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Parental child care during and outside of typical work hours

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ABSTRACT

It has been argued that when analyzing time use data, child care should be treated separately from leisure or housework because, unlike these two, its income gradient is positive. Using U.S. data from PSID-CDS, this paper computes parental child care during and outside of typical work hours (TWH) by income quintile for two-parent families. The TWH distinction is important because during TWH the opportunity cost of spending time with children is first and foremost in terms of forgone earnings, while outside of TWH it is mainly in terms of leisure or housework. Indeed, I find that during TWH active child care is actually decreasing in income and, hence, behaves a lot like leisure and other household chores. Outside of TWH, fathers partly catch up to mothers especially in high income families. Indeed, mothers' child care is still slightly decreasing in income, while fathers' active care is increasing. Implications for theory are derived in a static framework of time allocation and child quality production which encompasses the recent literature on the topic. Similar to patterns in leisure and housework, the variation in child care during TWH can be rationalized by assuming a high elasticity of substitution between leisure, consumption and child quality where the substitution effect dominates the income effect. However, the facts outside of TWH point to systematic differences by income in preferences or productivity. For instance, assuming father's productivity in child care is increasing, while mother's is decreasing in income could be a potential rationale for the observed behavior.

KEYWORDS

Parental Child Care, Opportunity Cost, Typical Work Hours, Child Quality.

EDITORIAL NOTE

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PARENTAL CHILD CARE DURING AND OUTSIDE OF TYPICAL WORK HOURS

TABLE OF CONTENTS

1. INTRODUCTION ……..1

2. PSID-CDS DATA: CHILD CARE BY TWO-PARENT FAMILIES ……3

2.1. TIME SPENT WITH CHILDREN: AN OPPORTUNITY COST VIEW ……4

2.2. CHILD CARE DURING AND OUTSIDE OF TYPICAL WORK HOURS ……5

2.2.1. OVERVIEW OF PARENTAL CHILD CARE ……..…..5

2.2.2. MOTHERS AND FATHERS ……..…6

2.2.3. MOTHERS AND FATHERS BY HOUSEHOLD INCOME ……...……..…..7

2.2.4. FATHERS AS A PERCENT OF MOTHERS BY HOUSEHOLD INCOME …..…….…...8

3. ADDITIONAL OBSERVATIONS BY INCOME QUINTILE ...……9

3.1. HOURS WORKED BY INCOME QUINTILE ……..…….…….…..…9

3.2. EXPENDITURES ON CHILDREN BY HOUSEHOLD INCOME ……..……...…….……10

4. IMPLICATIONS FOR THEORY …...……11

4.1. A STATIC FRAMEWORK ……..……12

4.1.1. ASSUMPTIONS ……..…….……....13

4.2. LEVEL DIFFERENCES BETWEEN MOTHERS AND FATHERS ……..……..16

4.3. TIME AND RESOURCE ALLOCATION BY INCOME QUINTILE ……17

4.3.1. TIME AND RESOURCE ALLOCATION BY INCOME QUINTILE DURING TYPICAL WORK HOURS ……..…….…….....18

4.3.2. TIME ALLOCATION BY INCOME QUINTILE OUTSIDE OF TYPICAL WORK HOURS ……..……19

5. CONCLUDING REMARKS ……...…….21

REFERENCES..……..……..23

APPENDICES..……..……...26

1 INTRODUCTION

While James Heckman and co-authors have shown that early childhood education matters the most for adult outcomes (see e.g., Cunha and Heckman 2007, *AER*), recent research findings suggest that parental time, in particular father's time, is a crucial ingredient in child quality production (see e.g., Del Boca, Flinn and Wiswall 2014, *ReStud*). Moreover, because the overall income gradient of child care appears to be positive, it has been argued that child care should be modeled separately from other household chores or leisure, both of which have negative income gradients (see e.g., Guryan, Hurst, and Kearney 2008, *JEL*). Understanding household's time allocation is important for family policy such as child care deductibility, education subsidies, etc. but also for labor policies at the macroeconomic level (see e.g., Aguiar and Hurst Forthcoming, *Handbook of Macroeconomics, Vol. 2*). This paper contributes to the above literature by first highlighting that parental time spent with children is not uniformly spread throughout the week and time of day. In particular, during typical work hours (TWH), defined as 8am to 6pm, Monday through Friday,[1] child care is actually decreasing in income—especially for mothers. Outside of TWH, child care is (partly) increasing in income—especially for fathers. Using these facts, I then analyze a simple model to see what kinds of properties of the utility and child quality production functions can rationalize the observed patterns. I show that parental time spent with children *during* TWH can indeed be explained by differing opportunity costs between mothers and fathers as well as across income groups if utility is such that substitution effects dominate income effects. The patterns *outside* of TWH require particular preference and/or child quality production parameters to systematically differ by income.

In the Panel Study of Income Dynamics Child Development Study (PSID-CDS) 1997 time diaries, a subsample of PSID households with children under the age of 12 were asked to keep time diaries for one week day and one weekend day. Following Folbre, Yoon, Finnoff, and Fuligni (2005), Folbre (2008), Del Boca et al. (2014) and Abbott (2015), I also use the PSID-CDS 1997 time diaries and implement a similar strategy to compute active and passive child care—with a few adjustments. The most important adjustment is that none of these authors makes the distinction between child care during and outside of TWH. As this paper shows, this is a crucial ingredient in determining the opportunity cost of spending time with children. In particular, I show that both mothers and fathers spend more time with children outside of TWH where the opportunity cost is in terms of leisure or housework, than they do during TWH where the opportunity cost is first and foremost in terms of foregone earnings. Moreover, I find that—presumably for similar reasons—some groups of the population catch up to other groups outside of TWH. For example, while overall mothers spend twice as much time in child care than fathers do, they spend three times as much during TWH. Hence, fathers catch up to mothers outside of TWH, albeit in relative rather than absolute terms (i.e., mothers still spend

[1] I discuss this choice of definition for "typical work hours" in Appendix A.2.2.1. Results for alternative definitions are provided in Appendix A.3.

more time with children than fathers do). By income quintile, I show that when restricting attention to TWH, child care is actually decreasing in income—especially for mothers, while it is indeed increasing outside of TWH—especially for fathers. These findings refine those in Guryan, Hurst and Kearney (2008) and suggests that, depending on the time of the week and day, child care actually does behave like leisure or other household chores. In sum then, high income parents catch up to low income parents outside of TWH, mothers in relative terms and fathers in absolute terms. Taken together, father's time relative to mother's outside of TWH is monotonically increasing in income, while it is almost flat during TWH. The above facts are generally more pronounced for active care. I therefore concentrate on this measure in analyzing implications for theory.[2]

From a Beckarian point of view, these facts can tell us a lot about what properties of the utility and child quality production functions are needed to rationalize these choices. Consider a model where households derive utility from consumption, leisure and child quality, where child quality is produced using parental time during and outside of TWH, expenditures and ability as inputs.

First, I assume logarithmic utility combined with a Cobb-Douglas production function for child quality. This specification is close to a static version of the model used in Del Boca et al. (2014), extended to differentiate between child care during and outside of TWH. Here I show that level differences for mothers and fathers can partly be rationalized by a positive gender wage gap. Quantitatively, these opportunity cost differences need to be combined with gender differences in the preference for leisure and in productivity in child quality production. By income quintile, however, this specification predicts that child care, hours worked and expenditure as a fraction of total income are independent on income and therefore cannot rationalize these choices unless various preferences and technology parameters systematically differ by income.

In order for time spent with children during TWH to be decreasing in income, rather than flat, without adding systematic heterogeneity by income, utility needs to be such that substitution effects of a higher wage dominate income effects. While, of course, many functional forms can deliver this result, one example is a homothetic CES utility specification with elasticity greater than one. This specification also yields that hours worked are increasing in income and that expenditures on child quality as a fraction of income are decreasing in income. However, I show that even with a nested CES quality production function as in Abbott (2015), patterns outside of TWH cannot be replicated. Indeed, this model predicts that mother's and father's child care outside of TWH must move in the same direction with income, either both are increasing or both are decreasing, a counterfactual prediction. Hence, even a static version of Abbott (2015)'s model extended to differentiate between child care during and outside of

[2]The facts described above also hold when conditioning on age of the child and number of children in the household (see Appendix A.4 for details).

TWH, requires preference and/or technology parameters to systematically vary with income. Del Boca et al. (2014) allow for preference but not productivity heterogeneity. Guryan et al. (2008) also suggest that preference or productivity systematically vary with income as one potential theory for the overall positive income gradient for child care. However, the specific pattern needed to account for the behavioral patters described in this paper are more subtle than those these papers.

In sum, while Del Boca et al. (2014) mainly use logarithmic utility and Cobb-Douglas production to get closed form solutions, Abbott (2015) uses CES utility with elasticity smaller than one and a nested CES production function to capture the dynamics of child quality accumulation. These specifications are at odds with the specifications needed to rationalize the static time allocation decision during and outside of TWH by household income analyzed in this paper. This calls for future research to develop a unified theory to simultaneously explain the static and the dynamic dimension of time allocation and child quality production across income groups.

The rest of the paper is organized as follows. Section 2 describes the child care measures and data results, reporting child care hours per child per week during and outside of TWH, for mothers and fathers, active and passive care by household income quintile. Section 4 discusses implications for theory while Section 5 concludes.

2 PSID-CDS DATA: CHILD CARE BY TWO-PARENT FAMILIES

In this section, I first discuss the per child measures of child care I construct. I then present the facts of mother's and father's active and total child care during and outside of typical work hours (TWH) by household income quintile.

I follow a similar strategy as the literature in selecting the sample. That is, I concentrate on families where children live with two parents (Del Boca et al. (2014) call them "intact families", Abbott (2015) calls them "traditional families") and no other adults (e.g., grandmothers). Following Del Boca et al. (2014), I discard observations where total household income, labor income, wage rate and hours worked reports are inconsistent. This boils down to eliminating wage reports of more than $150 per hour and those with non-labor income of more than $1,000 per week. Table 1 reports descriptive statistics for the sample used throughout the paper. The data sample has 2,992 24-hour observations for two-parent families with 1,498 weekend and 1,494 week day observations. Disaggregating into household income quintiles decreases the number of observations to about 300 per cell. The average age of mothers and fathers in the sample are 33.8 and 36, respectively, while the average age of observed children is 5.9 and the average number of children is 2.25. Average annual household income is $60,956 of which an average of $5,443 is non-labor income, with the latter varying a lot in the sample. These statistics are similar to those in Del Boca et al. (2014).

	Mean	Std.		Mean	Std.
Mother's age	33.80	6.31	Household Income	$60,956.14	$4,2345.51
Father's age	35.98	6.99	Non-Labor Income	$5,442.68	$9,818.25
Child's age	5.90	3.43	Number of children	2.25	0.86

Table 1. Descriptive Statistics

Notes: Incomes are per year and in 2000 dollars.

Source: PSID-CDS.

Folbre et al. (2005) compute parental time spent in active child care as well as supervisory (or on-call) care, excluding sleep, adjusting for sibling presence, by age of the child. Folbre (2008) then uses the same definitions but concentrates on middle income two-parent-two-children families. While I mostly disregard the age dimension in this paper, I use income quintiles instead of USDA high-middle-low income classification (see Lino 2001, *USDA*) as Folbre (2008) does. Del Boca et al. (2014) also compute active and passive child care by age of the child but restrict attention to families with one or two children over age three while I extend the sample to include families with three or more children ages 0 to 11. Abbott (2015) concentrates on the difference between single- and two-parent families but reports only active child care.

2.1 TIME SPENT WITH CHILDREN: AN OPPORTUNITY COST VIEW

Folbre (2008) provides replacement cost measures of parental child care. Her measures are useful if one wants to estimate the value of time parents spend with children but was not intended as an opportunity cost measure this paper pursues. I therefore closely follow Folbre et al. (2005) and Folbre (2008) to construct the relevant child care measures, with a few important adjustments.[3] While keeping the basic definition of active and passive child care as well as weighting procedure,[4] the focus on an opportunity cost measure affects how time spent with children is categorized. In particular, to get at the opportunity cost of children in terms of forgone market work, I restrict attention to typical work hours, defined as 8am to 6pm, Monday through Friday.[5] The opportunity cost view also impacts how overlaps between mothers and fathers are counted. In particular, if both parents are active, I count both times as opportunity costs, unlike Folbre (2008) who attributes this time only to the mother. If one parent is active and one passive, only the active parent's time counts because the passive parent is presumably not "on call" per se and hence the opportunity cost is zero. If both parents are passive, half the

[3] A more detailed description of the measurements can be found in Appendix A.2. Here I merely present a brief summary.

[4] Their analysis used child-level weights from the CDS demographic file to adjust for family selection and non-response factors. I further multiply time spent during week days by 5 and during weekends by 2.

[5] See Appendix A.2.2.1 for a discussion of this definition and Appendix A.3 for results for alternative definitions.

time is counted for each parent because only one parent needs to be "on call" at any point in time. Finally, while Del Boca et al. (2014) view sibling overlaps as separate time inputs into child quality production, I follow Folbre et al. (2005) and compute *per child* measures thereby adjusting for overlaps in one single measure. To get at this per child measure of child care, sibling presence is accounted for in each 24-hour observation directly, instead of subtracting an overall average as in Folbre (2008). Next, I describe the findings using these measures.

2.2 CHILD CARE DURING & OUTSIDE OF TYPICAL WORK HOURS

In this section, I describe active and total child care during and outside of typical work hours (TWH), where TWH are defined as 8am to 6pm, Monday through Friday. After a brief overview, I compare mothers and fathers in general. I then provide a decomposition by household income quintile and discuss how mother's and father's different types of child care vary with income, first in absolute, then in relative terms.

2.2.1 OVERVIEW OF PARENTAL CHILD CARE

Table 2 reports hours per child per week of active and passive child care during typical work hours (T.W.H., i.e., between 8am and 6pm, Mondays through Fridays) and outside of typical work hours (O.T.W.H., i.e., all times that are *not* between 8am and 6pm, Mondays through Fridays). For comparison, the bottom of Table 2 reports the numbers for all week (A.W., i.e. the sum of the previous two categories). The *Parents* rows are the sum of *Mother* and *Father* rows, while the *F rel. M* rows report father's time as a percent of mother's. The first two columns of Table 2 give active and passive child care as per the definition in Section 2.1, and the third is total time spent in child care per child per week (i.e., the sum of active and passive child care).

As can be seen in Table 2, overall parents spend 50 hours per child (age 0 to 12) per week in child care, but of those 33 hours are active care throughout the week, while only 17 hours are passive care. These represent averages over the first twelve years of the child's life. Similarly, Folbre (2008) finds that middle income two-parent-two-children families spend an average of 13.5 hours of passive care and 27.8 hours of active care per child per week (see her Tables 6.2 and 6.3).[6] However, this paper argues that estimates using the distinction during and outside of

[6]For comparison, Hill and Stafford (1980) analyzing time use data in 1976 find that women spend 7.33 hours (i.e. 440 minutes) per child per week if they have two preschoolers, which is lower than the estimate in this paper, especially during typical work hours. There are many studies on parental child care over time and within and across countries. For a comparison of the U.S., Canada, Australia and the U.K., see Folbre and Yoon (2007); for Sweden, see Gustafsson and Kjulin (1994); for Australia, see Apps and Rees (2002), Bittman and Craig (2008) and Bradbury (2008); for Spain, see Gutiérrez-Domènech (2010); for France, see Ekert-Jaffé and Grossbard (forthcoming); for changes over time in the U.S., see Sayer, Bianchi and Robinson (2004); for trends across selected industrialized countries, see Gauthier, Smeedeng and Furstenberg (2004); to name only a few. None of them show how different groups of the population compare at different times of the day and week.

TWH, while imperfect, are closer to the actual opportunity cost of spending time with children than Folbre (2008)'s overall number (designed to compute replacement costs). Indeed, of those 50 hours of overall child care only about 16 hours are provided during TWH while 34 hours are provided outside of TWH.

		Active	Passive	Total
T.W.H.	Mother	7.50	4.81	12.31
	Father	2.49	1.18	3.67
	Parents	9.99	5.99	15.98
	F rel. M	33.1%	24.5%	29.7%
O.T.W.H.	Mother	13.67	6.62	20.29
	Father	9.44	4.52	13.96
	Parents	23.11	11.14	34.25
	F rel. M	69.0%	68.3%	68.8%
A.W.	Mother	21.17	11.43	32.60
	Father	11.92	5.71	17.63
	Parents	33.10	17.13	50.23
	F rel. M	56.3%	50.0%	54.1%

Table 2. Active and Passive Child Care, Typical Work Hours and Overall, (Hours per child per week)

Notes: Typical Work Hours: Monday to Friday, 8am to 6pm, Outside T.W.H.: All Week - Typical Work Hours, Parents = Mother + Father, F rel. M = Father/Mother*100. Total = Active + Passive.

Source: PSID-CDS.

2.2.2 MOTHERS AND FATHERS

Comparing mothers and fathers in Table 2, mothers always spend more time in child care than fathers do—irrespective of the time of the week and type of child care. However, looking at the last column of the "F rel. M" rows, while fathers spend less than one third as much time on child care as mothers do during TWH, they spend more than two thirds as much outside of TWH. Hence, fathers spend just more than half as much as mothers do throughout the week at all times. That is, fathers catch up to mothers outside of TWH, albeit in relative rather than absolute terms (i.e., mothers still spend more time with children than fathers do). Decomposing into active and passive care, the largest relative discrepancies between mothers and father occur for passive care during TWH where fathers provide less than one fourth as much as mothers do. For active care the ratio between fathers and mothers is always higher than for passive care. Hence, fathers spend relatively more time in active care than passive care.

2.2.3 MOTHERS AND FATHERS BY HOUSEHOLD INCOME

Disaggregating by household income, average household income by quintile is given in Table 3, Q1 referring to the lowest income group and Q5 to the highest. As can be seen, average income in 2000 dollars almost doubles between Q1 and Q2, then increases more slowly between Q2 and Q4 and, finally, almost doubles again between Q4 and Q5.

Q1	Q2	Q3	Q4	Q5
$18,138.33	$35,374.72	$49,863.45	$69,220.39	$119,507.84

Table 3. Average annual household income by quintile (2000 dollars)
Source: PSID-CDS.

Figure 1 plots total and active child care during and outside of TWH for mothers and fathers by income quintile.[7] As can be seen in the figure, during TWH the relationship between child care and income is strongly decreasing for mothers and slightly decreasing for fathers. In panel (a) which plots total child care during TWH, the richest mothers (Q5) only spend 66 percent in total child care compared to the poorest mothers (Q1), while this percentage is 84 percent for fathers. Restricting attention to active child care in panel (c), these ratios become 72 percent for mothers and 65 percent for fathers. Hence, the relationship is steeper for total care for mothers and active care for fathers.

Outside of TWH, maternal child care is higher but still slightly decreasing in income, while it is increasing for fathers. Hence, high income mothers catch up with low income mothers in relative terms outside of TWH (i.e., the negative slope is less pronounced). High income fathers, on the other hand, catch up with low income fathers, in absolute terms outside of TWH (i.e., the negative slope becomes positive). In panel (b) the richest mothers spend 94 percent in total child care compared to the poorest mothers, while this percentage is 101 percent for fathers. In panel (d) the richest mothers still spend 94 percent in active child care compared to the poorest mothers, but this percentage is as high as 111 percent for fathers. Hence, for mothers, the relationship is similar for active and total child care while the catching up for fathers is more pronounced for active child care.[8]

Guryan et al. (2008) find that, unlike for leisure and home production, the education/earnings gradient is strikingly positive for child care time, especially for working parents. They conclude

[7] See Table A.1 for detailed numbers relating to Figure 1.

[8] Household income depends on education and labor force participation of parents. Similar observations as the ones laid out in this section can be seen when disaggregating by education and labor force participation. Details are available upon request. Trends in child care by education of the parents can be found in Ramey and Ramey (2010) and cross sectional evidence can be found in Gobbi (2013). These studies find that parental time with children increases with education. As the education of parents increases, the gap between child care supplied by mothers relative to that supplied by fathers decreases. Trends in child care by labor supply of parents can be found in Hallberg and Klevmarken (2003). They find that a change in the mother's working hours has less influence on the parents' time with their children than a change in the father's working hours. None of these papers disaggregate by "time of the day and week" as this paper does.

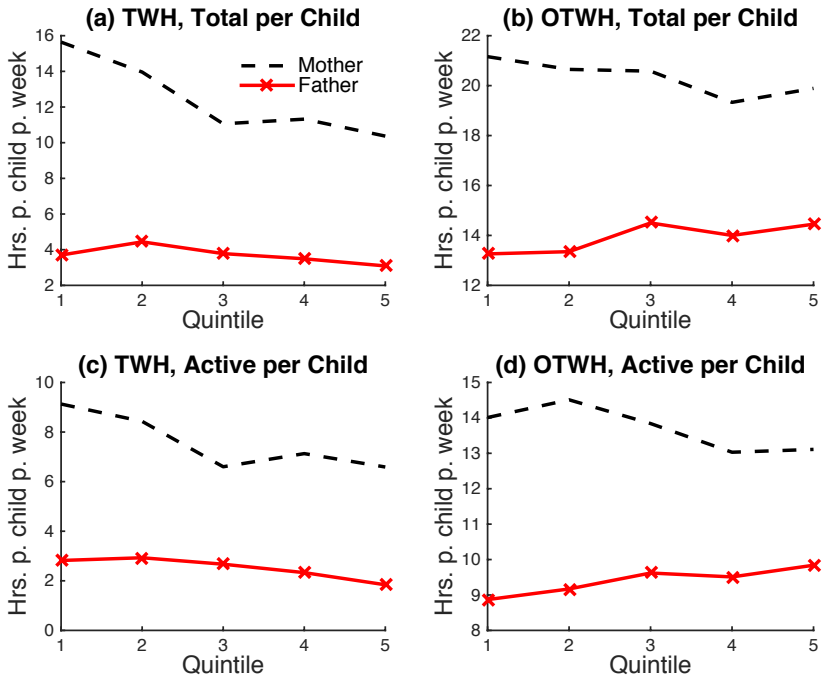

Figure 1. Child Care During and Outside of Typical Work Hours, Two-Parent Families

Notes: TWH = during typical work hours (8am-6pm, Monday through Friday), OTWH = outside typical work hours.

Source: PSID-CDS.

that child care must be fundamentally different from leisure and home production. Due to the limited number of observations, I do not control for various demographic characteristics as they do. The fact remains that, distinguishing between child care during and outside if TWH, reveals that during TWH, child care behaves a lot like leisure and home production, while the difference emerges mainly for fathers outside of TWH.

2.2.4 FATHERS AS A PERCENT OF MOTHERS BY HOUSEHOLD INCOME

As a last angle on the facts presented so far, Figure 2 plots father's time as a percent of mother's time by income quintile during and outside of TWH, for total as well as active child care per child.[9] As can be seen, catching up of fathers to mothers is more pronounced for high income groups than low. Indeed, during TWH, fathers spend about 30 to 40 percent of what mothers spend, except for Q1 fathers who spend only 24 percent in total child care and Q5 who spend only 28 percent in active child care. Outside of TWH, however, the ratio is about 63 percent for the poorest quintile (Q1), climbing up to 72 and 75 percent for the richest quintile (Q5) in terms of total and active child care, respectively.

[9]See Table A.2 for detailed numbers relating to Figure 2.

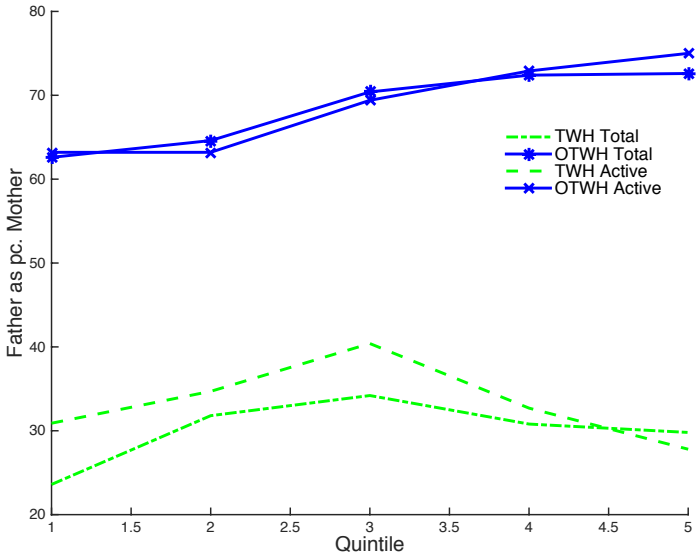

Figure 2. Child Care During and Outside of Typical Work Hours, Fathers Pct. Mothers

Notes: TWH = during typical work hours (8am-6pm, Monday through Friday), OTWH = outside typical work hours.

Source: PSID-CDS.

3 ADDITIONAL OBSERVATIONS BY INCOME QUINTILE

In this section, I describe hours worked as well as expenditures per child by income, which will guide implications for theory in Section 4.

3.1 HOURS WORKED BY INCOME QUINTILE

In addition to observations on parental child care, it is useful to look at mother's and father's hours worked. Table 4 reports hours worked during TWH by primary and secondary care givers (who correspond to mothers and fathers in our sample). As can be seen in the table, mothers' hours are slightly hump-shaped and fathers' hours are strictly increasing in income. The model presented below will be confronted with these facts.

	Q1	Q2	Q3	Q4	Q5
Mother*	11.37	14.95	20.40	19.37	19.51
Father**	21.90	25.94	27.36	26.58	34.86

Table 4. Hours Worked during TWH by Income Quintile

Notes: * Primary Caregiver, ** Secondary Caregiver.

Source: PSID-CDS.

3.2 EXPENDITURES ON CHILDREN BY HOUSEHOLD INCOME

Evidence suggests that while expenditures per child are increasing in income, expenditures as a fraction of income are actually decreasing in income. Even though child specific expenditures are available in the PSID survey, I do not use these reports because, as noted by Del Boca et al. (2014), the reports seem to improperly attribute some of the household's public goods to children. Instead, I use Lino (2001) who imputes expenditures on children by comparing families with and without children. In particular, Lino (2001) estimates annual expenditures on children from birth through age 17 for husband-wife and single-parent families with one, two or three and more children by region, broad income group and three-year age groups of children. Lino (2001) uses data from the 1990-92 CEX, updated to 2000 dollars. For husband-wife families with two children in the home, estimates in Lino (2001)'s Table ES-1 are reported for three income groups and six age groups (age 0-17).[10] Since the PSID-CDS data set only covers children age 0 to 11, Table 5 reports averages across Linos's age groups 0-2, 3-5, 6-8 and 9-11. The household income groups used in Lino are "low" defined as $\$38,000$ or less, "middle" as $\$38,000$ to $\$64,000$ and "high" as $\$64,000$ or more (all in 2000 dollars). Average income, reported in column 2, compares well with Table 3: for low income, it falls between Q1 and Q2, for middle income, it is almost the same as for Q3 and for high income, it falls between Q4 and Q5.

	Expenditure	Av. Income	Percent
All	\$9,489	\$56,733	16.73%
Low Income	\$6,438	\$23,800	27.05%
Middle Income	\$8,915	\$50,600	17.62%
High Income	\$13,115	\$95,800	13.69%

Table 5. Expenditures per child by household income in 2000 dollars and as percentage of average household income

Notes: Following Lino (2001), Low Household Income: $< \$38,000$, Middle Household Income: $(\$38,000; \$64,000)$, High Household Income: $> \$64,000$ (in 2000 dollars).

Source: PSID-CDS.

As can be seen in Table 5, expenditures per child in 2000 dollars are increasing in household income, ranging from about \$6,500 for low income households to about \$13,000 for high income families.[11] As a fraction of average household income, however, expenditures are de-

[10] The expenditure categories reported are: housing, food, transportation, clothing, health care, (paid) child care and education, and miscellaneous (including personal care items, entertainment, and reading materials).

[11] Lino also mentions that there are some economies of scale when having more children. "To estimate expenses for an only child, multiply the total expense for the appropriate age category by 1.24. To estimate expenses for each child in a family with three or more children, multiply the total expense for each appropriate age category by 0.77. For expenses on all children in a family, these totals should be summed." That is, if it takes $\$x$ per child to raise 2 children, the total expenditure for a one-child family is $\$1.24x$, for a two-child family is $\$2x$ and for a three-child family is $\$3 * 0.77x$. Lazear and Michael (1980) find large economies of scale, while Espenshade (1984) finds that they are of the order of five percent for an additional child.

creasing, ranging from 27 percent for low income families to 13.7 percent for high income families.

Dahl and Lochner (2012) find a causal relationship of income on children's math and reading achievement, suggesting that increased expenditure is indeed productive in child quality. However, they find decreasing returns to these effects. This finding is used in the model below.

4 IMPLICATIONS FOR THEORY

This section presents a static household optimization problem with consumption and leisure choices as well as child quality production that requires various time and goods inputs—in particular, child care during and outside of typical work hours. Households are heterogeneous in their earnings potential (quintiles) which are correlated with children's innate ability. After setting up the basic framework where I follow notation in Del Boca et al. (2014) as closely as possible, I explain why, for the purposes of the present paper, we can abstract from heterogeneity in the number of children, the age of the children and passive child care. I then introduce functional forms and make several data driven assumptions. Given this, I first analyze the logarithmic utility and Cobb-Douglas production case, which comes closest to Del Boca et al. (2014)'s model, albeit a static version. Here, I show that a positive gender wage gap and/or productivity differences in mother versus father's time inputs into child care production are sufficient to capture the average gender difference in child care provision during and outside of TWH presented in Table 2.

However, because of income and substitution effects canceling out, without additional heterogeneity, this specification cannot rationalize the child care choices by income quintile presented above, even after letting the parameters for number of children, the gender wage gap and non-labor income as a fraction of wages vary by income quintile as observed in the data. Next, I show that, thanks to the fact that child care is decreasing in income during TWH, a CES utility specification with high elasticity of substitution (more than logarithmic), is sufficient to capture all the facts relating to TWH, including hours worked and expenditures on children. This results from the well-known feature that the substitution effect dominates the income effect when the elasticity of substitution is high. This is at odds with Abbott (2015) who does not disaggregate by income and uses an elasticity of substitution less than logarithmic.

Finally, even following Abbott (2015) and allowing for a nested CES formulation for child quality production cannot simultaneously capture the patterns of child care provision during and outside of TWH for mothers and fathers. Instead, this commonly used framework needs to allow for preferences and/or productivity of time inputs to systematically vary with income. Throughout, I use numerical examples to illustrate these findings.

4.1 A STATIC FRAMEWORK

Households are composed of one mother, one father and n children. The household makes choices during and outside of typical work hours (TWH). TWH are characterized by positive wages for parents, (w_1^q, w_2^q), where the subscript 1 stands for the mother and 2 for the father and the superscript $q \in \{1,2,3,4,5\}$ indicates the household's income quintile. Wages are zero outside of TWH. Households care about leisure, consumption and child quality which is produced using time and goods inputs. Households decide how much of their time endowment during and outside of TWH, (T_1^j, T_2^j), $j \in \{d,o\}$, each parent dedicates to work, (h_1^j, h_2^j), leisure, (ℓ_1^j, ℓ_2^j) and child care, $(\tau_1^j(z), \tau_2^j(z))$, where (z) indicates whether the child care is active or passive, $z \in \{a,p\}$ and superscript $j \in \{d,o\}$ indicates whether these choices apply during or outside of TWH. Each parent has the same time endowment so that $T_1^j = T_2^j$, $j \in \{d,o\}$, so that we can simplify $T_i^j = T^j$, $j \in \{d,o\}$, $i \in \{1,2\}$. Since wages are zero outside of TWH, $h_1^o = h_2^o = 0$ and we simplify $h_i^d = h_i$, $i \in \{1,2\}$. Income earned from labor, $w_1^q h_1 + w_2^q h_2$, together with non-labor income, I^q, is then split between consumption, c, market child care per child, θ, and goods inputs per child, e with relative price p_e. Note that, as in Del Boca et al. (2014), "leisure" implicitly includes any kind of housework or home production. Explicitly adding home production does not add much to the analysis below.

Households rank bundles of leisure $(\ell_1^d, \ell_2^d, \ell_1^o, \ell_2^o)$, consumption c and child quality k according to the utility function

$$u(\ell_1^d, \ell_2^d, \ell_1^o, \ell_2^o, c, k; \tau_1^d(p), \tau_2^d(p), \tau_1^o(p), \tau_2^o(p)), \tag{1}$$

with passive child care $(\tau_1^d(p), \tau_2^d(p), \tau_1^o(p), \tau_2^o(p))$ potentially affecting leisure enjoyment (or, by extension, productivity in home production). Assume utility is twice differentiable, strictly increasing and concave in $(\ell_1^d, \ell_2^d, \ell_1^o, \ell_2^o, c, k)$ and decreasing and convex in $(\tau_1^d(p), \tau_2^d(p), \tau_1^o(p), \tau_2^o(p))$.

Following Del Boca et al. (2014), it takes innate/previously accumulated ability, k_0^q, parental time inputs, $\tau_i^j(z)$, as well as goods inputs, e, to produce child quality, k. Children's ability may be correlated with earnings ability, q—hence the superscript. For simplicity, I assume that all n children in a household have the same innate ability. That way, as long as utility is strictly concave in average quality, k, parents want to invest the same amounts of time and goods in each child. The child quality production function is then given by

$$k = f(k_0^q, \tau_1^d(a), \tau_2^d(a), \tau_1^o(a), \tau_2^o(a), \tau_1^d(p), \tau_2^d(p), \tau_1^o(p), \tau_2^o(p), e). \tag{2}$$

I assume that the parent can always enjoy leisure while providing passive child care. Therefore, passive child care does not enter the time constraint directly but only as an inequality constraint with leisure. Given the discussion so far, the time constraints of the household are

given by

$$\begin{aligned} T^d &= h_i + \ell_i^d + n\tau_i^d \qquad && i \in \{1,2\}, \\ T^o &= \ell_i^o + n\tau_i^o && i \in \{1,2\}, \\ \tau_i^j(p) &\leq \ell_i^j && j \in \{d,o\}, i \in \{1,2\}. \end{aligned} \tag{3}$$

Finally, the budget constraint of the household is given by

$$c + ne + \theta n \leq w_1^q h_1 + w_2^q h_2 + I^q, \tag{4}$$

where the market child care cost per child, θ, is given by

$$\theta = \underline{w}[(T^d - s - \tau_1^d(a) - \tau_2^d(a) - \tau_1^d(p) - \tau_2^d(p)) + (T^o - \tau_1^o(a) - \tau_2^o(a) - \tau_1^o(p) - \tau_2^o(p))].$$

That is, children have the same time endowments as parents and whatever time is not covered by some form of parental child care, $\tau_i^j(z)$, or time in public school, s, needs to be outsourced. Outsourcing child care comes at a price of $\underline{w}$ per hour. Note that public school, s, is assumed to occur during TWH only.

Households maximize utility in equation (1), subject to the child quality production function in equation (2) and the constraints in equations (3) and (4).

4.1.1 ASSUMPTIONS

Abstracting from heterogeneity in number of children: The average number of children by income quintile are reported in Table 6. However, the facts described in Section 2 also hold when conditioning on number of children (1, 2 or 3+).[12] There are economies of scale in child care, i.e., a level effect, but the cross-sectional patterns hold for each type of family.[13] Thus, this variation is not the main culprit to understand the observed patterns of child care. I therefore abstract from this heterogeneity in what follows.[14]

Abstracting from age of the child: In the model presented above, the age of the child may matter for the value of publicly provided schooling, s, which decreases the need for child care as children enter school age. This difference may account for the fact that, for the most part,

[12] See Appendix A.4 for details.

[13] Folbre (2008) also constructs an approximation of the economies of scale in parental child care by examining families of different composition. She finds that children in two-parent, single-child families receive about 50 percent more active care time from at least one parent than those in two-child families, while children in families of three or more children receive only 15 percent less than those in two-child families. Hill and Stafford (1980) find that women in 1976 spend 550 minutes per child per week in child care if they have one preschooler and 440 minutes per child per week if they have two (p.237), i.e. a factor of 1.25.

[14] A brief discussion of how heterogeneity in n would affect model predictions can be found in Appendix A.5.1.

	Q1	Q2	Q3	Q4	Q5
Number of Children	2.45	2.27	2.16	2.22	2.19

Table 6. Number of Children by Income Quintile

Source: PSID-CDS.

child care decreases with age of the child.[15] However, the phenomenon of high income fathers catching up to mothers and their lower income counterparts holds both for children before school age as well as school age children, though it is more pronounced for preschoolers.[16] Note that Del Boca et al. (2014) use a dynamic model where children move through different ages as they accumulate quality, k. The dynamic dimension is not very instructive for the facts analyzed in this paper, however. In what follows, I therefore abstract from the age dimension.

Abstracting from passive child care: Passive child care benefits the parents because it is productive for child quality and this time does not need to be outsourced. But the drawback of passive child care is that it may decrease the utility from leisure (or the productivity in home production) (see e.g., Browning 1992).

Now, Del Boca et al. (2014) find that passive time is much less productive for child quality than active time (see their Figures 2, 4 and 5). I therefore abstract from passive child care in child quality production. In addition, they do not take the outsourcing cost into account, basically assuming that $\underline{w} = 0$.

Note that, if the utility drawback is absent, passive child care is equal to leisure. If the utility drawback is so strong that leisure is no longer enjoyable (or housework is no longer productive), passive child care is equal to zero. Both of these corner solutions make passive child care irrelevant for analysis. Considering mothers during TWH, if we add up active and passive child care per child from Figure 1 (Table A.1) multiplied by the number of children in Table 6 as well as hours worked from Table 4, mothers have only 3 to 7 hours left for leisure during TWH per week. Therefore, assuming that mothers spend all their leisure/housework time in passive child care—the first corner solution, doesn't seem too far fetched. For fathers, the effect of passive child care on leisure enjoyment (or housework productivity) may be so strong that they spend virtually no time in passive child care during TWH (see Table A.1)—the second corner solution. I therefore also abstract from utility effects of passive child care.

Finally, the main fact under consideration in this paper, namely that high income fathers catch up to mothers more so than low income fathers, is most pronounced for active child care. Therefore, it seems reasonable to disregard passive child care altogether. To do this, I assume

[15] Passive child care is increasing between age 0 to 2 and 3 to 5. However, by adding an estimate of supervisory time during naps to passive child care (not included in Folbre (2008)'s measure, while Folbre et al. (2005) include nap times as a residual), passive child care is also monotonically decreasing in age of the child—in line with structural estimates in Hotz and Miller (1988). Details are available upon request.

[16] See Appendix A.4 for details.

that u and f are independent on passive child care, $\tau_i^j(p)$, and outsourcing is not costly, $\underline{w} = 0$.

Functional Form Assumptions: To encompass the recent literature analyzing parental child care as an input to child quality production, I make the following functional form and parameter assumptions. Utility is of the CES variety and given by:

$$\begin{aligned} u(.) \;=\; & \alpha_1^d \frac{(\ell_1^d)^{1-\sigma}-1}{1-\sigma} + \alpha_2^d \frac{(\ell_2^d)^{1-\sigma}-1}{1-\sigma} + \alpha_1^o \frac{(\ell_1^o)^{1-\sigma}-1}{1-\sigma} + \alpha_2^o \frac{(\ell_2^o)^{1-\sigma}-1}{1-\sigma} \\ & + \alpha_3 \frac{c^{1-\sigma}-1}{1-\sigma} + \alpha_4 \frac{k^{1-\sigma}-1}{1-\sigma}, \end{aligned} \tag{5}$$

where α's are positive and we assume the elasticity parameter, $\sigma > 0$, is the same for all types of leisure, consumption as well as child quality so that preferences are homothetic.

Child quality production is of the nested CES variety and given by:

$$f(.) \equiv R \left\{ \left[\left\{ \delta_1^d (\tau_1^d)^{\rho^d} + \delta_2^d (\tau_2^d)^{\rho^d} \right\}^{\frac{\rho}{\rho^d}} + \left\{ \delta_1^o (\tau_1^o)^{\rho^o} + \delta_2^o (\tau_2^o)^{\rho^o} \right\}^{\frac{\rho}{\rho^o}} \right]^{\frac{\zeta}{\rho}} + \delta_3 e^{\zeta} \right\}^{\frac{1}{\zeta}} (k_0^q)^{\delta_4}; \tag{6}$$

where R is the scaling factor, $\rho^d \in (-\infty, 1)$ and $\rho^o \in (-\infty, 1)$, capture the degree of substitutability between mother's and father's time during and outside of TWH, respectively, $\rho \in (-\infty, 1)$ captures complementarities between child care during and outside TWH, while $\zeta \in (-\infty, 1)$ captures complementarities between overall time and goods inputs and, finally, the δ's are positive and represent shares of all of the inputs. Note that k_0^q is a fixed factor here. Hence, we need $\delta_1^d + \delta_2^d + \delta_1^o + \delta_2^o + \delta_3 \leq 1$ for the production function to be overall concave.

To get as close as possible to a (static) version of the model in Del Boca et al. (2014), one would assume $\sigma \to 1$ in $u(.)$ and $\zeta \to 0$, $\rho \to 0$, $\rho^d \to 0$ and $\rho^o \to 0$ in $f(.)$. This gives logarithmic utility with a Cobb-Douglas production function. Similarly, to get as close as possible to a (static) version of the model in Abbott (2015), one would assume that $\sigma = 2$ (i.e., he assumes a Frisch elasticity of 0.5 which results in the same elasticity for consumption and leisure as specified above), but let $\zeta \in (-\infty, 1)$, $\rho \in (-\infty, 1)$ and $\rho^d \in (-\infty, 1)$ and $\rho^o \in (-\infty, 1)$. Hence, while neither distinguishes between child care during and outside of TWH, Abbott (2015) allows for goods and time inputs as well as time inputs of mothers and fathers to be more/less substitutable than in Del Boca et al. (2014). In the end, he finds that they are all more substitutable (see his equation (3) and Table 4).

Data driven assumptions: Further, I make a few data driven assumptions based on Table 7. Throughout, I assume w_i^q increasing in q for both parents, $i \in \{1, 2\}$ (see Table 7, rows 1 and 2). This evidence suggests that heterogeneity in earnings ability captures the quintiles based on total household income used in Section 2.2.3. In light of evidence on positive assortative matching and a positive wage gap (see Table 7, row 3), I assume that $w_1^q < w_2^q$ for all q but start

with $w_1^q = \lambda w_2^q$, $\lambda \in (0,1)$ for all q. That is, while mother's earnings potential depends on q, the wage gap, λ, itself is independent on q. Further, since non-labor income often represents the proceeds of some earlier labor income, correlated with current labor income (see Table 7, rows 4 and 5), I assume that, I^q is increasing in q but start with $I^q = \phi_1 w_1^q$ and $I^q = \phi_2 w_2^q$ for all q which implies $\phi_2 = \lambda\phi_1$. That is, ϕ_i are also independent on q.[17]

Finally, let $W^q \equiv (w_1^q + w_2^q)T^d + I^q$ be wealth during TWH. Under the above assumptions, $\frac{W^q}{w_1^q} = \left(1 + \frac{1}{\lambda}\right) T^d + \phi_1$ and $\frac{W^q}{w_2^q} = (\lambda + 1) T^d + \phi_2$. Note that wealth outside of typical work hours is simply T^o.

	All	Q1	Q2	Q3	Q4	Q5
Mother's Wage (w_1^q)	\$11.14	\$6.80	\$8.03	\$8.94	\$11.19	\$20.76
Father's Wage (w_2^q)	\$16.06	\$8.17	\$10.66	\$12.62	\$17.68	\$31.15
Ratio M/F (λ)	69.41%	83.29%	75.33%	70.84%	63.32%	66.66
Non-Lab. Inc. (I^q)	\$5,303	\$3,550	\$3,725	\$5,239	\$5,065	\$8,934
Ratio NLI/F (ϕ_2)	330.25	434.61	349.39	415.12	286.54	286.82

Table 7. Hourly wages and annual non-labor income by quintile (2000 dollars)
Source: PSID-CDS.

4.2 LEVEL DIFFERENCES BETWEEN MOTHERS AND FATHERS

To start, assume logarithmic utility ($\sigma \to 1$) and a Cobb-Douglas child quality production function ($\zeta \to 0$, $\rho \to 0$, $\rho^d \to 0$, $\rho^o \to 0$). In this case, after substituting out k in the utility function, the decision problems during and outside of TWH are completely separable. It is then straightforward to show that child care during and outside of TWH are given by (see Appendix A.5 for details):

$$\tau_1^{d,q} = \frac{\alpha_4 \delta_1^d}{n\Gamma^d}\left[\left(1 + \frac{1}{\lambda}\right) T^d + \phi_1\right]; \qquad \tau_2^{d,q} = \frac{\alpha_4 \delta_2^d}{n\Gamma^d}\left[(\lambda + 1) T^d + \phi_2\right]; \tag{7}$$

$$\tau_i^{o,q} = \frac{\alpha_4 \delta_i^o}{n\Gamma_i^o} T^o. \tag{8}$$

where $\Gamma^d \equiv \alpha_1^d + \alpha_2^d + \alpha_3 + \alpha_4(\delta_1^d + \delta_2^d + \delta_3)$ and $\Gamma_i^o \equiv \alpha_i^o + \alpha_4 \delta_i^o$.

During TWH (equations (7)), to replicate level differences by gender displayed in Table 2, a positive gender wage gap ($\lambda < 1$) and/or mothers being more productive in producing child quality ($\delta_1^d > \delta_2^d$) are sufficient, at least qualitatively.[18]

[17] The assumptions on n, λ and ϕ_2 are relaxed in Appendix A.5.1.

[18] Sayer et al. (2004) find that the ratio of time spent on child care by married mothers relative to married fathers decreased since 1965. According to this model, their observation may be due to the progressive closing of the gender wage gap (see e.g., Jones, Manuelli and McGrattan, 2015).

Outside of TWH (equation (8)), to capture level differences by gender displayed in Table 2, we need that mothers like child quality relatively more than fathers do, compared to leisure ($\alpha_1^o < \alpha_2^o$) and/or that mothers are more productive in producing child quality ($\delta_1^o > \delta_2^o$).

Del Boca et al. (2014) also find that mother's time is more productive than father's, $\delta_1 > \delta_2$, at least until the child is age 10, and that mothers put less weight on leisure (housework) than fathers do, $\alpha_1 < \alpha_2$, at least for families with two children.

4.3 TIME AND RESOURCE ALLOCATION BY INCOME QUINTILE

While the logarithmic utility and Cobb-Douglas production specification easily replicates level differences in child care by mothers and fathers, it predicts that child care, leisure and hours worked are independent on wages and therefore on quintiles, q. Hence, unless the number of children (n), the wage gap (λ), non-labor income as a fraction of wages (ϕ_i), preferences (α_i^d, α_4) or technology (δ_i^d), systematically differ with q, this model cannot capture the fact that during TWH, both mother's and father's child care are decreasing in q, and that outside of TWH, mother's child care is decreasing in q while father's child care is increasing in q. In addition to observations on parental child care, since time endowments are independent on q, the model with logarithmic utility and Cobb-Douglas production predicts that hours worked, h_i, are also independent on q. But looking at mothers' and fathers' hours worked in Table 4, this is clearly counterfactual. Finally, given the number of children, n, this model predicts that expenditures per child, e, are a constant faction of total household income, W^q. However, evidence suggests that expenditures as a fraction of income are actually decreasing in income (see Table 5). Even letting the parameters for the number of children (n^q), the wage gap (λ^q) and non-labor income as a fraction of wages (ϕ_i^q) vary by income quintile as suggested by data in Tables 7 and 6 does not save this specification (see Online Appendices A.5.1 and A.5.2 for details).

Systematic variation by income quintile in preferences (α_i^d, α_4) or productivity (δ_i^d) would have to move in the same direction for mothers and fathers during TWH as well as mothers outside of TWH and in the opposite direction for fathers outside of TWH (e.g, $\delta_1^{d,q}$, $\delta_2^{d,q}$ and $\delta_1^{o,q}$ decreasing in q and $\delta_2^{o,q}$ increasing in q).

Del Boca et al. (2014) allow for preference heterogeneity, α's, in their structural estimation but assume that productivity parameters are the same across households. They find a small negative correlation between preferences for consumption and leisure of the mother for families with one child, albeit with a large standard error. Instead, for families with two children preferences for consumption and leisure are negatively correlated with preferences for child quality. Since they do not report the correlation between α's and wages, it is hard to assess how preferences vary with income. In a separate experiment (reported in their footnote 11), they allow for productivity parameters to be a function of education. They find no evidence that

these parameters differ significantly by parental education. Distinguishing between child care during and outside of TWH may well change this result.

In what follows, I show that letting utility move away from the logarithmic case, $\sigma \in (0,1)$, helps replicate time allocation patterns during TWH but that preferences (α_i^d, α_4) and/or technology (δ_i^d) parameters still need to systematically vary with q, to rationalize child care patterns outside of TWH, albeit in a less complicated way than for logarithmic utility.

4.3.1 TIME AND RESOURCE ALLOCATION BY INCOME QUINTILE DURING TYPICAL WORK HOURS

Once we allow the elasticity of substitution to be higher than in the logarithmic case ($\sigma \in (0,1)$), patterns of child care and hours worked by income quintile during TWH can be matched fairly closely. Also, expenditure per child, $p_e e$, are now decreasing as a fraction of household income, $w_1^q h_1^q + w_2^q h_2^q + I^q$. While closed form solutions are no longer available, a numerical example illustrates this result.

Figure 3 plots model predictions (dashed lines) and data (solid lines) by income quintile for (a) child care during TWH, (b) child care outside of TWH, (c) hours worked and (d) expenditures per child. In this simulation, the only source of heterogeneity across income quintiles is father's wage, w_2^q, taken from Table 7, row 2. In order to concentrate on the effect of the elasticity of substitution, σ, the parameters n, λ and ϕ_2 are set to their average values. Mother's wage, $w_1^q = \lambda w_2^q$, and innate ability $k_0^q = \gamma w_2^q$, with $\gamma = 1$, which is without loss of generality here. Since the positive gender wage gap alone did not generate enough of a level difference in child care between mothers and fathers, as per the result in Section 4.2, productivity and preference parameters are allowed to vary by gender. They were set such that $\delta_1^d > \delta_2^d$, $\delta_1^o > \delta_2^o$, $\alpha_1^d < \alpha_2^d$ and $\alpha_1^o < \alpha_2^o$. Finally, to get hours worked to be increasing and child care during TWH to be decreasing, the parameter governing the elasticity of substitution between leisure, consumption and child quality is set within $\sigma \in (0,1)$. This generates the desired result during TWH because the substitution effect of a higher wage dominates the income effect. The exact parameter values can be found in Appendix A.6, Table A.22.

As can be seen in Figure 3, the model matches level differences between mothers and fathers in terms of child care as well as hours worked quite well. By income quintile, (a) child care during TWH is more decreasing for mothers than fathers, while (c) hours worked are increasing for both. For mothers, the model misses out on the slight hump shape in child care during TWH from Q3 to Q5 as well as on the slight decrease in hours worked from Q3 to Q5 observed in the data. Finally, (d) expenditures per child as a fraction of household income are decreasing as suggested by data in Table 5. Overall, a higher elasticity of substitution goes a long way in replicating time allocation patterns during TWH as well as expenditure patterns by income quintile. However, the model predicts (b) a slightly decreasing pattern outside of TWH

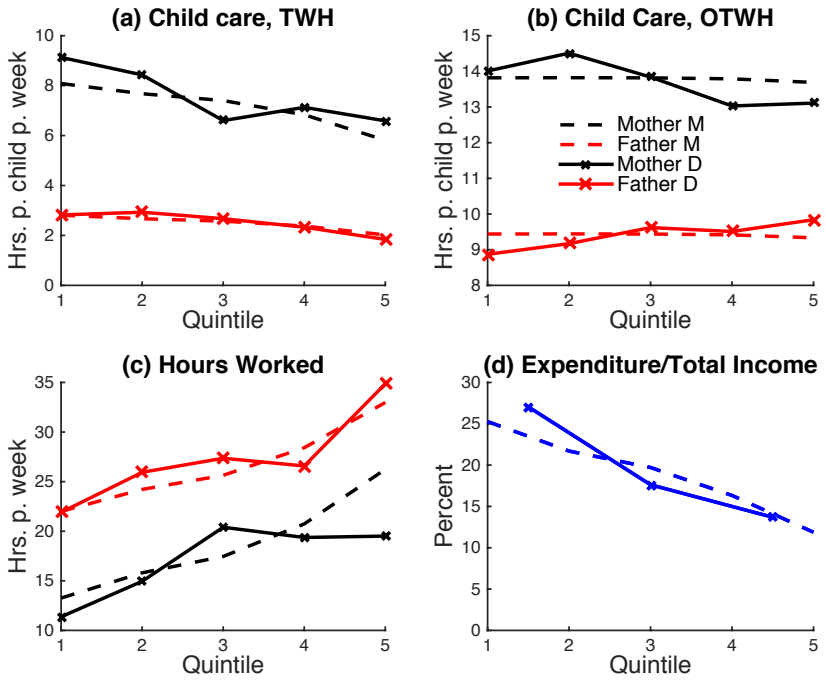

Figure 3. Numerical Example: CES Utility with $\sigma < 1$

for both mothers and fathers. The reason why child care outside of TWH is affected at all is because, unlike for logarithmic utility, the decision problems during and outside of TWH are not separable.

4.3.2 TIME ALLOCATION BY INCOME QUINTILE OUTSIDE OF TYPICAL WORK HOURS

While moving away from logarithmic utility towards a higher elasticity of substitution generates the main features of time allocation during TWH, it does not deliver the facts outside of TWH. In fact, this is a very general result that holds for all parameter values for the nested CES production function specified in equation (6).

Indeed, Proposition 1 shows that whenever parameters are such that father's child care outside of TWH are increasing in q as observed in the data, then the model counterfactually predicts that mother's child care outside of TWH is also increasing in q.

Proposition 1. *Assume functional forms for utility in equation (5) and child quality production in equation (6). Also assume heterogeneity is described by* w_2^q, $w_1^q = \lambda w_2^q$, $k_0^q = \gamma w_2^q$, *while all other parameters are independent on* q. *Further, suppose the solution is interior. Let* $\varphi_i^q \equiv \frac{\tau_i^{o,q+1}}{\tau_i^{o,q}}$, $i \in \{1,2\}$, $q \in \{1,2,3,4\}$. *Then,* $\varphi_2^q > 1$ *implies* $\varphi_1^q > 1$.

Proof. From the first-order conditions for leisure and child care outside of TWH, we get, for

$q \in \{1,2,3,4,5\}$[19]

$$\left(\frac{\tau_2^{o,q}}{\tau_1^{o,q}}\right)^{1-\rho^o} = \frac{\alpha_1^o}{\alpha_2^o}\frac{\delta_2^o}{\delta_1^o}\left(\frac{T^o - n\tau_2^{o,q}}{T^o - n\tau_1^{o,q}}\right)^{\sigma}. \tag{9}$$

For $q+1, q \in \{1,2,3,4\}$, the condition above can be written as

$$\left(\frac{\varphi_2^q\tau_2^{o,q}}{\varphi_1^q\tau_1^{o,q}}\right)^{1-\rho^o} = \frac{\alpha_1^o}{\alpha_2^o}\frac{\delta_2^o}{\delta_1^o}\left(\frac{T^o - n\varphi_2^q\tau_2^{o,q}}{T^o - n\varphi_1^q\tau_1^{o,q}}\right)^{\sigma}. \tag{10}$$

Proof by contradiction. Suppose $\varphi_2^q > 1$ but $\varphi_1^q < 1$. Then, since $\rho^o < 1$, the left-hand side of equation (9) is smaller than the left-hand side of equation (10) but the right-hand side of equation (9) is larger than the right-hand side of equation (10). Hence, equations (9) and (10) cannot both hold with equality—a contradiction. QED.

Hence, unless $b^{o,q} \equiv \frac{\alpha_1^{o,q}}{\alpha_2^{o,q}}\frac{\delta_2^{o,q}}{\delta_1^{o,q}}$ systematically varies with q, this model cannot replicate observations outside of TWH. To illustrate this result, Figure 4 plots the results for the Cobb-Douglas production case (a special case of the specification in equation (6) assumed in the proposition), the same parameter values as in the experiment in Figure 3, but where δ_i^j's are allowed to vary with q. In particular, it is assumed that low income fathers are relatively less productive and high income fathers more productive in child care. To keep the overall returns to time investment identical across income quintiles, mother's productivities are adjusted accordingly. More precisely, $\delta_i^{j,q}$'s are given by:

$$\begin{aligned}
&\delta_i^{j,3} = \delta_i^j, \quad i \in \{1,2\},\\
&\delta_1^{j,1} = \delta_1^j + 2\varepsilon, \qquad \delta_2^{j,1} = \delta_2^j - 2\varepsilon, \qquad \delta_1^{j,4} = \delta_1^j - \varepsilon, \qquad \delta_2^{j,4} = \delta_2^j + \varepsilon,\\
&\delta_1^{j,2} = \delta_1^j + \varepsilon, \qquad \delta_2^{j,2} = \delta_2^j - \varepsilon, \qquad \delta_1^{j,5} = \delta_1^j - 2\varepsilon, \qquad \delta_2^{j,5} = \delta_2^j + 2\varepsilon.
\end{aligned}$$

This pattern only differs by gender but not during versus outside of TWH, $j \in \{1,2\}$. In the logarithmic utility case, we needed a differential pattern for fathers during and outside of TWH.

As can be seen in Figure 4, (a) mother's child care during TWH is slightly steeper than in Figure 3, while father's child care is slightly flatter; (c) hours worked and (d) expenditures on children are also similar to the predictions in in Figure 3. Most importantly, however, (b) father's child care is now increasing outside of TWH, while mother's decreases more steeply. As a result, this variation of the model comes close to replicating fathers catching up to mothers outside of TWH shown Figure 5.

Guryan et al. (2008) also suggest that preference or productivity systematically vary with income as one potential theory for the overall positive income gradient for child care they find. However, the specific pattern needed to account for the behavioral patters described in this paper are different than those described in Guryan et al. (2008).

[19] For a detailed derivation of first-order conditions, see Appendix A.6.

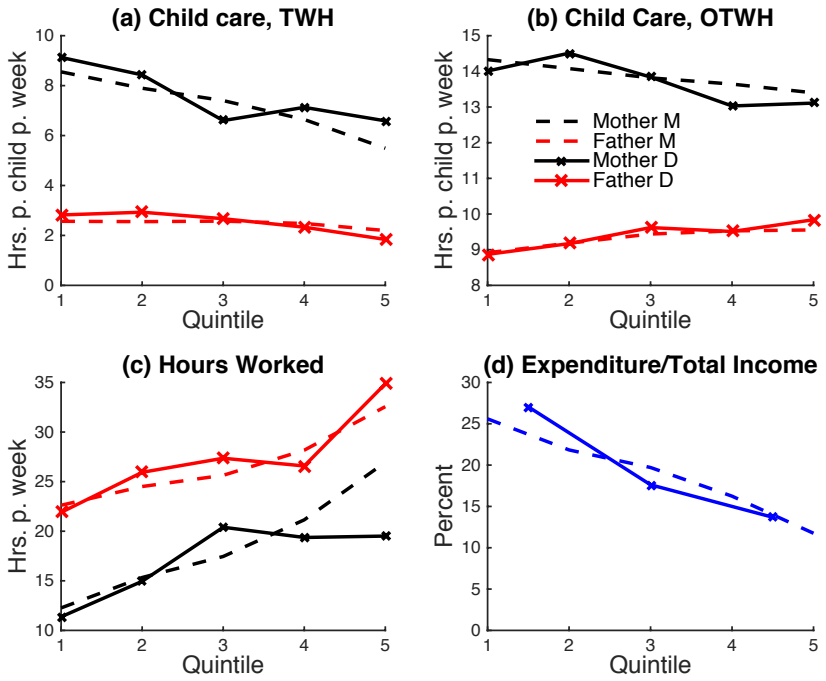

Figure 4. Numerical Example: CES Utility with $\sigma < 1$ and productivity heterogeneity

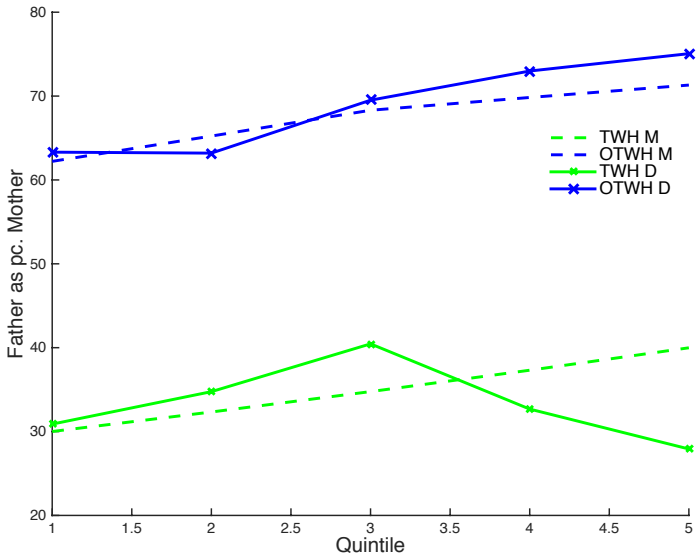

Figure 5. Numerical Example: Productivity heterogeneity, Father as percent of Mother

5 CONCLUDING REMARKS

This paper finds that the distinction between child care during and outside of typical work hours (TWH) is important in understanding household time allocation. More precisely, I find that high income fathers catch up to high income mothers outside of TWH, more so than low income fathers do.

While Guryan et al. (2008) find a positive education/earnings gradient for both mothers and fathers, this paper shows that child care is actually strongly decreasing in household income

(for mothers) during TWH and increasing for fathers outside of TWH.

Guryan et al. (2008) and, more recently, Aguiar and Hurst (Forthcoming) conclude that child care has to be treated separately from leisure and housework because the sign of the income gradient is different. Since the opportunity cost of spending time with children during TWH is first and foremost in terms of foregone earnings and child care is decreasing in income, child care is actually very similar to leisure and housework. Since outside of TWH the opportunity cost of spending time with children is in terms of forgone leisure or housework, it is not surprising that, if the latter two are decreasing in income, child care should almost be expected to increase with income. Hence, the difficulty is not necessarily the positive income gradient, only present outside of TWH where the opportunity cost is in terms of forgone leisure and housework, but rather the differential behavior of mothers and fathers outside of TWH.

Using a static model which encompasses features of two recent papers on the topic of child care as an input to child quality production, Del Boca et al. (2014) and Abbott (2015), extended to distinguish child care during and outside of TWH, this paper shows that the cross-sectional patterns are hard to reconcile with these models, unless preferences or productivity in child care production systematically differ across income groups. They suggest that the facts point to several potential reasons for the observed patters of child care, including that high income parents may have a higher preference for the output generated by child care time, relative to leisure or home produced goods, or be relatively more productive at producing child quality.

Of course, there are many potential theories that could explain the facts presented here. For instance elasticities may vary differently during and outside of TWH or different types of systematic heterogeneity could be assumed. However, currently widely used dynamic models are at odds with the cross-sectional facts presented in this paper. This calls for future research to develop a unified theory to simultaneously explain the static and the dynamic dimension of time allocation and child quality production across income groups.

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APPENDICES

List of Appendices

A.1 Detailed Tables

A.2 Concepts and Scope

A.2.1 Number of Observations in PSID-CDS . . . . . .

A.2.2 Time Spent with Children: An Opportunity Cost View . . . . . .

A.3 Alternative definitions of typical work hours

A.4 Child care by number of children and age of the child

A.5 Logarithmic Utility with Cobb-Douglas Production

A.5.1 Relaxing heterogeneity assumptions . . . . . .

A.5.2 Numerical example . . . . . .

A.6 CES Utility with Nested CES Production

A.6.1 Numerical examples . . . . . .

A.1 Detailed Tables

Table A.1 reports hours per child per week of active and passive child care disaggregated by household income, during and outside of typical work hours. As in Table 2, the *Parents* rows are the sum of *Mother* and *Father* rows. Further, there is one row for each type of child care per child (active, passive and total (active plus passive)). For comparison, the first column of Table A.1 repeats the overall numbers from Table 2, while the last five columns condition on household income quintile. Table A.2 provides the detailed numbers derived from dividing Father's time by Mother's time for each child care category in Table A.1.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	7.50	9.13	8.43	6.60	7.13	6.59
		Passive	4.81	6.51	5.53	4.46	4.19	3.78
		Total	12.31	15.64	13.96	11.06	11.32	10.37
	Father	Active	2.49	2.82	2.93	2.67	2.33	1.84
		Passive	1.18	0.88	1.51	1.12	1.15	1.26
		Total	3.67	3.70	4.44	3.78	3.49	3.09
	Parents	Active	9.99	11.95	11.36	9.27	9.46	8.43
		Passive	5.99	7.39	7.04	5.57	5.34	5.04
		Total	15.98	19.34	18.41	14.84	14.81	13.47
O.T.W.H.	Mother	Active	13.67	14.01	14.51	13.84	13.03	13.11
		Passive	6.62	7.15	6.13	6.73	6.30	6.78
		Total	20.29	21.16	20.65	20.58	19.33	19.89
	Father	Active	9.44	8.87	9.17	9.62	9.51	9.84
		Passive	4.52	4.39	4.17	4.88	4.49	4.61
		Total	13.96	13.26	13.35	14.50	14.00	14.45
	Parents	Active	23.11	22.88	23.69	23.46	22.53	22.95
		Passive	11.14	11.54	10.31	11.61	10.79	11.39
		Total	34.25	34.43	33.99	35.08	33.32	34.34

Table A.1. Active and Passive Child Care by Household Income, Typical Work Hours (T.W.H.) and Outside T.W.H. (O.T.W.H.), (Hours per child per week), Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	33.1%	30.9%	34.7%	40.4%	32.7%	27.8%
	Passive	24.5%	13.4%	27.2%	25.0%	27.5%	33.2%
	Total	29.7%	23.6%	31.8%	34.2%	30.8%	29.8%
O.T.W.H.	Active	69.0%	63.2%	63.2%	69.4%	72.9%	75.0%
	Passive	68.3%	61.4%	67.9%	72.4%	71.2%	67.9%
	Total	68.8%	62.6%	64.6%	70.4%	72.4%	72.6%

Table A.2. Child Care During and Outside of Typical Work Hours, Fathers as Percent of Mothers, Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

A.2 Concepts and Scope

In this paper, I use the Panel Study of Income Dynamics Child Development Study (PSID-CDS) 1997, where a subsample of PSID households with children under the age of 12 were asked to keep time diaries for one week day and one weekend day. For each activity, except naps, the survey records who else is present and whether the person is actively involved in the activity or not. The data allows us to infer how much time mothers and fathers (including step-parents) spend in active and passive child care and at what times of the day and week. In addition, one can compute child care per child by adjusting for sibling presence and involvement. For the purpose of this paper, I ignore the exact type of activity the child is involved in and whether any other adults (besides parents) are present or not.

There are at least two advantages of using PSID-CDS data over the American Time Use Study (ATUS) for this project. First, the study is child-based and therefore also reports time spent by parents who are not living in the same household as the child. Second, from the PSID one can get an exact household income measure, rather than broad income brackets as reported in ATUS. This makes it possible to create precise income quintiles used throughout this paper.[20]

A.2.1 Number of Observations in PSID-CDS

Since (almost) each observation consists of two 24 hour time diaries, including one week day and one weekend day, the disaggregation by active and passive child care, week day versus weekend, time of the day and mother-father-parents do not decrease the number of observations per cell. Following Del Boca et al. (2014), I concentrate on two-parent families and discard observations where total household income, labor income, wage rate and hours worked reports are inconsistent. This boils down to eliminating wage reports of more than $150 per hour and those with non-labor income of more than $1,000 per week. The data sample I use has 2,992 24-hour observations for two-parent families with 1,498 weekend and 1,494 week

[20] In ongoing work, I exploit the advantages of ATUS to distinguish between educational and basic child care as well as leisure (spent with children) versus strict child care, including children age 12 and above. For the purpose of the current paper, PSID-CDS 1997 time diaries were a more natural choice.

day observations. Disaggregating into household income quintiles decreases the number of observations to about 300 per cell. Discrepancies are due to the way ties are handled.

	All	Q1	Q2	Q3	Q4	Q5
M-F	1494	299	297	300	300	298
W-E	1498	300	299	299	301	299

Table A.3. Number of 24h-Observations by Household Income Quintile, Two-Parents Families

Notes: W-E = weekend (Saturday and Sunday), M-F = week day (Monday through Friday).

Source: PSID-CDS.

A.2.2 Time Spent with Children: An Opportunity Cost View

In a recent book Nancy Folbre uses PSID-CDS data to estimate weekly parental time spent in active and passive child care. Folbre (2008), where Chapter 6 is largely based on Folbre et al. (2005), computes parental time spent in active child care as well as passive child care (supervisory or on-call care, excluding sleep), adjusting for sibling presence, by age of the child for Lino (2001)'s two-parent-two-children middle income families as well as, less extentsively, for single mothers with low income.

This paper follows a similar strategy to hers in that it focuses on active and passive child care for two-parent families. As opposed to Folbre's calculations, this paper aims at computing opportunity costs of children for a variety of alternative activities rather than a grand total or replacement cost. This opportunity cost view has implications for how active and passive care is interpreted. For example the opportunity costs of spending time with children during typical work hours is in terms of forgone market work, while the opportunity cost of spending time with children outside of typical work hours is in terms of foregone leisure or housework if the parent is actively involved with the child and in terms of leisure enjoyment or productivity in housework if the parent is in a passive, supervisory role.

In the next subsection, I discuss the chosen definition of typical work hours. In the two subsections that follow, I discuss the implications of this opportunity cost view for how parental overlaps are counted and how sibling presence is dealt with. In particular, unlike Folbre et al. (2005) and Folbre (2008), I count how much time parents spend, rather than how much time children receive (see Section A.2.2.2). I also account for sibling presence more precisely to get at a per child measure of child care. While Folbre et al. (2005) and Folbre (2008) subtract an overall average deduced from active care only, I deal with sibling presence for each type of child care, each parent, each income and age group, separately (see Section A.2.2.3).

Finally, while Folbre focuses on middle income families, I report estimates for five income quintiles. However, the focus here is still on two-parent families.

A.2.2.1 What are "typical work hours"?

Standard versus non-standard work hours have been defined in a variety of ways in the literature. A schedule of "9 to 5, Monday through Friday" is the most commonly used concept of a

standard work week in casual observation. Seminal papers by Presser (1988, 1995, 2000) use 8am to 4pm, Monday through Friday, while Leupp, Kornrich and Brines (2010) define nonstandard employment as "employment that occurs outside of the Monday through Friday, daytime hours of 5am and 6pm".

Given the purpose of this paper, it is important to make sure that the chosen time frame of 8am to 5pm, Monday through Friday, actually captures the majority of hours worked by adults in two-parent families while not including daytimes where very few people work. The PSID-CDS data provides "Work outside of the home" for primary and secondary caregivers for each observed child. For our families, those caregivers correspond to mothers (primary) and fathers (secondary) for the most part.

The fraction of hours worked falling within "standard work hours" can be found in Table A.4. For the 9am to 5pm definition, only 74 percent of hours worked outside the home by mothers fall within these times and only 69 percent of hours worked by fathers do. On the other hand, for Leupp et al. (2010)'s preferred definition, namely 5am to 6pm, these percentages are about 88 percent for both parents. As a middle ground, the hours of 8am to 6pm were chosen for the purposes of this paper, where for mothers the percentage is 83 percent and for fathers it is 80 percent.

9am to 5pm	Mother*	73.6%
	Father**	68.7%
8am to 6pm	Mother*	83.6%
	Father**	80.2%
5am to 6pm	Mother*	88.1%
	Father**	87.8%

Table A.4. Percent of Hours Worked Outside of the Home Falling within Standard Work Hours, Depending on Definition

Notes: All restricted to Monday through Friday, * Primary Caregiver, ** Secondary Caregiver.

Source: PSID-CDS.

A.2.2.2 Mothers, Fathers and Parents: Overlaps in Active and Passive Child Care

First, I follow Folbre (2008) in defining parents as including stepparents. While Folbre (2008) assumes that active time of a second parent has no value added and therefore counts this time only once—giving mothers priority over fathers, this paper is interested in how much work time, leisure time, etc. is forgone because of active child care and therefore fully counts both parent's time as active child care in this case. If both parents are around but not actively involved, half of each parent's time counts as passive child care—the idea being that only one has to jump in if need be. If one parent is actively involved in the activity, then the presence of the other parent is not counted as passive child care: the second parent may well be present but is probably not "on call"; the active parent is already there.

A.2.2.3 Per Child Child Care: Adjustment for Sibling Presence and Involvement

To compute per child measures of child care, I make adjustments for sibling presence and involvement in the activity the observed child is doing. With the aim of calculating how much care children receive, Folbre (2008), following Folbre et al. (2005), deals with this issue by computing that, on average, the sibling is present for 26 percent of active child care for two-parent-two-children middle income families and then subtracts half of that time, 13 percent, from all active care measures. In this paper I account for sibling presence for both active and passive child care and make adjustments for each quintile separately. As opposed to Folbre (2008), the goal is to avoid implicit double counting. That is, if the sibling were also observed, the overlap would be counted for the sibling as well. Since the sibling is not actually observed on the same day, I have to infer what the sibling's involvement with the parent was. As it turns out, the implied adjustment is the same whether the sibling was actively or passively involved with the parent. Table A.5 gives an example of the sibling adjustment for mothers of two children under age 12, showing hours per week, all week, all times. I now review how each number in this table is used to deduce active and passive child care per child. For families with only one child, these adjustments are obviously not necessary. For families with more than two children, I assume that if one sibling is present, so are the others and divide by the average number of children in this subgroup.[21]

		Overall	Sibling Participating	Sibling Around	Per Child
Mother	Active	25.90	14.87	4.63	18.46
	Passive	19.32	8.65	6.28	9.54

Table A.5. Sibling Adjustment: An Example (Mothers in two-parent families with 2 children under age 12)

Source: PSID-CDS.

For active care, Table A.5 shows that the average total amount of active time mothers spend with the observed child is 25.9 hours per week. If a parent is actively involved in an activity with the observed child and the sibling is also actively involved, then I count the time as half the active child care time; the other half would be counted if the sibling was the observed child. On average, for 14.87 of the active hours, the sibling is actively involved with the observed child as well as the mother. Therefore, after sibling adjustment, active child care by mothers is given by $25.9 - 14.87/2 = 18.46$ hours per child per week. This is the only adjustment needed to get at a per child measure of active child care.

To get at passive child care (excluding naps) per child, the procedure is a bit more complicated. Table A.5 shows that the average total amount mothers spend supervising the observed child is 19.32 hours per week. If a parent is passive (and the other parent is not active) but the sibling is actively involved in the activity with the observed child, then the sibling is also under passive care of the parent. Therefore, half the time is counted as passive child care time for

[21] Folbre's percentage is significantly smaller than what I find in my calculations. The reason can be found in Folbre et al. (2005) where child overlaps are computed as a fraction of the time where only one parent is present (see Folbre, Yoon, Finnoff and Fuligni 2005, Table 5). However, whenever both parents are present in two-parent multi children families, the siblings are very likely present as well and I take this fact into account here.

the observed child; the other half would be counted if the sibling was the observed child. This occurs for 8.65 hours among the passive hours spent by mothers. If a parent is actively involved in an activity with the observed child and the sibling is around but not actively involved, then we want to fully count this time as active child care but not passive child care. If the sibling was observed, this time would show up as passive child care. Therefore, I count this time as active child care (included in the 25.9 hours a week) but subtract half that time from passive child care time per child; the other half would be subtracted if the sibling was the observed child (thanks to the next adjustment). This occurs for 4.63 hours among the active hours spent by mothers. If a parent is passive (and the other parent is not active) and the sibling is around but not actively involved in the activity with the observed child, then there are two cases: (1) the parent is actively involved in the sibling's activity, or (2) the parent is also passive with the sibling. In both cases, half the time should be subtracted from passive child care (in line with the previous two adjustments). In the first case, an additional half will be subtracted from passive time in the sibling's observation and hence only active and no passive time would be counted. In the second case, the other half of passive time would be counted in the sibling's observation. Hence, the adjustment avoids double counting in both cases. This occurs for 6.28 hours among the passive hours spent by mothers. Therefore, after sibling adjustment, passive child care per child by mothers is given by $19.32 - 8.65/2 - 4.63/2 - 6.28/2 = 9.54$ hours per child per week.

A.3 Alternative definitions of typical work hours

This section provides the same child care measures as in Section 2.2 but for alternative definitions of typical work hours, namely 9am to 5pm (standard expression) and 5am to 6pm (Leupp et al. 2010). Table A.6 shows overall hours, Tables A.7 and A.9 disaggregate by household income quintile and Tables A.8 and A.10 report father's child care as a percent of mother's. Comparing to Tables 2,A.1 and A.2, levels are lower for the 9am to 5pm definition and higher for the 5am to 6pm, but the patterns are very similar to those observed for the main definition of 8am to 6pm. In particular, as can be seen in Figures A.1 and A.2, both alternative definitions deliver the same result as the one shown in Figure 2: high income fathers catch up to high income mothers more so than their low income counterparts do.

		Active	Passive	Total
M-F, 9am-5pm	Mother	5.53	3.69	9.21
	Father	1.53	0.78	2.32
	Parents	7.06	4.47	11.53
M-F, 5am-6pm	Mother	8.38	5.27	13.65
	Father	2.81	1.35	4.16
	Parents	11.19	6.62	17.81

Table A.6. Active and Passive Child Care, Alternative Definitions of Typical Work Hours, (Hours per child per week), Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive. M-F = Monday through Friday.

Source: PSID-CDS.

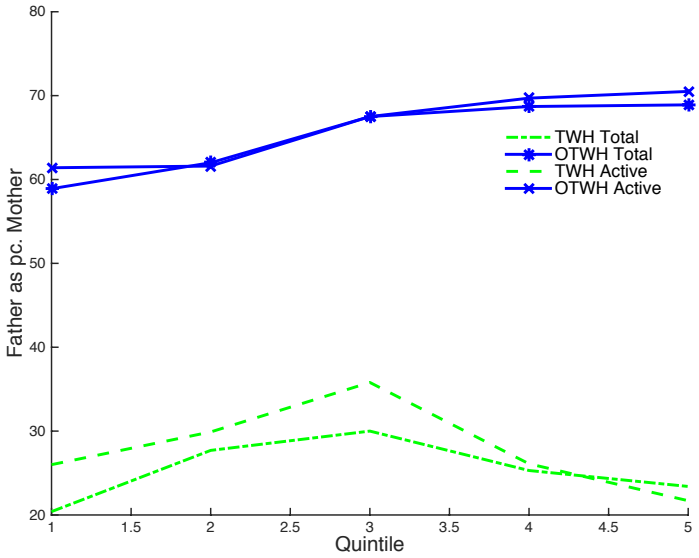

Figure A.1. Child Care During and Outside of Typical Work Hours (9am to 5pm), Fathers Pct. Mothers

Notes: TWH = during typical work hours (9am-5pm, Monday through Friday), OTWH = outside typical work hours.

Source: PSID-CDS.

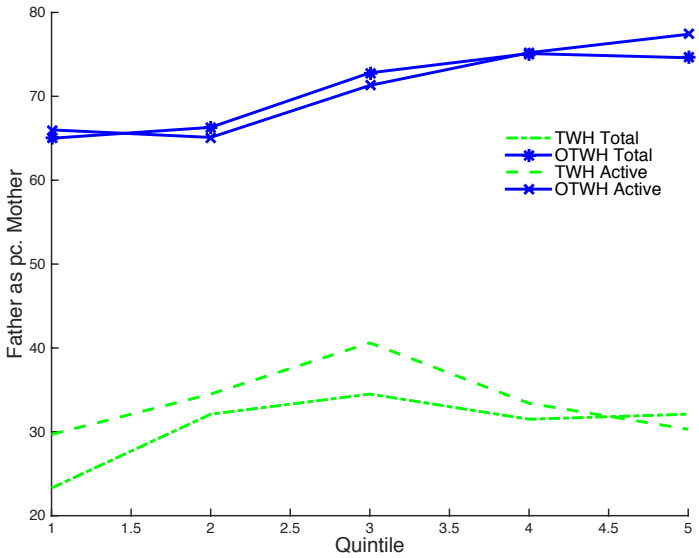

Figure A.2. Child Care During and Outside of Typical Work Hours (5am to 6pm), Fathers Pct. Mothers

Notes: TWH = during typical work hours (5am-6pm, Monday through Friday), OTWH = outside typical work hours.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	5.53	7.13	6.42	4.79	5.10	4.56
		Passive	3.69	5.16	4.32	3.45	3.15	2.75
		Total	9.21	12.29	10.74	8.23	8.25	7.31
	Father	Active	1.53	1.85	1.92	1.72	1.33	0.99
		Passive	0.78	0.65	1.06	0.76	0.76	0.72
		Total	2.32	2.51	2.98	2.48	2.09	1.71
	Parents	Active	7.06	8.99	8.35	6.50	6.44	5.55
		Passive	4.47	5.81	5.37	4.21	3.91	3.47
		Total	11.53	14.80	13.72	10.71	10.34	9.02
O.T.W.H.	Mother	Active	15.65	16.01	16.52	15.66	15.05	15.14
		Passive	7.74	8.51	7.35	7.74	7.34	7.82
		Total	23.39	24.52	23.87	23.40	22.39	22.96
	Father	Active	10.39	9.84	10.18	10.57	10.51	10.69
		Passive	4.92	4.62	4.63	5.23	4.88	5.14
		Total	15.31	14.46	14.81	15.81	15.39	15.83
	Parents	Active	26.03	25.85	26.70	26.23	25.56	25.83
		Passive	12.66	13.13	11.98	12.98	12.22	12.96
		Total	38.70	38.98	38.68	39.21	37.79	38.78

Table A.7. Typical Work Hours Defined as 9am to 5pm, (Hours per child per week, Monday through Friday), Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	27.7%	26.0%	29.9%	35.8%	26.1%	21.7%
	Passive	21.2%	12.6%	24.4%	22.1%	24.0%	26.3%
	Total	25.1%	20.4%	27.7%	30.0%	25.3%	23.4%
O.T.W.H.	Active	66.3%	61.4%	61.6%	67.5%	69.7%	70.5%
	Passive	63.5%	54.2%	62.9%	67.5%	66.5%	65.7%
	Total	65.4%	58.9%	62.0%	67.5%	68.7%	68.9%

Table A.8. Typical Work Hours Defined as 9am to 5pm, Fathers as Percent of Mothers, Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	8.38	9.89	9.29	7.50	7.95	7.60
		Passive	5.27	6.81	5.87	4.96	4.76	4.31
		Total	13.65	16.70	15.16	12.46	12.71	11.91
	Father	Active	2.81	2.94	3.21	3.05	2.66	2.31
		Passive	1.35	0.95	1.67	1.26	1.34	1.53
		Total	4.16	3.89	4.88	4.31	4.00	3.83
	Parents	Active	11.19	12.84	12.49	10.55	10.61	9.91
		Passive	6.62	7.76	7.54	6.22	6.10	5.84
		Total	17.81	20.60	20.04	16.77	16.71	15.75
O.T.W.H.	Mother	Active	12.79	13.24	13.66	12.94	12.20	12.09
		Passive	6.16	6.86	5.80	6.23	5.73	6.26
		Total	18.95	20.10	19.45	19.17	17.94	18.35
	Father	Active	9.11	8.75	8.90	9.24	9.18	9.37
		Passive	4.35	4.32	4.01	4.74	4.30	4.33
		Total	13.47	13.07	12.91	13.97	13.48	13.71
	Parents	Active	21.90	21.99	22.56	22.18	21.38	21.46
		Passive	10.52	11.18	9.81	10.97	10.03	10.59
		Total	32.42	33.17	32.36	33.15	31.42	32.05

Table A.9. Typical Work Hours Defined as 5am to 6pm, (Hours per child per week, Monday through Friday), Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	33.5%	29.7%	34.5%	40.6%	33.4%	30.3%
	Passive	25.6%	13.9%	28.4%	25.3%	28.2%	35.4%
	Total	30.5%	23.3%	32.1%	34.5%	31.5%	32.1%
O.T.W.H.	Active	71.2%	66.0%	65.1%	71.3%	75.2%	77.4%
	Passive	70.6%	63.0%	69.2%	76.0%	75.0%	69.2%
	Total	71.0%	65.0%	66.3%	72.8%	75.1%	74.6%

Table A.10. Typical Work Hours Defined as 5am to 6pm, Fathers as Percent of Mothers, Two-Parent Families

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

A.4 Child care by number of children and age of the child

In this section, I report the same child care measures as in Section 2.2 but condition on the number of children in the household (1 or 2 versus 3 or more) and age of the child (Preschool, age 0-5, versus School age, age 6-11). Tables A.11 and A.12 report sample sizes by number of children, age of the child and income quintiles. The number of observations varies by income quintile because I keep the same cuffs as in the main text for the select sample under consideration. Decomposing any further leeds to very small sample sizes. Tables A.13 to A.19 report active and passive child care per child per week by household income quintile and Tables A.14 to A.20 report father's child care as a percent of mother's by household income quintile. Comparing to Tables 2,A.1 and A.2, generally speaking observations are similar to those in the main text. In particular, as can be seen in Figure A.3, for all subsamples, high income fathers catch up to high income mothers more so than their low income counterparts do. This pattern is most pronounced for active child care, families with 3 or more children (panel (b)) and for preschoolers (panel (c)).

		All	Q1	Q2	Q3	Q4	Q5
M-F	All	1494	299	297	300	300	298
	1 or 2	1045	202	197	209	210	227
	3 or more	449	97	100	91	90	71
W-E	All	1498	300	299	299	301	299
	1 or 2	1051	204	200	208	211	228
	3 or more	447	96	99	91	90	71

Table A.11. Number of 24h-Observations by Household Income Quintile and Number of Children, Two-Parents Families

Notes: W-E = weekend (Saturday and Sunday), M-F = week day (Monday through Friday).

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
M-F	All Ages	1494	299	297	300	300	298
	Preschool	779	173	175	147	152	132
	School Age	715	126	122	153	148	166
W-E	All Ages	1498	300	299	299	301	299
	Preschool	779	171	176	147	153	132
	School Age	719	129	123	152	148	167

Table A.12. Number of 24h-Observations by Household Income Quintile and Age of the Child, Two-Parent Families

Notes: W-E = weekend (Saturday and Sunday), M-F = week day (Monday through Friday).

Source: PSID-CDS.

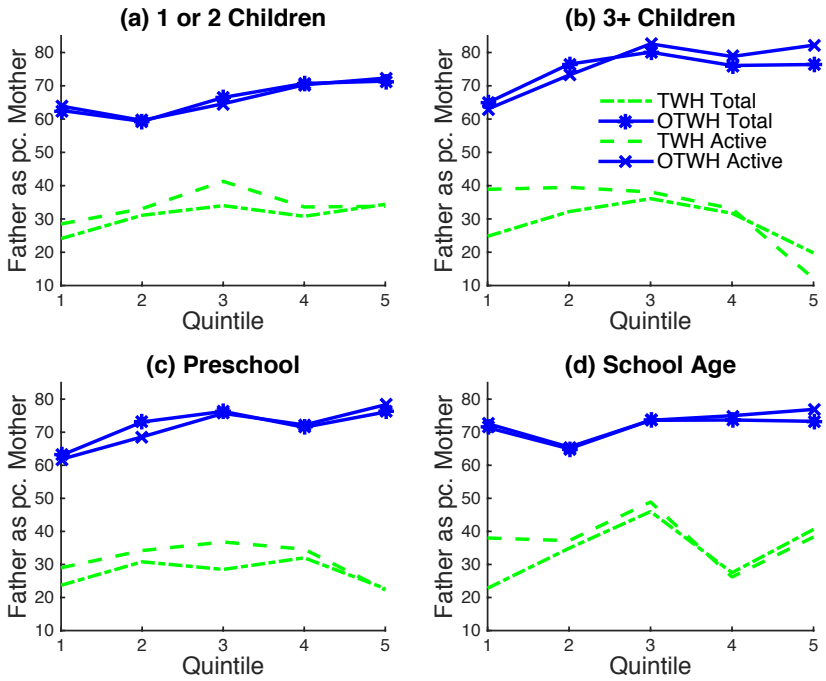

Figure A.3. Child Care During and Outside of Typical Work Hours, Fathers Pct. Mothers, Select Groups

Notes: TWH = during typical work hours (8am-6pm, Monday through Friday), OTWH = outside typical work hours.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	8.06	11.01	9.43	7.13	7.30	6.48
		Passive	3.97	4.50	4.62	4.14	3.91	3.01
		Total	12.03	15.51	14.05	11.27	11.22	9.49
	Father	Active	2.72	3.14	3.13	2.95	2.46	2.19
		Passive	0.97	0.61	1.26	0.89	1.00	1.08
		Total	3.70	3.74	4.38	3.84	3.46	3.27
	Parents	Active	10.78	14.14	12.56	10.08	9.76	8.68
		Passive	4.95	5.11	5.88	5.03	4.92	4.08
		Total	15.73	19.25	18.44	15.11	14.68	12.76
O.T.W.H.	Mother	Active	14.57	15.83	15.12	14.88	13.96	13.58
		Passive	5.41	4.41	5.25	6.14	5.19	5.81
		Total	19.99	20.25	20.37	21.02	19.15	19.38
	Father	Active	9.68	10.13	9.01	9.63	9.82	9.83
		Passive	3.61	2.56	3.08	4.36	3.73	4.02
		Total	13.29	12.69	12.09	13.98	13.54	13.85
	Parents	Active	24.25	25.97	24.14	24.51	23.77	23.40
		Passive	9.03	6.97	8.33	10.50	8.92	9.83
		Total	33.28	32.94	32.47	35.00	32.69	33.23

Table A.13. Active and Passive Child Care by Household Income, Typical Work Hours (T.W.H.) and Outside T.W.H. (O.T.W.H.), (Hours per child per week), Two-Parent Families, 1 or 2 Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	33.8%	28.5%	33.1%	41.3%	33.6%	33.8%
	Passive	24.5%	13.4%	27.1%	21.6%	25.5%	35.7%
	Total	30.7%	24.1%	31.1%	34.0%	30.8%	34.4%
O.T.W.H.	Active	66.4%	63.9%	59.6%	64.6%	70.3%	72.3%
	Passive	66.7%	57.9%	58.7%	70.9%	71.7%	69.2%
	Total	66.5%	62.6%	59.3%	66.5%	70.7%	71.4%

Table A.14. Child Care During and Outside of Typical Work Hours, Fathers as Percent of Mothers, Two-Parent Families, 1 or 2 Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	6.31	6.16	6.43	5.70	6.39	6.90
		Passive	6.12	8.60	7.02	4.97	4.33	5.52
		Total	12.42	14.77	13.45	10.67	10.72	12.41
	Father	Active	2.03	2.40	2.54	2.17	2.12	0.84
		Passive	1.51	1.27	1.80	1.68	1.29	1.62
		Total	3.54	3.67	4.34	3.85	3.41	2.46
	Parents	Active	8.33	8.56	8.98	7.87	8.51	7.74
		Passive	7.63	9.87	8.82	6.65	5.62	7.14
		Total	15.96	18.43	17.79	14.52	14.13	14.88
O.T.W.H.	Mother	Active	11.36	10.46	12.66	11.64	10.69	11.57
		Passive	8.24	10.43	7.00	7.30	7.64	8.52
		Total	19.60	20.89	19.66	18.94	18.33	20.09
	Father	Active	8.62	6.59	9.27	9.62	8.42	9.52
		Passive	5.97	6.97	5.78	5.56	5.54	5.84
		Total	14.58	13.56	15.05	15.18	13.96	15.35
	Parents	Active	19.98	17.05	21.93	21.26	19.11	21.09
		Passive	14.21	17.40	12.77	12.86	13.18	14.35
		Total	34.19	34.45	34.71	34.11	32.29	35.44

Table A.15. Active and Passive Child Care by Household Income, Typical Work Hours (T.W.H.) and Outside T.W.H. (O.T.W.H.), (Hours per child per week), Two-Parent Families, 3+ Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	32.1%	38.9%	39.5%	38.1%	33.1%	12.1%
	Passive	24.7%	14.7%	25.6%	33.8%	29.7%	29.4%
	Total	28.4%	24.8%	32.2%	36.1%	31.7%	19.8%
O.T.W.H.	Active	75.8%	63.0%	73.2%	82.6%	78.8%	82.2%
	Passive	72.3%	66.8%	82.6%	76.2%	72.4%	68.5%
	Total	74.3%	64.9%	76.5%	80.1%	76.1%	76.4%

Table A.16. Child Care During and Outside of Typical Work Hours, Fathers as Percent of Mothers, Two-Parent Families, 3+ Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	10.96	13.18	11.90	9.64	10.38	9.65
		Passive	5.56	7.38	6.57	5.58	4.23	4.16
		Total	16.52	20.55	18.47	15.22	14.61	13.81
	Father	Active	3.45	3.83	4.08	3.55	3.59	2.16
		Passive	1.10	1.05	1.62	0.80	1.09	0.98
		Total	4.56	4.88	5.70	4.35	4.69	3.14
	Parents	Active	14.41	17.01	15.98	13.20	13.97	11.81
		Passive	6.66	8.43	8.19	6.37	5.33	5.13
		Total	21.07	25.43	24.17	19.57	19.30	16.94
O.T.W.H.	Mother	Active	13.85	13.91	14.94	14.12	12.85	13.58
		Passive	6.81	8.50	6.06	6.01	6.67	6.70
		Total	20.65	22.42	20.99	20.13	19.51	20.27
	Father	Active	9.84	8.61	10.26	10.70	9.28	10.64
		Passive	4.96	5.53	5.09	4.68	4.69	4.79
		Total	14.80	14.14	15.35	15.38	13.96	15.43
	Parents	Active	23.69	22.52	25.19	24.82	22.12	24.22
		Passive	11.77	14.03	11.15	10.69	11.35	11.49
		Total	35.46	36.56	36.34	35.50	33.48	35.70

Table A.17. Active and Passive Child Care by Household Income, Typical Work Hours (T.W.H.) and Outside T.W.H. (O.T.W.H.), (Hours per child per week), Two-Parent Families, Preschool Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	31.4%	29.0%	34.2%	36.8%	34.6%	22.3%
	Passive	19.8%	14.1%	24.7%	14.2%	25.8%	23.5%
	Total	27.5%	23.7%	30.8%	28.5%	32.0%	22.7%
O.T.W.H.	Active	71.0%	61.8%	68.6%	75.7%	72.2%	78.3%
	Passive	72.9%	65.0%	84.0%	77.8%	70.2%	71.5%
	Total	71.6%	63.0%	73.1%	76.3%	71.5%	76.1%

Table A.18. Child Care During and Outside of Typical Work Hours, Fathers as Percent of Mothers, Two-Parent Families, Preschool Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

			All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Mother	Active	3.80	4.08	3.43	3.76	3.48	4.10
		Passive	3.91	5.31	3.98	3.31	4.05	3.41
		Total	7.71	9.39	7.41	7.06	7.53	7.51
	Father	Active	1.45	1.55	1.28	1.84	0.91	1.57
		Passive	1.23	0.60	1.31	1.41	1.16	1.48
		Total	2.68	2.15	2.59	3.25	2.08	3.05
	Parents	Active	5.25	5.63	4.72	5.60	4.39	5.68
		Passive	5.14	5.91	5.29	4.72	5.21	4.89
		Total	10.38	11.54	10.00	10.32	9.61	10.57
O.T.W.H.	Mother	Active	11.08	10.38	11.82	11.11	10.67	11.35
		Passive	7.90	7.90	7.69	8.20	7.38	8.17
		Total	18.98	18.28	19.51	19.32	18.06	19.51
	Father	Active	8.12	7.54	7.74	8.19	8.01	8.73
		Passive	5.52	5.51	4.95	6.03	5.32	5.59
		Total	13.64	13.05	12.69	14.22	13.33	14.31
	Parents	Active	19.21	17.93	19.57	19.30	18.68	20.07
		Passive	13.42	13.41	12.63	14.23	12.71	13.75
		Total	32.62	31.33	32.20	33.54	31.38	33.83

Table A.19. Active and Passive Child Care by Household Income, Typical Work Hours (T.W.H.) and Outside T.W.H. (O.T.W.H.), (Hours per child per week), Two-Parent Families, School Age Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

		All	Q1	Q2	Q3	Q4	Q5
T.W.H.	Active	38.1%	38.0%	37.2%	48.9%	26.2%	38.3%
	Passive	31.3%	11.2%	32.8%	42.7%	28.7%	43.3%
	Total	34.7%	22.8%	34.9%	46.0%	27.5%	40.6%
O.T.W.H.	Active	73.3%	72.6%	65.5%	73.6%	75.0%	76.9%
	Passive	69.8%	69.8%	64.3%	73.5%	72.0%	68.3%
	Total	71.8%	71.4%	65.0%	73.6%	73.7%	73.3%

Table A.20. Child Care During and Outside of Typical Work Hours, Fathers as Percent of Mothers, Two-Parent Families, School Age Children

Notes: Parents = Mother + Father. Total = Active + Passive.

Source: PSID-CDS.

A.5 Logarithmic Utility with Cobb-Douglas Production

In Section 4.2, assuming logarithmic utility ($\sigma \to 1$)

$$\tilde{u}(\ell_1^d, \ell_2^d, \ell_1^o, \ell_2^o, c, k) = \alpha_1^d \ln \ell_1^d + \alpha_2^d \ln \ell_2^d + \alpha_1^o \ln \ell_1^o + \alpha_2^o \ln \ell_2^o + \alpha_3 \ln c + \alpha_4 \ln k, \tag{A.1}$$

and Cobb-Douglas child quality production ($\zeta \to 0$,$\rho \to 0$, $\rho^d \to 0$, $\rho^o \to 0$)

$$k = R(\tau_1^d)^{\delta_1^d}(\tau_2^d)^{\delta_2^d}(\tau_1^o)^{\delta_1^o}, (\tau_2^o)^{\delta_2^o} e^{\delta_3}(k_0^q)^{\delta_4}, \tag{A.2}$$

the household's problem boils down to

$$\begin{aligned} \max_{\ell_i^j, \tau_i^j, j\in\{d,o\}, i\in\{1,2\}, c, e} \quad & \alpha_1^d \ln \ell_1^d + \alpha_2^d \ln \ell_2^d + \alpha_1^o \ln \ell_1^o + \alpha_2^o \ln \ell_2^o + \alpha_3 \ln c \\ & + \alpha_4(\delta_1^d \ln \tau_1^d + \delta_2^d \ln \tau_2^d + \delta_1^o \ln \tau_1^o + \delta_2^o \ln \tau_2^o + \delta_3 \ln e) \\ s.t. \quad & \\ & c + p_e n e \leq w_1^q h_1 + w_2^q h_2 + I^q, \\ & T^d = h_i + \ell_i^d + n\tau_i^d \qquad i \in \{1,2\}, \\ & T^o = \ell_i^o + n\tau_i^o \qquad i \in \{1,2\}. \end{aligned} \tag{A.3}$$

Note that, the parameter for innate ability, k_0^q does not affect any choices in this setup. Since utility is separable and the time constraint outside of TWH does not interact with the other constraints, this problem can be split into three sub-problems: the household's problem during TWH, the mother's problem outside of TWH and the father's problem outside of TWH. Let $W^q \equiv (w_1^q + w_2^q)T^d + I^q$ be wealth during TWH. Note that the only endowment outside of typical work hours is T^o. Since these are homogeneous problems and preference and technology parameters do not vary with q, expenditures on each commodity are a constant (i.e., independent on q) fraction of wealth or endowment, W^q or T^o.

During TWH, the household solves

$$\begin{aligned} \max_{\ell_i^d, \tau_i^d, i\in\{1,2\}, e} \quad & \alpha_1^d \ln \ell_1^d + \alpha_2^d \ln \ell_2^d + \alpha_3 \ln c + \alpha_4(\delta_1^d \ln \tau_1^d + \delta_2^d \ln \tau_2^d + \delta_3 \ln e) \\ s.t. \quad & c + p_e n e + w_1^q(\ell_1^d + n\tau_1^d) + w_2^q(\ell_2^d + n\tau_2^d) \leq (w_1^q + w_2^q)T^d + I^q \equiv W^q. \end{aligned} \tag{A.4}$$

Since this is a homogeneous problem and preference parameters do not vary with q, expenditures on each commodity are a constant fraction of wealth, W^q, for each quintile, q. That is, let $\Gamma^d \equiv \alpha_1^d + \alpha_2^d + \alpha_3 + \alpha_4(\delta_1^d + \delta_2^d + \delta_3)$, then the solution is

$$\begin{aligned} & c^q = \frac{\alpha_3}{\Gamma^d} W^q, \quad p_e n e^q = \frac{\alpha_4 \delta_3}{\Gamma^d} W^q, \\ & w_i^q \ell_i^{d,q} = \frac{\alpha_i^d}{\Gamma^d} W^q, \quad w_i^q n \tau_i^{d,q} = \frac{\alpha_4 \delta_i^d}{\Gamma^d} W^q. \end{aligned} \tag{A.5}$$

Assuming that $w_1^q = \lambda w_2^q$, $\lambda \in (0,1)$ for all q, and that for all q, $I^q = \phi_1 w_1^q$ and $I^q = \phi_2 w_2^q$ which implies $\phi_2 = \lambda \phi_1$, $\frac{W^q}{w_1^q} = \left(1 + \frac{1}{\lambda}\right) T^d + \phi_1$ and $\frac{W^q}{w_2^q} = (\lambda + 1)\, T^d + \phi_2$ and the solution

for leisure and child care during TWH is given by

$$\ell_1^{d,q} = \frac{\alpha_1^d}{\Gamma^d}\left[\left(1+\frac{1}{\lambda}\right)T^d + \phi_1\right], \quad \tau_1^{d,q} = \frac{\alpha_4\delta_1^d}{n\Gamma^d}\left[\left(1+\frac{1}{\lambda}\right)T^d + \phi_1\right]; \tag{A.6}$$

$$\ell_2^{d,q} = \frac{\alpha_2^d}{\Gamma^d}\left[(\lambda+1)T^d + \phi_2\right], \quad \tau_2^{d,q} = \frac{\alpha_4\delta_2^d}{n\Gamma^d}\left[(\lambda+1)T^d + \phi_2\right]. \tag{A.7}$$

Outside of TWH, we have for $i \in \{1,2\}$, the household solves

$$\begin{aligned} \max_{\ell_i^o, \tau_i^o} \quad & \alpha_i^o \ln \ell_i^o + \alpha_4\delta_i^o \ln \tau_1^d \\ s.t. \quad & T^o = \ell_i^o + n\tau_i^o. \end{aligned} \tag{A.8}$$

Again, this is a homogeneous problem, hence time, T^o, is split in constant (i.e., independent on q) fractions across leisure and child care. Let $\Gamma_i^o \equiv \alpha_i^o + \alpha_4\delta_i^o$. Then the solution is given by

$$\ell_i^{o,q} = \frac{\alpha_i^o}{\Gamma_i^o}T^o, \quad \tau_i^{o,q} = \frac{\alpha_4\delta_i^o}{n\Gamma_i^o}T^o. \tag{A.9}$$

A.5.1 Relaxing heterogeneity assumptions

Here I relax some of the assumptions on parameters made above. In particular, while keeping preference and technology parameters fixed across q-types, I allow the following parameters to vary with q as supported by data:

1. the number of children, n^q;
2. the gender wage gap, λ^q;
3. the ratio of non-labor income to father's wages, ϕ_2^q.

Number of children by quintile (n^q): Table 6 reports average number of children by income quintile. As can be seen, between Q1 and Q3 the number of children decreases from 2.45 to 2.16 while it is slightly hump-shaped between Q3 and Q5. Allowing for this variation in equations (7) and (8) while holding all other assumptions fixed, the model would suggest that child care per child, $\tau_i^{j,q}$, should be increasing, then slightly U-shaped for both, mothers and fathers, $i \in \{1,2\}$, during as well as outside of TWH, $j \in \{d,o\}$. Hence, this type of heterogeneity by income quintile will not help this model specification.

Wage gap by quintile (λ^q): Table 7 reports mother's and father's average wages (conditional on working positive hours) and the gender wage gap by income quintile. Mothers in Q1 make 83 percent of what fathers in Q1 make. This ratio decreases to 63 percent for Q4, then increases to 67 percent for Q5. Notwithstanding the selection issues that may be at work in this measure, allowing for this variation in λ in equations (7) while holding all other assumptions fixed (including number of children, n), the model would suggest that during TWH child care per child, $\tau_i^{d,q}$, should be increasing for mothers and decreasing for fathers, at least up to Q4. However, this is not what we observe in the data in Section 2. Rather, child care is strongly decreasing for mothers and slightly decreasing for fathers. In addition, relaxing the assumption on the constant gender wage gap does not affect the results outside of TWH in equation (8).

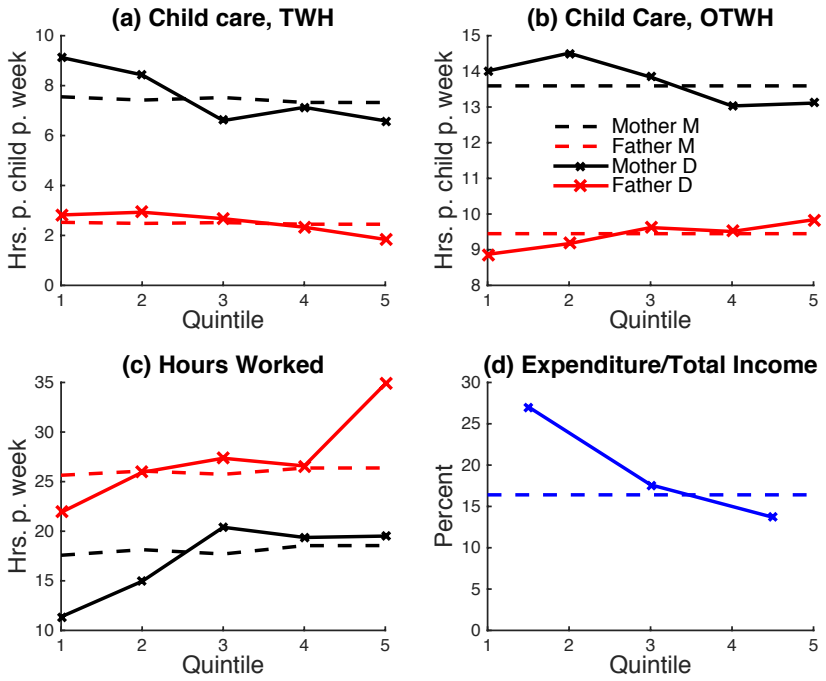

Figure A.4. Numerical Example: Log. Utility with C-D production, ϕ_2^q heterogeneity

Non-labor income by quintile (ϕ_i^q): Table 7 also reports non-labor income (NLI) as well as non-labor income as a fraction of fathers wage. Average NLI is increasing by quintile, except between Q3 and Q4. Now, NLI as a fraction of fathers wage is is overall decreasing by income quintile, except for the uptick at Q3. Allowing for this variation in ϕ_i in equations (7) while holding all other assumptions fixed (including number of children, n, and the gender wage gap, λ), the model would suggest that during TWH child care per child, $\tau_i^{d,q}$, should be decreasing in q for both mothers and fathers with an uptick at Q3. This replicates the main qualitative feature of the data, though the slight uptick is observed for Q4 rather that Q3. Again, relaxing the assumption on the constant ϕ_i does not affect the results outside of TWH in equation (8).

A.5.2 Numerical example

A numerical example illustrates the results relating to the logarithmic utility with Cobb-Douglas production allowing for heterogeneity in ϕ_i^q. Figure A.4 plots model predictions (dashed lines) and data (solid lines) by income quintile for (a) child care during TWH, (b) child care outside of TWH, (c) hours worked and (d) expenditures per child as a fraction of household income.

In this simulation, the utility function is logarithmic and production is Cobb-Douglas. The main source of heterogeneity across income quintiles is father's wage, w_2^q, taken from Table 7, row 2. In order to concentrate on the effect of heterogeneity in ϕ_2^q, the parameters λ and n are set to their average values (see Tables 7 and 6). Hence, mother's wage, $w_1^q = \lambda w_2^q$, is also heterogeneous across quintiles and innate ability is assumed to be proportional to the father's wage, $k_0^q = \gamma w_2^q$, with $\gamma = 1$ which is without loss of generality here. Since the positive gender wage gap alone did not generate enough of a level difference in child care between mothers and fathers, as per the result in Section 4.2, productivity and preference parameters are allowed to vary by gender. They were set such that $\delta_1^d > \delta_2^d$, $\delta_1^o > \delta_2^o$, $\alpha_1^d < \alpha_2^d$ and $\alpha_1^o < \alpha_2^o$. The exact parameter values are given in Table A.21.

Preference Parameters					
Description	Parameter	Value	Description	Parameter	Value
Elasticity of substitution	σ	1			
Mother's leis. TWH	α_1^d	0.16	Father's leis. TWH	α_2^d	0.27
Mother's leis. OTWH	α_1^o	0.09	Father's leis. OTWH	α_2^o	0.11
Consumption	α_3	0.65	Child quality	α_4	0.5
Productivity Parameters					
Description	Parameter	Value	Description	Parameter	Value
Mother's child c. TWH	δ_1^d	0.16	Father's child c. TWH	δ_2^d	0.27
Mother's child c. OTWH	δ_1^o	0.09	Father's child c. OTWH	δ_2^o	0.11
Expenditures	δ_3	0.05	Child ability	δ_4	0.5
Price of expenditures	p_e	0.1	Scaling factor	R	1
Time Endowments					
Description	Parameter	Value	Description	Parameter	Value
Time end. TWH	T^d	50	Time end. OTWH	T^o	62

Table A.21. Parameter Values for Numerical Example with Logarithmic Utility

Notes: Time endowment TWH=8am-6pm, Monday through Friday; Time endowment OTWH=total non-sleeping time-TWH=(24h-8h of sleep)*7-50 of TWH=112-50.

As can be seen in Figure A.4, the heterogeneity in ϕ_2^q tilts child care during TWH and hours worked a little bit but, quantitatively, doesn't come close to generating the patterns observed in the data.

A.6 CES Utility with Nested CES Production

Given the assumptions made for Section 4.3, the household solves the following problem:

$$\max_{\ell_i^j,\tau_i^j,j\in\{d,o\},i\in\{1,2\},c,k,e} \alpha_1^d\frac{(\ell_1^d)^{1-\sigma}-1}{1-\sigma}+\alpha_2^d\frac{(\ell_2^d)^{1-\sigma}-1}{1-\sigma}+\alpha_1^o\frac{(\ell_1^o)^{1-\sigma}-1}{1-\sigma}+\alpha_2^o\frac{(\ell_2^o)^{1-\sigma}-1}{1-\sigma}$$
$$+\alpha_3\frac{c^{1-\sigma}-1}{1-\sigma}+\alpha_4\frac{k^{1-\sigma}-1}{1-\sigma}$$

$s.t.$

$$c+p_e ne \leq w_1^q(T^d-h_1-n\tau_1^d)+w_2^q(T^d-h_2-n\tau_2^d)+I^q,$$
$$T^o=\ell_1^o+n\tau_1^o,$$
$$T^o=\ell_2^o+n\tau_2^o,$$
$$k=f(.)\equiv R\left\{\left[\left\{\delta_1^d(\tau_1^d)^{\rho^d}+\delta_2^d(\tau_2^d)^{\rho^d}\right\}^{\frac{\rho}{\rho^d}}+\left\{\delta_1^o(\tau_1^o)^{\rho^o}+\delta_2^o(\tau_2^o)^{\rho^o}\right\}^{\frac{\rho}{\rho^o}}\right]^{\frac{\zeta}{\rho}}+\delta_3 e^{\zeta}\right\}^{\frac{1}{\zeta}}(k_0^q)^{\delta_4}.$$

Let λ^d be the multiplier on the budget constraint, λ_1^o be the multiplier on the time constraint outside of TWH for mothers, λ_2^o be the multiplier on the time constraint outside of TWH for fathers and μ be the multiplier on the child quality production constraint.

Then, the first-order conditions for leisure, consumption and child quality are given by:

$$\begin{aligned}
&\ell_1^d : \alpha_1^d(\ell_1^d)^{-\sigma} = \lambda^d w_1^q \qquad && \ell_1^o : \alpha_1^o(\ell_1^o)^{-\sigma} = \lambda_1^o \\
&\ell_2^d : \alpha_2^d(\ell_2^d)^{-\sigma} = \lambda^d w_2^q \qquad && \ell_2^o : \alpha_2^o(\ell_2^o)^{-\sigma} = \lambda_2^o \\
&c : \alpha_3 c^{-\sigma} = \lambda^d && k : \alpha_4 k^{-\sigma} = \mu
\end{aligned}$$

Let (A, B, B^d, B^o) be defined as follows:

$$\begin{aligned}
A &\equiv \left[\left\{\delta_1^d(\tau_1^d)^{\rho^d} + \delta_2^d(\tau_2^d)^{\rho^d}\right\}^{\frac{\rho}{\rho^d}} + \left\{\delta_1^o(\tau_1^o)^{\rho^o} + \delta_2^o(\tau_2^o)^{\rho^o}\right\}^{\frac{\rho}{\rho^o}}\right]^{\frac{\zeta}{\rho}} + \delta_3 e^{\zeta}, \\
B &\equiv \left[\left\{\delta_1^d(\tau_1^d)^{\rho^d} + \delta_2^d(\tau_2^d)^{\rho^d}\right\}^{\frac{\rho}{\rho^d}} + \left\{\delta_1^o(\tau_1^o)^{\rho^o} + \delta_2^o(\tau_2^o)^{\rho^o}\right\}^{\frac{\rho}{\rho^o}}\right]^{\frac{\zeta}{\rho}-1}, \\
B^d &\equiv \left\{\delta_1^d(\tau_1^d)^{\rho^d} + \delta_2^d(\tau_2^d)^{\rho^d}\right\}^{\frac{\rho}{\rho^d}-1}, \\
B^o &\equiv \left\{\delta_1^o(\tau_1^o)^{\rho^o} + \delta_2^o(\tau_2^o)^{\rho^o}\right\}^{\frac{\rho}{\rho^o}-1}.
\end{aligned}$$

Then the first-order conditions for child care and expenditures for children are given by:

$$\begin{aligned}
&\tau_1^d : \left(\frac{BB^d}{A}\right)\mu\delta_1^d k(\tau_1^d)^{\rho^d-1} = \lambda^d w_1^q n \qquad && \tau_1^o : \left(\frac{BB^o}{A}\right)\mu\delta_1^o k(\tau_1^o)^{\rho^o-1} = \lambda_1^o n \\
&\tau_2^d : \left(\frac{BB^d}{A}\right)\mu\delta_2^d k(\tau_2^d)^{\rho^d-1} = \lambda^d w_2^q n \qquad && \tau_2^o : \left(\frac{BB^o}{A}\right)\mu\delta_2^o k(\tau_2^o)^{\rho^o-1} = \lambda_2^o n \\
&e : \left(\frac{1}{A}\right)\mu\delta_3 k e^{\zeta-1} = \lambda^d n p_e
\end{aligned}$$

Focusing on child care outside of TWH for the mother and father and substituting out multipliers using the first-order conditions for leisure and child quality, we get:

$$\begin{aligned}
k^{1-\sigma} &= \frac{\alpha_1^o}{\alpha_4}\frac{n}{\delta_1^o}\left(\frac{A}{BB^d}\right)\frac{(\tau_1^o)^{1-\rho^o}}{(\ell_1^o)^{\sigma}}, \\
k^{1-\sigma} &= \frac{\alpha_2^o}{\alpha_4}\frac{n}{\delta_2^o}\left(\frac{A}{BB^d}\right)\frac{(\tau_2^o)^{1-\rho^o}}{(\ell_2^o)^{\sigma}}.
\end{aligned}$$

Combining these two and simplifying gives:

$$\left(\frac{\tau_2^{o,q}}{\tau_1^{o,q}}\right)^{1-\rho^o} = \frac{\alpha_1^o}{\alpha_2^o}\frac{\delta_2^o}{\delta_1^o}\left(\frac{\ell_2^o}{\ell_1^o}\right)^{\sigma}.$$

Using the time constraints outside of TWH to substitute out leisure for mothers and fathers leads to equation (9) in the proof of Proposition 1.

A.6.1 Numerical examples

Figure 3 in the main text plots model predictions (dashed lines) and data (solid lines) by income quintile for (a) child care during TWH, (b) child care outside of TWH, (c) hours worked and (d) expenditures per child. In this simulation, the only source of heterogeneity across income quintiles is father's wage, w_2^q, taken from Table 7, row 2. In order to concentrate on the effect of the elasticity of substitution, σ, the parameters n, λ and ϕ_2 are set to their average values (see Tables 7 and 6). Again, mother's wage, $w_1^q = \lambda w_2^q$, and innate ability $k_0^q = \gamma w_2^q$, with $\gamma = 1$. As in the previous simulation, productivity and preference parameters were allowed to vary by gender. Finally, to get hours worked to be increasing and child care during TWH to be decreasing, the parameter governing the elasticity of substitution between leisure, consumption and child quality is set within $\sigma \in (0, 1)$. This generates the desired result during TWH because the substitution effect of a higher wage dominates the income effect. The exact parameter values are given in Table A.22.

The parameters differ from the ones in the numerical example with logarithmic utility above because the curvature parameter, σ, not only affects the slope but also the levels of child care, hours worked and expenditures on children.

Finally, Figure 4 plots the results for the same parameter values as in the experiment in Figure 3, but where δ_i^j's are allowed to vary with q. In particular, it is assumed that low income fathers are relatively less productive and high income fathers more productive in child care. To keep the overall returns to time investment identical across income quintiles, mother's productivities are adjusted accordingly. That is,

$$\begin{aligned}
\delta_1^{j,1} &= \delta_1^j + 2\varepsilon, & \delta_2^{j,1} &= \delta_2^j - 2\varepsilon, \\
\delta_1^{j,2} &= \delta_1^j + \varepsilon, & \delta_2^{j,2} &= \delta_2^j - \varepsilon, \\
\delta_i^{j,3} &= \delta_i^j, & & \\
\delta_1^{j,4} &= \delta_1^j - \varepsilon, & \delta_2^{j,4} &= \delta_2^j + \varepsilon, \\
\delta_1^{j,5} &= \delta_1^j - 2\varepsilon, & \delta_2^{j,5} &= \delta_2^j + 2\varepsilon,
\end{aligned}$$

where δ_i^j are given in Table A.22 and $\varepsilon = 0.07$.

Preference Parameters					
Description	Parameter	Value	Description	Parameter	Value
Elasticity of substitution	σ	0.57			
Mother's leis. TWH	α_1^d	0.23	Father's leis. TWH	α_2^d	0.35
Mother's leis. OTWH	α_1^o	0.18	Father's leis. OTWH	α_2^o	0.175
Consumption	α_3	0.19	Child quality	α_4	1
Productivity Parameters					
Description	Parameter	Value	Description	Parameter	Value
Mother's child c. TWH	δ_1^d	0.3	Father's child c. TWH	δ_2^d	0.145
Mother's child c. OTWH	δ_1^o	0.3	Father's child c. OTWH	δ_2^o	0.17
Expenditures	δ_3	0.05	Child ability	δ_4	0.05
Price of expenditures	p_e	0.1	Scaling factor	R	1
Time Endowments					
Description	Parameter	Value	Description	Parameter	Value
Time end. TWH	T^d	50	Time end. OTWH	T^o	62

Table A.22. Parameter Values for Numerical Example with CES Utility and C-D Production

Notes: Time endowment TWH=8am-6pm, Monday through Friday; Time endowment OTWH=total non-sleeping time-TWH=(24h-8h of sleep)*7-50 of TWH=112-50.

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