Causal Effects of Maternal Time-Investment on Children's Cognitive Outcomes[*]

Benjamín Villena-Roldán

University of Chile[†]

Cecilia Ríos-Aguilar

Claremont Graduate University [‡]

December 18, 2011

[*]We thank Amy Hsin, Sandra Hofferth, Frank Stafford, Almudena Sevilla, Giacomo de Giorgi, Alejandra Mizala, Eugenio Giolito, Dante Contreras, Jeanne Lafortune, as well as participants of conferences at University of Maryland, University of Michigan, 2011 LAMES-LACEA, University of Chile, and ILADES-Georgetown. We thank Andrea Tartakowsky for her research assistance.

[†]Center for Applied Economics. Corresponding author email: bvillena@dii.uchile.cl . This research has received financial support from *Centro de Investigación Avanzada en Educación* Bicentenario Project CIE-05 grant.

[‡]School of Educational Studies. email: cecilia.rios-aguilar@cgu.edu

Abstract

Many social scientists hypothesize that the time mothers spend with their children is crucial for children's cognitive development. Unlike most studies that investigate maternal employment effects on children, we estimate direct causal effects of time-diary measured maternal time using the CDS - PSID dataset. Considering maternal time allocation endogenous, the effect of an increase of maternal time associated with a rise in childcare price (IV estimate) is an order of magnitude larger than OLS estimates for Applied Problems and Word-Letter Identification tests. Evidence also shows that the effect is larger for children living with college-educated mothers and in two-parent households.

Keywords: Children outcomes, maternal time-investment, causal effect, Instrumental Variables.

JEL codes: D1,J13,C36.

1 Introduction

What is the best way parents can use their time with their children? A longstanding and reasonable hypothesis in social sciences is that parents have, potentially, a large influence over the outcomes of their offspring. In addition to the well-deserved practical and scientific interest on this topic, there is also a recent literature showing that children's outcomes are, in turn, key determinants of future adulthood outcomes, including earnings (Danziger and Waldfogel 2000; Heckman et al. 2006) and health (Currie et al. 2008). Despite the importance of the time parents and children spend together, available empirical evidence about its *causal* effects on children is surprisingly scarce. The main contribution of our paper, then, is to estimate the causal effects of time-diary measured maternal time-investment on several cognitive outcomes using a simple empirical model of human capital accumulation.

Some of the existing scholarship[1] that examines the impact of maternal labor force participation

[1] See the literature review section for a thorough discussion on this topic

or hours worked on children's outcomes interprets maternal employment as an indirect measure of maternal time-investment on children. Our approach differs in three specific ways from this vast literature. First, since the relationship between the number of hours worked and time mothers devote to their children is weak at best, we use time-diary data to obtain direct estimates of the time mothers and children spend together. Even though time-diary data shows that working mothers devote slightly less total time to children, most of the maternal time used at work is offset by housework and leisure (Hill and Stafford 1985; Datcher-Loury 1988; Sandberg and Hofferth 2001). Second, as described in Section 3, we find evidence that there is a great deal of heterogeneity in maternal childcare time allocations across different demographic groups of mothers. Hence, there is an important identification issue of the maternal work "treatment" since its impact could be either generated by changes of quantity or composition of maternal time, or by heterogeneous responses of children to a change in maternal time-investments. Third, we estimate a simple theoretical model of human capital to surmount these issues. Our framework considers that maternal time-investment is endogenously determined, has a cumulative impact on children outcomes, and affects children in heterogeneous ways.

Several data requirements need to be met to properly estimate the causal effects of interest in this paper: (1) a longitudinal database with information on children's outcomes, (2) reliable records of mother-child shared time, and (3) measures of family background for a group of individuals over time. The Child Development Supplement (CDS) (waves I, II and III) merged with the Panel Study of Income Dynamics (PSID) provides us with such a special data combination. Using the CDS-PSID data has many advantages. First, instead of using potentially biased self-reported and inaccurate maternal time use, we employ the Time Diaries (TD) data to directly measure maternal time investments. More specifically, the TD data include the type and duration of various kinds of activities in which mothers and children engage together. Second, we can also examine the causal effects of different activity categories (e.g., total and educational) and of distinct levels of maternal involvement (i.e., "active" or directly participating in the activity versus "passive" or being around during child's activity). Finally, the PSID contains valuable historical and demographic data on mothers (and households) that may also exert an influence on children's outcomes, and therefore can be used as statistical controls.

We propose a simple framework of human capital accumulation built by maternal time-investment, which implies a theoretical relationship between *changes* in outcomes and maternal time-investments *levels*. However, although maternal time allocation affects children's outcomes, the causality may also run in the opposite direction. That is, mothers usually devote more time to children whose academic achievement is low. Hence, inputs are essentially endogenous (Todd and Wolpin 2003; Cunha and Heckman 2008). Given the existing endogeneity, the causal effects are difficult to estimate. Out of several possible exogenous sources of maternal time variation, in this paper, we focus on predicted childcare prices. To obtain them, we estimate an equation of the childcare price[2] using the panel sample-selection model of Wooldridge (1995). Next, we estimate the effect of maternal investment on children's outcomes using a Fixed-Effects Instrumental Variables estimation technique. This identification strategy is valid if the variation in childcare prices solely affects children through the substitution of day care time for maternal time, holding constant family background characteristics. We find this to be a very plausible claim. Moreover, Kimmel and Connelly (2007) document that mother-child shared time increases when the predicted childcare price raises. Our first-step estimates are consistent with their results, and also show that the maternal response to childcare prices declines with child age. Furthermore, we also take care of the possible weakness of the instruments used by (1) estimating the model utilizing the Limited Information Maximum Likelihood (LIML) estimator, substantially less biased than the traditional Two-Stage Least Squares (Stock et al. 2002), and by (2) reporting the Cragg and Donald (1993) test for weak instruments as suggested by Stock and Yogo (2005). We interpret our estimates as a Local Average (marginal) Treatment Effect, that is, the marginal average impact of a rising maternal-investment in response to a childcare price increase in a particular sub-population of children (Imbens and Angrist 1994).

Our findings largely support the hypothesis of endogenous maternal time-investment alloca-

[2] For details, please see Appendix 2

tion because LIML estimates are an order of magnitude larger than OLS for Applied Problems and Word-Letter Identification cognitive tests. Moreover, since IV estimates are biased towards OLS, the level of bias (10-20%) consistent with Stock and Yogo (2005) critical values of the Cragg-Donald statistic becomes secondary because LIML estimates are roughly 10 to 20 times larger than OLS. By estimating the results for different sub-populations[3], we find that children living with college-educated mothers and in two-parent homes benefit the most from the exogenous variation in maternal time-investment. This suggests that marginal substitution of maternal time by formal child care should be beneficial in terms of those outcomes, which is consistent with previous evidence (Brooks-Gunn, Han, and Waldfogel 2002; Ruhm 2004). The magnitude of the effect of increasing total average maternal time by 1% per year is similar to the impact of joint maternal employment and day care placement estimated by Bernal and Keane (2008, 2010). While the effects of total active maternal time and of educational time are also significant and much higher than OLS for Applied Problems and Word-Letter Identification , their magnitude is lower than the one estimated for total maternal time-investment. In addition, our results show a less clear impact of an increase in maternal time-investment on Passage Comprehension and Digit Span tests. Finally, the results related to certain sub-populations are less reliable because our instruments are not so strong in some cases.

Findings from this study have policy implications. First, childcare subsidies and regulations should take into account the cost involved in maternal time allocation decisions on the child's cognitive abilities. Second, schools need to consider the compensatory and complimentary efforts of families in producing higher cognitive achievement. Educational policies should explicitly consider the role of mothers and household socioeconomic conditions in children's skill formation process.

The rest of the paper is organized as usual. Section 2 discusses the related literature. We describe the databases and present some descriptive statistics, emphasizing the weak connection between maternal employment and maternal time-investment in the data in Section 3. We present

[3]based on child's gender, child's race, mother's educational background, and child's living arrangement

the model, and discuss estimation and identification in Section 4. The results and the related discussion are in Section 5. We conclude in Section 6.

2 Literature Review

Our paper is primarily related to the vast literature in sociology, psychology, economics, and education that studies the effects of maternal time-inputs on children's cognitive outcomes. As mentioned before, since effective mother-child shared time is hard to observe, in practice most of the studies have focused on the effect of maternal employment. Bernal and Keane (2008, 2010) provide a good summary of the literature in this area. According to them, there is no consensus on the effect of maternal employment on children's cognitive outcomes. Previous research has failed to acknowledge the impact of earlier time-investments on children's cognitive development, as well as the inevitable sample selection of mothers into employment. Very few scholars have recognized the inherent reverse causal relation between children's outcomes and maternal time and good inputs. Using IV and OLS techniques, Blau and Grossberg (1992) find a negative impact of early maternal employment, but a potential offsetting effect later in life. James-Burdumy (2005) find little evidence of negative effects on children's cognitive development using IV and fixed-effects procedures. Bernal and Keane (2008) use different IV techniques, and Bernal (2008) and Bernal and Keane (2010) estimate a micro-founded structural model to find a significant effect of negative impact of maternal employment associated to day care placement. Hill and O'Neill (1994) find that an increase of hours worked has a negative effect on children's outcomes, but this effect is partially offset by higher income. Neidell (2000) find that maternal work has a detrimental effect on cognitive and non-cognitive outcomes, even though the effect is greater for working mothers. Waldfogel et al. (2002) find a negative impact of very early maternal employment. Brooks-Gunn et al. (2002) and Ruhm (2004) find that maternal employment is harmful to children's cognitive outcomes, especially for children of highly educated mothers.

An evident difficulty of the latter literature is the fact that the link between maternal employment and maternal time devoted to children is quite weak, as a shown in empirical studies on maternal time allocation. A robust finding is that maternal time devoted to children has not changed that much in the last decades despite the rise in maternal labor force participation (Bianchi 2000). Gauthier, Smeeding, and Furstenberg (2004) look at data from several countries and find that paid work seems not to crowd-out child-parent shared time. Moreover, mothers and fathers are increasing childcare time in absolute terms. Monna and Gauthier (2008) review evidence showing that most of mother's hours worked displaces housework and leisure, with a slight effect on childcare. Moreover, Bryant and Zick (1996) report that employed mothers devote more time to children in shared housework and leisure activities. Zick, Bryant, and Österbacka (2001) find that employed mothers engage in reading/homework activities more frequently than nonemployed ones, although Cawley and Liu (2007) find a lower chance of being involved in educational activities with children of working mothers in the ATUS data.

On the other hand, there is strong evidence showing that more educated parents devote more total time to their offspring (Datcher-Loury 1988; Bryant and Zick 1996; Kimmel and Connelly 2007) as well as more time in developmental activities despite maternal employment (Sandberg and Hofferth 2001; Craig 2006). Guryan, Hurst, and Kearney (2008) examine international data to conclude that families with high levels of income and education devote substantially more time to childcare in all the countries studied and within countries. In contrast, other time uses such as leisure and housework decrease with income and education. This suggests that the correlation between employment status and childcare depends on observable characteristics of the household. We present some evidence of this below.

There are few studies that use direct measures of maternal-child shared time as a determinant of children's outcomes. Hsin (2009) summarizes this scant empirical literature that roughly finds no significant correlation between children's outcomes and the time mothers devote to them. These results are misleading because those papers do not properly account for heterogenous backgrounds or address endogenous inputs. Hsin (2008) finds that maternal time-investment has a positive impact on children's outcomes, but only among mothers with high literacy levels. Carneiro and

Rodrigues (2009) use generalized propensity score matching to estimate the "dosage" effect of maternal time, but neglect the effects of cumulative inputs on a child's cognitive achievement. Del Boca, Flinn, and Wiswall (2010) develop and estimate a structural microeconomic model with specific functional forms for preferences, child outcome production technology, and time and budget constraints using data from the CDS. Their model and policy experiments focus primarily on the trade-off between hours worked and household income. Nevertheless, they neglect empirically important time-use buffer activities such as leisure and housework.

We explicitly address the importance of cumulative time and goods inputs, unobserved time-invariant heterogeneity, and contemporaneous input endogeneity by using a simple human capital model. Our approach is related to the existing literature on child skill formation, also known as outcome production function. Under this perspective, the time parents spend with children is an investment that directly stimulates cognitive development and provides an emotionally-, ethically-, and intellectually-rich environment for their children that promotes learning and positive behaviors. Todd and Wolpin (2003) and Cunha and Heckman (2007, 2008) (and subsequent papers) propose a theoretical and empirical framework for children skill formation based on dynamic unobserved skills or factors. Almond and Currie (2010) use a similar framework to organize empirical findings of children's academic achievement before age five. Cunha and Heckman's approach suggests that unobserved factors interact, simultaneously, with parental time-investments and with family background to determine children's outcomes. In contrast, our approach is more direct, since our ultimate goal is to estimate the causal effect of maternal time-investment on children's cognitive outcomes, without a very specific stance on the presumed underlying technology. Given our goal, the approach we take is closely in line with the work by Bernal and Keane (2008), which relies on a more direct and theoretically sound empirical specification.

3 Data

In this section, we describe the databases we use in our investigation.

Child Development Supplement (CDS) The CDS is a supplementary survey of the Panel Study of Income Dynamics . In 1997, the PSID supplemented its data with additional information on the sample of PSID parents and their 0-12 year-old children to generate a longitudinal data base of children and their families. Out of the 2,705 families selected for the CDS-I, 2,394 families (88%) participated, providing information on 3,563 children. In 2002-2003, CDS re-contacted families in CDS-I who remained active in the PSID panel as of 2001. CDS-II successfully re-interviewed 2,017 families (91%) who provided data on 2,908 children/adolescents aged 5-18 years. CDS-III data was collected in 2007. A great deal of the original sample in 2007 was ineligible due to being 18 or older.

From the CDS longitudinal data, we use the following information: (1) age-graded assessments of the cognitive and behavioral outcomes of each child such as Woodcock-Johnson Applied Problems (math), Passage Comprehension , and Word-Letter Identification tests (Woodcock, Johnson, and Mather 1989). In this paper we also study the impact of maternal time on the WISC Digit Span test (short-term memory) (Wechsler 1974). We extract demographic characteristics of the children which are supplemented with their PSID Individual records. Finally, we obtain measures of Home Quality Index , which is constructed from an observational assessment of the CDS interviewer. The details are explained in Appendix 3.

Time Diaries (TD) Researchers are often interested in measuring time devoted to certain activities over a period of time, such as the amount of hours per day that parents spent on a variety of activities with their children. Time diary collection is the preferred way to measure actual time use of individuals (Juster and Stafford 1991). The observation methods are very costly, intrusive, and limited in the amount of a day that can be covered (Juster 1985). Retrospective recall surveys that consist of the type and frequency of activities tend to provide inaccurate measurement of actual time uses (Robinson 1985). Hofferth (1999) shows that parents, especially the highly educated, tend to overstate the time they spent on “socially desirable” activities, such as helping their child with his/her homework.

In contrast to recall surveys, considerable methodological work has established the validity and reliability of data collected in time-diary form. Time diaries are a chronological report by the child's primary caretaker, and if sufficiently old, by the child him or herself about the child's activities over a specified 24-hour period. In the TD data, respondents were asked to provide the detailed time and nature of the activity in which children participated. For each activity, respondents report (1) time the activity began and ended, (2) whether the child was watching TV or a video, (3) where the child was doing the activity, (4) who was participating in the activity with the child, (5) who else was with the child, but was not directly involved in the activity, and (6) what else the child was doing during the primary activity. One of the most important advantages of the TD data a is that total time in one day has to add to 24 hours. Consequently, while individual times may be slightly inaccurate, the times are consistent with one another. The disadvantage of the TD data is that it represents only a sample of children's days. As such, it has limited reliability. To ameliorate this problem, the CDS-TD collects time diaries of one weekday and one weekend day. We construct the total time a mother devotes to her child by weighting weekdays by five and weekend days by two.

The TD data contained in the CDS is very extensive. There are approximately 600 primary activities that were aggregated into 11 major categories. In this paper, we focus on the education-oriented activities, which include only those labeled as educational and professional training (e.g., doing homework, taking classes, courses or lectures outside of school, etc.). Thus, we use two broad time categories: (1) total time spent on all activities, and (2) total time spent on educationally-oriented activities[4] (Yeung et al. 2001).

We are also interested in examining potential differences that may arise when parents are actively involved in the activities versus when they are not. Consistent with our interest, Folbre et al. (2005) argue that it is important to make the distinction between "active" and "passive" time-investments because they may influence children's outcomes in different ways. The Time Diaries allows us to distinguish between these distinct levels of involvement. More specifically, we define active time as the time the mother spends directly involved in an activity, and passive

[4]We thank Sandra Hofferth for sharing these data with us.

as the time she spends with her child being just “around” the activity. To aid in the interpretation of our analysis, we use the last two criteria to construct four variables reflecting maternal time investment: (1) Total maternal time, (2) total maternal time active, (3) educational maternal time, and (4) educational maternal time active.

Panel Study of Income Dynamics (PSID) The PSID is a longitudinal study of a representative sample of U.S. individuals and their families. Since 1968, the PSID has collected data on family composition changes, marriage and fertility histories, employment, income, time spent on housework, health, and many others. The sample size has grown from 4,800 families in 1968 to more than 7,000 families in 2001. For this particular paper, the PSID data was used in two specific ways. First, we use the PSID Family records for maternal education, maternal age[5], family income, childcare expenditure, family structure, reported hours worked and housework hours.

Current Population Survey (CPS) The Current Population Survey March data was used to construct labor market and welfare variables that may generate an exogenous source of variation in maternal time use allocations. We consider several local labor markets variables that may influence maternal time-allocation decisions. We collected data on average child benefits by year and state, and wages of childcare occupation workers by year and state for the period 1990-2007.

3.1 Descriptive statistics

Children outcomes and family background Standardized cognitive outcomes scores vary a great deal according to child gender and maternal education. These differences are meaningful since all measures of children’s cognitive outcomes are ordinal scales that allow comparisons within the same test (but not between them). Panel A of Table 1 show that the children in the sample exhibit a slight decreasing pattern for the Applied Problems , Passage Comprehension and Word-Letter Identification tests. We do not have an explanation for these patterns. We notice that female children perform better than males in all four tests, for ages 5 to 11. For children older than

[5]We checked the consistency of maternal educational attainment and maternal age for several years. We also supplement these family variables with PSID Individual files in order to minimize the missing observations. The details of the procedures applied are available upon request.

11, females still outperform males except on the Applied Problems test. Looking at Panel B, it is apparent that children of highly educated mothers perform substantially better than children of low educated mothers in all tests. Panel C shows that children from part-time workers have higher test scores than either full-time employed and non-employed mothers. In turn, the children of these last two groups of mothers have similar scores.

The Table 2 shows little systematic differences between the households of boys and girls in the sample, except for the fact that actual expenditure in childcare for young girls is considerably larger than the amount spent on boys of the same age. The sample also shows that the group of older children has a larger share of Black children and a lower share of White children in comparison to the youngest group. The share of households with female heads is notably larger for children older than 11, probably because of the higher frequency of divorce once children get older. The number of other adults at home also increases with a child's age, as well as the value of the house in which they live.

Table 2 also shows that highly educated mothers are roughly 3.5 years older on average. Households with a highly educated mother have a larger proportion of White children and male heads.[6] Home quality, *per capita* family income, and books per child are higher for more educated mothers. The predicted childcare cost is higher for more educated mothers on average, and so it is the actual childcare expenditure. There is also a striking difference between highly and low educated mothers in regards to the value of the house. Indeed, a great deal of the difference is driven by the fact that these statistics are computed using a house price of one cent if the family does not own a house.[7]

Mothers greatly differ according to their working status. We observe that full-time working mothers are more educated, on average, than mothers who work part-time. Mothers who work part-time are also more educated than non-working mothers. Part-time working mothers tend to have more White children and to live with a male partner more frequently in the sample. Interestingly,

[6] This claim uses the standard PSID convention that defines a household head to be any male older than 18 years old at home.

[7] We report log(value house +0.01)

a larger share of mothers working full-time are household heads. Full-time working mothers tend to live in households with a relatively higher Home Quality Index and *per capita* family income. Regarding childcare costs, our estimates show that it is 0.2 log points larger for working mothers with respect to the non-working ones. Nevertheless, the actual childcare expenditure of full-time working mothers almost doubles the amount spent by mothers working part-time. Finally, part-time working mothers live in households that are 0.17 log points more valuable than full-time working mothers (these numbers include the zeroes of "no-owner" status.

Maternal employment vs maternal time-investment While many studies have found that employed mothers devote less time to their children than their non-working counterparts, it is clear that other activities such as housework and leisure, are the ones that are drastically reduced to accommodate the number of hours worked (Guryan, Hurst, and Kearney 2008). Aguiar and Hurst (2007) documented that over the last decades several categories of total maternal childcare time have increased as well as total hours worked. These time uses have increased as a result of declining housework hours.

A set of scatter plots in Figure 2 reveal that maternal hours worked are weakly and negatively correlated with each one of the time use categories we analyze here (total maternal time, total maternal time active, total educational time, and total educational time active). However, the dispersion around the local polynomial regression lines is substantial.[8] This evidence suggests that maternal hours worked is, at best, a very noisy proxy of maternal time-investment. We also find a positive association between housework time and maternal time-investment categories, but again, the conclusion is that the latter time use category is a very noisy measure of the time mother and child engage in together.

Nevertheless, our skepticism on using maternal employment as a measure for maternal time input goes beyond this issue. There is substantial evidence showing that the time allocation of working mothers varies by educational patterns, child age, and gender (Datcher-Loury 1988; Bryant and Zick 1996; Yeung et al. 2001 among many others). The economic literature[9] has considered

[8]For details, see on the footnotes of Figure 2

[9]Aguiar and Hurst (2007) provides a more complete discussion on the conceptual distinction between childcare

childcare as a separate time category which is distinct from leisure and housework not only on theoretical grounds, but also because it behaves differently in response to exogenous shocks such as changes in childcare price and wages. For instance Kimmel and Connelly (2007) show that while leisure and housework decrease in predicted wages, maternal childcare time increases. Ignoring these issues would lead to misleading conclusions.

Maternal time allocation substantially varies across groups defined by child age, gender, and maternal education. In Table 1 we observe average total maternal time is higher for male children when their age ranges 5-11, but the pattern reverses for female children older than 11. The time allocation for narrowly defined activities such as educational active is not gender-biased. When we look at the maternal education gradient, we do observe that highly educated mothers devote more time to children but these differences seem less important for more specific time categories. Finally, Panel C of Table 3 shows us that maternal employment reveals little about time allocation. While non-employed mothers provide more total hours to children, the differences across groups suggests that most of the hours worked have displaced other time categories such as leisure and housework. A remarkable finding is that mothers working part-time actually provide more hours to total active childcare and to educational activities.

Table 3 shows pairwise correlations between maternal hours worked and mother-child shared time for different subsamples. We observe that the negative correlation between hours worked and maternal time-investment decreases as we consider more specific time uses. Moreover, the negative correlation seems larger (in absolute terms) for younger, male children with low educated mothers.

This evidence reassures our skepticism on evidence regarding maternal employment "treatment" effects. Our concern is not only that hours worked or employment status is a very noisy proxy for maternal time devoted to children, but that the evidence also indicates that the link between the two variables weakens as we focus on more active types of maternal time-investment. The fact that the correlation consistently varies according to child gender, child age, and maternal

time and housework

education suggests that the maternal employment is a very different treatment across groups. This also implies that the noisiness of maternal time cannot be treated as a textbook measurement error problem. Since classic measurement error biases estimates towards zero, each subsample provides estimates with a varying level of bias. To summarize, we see a severe identification problem: maternal employment heterogeneity effect. This effect may be due to: (i) working mothers actually provide a different level or composition of time-investment, or (ii) certain groups of children may, intrinsically, be more sensitive to maternal time-investment. Metaphorically, maternal employment is a cocktail of a varying number of pills of several possible kinds that is administered to heterogeneous patients. In addition, the drugs are administered using a varying degree of uncertainty that depends on the patient's condition. Clearly, little could be learned from this poor experimental design.

4 Model

There are several approaches in the literature to model children's outcomes development. Cunha and Heckman (2007, 2008 and subsequent papers) focus on the dynamic evolution of unobserved skills that are identified as dynamic factors. Our approach here is closer to Bernal and Keane (2008) since it establishes a more straightforward relation between observable inputs and outcomes, without a mediating role of unobserved factors.

Despite the fact that the model we propose is non-linear in deep parameters (because of the unobservable maternal time-investment), we can recover the parameters of interest by estimating a linear model. After presenting the model and recognizing the potential endogeneity problem, we examine the potential sources of exogenous variation –notably, childcare price variation– that can provide a reasonable identification strategy. Then, we utilize strategies in the econometric literature to handle potential Weak Instruments problems in Instrumental Variables methods. We implement the Limited Information Maximum Likelihood (LIML) estimator, which is less prone to these problems (Stock, Wright, and Yogo (2002) for a survey). We also report tests for weak instruments (Cragg and Donald 1993) with tabulated values from Stock and Yogo (2005).

Theoretical setup Most of the literature suggests models in which maternal time and goods enter as an input into the production function as well as usually unobserved genetic conditions. As noticed by Bernal and Keane (2008, 2010), only few papers recognize the importance of previous inputs in generating current outcomes. We explicitly consider this issue in our model specification.

We postulate that there is a natural, possibly nonlinear, trend for cognitive development as the child grows older. Nevertheless, we consider heterogeneous cognitive development profiles that vary according to child gender, and a proxy for maternal ability (as measured traditionally by schooling). Deviations from this standard trend may be caused by higher human capital level, X, built via maternal time-investment or by higher physical capital, K, accumulated through goods investments.

Both capital stocks, X and K , can be written as a cumulative weighted sum of investments x and k. We recognize that the marginal contribution of investments is essentially heterogenous across children and it may be determined by factors such as maternal education, child gender, age, race, and family environment variables. Notably, previous research in child development psychology and several studies in skill-formation technology have suggested that early investments have a stronger impact in a child's early ages (Cunha and Heckman 2008; Almond and Currie 2010). It is also reasonable to think that the marginal impact of maternal time-investment varies according to her education or skills. Indeed, Hsin (2008) found that the time-investment of mothers with high literacy skills has a positive impact on children's outcomes, other maternal time-investments were unproductive. Evidence of higher detrimental effects of the employment of highly educated mothers can be rationalized in the same way (Ruhm 2004).

We propose a reduced form linear specification for child outcomes that is expressed in the following equation

$$y_{n,t}^{h} = \alpha_{n}^{h} + \sum_{i=0}^{a_{n,t}} \beta_{n,i}^{h} + \sum_{i=0}^{a_{n,t}} \gamma_{n,i}^{h} x_{n,i} + \sum_{i=0}^{a_{n,t}} \delta_{n,i}^{h} k_{n,i} + u_{n,t}^{h} \tag{1}$$

where t represents time and the n subindex represents children in the CDS sample.

The outcome h of child n at time t is represented by $y_{n,t}^{h}$. The term α_{n}^{h} stands for an unobserved environmental/genetic component of the child n that specifically affects the h-th outcome at all ages. The coefficients $\beta_{n,i}^{h}$ represent the outcome specific age-trend determining the average development of the n-th child.

The cumulative weighted sum of $x_{n,i}$ is the human capital accumulated up to time t by the child n due to maternal time-investment for outcomes $h = 1, 2, ..., H$. Likewise, the cumulative weighted sum of $k_{n,i}$ represents the physical capital accumulated by the household n up to time t. The coefficients $\gamma_{n,i}^{h}$ and δ_{n}^{h} represent the outcome-specific marginal effects of investments x and k for the n-th child at age i. This formulation allows for marginal effects varying on the child's current age $a_{n,t}$.

Our method estimates first-differences of equation (1) to get rid of unobserved child-home heterogeneity. This approach is also convenient to maximize the sample size since there is substantial non-response in the first and third waves of the CDS. Some children were too young in 1997 or too old in 2007 to take the cognitive tests. Since the CDS reports time use every 5 years, the 5-year variation can be written as

$$\Delta_5 y_{n,t}^{h} = \sum_{i=a_{n,t-5}}^{a_{n,t}} \beta_{n}^{h} + \sum_{i=a_{n,t-5}}^{a_{n,t}} \gamma_{n}^{h} x_{n,t} + \sum_{i=a_{n,t-5}}^{a_{n,t}} \delta_{n,i}^{h} k_{n,t} + \Delta_5 u_{n,t}^{h} \tag{2}$$

The logical implication of this setup is that accumulated maternal time-investment between the two dates is the key determinant of changes in children's outcomes. One important limitation is that we do not observe these investments in every moment of time in the CDS data. We need to make additional assumptions on the way mothers behave in order to identify the impact of maternal time-investment on the outcome h. We assume that both investment data we observe $x_{n,t}^{*}$ and $x_{n,t-5}^{*}$ are related to the unobserved time-investments in the following way

$$x_{n,t} = \xi_n + \rho x_{n,t-1} + e_{n,t} \tag{3}$$

This equation shows that the maternal time allocation at time t depends on child and family unobserved factors ξ_n, the choice of maternal investment in the previous period and a random shock

$e_{n,t}$. We can get rid of the unobserved family effect by taking first-differences in the equation (3)

$$\Delta x_{n,t} = \rho \Delta x_{n,t-1} + \Delta e_{n,t}$$
$$x_{n,t} - \mu x_{n,t-1} + (1-\mu) x_{n,t-2} = \Delta e_{n,t} \quad \text{with } \mu \equiv 1+\rho$$

Using equations for $t, t-1, t-2$ and $t-3$ we formulate a 4×4 linear system whose detailed solution is shown in . Once solved, every period time-investment can be written as

$$x_{n,i} = \lambda_i x^*_{n,t} + (1-\lambda_i)_i x^*_{n,t-5} + \sum_{j=t-3}^{t} \tau_{j,i} e_{n,t-j} \quad \forall i = t-4, \ldots, t-1$$

We assume the effect of maternal time-investment can be decomposed as $\gamma_{n,i} = \phi_n \phi_i$ where ϕ_n is a child-household specific component and ϕ_i is a child-age specific component. The expected change in human capital stock can be expressed as

$$\begin{aligned}
\Delta_5 X^h_{n,t} &= \sum_{i=t-4}^{t} \gamma^h_{n,i} x_{n,i} = \sum_{i=t-4}^{t} \gamma^h_{n,i} \left(\lambda_i x^*_{n,t} + (1-\lambda_i) x^*_{n,t-5} \right) + \tau e \\
&= \gamma^h_n \Lambda x^*_{n,t} + \gamma^h_n (5 - \Lambda) x^*_{n,t-5} + \tau e \\
&\text{with } \Lambda = \frac{5 \sum_{i=t-4}^{t} \lambda_i \gamma_{n,i}}{\sum_{i=t-4}^{t} \gamma_{n,i}} = \frac{5 \sum_{i=t-4}^{t} \lambda_i \phi_i}{\sum_{i=t-4}^{t} \phi_i} \text{ and } \gamma_n = \frac{1}{5} \sum_{i=t-4}^{t} \gamma_{n,i}
\end{aligned}$$

The term τe is the dot product of the vector maternal time allocation shocks e and its associated coefficient. Finally, we can see that the marginal effect of the conditional expectation across N children is

$$\mathbb{E}\left[\frac{\partial \mathbb{E}[\Delta_5 X^h_{n,t} | e]}{\partial x^*_{n,t}} \right] = \Lambda \mathbb{E}[\gamma_n] = \Lambda \gamma^h$$

The conditional expected variation of maternal-time accumulated human capital X can be expressed as the average marginal effect of maternal time-investment $x^*_{n,t}$ amplified by a factor Λ, the 5-year temporal impact of the investment.

Since goods helping child development are likely to be financed with labor income, and maternal labor supplies are correlated with maternal time-investment on the child, we consider a proxy for child goods in period $t-5$ instead of its contemporaneous measure. By doing so, we avoid a new source of simultaneity into the estimation. As a measure of material well-being we primarily use the Home Quality Index . A careful description of this index is in Appendix 3. We also explore other measures of material well-being including log *per capita* real household income and the number of books of the child, although we do not notice important differences using the latter variables. Therefore, we estimate the following generic equation

$$\Delta_5 y^h_{n,t} = \pi^h_0 x^*_{n,t} + \pi^h_1 x^*_{n,t-5} + \pi^h_2 k_{n,t-5} + \pi^h_3 a_{n,t} k_{n,t-5} + \pi^h_4 e_n + v^h_{n,t} \tag{4}$$

We can easily recover the value of γ^h by computing $\frac{\pi^h_0+\pi^h_1}{5}$ because $\pi_0 = \gamma^h \Lambda$ and $\pi_1 = \gamma^h(5-\Lambda)$.

Identification Strategy Identification problems arise due to the potential endogeneity of contemporaneous maternal time-investment. In our framework, this problem is equivalent to an omitted variable bias of the time shocks e. Therefore, the error of equation (4) is likely to be correlated with the contemporaneous maternal time investment $x^*_{n,t}$. In contrast to our approach, the literature has mostly highlighted the fact that maternal time allocation may depend on unobserved time-invariant child characteristics. Although such an assumption may be reasonable, it is more general to assume that maternal time allocation may depend on time-varying conditions such as children's outcomes (Todd and Wolpin 2003). For instance, mothers may devote more time to their children if, for instance, they perform poorly at school, regardless of whether the low academic achievement is caused by early disadvantage or by a negative shock later in life.

A natural approach to solve these difficulties is Instrumental Variables estimation. As discussed in the literature (Wooldridge 2002; Murray 2006; Angrist and Pischke 2009), we need a significant exogenous source of variation of the maternal time allocation (i.e., instruments are not weak) that does not directly affect children's outcomes conditioning on other covariates (i.e., exclusion restriction). Formally,

1. Exclusion restriction of z: $\Delta y^h_{n,t} |$ covariates $\perp z$

2. No weak instruments z: $\mathbb{E}\,[ze|$ covariates$] \neq 0$

We recognize that there may be plenty of heterogeneous responses of children's outcomes to exogenous variation of maternal time induced, in turn, by a change in z. Hence, we interpret our results as a Local Average Treatment Effect (LATE) that may depend on the particular instrument used. As shown in this literature (Imbens and Angrist 1994; Angrist and Pischke 2009), the estimated effect is driven by a group of mothers who only changed the time they spend with their children in response to a variation of z.

We rely on a standard theory of household time allocation to find appropriate instruments. In line with Gronau (1977), mothers decide how to split their limited time into four possible uses: work, housework, childcare, and leisure. Our instrumental variables capture exogenous shocks to the benefits and costs associated with these time use categories. Hence natural candidates for being instruments are variables associated to (i) the cost of childcare service, (ii) the benefits and costs of hours worked in the market, (iii) the cost of external housework provision, and (iv) the government resources for welfare benefits, related regulations and eligibility rules. Each one of these instruments represents exogenous variations that are essentially distinct. We prefer to use the least number of instruments per estimation in order to interpret each result as a response induced by distinct quasi-natural experiments. This approach is also consistent the literature of Weak Instruments that warns of the danger of using too many instruments (Bound et al. 1995; Stock et al. 2002).

In addition of the two standard identification conditions for IV estimation, under heterogeneous effects, we will also need to satisfy *monotonicity* of maternal time response to z. That is, if z changes, then all individuals in the population of interest must show either a weak increase or weak decrease in the time spent with children in response to such a change. In principle, since the household owns a time endowment, there are substitution and income effects that work in opposite directions. Thus, families differing in observable characteristics (wealth, age, etc) may respond to a price change in different ways. Since the IV estimation implicitly averages the responses across the population, then, it is possible that we could obtain a negligible effect in practice. Even though monotonicity may not hold in practice, it is important to state that this drawback works *against* obtaining significant results.

Out of many possible instruments, we focus in this paper on the effects of childcare price variation. While this choice is somewhat based on space considerations[10], we believe that childcare services is a direct substitute for mother-child shared time. As such, this price greatly affects the time-use allocation considering that the total cost can be close to 1/4 of the earnings of a full-time minimum-wage worker (Connelly and Kimmel 2003). This price consideration is likely to be relevant for most families with children since they, unquestionably, need some minimum amount of time-investment. Consistently with theory, Kimmel and Connelly (2007) estimated a significant positive response of actual mother-child shared time to an increase in childcare prices. For other time uses, we argue, it is not clear how maternal time-investment changes when other mentioned costs and benefits adjust.

We obtain estimative child care costs using PSID historical records on childcare household expenses divided by the number of children under the age of six. Since some families do not spend money on childcare, we need to generate a counterfactual unobserved price along the lines of Kimmel and Connelly (2007). To do this, we use the basic insight of non-random sample selection (Heckman 1976): old children or adult relatives at home are likely to affect the decision of hiring external childcare services, but they do not affect the price paid once the parents send the child to daycare. We exploit the panel dimension of the data to control for family time-invariant effects using the model of Wooldridge (1995). The details of this method and results are explained in Appendix 2. Even though the expected effect of an increase of this price is an increase in maternal time with the child, this instrument may not strictly satisfy monotonicity of maternal time response for all the population. For instance, females who work in childcare probably decrease their maternal time due to a substitution effect. In the worst-case scenario, as argued earlier in this paper, our estimates provide a lower bound of the effect.

[10] Estimates using other instruments are available upon request.

5 Results

Overview The main results are displayed in Tables 4-7.[11] We report the results obtained from using the exogenous variation in the predicted childcare price and report the Cragg-Donald test in different sub-populations. Our results show that LIML estimates are an order of magnitude larger than those of OLS, particularly for Word-Letter Identification (word) and Applied Problems (aprob) tests. This evidence suggests that the hypothesized reversed causality is important and empirically sizeable for these cognitive outcomes. To illustrate our point, in Panel A of Table 4, the OLS estimator shows that an increase of 1% in the average total maternal time would increase 0.96% of a standard deviation in the test score in Word-Letter Identification . The LIML estimator suggests an increase of 22.16% of a standard deviation in the same test score as a result of a 1% exogenous increase in the weekly average maternal time. Thus, for word-letter identification, the LIML effect is roughly 23 times larger than the OLS. Similar magnitudes are obtained when comparing OLS and LIML estimates for education time and when the mother directly participates in the activities (see Tables 6-7). The order of magnitude of these effects is similar to the estimates for a joint treatment of maternal employment and day care placement (roughly a drop of about 14-16% of a standard deviation) obtained by Bernal and Keane (2008, 2010). Herbst and Tekin (2010) estimate that childcare subsidized children obtain 26-30% lower cognitive test scores until the end of kindergarten, other things equal, although the underlying mechanism involving maternal time devoted to children is not directly comparable to our estimates.

Although the reported Cragg-Donald tests are not very large (and in most cases do not surpass the rule-of-thumb value of 10), the difference between OLS and LIML estimators is remarkable. Even if we had the level of bias towards OLS estimates (around a 10%) implicit in the most used critical values of Stock and Yogo (2005), the main conclusions remain intact due to the large difference between OLS and LIML estimators.

Effects of total maternal time Table 4 shows that the causal effect associated with to-

[11] We use the Stata package `ivreg2` by Baum, C.F., Schaffer, M.E., Stillman, S. (2010) http://ideas.repec.org/c/boc/bocode/s425401.html

tal maternal time is large and significant. Furthermore, results show that this effect holds true for every sub-population analyzed (High/Low educated mothers, Male/Female child, White/Black child, Male/Female household head) for word and aprob tests, even though the weakness of the instrument increases for some sub-populations. The results indicate that the positive impact of total maternal time on word and aprob tests is mainly driven by highly educated mothers of male children in two-parent households (male head in PSID convention). Although the effect on Black children seems to be larger, the Cragg-Donald test is quite low for that sub-population and the coefficient is significant only at the 20% for the Applied Problems test. This result suggests that marginal substitution of maternal time by formal childcare should be beneficial in terms of those outcomes. On the other hand, the effect of maternal time on the Passage Comprehension (pcom) tests seems to be non-significant in general, with the exception of the sub-population of highly educated mothers. For the Digit Span (dstot) test, the effects seem non-significant except for the female head sub-population. There is indeed a negative effect for this particular sub-population.

The effect of material well-being in households, as measured by the Home Quality Index , varies across outcomes. For the Word-Letter Identification test, the main impact seems negative, but it varies according to a child's age. In fact, the effect of home quality is less detrimental for older children. For other outcomes, the effect of material well-being is, for the most part, non-significant with some exceptions in some sub-populations.

When focusing only in time-investment when the mother is active in the activity (Table 5), we find that, on average, this kind of maternal time-investment significantly and positively affects the Word-Letter Identification and Applied Problems tests for the whole sample. While the effects are still very large compared to OLS estimates, the causal impact is roughly half of the effect of a marginal increase of total maternal time for Word-Letter Identification . In the case of Applied Problems , the marginal impact of active participation is about the same as the one we estimate for total maternal time in Table 4. The average effects in these two tests are driven by the same groups as in the total maternal time case, but here there is strong evidence to suggest that the effects are greater for White children compared to Black children. For this maternal time category, we do obtain significant positive effects (at the 10%) on Passage Comprehension and Digit Span tests for the entire sample. As in other cases, the magnitude of our LIML estimates is much larger than OLS estimates. The effects across different sub-populations are not significant in most cases, with the exception of a positive impact on the pcom test of Black children (at the 10%). The magnitudes of the coefficients are positive in almost all cases and reproduce the patterns we observe for Word-Letter Identification and Applied Problems tests, with the exception of race.

To summarize, when we study the effect of total time the mother is actively engaged with her child, we find that the impact of Home Quality Index increases with child age for the word test. This finding seems common to most sub-populations. These patterns are similar to those obtained for Passage Comprehension and Digit Span tests, although the effect is negative. In contrast, home quality has a non-significant effect on the Applied Problems test, except for sub-population of Black children, which shows a positive and decreasing-in-age impact of this variable.

Effects of educational maternal time In Table 6 we show the results when we use total maternal time devoted to educational activities with the child. One drawback of these estimates is the fact that the Cragg-Donald tests are substantially lower compared to those for total maternal time. For this reason, results need to be carefully interpreted (even though the gap OLS-LIML is quite large). Nevertheless, we obtain similar patterns: a marginal increase in total maternal time does increase Word-Letter Identification and Applied Problems tests for the whole sample. The effects are, perhaps surprisingly, generally smaller than those obtained from total maternal time. Still, similar patterns of heterogeneity across sub-populations emerge: White children seem to experience a larger positive impact on these tests, compared to Black children. Children living in two-parent homes also seem to demonstrate a larger positive impact on these tests, compared to children in other living arrangements. Finally, children with highly educated mothers tend to have larger positive impact on these tests, compared to children with low educated mothers. For the Passage Comprehension and Digit Span tests, the causal effects of this time category are mostly positive but statistically non-significant. The impact of Home Quality Index in these cases are non-significant for aprob, but they are increasing on age for older children in the word test. A similar pattern emerges for pcom and dstot tests, but for most sub-populations the effects are non-significant.

Focusing on a narrower maternal time-investment does not change the main observed results. Perhaps, most surprisingly, is the fact that the Cragg-Donald tests are quite large for this variable, so that the results seem somewhat more reliable. Even though the effects of educational maternal time active with the child are typically positive, their magnitude is substantially lower than those obtained for total maternal time. Yet, they are still much larger than OLS (roughly 10-20 times larger). Again, Word-Letter Identification and Applied Problems are consistently positively and significantly influenced by changes in this particular kind of maternal time-investment. For the Word-Letter Identification and Passage Comprehension tests, results show a relatively higher impact for more educated mothers with respect to their less educated counterparts. Unlike other time categories, female children seem to benefit the most from this particular time use. White children and male-head households show a higher effect as well. For Passage Comprehension and Digit Span tests, the effects are generally positive, but non-significant. Regarding home quality effects, the same patterns we observe for other categories occur here. The Home Quality Index effect on Word-Letter Identification is significantly increasing in age in most sub-populations. We obtain a similar pattern for Passage Comprehension , but in most cases is non-significant. For Digit Span , the effect seems marginally detrimental for the whole sample and some sub-populations, but generally non-significant. Home Quality Index impact on the Applied Problems test is, for the most part, non-significant.

First stage The Weak Instruments literature has convincingly argued for paying close attention to the first state. In other words, this scholarship claims that the first stage in Instrumental Variables method has to make sense. Several authors recommend not only finding joint significance of instruments, but also obtaining estimates that are consistent with the underlying economic mechanism generating the exogenous change in the endogenous regressor (Murray 2006; Angrist and Pischke 2009). In Table 8 we can see the first-stage estimates for the Word-Letter Identification test.[12] Other first-stages slightly differ from this one because some children did not take all tests. The results show a systematic pattern: the predicted log childcare price significantly increases maternal time, but its impact decreases with the child's age. The impact also shows an increasing value when the time category becomes narrower for the whole sample. For instance, the elasticity of maternal time to childcare price is roughly 0.08 for a 10 year-old child when we focus on total time, but it increases up to 0.423 for total active time, 0.391 for total educational time, and 0.54 for total educational time when the mother is active. Similar patterns emerge across sub-populations.

When looking at heterogenous total time elasticities across mothers, we observe a higher elasticity for more educated mothers with a female child in female-headed households. For total maternal time active, we observe a larger response in less educated household-head mothers, with female and Black children. When we focus on total educational time, some patterns change. Mothers who show a greater time-childcare price elasticity are more likely to be less educated and household heads. They are more likely to have male and Black children, as well. For the narrower category of educational time, that is when the mother is actively participating, we find similar patterns although the magnitudes are somewhat larger.

Finally, time allocation five years ago significantly increases time spent today in several sub-populations, but the magnitude is quite small. In addition, the Home Quality Index tends to increase maternal time in some equations, but remains non-significant in most cases.

6 Conclusions

Having witnessed a unprecedented rise in maternal labor force participation during the last century, many researchers have attempted to quantify and to understand the impact of mothers' work on children's outcomes. Although studying the impact of the "treatment" of maternal employment is a reasonable first step, there is substantial evidence that this is a very noisy, and potentially, biased measure of the actual time-investment on children. Thus, we take advantage of the special features

[12] We choose this particular outcome because it is the one with the largest sample size.

of the CDS-PSID data set, which allows us to merge important quality and quantity components of maternal time-investment into an integrated framework that takes into consideration: (1) high-quality measures of mother-child shared time (Time Diaries), (2) child cognitive achievements (Child Development Supplement), and (3) family background (CDS-PSID family records).

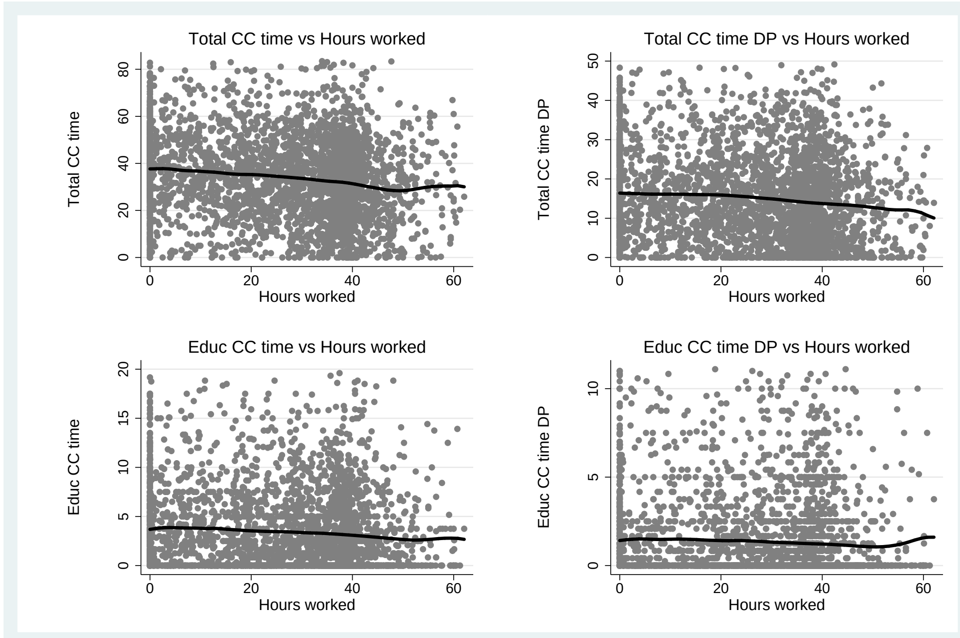
Next, we propose a simple linear human capital empirical model and devise an identification strategy based on exclusion restrictions rooted in standard time-allocation theory (Gronau 1977). Our main results show that Applied Problems and Word-Letter Identification tests consistently increase when mothers increase the time shared with their children in response to a rise in predicted childcare price. These effects are an order of magnitude larger than those obtained by OLS, which reassures the importance of using Instrumental Variables techniques to uncover true effects when theory suggests endogeneity is a problem. The discrepancy between OLS and LIML estimators is so large, that even if our estimates are biased due to Weak Instruments problem (Stock and Yogo 2005), the main conclusions remain qualitatively unaltered. In a context of heterogenous effects, the response seems to be driven by the response of children of highly educated mothers living in two-parent households. In some cases, male and White children seem to be the most benefited. The effects on Passage Comprehension and Digit Span are less clear, but there is some evidence of similar effects when some particular time uses are analyzed. First-stage results are theoretically sound and are in line with evidence showing that maternal childcare time increases with day care price, especially for young children (Kimmel and Connelly 2007). The fact that Home Quality Index generates insignificant impact of children's outcomes, in most cases, seems roughly consistent with existing evidence showing that family income variation barely affects children's outcomes because results are quite modest or insignificant (Blau 1999; Shea 2000).

At least for Applied Problems and Word-Letter Identification tests our results are similar to studies on maternal employment treatment. Bernal (2008) finds that the effect of maternal employment and a joint increase in childcare is detrimental for cognitive outcomes. Brooks-Gunn, Han, and Waldfogel (2002) and Ruhm (2004) also find a significant negative impact of maternal employment, especially among more educated mothers. Herbst and Tekin (2010) find a negative impact of low-quality childcare driven by the welfare benefits. However, we interpret this resemblance very cautiously because, as we mentioned above, the maternal employment status is a very imperfect proxy for maternal time-investment in children. Using actual CDS time-investment measures, Hsin (2008) finds that only mothers with high literacy test scores positively affect children's outcomes.

Using detailed time-diary data allows researchers to investigate in greater detail how complex family interactions shape the performance of children in several dimensions. A policy implication of our results is that government regulations attempting to foster female labor supply or to provide subsidies for childcare should be carefully evaluated. Although we could interpret the results as a non-optimality in the margin of maternal time-allocation decisions, we realize that optimal household welfare may not be consistent with maximizing children's output (i.e., cognitive outcomes). One one hand, there are many other child characteristics and skills that are highly valued by parents, beyond cognitive outcomes. On the other hand, household problems also involve allocating a scarce resource of time to generate enough income, leisure, and home goods, as well as children outputs (Del Boca, Flinn, and Wiswall 2010).

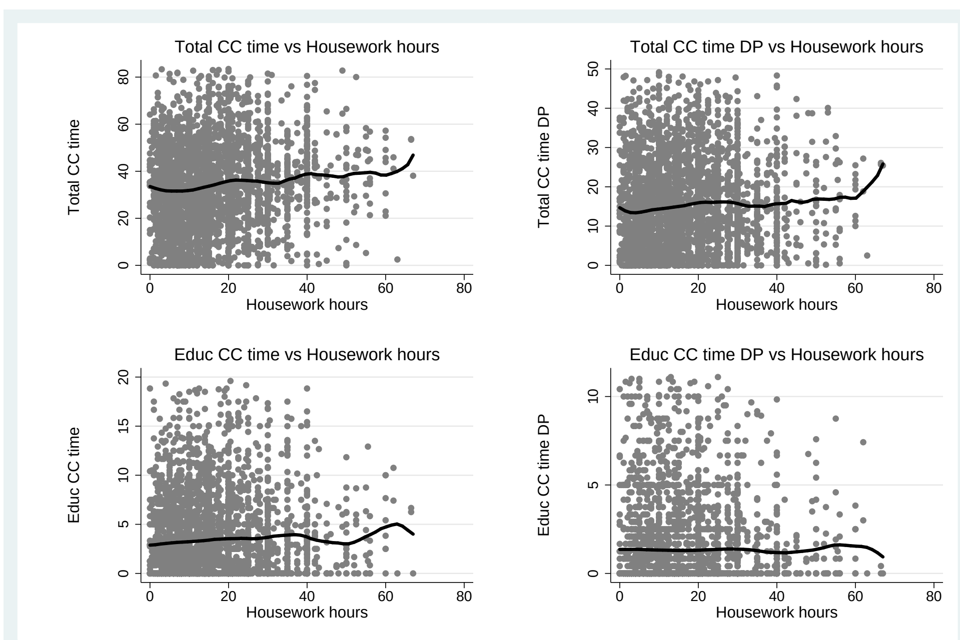
On a more general level, a comprehensive empirical understanding of family behavior is fundamental to understanding the human capital formation process and the intergenerational persistence of outcomes. The "nature vs. nurture" debate may be rephrased in terms of "passive" and "active" parental effects on children's development. We may understand family environment as a passively transmitted influence of family "public goods". For instance, children may be benefited (or harmed) by inheriting genes, but also by observing and imitating parental behaviors, or by interacting within their social networks. Children can also use educational or cultural goods that are available for them in a particular household without mediating parental involvement. The second conceptual "active" channel is related to purposeful parental behavior and the achieved child specific interaction. This is not only related to the amount of time devoted to children, but also to the level of involvement (Folbre, Yoon, Finnoff, and Fuligni 2005), the type of activities chosen, and the parenting style generated during those interactions (Burton, Phipps, and Curtis 2002; Dooley and Stewart 2007). Estimating the impact of maternal time resources that are willingly allocated to raise children could be seen as a first and quite limited attempt to identify the contribution of "active" maternal effects. Furthermore, given the empirical strategy proposed in this paper and the findings of our study, future research should incorporate into their analyses: (1) the time other family members invest in children (i.e., fathers, siblings, and grandparents), (2) non-cognitive outcomes (i.e., behavior, motivation, and health), and (3) different types of activities (i.e., social, leisure and household time uses). The CDS and PSID offer numerous possibilities to extend this study.

Figure 1: Maternal childcare time vs Maternal hours worked



The figures show scatter diagrams of maternal time with children and hours worked. The solid line correspond to a local polynomial regression of degree 1 with Epanechnikov kernel.

Figure 2: Maternal childcare time vs Maternal housework hours



The figures show scatter diagrams of maternal time with children and housework hours. The solid line correspond to a local polynomial regression of degree 1 with Epanechnikov kernel.

Appendix 1 Model details

We obtain a solution for unobserved time-investments in terms of the observed ones by solving the following linear system

$$
\begin{aligned}
x^*_{n,t} &= \mu x_{n,t-1} + (1-\mu)x_{n,t-2} + \Delta e_{n,t} \\
x_{n,t-1} &= \mu x_{n,t-2} + (1-\mu)x_{n,t-3} + \Delta e_{n,t-1} \\
x_{n,t-2} &= \mu x_{n,t-3} + (1-\mu)x_{n,t-4} + \Delta e_{n,t-2} \\
x_{n,t-3} &= \mu x_{n,t-4} + (1-\mu)x^*_{n,t-5} + \Delta e_{n,t-3}
\end{aligned}
$$

The solution is the following

$$
\begin{aligned}
&\lambda_1 = \mu(\mu^2 - 2\mu + 2)/\tilde{\mu} \quad && \lambda_2 = (\mu^2 - \mu + 1)/\tilde{\mu} \\
&\lambda_3 = \mu/\tilde{\mu} && \lambda_4 = 1/\tilde{\mu}
\end{aligned}
$$

with $\tilde{\mu} \equiv \mu^4 - 3\mu^3 + 4\mu^2 - 2\mu + 1$

Appendix 2 Construction of childcare price

To construct childcare prices, we obtained data on expenditure in formal childcare of PSID households in the period 1990 - 2007. Since we do not have information of the number of children participating in those childcare arrangements, we construct a price measure by taking the CPI-deflated expenditure in households with only one child younger than six at a time. Another measure was calculated as the childcare expenditure per child under six years of age in households with at least one child in the mentioned group. However, the obtained results in each case were practically identical.

The main difficulty here is to estimate the price of households that do not report any childcare expenditures. Our approach relies on two-stage self-selection models (Heckman 1976). However

Table 1: Descriptive statistics for Children Outcomes and Maternal Time

Panel A: Summary Statistics by Child sex and age

		Outcomes				Parental Investment (Weekly hours)			
		aprob	dstot	pcom	word	Total	Total DP	Educ	Educ DP
male	mean	104.6	99.5	105.9	104.2	39.4	19.5	4.3	3.0
0-11 yr	sdev	18.8	13.0	17.5	17.2	17.1	10.8	4.1	3.5
	nobs	487	485	455	490	484	484	484	484
female	mean	105.6	102.3	109.6	108.8	37.1	19.5	4.3	2.7
0-11 yr	sdev	15.6	11.9	18.8	16.0	16.3	10.5	4.3	3.4
	nobs	433	426	412	433	423	423	423	423
male	mean	104.3	99.4	98.7	100.8	35.7	14.8	3.6	1.3
11-15 yr	sdev	16.5	15.5	15.8	17.9	18.3	11.8	5.0	3.0
	nobs	640	577	638	640	614	614	614	614
female	mean	103.8	100.3	102.2	104.4	37.4	17.2	4.3	1.4
11-15 yr	sdev	15.4	14.5	14.1	16.9	18.8	12.1	5.3	2.5
	nobs	665	614	664	666	650	650	650	650
male	mean	101.3	99.5	97.5	99.9	28.1	9.8	2.9	0.7
15+ yr	sdev	16.5	17.2	16.5	20.6	19.4	11.3	5.4	2.1
	nobs	549	497	546	549	527	527	527	527
female	mean	99.3	101.2	99.5	103.3	30.5	12.6	3.3	0.7
15+ yr	sdev	15.2	17.6	14.9	19.8	19.7	12.2	5.2	1.9
	nobs	578	527	580	581	557	557	557	557

Panel B: Summary Statistics by Mother Education and Age

		Outcomes				Parental Investment (Weekly hours)			
		aprob	dstot	pcom	word	Total	Total DP	Educ	Educ DP
mom low	mean	98.4	97.3	100.7	99.4	35.6	17.0	4.3	2.8
0-11 yr	sdev	15.0	12.9	20.2	16.8	17.3	10.8	4.1	3.6
	nobs	169	169	159	171	173	173	173	173
mom high	mean	106.5	101.6	109.2	108.0	39.1	20.1	4.3	2.9
0-11 yr	sdev	17.6	12.4	16.9	16.1	16.6	10.6	4.3	3.5
	nobs	716	707	676	717	699	699	699	699
mom low	mean	96.3	93.6	91.6	92.9	33.2	13.6	3.0	1.0
11-15 yr	sdev	13.7	12.5	13.3	14.9	18.5	12.1	4.1	1.9
	nobs	200	184	199	200	188	188	188	188
mom high	mean	105.5	101.1	102.3	104.6	37.1	16.5	4.1	1.4
11-15 yr	sdev	16.0	15.2	14.8	17.4	18.5	12.1	5.4	2.9
	nobs	1058	965	1057	1059	1033	1033	1033	1033
mom low	mean	93.3	93.5	90.3	92.9	30.2	11.5	2.2	0.7
15+ yr	sdev	13.1	15.0	12.9	16.2	19.3	12.0	3.8	2.4
	nobs	171	159	172	173	165	165	165	165
mom high	mean	101.9	101.8	100.3	103.5	29.2	11.3	3.3	0.7
15+ yr	sdev	16.1	17.6	15.8	20.5	19.7	11.9	5.5	2.0
	nobs	919	829	917	920	880	880	880	880

Panel C: Summary Statistics by Mother Working Status

		Outcomes				Parental Investment (Weekly hours)			
		aprob	dstot	pcom	word	Total	Total DP	Educ	Educ DP
no work	mean	102.8	98.5	100.3	102.4	39.0	17.0	4.1	1.6
	sdev	17.0	14.8	17.8	19.6	19.9	13.0	5.0	2.7
	nobs	478	438	475	478	465	465	465	465
Part-time	mean	104.5	100.7	103.9	104.7	36.8	16.5	4.3	1.9
(0-25 hours	sdev	17.2	15.5	16.4	18.4	18.2	11.7	5.6	3.5
per week)	nobs	933	884	905	938	923	923	923	923
Full-time	mean	102.4	100.6	101.1	102.9	32.6	14.5	3.4	1.4
(25+ hours	sdev	15.9	15.1	16.3	18.0	18.7	11.9	4.6	2.6
per week)	nobs	1941	1804	1915	1943	1875	1875	1875	1875
	mean	103.0	100.3	101.7	103.3	34.7	15.4	3.8	1.6
Total	sdev	16.4	15.2	16.6	18.4	18.9	12.1	5.0	2.9
	nobs	3352	3126	3295	3359	3263	3263	3263	3263

We restrict the sample to child whose Primary Care Giver (PCG) is his/her biological mother.

Table 2: Descriptive statistics for Other variables (1)

	Mother Education	Mother Age	Child White	Child Black	Female Head	Home Quality Index	Log PC Family Income	Books per child	Log Cost Childcare (2)	Number other adults	Childcare Expenditure Real (3)	Child Support (CPS) (4)	CPS Median log wage childcare (5)	Log Real Value House (6)
Statistics by Child Sex and Age														
male, 0-11 yr	12.98	35.45	0.52	0.34	0.26	16.74	9.12	4.72	3.14	0.10	17.79	175.06	5.69	5.36
female, 0-11 yr	13.00	34.57	0.52	0.33	0.28	16.67	9.06	4.79	3.13	0.12	25.21	176.37	5.68	5.52
male, 11-15 yr	12.97	39.54	0.47	0.40	0.35	16.34	9.10	4.44	2.88	0.20	7.95	164.94	5.67	5.80
female, 11-15 yr	13.00	39.07	0.51	0.38	0.33	16.28	9.11	4.61	2.88	0.17	7.95	166.01	5.70	6.01
male, 15+ yr	13.00	42.99	0.46	0.44	0.33	16.32	9.18	4.22	2.94	0.41	3.00	169.50	5.71	7.16
female, 15+ yr	12.88	43.00	0.48	0.39	0.32	16.27	9.18	4.47	2.97	0.42	2.77	168.28	5.70	6.86
Statistics by Mother Education and and Child Age														
mom low, 0-11 yr	9.42	32.27	0.27	0.45	0.39	14.86	8.32	4.39	2.68	0.15	7.93	170.57	5.64	1.61
mom high 0-11 yr	13.85	35.69	0.58	0.31	0.24	17.08	9.28	4.84	3.24	0.1	23.8	176.46	5.69	6.36
mom low, 11-15 yr	9.1	36.76	0.23	0.46	0.46	14.31	8.19	4.05	2.36	0.31	3.86	154.04	5.65	1.48
mom high, 11-15 yr	13.71	39.8	0.55	0.37	0.33	16.62	9.28	4.62	2.98	0.16	8.2	167.92	5.69	6.77
mom low, 15+ yr	8.63	40.74	0.16	0.48	0.43	15.1	8.32	4.09	2.45	0.54	3.26	155.63	5.67	3.16
mom high, 15+ yr	13.74	43.44	0.54	0.4	0.31	16.52	9.34	4.41	3.05	0.39	2.91	171.31	5.71	7.72
Statistics by Maternal Working Status														
No work	12.2	39.91	0.5	0.34	0.27	16.05	8.76	4.5	2.81	0.24	1.19	162.76	5.68	5.36
Part-time (7)	12.76	38.86	0.57	0.29	0.24	16.46	9.02	4.55	3.00	0.19	6.89	172.17	5.69	6.36
Full-time (8)	13.25	39.48	0.46	0.44	0.37	16.49	9.27	4.52	3.01	0.28	13.64	170.39	5.69	6.19
Total	12.97	39.37	0.5	0.38	0.32	16.39	9.13	4.53	2.98	0.24	9.65	169.43	5.69	6.15

NOTES: (1) We restrict the sample to child whose Primary Care Giver (PCG) is his/her biological mother
(2) Variable is predicted log cost of formal childcare faced by households (see in (Appendix 2))
(3) Total actual real expenditure in childcare in US dollars of 2000 (PSID Family records)
(4) Average child support in 2000 dollars by state and year (March CPS)
(5) Median of log real wage of childcare workers by state and year in 2000 dollars (March CPS)
(6) Log(value of house in 2000 dollars + 0.01) including zeroes if the household does not have a house (PSID Family records)
(7) Part-time means 0-25 hours worked per week
(8) Full-time means more than 25 hours worked per week.

Table 3: Pairwise correlations between maternal time and other time uses

		Total time	Total DP time	Educ time	Educ DP time
All	work	-0.1484***	-0.098***	-0.0859***	-0.0611***
	housework	0.1178***	0.0787***	0.0534***	0.0011
		By child sex and age			
male, 0-11 yr	work	-0.2223***	-0.1243***	-0.0298	-0.0343
	housework	0.2393***	0.1288***	0.0489	0.0054
female, 0-11 yr	work	-0.1726***	-0.1475***	-0.1506***	-0.065*
	housework	0.1675***	0.1039***	0.0497	0.0043
male, 11-15 yr	work	-0.1408***	-0.0886***	-0.1154***	-0.0601*
	housework	0.1033***	0.0362	0.0009	-0.0383
female, 11-15 yr	work	-0.0342	-0.0174	-0.0503	-0.0295
	housework	0.114***	0.0857***	0.105***	0.0473
male, 15+ yr	work	-0.1582***	-0.1034***	-0.1147***	-0.0655*
	housework	0.0582*	0.0978***	0.0738**	-0.0381
female, 15+ yr	work	-0.1272***	-0.0353	-0.0251	0.0259
	housework	0.0754**	0.0341	0.0466	-0.0357
		By mother education and child age			
Mom low, 0-11	work	-0.3086***	-0.294***	-0.1623***	-0.134**
	housework	0.3426***	0.2637***	0.1685***	0.1088*
Mom high, 0-5	work	-0.1994***	-0.14***	-0.0802***	-0.0439
	housework	0.1619***	0.0785***	0.0164	-0.029
Mom low 11-15	work	-0.1338**	-0.146***	-0.0337	-0.0696
	housework	0.1667***	0.1162*	-0.0191	0.0097
mom high, 11-15	work	-0.0888***	-0.0464*	-0.1075***	-0.0559**
	housework	0.0976***	0.0504*	0.0789***	0.0064
mom low, 15+	work	0.0354	-0.038	-0.1454**	-0.1832***
	housework	-0.0585	-0.0895	0.21***	0.0099
mom high, 15+	work	-0.1664***	-0.0627**	-0.0777***	0.0168
	housework	0.0875***	0.0973***	0.0503*	-0.054*

All statistics are pairwise correlations in different subsamples.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 4: Effects of Log total maternal time

	Panel A: WJ Word-Letter Identification Test								Panel B: WJ Passage Comprehension Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.962***	0.21	-0.217***		22.159***	-9.317***	0.561***	7.404	0.381	-2.914***	0.062		3.508	-4.339**	0.179	7.586
	[2.71]	[0.28]	[3.73]	1751	[3.10]	[2.68]	[2.01]	1731	[0.84]	[2.90]	[0.73]	1446	[0.74]	[1.80]	[0.96]	1428
Mother	1.261***	-0.295	-0.174***		18.770***	-8.309**	0.443	4.539	0.317	-1.161	-0.066		-4.608	1.359	-0.23	4.213
educ $\leq$ 12	[3.06]	[0.31]	[2.33]	802	[2.02]	[1.78]	[1.24]	789	[0.50]	[0.73]	[0.49]	661	[0.81]	[0.42]	[0.97]	648
Mother	0.547	0.706	-0.262***		23.437***	-9.426***	0.592*	4.446	0.422	-4.382***	0.164*		10.166**	-8.763***	0.518***	5.594
educ $>$ 12	[0.92]	[0.63]	[2.99]	949	[2.49]	[2.08]	[1.60]	942	[0.65]	[3.40]	[1.51]	785	[1.78]	[2.99]	[2.18]	780
Male	1.126***	1.472*	-0.322***		26.599**	-11.902*	0.718	2.237	0.501	-4.205***	0.162*		14.629	-12.285*	0.771	2.547
Child	[2.34]	[1.39]	[3.95]	875	[1.93]	[1.57]	[1.22]	869	[0.87]	[3.12]	[1.43]	703	[1.06]	[1.54]	[1.28]	697
Female	0.780*	-1.102	-0.107		18.921***	-8.096***	0.501**	5.935	0.266	-1.769	-0.026		0.395	-1.682	-0.02	5.148
Child	[1.49]	[1.04]	[1.28]	876	[2.43]	[2.36]	[1.77]	862	[0.38]	[1.19]	[0.21]	743	[0.07]	[0.65]	[0.10]	731
White	0.17	2.278***	-0.365***		19.012***	-5.637**	0.301	7.031	0.436	-1.498	-0.042		4.948	-3.591	0.133	5.722
Child	[0.27]	[2.16]	[4.49]	968	[2.73]	[1.71]	[1.12]	962	[0.57]	[1.09]	[0.37]	780	[0.91]	[1.28]	[0.60]	776
Black	0.876***	-1.738*	-0.058		15.752**	-8.102**	0.405*	1.995	-0.072	-6.26***	0.322***		11.919	-11.085*	0.64	2.829
Child	[2.00]	[1.58]	[0.66]	635	[1.72]	[1.89]	[1.31]	625	[0.12]	[3.99]	[2.40]	538	[0.67]	[1.50]	[1.28]	528
Male	0.458	0.91	-0.288***		30.584***	-13.183**	0.808*	3.028	0.584	-2.72***	0.028		2.094	-3.454	0.092	5.069
Head	[0.85]	[0.97]	[3.92]	1206	[1.99]	[1.77]	[1.41]	1192	[0.84]	[2.21]	[0.27]	996	[0.37]	[1.12]	[0.39]	984
Female	1.034***	-0.523	-0.068		8.594***	-3.825**	0.206	9.022	-0.838*	-2.604*	0.138		2.757	-3.949**	0.241*	6.998
Head	[2.16]	[0.43]	[0.73]	545	[2.60]	[1.87]	[1.26]	539	[1.38]	[1.49]	[0.97]	450	[0.72]	[1.70]	[1.33]	444

	Panel C: WJ Applied Problems Test								Panel D: WISC Digit Span Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.856***	7.749***	-0.71***		26.533***	-3.939	0.226	7.565	-0.086	-1.934***	-0.13**		3.907	-3.72	0.011	8.075
	[2.31]	[9.93]	[11.68]	1743	[3.27]	[0.98]	[0.70]	1723	[0.21]	[2.16]	[1.86]	1638	[0.44]	[0.93]	[0.03]	1618
Mother	0.932***	6.839***	-0.616***		17.229***	-0.943	-0.024	4.937	0.026	-3.327***	-0.083		0.71	-3.787	-0.057	4.301
educ $\leq$ 12	[1.97]	[6.19]	[7.17]	797	[2.55]	[0.26]	[0.08]	784	[0.05]	[2.72]	[0.87]	770	[0.11]	[1.20]	[0.24]	757
Mother	0.734	8.621***	-0.798***		36.123***	-6.914	0.483	4.315	-0.182	-0.683	-0.178**		47.695	-20.751	1.528	4.336
educ $>$ 12	[1.25]	[7.81]	[9.25]	946	[2.06]	[0.85]	[0.73]	939	[0.27]	[0.52]	[1.74]	868	[0.64]	[0.66]	[0.58]	861
Male	0.989**	8.772***	-0.769***		36.094**	-9.653	0.658	2.15	-0.055	-0.889	-0.163**		36.941	-19.631	1.346	2.203
Child	[1.91]	[7.75]	[8.80]	874	[1.81]	[0.89]	[0.78]	868	[0.10]	[0.70]	[1.66]	808	[0.75]	[0.78]	[0.66]	802
Female	0.687*	6.837***	-0.658***		20.574***	-1.028	-0.005	6.3	-0.13	-2.763***	-0.109		-1.51	-2.356	-0.145	6.816
Child	[1.29]	[6.32]	[7.75]	869	[2.80]	[0.30]	[0.02]	855	[0.21]	[2.19]	[1.10]	830	[0.27]	[0.96]	[0.75]	816
White	0.576	9.863***	-0.855***		26.383***	-1.005	0.049	7.074	-0.188	-2.426**	-0.06		-1.045	-2.037	-0.094	6.983
Child	[0.92]	[9.29]	[10.42]	964	[3.20]	[0.25]	[0.15]	958	[0.27]	[1.95]	[0.62]	878	[0.18]	[0.73]	[0.42]	872
Black	0.61	5.090***	-0.487***		34.336*	-9.457	0.526	2.084	-0.468	-1.354	-0.261***		-5.124	0.339	-0.384	2.488
Child	[1.21]	[4.00]	[4.84]	630	[1.30]	[0.79]	[0.62]	620	[0.78]	[0.91]	[2.24]	578	[0.42]	[0.07]	[1.09]	568
Male	0.6	8.755***	-0.751***		38.508***	-9.175	0.619	3.096	0.559	-2.158***	-0.092		11.004	-6.903*	0.274	2.724
Head	[1.12]	[9.26]	[10.19]	1201	[2.27]	[1.10]	[0.97]	1187	[0.95]	[2.02]	[1.09]	1145	[0.99]	[1.33]	[0.69]	1131
Female	0.808*	5.421***	-0.632***		8.191***	2.072	-0.362***	9.169	-1.483***	-0.917	-0.202*		-7.141***	1.341	-0.392***	11.157
Head	[1.46]	[3.85]	[5.85]	542	[2.50]	[0.96]	[2.10]	536	[2.27]	[0.55]	[1.60]	493	[2.12]	[0.59]	[2.24]	487

Notes: (1) LIML IV is estimated childcare price and the same variable interacted with child age;
Test-t are in brackets below estimated coefficients.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 5: Effects of Log total active maternal time

	Panel A: WJ Word-Letter Identification Test								Panel B: WJ Passage Comprehension Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.650***	0.168	-0.21***		12.472***	-9.071***	0.796***	7.544	0.464*	-3.084***	0.085		5.115**	-6.624***	0.458**	6.134
	[2.62]	[0.22]	[3.55]	1751	[3.37]	[2.87]	[2.44]	1731	[1.47]	[3.05]	[0.99]	1446	[1.70]	[2.59]	[1.80]	1428
Mother	0.693***	-0.258	-0.161***		8.879***	-6.925***	0.567**	4.935	0.551	-1.529	-0.029		1.835	-2.43	0.08	4.088
educ <= 12	[2.38]	[0.27]	[2.12]	802	[2.70]	[2.23]	[1.80]	789	[1.23]	[0.96]	[0.22]	661	[0.54]	[0.77]	[0.26]	648
Mother	0.546*	0.566	-0.257***		14.949***	-10.188***	0.914**	3.901	0.33	-4.379***	0.176*		8.174*	-10.144***	0.776**	2.875
educ > 12	[1.32]	[0.50]	[2.88]	949	[2.38]	[2.02]	[1.76]	942	[0.73]	[3.37]	[1.60]	785	[1.63]	[2.53]	[1.93]	780
Male	0.692***	1.461*	-0.311***		13.931***	-11.905**	1.068*	2.875	0.507	-4.408***	0.185*		9.164*	-13.447**	1.076*	2.04
Child	[2.03]	[1.37]	[3.72]	875	[2.17]	[1.76]	[1.56]	869	[1.26]	[3.25]	[1.62]	703	[1.38]	[1.90]	[1.56]	697
Female	0.586*	-1.19	-0.102		11.492***	-7.29***	0.621***	4.983	0.445	-1.876	-0.005		2.866	-3.065	0.143	4.498
Child	[1.61]	[1.12]	[1.21]	876	[2.64]	[2.45]	[2.02]	862	[0.91]	[1.26]	[0.04]	743	[0.82]	[1.25]	[0.58]	731
White	0.253	2.197***	-0.36***		11.711***	-5.954**	0.489*	6.764	0.211	-1.461	-0.035		2.642	-3.286	0.155	6.02
Child	[0.57]	[2.08]	[4.36]	968	[2.69]	[1.73]	[1.44]	962	[0.38]	[1.06]	[0.31]	780	[0.83]	[1.23]	[0.61]	776
Black	0.209	-1.595*	-0.074		6.413**	-6.807***	0.495*	4.524	0.063	-6.372***	0.330***		6.262**	-11.083***	0.814***	3.627
Child	[0.67]	[1.42]	[0.83]	635	[1.76]	[2.03]	[1.46]	625	[0.16]	[4.00]	[2.43]	538	[1.79]	[3.28]	[2.51]	528
Male	0.653**	0.679	-0.275***		19.181***	-13.169**	1.200*	2.589	0.842**	-3.061***	0.071		1.612	-3.611	0.137	3.328
Head	[1.68]	[0.72]	[3.66]	1206	[2.03]	[1.80]	[1.59]	1192	[1.71]	[2.49]	[0.67]	996	[0.40]	[1.11]	[0.42]	984
Female	0.335	-0.392	-0.068		6.653***	-5.984***	0.514**	5.705	-0.726**	-2.455*	0.112		6.103*	-8.052**	0.664**	2.579
Head	[1.00]	[0.32]	[0.72]	545	[2.53]	[2.09]	[1.89]	539	[1.70]	[1.39]	[0.78]	450	[1.40]	[1.85]	[1.65]	444

	Panel C: WJ Applied Problems Test								Panel D: WISC Digit Span Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.687***	7.683***	-0.703***		22.352***	-9.488	1.131*	8.053	-0.017	-2.017***	-0.129**		7.722**	-8.165***	0.514*	7.975
	[2.65]	[9.78]	[11.37]	1743	[2.18]	[1.13]	[1.28]	1723	[0.06]	[2.23]	[1.82]	1638	[1.72]	[2.19]	[1.34]	1618
Mother	0.620**	6.856***	-0.611***		13.503*	-4.098	0.571	5.866	0.395	-3.679***	-0.052		2.89	-5.926***	0.165	6.378
educ <= 12	[1.86]	[6.17]	[6.99]	797	[1.56]	[0.54]	[0.70]	784	[1.07]	[2.99]	[0.53]	770	[1.04]	[2.23]	[0.64]	757
Mother	0.739**	8.450***	-0.785***		25.813**	-10.13	1.191	3.926	-0.548	-0.433	-0.218***		20.048	-15.342	1.416	3.227
educ > 12	[1.81]	[7.60]	[8.95]	946	[1.73]	[0.88]	[0.99]	939	[1.16]	[0.33]	[2.08]	868	[1.24]	[1.28]	[1.09]	861
Male	0.995***	8.562***	-0.745***		22.591**	-13.231	1.493	3.03	0.165	-1.057	-0.158*		11.518*	-12.576*	1.021	3.087
Child	[2.73]	[7.50]	[8.31]	874	[1.69]	[0.96]	[1.06]	868	[0.41]	[0.82]	[1.56]	808	[1.42]	[1.48]	[1.19]	802
Female	0.343	6.884***	-0.665***		20.979*	-5.056	0.688	5.291	-0.186	-2.745***	-0.114		3.571	-4.978**	0.123	5.263
Child	[0.93]	[6.34]	[7.76]	869	[1.51]	[0.60]	[0.74]	855	[0.43]	[2.16]	[1.13]	830	[0.81]	[1.76]	[0.42]	816
White	0.367	9.895***	-0.861***		16.042***	-1.303	0.284	6.915	-0.142	-2.426**	-0.063		-0.954	-1.824	-0.126	8.31
Child	[0.82]	[9.27]	[10.32]	964	[3.17]	[0.32]	[0.72]	958	[0.28]	[1.94]	[0.64]	878	[0.29]	[0.70]	[0.50]	872
Black	0.341	5.123***	-0.495***		-12.647*	16.119***	-1.671***	4.683	-0.362	-1.457	-0.277***		7.800*	-8.393*	0.446	2.324
Child	[0.96]	[3.98]	[4.85]	630	[1.53]	[2.15]	[2.16]	620	[0.87]	[0.96]	[2.32]	578	[1.34]	[1.59]	[0.83]	568
Male	0.710**	8.544***	-0.736***		27.360***	-11.6	1.363	2.711	0.373	-2.153***	-0.096		7.412*	-7.441**	0.45	3.263
Head	[1.82]	[8.98]	[9.79]	1201	[1.97]	[1.07]	[1.23]	1187	[0.87]	[2.00]	[1.12]	1145	[1.34]	[1.72]	[1.03]	1131
Female	0.547*	5.631***	-0.627***		6.061**	0.583	-0.108	6.348	-0.763**	-1.303	-0.199*		-5.978*	3.223	-0.683**	6.373
Head	[1.41]	[3.95]	[5.71]	542	[1.92]	[0.18]	[0.33]	536	[1.65]	[0.77]	[1.55]	493	[1.49]	[0.79]	[1.73]	487

Notes: (1) LIML IV is estimated childcare price and the same variable interacted with child age;
Test-t are in brackets below estimated coefficients.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 6: Effects of Log educational maternal time

	Panel A: WJ Word-Letter Identification Test								Panel B: WJ Passage Comprehension Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.344**	0.346	-0.219***		11.991***	-10.2***	0.879**	3.757	0.511***	-3.237***	0.087		6.811	-9.013**	0.657*	2.723
	[1.74]	[0.46]	[3.76]	1751	[2.56]	[2.23]	[1.93]	1731	[2.03]	[3.20]	[1.02]	1446	[1.24]	[1.72]	[1.30]	1428
Mother	0.548***	-0.284	-0.155***		8.249***	-8.997***	0.807**	3.179	0.494	-1.532	-0.014		-0.781	-0.202	-0.144	3.581
educ <= 12	[2.15]	[0.29]	[2.03]	802	[2.29]	[2.01]	[1.72]	789	[1.27]	[0.97]	[0.11]	661	[0.27]	[0.06]	[0.43]	648
Mother	0.153	0.817	-0.262***		13.241**	-8.824*	0.693	1.975	0.598**	-4.85***	0.194**		9.256*	-12.849***	0.893*	1.239
educ > 12	[0.51]	[0.72]	[3.02]	949	[1.82]	[1.49]	[1.25]	942	[1.80]	[3.71]	[1.79]	785	[1.38]	[1.98]	[1.59]	780
Male	0.660***	1.437*	-0.304***		7.000***	-4.135*	0.293	5.518	0.869***	-4.805***	0.189**		8.179*	-10.365***	0.671**	1.784
Child	[2.42]	[1.36]	[3.77]	875	[2.73]	[1.50]	[1.09]	869	[2.71]	[3.57]	[1.69]	703	[1.53]	[2.28]	[1.72]	697
Female	0.012	-0.727	-0.13*		53.6	-50.962	4.871	0.132	0.128	-1.789	-0.012		-0.323	-1.173	-0.057	1.437
Child	[0.04]	[0.68]	[1.55]	876	[0.45]	[0.46]	[0.44]	862	[0.33]	[1.19]	[0.09]	743	[0.06]	[0.20]	[0.09]	731
White	-0.296	2.573***	-0.388***		12.641**	-7.157	0.65	2.542	0.081	-1.416	-0.066		3.054	-4.13	0.209	1.82
Child	[1.04]	[2.47]	[4.83]	968	[1.65]	[1.14]	[1.02]	962	[0.23]	[1.04]	[0.58]	780	[0.68]	[0.97]	[0.51]	776
Black	0.759***	-2.131**	-0.027		6.713**	-7.528***	0.576*	2.42	0.810***	-6.836***	0.381***		16.114	-16.609	1.47	1.44
Child	[2.66]	[1.90]	[0.31]	635	[1.95]	[2.15]	[1.60]	625	[2.19]	[4.32]	[2.86]	538	[0.60]	[0.93]	[0.75]	528
Male	-0.056	1.168	-0.309***		23.556	-20.199	1.872	0.834	0.048	-2.46***	0.011		1.912	-4.279	0.198	0.756
Head	[0.22]	[1.24]	[4.22]	1206	[1.03]	[0.96]	[0.88]	1192	[0.15]	[2.00]	[0.11]	996	[0.35]	[0.77]	[0.37]	984
Female	0.894***	-0.94	-0.025		5.847***	-5.642***	0.425**	5.517	1.058***	-4.501***	0.228*		2.405	-5.61*	0.335	4.751
Head	[2.72]	[0.77]	[0.27]	545	[2.64]	[2.15]	[1.83]	539	[2.47]	[2.56]	[1.60]	450	[0.54]	[1.39]	[0.93]	444

	Panel C: WJ Applied Problems Test								Panel D: WISC Digit Span Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.324*	7.878***	-0.703***		21.750**	-11.445	1.285	4.229	0.206	-2.178***	-0.122**		11.430*	-11.393**	0.933	4.203
	[1.56]	[10.02]	[11.53]	1743	[1.76]	[0.99]	[1.10]	1723	[0.88]	[2.43]	[1.74]	1638	[1.44]	[1.70]	[1.23]	1618
Mother	0.341	6.996***	-0.605***		13.676*	-8.19	1.067	4.09	0.363	-3.697***	-0.041		3.287	-6.799***	0.336	4.495
educ <= 12	[1.16]	[6.27]	[6.88]	797	[1.48]	[0.76]	[0.91]	784	[1.13]	[3.02]	[0.42]	770	[1.20]	[2.21]	[0.90]	757
Mother	0.269	8.702***	-0.784***		25.598	-9.601	0.992	2.014	0.084	-0.885	-0.195**		27.585	-19.558	1.741	1.473
educ > 12	[0.92]	[7.82]	[9.17]	946	[1.19]	[0.59]	[0.64]	939	[0.25]	[0.67]	[1.91]	868	[0.72]	[0.74]	[0.64]	861
Male	0.355	8.815***	-0.743***		12.096***	-1.644	0.363	5.937	0.083	-0.937	-0.153*		4.932*	-4.663*	0.327	4.827
Child	[1.21]	[7.74]	[8.52]	874	[2.02]	[0.28]	[0.61]	868	[0.26]	[0.74]	[1.56]	808	[1.62]	[1.63]	[1.01]	802
Female	0.292	6.961***	-0.663***		64.805	-52.098	5.264	0.182	0.344	-3.321***	-0.093		715.538	-615.281	63.719	0.474
Child	[1.00]	[6.40]	[7.76]	869	[0.44]	[0.39]	[0.39]	855	[1.01]	[2.62]	[0.93]	830	[0.02]	[0.02]	[0.02]	816
White	-0.235	10.281***	-0.875***		15.873***	-2.014	0.415	2.485	0.483*	-2.812***	-0.051		-6.877	2.388	-0.642*	2.892
Child	[0.82]	[9.77]	[10.77]	964	[2.02]	[0.30]	[0.62]	958	[1.45]	[2.29]	[0.53]	878	[1.19]	[0.54]	[1.33]	872
Black	0.676***	4.789***	-0.443***		-196.108	171.101	-19.242	3.029	-0.56*	-1.087	-0.279***		6.632	-7.251	0.426	2.067
Child	[2.04]	[3.69]	[4.39]	630	[0.10]	[0.10]	[0.10]	620	[1.45]	[0.71]	[2.36]	578	[0.81]	[1.00]	[0.52]	568
Male	0.065	8.974***	-0.775***		26.575	-15.287	1.66	0.836	0.484**	-2.309***	-0.105		12.931	-12.217	0.996	1.184
Head	[0.26]	[9.51]	[10.55]	1201	[1.25]	[0.77]	[0.84]	1187	[1.74]	[2.17]	[1.26]	1145	[0.83]	[0.97]	[0.72]	1131
Female	0.740**	5.593***	-0.551***		8.298***	-1.371	0.123	6.671	-0.878**	-1.288	-0.177*		-7.626**	4.704	-0.841***	5.269
Head	[1.89]	[3.88]	[5.03]	542	[2.18]	[0.34]	[0.33]	536	[1.89]	[0.76]	[1.38]	493	[1.94]	[1.11]	[2.01]	487

Notes: (1) LIML IV is estimated childcare price and the same variable interacted with child age;
Test-t are in brackets below estimated coefficients.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 7: Effects of Log educational active maternal time

	Panel A: WJ Word-Letter Identification Test								Panel B: WJ Passage Comprehension Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.302*	0.448	-0.208***		6.702***	-5.379***	0.431***	17.529	0.462*	-3.102***	0.085		3.377	-5.472**	0.316	5.293
	[1.31]	[0.57]	[3.49]	1751	[4.19]	[3.01]	[2.49]	1731	[1.54]	[2.92]	[0.98]	1446	[0.99]	[1.83]	[1.15]	1428
Mother	0.674***	-0.225	-0.143**		6.152***	-4.877***	0.407**	8.596	0.569	-1.174	-0.047		-1.029	-0.191	-0.145	3.864
educ <= 12	[2.28]	[0.22]	[1.87]	802	[3.14]	[2.27]	[1.86]	789	[1.24]	[0.71]	[0.34]	661	[0.29]	[0.08]	[0.56]	648
Mother	-0.007	1.073	-0.265***		6.924***	-5.709***	0.436**	9.835	0.46	-4.734***	0.201**		9.167*	-13.864***	0.971**	1.908
educ > 12	[0.02]	[0.90]	[2.94]	949	[2.97]	[2.09]	[1.72]	942	[1.16]	[3.43]	[1.79]	785	[1.47]	[2.06]	[1.72]	780
Male	0.567**	1.497*	-0.295***		4.996***	-2.678*	0.153	18.718	0.782***	-4.689***	0.201**		4.444**	-7.839***	0.465***	6.753
Child	[1.74]	[1.37]	[3.55]	875	[3.59]	[1.49]	[0.92]	869	[1.96]	[3.34]	[1.75]	703	[1.67]	[2.95]	[2.11]	697
Female	0.066	-0.631	-0.115*		12.409**	-11.179**	1.056**	2.726	0.165	-1.643	-0.023		-3.278	1.214	-0.308	1.276
Child	[0.20]	[0.56]	[1.35]	876	[1.86]	[1.81]	[1.65]	862	[0.37]	[1.04]	[0.18]	743	[0.48]	[0.22]	[0.52]	731
White	-0.121	2.476***	-0.379***		6.757***	-3.382*	0.315	9.67	-0.254	-1.013	-0.079		2.148	-3.099	0.144	3.735
Child	[0.37]	[2.28]	[4.56]	968	[2.84]	[1.36]	[1.21]	962	[0.61]	[0.71]	[0.68]	780	[0.64]	[0.99]	[0.46]	776
Black	0.496*	-1.708*	-0.035		3.602***	-4.912***	0.289**	10.103	1.051***	-7.188***	0.378***		11.955	-14.538*	0.962*	2.19
Child	[1.45]	[1.44]	[0.39]	635	[2.38]	[2.51]	[1.71]	625	[2.34]	[4.24]	[2.75]	538	[0.95]	[1.61]	[1.35]	528
Male	0.206	0.903	-0.283***		7.689***	-6.008***	0.503**	8.606	0.321	-2.672***	0.03		1.189	-3.408	0.112	2.807
Head	[0.71]	[0.91]	[3.73]	1206	[2.94]	[2.15]	[1.75]	1192	[0.85]	[2.06]	[0.28]	996	[0.33]	[1.02]	[0.34]	984
Female	0.228	-0.072	-0.05		3.695***	-3.279**	0.256*	12.713	0.547	-3.754***	0.186		5.933*	-7.49***	0.490**	4.023
Head	[0.62]	[0.06]	[0.54]	545	[2.52]	[1.72]	[1.59]	539	[1.13]	[2.07]	[1.28]	450	[1.56]	[2.17]	[1.78]	444

	Panel C: WJ Applied Problems Test								Panel D: WISC Digit Span Test							
	OLS				LIML Childcare Price (1)				OLS				LIML Childcare Price (1)			
	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N	γ	δ_0	δ_a	CD/N
All	0.19	7.916***	-0.702***		9.335***	-0.475	0.193	17.824	0.035	-1.958***	-0.135**		1.362	-3.204**	-0.001	17.976
	[0.79]	[9.64]	[11.22]	1743	[4.01]	[0.19]	[0.78]	1723	[0.13]	[2.09]	[1.88]	1638	[0.82]	[1.82]	[0.00]	1618
Mother	0.244	7.119***	-0.604***		7.621***	0.72	0.14	10.01	0.134	-3.271***	-0.054		1.194	-4.266***	0.058	10.775
educ <= 12	[0.72]	[6.19]	[6.85]	797	[2.19]	[0.21]	[0.38]	784	[0.36]	[2.59]	[0.55]	770	[0.70]	[2.35]	[0.29]	757
Mother	0.137	8.697***	-0.786***		9.864***	-0.785	0.16	9.263	-0.055	-0.776	-0.208***		2.414	-3.238	0.038	8.452
educ > 12	[0.40]	[7.42]	[8.83]	946	[3.14]	[0.22]	[0.48]	939	[0.14]	[0.56]	[1.96]	868	[0.62]	[0.78]	[0.10]	861
Male	0.271	8.829***	-0.737***		6.353***	3.121*	-0.122	19.167	0.247	-1.068	-0.141*		1.739	-2.449	0.011	15.977
Child	[0.77]	[7.48]	[8.22]	874	[3.39]	[1.36]	[0.56]	868	[0.63]	[0.81]	[1.41]	808	[1.05]	[1.21]	[0.06]	802
Female	0.135	6.964***	-0.662***		15.504**	-6.315	0.766	2.717	-0.135	-2.792***	-0.128		-0.19	-2.88	-0.13	4.447
Child	[0.41]	[6.08]	[7.57]	869	[1.96]	[0.86]	[1.00]	855	[0.35]	[2.08]	[1.24]	830	[0.04]	[0.74]	[0.30]	816
White	-0.127	10.274***	-0.875***		9.649***	1.976	0.099	9.507	0.355	-2.803***	-0.033		-1.333	-1.334	-0.206	10.6
Child	[0.39]	[9.37]	[10.43]	964	[3.42]	[0.66]	[0.32]	958	[0.92]	[2.19]	[0.33]	878	[0.65]	[0.62]	[0.91]	872
Black	0.337	4.932***	-0.456***		6.341	-1.129	0.107	10.77	-0.641*	-0.806	-0.331***		1.194	-2.825	-0.145	10.576
Child	[0.85]	[3.59]	[4.41]	630	[1.26]	[0.21]	[0.22]	620	[1.37]	[0.50]	[2.74]	578	[0.61]	[1.12]	[0.65]	568
Male	0.173	8.740***	-0.762***		10.686***	-1.096	0.317	8.349	0.351	-2.339***	-0.089		2.19	-3.934***	0.098	9.982
Head	[0.59]	[8.80]	[10.01]	1201	[3.33]	[0.32]	[0.90]	1187	[1.08]	[2.09]	[1.04]	1145	[1.14]	[1.96]	[0.47]	1131
Female	0.085	6.266***	-0.57***		4.213*	2.452	-0.21	14.23	-0.883**	-1.14	-0.226**		-3.398*	1.206	-0.477**	11.004
Head	[0.20]	[4.25]	[5.16]	542	[1.62]	[0.87]	[0.83]	536	[1.69]	[0.66]	[1.75]	493	[1.31]	[0.39]	[1.68]	487

Notes: (1) LIML IV is estimated childcare price and the same variable interacted with child age;
Test-t are in brackets below estimated coefficients.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 8: First-Stage Estimates

	First Stage Log Total Maternal Time											
	Total time						Directly participating time					
	IV A	IV B	x^*_{t-5}	k_{t-5}	$k_{t-5}a_{t-5}$	R^2 / N	IV A	IV B	x^*_{t-5}	k_{t-5}	$k_{t-5}a_{t-5}$	R^2 / N
All	0.380***	-0.03***	0.023***	0.026*	-0.001	0.069	0.873***	-0.045***	0.090***	0.066***	-0.006***	0.116
	[2.59]	[3.75]	[1.99]	[1.34]	[0.48]	1731	[3.80]	[3.59]	[4.83]	[2.18]	[2.05]	1731
Mother	0.391*	-0.038***	0.023	0.013	0	0.067	1.294***	-0.071***	0.092***	0.033	-0.003	0.102
educ ≤ 12	[1.47]	[2.56]	[1.27]	[0.40]	[0.09]	789	[3.08]	[3.00]	[3.15]	[0.65]	[0.57]	789
Mother	0.466***	-0.026***	0.024*	0.036*	-0.001	0.067	0.714***	-0.036***	0.096***	0.069**	-0.006**	0.12
educ > 12	[2.70]	[2.89]	[1.56]	[1.50]	[0.55]	942	[2.67]	[2.58]	[3.96]	[1.87]	[1.80]	942
Male	0.311*	-0.024***	0.037***	0.052**	-0.003	0.076	0.722***	-0.043***	0.099***	0.104***	-0.01***	0.138
Child	[1.47]	[2.08]	[2.19]	[1.90]	[1.08]	869	[2.19]	[2.35]	[3.70]	[2.43]	[2.36]	869
Female	0.455***	-0.037***	0.01	-0.002	0.001	0.064	1.005***	-0.048***	0.087***	0.024	-0.002	0.086
Child	[2.23]	[3.32]	[0.63]	[0.06]	[0.48]	862	[3.14]	[2.78]	[3.30]	[0.58]	[0.45]	862
White	0.276**	-0.028***	0.034**	0.014	-0.001	0.078	0.407*	-0.045***	0.045*	0.028	-0.004*	0.111
Child	[1.69]	[3.43]	[1.93]	[0.68]	[0.32]	962	[1.52]	[3.30]	[1.57]	[0.81]	[1.31]	962
Black	0.478*	-0.035***	0	0.012	0.001	0.042	1.342***	-0.045*	0.097***	0.090*	-0.007	0.093
Child	[1.47]	[1.96]	[0.02]	[0.28]	[0.32]	625	[2.70]	[1.62]	[3.01]	[1.40]	[1.10]	625
Male	0.186	-0.018***	0.037***	0.048***	-0.003*	0.085	0.389*	-0.028***	0.079***	0.078***	-0.008***	0.121
Head	[1.18]	[2.27]	[1.99]	[2.32]	[1.58]	1192	[1.59]	[2.26]	[2.90]	[2.44]	[2.81]	1192
Female	0.656**	-0.075***	-0.039**	-0.056	0.007*	0.064	1.817***	-0.11***	0.052*	-0.027	0.004	0.094
Head	[1.76]	[3.59]	[1.66]	[1.28]	[1.64]	539	[3.09]	[3.34]	[1.36]	[0.39]	[0.58]	539

	First Stage Log Educational Maternal Time											
	Total time						Directly participating time					
	IV A	IV B	x^*_{t-5}	k_{t-5}	$k_{t-5}a_{t-5}$	R^2 / N	IV A	IV B	x^*_{t-5}	k_{t-5}	$k_{t-5}a_{t-5}$	R^2 / N
All	0.871***	-0.048***	0.104***	0.076**	-0.007*	0.078	1.470***	-0.093***	0.034*	-0.001	0	0.098
	[2.58]	[2.65]	[4.05]	[1.74]	[1.61]	1731	[5.02]	[5.91]	[1.37]	[0.02]	[0.06]	1731
Mother	1.260***	-0.075***	0.144***	0.066	-0.007	0.1	1.774***	-0.105***	0.090***	-0.023	0.001	0.109
educ ≤ 2	[2.35]	[2.50]	[3.79]	[1.02]	[1.17]	789	[3.87]	[4.11]	[2.51]	[0.42]	[0.25]	789
Mother	0.861**	-0.043**	0.069***	0.058	-0.004	0.04	1.381***	-0.091***	-0.008	0.004	0.001	0.09
educ > 12	[1.90]	[1.84]	[1.97]	[0.94]	[0.63]	942	[3.46]	[4.43]	[0.24]	[0.07]	[0.11]	942
Male	1.512***	-0.081***	0.130***	0.013	0.001	0.088	2.199***	-0.133***	0.003	-0.055	0.007*	0.129
Child	[3.19]	[3.14]	[3.62]	[0.21]	[0.09]	869	[5.43]	[6.06]	[0.08]	[1.06]	[1.43]	869
Female	0.188	-0.013	0.073***	0.147***	-0.014***	0.068	0.697*	-0.052***	0.067**	0.053	-0.007	0.076
Child	[0.39]	[0.51]	[2.01]	[2.32]	[2.43]	862	[1.64]	[2.29]	[1.85]	[0.93]	[1.26]	862
White	0.09	-0.036*	0.060**	0.039	-0.007	0.064	0.604*	-0.076***	0.001	-0.015	-0.004	0.104
Child	[0.20]	[1.59]	[1.72]	[0.67]	[1.28]	962	[1.51]	[3.80]	[0.03]	[0.29]	[0.75]	962
Black	1.375***	-0.07***	0.130***	0.031	-0.003	0.078	2.359***	-0.128***	0.049	-0.044	0.008	0.104
Child	[2.19]	[2.00]	[2.92]	[0.38]	[0.38]	625	[4.39]	[4.30]	[1.13]	[0.63]	[1.16]	625
Male	0.191	-0.023	0.114***	0.105***	-0.011***	0.074	0.817***	-0.071***	0.029	0.024	-0.005	0.1
Head	[0.47]	[1.12]	[3.69]	[2.01]	[2.34]	1192	[2.33]	[3.97]	[0.98]	[0.52]	[1.18]	1192
Female	1.896***	-0.132***	-0.014	-0.051	0.007	0.084	2.966***	-0.17***	0.028	-0.119*	0.016***	0.108
Head	[2.66]	[3.29]	[0.27]	[0.60]	[0.87]	539	[4.80]	[4.95]	[0.59]	[1.63]	[2.19]	539

Notes: **IV A** is estimated childcare price; (2) **IV B** is the estimated childcare price and child age interaction
Reported values are estimated using the sample of valid WJ Letter-Word Identification Test, which is the largest one among all the cognitive tests considered in this paper. First-stage estimations for samples with valid Applied Problems, Passage Comprehension, and Digit Span tests are very similar, but differ because there are missing values for some tests in the CDS sample.
Test-t are in brackets below estimated coefficients.
*** Significant at 5%; ** Significant at 10%; * Significant at 20%.

this approach is not directly applicable to the problem in here because we are using panel data. We implement the two-stage Wooldridge (1995) estimator for panel data selection model due to its robustness and computational easiness.

To generate a sound identification strategy, we came up with variables that affect the extensive margin of childcare use (i.e whether or not they decide to use childcare services), but not the intensive margin (i.e how many hours of childcare to buy once the household decides to use this service). Following **?**) we assert that variables such as the presence of husband, number of adults aged 18 to 70; number of other older children aged 14-17, the average welfare income and the average child subsidies in the year and the state in which the household is located affect the extensive but not the intensive margin of childcare demand. Other specifications were also tried (with state dummies trying to capture other welfare incentives mothers may face), but the results remain roughly unaltered. In the main equation, we consider the following regressors: log of the per capita family income, log of the house value, mother age, and mother schooling. We believe that the childcare price faced by individuals may depend on these variables. More affluent families live in wealthier neighborhoods in which these services are more expensive. Mother age and education may influence the kind of jobs they have and indirectly affect the price of childcare they face in the nearby area.

Using these estimates, we construct expected offered childcare prices depending of household income, maternal characteristics, and state welfare policies.

Appendix 3 Construction of Home Quality Index

The CDS interviewer is asked several questions regarding the household he/she visits. In all of these questions the interviewer has to express his/her agreement with the following statements

- Interior of the home is dark or perceptually monotonous.
- All visible rooms in the (house/apartment) are cluttered

- All visible rooms in the (house/apartment) are clean
- Child's play environment is safe (no potentially dangerous health or structural hazards within a child's range)

Answers are expressed using a Likert scale ranging from 1 to 5 ("Not at all" (1) to "Somewhat" (3) to "Very much" (5)) except for the last one which receives a value of 5 if the interviewer agrees or 1 if he/she does not agree or does not know. Since we want the Home Quality Index to be a positive scale we reverse the scale of the two first questions. Once this is done, the Home Quality Index is built by adding the scores for the four mentioned questions. Although the measure cannot completely capture the quality of the goods and the environment where the child lives, it is a consistent measure we can compute from the three waves of the CDS.

References

Aguiar, M. and E. Hurst (2007). Measuring Trends in Leisure: The Allocation of Time Over Five Decades. *The Quarterly Journal of Economics 122*(3), 969–1006.

Almond, D. and J. Currie (2010, March). Human Capital Development Before Age Five. Working Paper 15827, National Bureau of Economic Research.

Angrist, J. D. and J.-S. Pischke (2009). *Mostly Harmless Econometrics - An Empiricist Companion*. Princeton University Press.

Bernal, R. (2008, November). The Effect Of Maternal Employment and Child Care on Children's Cognitive Development. *International Economic Review 49*(4), 1173–1209.

Bernal, R. and M. P. Keane (2008). Child Care Choices and Children's Cognitive Achievement: The Case of Single Mothers. Mimeo.

Bernal, R. and M. P. Keane (2010). Quasi-structural estimation of a model of childcare choices and child cognitive ability production. *Journal of Econometrics 156*(1), 164 – 189. Structural Models of Optimization Behavior in Labor, Aging, and Health.

Bianchi, S. (2000). Maternal employment and time with children: Dramatic change or surprising continuity? *Demography 37*(4), 401–414.

Blau, D. M. (1999, May). The effect of income on child development. *The Review of Economics and Statistics 81*(2), 261–276.

Blau, F. D. and A. J. Grossberg (1992, August). Maternal Labor Supply and Children's Cognitive Development. *The Review of Economics and Statistics 74*(3), 474–81.

Bound, J., D. A. Jaeger, and R. M. Baker (1995, Jun). Problems With Instrumental Variables Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variable is Weak. *Journal of the American Statistical Association 90*(430), 443–450. Application and Case Studies.

Brooks-Gunn, J., W. Han, and J. Waldfogel (2002). Maternal Employment and Child Cognitive Outcomes in the First Three Years of Life: The NICHD Study of Early Child Care. *Child Development 73*(4), 1052–1072.

Bryant, W. K. and C. D. Zick (1996, Feb). An Examination of Parent-Child Shared Time. *Journal of Marriage and the Family 58*, 227–237.

Burton, P., S. Phipps, and L. Curtis (2002, May). All in the Family: A Simultaneous Model of Parenting Style and Child Conduct. *American Economic Review 92*(2), 368–372.

Carneiro, P. and M. Rodrigues (2009). Evaluating the Effect of Maternal Time on Child Development Using the Generalized Propensity Score. Institute for the Study of Labor, 12th IZA European Summer School in Labor Economics.

Cawley, J. and F. Liu (2007, November). Mechanisms for the Association Between Maternal Employment and Child Cognitive Development. Working Paper 13609, National Bureau of Economic Research.

Connelly, R. and J. Kimmel (2003). The Effect of Child Care Costs on the Employment and Welfare Recipiency of Single Mothers. *Southern Economic Journal*, 498–519.

Cragg, J. G. and S. G. Donald (1993, April). Testing Identifiability and Specification in Instrumental Variable Models. *Econometric Theory 9*(02), 222–240.

Craig, L. (2006). Parental Education, Time in Paid Work and Time with Children: an Australian Time-diary Analysis. *The British Journal of Sociology 57*(4), 553–575.

Cunha, F. and J. Heckman (2007, May). The Technology of Skill Formation. *American Economic Review 97*(2), 31–47.

Cunha, F. and J. J. Heckman (2008). Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation. *Journal of Human Resources 43*(4), 738 – 782.

Currie, J., M. Stabile, P. Manivong, and L. L. Roos (2008, November). Child Health and Young Adult Outcomes. NBER Working Papers 14482, National Bureau of Economic Research, Inc.

Danziger, S. and J. Waldfogel (2000). *Securing the Future: Investing in Children from Birth to College*. The Ford Foundation Series on Asset Building. New York, NY: Russel Sage Foundation.

Datcher-Loury, L. (1988, Aug). Effects of Mother's Home Time on Children's Schooling. *The Review of Economics and Statistics 70*(3), 367–373.

Del Boca, D., C. Flinn, and M. Wiswall (2010, August). Household Choices and Child Development. IZA Discussion Papers 5155, Institute for the Study of Labor (IZA).

Dooley, M. and J. Stewart (2007). Family Income, Parenting Styles and Child Behavioural-Emotional Outcomes. *Health Economics 16*(2), 145–162.

Folbre, N., J. Yoon, K. Finnoff, and A. S. Fuligni (2005). By What Measure? Family Time Devoted to Children in the United States. *Demography 42*(2), 373–390.

Gauthier, A. H., T. M. Smeeding, and F. F. Furstenberg (2004). Are Parents Investing Less Time in Children? Trends in Selected Industrialized Countries. *Population and Development*

Review 30(4), 647–671.

Gronau, R. (1977). Leisure, Home production, and Work: the Theory of the Allocation of Time Revisited. *The Journal of Political Economy 85*(6), 1099–1123.

Guryan, J., E. Hurst, and M. Kearney (2008). Parental education and parental time with children. *Journal of Economic Perspectives 22*(3), 23–46.

Heckman, J. J. (1976). The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for such Models. *Annals of Economic and Social Measurement 5*, 475–92.

Heckman, J. J., J. Stixrud, and S. Urzúa (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics 24*(3), 411–482.

Herbst, C. M. and E. Tekin (2010). Child care subsidies and child development. *Economics of Education Review 29*(4), 618 – 638.

Hill, C. R. and F. P. Stafford (1985). *Parental Care of Children: Time Diary Estimates of Quantity, Predictability and Variety*, Chapter 17, pp. 415–438. Time, Goods, and Well-Being. Survey Research Center, Institute for Social Research, The University of Michigan.

Hill, M. A. and J. O'Neill (1994). Family Endowments and the Achievement of Young Children with Special Reference to the Underclass. *Journal of Human Resources 29*(4), 1064–1100.

Hofferth, S. L. (1999). Family Reading to Young Children: Social Desirability and Cultural Biases in Reporting. In *Workshop on Measurement of and Research on Time Use, Committee on National Statistics*. National Research Council.

Hsin, A. (2008). Mothers' Time with Children and the Social Reproduction of Cognitive Skills. unpublished manuscript, California Center for Population Research, University of California, Los Angeles.

Hsin, A. (2009). Parent's Time with Children: Does Time Matter for Children's Cognitive

Achievement? *Social Indicator Research: Special Edition on Time Use (John Robinson, ed.) 93*, 123–126.

Imbens, G. W. and J. D. Angrist (1994). Identification and Estimation of Local Average Treatment Effects. *Econometrica 62*(2), pp. 467–475.

James-Burdumy, S. (2005). The Effect of Maternal Labor Force Participation on Child Development. *Journal of Labor Economics 23*(1), 177–211.

Juster, F. and F. Stafford (1991). The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement. *Journal of Economic Literature 29*(2), 471–522.

Juster, F. T. (1985). *Conceptual and Methodological Issues Involved in the Measurement of Time Use*, Chapter 2, pp. 19–32. Time, Goods, and Well-Being. Survey Research Center, Institute for Social Research, The University of Michigan.

Kimmel, J. and R. Connelly (2007). Mothers' Time Choices Caregiving, Leisure, Home Production, and Paid Work. *Journal of Human Resources 42*(3), 643–681.

Monna, B. and A. Gauthier (2008). A Review of the Literature on the Social and Economic Determinants of Parental Time. *Journal of Family and Economic Issues 29*(4), 634–653.

Murray, M. P. (2006, Fall). Avoiding Invalid Instruments and Coping with Weak Instruments. *Journal of Economic Perspectives 20*(4), 111–132.

Neidell, M. J. (2000, November). Early Parental Time Investments In Children's Human Capital Development: Effects Of Time In The First Year On Cognitive And Non-Cognitive Outcomes. UCLA Economics Working Papers 806, UCLA Department of Economics.

Robinson, J. P. (1985). *The Validity and Reliability of Diaries versus Alternative Time Use Measures*, Chapter 3, pp. 33–62. Time, Goods, and Well-Being. Survey Research Center, Institute for Social Research, The University of Michigan.

Ruhm, C. (2004). Parental Employment and Child Cognitive Development. *Journal of Human Resources 39*(1), 155.

Sandberg, J. L. and S. L. Hofferth (2001). Changes in Children's Time with Parents: United States, 1981-1997. *Demography 38*(3), 423–436.

Shea, J. (2000). Does Parents' Money Matter? *Journal of Public Economics 77*, 155–184.

Stock, J., J. Wright, and M. Yogo (2002, Oct). A Survey of Weak Instruments and Weak Identification in GMM. *Journal of Business and Economic Statistics 20*(4), 518–529.

Stock, J. H. and M. Yogo (2005). *Testing for Weak Instruments in Linear IV Regression*, Chapter Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg, pp. 80–108. Cambridge University Press.

Todd, P. E. and K. I. Wolpin (2003). On the Specification and Estimation of the Production Function for Cognitive Achievement. *The Economic Journal 113*(485), F3–F33.

Waldfogel, J., W. Han, and J. Brooks-Gunn (2002). The Effects of Early Maternal Employment on Child Cognitive Development. *Demography 39*(2), 369–392.

Wechsler, D. (1974). *Manual for the Wechsler Intelligence Scale for Children, Revised*. New York: Psychological Corp.

Woodcock, R., M. Johnson, and N. Mather (1989). *Woodcock-Johnson tests of achievement: standard and supplemental batteries*. DLM Teaching Resources.

Wooldridge, J. M. (1995, July). Selection Corrections for Panel Data Models under Conditional Mean Independence Assumptions. *Journal of Econometrics 68*(1), 115–132.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. The MIT Press.

Yeung, W.-J., J. F. Sandberg, P. E. Davis-Kean, and S. L. Hofferth (2001). Children's Time with Fathers in Intact Families. *Journal of Marriage and the Family 63*(1), 136–154.

Zick, C., W. Bryant, and E. Österbacka (2001). Mothers' employment, parental involvement, and the implications for intermediate child outcomes. *Social Science Research 30*(1), 25–49.