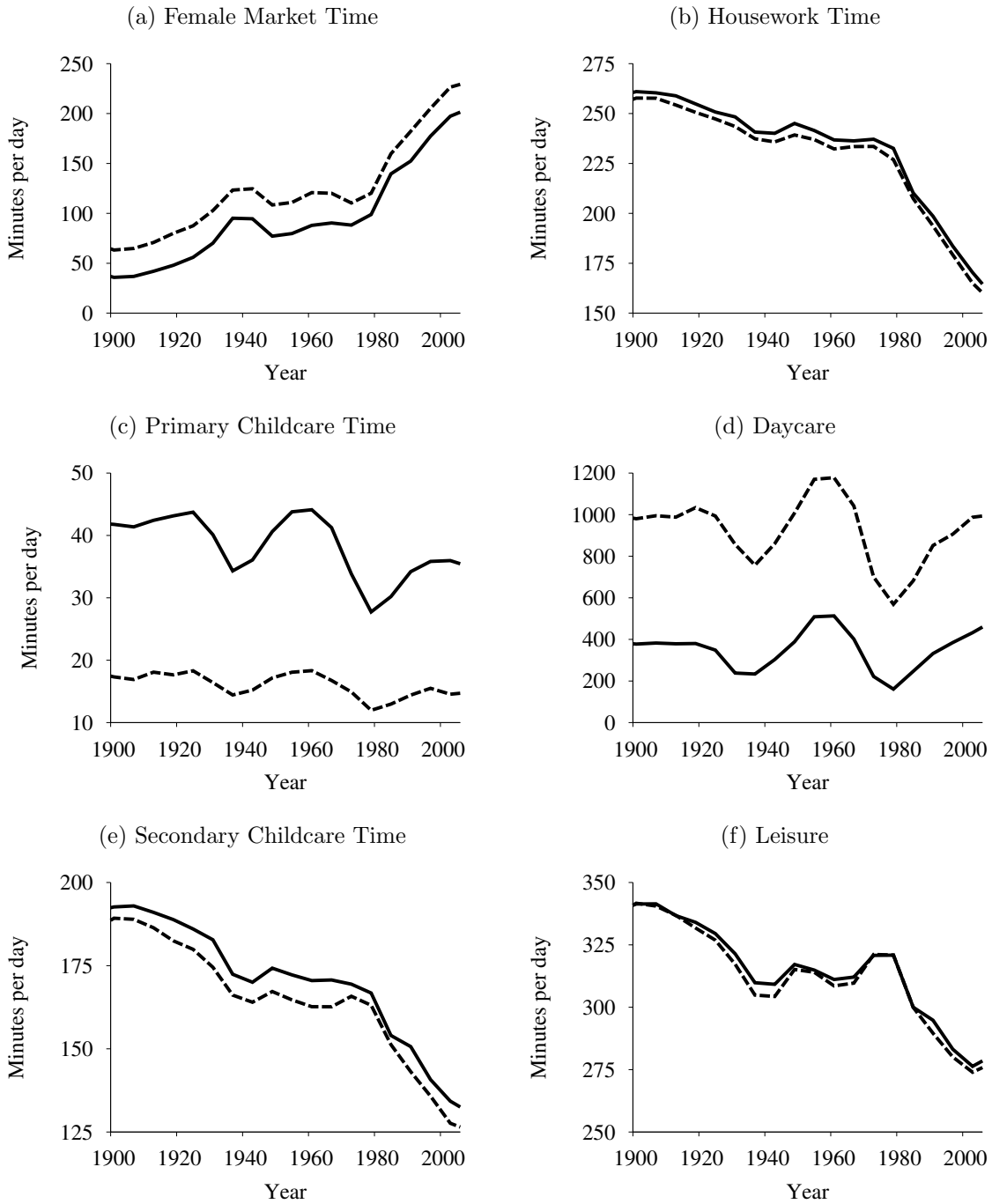
What if daycare were cheaper? This experiment is interesting for a couple of reasons. First, [Attanasio *et al.* \(2008\)](#) attribute the change in women's market time after 1980 jointly to the rise in the relative wage of women and less expensive childcare. This experiment gives the model's evaluation of the second of their explanations. Second, there is a public policy angle to this exercise since some governments make available subsidized daycare. For example, Québec offers \$7 a day daycare (the unregulated market price is around \$45 per day). In contemplating such policies, policymakers may be interested in the likely effects on the allocation of women's time. The specific experiment is to make daycare 25% cheaper than in the benchmark model. Recall that in the benchmark calibration, the price of daycare services is set to 50% of the wage of women; this experiment makes the price of daycare 37.5% of the wage of women.

As shown in [Figure 14d](#), the model predicts a very large increase in the use of daycare. In 2003, for example, daycare rises from 337.8 in the benchmark model to 853 with cheaper daycare – roughly a 2.5 times increase. Operating through the childcare production function, there is an associated decline in primary childcare time, from an average of 36.8 minutes per day to 14.9 in 2003. There is a more modest decline in secondary childcare time: in 2003, from 135.8 to 128.5. Since part of the return to both housework and leisure is their shadow return in helping to satisfy the childcare constraint, both fall when daycare is less expensive since the shadow return falls. Housework time falls by an average of 6.3 minutes per day in 2003 while leisure falls by 5 minutes. Finally, in 2003 market work time rises by 33.3 minutes per day.

These results have clear policy implications. Subsidized daycare can certainly be expected to increase the amount of time women spent in the market. However, the model predicts that it also leads to a sharp decline in primary childcare time. Given the importance of parental time inputs to child development, this decline in primary childcare time may have an important negative impact on child development.

To compare the model's predictions with those of [Attanasio *et al.* \(2008\)](#), consider the period 1979 to 2003. The benchmark calibration generates an increase in market time of 91.7 minutes, from 102.8 to 194.5. The experiment that kept the relative wage of women fixed at its 1900 level results in a change of 9.4 minutes over the same horizon. The difference, 82.3 minutes, can then be attributed to changes in the relative wages of women. In this context,

Figure 14: Cheaper Daycare



Legend: (1) black solid line: benchmark model; (2) black dashed line: 25% cheaper daycare.

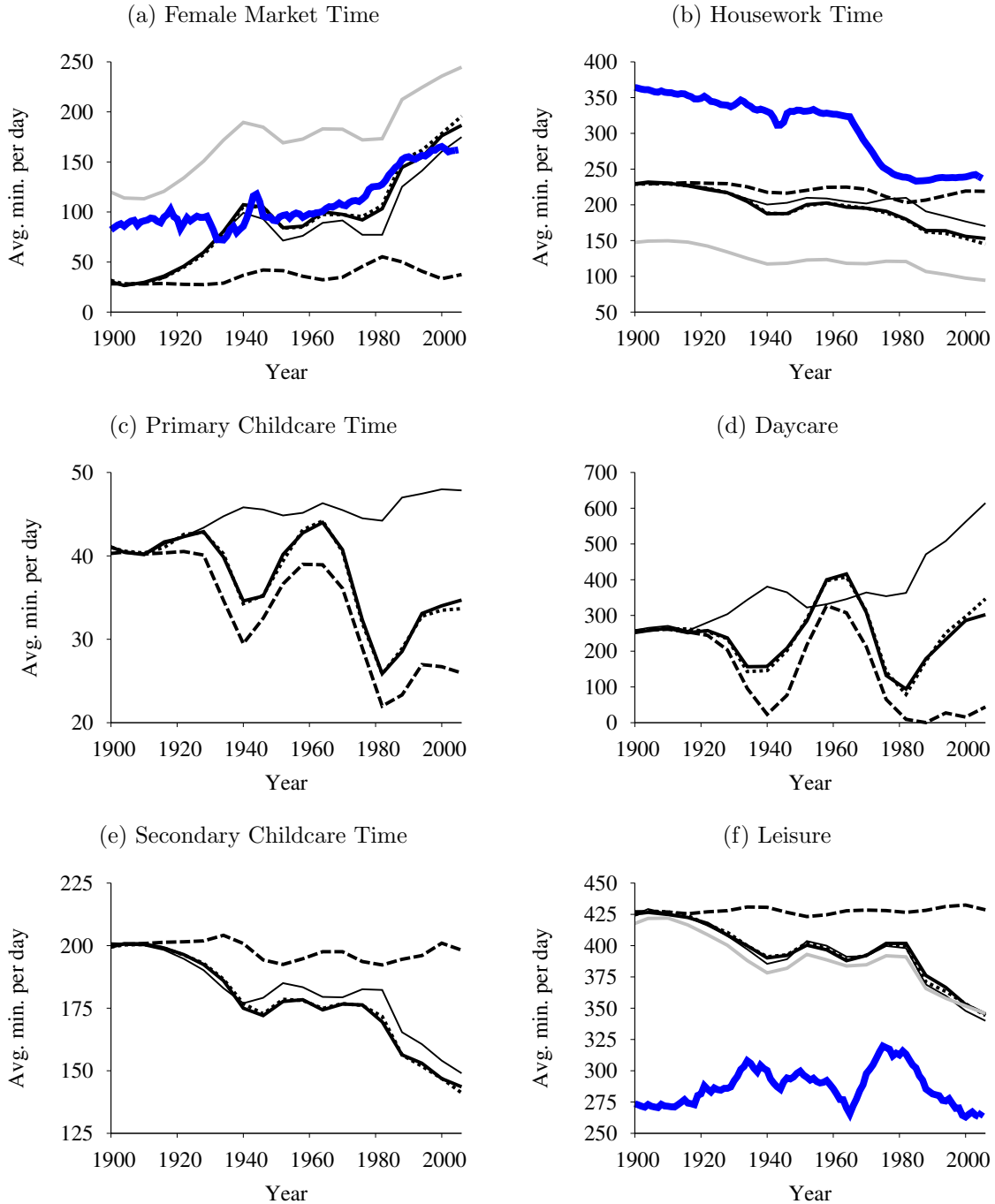
the model’s prediction for the cheaper daycare scenario – 33.3 minutes is sizable, but not the primary cause of the increase in market time by married women. Of course, one could argue that a 25% reduction in the price of daycare is not what was actually observed. The problem is that there is a dearth of information on daycare costs, much less childcare costs.

7 The Elasticity of Substitution Between Market and Home Goods

One difference in calibration relative to [Jones *et al.* \(2003\)](#) is that they set a parameter that corresponds to ξ in our paper to -0.75 whereas we use $\xi = -0.3$. As discussed in the calibration section, the empirical evidence is that market and home goods are good substitutes; see [McGrattan *et al.* \(1997\)](#) and [Rupert *et al.* \(1995\)](#). [Figure 15](#) replicates [Figure 12](#) for a calibration setting $\xi = 0.45$ which is in the ballpark of the values estimated by the aforementioned papers. The other parameters that need to be adjusted are ψ (which governs the importance of market goods relative to home goods) and ω (which governs the importance of leisure in utility) that are set to 0.75 and 0.4, respectively; all other parameters are as reported in [Table 2](#). The takeaway message is that resetting the value of ξ to an empirically plausible number gives almost no role for the change in the price of durables in accounting for changes in the allocation of womens’ time. In particular, the simulation keeping the price of durables at their 1900 value is virtually coincident with the baseline simulation with the historical changes in the relative wage, price of durables, and childcare in play. Recall that the benchmark calibration ends up attributing relatively little of the changes in womens’ time to the durable goods revolution. The results in [Figure 15](#) indicate that the benchmark calibration is, if anything, rather favorable to finding any role for the price of durables.

These results dovetail nicely with those in [Jones *et al.* \(2003\)](#). As they report, complementarity between market and home goods is necessary for improvements in the home technology to generate a positive effect on female market work. In their base case, [Jones *et al.*](#) set $\xi = 0.429$; they find that for such a setting, technological improvements in the home sector have almost no effect on market work. [Jones *et al.*](#) also tried a case with much less substitutability ($\xi = -4$). In this case, they generate an increase in market time of only 27 minutes per day between 1950 and 1900 – considerably smaller than that observed in the data.

Figure 15: Aggregates: Changing the Elasticity of Substitution Between Market and Home Goods



Legend: (1) heavy, blue solid line: Ramey and Francis data; (2) black solid line: model with $\xi = 0.45$; (3) black dashed line: 1900 relative wage; (4) black dotted line: 1900 price of durables; (5) thin black line: 1900 childcare requirements; (6) gray solid line: no childcare.

8 Conclusions

This paper investigated the effects of childcare requirements on the allocation of womens' time over the twentieth century. Childcare was taken as a constraint on the allocation of womens' time. The parameters of the childcare production function were chosen to roughly fit micro data from the 2006 ATUS, and the childcare requirement was computed from a combination of calculations based on the 2006 ATUS and observed fertility.

In terms of life-cycle profiles, we found that modeling childcare is quite important for understanding the pattern of market work. Specifically, a version of the model without childcare predicts that market time is monotonically declining with a woman's age; the data shows a flatter or even hump-shaped pattern, depending on the vintage of the time use survey. The benchmark model with childcare comes closer to matching the life-cycle patterns for market time seen in the U.S. time use surveys. The benchmark model also does well in replicating the life-cycle patterns for housework, primary childcare and leisure time.

In term of aggregates, the benchmark model predicts a rapid rise in the time that married women spend working in the market over the twentieth century. This rapid rise is broadly consistent with evidence on womens' work time. Our simulations support the results of [Attanasio *et al.* \(2008\)](#) and [Jones *et al.* \(2003\)](#) that increases in the relative wage of women are crucial in explaining the large increase in womens' market work time. Except for the period after 1990, the durable goods revolution plays a distinctly secondary role in accounting for the changes in market time.

While the model successfully captures the broad trends in housework and leisure time, it does less well early in the twentieth century and in the aftermath of World War II. Both periods are characterized by high fertility, and so large childcare requirements. During these periods, it may be that our model is missing an increase in housework associated with having more children in a household, such as more time spent on laundry and meal preparation. In any event, any successful resolution needs to reallocate time from leisure to housework, not from market work to housework.

The results for the impact of the durable goods revolution depend crucially on the elasticity of substitution between market and home goods. For the price of durables to have much of an impact on the allocation of time, market and home goods must be complements, yet the available empirical evidence indicates that they are good substitutes. On the other hand, empirical work typically needs to detrend the data in some way. It is possible that removing the trend from the data also removes useful information that biases the estimate of this elasticity of substitution away from complementarity towards substitutability. In any event, even when market and home goods are assumed to be complements, the durable goods

revolution plays a small role in accounting for changes in the allocation of womens' time; the dominant factor is the observed increase in the relative wage of women.

References

- Aguiar, Mark and Erik Hurst (2007). “Measuring Trends in Leisure: The Allocation of Time over Five Decades,” *Quarterly Journal of Economics*, 122 (3): 969–1006.
- Albanesi, Stefania and Claudia Olivetti (2007). “Gender Roles and Technological Progress,” Working Paper 13179, NBER.
- Allard, Mary Dorinda, Suzanne Bianchi, Jay Stewart and Vanessa R. Wright (2007). “Comparing Childcare Measures in the ATUS and Earlier Time-diary Studies,” *Monthly Labor Review*: 27–36.
- Attanasio, Orazio, Hamish Low and Virginia Sanchez-Marcos (2008). “Explaining Changes in Female Labor Supply in a Life-Cycle Model,” *American Economic Review*, 98 (4): 1517–52.
- Baxandall, R.F., L. Gordon and S. Reverby (1995). *America’s Working Women: A Documentary History 1600 to the Present.*, London: W. W. Norton & Company Ltd.
- Blau, F.D., M.A. Ferber and A.E. Winkler (2002). *The Economics of Women, Men and Work.*, New Jersey: Englewood Cliffs, Prentice Hall.
- 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.
- Cardia, Emanuela (2012). “Household Technology and Female Labor Participation: Evidence from the U.S.” Mimeo, Université de Montréal.
- Cardia, Emanuela and Serena Ng (2003). “Intergenerational time transfers and childcare,” *Review of Economic Dynamics*, 6: 431–454.
- Dinkelman, Taryn (2011). “The Effects of Rural Electrification on Employment: New Evidence from South Africa,” *American Economic Review*, 101 (7): 3078–3108.
- Goldin, Claudia (1990). *Understanding the Gender Gap: An Economic History of American Women.*, Oxford: Oxford University Press.
- Gomme, Paul and Peter Rupert (2007). “Theory, Measurement, and Calibration of Macroeconomic Models,” *Journal of Monetary Economics*, 54 (2): 460–497.
- 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.

- Jones, Larry E., Ellen R. McGrattan and Rodolfo E. Manuelli (2003). “Why Are Married Women Working So Much?” *Review of Economic Studies*, 72 (1): 109–133.
- 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.
- Presser, H.B. (1989). “Some economic complexities of child care provided by grandmothers.” *Journal of Marriage and the Family*, 51: 581—591.
- Ramey, Valerie A. (2009). “Time Spent in Home Production in the 20th Century United States,” *The Journal of Economic History*, 69: 1–47.
- Ramey, Valerie A. and Neville Francis (2009). “A Century of Work and Leisure,” *American Economic Journal: Macroeconomics*, 1: 189–224.
- Rupert, Peter, Richard Rogerson and Randall Wright (1995). “Estimating Substitution Elasticities in Household Production Models,” *Economic Theory*, 6 (1): 179–93.
- Rupert, Peter, Richard Rogerson and Randall Wright (2000). “Homework in Labor Economics: Household Production and Intertemporal Substitution,” *Journal of Monetary Economics*, 46 (3): 557–80.
- Schittkowski, Klaus (1985/86). “NLPQL: A FORTRAN subroutine solving constrained non-linear programming problems,” *Annals of Operations Research*, 5: 485–500.
- Vanek, Joann (1973). *Keeping Busy: Time Spent in Housework, United States, 1920–1970*, Ph.D. thesis, The University of Michigan.