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Nº 285 CAUSAL EFFECTS OF MATERNAL TIME-INVESTMENT ON CHILDREN'S COGNITIVE OUTCOMES

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Causal Effects of Maternal Time-Investment on Children's Cognitive Outcomes[1]

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Abstract

Many social scientists hypothesize that the time mothers spend with their children is crucial for children's cognitive development. Unlike most studies that focus on maternal employment effects on children, we estimate direct causal effects of time-diary measured maternal time using the CDS - PSID data set. Considering endogeneity and using different instruments, the effect of an increase of mother's time associated to a rise in her opportunity cost of time is an order of magnitude larger than OLS estimates for cognitive tests. These effects are greater for white children living with college-educated mothers in two-parent households.

Keywords: Children outcomes, maternal time-investment, time allocation, causal effect, instrumental variables.

JEL codes: D1,J13,C36.

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1 Introduction

Does maternal time affect children's cognitive development? A longstanding and reasonable hypothesis in social sciences is that mothers have a large influence over the outcomes of their offspring. In addition to the well-deserved practical and scientific interest on this topic, the recent literature shows 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 mothers 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 cognitive outcomes using a simple empirical model of human capital accumulation.

Some of the existing scholarship[2] that examines the impact of maternal labor force participation 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 ways from this vast literature. First, since the relationship between the hours worked and the time mothers devote to their children is weak at best, we use time-diary data to obtain accurate measures of the time mothers and children spend together. Even though time-diary data shows that full-time 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 quality 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

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

determined, has a cumulative impact on children outcomes and affects children in heterogeneous ways.

Several data requirements need to be met to 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 measure maternal time investments directly. 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 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 can, therefore, be used as 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. In order to achieve a reasonable external validity of our results, we estimate our model using several possible exogenous sources of maternal time variation in local labor markets: average childcare costs, housekeeping costs, maternal offered wages, and income child subsidies. 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 of these prices or costs solely affects children through the substitution of other time uses (work, housework, leisure) for childcare maternal time, holding constant family background characteristics.

Our first-step estimates for these instruments are in line with standard time-allocation theory predictions. Consistent with a prevailing substitution effect, higher average childcare and housekeeping costs increase the time mothers spend with their child. However, this effect decreases in child age suggesting a lower marginal utility of childcare for older children. A higher average offered market wage in general decreases maternal childcare time, especially for older children, in line with a predominant substitution effect. Finally, higher state child subsidies increases time spent with children with a declining impact in child age. The latter can be understood as an income effect response for households with children due to a transfer.

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 time-investment in response to a price increase in a particular sub-population of children (Imbens and Angrist 1994).

Our findings largely support the hypothesis of endogenous maternal time-investment allocation because LIML estimates are an order of magnitude, 6-15 times larger, than OLS for both cognitive tests. Moreover, the results are remarkably similar for all instrumental variables utilized. By estimating the results for different sub-populations, we find that white high-income children living with college-educated mothers in two-parent households benefit the most from the exogenous variation in maternal time-investment. This suggests that marginal substitution of maternal time by formal childcare or housekeeping services should be beneficial in terms of those outcomes, which is consistent with previous evidence (Brooks-Gunn et al. 2002; Ruhm 2004). A marginal hour worked increase motivated by a raise of average offered wages also has a similar detrimental effect. Finally, larger child income subsidies induce greater maternal time for children, with a similar positive marginal effect. First-stage estimates show that time responses to these changes in price or in income fade out as children grows older, suggesting that the estimated effects chiefly capture the outcome responses of young children. 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 (2010, 2011). While the effects of active maternal time are significant and much higher than OLS, their magnitude is lower than the one estimated for total maternal time-investment.

Findings from this study have policy implications. First, regulations affecting key prices and incentives for mothers should consider the implicit costs of maternal time allocation on the child's cognitive outcomes. 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 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 studies have focused on the effect of maternal employment. Bernal and Keane (2010, 2011) 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 (2011) 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 et al. (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 et al. (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 et al. (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 et al. (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 (2011), which relies on a more direct and theoretically sound empirical specification.

3 Data description

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. Most of the children were re-contacted in 2002. By 2007, a large portion of the original sample become ineligible, by survey design, since they had turned age 18.

From the CDS longitudinal data, we use age-standardized Applied Problems (math) and Word-Letter Identification tests (Woodcock et al. 1989). We also 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 2.

Time Diaries (TD): As a part of the CDS design, children or their caregivers were required to complete Time Diaries, i.e. to chronologically record all their activities for one random weekday and one random weekend day. There are approximately 600 primary activities, aggregated into 11 major categories. Besides reporting beginning and ending time for activities, the data also contain information on who else participated in the child's activity. With these inputs, we construct two time-investment categories, weighting weekdays by five and weekend days by two: total time the mother spent on all activities with the child, and total time spent while the mother is directly participation. As a shorthand, we refer the latter time as "active" maternal time. Active and passive time-investments may influence children's outcomes in different ways (Folbre et al. 2005).

Time-diary collection is the preferred way to measure actual time use of individuals (Juster 1985; Juster and Stafford 1991). 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.

Panel Study of Income Dynamics (PSID): The PSID is a widely-known longitudinal study of a representative sample of U.S. individuals and their families since 1968. We use the PSID Family records for maternal education, maternal age[3], family living arrangements, income, reported hours worked and housework hours.

Current Population Survey (CPS): We use the Current Population Survey March data[4] to construct labor market and welfare variables that may generate an exogenous source of variation in maternal time use allocations. We consider several variables that may influence maternal time-allocation decisions by year and state for the period 1990-2007.

Cognitive outcomes: Standardized cognitive outcomes scores vary according to child gender and maternal education. These differences are meaningful since all

[3]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.

[4]Obtained from IPUMS-CPS (King et al. 2010)

measures of children's cognitive outcomes are ordinal scales that allow comparisons within the same test, but not between them. In Panel A of Table 1, we see that children have a slight decreasing pattern for both cognitive tests. We do not have an explanation for these patterns. We notice that girls perform better than boys in both tests, for ages 5 to 10. For children older than 10, females outperform males in word test but not in the aprob test. Looking at Panel B, 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 the last two groups of mothers have similar scores.

Maternal and household characteristics: Table 1 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.[5] Home quality index and *per capita* log family income are also higher for more educated mothers.

The Table 2 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 Home Quality Index index is slightly higher for older children, while the log family income is lower for the group of younger children. The Table 2 also shows that there are some differences between boys and girls in the mean and dispersion of log family income, especially for younger children.

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. In turn, mothers who work part-time are 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, the share of head mothers working full-time is household heads. Full-time working mothers tend

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

to live in households with a relatively higher Home Quality Index and *per capita* family income.

Maternal employment and 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 et al. 2008). Over the last decades several categories of total maternal childcare time and total hours worked have increased, while housework hours have declined (Aguiar and Hurst 2007).

A set of scatter plots in Figure 1 reveal that maternal hours worked are weakly and negatively correlated with total maternal time and active maternal time. However, the dispersion around the local polynomial regression lines is substantial.[6] 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 in Figure 2, but again, the conclusion is that the latter time use category is a very imprecise measure of the time mother and child engage 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[7] has considered childcare as a separate time-use 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,

[6]For details, see on the footnotes of Figure 1

[7]Aguiar and Hurst (2007) provides a more elaborated discussion on the conceptual distinction between childcare time and housework

gender, and maternal education. Total and active maternal time also show a great deal of variation across child gender and age in Table 1.[8] We observe average total maternal time is higher for boys when their age ranges 5-10, but the pattern reverses for girls older than 10. On the other hand, as children grow older, they receive less maternal time and the actual time allocation observed becomes more volatile.

Panel B of Table 1 shows that college-educated mothers spend more time on children younger than 14, but slightly less than less educated mothers for older children. The highly educated mothers devote substantially more time to market work than their non-college counterparts. However, the latter group devotes more time to housework. Panel C shows that, on average, non-working mothers devote 2.2 and 6.4 weekly hours more than do part-time and full-time working mothers, respectively. However, these gaps decrease to 0.5 and 2.5 weekly hours for active maternal time. This suggests that mothers accommodate other time-uses to avoid reducing time directly spent with children. The standard deviation of maternal time of both part-time and full-time working mothers is smaller than that of non-working mothers.

Table 3 shows modest but significant pairwise correlations between maternal hours worked and mother-child shared time for different subsamples. Moreover, the negative correlation seems larger (in absolute terms) for young children and low educated mothers. This evidence reassures our skepticism on evidence regarding maternal employment "treatment" effects. The fact that the correlation consistently varies according to child age and maternal 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. Little can be learned from maternal employment treatment since it masks different input intensities that systematically vary on child and household characteristics.

[8]Columns considering only positive measured total and active time show that this feature of the data does not alter the quantitative conclusions we obtain.

4 Model

There are several approaches in the literature to modeling 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 (2011) since it establishes a more straightforward relation between observable inputs and outcomes, without a mediating role of unobserved factors.

Although 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 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 et al. (2002) for a survey). We also report tests for weak instruments (Cragg and Donald 1993)(CD) 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 (2010, 2011), 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 (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 affected 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) finds that only the time-investment of mothers with high literacy skills has a positive impact on children's outcomes. Evidence of higher detrimental effects of employment for 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

$$y^h_{n,t} = \alpha^h_n + \sum_{i=0}^{a_{n,t}} \beta^h_{n,i} + \sum_{i=0}^{a_{n,t}} \gamma^h_{n,i} x_{n,i} + \sum_{i=0}^{a_{n,t}} \delta^h_{n,i} k_{n,i} + u^h_{n,t} \tag{1}$$

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 $y^h_{n,t}$. The term α^h_n stands for an unobserved environmental/genetic component of the child n that specifically affects the h-th outcome at all ages. The coefficients $\beta^h_{n,i}$ 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 $\gamma^h_{n,i}$ and δ^h_n 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

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

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

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

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.[9] As a measure of material well-being, we primarily use the Home Quality Index. A careful description of this index is in Appendix 2. In the online Appendix, we consider an alternative measure of material well-being: log *per capita* real household income. In regards to the marginal impact of physical goods investment, $\delta^h_{n,i}$, we assume that it does not vary with child age, i.e. $\delta^h_{n,i} = \delta^h_n$. In the online Appendix, we relax this assumption by allowing the coefficient to depend

[9]Nevertheless, we realize that the effect of maternal time-investment defined in these equations potentially includes the marginal change in child goods generated by income variations. In turn, income may vary due to the potential displacement of hours worked by childcare. Hence, a marginal income variation is part of the "treatment" received by a child when his mother decides to change her time allocation.

on child age.[10]. However, we do not notice important differences using the latter specifications. We estimate the following generic equation

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

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 a bias due to the omitted 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 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 (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

[10]This change basically adds an interaction term between child age and the physical investment measure to equation (4)

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-investment in response to a variation of z.

We rely on a standard theory of household time allocation to find appropriate instruments. 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 cost of external housework provision, (iii) the benefits and costs of hours worked in the market, and (iv) the government resources for welfare benefits 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 a weak decrease in the time spent with children in response to such a change. In principle, since the household owns a time endowment and potentially supply it to the market, 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.

A first possible instrument is related to childcare prices. Nevertheless, child care price itself is likely to be related to the quality of the service provider, creating a secondary channel to affect child outcomes besides maternal time variation. This clearly implies a violation to the exclusion restriction.[11] Since we do not have a way to control for childcare service quality, we rely on the average CPS wages of childcare workers by year and state.[12] Moreover, we also include this variable interacted with child age to take into consideration the fact that the sensitivity to price variation is likely to decay as children grow older. In this case, the exclusion restriction theoretically holds because average childcare workers wage is a cost pressure on childcare service price, for all potential and actual daycare providers. Consistently with theory, Kimmel and Connelly (2007) estimate a significant positive response of actual mother-child shared time to an increase in predicted childcare prices. Even though the expected effect of a raise 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 and similar occupations 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 causal effect.

The second relevant price for maternal time allocation decisions is the one of housework services. We measure the wages of housekeeping occupations in March IPUMS CPS to build a variable related to the price of these services.[13] This strategy is based on Cortés (2008) and Cortés and Tessada (2011), who show that maternal employment increases when unskilled labor immigration raises, and drives down the housekeeping services price. In addition, Amuedo-Dorantes and Sevilla Sanz (2011) find that unskilled immigration reduced basic childcare of college-educated mothers, but increases educational time spent with children. As we do with childcare workers wage, we interact average housekeeping log wage variable with child age because the price sensitivity of maternal time allocation is likely to decrease as children grow older. In our case, we expect that a greater housekeeping price induces more maternal time with children due to a substitution effect. Neverthe-

[11] We thank William Evans for pointing this out.
[12] For details, see in the online Appendix
[13] For details, see the online Appendix.

less, an income effect response may prevail due to the revalorization of the time endowment of unskilled mothers, reducing time with children. Thus, this variable is likely to affect unskilled immigrant women in the opposite direction, violating monotonicity and biasing our estimates towards non-significance.

A third Instrumental Variables is the average offered wage for women in the labor market defined by year and state. Our empirical challenge is to construct a measure of *offered* hourly market wage since this is the relevant price that affects the number of hours devoted to work. We construct these market wages using IPUMS-CPS database by estimating a selection model with a hours-worked selection equation (Tobit III model) along the lines of Vella (1993) and Wooldridge (2002, ch 17). We use this model to impute expected log wages to all females (workers and non-workers) in the sample. Our offered wage measure is the CPS weighted average offered wage by year and state, and its interaction with child age. The details of this selection wage model are thoroughly explained in the online Appendix. Consistent with the standard labor supply setup, income effects are potentially important in this context because the household is a (net) supplier of hours to the market. Indeed, Kimmel and Connelly (2007) find that a wage increase *raises* the time mothers devote to children on weekends, suggesting an important income effect. Other literature surveyed by Monna and Gauthier (2008) finds negative effects of wages on maternal time. In light of these theoretically opposing forces, we need to control for children goods or income to capture time substitution effects. Conditional on material well-being, higher offered wages should reduce maternal time with children. Because our controls are imperfect, strict monotonicity requirements may be violated. Again, these issues make it hard for us to find significant causal effects.

Finally, we hypothesize that the existence of government benefits for households with children may induce mothers to substitute their time with physical goods. We implement this idea by using the average income child subsidy by year and state, reported by IPUMS-CPS. As with the other instrumental variables discussed, we include the latter variable interacted with child age, to capture an expectable decaying sensitivity of mother-child shared time as children grow older. Admittedly, the effect of a change in welfare programs on maternal time allocation is *a priori* uncertain. They may induce women to devote fewer hours to work, but to increase other time uses such as leisure or housework instead of childcare. Hence, the final effect of welfare benefits related to children has to be elucidated on empirical grounds. Moreover, we are certainly aware that the group of mothers who change time allocation due to changes in welfare policies may be quite different from groups who respond to other of our instruments. Thus, exploiting this additional source of variation would shade light on the external validity of our results (Angrist and Pischke 2009). Our benchmark to assess this particular strategy is Herbst and Tekin (2010), who show that childcare welfare policies are detrimental to children outcomes due to the substitution of maternal time for low-quality paid day care.

5 Results

Overview: The main results are displayed in Tables 4-7.[14] Our maternal time-investment measure is the log of total maternal time (in minutes) plus one second (1/60), in order to handle observations with zero-minute recorded time. We show that LIML estimates are an order of magnitude larger than those of OLS for Applied Problems(aprob) and Word-Letter Identification(word) and tests. The results are also remarkably robust to a series of alternative specifications. We explain and discuss a series of robustness results at the end of this section and show various estimations in the online Appendix of this paper.[15] This evidence suggests that the hypothesized reversed causality is very important and empirically sizeable for these cognitive outcomes. To illustrate our point, in the column **IV1** of Table 4, according to the OLS estimator an increase of 1% in the average total maternal time would increase 1.54% of a standard deviation in the test score in Applied Problems. The LIML estimator shows a causal increase of 19.81% of a standard deviation in the same test score as a result of a 1% increase in the weekly average maternal time. Thus, for Applied Problems, the LIML effect is roughly 12.8 times larger than the

[14] We use the Stata package `ivreg2` by Baum et al. (2010) to estimate our models. For further information see `http://ideas.repec.org/c/boc/bocode/s425401.html`

[15] The online Appendix can be found in `http://www.benjaminvillena.com/data/uploads/online-appendix-VR-RA.pdf`

OLS. The order of magnitude of these effects for Applied Problems are of the same order of magnitude of 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 (2010, 2011). Herbst and Tekin (2010) estimate that childcare subsidized children obtain 26-30% lower cognitive test scores until the end of kindergarten, other things equal. In the case of Word-Letter Identification, our estimates are roughly half the value of those obtained for Applied Problems. Still, the gap between OLS and LIML estimates remain very large for both cognitive outcomes. Fortunately, instrumental variables are strong in the sense of Stock and Yogo (2005) in that the Cragg-Donald test largely surpasses the rule-of-thumb value of 10.

In addition, we report the results from using the exogenous variation for four sets of instruments (Average log wage in childcare occupations, average log wage in housekeeping occupations, average log offered female wages, and average income child subsidy. In all cases, we also include interactions with child age) and report the Cragg-Donald test in different sub-populations. Since the estimated parameter γ is a local average treatment effect, the underlying price/budget exogenous shocks we exploit as different sources of identification may generate heterogenous responses across the population. Showing similar results for different sources of exogenous variation indicates external validity of our results. To uncover heterogenous responses patterns across the whole population, we estimate the model for several subsamples: low-education mothers (high school or less), high-education mothers, male child, female child, white child, black child, low family income (below median), high family income, two-parent household (male head in PSID nomenclature) and female head.

Effects of total maternal time: Tables 4 and 5 show that the local average causal effect associated with total maternal time, γ, is large and significant. Furthermore, these results hold for every subpopulation analyzed (High/Low educated mothers, Male/Female child, White/Black child, Male/Female household head) for aprob and word tests. Even though the strength of the instruments mildly worsens for some subpopulations, the Cragg-Donald tests remain above 10 in almost all estimations.

The results in Table 4 indicate that the positive impact of total maternal time on aprob tests is particularly high for white children, a those with college-educated mothers, with family income above the median family, and with two-parent households (male head in PSID convention). Remarkably, the estimates obtained are quite similar for all the instruments used, indicating that the effects may apply more generally to several groups in the population, i.e. they are externally valid. The partial exception is the estimation using the last instrument (IV4), the average income child subsidy, because it yields slightly lower IV estimates for almost all subpopulations. The latter suggests that this subpopulation of mothers who are induced to share more time with their children is somewhat different from the other groups induced by other instruments.

Similar results are obtained for the Word-Letter Identification test, although some important differences arise. First, the impact of a marginal increment of maternal time-investment in the word test is roughly 50% - 60% of their proper counterpart for the aprob test. However, OLS estimates are also smaller and, therefore, the relative ratio between LIML and OLS estimators is still very large. For instance, the LIML IV1 point estimate for the whole sample is 7 times larger than OLS. Again, the first three sets of instruments deliver quite similar results, but IV4 is somewhat different. In the case of Word-Letter Identification test, highly educated mothers have a larger marginal impact of their child's word test, but the difference is quite small for IV4. In contrast to Applied Problems test, there is a gender difference in word results: the marginal impact of sharing time with a boy is substantially larger. The white-black difference is much larger in this test: the effect of maternal time on a white child is roughly three times the impact on a black child. For Word-Letter Identification, it is also true that the maternal time has a greater effect on high-income families, even though the result reverses when the maternal time-allocation change is induced by income child subsidies (IV4). With respect to family composition, we also see that the gap between male and female headed households widens, since the marginal effect of maternal time in a two-parent family (male head) is about 2-3 times larger. In the case of Word-Letter Identification, the fact that LIML estimations from different sources of identification yield similar results let us conclude that our estimates have external validity.

The effect of material well-being in households, as measured by the Home Quality Index, is significant at 20% for the whole sample for Applied Problems test, but not significant in most examined subpopulations. The exceptions are below-median-income and female-head households, with negative marginal impact on math scores. In the case of Word-Letter Identification test, the marginal negative impact of lagged Home Quality Index is pervasive and significant. Even though these results may seem counterintuitive, it may simply reflect that the mothers in these subpopulations may increase their children's Word-Letter Identification tests by sharing more time with them and by providing less physical goods on the margin. Of course, this is not incompatible with a rational decision investment in children since the mother (or the household) presumably optimizes family welfare, which is not equivalent to children's cognitive outcomes. Another possibility is that the model is simply misspecified. If this were true, we should try to learn how sensitive the results of the average marginal impact of maternal time-investment are to this problem. We address this possible issue in the robustness subsection 5.

Effects of active maternal time: In Tables 6-7) We find that active maternal time-investment, i.e. when the mother directly participates in the activity has a significant and positive effect on the Applied Problems and Word-Letter Identification tests for the whole sample and different aforementioned subpopulations. In addition, we observe that the Weak Instruments concern is not very important in this set of estimations because the Cragg-Donald test can exceedingly reject a large bias of the Limited Information Maximum Likelihood estimator (Stock and Yogo 2005).

The causal impact of active maternal time for Applied Problems is roughly half of the effect of a marginal increase of total maternal time. However, these estimates are still very large compared to the OLS estimates. Among subpopulations, we observe that the marginal effects of highly educated mothers are significantly larger than those of children with less educated mothers. In addition, mother-daughter shared time yields, at the margin, higher effects than maternal time spent with boys. In this particular time use, there is a substantial racial gap, too. Time invested in white children yields higher marginal increases in the aprob test. As in the case of total maternal time, the marginal effect of maternal active time in high-income and two-parent households exceeds the average impact for low-income, and female-headed, respectively. Comparing results across different sets of instruments, we obtain very similar results for all of them in Table 6. This reassures our claim that the results we obtain have external validity.

For the case of the Word-Letter Identification test in Table 7, we observe that the marginal effects of maternal active time are noticeably smaller, about one-half times of those for the Applied Problems test. As in the other cases, the effect is greater for the following subpopulations: high-education mothers, male child, white child, high-income, and male-headed households. It is remarkable a very large racial gap in this regard: the marginal impact of maternal time among whites is roughly four times larger than it is for blacks. The ratio between the marginal effects of male and female headed households is roughly 3. Nevertheless, LIML estimators for the whole sample are 4-6 times larger than OLS. Comparing the results obtained across different instrumental variable sets, we see that they remain unchanged for the most part. Partial exceptions for these patterns are the results from the average income child subsidy (IV4). The whole-sample marginal effect is somewhat larger. Although the signs of the gaps between complement subpopulation we have mentioned are still there, the size of that difference decreases in these cases.

The impact of Home Quality Index in Table 6 show that the effect of material well-being conditions is generally positive, though not always significant at conventional levels. The marginal effect seems particularly high and significant for white children, high-income households, and male-head households. The results remain roughly constant across different instrument sets. In contrast, in Table 7 we observe a pattern that is similar to what we have seen in the case for total maternal time. Most marginal effects of Home Quality Index are negative and significant.

First stage: The literature on Weak Instruments has convincingly argued for paying close attention to the first stage in Instrumental Variables estimation. Several authors recommend not only finding joint significance of instruments, but also obtaining estimates that are theoretically consistent with the underlying economic mechanism generating the exogenous change in the endogenous regressor of interest (Murray 2006; Angrist and Pischke 2009). In Table 8 we can see the first-stage estimates for log total maternal time for the sample of non-missing word tests.[16] Table 9 shows analogous results for maternal active time. These patterns are totally consistent with the hypothesized underlying "experiments" behind our identification strategy.

In all cases of Tables 8 and 9, the coefficients of basic instruments reflecting the cost of maternal alternative time uses, and its interaction with child age have the expected signs and are highly significant. The effect of raising the average log childcare wage (IV1), the average log housekeeping wage (IV2), and the child income subsidy (IV4) are positive, decreasing in child age and significant. Only IV3, the average log offered wage, has a mostly non-significant main effect for both total and active maternal time. A notable difference between Tables 8 and 9 is that the first-stage estimated responses to exogenous variation of prices for active maternal time are substantially larger than their analogous counterparts for total maternal time. The same pattern repeats for all kinds of instruments used in virtually all analyzed subpopulations in Tables 8 and 9.

In addition, in Table 8, the coefficients accompanying the lagged maternal time are small, but significant, showing a small persistency. In contrast, this level of persistence is much greater in the case of active maternal time for all instruments and subpopulations, as seen in Table 9. This finding, combined with the larger sensitivity of active maternal time to exogenous variations, suggests a considerably larger response to prices of this time category in the long-run. Even though essentially reduced-form, these findings can be of interest for policy purposes.

Looking closer to results by Instrumental Variables, we see that in the case of average log wage of childcare workers by year and state and its interaction with child age (IV1), a 1% increase of the average childcare workers wage would increase 0.342% the mother-child total maternal time, but this elasticity decreases in 0.027% per year, implying that the effect matters for children below age 13. These

[16] We choose this particular outcome because it is the one with the largest sample size. The first-stage estimates for aprob slightly differ from this.

magnitudes get increased for active maternal time in Table 9: the main effect elasticity is 0.858 and yearly decreases at rate 0.056, as the child grows older.

In addition, there are important differences across subpopulations. For both maternal time use categories, the elasticity of response to childcare wages is larger for less educated women, for mothers with a male child and a white child, and for female-headed families. The child-age interaction term is always negative and highly significant, indicating that most of the maternal time response to childcare costs is directed towards young children.

For the second set of instruments in Table 8 (IV2), a 1% increase of average log wage of housekeeping occupations increases maternal total time by about 0.131%, but the effect decays in 0.02% by year suggesting the impact of maternal time are concentrated in children below 7 years old. For maternal active time in Table 9 the analogous elasticity is 0.58, decaying at 0.042 per year of the child.

There is a great deal of heterogeneity responses across different subpopulations. Notably, the elasticity for highly educated mothers is substantially larger in the case of active maternal time, but there is just a little difference between high and low educated mothers for total maternal time. This is roughly consistent with Cortés and Tessada (2011), who find that the labor supply of more educated women is largely affected by the availability of housekeeping services, and with Amuedo-Dorantes and Sevilla Sanz (2011), who find that housekeeping services switch maternal time use towards mother-child activities of higher involvement. There is also a substantial racial elasticity gap: total maternal time of white children is much more reactive to housekeeping wages than it is the total time spent in black children, but the result reverses for active maternal time. In addition, the active maternal time response to housekeeping costs in female-head households is considerably larger than that in male-head households, but the response is very similar for total maternal time. This suggests that female heads react much strongly to substitute expensive housekeeping than do their counterparts living with a male partner.

The first-stage estimates for IV3 show that mothers reduce their total time with children as their offered wages increase, and that effect is magnified with child age. For total and active time, in most cases, the main effect is not individually significant at 20%, but its interaction with child age is highly significant and negative. In both cases (see Tables 8 and 9) the negative effect of average log offered wage seems particularly negative for male children and for mothers living in female-headed households. Indeed, considering the main and the interaction effects, the elasticity total and active time for female-head mothers and low-income households is substantially larger (in absolute value) than the one for other subpopulations. Since these groups are likely to have the largest marginal utility of consumption, finding large elasticities supports the existence of a meaningful economic mechanism behind the identification strategy.

In regards to the last set of instruments (IV4), there is a significant, positive effect of average child income subsidy on total maternal time that significantly decreases in child age. For instance, a 100 dollar increase in average log child subsidies would generate a 0.6% increase of total maternal time, and a 1.6% increase of active maternal time. These effects are decreasing in child age. While total-time estimates suggests important effects only for very young children, the active-time one shows positive impact even for adolescents. As in the other instruments, the mentioned effects vary across different subpopulations. In both total and active time, mothers of white children react more to this subsidy than their counterparts raising black children. For the other subpopulations, the patterns of total and active time generally differ. The total time that mothers who are college-educated or who are raising a girl devote to children is more sensitive to income child subsidies. For the active time category, less educated, low-income, and female-head mothers react the most to variations in this subsidy. Our interpretation is that state transfers relax the household budget constraint, allowing the mother to spend highly valued time with her child. As children grow older and have lower care requirements, there is an increasing reduction over the effect of maternal time-allocation.

Robustness of the results: We devote the online appendix to exhibit a large number of results confirming our findings. We take care of several caveats about our empirical results. In short, we address the following issues:

First, we study whether an alternative maternal investment measure change our findings. Is a raw measure of maternal time input appropriate if we explain changes in age-standardized cognitive outcomes? In the first place, our rationale for using observed maternal time measures is that mothers allocate their time taking into account that there is a natural trend for child development, given certain child and household characteristics. Under this premise, time-use choices entail an *endogenous* natural decreasing of the total time allocated for the child, and a simultaneous re-allocation of that amount of time indifferent uses. On the contrary, one may believe that such a decreasing pattern of time allocation is exogenous, because of the increasing demand of child time in school and social activities as they grow older. Under the latter assumption, we should adjust time allocation by age. We construct such a measure as the gap between the log maternal time and its average by child age. Using age-standardized time-investments, we obtain new estimates that turn out to be about 20% smaller than those obtained in Tables 4 and 5 for total maternal time, but 30-60% larger than those in Tables 6 and 7 for active maternal time. In any case, the estimates are still many times larger that those obtained from OLS, and instruments are quite strong with quite high Cragg-Donald tests.

A second justified concern is the notion of physical investment we use. Even though the Home Quality Index measures the quality of the child's household, it may be insufficient for capturing elements that matter for cognitive formation. An alternative, plausible specification uses log *per capita* income of the family to proxy the amount and quality of goods incorporated in the stock of physical capital for the child. Using this variable also connects our work to the literature trying to measure the impact of family income on children's cognitive outcomes (Blau 1999; Shea 2000; Løken et al. 2012). This alternative measure barely changes the results, with the exception of larger effects of active time on aprob test. Perhaps puzzling, the marginal effect of family income is negative for aprob test, but positive and non-significant for word. Cragg-Donald tests remain high.

A third caveat is the possibility of child-age and Physical investment interactions. As in the case of maternal time reactions to prices, physical capital may affect children's cognitive outcomes differently according to their age. To do this, we introduce a term of Home Quality Index (lagged in five years) interacted with child age. There are two reasons behind this. First, we try to explore whether some negative marginal responses to Home Quality Index we observe in Tables 4, 6, 5, and 7 are due to a possible misspecification. Second, as we include a physical investment measure interacted with age, we are introducing a variable that is quite collinear to the price instruments interacted with age. This fact puts greater strain on our identification strategy because we control for an addition channel that might explain heterogeneous responses varying in child age. The results show that the estimates become larger, except in the case of total maternal time and aprob test. The marginal effects obtained through different instruments differ more one to another, but they remain considerably larger than OLS estimates. The point main effect of Home Quality Index is negative, and the interaction term with age is positive, but often non-significant. In these cases, Cragg-Donald tests sometimes fall below the rule-of-thumb value of 10. This is of little concern in this case because the tolerable bias consistent with a critical value of 10 is close to 10%. Even if we had such bias, it is unimportant since the LIML estimate is at least 6-20 times as large as the OLS.

Finally, in our online Appendix we also present estimations than jointly address combinations of these caveats. The main results we present here remain intact, even though it becomes harder to make strong statements due to IV weakness for certain subpopulations.

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 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. Our main results show that Applied Problems and Word-Letter Identification tests consistently improve when mothers increase the time shared with their children in response to a rise of the cost of opportunity of competing time uses (childcare, housekeeping, offered wages) and changes in budget constraints (child income subsidy). The estimates effects are an order of magnitude larger than those obtained by OLS, which suggests endogeneity is a severe problem for OLS estimation. The discrepancy between OLS and LIML estimators is so large, that even if our estimates were biased due to Weak Instruments problem (Stock and Yogo 2005), the main conclusions remain unaltered. In the context of Local Average Effects, the results obtained by different instruments are remarkably similar one to another, even across different subpopulations of interests. We also perform several robustness checks that show our results hold even under different conceptualization of maternal time inputs, different measures of physical goods investment, and potential age-varying effects of the household investment in goods.

In a context of heterogenous effects, the average effects seem to be driven by the large response of white high-income children of highly educated mothers, living in two-parent households. There is also some evidence of larger response of girls for aprob test, and boys for word test. Moreover, the results remain very similar using different instruments, showing external validity. 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).

First-stage results are theoretically sound and are in line with evidence showing that maternal childcare time increases with day care price (or underlying costs in our case), especially for young children (Kimmel and Connelly 2007). The same kind of substitution effect shows up for variations of housekeeping costs, in line with previous literature (Cortés and Tessada 2011). A raise of offered wages usually reduces maternal time-investment, while an increment of average child income subsidies increases it. In all cases, the described effects fade out as children grow older, suggesting that the identified effect mainly accounts for changes in behavior of households with young children.

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 are detrimental for cognitive outcomes. Brooks-Gunn et al. (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 spur 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 cognitive outcomes. On one hand, there are many other child characteristics and skills that are highly valued by parents. 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 et al. 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 et al. 2005), the type of activities chosen, and the parenting style generated during those interactions. Estimating the impact of maternal time resources that are willingly allocated to raise children is a first and limited attempt to identify the contribution of “active” maternal effects.

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

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

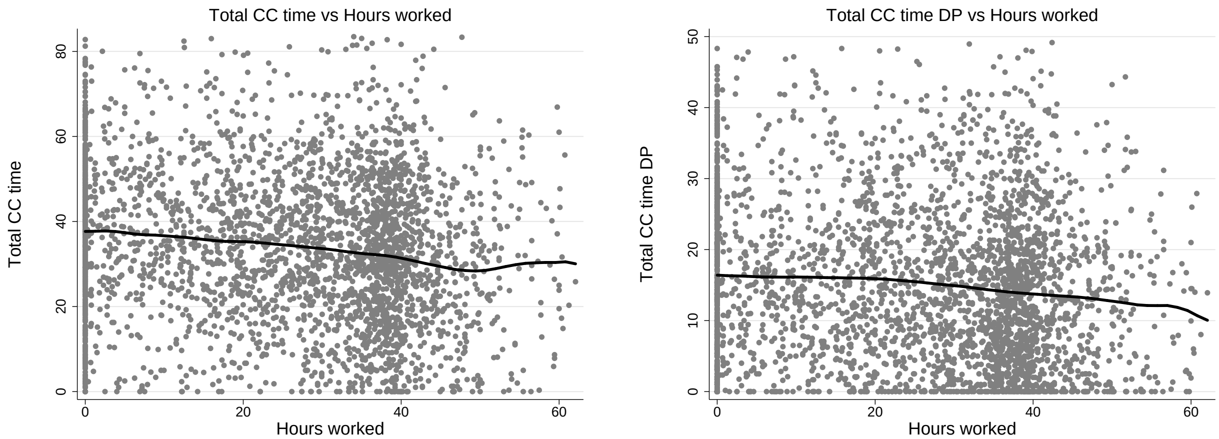
with $\tilde{\mu} \equiv \mu^4 - 3\mu^3 + 4\mu^2 - 2\mu + 1$

Appendix 2 Construction of Home Quality Index

The CDS interviewer is asked several questions regarding the household he/she visits by expressing his/her agreement with the following statements: (1) Interior of the home is dark or perceptually monotonous; (2) All visible rooms in the (house/apartment) are cluttered; (3) All visible rooms in the (house/apartment) are clean; and (4) Child's play environment is safe (no potentially dangerous health or structural hazards within a child's range).

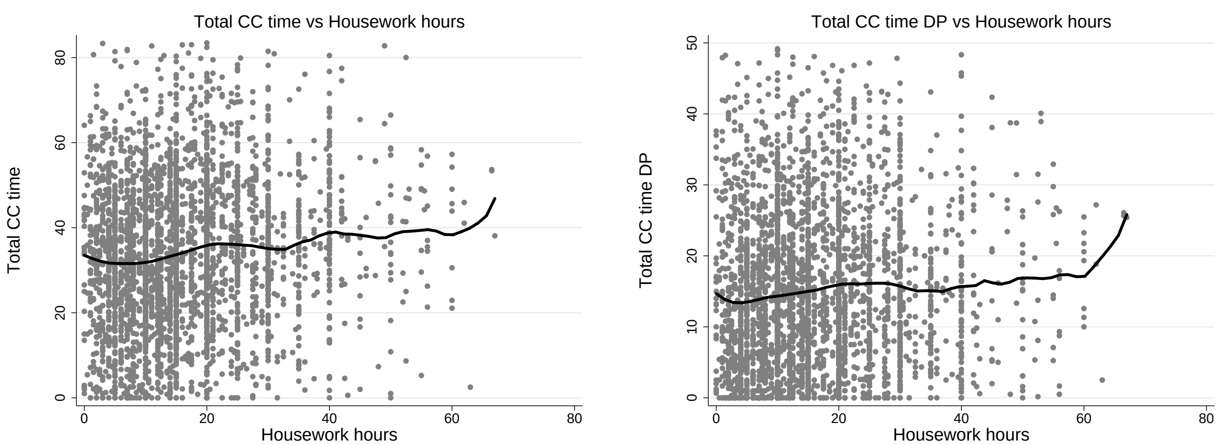
Answers use an ordinal scale ranging from 1 to 5 ("Not at all" (1) to "Somewhat" (3) to "Very much" (5)) except for the safety question which receives 1 ("Not safe" or "I do not know") or 5 ("Safe"). Since we want the Home Quality Index to be a positive scale, we reverse the scale of the two first questions. Once this is done, the Home Quality Index is built by adding the scores for the four mentioned questions. Even though is not perfect, this is a consistent measure for the three waves of the CDS.

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.

Table 1: Descriptive statistics (I)

Bin	Stat	aprob	word	Total time	Total time> 0	Active time	Active time> 0	Mom hours worked	Mom hours housework	Mom educ	Mom age
		Panel A: Child gender and Child Age									
male age 5-10	$\overline{X}$	104.6	104.2	39.4	39.8	19.5	19.8	23.8	17.0	13.0	35.5
	S	18.8	17.2	17.1	16.8	10.8	10.5	16.1	12.3	2.5	6.5
	N	487	490	484	479	484	476	511	511	490	511
female age 5-10	$\overline{X}$	105.6	108.8	37.1	37.3	19.5	20.0	25.1	16.6	13.0	34.6
	S	15.6	16.0	16.3	16.2	10.5	10.2	16.1	12.9	2.5	6.0
	N	433	433	423	421	423	414	450	450	435	450
male age 11-14	$\overline{X}$	104.3	100.8	35.7	36.1	14.8	15.5	26.2	16.7	13.0	39.5
	S	16.5	17.9	18.3	18.0	11.8	11.6	17.2	12.9	2.5	6.1
	N	640	640	614	608	614	586	658	657	629	658
female age 11-14	$\overline{X}$	103.8	104.4	37.4	37.8	17.2	17.8	25.5	16.3	13.0	39.1
	S	15.4	16.9	18.8	18.5	12.1	11.9	16.7	11.9	2.5	5.9
	N	665	666	650	643	650	627	679	677	660	679
male age 15+	$\overline{X}$	101.3	99.9	28.1	29.2	9.8	11.7	28.4	16.1	13.0	43.0
	S	16.5	20.6	19.4	19.0	11.3	11.4	17.2	11.5	2.8	5.6
	N	549	549	527	508	527	445	565	564	546	565
female age 15+	$\overline{X}$	99.3	103.3	30.5	31.5	12.6	14.1	27.8	15.9	12.9	43.0
	S	15.2	19.8	19.7	19.2	12.2	12.1	17.5	11.5	2.7	5.6
	N	578	581	557	540	557	496	597	597	577	597
		Panel B: Mother College and Child Age									
mom NC age 5-10	$\overline{X}$	98.4	99.4	35.6	36.4	17.0	18.0	17.7	17.8	9.4	32.3
	S	15.0	16.8	17.3	16.6	10.8	10.3	15.1	15.5	2.0	6.2
	N	169	171	173	169	173	164	179	179	179	179
mom C age 5-10	$\overline{X}$	106.5	108.0	39.1	39.2	20.1	20.3	26.0	16.8	13.9	35.7
	S	17.6	16.1	16.6	16.4	10.6	10.4	15.9	11.9	1.8	6.1
	N	716	717	699	696	699	691	746	746	746	746
mom NC age 11-14	$\overline{X}$	96.3	92.9	33.2	34.0	13.6	14.7	18.6	19.0	9.1	36.8
	S	13.7	14.9	18.5	18.1	12.1	11.9	17.2	14.4	2.4	6.1
	N	200	200	188	184	188	174	204	204	204	204
mom C age 11-14	$\overline{X}$	105.5	104.6	37.1	37.5	16.5	17.1	27.1	16.1	13.7	39.8
	S	16.0	17.4	18.5	18.3	12.1	11.9	16.6	11.9	1.7	5.8
	N	1058	1059	1033	1024	1033	1000	1085	1082	1085	1085
mom NC age 15+	$\overline{X}$	93.3	92.9	30.2	30.9	11.5	13.5	21.0	20.1	8.6	40.7
	S	13.1	16.2	19.3	18.9	12.0	11.9	17.2	15.3	2.9	5.7
	N	171	173	165	161	165	141	177	177	177	177
mom C age 15+	$\overline{X}$	101.9	103.5	29.2	30.3	11.3	13.0	29.2	15.3	13.7	43.4
	S	16.1	20.5	19.7	19.2	11.9	11.9	17.1	10.4	1.8	5.4
	N	919	920	880	848	880	766	946	945	946	946
		Panel C: Mother working status									
No work	$\overline{X}$	102.8	102.4	39.0	39.5	17.0	18.3	0.0	23.9	12.2	39.9
	S	17.0	19.6	19.9	19.6	13.0	12.6	0.0	15.8	2.9	6.4
	N	478	478	465	459	465	433	528	526	511	528
Part-time (1-25 hours)	$\overline{X}$	104.5	104.7	36.8	37.2	16.5	17.4	14.1	19.5	12.8	38.9
	S	17.2	18.4	18.2	17.8	11.7	11.3	7.3	13.5	2.9	7.0
	N	933	938	923	912	923	873	1020	1018	988	1020
Full time (25+ hours)	$\overline{X}$	102.4	102.9	32.6	33.3	14.5	15.6	38.6	13.1	13.3	39.5
	S	15.9	18.0	18.7	18.2	11.9	11.7	8.6	9.0	2.3	6.5
	N	1941	1943	1875	1836	1875	1746	2127	2127	2044	2127
Total	$\overline{X}$	103.0	103.3	34.7	35.3	15.4	16.5	26.2	16.4	13.0	39.4
	S	16.4	18.4	18.9	18.5	12.1	11.7	16.9	12.3	2.6	6.7
	N	3352	3359	3263	3207	3263	3052	3675	3671	3543	3675

Notes: (1) We restrict the sample to children whose Primary Care Giver (PCG) is his/her biological mother.
(2) Mom C stands for mother with college education; Mom NC for mother with no college.

Table 2: Descriptive statistics (II)

Bin	Stat	Child fem	Child white	Child black	Fem Head	HQI	Avg log fam inc	Avg log w childcare	Avg log w housekeep	Avg log w offered	Avg child inc subsidy
		Panel A: Child gender and Child Age									
male age 5-10	$\overline{X}$	0.00	0.52	0.34	0.26	16.7	9.12	3.42	5.04	5.94	175.1
	S	0.00	0.50	0.48	0.44	3.5	0.87	0.73	0.47	0.13	41.4
	N	511	511	511	511	453	511	511	511	511	511
female age 5-10	$\overline{X}$	1.00	0.52	0.33	0.28	16.7	9.06	3.47	5.11	5.93	176.4
	S	0.00	0.50	0.47	0.45	3.6	0.95	0.64	0.41	0.12	41.3
	N	450	450	450	450	406	450	448	448	448	448
male age 11-14	$\overline{X}$	0.00	0.47	0.40	0.35	16.3	9.10	3.47	4.98	5.89	164.9
	S	0.00	0.50	0.49	0.48	3.8	0.93	0.73	0.48	0.15	43.3
	N	658	658	658	658	528	658	658	658	658	658
female age 11-14	$\overline{X}$	1.00	0.51	0.38	0.33	16.3	9.11	3.51	5.01	5.88	166.0
	S	0.00	0.50	0.49	0.47	3.9	1.00	0.70	0.45	0.15	43.4
	N	679	679	679	679	562	678	678	678	678	678
male age 15+	$\overline{X}$	0.00	0.46	0.44	0.33	16.3	9.18	3.54	5.04	5.89	169.5
	S	0.00	0.50	0.50	0.47	3.7	0.93	0.71	0.49	0.14	43.8
	N	565	565	565	565	456	564	565	565	565	565
female age 15+	$\overline{X}$	1.00	0.48	0.39	0.32	16.3	9.18	3.50	5.00	5.89	168.3
	S	0.00	0.50	0.49	0.47	3.8	1.00	0.64	0.49	0.15	43.7
	N	597	597	597	597	490	594	597	597	597	597
		Panel B: Mother College and Child Age									
mom NC age 5-10	$\overline{X}$	0.49	0.27	0.45	0.39	14.9	8.32	3.44	5.07	5.90	170.6
	S	0.50	0.44	0.50	0.49	4.3	0.94	0.65	0.51	0.12	41.1
	N	179	179	179	179	157	179	179	179	179	179
mom C age 5-10	$\overline{X}$	0.47	0.58	0.31	0.24	17.1	9.28	3.46	5.08	5.95	176.5
	S	0.50	0.49	0.46	0.43	3.2	0.78	0.70	0.42	0.12	41.6
	N	746	746	746	746	670	746	744	744	744	744
mom NC age 11-14	$\overline{X}$	0.53	0.23	0.46	0.46	14.3	8.19	3.47	4.95	5.85	154.0
	S	0.50	0.42	0.50	0.50	4.7	0.92	0.62	0.49	0.14	41.3
	N	204	204	204	204	163	204	204	204	204	204
mom C age 11-14	$\overline{X}$	0.51	0.55	0.37	0.33	16.6	9.28	3.49	5.00	5.89	167.9
	S	0.50	0.50	0.48	0.47	3.6	0.87	0.73	0.47	0.15	43.8
	N	1085	1085	1085	1085	884	1084	1084	1084	1084	1084
mom NC age 15+	$\overline{X}$	0.55	0.16	0.48	0.43	15.1	8.32	3.50	4.96	5.86	155.6
	S	0.50	0.37	0.50	0.50	4.0	0.93	0.59	0.51	0.14	41.6
	N	177	177	177	177	136	173	177	177	177	177
mom C age 15+	$\overline{X}$	0.51	0.54	0.40	0.31	16.5	9.34	3.52	5.03	5.90	171.3
	S	0.50	0.50	0.49	0.46	3.6	0.90	0.69	0.48	0.14	43.8
	N	946	946	946	946	778	946	946	946	946	946
		Panel C: Mother working status									
No work	$\overline{X}$	0.50	0.50	0.34	0.27	16.1	8.76	3.53	4.95	5.88	162.8
	S	0.50	0.50	0.47	0.44	4.2	1.29	0.70	0.47	0.15	41.9
	N	528	528	528	528	412	523	528	528	528	528
Part-time (1-25 hours)	$\overline{X}$	0.49	0.57	0.29	0.24	16.5	9.02	3.45	5.05	5.92	172.2
	S	0.50	0.50	0.45	0.43	3.8	1.01	0.72	0.46	0.14	43.3
	N	1020	1020	1020	1020	817	1020	1017	1017	1017	1017
Full time (25+ hours)	$\overline{X}$	0.49	0.46	0.44	0.37	16.5	9.27	3.49	5.02	5.90	170.4
	S	0.50	0.50	0.50	0.48	3.5	0.78	0.68	0.48	0.14	43.5
	N	2127	2127	2127	2127	1689	2127	2127	2127	2127	2127
Total	$\overline{X}$	0.49	0.49	0.38	0.32	16.4	9.13	3.48	5.02	5.90	169.8
	S	0.50	0.50	0.49	0.47	3.7	0.95	0.70	0.47	0.14	43.3
	N	3675	3675	3675	3675	2918	3670	3672	3672	3672	3672

Notes: (1) We restrict the sample to children whose Primary Care Giver (PCG) is his/her biological mother.
(2) Mom C stands for mother with college education; Mom NC for mother with no college.

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

		log (hours worked + 1/60)	log (hours housew + 1/60)	log hours worked > 0	log hours housew > 0	log (hours worked + 1/60)	log (hours housew + 1/60)	log hours worked > 0	log hours housew > 0
		All				Child age 5-10			
log (total shared	ρ	-0.073***	0.076***	-0.084***	0.086***	-0.118***	0.162***	-0.108***	0.205***
time + 1/60)	N	3263	3259	2798	3231	907	907	791	900
log (total shared	ρ	-0.094***	0.092***	-0.102***	0.088***	-0.151***	0.147***	-0.181***	0.184***
time), time > 0	N	3207	3204	2748	3176	900	900	784	893
log (active shared	ρ	-0.036***	0.081***	-0.075***	0.114***	-0.034	0.115***	-0.068**	0.156***
time + 1/60)	N	3263	3259	2798	3231	907	907	791	900
log (active shared	ρ	-0.068***	0.059***	-0.083***	0.069***	-0.081***	0.096***	-0.102***	0.133***
time), time > 0	N	3052	3049	2619	3021	890	890	777	883
		Child age 11-14				Child age 15+			
log (total shared	ρ	-0.028	0.066***	-0.05**	0.07***	-0.084***	0.06***	-0.066***	0.051**
time + 1/60)	N	1264	1261	1067	1246	1084	1083	933	1077
log (total shared	ρ	-0.058***	0.089***	-0.042*	0.081***	-0.097***	0.087***	-0.077***	0.056**
time), time > 0	N	1251	1249	1057	1234	1048	1047	900	1041
log (active shared	ρ	-0.039*	0.058***	-0.054**	0.09***	-0.022	0.106***	-0.037	0.129***
time + 1/60)	N	1264	1261	1067	1246	1084	1083	933	1077
log (active shared	ρ	-0.046*	0.059***	-0.055**	0.073***	-0.079***	0.06**	-0.039	0.045*
time), time > 0	N	1213	1211	1023	1196	941	940	812	934
		Mother no college				Mother college			
log (total shared	ρ	-0.008	0.094***	-0.018	0.139***	-0.099***	0.07***	-0.100***	0.076***
time + 1/60)	N	527	527	388	518	2619	2615	2308	2600
log (total shared	ρ	-0.069*	0.078**	-0.12***	0.094***	-0.108***	0.09***	-0.100***	0.089***
time), time > 0	N	515	515	380	506	2575	2572	2266	2557
log (active shared	ρ	-0.023	0.042	-0.073*	0.096***	-0.051***	0.102***	-0.079***	0.128***
time + 1/60)	N	527	527	388	518	2619	2615	2308	2600
log (active shared	ρ	-0.097***	0.038	-0.152***	0.059	-0.075***	0.068***	-0.071***	0.075***
time), time > 0	N	480	480	355	471	2464	2461	2171	2446

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 in Applied Problems

	OLS		**IV 1**			**IV 2**			**IV 3**			**IV 4**		
	γ	δ_0	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**
All	1.537***	0.281	19.811***	-1.05*	40.522	19.331***	-1.015*	48.938	20.026***	-1.066*	45.845	18.219***	-0.932	54.999
	[4.05]	[0.61]	[7.46]	[1.34]	1740	[8.1]	[1.33]	1740	[7.96]	[1.36]	1740	[8.37]	[1.27]	1740
Mother	1.383***	0.611	17.317***	-1.061	15.14	16.092***	-0.933	20.585	16.942***	-1.022	17.929	15.619***	-0.883	21.425
educ $\leq$ 12	[2.86]	[0.87]	[4.67]	[0.87]	797	[5.14]	[0.81]	797	[4.93]	[0.85]	797	[5.2]	[0.78]	797
Mother	1.731***	0.014	22.250***	-1.066	27.234	22.483***	-1.079	29.742	22.956***	-1.104	29.707	20.530***	-0.973	36.198
educ $>$ 12	[2.88]	[0.02]	[5.89]	[1.05]	943	[6.32]	[1.06]	943	[6.36]	[1.07]	943	[6.68]	[1.02]	943
Male	1.660***	0.636	19.682***	-1.139	22.984	19.503***	-1.121	26.052	19.789***	-1.15	26.649	17.168***	-0.892	34.839
Child	[3.11]	[0.93]	[5.66]	[0.99]	874	[5.96]	[0.98]	874	[6.07]	[1]	874	[6.42]	[0.85]	874
Female	1.387***	-0.059	19.967***	-0.983	18.034	19.045***	-0.935	23.442	20.175***	-0.994	20.348	18.933***	-0.929	23.096
Child	[2.56]	[0.09]	[4.95]	[0.93]	866	[5.55]	[0.91]	866	[5.29]	[0.93]	866	[5.52]	[0.91]	866
White	1.841***	0.639	24.802***	-0.394	29.612	23.702***	-0.343	37.373	23.980***	-0.356	36.817	22.183***	-0.273	41.775
Child	[2.84]	[1.04]	[6.41]	[0.38]	961	[7.02]	[0.34]	961	[6.96]	[0.35]	961	[7.15]	[0.28]	961
Black	0.806*	0.207	15.195***	-1.652	8.966	15.124***	-1.642	9.837	16.241***	-1.787	9.272	12.504***	-1.304	17.816
Child	[1.57]	[0.26]	[3.05]	[1.18]	630	[3.52]	[1.21]	630	[3.55]	[1.25]	630	[4.34]	[1.11]	630
Low	1.088***	-0.12	18.281***	-3.045***	14.57	18.638***	-3.106***	16.234	18.804***	-3.134***	16.604	18.023***	-3.002***	16.767
Income	[2.15]	[0.15]	[4.52]	[2.05]	771	[4.73]	[2.08]	771	[4.8]	[2.09]	771	[4.82]	[2.07]	771
High	2.405***	0.384	20.606***	0.043	27.998	19.172***	0.072	36.038	20.208***	0.051	32.283	17.534***	0.106	43.718
Income	[4.06]	[0.67]	[6.15]	[0.05]	969	[6.78]	[0.09]	969	[6.56]	[0.06]	969	[7.03]	[0.13]	969
Male	1.617***	0.708*	21.179***	-1.063	32.643	20.736***	-1.022	39.068	21.740***	-1.114	35.421	20.727***	-1.021	38.019
Head	[2.94]	[1.31]	[6.54]	[1.16]	1198	[7.07]	[1.14]	1198	[6.91]	[1.2]	1198	[7.01]	[1.14]	1198
Female	1.156***	-0.901	16.422***	-1.971*	10.1	15.551***	-1.91*	12.921	14.896***	-1.864*	14.961	12.343***	-1.685*	21.337
Head	[2.03]	[0.97]	[3.74]	[1.29]	542	[4.06]	[1.3]	542	[4.08]	[1.3]	542	[4.57]	[1.32]	542

Notes:

1. Unreported regressors include female child dummy and mother education. Home Quality Index is the physical investment measure.
2. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
3. Test-t are in brackets below estimated coefficients.
4. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 5: Effects of Log total maternal time in Word-Letter Identification

	OLS		**IV 1**			**IV 2**			**IV 3**			**IV 4**		
	γ	δ_0	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**
All	1.171***	-2.078***	8.184***	-2.527***	39.91	8.000***	-2.514***	47.92	7.962***	-2.511***	44.98	7.429***	-2.473***	54.12
	[3.33]	[4.84]	[4.79]	[5.05]	1748	[5.12]	[5.08]	1748	[4.72]	[5.06]	1748	[4.75]	[5.08]	1748
Mother	1.390***	-2.061***	7.197***	-2.652***	14.41	6.528***	-2.584***	19.38	6.768***	-2.608***	16.96	7.325***	-2.665***	20.49
educ ≤ 12	[3.39]	[3.46]	[3.14]	[3.69]	802	[3.3]	[3.73]	802	[3.13]	[3.71]	802	[3.58]	[3.73]	802
Mother	0.874*	-2.125***	9.093***	-2.469***	27.54	9.445***	-2.487***	30.07	9.168***	-2.473***	30.04	7.542***	-2.387***	36.51
educ > 12	[1.48]	[3.51]	[3.59]	[3.57]	946	[3.86]	[3.57]	946	[3.66]	[3.57]	946	[3.24]	[3.59]	946
Male	1.407***	-1.941***	9.747***	-2.73***	23.26	9.906***	-2.745***	26.25	9.717***	-2.727***	26.87	8.349***	-2.597***	34.98
Child	[2.93]	[3.16]	[4.27]	[3.58]	875	[4.53]	[3.59]	875	[4.15]	[3.57]	875	[4.01]	[3.59]	875
Female	0.893**	-2.222***	6.030***	-2.383***	17.23	5.684***	-2.366***	22.27	5.649***	-2.364***	19.43	5.764***	-2.37***	22.24
Child	[1.73]	[3.7]	[2.38]	[3.65]	873	[2.55]	[3.67]	873	[2.34]	[3.66]	873	[2.51]	[3.66]	873
White	0.707	-1.668***	12.163***	-2.092***	29.6	11.406***	-2.058***	36.97	11.154***	-2.047***	36.54	10.208***	-2.005***	41.52
Child	[1.15]	[2.85]	[4.51]	[2.9]	965	[4.79]	[2.93]	965	[4.55]	[2.93]	965	[4.48]	[2.95]	965
Black	0.899***	-2.32***	4.805**	-2.804***	8.591	4.380**	-2.751***	9.476	3.560*	-2.65***	8.836	3.372**	-2.626***	17.35
Child	[2.06]	[3.46]	[1.82]	[3.57]	635	[1.79]	[3.59]	635	[1.42]	[3.51]	635	[1.82]	[3.64]	635
Low	1.118***	-2.41***	7.841***	-3.505***	14.05	7.314***	-3.419***	15.56	7.143***	-3.391***	15.93	8.832***	-3.666***	16.1
Income	[2.55]	[3.51]	[3.12]	[3.92]	775	[3.02]	[3.92]	775	[2.86]	[3.88]	775	[3.24]	[3.9]	775
High	1.387***	-1.952***	8.352***	-2.016***	28.07	8.764***	-2.025***	35.83	8.348***	-2.016***	32.26	6.408***	-1.975***	43.73
Income	[2.4]	[3.48]	[3.62]	[3.27]	973	[4.2]	[3.25]	973	[3.73]	[3.27]	973	[3.37]	[3.35]	973
Male	0.844*	-2.177***	9.700***	-2.903***	32.26	9.715***	-2.905***	38.29	9.774***	-2.91***	34.96	9.546***	-2.89***	37.78
Head	[1.59]	[4.18]	[4.3]	[4.58]	1203	[4.66]	[4.62]	1203	[4.38]	[4.59]	1203	[4.34]	[4.59]	1203
Female	1.072***	-1.203*	4.470**	-1.432**	9.897	3.988**	-1.399**	12.64	2.859*	-1.323**	14.53	2.825*	-1.321**	20.53
Head	[2.26]	[1.55]	[1.84]	[1.73]	545	[1.85]	[1.72]	545	[1.4]	[1.67]	545	[1.59]	[1.67]	545

Notes:

1. Unreported regressors include female child dummy and mother education. Home Quality Index is the physical investment measure.
2. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
3. Test-t are in brackets below estimated coefficients.
4. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 6: Effects of Log total active maternal time in Applied Problems

	OLS		**IV 1**			**IV 2**			**IV 3**			**IV 4**		
	γ	δ_0	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**
All	1.315***	0.33	9.215***	1.144**	68.922	9.388***	1.161**	76.329	9.353***	1.158**	77.745	9.327***	1.155**	76.625
	[5.01]	[0.71]	[8.9]	[1.76]	1740	[9.35]	[1.77]	1740	[9.45]	[1.77]	1740	[9.34]	[1.77]	1740
Mother	1.058***	0.713	7.234***	1.248*	32.216	7.588***	1.279*	33.211	7.444***	1.266*	33.793	7.552***	1.276*	32.96
educ $\leq$ 12	[3.14]	[1.02]	[5.63]	[1.33]	797	[6.03]	[1.33]	797	[6.02]	[1.33]	797	[5.99]	[1.33]	797
Mother	1.630***	0.028	10.847***	1.087	41.474	11.122***	1.118	45.169	11.206***	1.127	46.324	11.002***	1.104	46.081
educ > 12	[3.95]	[0.05]	[6.91]	[1.24]	943	[7.23]	[1.26]	943	[7.37]	[1.27]	943	[7.26]	[1.26]	943
Male	1.654***	0.744	8.397***	1.335*	49.31	8.446***	1.339*	54.35	8.552***	1.349*	55.976	8.485***	1.343*	54.044
Child	[4.47]	[1.11]	[7.21]	[1.52]	874	[7.54]	[1.52]	874	[7.68]	[1.52]	874	[7.54]	[1.52]	874
Female	0.933***	-0.073	10.728***	1.088	21.728	11.088***	1.13	24.267	10.897***	1.108	24.419	10.788***	1.095	25.102
Child	[2.5]	[0.12]	[5.3]	[1.08]	866	[5.56]	[1.1]	866	[5.62]	[1.09]	866	[5.6]	[1.09]	866
White	1.476***	0.66	12.485***	1.515**	42.979	12.076***	1.484**	53.036	12.094***	1.486**	53.145	11.922***	1.472**	52.377
Child	[3.22]	[1.07]	[7.13]	[1.65]	961	[7.74]	[1.65]	961	[7.73]	[1.65]	961	[7.65]	[1.65]	961
Black	0.611**	0.144	6.042***	0.482	19.949	6.476***	0.509	19.934	6.719***	0.525	20.543	6.697***	0.523	23.167
Child	[1.72]	[0.18]	[4.13]	[0.48]	630	[4.19]	[0.49]	630	[4.44]	[0.5]	630	[4.68]	[0.5]	630
Low	1.129***	-0.09	7.787***	-0.352	30.103	8.145***	-0.367	31.329	8.060***	-0.363	33.444	8.005***	-0.361	31.991
Income	[3.26]	[0.12]	[5.67]	[0.34]	771	[5.92]	[0.34]	771	[6.11]	[0.34]	771	[5.94]	[0.34]	771
High	1.878***	0.475	10.428***	2.086***	40.744	10.101***	2.025***	49.078	10.231***	2.050***	47.649	10.100***	2.025***	48.417
Income	[4.47]	[0.83]	[7]	[2.51]	969	[7.47]	[2.5]	969	[7.42]	[2.51]	969	[7.42]	[2.5]	969
Male	1.667***	0.733*	10.619***	1.556***	49.217	10.505***	1.546***	58.246	10.547***	1.550***	58.208	10.621***	1.556***	55.486
Head	[4.25]	[1.36]	[7.6]	[2.04]	1198	[8.12]	[2.04]	1198	[8.13]	[2.04]	1198	[7.95]	[2.04]	1198
Female	0.918***	-0.719	6.787***	-0.354	23.144	7.031***	-0.339	24.068	7.114***	-0.334	24.24	6.837***	-0.351	26.299
Head	[2.34]	[0.78]	[4.69]	[0.3]	542	[4.83]	[0.28]	542	[4.93]	[0.27]	542	[5.01]	[0.29]	542

Notes:

1. Unreported regressors include female child dummy and mother education. Home Quality Index is the physical investment measure.
2. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
3. Test-t are in brackets below estimated coefficients.
4. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 7: Effects of Log total active maternal time in Word-Letter Identification

	OLS		**IV 1**			**IV 2**			**IV 3**			**IV 4**		
	γ	δ_0	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**	γ	δ_0	**CD/N**
All	0.838***	-2.032***	3.804***	-1.662***	67.58	3.912***	-1.651***	74.7	3.840***	-1.658***	76.17	4.205***	-1.619***	75.03
	[3.45]	[4.75]	[5.06]	[3.58]	1748	[5.42]	[3.54]	1748	[5.29]	[3.57]	1748	[5.64]	[3.42]	1748
Mother	0.811***	-1.887***	2.582***	-1.732***	30.45	3.257***	-1.672***	31.24	3.063***	-1.689***	31.79	3.733***	-1.631***	31.2
educ ≤ 12	[2.83]	[3.17]	[2.91]	[2.78]	802	[3.72]	[2.6]	802	[3.52]	[2.65]	802	[4.11]	[2.46]	802
Mother	0.837***	-2.196***	4.616***	-1.649***	41.96	4.563***	-1.655***	45.75	4.589***	-1.652***	46.99	4.724***	-1.636***	46.4
educ > 12	[2.08]	[3.63]	[3.91]	[2.48]	946	[3.98]	[2.5]	946	[4.02]	[2.49]	946	[4.03]	[2.45]	946
Male	0.967***	-1.813***	4.072***	-1.508***	49.39	4.291***	-1.487***	54.21	4.154***	-1.5***	55.99	4.525***	-1.464***	53.63
Child	[2.89]	[2.97]	[4.62]	[2.27]	875	[5.03]	[2.21]	875	[4.84]	[2.25]	875	[5.06]	[2.15]	875
Female	0.677**	-2.257***	3.314***	-1.848***	20.58	3.192***	-1.862***	23.06	3.237***	-1.857***	23.21	3.583***	-1.817***	24.02
Child	[1.91]	[3.75]	[2.45]	[2.84]	873	[2.48]	[2.88]	873	[2.51]	[2.87]	873	[2.78]	[2.77]	873
White	0.716**	-1.676***	6.050***	-1.127**	43.19	5.779***	-1.15**	52.85	5.574***	-1.168**	53.33	5.746***	-1.153**	52.3
Child	[1.65]	[2.88]	[4.75]	[1.67]	965	[5.01]	[1.73]	965	[4.81]	[1.77]	965	[4.93]	[1.74]	965
Black	0.249	-2.341***	1.660*	-2.251***	18.5	1.734*	-2.246***	18.43	1.659*	-2.251***	18.99	2.230***	-2.215***	21.58
Child	[0.81]	[3.47]	[1.55]	[3.25]	635	[1.64]	[3.24]	635	[1.61]	[3.25]	635	[2.22]	[3.12]	635
Low	0.679***	-2.326***	3.377***	-2.392***	28.51	3.396***	-2.392***	29.58	3.158***	-2.386***	31.68	3.921***	-2.405***	30.1
Income	[2.26]	[3.42]	[3.46]	[3.26]	775	[3.53]	[3.25]	775	[3.33]	[3.29]	775	[3.86]	[3.17]	775
High	1.196***	-1.917***	4.241***	-1.269***	41.27	4.565***	-1.209**	49.63	4.372***	-1.245***	48.2	4.423***	-1.235***	48.98
Income	[2.92]	[3.42]	[3.79]	[2.04]	973	[4.35]	[1.94]	973	[4.11]	[2.01]	973	[4.18]	[1.99]	973
Male	1.010***	-2.236***	4.966***	-1.781***	49.11	5.021***	-1.776***	57.82	4.790***	-1.798***	58.15	5.196***	-1.759***	55.4
Head	[2.67]	[4.31]	[4.69]	[3.09]	1203	[5.06]	[3.08]	1203	[4.82]	[3.15]	1203	[5.04]	[3.03]	1203
Female	0.376	-1.087*	1.602*	-1.013*	22.07	1.841**	-0.999	22.72	1.745**	-1.005	22.88	2.122***	-0.982	24.65
Head	[1.14]	[1.42]	[1.64]	[1.3]	545	[1.9]	[1.27]	545	[1.8]	[1.28]	545	[2.2]	[1.24]	545

Notes:

1. Unreported regressors include female child dummy and mother education. Home Quality Index is the physical investment measure.
2. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
3. Test-t are in brackets below estimated coefficients.
4. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 8: First stage for Log total maternal time

	IV 1				**IV 2**				**IV 3**				**IV 4**			
	z_t	$z_t \times a_t$	x^*_{t-5}	R^2 / N	z_t	$z_t \times a_t$	x^*_{t-5}	R^2 / N	z_t	$z_t \times a_t$	x^*_{t-5}	R^2 / N	z_t	$z_t \times a_t$	x^*_{t-5}	R^2 / N
All	0.342***	-0.027***	0.025***	0.065	0.131***	-0.02***	0.022***	0.073	-0.131	-0.017***	0.024***	0.07	0.006***	-0.001***	0.022**	0.079
	[5.9]	[8.85]	[2.21]	1748	[2.01]	[9.42]	[1.96]	1748	[0.64]	[9.34]	[2.1]	1748	[5.8]	[9.81]	[1.9]	1748
Mother	0.379***	-0.027***	0.028**	0.058	0.08	-0.021***	0.026*	0.069	-0.352	-0.017***	0.024*	0.064	0.005***	-0.001***	0.024*	0.071
educ <= 12	[3.82]	[5.37]	[1.65]	802	[0.77]	[5.88]	[1.52]	802	[1.04]	[5.52]	[1.41]	802	[3.12]	[5.85]	[1.41]	802
Mother	0.315***	-0.027***	0.024*	0.065	0.168***	-0.02***	0.022*	0.069	0.07	-0.017***	0.024*	0.069	0.007***	-0.001***	0.022*	0.081
educ > 12	[4.58]	[7.21]	[1.57]	946	[2.07]	[7.54]	[1.38]	946	[0.28]	[7.75]	[1.56]	946	[5.01]	[8.15]	[1.4]	946
Male	0.371***	-0.03***	0.037***	0.075	0.146*	-0.022***	0.035***	0.081	-0.365	-0.019***	0.036***	0.083	0.006***	-0.001***	0.034***	0.098
Child	[4.38]	[6.69]	[2.27]	875	[1.56]	[6.96]	[2.12]	875	[1.23]	[7.06]	[2.21]	875	[3.68]	[7.52]	[2.09]	875
Female	0.331***	-0.025***	0.013	0.054	0.123*	-0.019***	0.01	0.065	0.104	-0.016***	0.012	0.059	0.007***	-0.001***	0.01	0.065
Child	[4.11]	[5.86]	[0.82]	873	[1.35]	[6.45]	[0.63]	873	[0.37]	[6.23]	[0.74]	873	[4.64]	[6.55]	[0.64]	873
White	0.367***	-0.026***	0.038***	0.07	0.172***	-0.02***	0.037***	0.083	-0.149	-0.017***	0.037***	0.082	0.006***	-0.001***	0.035***	0.091
Child	[6.08]	[7.69]	[2.14]	965	[2.32]	[8.48]	[2.09]	965	[0.61]	[8.37]	[2.09]	965	[5.5]	[8.81]	[2.02]	965
Black	0.144	-0.023***	0.005	0.044	0.005	-0.016***	-0.002	0.046	-0.538*	-0.014***	-0.003	0.044	0.002	-0.001***	-0.01	0.069
Child	[1.07]	[3.73]	[0.25]	635	[0.04]	[3.7]	[0.12]	635	[1.41]	[3.81]	[0.17]	635	[0.95]	[4.24]	[0.55]	635
Low	0.297***	-0.027***	0.016	0.057	0.117	-0.02***	0.012	0.06	-0.402	-0.017***	0.011	0.061	0.006***	-0.001***	0.012	0.061
Income	[2.92]	[5.15]	[1]	775	[1.12]	[5.39]	[0.73]	775	[1.17]	[5.4]	[0.68]	775	[3.55]	[5.52]	[0.75]	775
High	0.364***	-0.028***	0.033**	0.073	0.135*	-0.021***	0.031*	0.087	-0.015	-0.018***	0.031*	0.081	0.006***	-0.001***	0.029*	0.101
Income	[5.34]	[7.46]	[1.69]	973	[1.63]	[8.09]	[1.61]	973	[0.06]	[7.99]	[1.61]	973	[4.55]	[8.5]	[1.54]	973
Male	0.334***	-0.026***	0.041***	0.082	0.117**	-0.019***	0.038***	0.091	0.036	-0.016***	0.041***	0.086	0.006***	-0.001***	0.038***	0.09
Head	[5.54]	[7.96]	[2.18]	1203	[1.66]	[8.42]	[2.06]	1203	[0.16]	[8.34]	[2.18]	1203	[5.48]	[8.43]	[2.05]	1203
Female	0.378***	-0.03***	-0.005	0.04	0.117	-0.023***	-0.011	0.049	-0.82***	-0.019***	-0.016	0.056	0.006***	-0.001***	-0.02	0.075
Head	[2.71]	[4.43]	[0.25]	545	[0.84]	[4.74]	[0.56]	545	[1.98]	[4.71]	[0.84]	545	[2.44]	[5.51]	[1.02]	545

Notes:

1. First-stage estimates come from the sample of valid Word-Letter Identification test. Minor differences occur for samples of other tests.
2. Unreported regressors include female child dummy, mother education and Home Quality Index.
3. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
4. Test-t are in brackets below estimated coefficients.
5. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

Table 9: First stage for Log active maternal time

	IV 1				**IV 2**				**IV 3**				**IV 4**			
	IV	**IV** $\times a$	x^*_{t-5}	R^2 / N	**IV**	**IV** $\times a$	x^*_{t-5}	R^2 / N	**IV**	**IV** $\times a$	x^*_{t-5}	R^2 / N	**IV**	**IV** $\times a$	x^*_{t-5}	R^2 / N
All	0.858***	-0.056***	0.085***	0.107	0.580***	-0.042***	0.085***	0.113	0.274	-0.036***	0.083***	0.115	0.016***	-0.001***	0.084***	0.114
	[9.41]	[11.59]	[4.64]	1748	[5.68]	[12.22]	[4.62]	1748	[0.86]	[12.34]	[4.55]	1748	[9.46]	[12.24]	[4.57]	1748
Mother	1.098***	-0.06***	0.080***	0.095	0.582***	-0.045***	0.082***	0.096	0.053	-0.038***	0.078***	0.097	0.016***	-0.001***	0.082***	0.096
educ <= 12	[7.01]	[7.42]	[2.87]	802	[3.52]	[7.9]	[2.93]	802	[0.1]	[7.91]	[2.75]	802	[5.94]	[7.88]	[2.91]	802
Mother	0.705***	-0.053***	0.094***	0.114	0.572***	-0.039***	0.093***	0.121	0.432	-0.034***	0.092***	0.123	0.015***	-0.001***	0.091***	0.122
educ > 12	[6.61]	[9.12]	[3.88]	946	[4.56]	[9.56]	[3.84]	946	[1.13]	[9.68]	[3.81]	946	[7.56]	[9.63]	[3.77]	946
Male	1.057***	-0.07***	0.095***	0.131	0.667***	-0.051***	0.094***	0.14	0.037	-0.044***	0.092***	0.143	0.018***	-0.001***	0.092***	0.139
Child	[8]	[9.93]	[3.61]	875	[4.57]	[10.4]	[3.59]	875	[0.08]	[10.54]	[3.53]	875	[7.55]	[10.32]	[3.52]	875
Female	0.669***	-0.043***	0.081***	0.074	0.500***	-0.032***	0.081***	0.079	0.525	-0.028***	0.080***	0.079	0.014***	-0.001***	0.081***	0.081
Child	[5.28]	[6.36]	[3.14]	873	[3.51]	[6.77]	[3.14]	873	[1.2]	[6.79]	[3.13]	873	[5.71]	[6.93]	[3.13]	873
White	0.820***	-0.052***	0.054**	0.1	0.389***	-0.04***	0.051**	0.116	-0.159	-0.034***	0.047**	0.117	0.015***	-0.001***	0.051**	0.115
Child	[8.27]	[9.17]	[1.87]	965	[3.21]	[10.2]	[1.78]	965	[0.4]	[10.19]	[1.66]	965	[8.07]	[10.23]	[1.8]	965
Black	0.773***	-0.059***	0.065***	0.079	0.726***	-0.041***	0.068***	0.079	0.037	-0.036***	0.061***	0.081	0.013***	-0.001***	0.053**	0.088
Child	[3.7]	[6.07]	[2.2]	635	[3.73]	[6.04]	[2.27]	635	[0.06]	[6.14]	[2]	635	[3.63]	[6.19]	[1.78]	635
Low	0.961***	-0.063***	0.073***	0.087	0.712***	-0.044***	0.075***	0.09	-0.109	-0.039***	0.066***	0.094	0.017***	-0.001***	0.072***	0.091
Income	[5.97]	[7.52]	[2.77]	775	[4.36]	[7.61]	[2.83]	775	[0.2]	[7.92]	[2.46]	775	[6.08]	[7.76]	[2.7]	775
High	0.782***	-0.052***	0.087***	0.126	0.447***	-0.04***	0.083***	0.14	0.345	-0.034***	0.083***	0.137	0.015***	-0.001***	0.081***	0.139
Income	[7.37]	[9.07]	[3.05]	973	[3.48]	[9.87]	[2.95]	973	[0.88]	[9.82]	[2.92]	973	[7.49]	[9.86]	[2.87]	973
Male	0.761***	-0.051***	0.083***	0.11	0.393***	-0.039***	0.081***	0.122	0.124	-0.033***	0.080***	0.123	0.015***	-0.001***	0.081***	0.119
Head	[8.04]	[9.9]	[3.06]	1203	[3.59]	[10.66]	[3.02]	1203	[0.35]	[10.77]	[2.97]	1203	[8.26]	[10.52]	[3.01]	1203
Female	1.169***	-0.07***	0.038	0.087	0.913***	-0.05***	0.045*	0.089	-0.051	-0.043***	0.032	0.089	0.018***	-0.002***	0.029	0.095
Head	[5.35]	[6.53]	[1.21]	545	[4.17]	[6.65]	[1.41]	545	[0.08]	[6.7]	[0.99]	545	[4.88]	[6.94]	[0.91]	545

Notes:

1. First-stage estimates come from the sample of valid Word-Letter Identification test. Minor differences occur for samples of other tests.
2. Unreported regressors include female child dummy, mother education and Home Quality Index.
3. IV1 are Avg log wage child care occupation by state & year (CPS) and child age interaction. IV2 are Avg log wage housekeeping by state & year (CPS) and child age interaction. IV3 are Avg log wage offered by state & year (CPS) and child age interaction. IV4 are Avg income child subsidy by state & year (CPS) and child age interaction.
4. Test-t are in brackets below estimated coefficients.
5. *** Significant at 5%; ** Significant at 10%; * Significant at 20%.

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