Appendix

Towards Causal Estimates of Children's Time Allocation on Skill Development

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The appendix is organized as follows. In Section A, we provide evidence that our test is capable of detecting other sources of endogeneity, such as simultaneity, measurement error and various types of model misspecification. In Section B, we present many robustness checks, aiming at detecting endogeneity caused by types (a2) and (b) confounders and bridging our input specification with others in the literature. Section C presents estimates from a linear B-spline specification to detect possible hidden heterogeneity in our linear effects showed in Section 4 of the paper. In Section D, we discuss why selection on observables work in this context and what can and cannot be inferred from our estimates. In Section E, we explore heterogeneity in the impact of time use with respect to age. In Section F, we consider an alternative categorization of time inputs. In Section G, we show additional tables and figures, including estimates for noncognitive skills, an analogous study of the power of the test with the classification of time inputs from Fiorini and Keane (2014), estimates for all estimated models (including the ones rejected by the test), activity composition charts for all other activity partners and standard error plots of time input dummy variables.

A Additional Sources of Detectable Endogeneity

In this section, we extend the discussion from Section 3.3 of the paper. The purpose is to show that the test has power to detect endogeneity arising from a multitude of relevant sources in the context of skill production.

A.1 Simultaneity

If time inputs are caused by skills, rather than the other way around, Assumption 1 in the paper will be violated. For instance, children with low comprehension skill may be less willing to read, which may generate a spurious correlation between time spent reading and the comprehension skill measure. The test has power to detect endogeneity due to simultaneity exactly because of bunching. Indeed, the causal relationship of interest is plausibly continuous at zero, while the reverse causal relationship implies a discontinuous correlation between skill and inputs at zero minutes because children of different skills are bunched at that threshold. For instance, spending time to read the first word of the title of a book has essentially the same effect on comprehension skills as not reading it at all. In contrast, children that spend zero minutes reading should have a discontinuously lower comprehension ability in comparison to children reading a little amount, since children reading zero minutes may not even know how to read. In Figure A.1, we show that strong correlates of skill levels, such as birth weight, race, age and lagged test score, are in fact discontinuous when various time inputs are zero, suggesting that we have power to detect endogeneity stemming from simultaneity.

A.2 Measurement Error

While time diary data may mitigate concerns regarding omitted inputs, it can raise issues related to reliability. To the extent that time inputs are mismeasured, estimates of the production technology can be biased. To understand this potential source of endogeneity in detail, consider the model from equation (1) in the paper with measurement error in time inputs:

$$\text{Skill}_i = \widetilde{\text{Input}}_i\beta + \text{Control}_i\Pi + \text{Error}_i,$$

where $\widetilde{\text{Input}}_i = \text{Input}_i + \eta_i$. $\widetilde{\text{Input}}_i$ represents the true value of the vector of inputs, while Input_i represents the value observed by the researcher, so that η_i is the measurement error vector, which may vary with each observation and each input in an unrestricted way. Rewriting

the equation above,

$$\text{Skill}_i = \text{Input}_i\beta + \text{Control}_i\Pi + \underbrace{\eta_i\beta + \text{Error}_i}_{\text{Error}'_i}.$$

Thus, determinants of η_i that are correlated with Input_i are likely to generate endogeneity stemming from measurement error, unless control variables are able to absorb them. For example, children who spend more (active or passive) time alone may be more likely to fill out their own time-use survey, and children might tend to overstate certain inputs relative to adults (e.g., they might overstate the amount of time they spend with friends or other family members to conceal how often they are alone).

While we cannot observe η_i directly, the misreporting of time use data is likely to depend on the form of the interviews, such as who completed the diary (child, primary caregiver, or other), whether the interview was completed with the help of an interviewer, and whether the interview was concluded face-to-face or by phone. In Figure A.2, we show discontinuity plots of some examples of such correlates of misreporting, such as whether the child completed the time diary alone. The fact that these variables are discontinuous at zero time inputs for some inputs j suggests that the degree of misreporting is likely discontinuous, implying that our test has power to detect endogeneity stemming from measurement error. Additional examples are provided in Panels (c) and (d) of Figure A.6 in the appendix.

An alternative model of measurement error that may be relevant for our analysis is a situation where individuals who actually spend positive amounts of time in a given activity mistakenly report a zero. If the true input choices are in fact endogenous, this type of misreporting is likely to reduce the power of our test since it will tend to shrink any discontinuity at zero. The reason is that the households that are truly reporting zeros will differ discontinuously on some unobserved dimension, while the households that mistakenly report zero are closer to the average on this same dimension. This will tend to smooth out any jump. We allay this concern by showing evidence of the power of the test to detect endogeneity stemming from observed variables that may have been omitted. Indeed, to the extent that this kind of measurement error happens, it does not seem to be too important to make the discontinuity undetectable.

A.3 Misspecification

Our test is also useful for detecting misspecification errors. This is important in our context since there are countless ways to group activities and model the relationship between skill and time inputs. In particular, we make four key simplifying assumptions to arrive at Equation (1). We discuss each assumption in turn, along with evidence that key variables w_i elicited by the corresponding assumption vary discontinuously at zero.

Over-aggregation

First, we aggregate many time activities into only a few categories, which may induce endogeneity due to over-aggregation (i.e., $\tilde{J} > J$). Suppose that the true model is more disaggregated than the one from equation (1), in the sense that $\text{Input}_i^j = \text{Input}_i^{Aj} + \text{Input}_i^{Bj}$ for each j, where A and B are different time input activities that are originally included in time input activity j. Then the true model is given by

$$\text{Skill}_i = \text{Input}_i^A \beta^A + \text{Input}_i^B \beta^B + \text{Control}_i \Pi + \text{Error}_i,$$

where $\text{Input}_i^A := (\text{Input}_i^{A1}, ..., \text{Input}_i^{AJ})$ and $\text{Input}_i^B := (\text{Input}_i^{B1}, ..., \text{Input}_i^{BJ})$, so that:

$$\text{Skill}_i = \text{Input}_i \beta + \text{Control}_i \Pi + \underbrace{\text{Input}_i \left[w_i \cdot \left(\beta^A - \beta \right) + (\mathbf{1} - w_i) \cdot \left(\beta^B - \beta \right) \right] + \text{Error}_i}_{\text{Error}_i'}.$$

Here, w_i is a column vector whose *jth* element is $w_i^j := \frac{\text{Input}_i^{Aj}}{\text{Input}_i^j}$, and β is a weighted average of β^A and β^B, with w_i and $1 - w_i$ as weights, respectively. ($w_i \cdot \beta$ represents an inner product between two column vectors, and $\mathbf{1}$ represents a column vector of 1s.) If $\beta^A \neq \beta^B$ (so that $\beta^A, \beta^B \neq \beta$), then elements of w_i that are correlated with Input_i are likely to generate endogeneity, unless control variables are able to absorb them. As an example, if a subcategory of maternal active time, such as reading with the mother, increases disproportionately as active time with the mother increases, then we may arrive at a biased estimate of maternal active

time.

Figure A.3 shows discontinuities for some examples of w_i that speak directly to this potential issue. For example, Panel (a) shows that children who spend no passive time with their friends are likely to spend a discontinuously larger proportion of the active time they spend with their friends during weekends, relative to children who spend little passive time with their friends This suggests that if active time with friends is differentially productive during weekends (a type of heterogeneity precluded by our aggregation scheme) and results in endogeneity, then the indicator variable for passive time with friends would detect it. Additional examples are provided in Panels (e) and (f) of Figure A.6 in the appendix.

Heterogeneous Treatment Effects

Another source of endogeneity due to misspecification arises with heterogeneous treatment effects, i.e., $f(\widetilde{\text{Input}}_i, \text{Other}_i)$ is non-separable. For instance, mothers who read well may be more willing to read to their children, and this activity may generate a higher return to their children's skill relative to mothers who do not read well. To understand this potential source of endogeneity, assume here a model with heterogeneous effects of time inputs:

$$\text{Skill}_i = \text{Input}_i\beta_i + \text{Control}_i\Pi + \text{Error}_i,$$

Then

$$\text{Skill}_i = \text{Input}_i\beta + \text{Control}_i\Pi + \underbrace{\text{Input}_i.\,(\beta_i - \beta) + \text{Error}_i}_{\text{Error}'_i},$$

where $\beta := E[\beta_i]$. Thus, determinants of β_i that are correlated with Input_i are likely to generate endogeneity, unless control variables are able to absorb them.

The plots in Figure 4 in the paper (see also Figure A.5) depict discontinuities for examples of w_i along which heterogeneity in returns of activities likely occurs, suggesting that we can detect endogeneity resulting from heterogeneous treatment effects. For instance, Panel (a) of Figure 4 shows that lagged math score is discontinuous when passive time with friends is zero.

Thus, the test has power to detect endogeneity from heterogeneous effects to the extent that any other time input (e.g., active time with the mother) has a different effect on the child's skills depending on lagged math score.

Non-linear Treatment Effects

A third potential misspecification issue that will generate endogeneity is the presence of non-linear effects (i.e., $f(\text{Input}_i, \text{Other}_i) \neq \text{Input}_i\beta + \text{Control}_i\pi$). For instance, the effect of the 10th hour reading to the child in a week may be different from the effect of the first hour. To understand this potential source of endogeneity, assume here a model with non-linear effects of time inputs:

$$\text{Skill}_i = f(\text{Input}_i) + \text{Control}_i\Pi + \text{Error}_i,$$

where $f(\cdot)$ is continuous at $\text{Input}_i^j = 0$ for each j. We can rewrite the equation as

$$\text{Skill}_i = \text{Input}_i\beta + \text{Control}_i\Pi + \underbrace{f(\text{Input}_i) - \text{Input}_i\beta + \text{Error}_i}_{\text{Error}_i'}. \tag{5}$$

In this case, $w_i := f(\text{Input}_i, \text{Other}_i) - \text{Input}_i\beta$ might be discontinuous when inputs are zero. Panel (a) of Figure A.4 shows that $E[\text{Input}_i^{j'} | \text{Input}_i^j = x]$ is discontinuous at $x = 0$ for examples of $j \neq j'$. Children who spend zero active time with their mother spend a discontinuously larger amount of passive time with their grandparents, an average increase from 1 to 3 hours per week. If the impact of passive time with grandparents is nonlinear, then this mean shift will not be fully captured by the coefficient on grandparents passive time (e.g., $f^{j'}(3) - f^{j'}(1) \neq (3-1)\beta^{j'}$). This is direct evidence that the test has power to detect endogeneity from non-linear effects.[1]

Additionally, our linear model (2) in the paper may incorrectly predict a discontinuous impact of inputs at zero because of non-linearities away from zero. In this case, D_i will

[1] In reality, there is heterogeneity across observations with the same value of Input_i^j, which enhances the power of the test because it can detect endogeneity if $f^{j'}(x_1) - f^{j'}(x_2) \neq (x_1 - x_2)\beta^{j'}$ for other values of x_1 and x_2. For instance, Panel (b) of Figure A.4 shows that the entire distribution is discontinuous at $x = 0$, not only its first moment. Caetano and Maheshri (2016) discusses this point in more detail.

be significantly different from zero in an attempt to correct for this model misspecification. Regardless of the reason, the test has power to detect endogeneity stemming from non-linear effects.

Misspecification of Controls

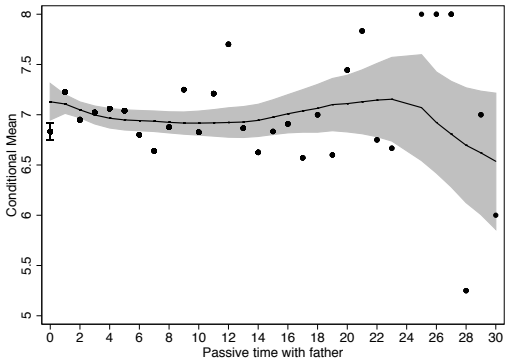
If w_i is discontinuous at zero, then $w_i' := g(w_i)$ is also discontinuous at zero for almost all functions $g(\cdot)$. Thus, the test also has power to detect endogeneity due to misspecification of observed controls w_i, which can occur since it is unclear how they should be included in the equation.[2]

The examples of w_i discussed in Section A of the appendix and Section 3.3 of the paper are just a small subset of observed variables for which we find discontinuities at $x = 0$. Moreover, for ease of exposition, we have discussed in turn the implications of each simplification that is needed to go from the general production function outlined in equation (3) in the paper to the specifications we estimate. Our approach is agnostic about the specific reason why Assumption 1 might fail, and in fact jointly tests for all sources of detectable endogeneity, even ones we may not conceive. Of course, even among these sources of endogeneity there may be confounders that cannot be detected by the test. For example, some confounder w_i implied by an aggregation choice may not be discontinuous when inputs are zero. However, in the next section we argue why these confounders are likely to be rare in our context. In light of this discussion, our claim is ultimately that we can interpret a failure to reject exogeneity as a lack of endogeneity.

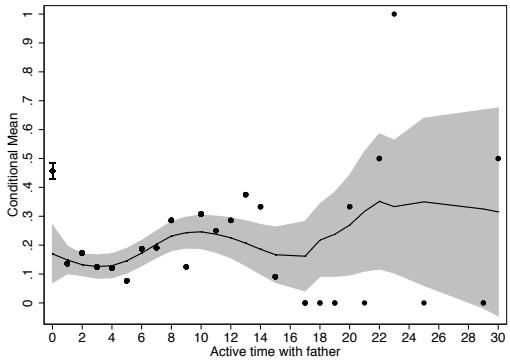
[2]If w_i enters the equation non-linearly, discontinuities in higher moments of the distribution will add power to the test. Here we mostly show discontinuities in the first moment of the distribution, but we actually find discontinuities in the whole distribution (e.g., Panel (b) of Figure A.4). For instance, the variance of w_i is often discontinuously higher when inputs are zero. This is intuitive, as observations tend to be discontinuously more heterogeneous at that point because of bunching.

Figure A.1: Evidence of Power to Detect Endogeneity from Simultaneity

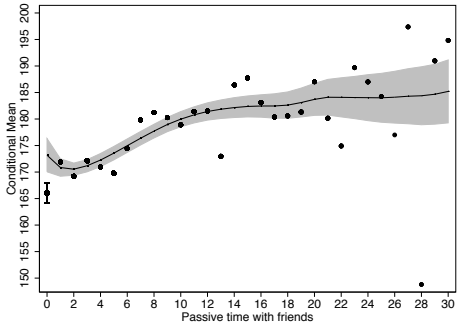
(a) Child's Birth Weight (Pounds)



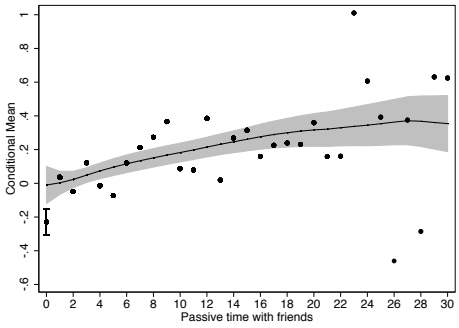
(b) Child is Black



(c) Child's Age (Months)



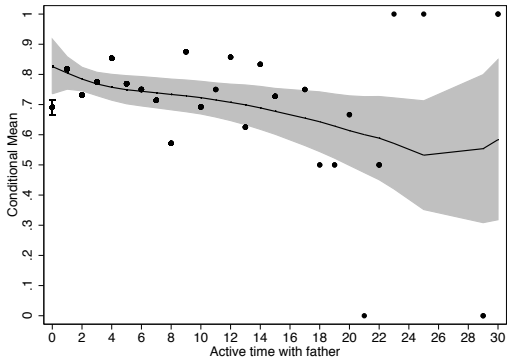
(d) Lagged Math Score



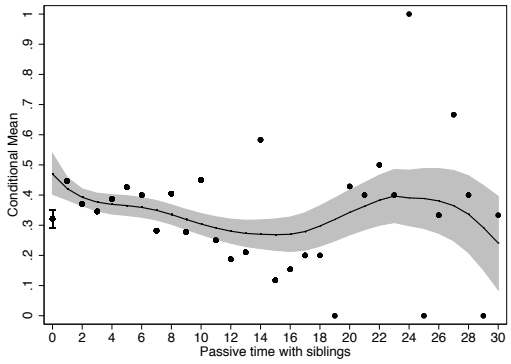
Note: In each plot, the vertical axis shows the mean of a potential confounder conditional on a given level of time input (i.e. horizontal axis variable). The scatter plot represents the observed conditional mean of the confounder (aggregated to the next hour of the time input). At zero time input, we show the 95% confidence interval. The solid curve represents a third order local polynomial regression of the confounder on the time input, using time input data at the minute per week level. The shaded region represents the 95% confidence interval for this regression with an out-of-sample prediction at zero minutes. See footnote 32 of the paper for more details on the regression and confidence interval.

Figure A.2: Evidence of Power to Detect Endogeneity from Measurement Error

(a) Weekday Diary was Completed Without Help



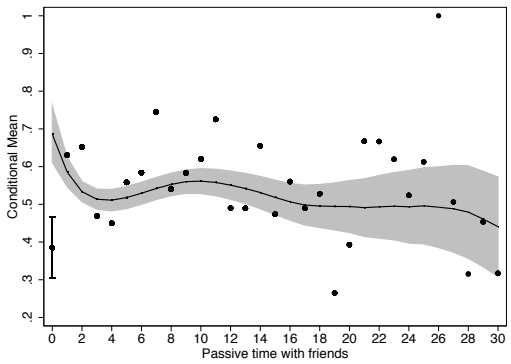
(b) Primary Caregiver Completed Weekend Diary



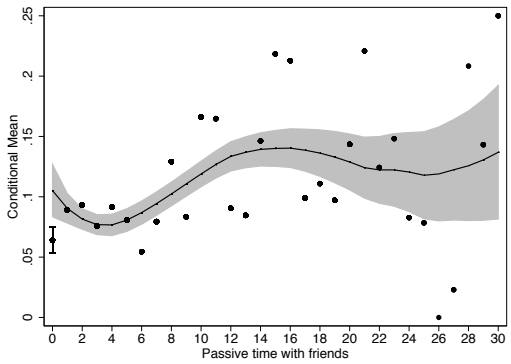
Note: In each plot, the vertical axis shows the mean of a potential confounder conditional on a given level of time input (i.e. horizontal axis variable). The scatter plot represents the observed conditional mean of the confounder (aggregated to the next hour of the time input). At zero time input, we show the 95% confidence interval. The solid curve represents a third order local polynomial regression of the confounder on the time input, using time input data at the minute per week level. The shaded region represents the 95% confidence interval for this regression with an out-of-sample prediction at zero minutes. See footnote 32 of the paper for more details on the regression and confidence interval.

Figure A.3: Evidence of Power to Detect Endogeneity from Over-Aggregation of Inputs

(a) Proportion of Active Time with Friends During Weekends



(b) Proportion of Leisure time with Mother

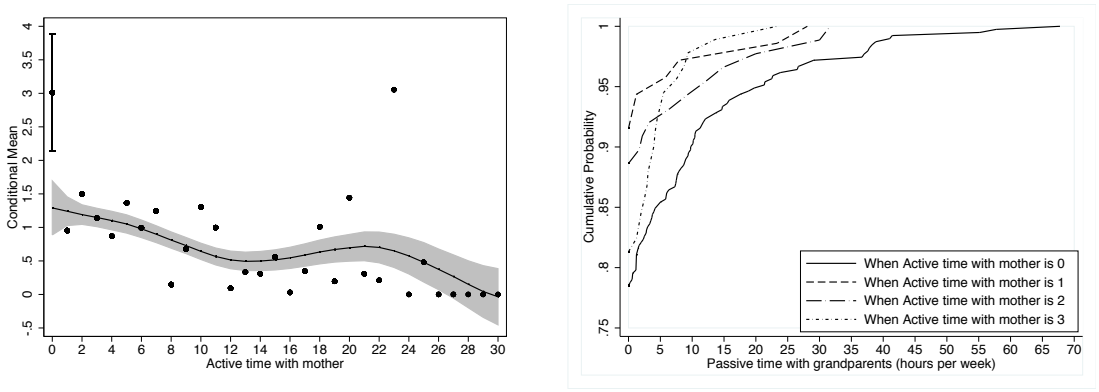


Note: In each plot, the vertical axis shows the mean of a potential confounder conditional on a given level of time input (i.e. horizontal axis variable). The scatter plot represents the observed conditional mean of the confounder (aggregated to the next hour of the time input). At zero time input, we show the 95% confidence interval. The solid curve represents a third order local polynomial regression of the confounder on the time input, using time input data at the minute per week level. The shaded region represents the 95% confidence interval for this regression with an out-of-sample prediction at zero minutes. See footnote 32 of the paper for more details on the regression and confidence interval.

Figure A.4: Evidence of Power to Detect Endogeneity from Non-Linear Effects

(a) Passive Time with Grandparents (1st Moment)

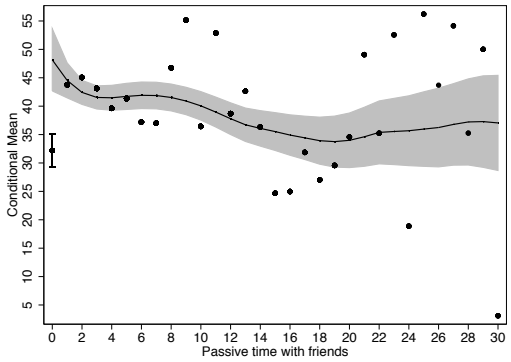
(b) Passive Time with Grandparents (Distribution)



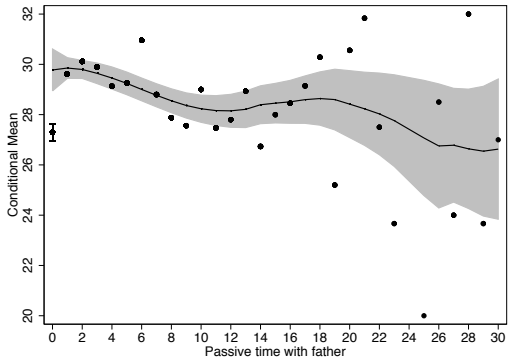
Note: In the plots of the right, we show the cumulative density function of the confounder for selected values of the time input (in hours), for the confounder and time input shown in the corresponding plot of the left. In the plots of the left, the vertical axis shows the mean of a potential confounder conditional on a given level of time input (i.e. horizontal axis variable). The scatter plot represents the observed conditional mean of the confounder (aggregated to the next hour of the time input). At zero time input, we show the 95% confidence interval. The solid curve represents a third order local polynomial regression of the confounder on the time input, using time input data at the minute per week level. The shaded region represents the 95% confidence interval for this regression with an out-of-sample prediction at zero minutes. See footnote 32 of the paper for more details on the regression and confidence interval.

Figure A.5: Further Evidence of Power of Test (1 of 2)

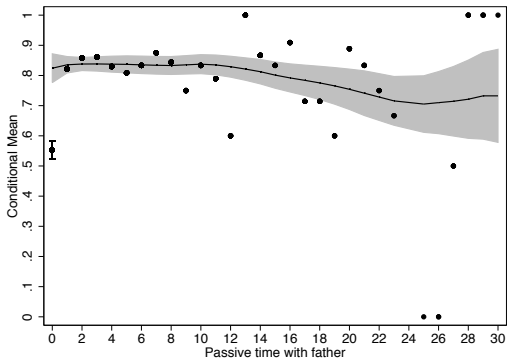
(a) Mother's Annual Income ($1,000s)



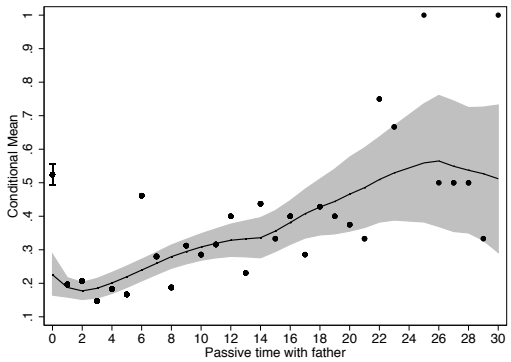
(b) Mother's Age at Child Birth



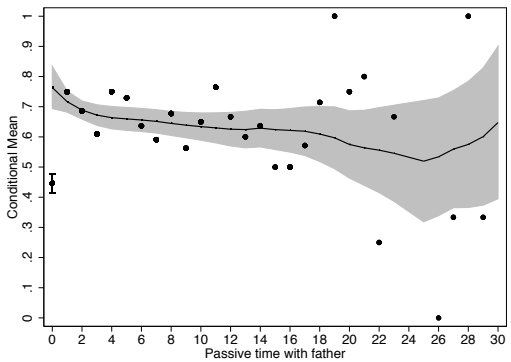
(c) Mother is Married



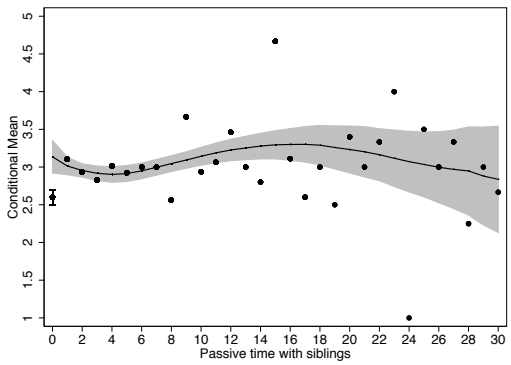
(d) Child Lives with Biological Parents



(e) Mother Is White



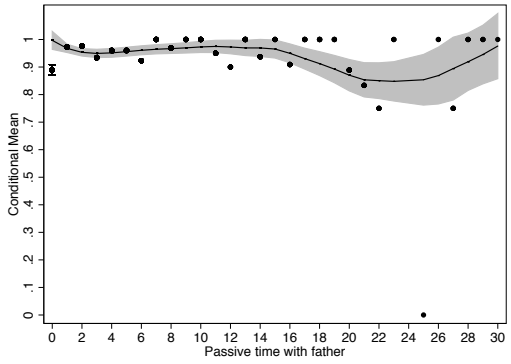
(f) Number of Children Born to Father



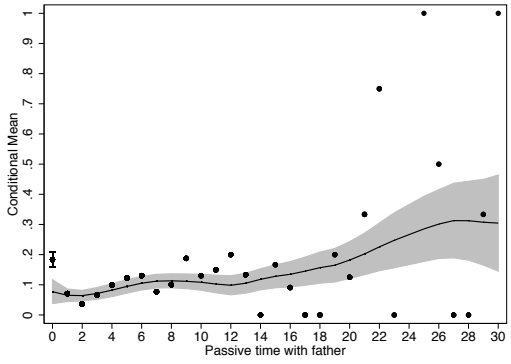
Notes: See the note for Figure 4 in the paper

Figure A.6: Further Evidence of Power of Test (2 of 2)

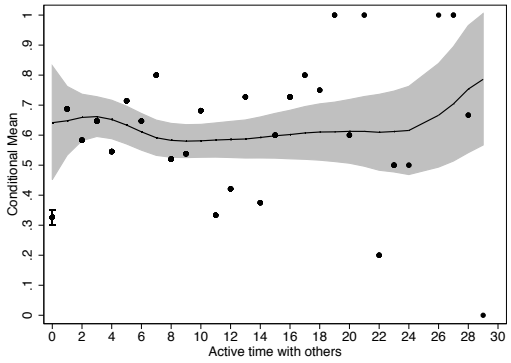
(a) Primary Caregiver Spent Money on Toys for the Child



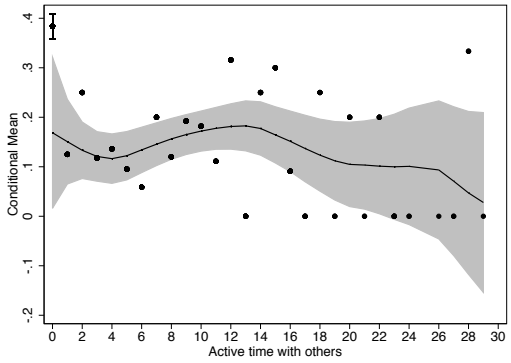
(b) Child Repeated Grade



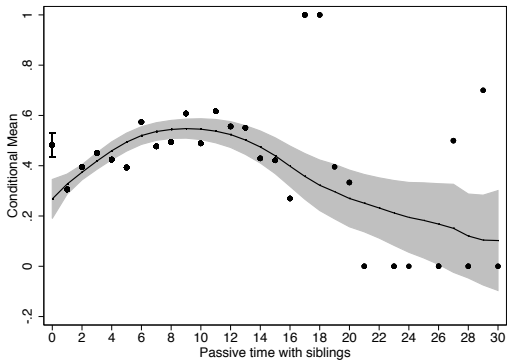
(c) Child Completed Weekday Diary (With or Without Help)



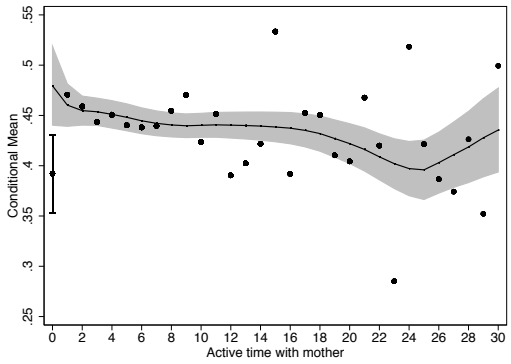
(d) Primary Caregiver Completed Weekday Diary



(e) Proportion of Passive time with Others Participating in activities with the Child



(f) Proportion of Passive Time with Mother During Weekends



Notes: See the note for Figure 4 in the paper.

B Sensitivity Analysis

B.1 Comparing Surviving and Non-surviving Specifications

Thus far, we have chosen appropriate models for causal inference purely based on the exogeneity test described in Section 3 of the paper. However, there can be confounders that are not detectable by the test. As discussed in Section 3.4, there are two potential categories of confounders: (a) confounders that are discontinuous at $\text{Input}_i^j = 0$, and (b) confounders that are continuous at $\text{Input}_i^j = 0$. Among type (a) confounders, there are two subtypes: (a1) those that are correlated with skill at $\text{Input}_i^j = 0$, and (a2) those that are not. The exogeneity test introduced in Section 3.1 is capable of detecting all unobservables of type (a1), but is incapable of detecting unobservables of types (a2) or (b).

As discussed in Section 3.4 of the paper, there are a number of reasons to believe that the class of variables included in types (a2) and (b) is small in our context. Regardless of how implausible the existence of these variables might be, this subsection provides one common robustness check that can in principle detect them if they exist.

We compare estimates of β across specifications, irrespective of whether the specification survives or does not survive the test, as shown in Section 4 of the paper. This comparison is often done in empirical studies, where, heuristically, a good model is one that provides estimates that are robust to added controls (which might be omitted variables in the model).[3] This "test of stable coefficients" is in principle capable of detecting endogeneity from the two undetectable sources of endogeneity discussed above. Indeed, added controls may partly absorb (both at $\text{Input}_i^j = 0$ and at $\text{Input}_i^j > 0$) confounders of type (a2) or (b), leading to a change in the main estimates. If a model survives the test of exogeneity, but does not survive this test, then it is evidence that the test of exogeneity did not detect some important source of endogeneity.

We test for whether the fifteen elements of β in each specification (1)-(5) from Section 4 of the paper are jointly significantly different from the corresponding coefficients in specification

[3]For instance, Fiorini and Keane (2014) implement a somewhat weaker version of this test whereby they compare whether the ranking of the magnitude of each coefficient is the same across specifications.

(6), our preferred model. We present the p-value of this test for each skill measure in Table B.1. Numbers in bold refer to those specifications that survive the exogeneity test at the 10% level of significance. In general, specifications that survive the exogeneity test (in bold) also survive the test of stable coefficients (p-value $> 10\%$). Across all models, only one model that survives the exogeneity test is rejected by the other test: specification (3) for comprehension in Table 3 of the paper. This suggests that confounders from the undetectable sources of endogeneity discussed above are only controlled for after family demographic characteristics are added as controls (specification (4)). Conversely, no models do not survive the exogeneity test but survive the other test. From specification (4) onwards, all specifications survive both tests for all skills. Overall, these results are consistent with the idea that, as we add controls from specifications (1) to (6) in Section 4, we converge to the true causal estimates.[4]

In Section G, we present the actual estimates for specifications (1)-(6) for each skill, for both the linear and the B-spline cases, illustrating more explicitly how the estimates are virtually unchanged for the surviving specifications but often change for the non-surviving ones.

Table B.1: P-Values for Comparing Surviving and Non-surviving Specifications

	Controls	Math	Vocabulary	Comprehension	Noncognitive
(1)	Lagged Score	0.000	0.000	0.000	**0.805**
(2)	Child Chrs.	0.004	**0.326**	0.001	**0.634**
(3)	Mother Demog. Chrs.	0.040	**0.693**	**0.029**	**0.634**
(4)	Family Demog. Chrs.	**0.109**	**0.745**	**0.140**	**0.612**
(5)	Family Environ. Chrs.	**0.383**	**0.912**	**0.512**	**0.620**

Note: This table shows the p-values of a joint test for whether the 15 coefficients of Input_i for each specification are the same as the corresponding ones from specification (6) in Table 3. Entries in bold are "surviving specifications" with respect to the exogeneity test, i.e., those for which we cannot reject exogeneity at 10% of significance. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics. See footnote 38 for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

[4]Table C.3 shows analogous results for the non-linear models discussed at the end of the previous subsection. All surviving specifications according to the exogeneity test also survive the test of stable coefficients with one exception.

B.2 Alternative Specifications

In this section, we perform many additional robustness checks on specification (6) from Section 4 of the paper. Table B.2 report the p-value of a test for whether the coefficient of β changes as we add controls to specification (6) from Section 4. Each specification in these tables contain additional controls of two types: (a') variables that are discontinuous when some input is zero (some of which are shown in the plots presented in Section 3 of the paper), and (b') variables that are continuous when each input is zero, for all inputs.[5] These variables might be correlated to undetectable confounders, as discussed above. For instance, observables of type (a') (type (b')) might be correlated to unobservables of type (a2) (type (b)). If they are, then they will partly absorb confounders that are undetectable by the exogeneity test, which would tell us that the test is unable to detect important sources of endogeneity. The p-values in Table B.2 provide clear evidence that our estimates of specification (6) are statistically unchanged in all alternative specifications .

Specifications (1')-(3') are particularly useful to allay further concerns about omitted variables and simultaneity. In specification (1'), we add more control variables related to child characteristics, family demographic characteristics, and environmental characteristics.[6] In specification (2'), we add the 15 lagged (i.e., from the previous wave) time inputs.[7] In specification (3'), we add the other three lagged skill measures as well as the interactions between any two of the four lagged skills.

In specification (4'), we add controls related to misreporting of time diaries (12 additional controls)[8], to allay further concerns about measurement error. Specifications (5')-(11') are included to check for undetectable confounders from over-aggregation. Active time activities are further subcategorized in the data as educational, social, and school activities, while passive

[5] Of course, these variables may not be confounders of type (b), because they may not be correlated to inputs at all.

[6] Here is the full list of added controls in specification (1'): child's birth weight, number of children born to father, number of children born to mother, months first cared by non-parents, months child began kindergarten, indicator for whether mother's working schedule is a regular (vs. night) shift, and money caregivers spent on toys for the child last year.

[7] This specification is referred to as the "cumulative model" by Todd and Wolpin (2007) and Fiorini and Keane (2014).

[8] The list includes whether the diary was self-administered, whether the diary was reviewed face-to-face, whether the diary was reviewed via phone, and indicators of who completed the diaries.

time activities are further subcategorized in the data as general care and media activities.[9] In specification (5'), we add one more time input by separating school time from self active time, and test whether any of the 15 original coefficients change.[10] In specification (6'), we add the proportions of each active time input spent in educational activities (7 additional controls).[11] In specification (7'), we add the proportions of each passive time input spent in general care (7 additional controls).[12] In specification (8'), we add the proportions of each passive time input spent watching TV (7 additional controls).[13] In specification (9'), we add the proportions of each time input spent at home as opposed to elsewhere (14 additional controls).[14] In specification (10'), we add the proportions of each time input spent in activities with someone "participating" (14 additional controls).[15] In specification (11'), we add the proportions of each time input spent during weekends (14 additional controls).

Given the evidence presented in this section, it is difficult to conceive of a confounder that may be biasing our estimates. It needs to be of type (a2) or (b) for all inputs and at the same time be undetectable by all the robustness checks provided in this section. For instance, it is difficult to conceive of variables (of type (a2) or (b) for all inputs) correlated to both Skill_i and Input_i observed in the current wave, and yet uncorrelated to both Skill_i and Input_i observed in the previous wave.

[9] Fiorini and Keane (2014) stratifies active and passive activities according to these five types, depending on whether the activity involves parents. Thus, specifications (5') and (6') attempts to check for evidence of heterogeneous effects in dimensions that are captured by their specification of inputs and not captured by ours.

[10] School activities, originally fully included in self active time, comprise attending classes for full-time students, and daycare or nursery school for children not in school. They represent about 18% of all activities, 58% of all active activities and 88% of the self active time activity.

[11] Educational activities include helping adults doing household chores, taking extracurricular lessons, and reading. They represent about 6% of all activities and 20% of all active activities.

[12] General care include obtaining goods and services, personal needs and care (e.g. having meals), and traveling/waiting. They represent about 15% of all activities and 56% of all passive activities.

[13] Watching TV represents about 10% of all activities and 35% of all passive activities.

[14] Time spent at home accounts for about 26% of children's total time in a week.

[15] When filling out the time diaries, the respondents were asked not only about with whom each activity was performed, but also whether the partner actually participated in the activity (versus being just around while the child performed the activity). Participation time accounts for about 18% of children's total time in a week. This variable was used in Del Boca et al. (2013) to categorize inputs.

Table B.2: Do Coefficients Change as Controls are Added? (P-Value)

	Alternative Specifications	Math	Vocabulary	Comprehension	Noncognitive
(1')	(6) + more controls	0.967	0.990	0.620	0.778
(2')	(6) + lagged inputs	0.991	0.912	0.989	0.986
(3')	(6) + lagged skills	0.896	0.866	0.572	0.772
(4')	(6) + measurement error controls	0.915	0.883	0.946	0.998
(5')	(6), school time as a separate input	0.996	1.000	0.998	1.000
(6')	(6) + prop. educational activities	0.987	1.000	0.988	0.891
(7')	(6) + prop. general care	0.948	0.737	0.906	0.999
(8')	(6) + prop. watching TV	0.917	0.806	0.526	1.000
(9')	(6) + prop. at home	0.609	0.722	0.974	0.725
(10')	(6) + prop. participation time	0.999	0.987	0.926	0.787
(11')	(6) + prop. weekend time	0.873	0.928	0.976	0.764

Note: This table shows the p-values of a test for whether the 15 coefficient estimates of Input_i for each alternative specification are statistically the same as the corresponding ones from Specification (6) in Table 3 of the paper. Alternative specifications: (1') the full list of added controls can be seen in footnote 6; (2') lagged time inputs of all 15 activities; (3') lagged skill measures of other types and interactions of any two skills; (4') full list of added controls can be seen in footnote 8; (5') 16 time inputs (15 original time inputs plus school activities), whereby the p-value refers to a test of whether the 15 coefficients of the original time inputs are statistically unchanged with respect to specification (6); (6') proportions of each time input spent in educational activities (e.g. reading): 7 additional covariates; (7') proportions of each time input spent in general care (i.e having meals): 7 additional covariates; (8') proportions of each time input spent watching TV: 7 additional covariates; (9') proportions of each time input spent at home: 14 additional covariates; (10') proportions of each time input that partner actually participates in the activity: 12 additional covariates; (11') proportions of each time input spent during weekends: 15 additional covariates.

C Non-Linear Treatment Effects

The exogeneity test results are presented in Table C.1. For comparison, we show in bold the surviving specifications according to the linear model (2) of the paper. It is useful to check if the models that survive the linear exogeneity test also survive the non-linear exogeneity test. As discussed at the end of Section 3.3 of the paper, the coefficients of D_i in these linear models can capture endogeneity from either discontinuous confounders or from a failure of the linearity assumption. The results show that the specifications that survive the exogeneity test in the linear model also tend to survive the exogeneity test in the B-spline model, and vice-versa. The exception, specification (2) for comprehension**,** survives the non-linear test but does not survive the linear test, suggesting that the linear test detects endogeneity partly due to misspecification of the production function. Overall, most of the power of the test seems to stem from discontinuous unobservables, otherwise the B-spline models would fail to reject in even the most parsimonious specifications. In specifications (6), all models survive both exogeneity tests for all skills.

Table C.2 shows estimates for all four skill measures in our preferred model of specification (6). We find that maternal passive time only has a significant positive effect on math when it is below 15 hours per week, and in fact has a negative, significant effect in comprehension skills when it is above 27 hours per week. A large amount (above 38 hours per week) of active self time (e.g., mostly due to school activities) seems to be productive for math, while a little (up until 5 hour per week) passive time with friends seems to be unproductive for cognitive skills, compared to sleeping or napping. These results are consistent with the linear results, but provide further details about the production function of skills.

Table C.3 presents the robustness check results for the non-linear models to compare surviving and non-surviving specifications as discussed in Section B.1. For each specification (1)-(5), we show the p-value from a test of whether the 29 coefficients β^{jk} are significantly different from the corresponding ones in specification (6).[16] We show in bold the specifications that survive the exogeneity test. All surviving specifications according to the exogeneity test

[16]Some inputs did not allow for more than one or two B-spline terms.

also survive the other test with one exception. As in the linear models, all specifications from specification (4) onwards survive both tests for all skills.

We implement the same robustness checks discussed in Section B for the non-linear models, with the aim of allaying further concerns about non-linearities. The results are in Table C.4. We test whether the coefficients β^{jk}, for all j and k (27 coefficients) change as we change specification (6). The results show that, similarly to the linear models, the estimates do not change.

Remark 2. As discussed in Remark 1 in the paper, the fact that the treatment effect estimates are not linear is not evidence that our surviving specifications in the linear models suffer from endogeneity. Indeed, the results suggest that the linear estimates in our preferred models are a weighted average of the corresponding non-linear estimates. For example, the coefficient of passive time with the mother on mathematics skills is 0.004, which is similar to a weighted average of the three coefficients of passive time with the mother from specification (6) shown in Table C.2 (i.e. 0.004≈1/3(0.013+0.002+0.003)). In general, an F-test for whether each coefficient of the linear model is the same as the weighted average of the corresponding coefficients of the B-spline model for all 15 time inputs yields a p-value of 0.5392.

Table C.1: Exogeneity Test Results: B-spline

	Controls	Math		Vocabulary		Comprehension		Noncognitive	
		F-stat	p-Value	F-stat	p-Value	F-stat	p-Value	F-stat	p-Value
(1)	Lagged Score	2.392	0.002	1.470	0.108	1.749	0.037	**1.501**	**0.097**
(2)	Child Chrs.	1.431	0.124	**1.234**	**0.239**	1.373	0.152	**1.621**	**0.061**
(3)	Mother Demog. Chrs.	1.553	0.079	**1.297**	**0.195**	**1.456**	**0.114**	**1.649**	**0.055**
(4)	Family Demog. Chrs.	**1.487**	**0.102**	**1.258**	**0.221**	**1.382**	**0.147**	**1.726**	**0.040**
(5)	Family Environ. Chrs.	**1.591**	**0.069**	**1.263**	**0.218**	**1.296**	**0.196**	**1.437**	**0.122**
(6)	School's Experience	**1.561**	**0.077**	**1.242**	**0.233**	**1.330**	**0.175**	**1.284**	**0.204**

Note: All specifications in this table are in the form of a linear B-Spline with 2 knots placed at 33rd and 67th percentiles of each time input, whenever possible. Entries in bold are "surviving specifications" for which we cannot reject exogeneity at 10% of significance *in the linear model*. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

Table C.2: B-spline Estimation Results

	Math	Vocabulary	Comprehension
Active time with mother (0,2.3)	0.041	0.031	0.027
	(0.047)	(0.047)	(0.052)
Active time with mother (2.3,9.5)	-0.003	0.007	0.010
	(0.008)	(0.009)	(0.010)
Active time with mother (9.5,.)	0.006	-0.002	-0.004
	(0.004)	(0.003)	(0.004)
Passive time with mother (0,14.6)	0.013**	0.004	0.004
	(0.006)	(0.006)	(0.007)
Passive time with mother (14.6,26.9)	0.002	0.001	0.007
	(0.005)	(0.005)	(0.005)
Passive time with mother (26.9,.)	0.003	-0.001	-0.009**
	(0.003)	(0.003)	(0.004)
Active time with father (0,.)	0.014**	0.007	-0.000
	(0.005)	(0.006)	(0.007)
Passive time with father (0,1.0)	0.131	0.204	0.120
	(0.134)	(0.196)	(0.200)
Passive time with father (1.0,.)	-0.001	-0.001	0.009**
	(0.004)	(0.004)	(0.004)
Active time with grandparents (0,.)	0.021**	0.021*	0.035**
	(0.010)	(0.012)	(0.010)
Passive time with grandparents (0,.)	-0.004	-0.002	-0.004
	(0.004)	(0.005)	(0.006)
Active time with siblings (0,.)	-0.002	-0.008	-0.014**
	(0.005)	(0.006)	(0.007)
Passive time with siblings (0,2.3)	-0.090**	-0.083*	-0.065
	(0.044)	(0.047)	(0.045)

Passive time with siblings (2.3,.)	0.009**	0.006*	0.006
	(0.003)	(0.003)	(0.004)
Active time with friends (0,4)	-0.016	-0.011	0.004
	(0.028)	(0.030)	(0.032)
Active time with friends (4,.)	0.007**	0.003	0.000
	(0.003)	(0.003)	(0.004)
Passive time with friends (0,5)	-0.032**	-0.035**	-0.044**
	(0.014)	(0.016)	(0.016)
Passive time with friends (5,.)	0.005	-0.002	0.004
	(0.003)	(0.003)	(0.003)
Self active time (0,34.6)	0.003	-0.001	0.001
	(0.003)	(0.003)	(0.003)
Self active time (34.6,37.9)	0.013	-0.017	-0.019
	(0.013)	(0.014)	(0.015)
Self active time (37.9,.)	0.006**	0.001	0.005
	(0.003)	(0.003)	(0.003)
Self passive time (0,7.0)	-0.019	-0.000	-0.022
	(0.013)	(0.014)	(0.015)
Self passive time (7.0,11.5)	0.011	0.001	0.008
	(0.011)	(0.011)	(0.012)
Self passive time (11.5,.)	0.004*	-0.001	0.002
	(0.003)	(0.003)	(0.003)
Active time with others (0,.)	0.001	-0.008*	-0.004
	(0.005)	(0.004)	(0.005)
Passive time with others (0,1)	-0.210	-0.006	-0.502**
	(0.134)	(0.115)	(0.162)
Passive time with others (1,.)	0.002	-0.005	-0.004
	(0.003)	(0.004)	(0.004)

Don't know or refuse to answer(0,1.25)	-0.136	0.058	-0.108
	(0.097)	(0.096)	(0.124)
Don't know or refuse to answer(1.25,.)	0.005	-0.002	0.006*
	(0.003)	(0.003)	(0.004)
R-squared	0.666	0.638	0.576
Observations	1698	1698	1698
Exogeneity test F-statistic	1.561*	1.242	1.330
Exogeneity test p-value	0.077	0.233	0.175

Note: All estimates are for specification (6). See footnote 38 of the paper for a full description of the control variables. In the first column, the parentheses shown after each time input indicates the time intervals. For example, (0,2.5) means between 0 hours and 2.5 hours per week. Depending on the distribution, some time inputs have less than three time intervals because the time input was not complex enough to accommodate two knots. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

Table C.3: P-Values for Comparing Surviving and Non-surviving Specifications: B-spline

	Controls	Math	Vocabulary	Comprehension	Noncognitive
(1)	Lagged Score	0.000	0.000	0.000	0.958
(2)	Child Chrs.	**0.064**	**0.593**	**0.012**	0.949
(3)	Mother Demog. Chrs.	0.358	**0.768**	**0.138**	0.968
(4)	Family Demog. Chrs.	**0.472**	**0.843**	**0.355**	**0.883**
(5)	Family Environ. Chrs.	0.668	**0.991**	**0.855**	**0.917**

Note: This table shows the p-values of a test for whether the 26 coefficient estimates of Input_i for each specification are statistically the same as the corresponding ones from Specification (6) in Table C.1. Entries in bold are "surviving specifications" in the b-spline test for which we cannot reject exogeneity at 10% of significance. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics. All standard errors are corrected for heteroskedasticity. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

Table C.4: Do Coefficients Change as Controls are Added? (P-Value): B-spline

	Alternative Specifications	Math	Vocabulary	Comprehension	Noncognitive
(1')	(6) + more controls	1.000	1.000	0.967	0.969
(2')	(6) + lagged inputs	0.999	0.995	1.000	1.000
(3')	(6) + lagged skills	0.976	0.904	0.664	0.985
(4')	(6) + measurement error controls	0.996	0.999	0.999	1.000
(5')	(6), school time as a separate input	0.974	1.000	1.000	0.973
(6')	(6) + prop. educational activities	1.000	1.000	1.000	1.000
(7')	(6) + prop. general care	1.000	1.000	1.000	1.000
(8')	(6) + prop. watching TV	1.000	1.000	0.989	1.000
(9')	(6) + prop. at home	0.970	0.994	1.000	0.956
(10')	(6) + prop. participation time	1.000	1.000	0.997	0.996
(11')	(6) + prop. weekend time	1.000	1.000	1.000	0.957

Note: This table shows the p-values of a test for whether the coefficient estimates of Input_i for each alternative specification are statistically the same as the corresponding ones from Specification (6) in Table C.1. All specifications in this table are in the form of a linear B-Spline with 2 knots placed at 33rd and 67th percentiles of each time input, whenever possible. Alternative specifications: (1') the full list of added controls can be seen in footnote 6; (2') lagged time inputs of all 15 activities; (3') lagged skill measures of other types and interactions of any two skills; (4') full list of added controls can be seen in footnote 8; (5') 30 time inputs (27 original time inputs plus 3 school inputs), whereby the p-value refers to a test of whether the 27 coefficients of the original time inputs are statistically unchanged with respect to specification (6); (6') proportions of each time input spent in educational activities (e.g. reading): 7 additional covariates; (7') proportions of each time input spent in general care (i.e having meals): 7 additional covariates; (8') proportions of each time input spent watching TV: 7 additional covariates; (9') proportions of each time input spent at home: 14 additional covariates; (10') proportions of each time input that partner actually participates in the activity: 12 additional covariates; (11') proportions of each time input spent during weekends: 15 additional covariates.

D Discussion

D.1 Why Does Selection on Observables Seem to Work in This Context?

The results for the linear and non-linear models discussed in the main body and Section C indicate that with rich enough controls we are able to arrive at specifications for which we fail to reject exogeneity. Moreover, as discussed in detail in the main body, this does not appear to result from a lack of power with the exception of noncognitive skills. A natural question to ask at this point is why a selection on observables approach seems to be appropriate in the context of this application.

While the richness of the available controls in the PSID is certainly helpful for mitigating endogeneity, incorporating the full set of inputs into the production function is also quite useful. To see this, consider the following simple model of input choices and skill formation where, for simplicity, we treat the child as the sole decision-maker. Skill for individual i is determined according to

$$\text{Skill}_i = f(\text{Input}_i, \theta_i),$$

where Input_i is a vector of J time inputs and θ_i is a vector of other inputs (i.e., Other_i in equation (3) of the paper) impacting skill which reflects any heterogeneity in the production function across children (e.g., how much attention the child pays when reading). Children choose Input_i to maximize utility

$$U_i = g(\text{Input}_i, \theta_i, \omega_i)$$

subject to $\text{Input}_i^j \geq 0$ and $\sum_{j=1}^{J} \text{Input}_i^j = T$, where T is the total available time (i.e., 24 hours per day). ω_i is a vector denoting heterogeneity in utility that is not associated with heterogeneity in skill production (e.g., preferences for maternal versus paternal time). In this general formulation, skill and time inputs can in principle affect utility directly, as can the other inputs influencing the production of skill, θ_i.

Given this maximization problem, the chosen vector of time inputs, Input_i^*, is implicitly

defined by the levels of θ_i and ω_i:[17]

$$\text{Input}_i^* = h(\theta_i, \omega_i)$$

so that individuals with different levels of (θ_i, ω_i) tend to choose different levels of the vector of inputs. For a given θ_i, the variation in inputs due to ω_i is not endogenous and is in fact precisely the type of variation we want to exploit when estimating the production function. Of course, although the component of ω_i that is orthogonal to θ_i would make ideal instruments to identify the effect of interest, it is difficult to know *ex ante* which source of variation is included in ω_i and which source of variation is included in θ_i, hence our need to develop an alternative identification strategy in this paper.

We can write $\text{Input}_i^{*,j}$ as

$$\text{Input}_i^{*,j} = h^j(\theta_i, \omega_i, \text{Input}_i^{*,-j}).$$

In our context, endogeneity arises if an input is correlated with θ_i across individuals, conditional on covariates: $Cov\left(\text{Input}_i^{*,j}, \theta_i | \text{Input}_i^{*,-j}, \text{Control}_i\right) \neq 0$, i.e., if $h^j(\cdot, \text{Input}_i^{*,-j}, \text{Control}_i)$ varies with θ_i.

We conjecture that we are able to eliminate endogeneity and identify the effects of interest with our data for two reasons. First, to the extent that $\text{Input}_i^{*,-j}$ absorb elements of θ_i, adding them as covariates can substantially reduce the potential for endogeneity, requiring less of the vector Control_i. Second, as we add Control_i we are able to shut down any correlation between θ_i and $\text{Input}_i^{*,j}$ (conditional on $\text{Input}_i^{*,-j}$) before we shut down the correlation between ω_i and $\text{Input}_i^{*,j}$. The full set of controls incorporated in the empirical model must be unable to thoroughly absorb ω_i, otherwise there would be no independent variation remaining in Input_i to estimate the production function. ω_i reflects tastes and household constraints, which are likely quite heterogeneous across people, while θ_i is bound by technical features of the skill production technology. Thus, it is not surprising that covariates can fully control for θ_i without

[17] Input_i^* represents $\widetilde{\text{Input}}_i$ in equation (3) of the paper. For simplicity in the exposition, we assume no measurement error in this section.

fully controlling for ω_i.

The above discussion illustrates a largely under-appreciated benefit of modeling the full vector of inputs in skill production. The inclusion of a comprehensive list of time activities not only enhances the interpretability of the production parameters, but can also substantially allay endogeneity concerns. Indeed, all else constant, $\text{Input}_i^{*,-j}$ helps absorb more confounders the more disaggregated inputs are. This is evident in the exercise conducted in Section 3.4 of the paper, where we show that less than 30% of the observable variables we considered as potential confounders end up being confounders in a omitted variable test controlling for all inputs. In contrast, if we only include one time input, for example, active time with mother, the number of confounders essentially doubles.

D.2 What Can (and Cannot) be Inferred from Our Estimates?

In this paper, we estimate the average marginal productivity of each input on each skill. It is useful to interpret these estimates with the aid of the framework described above. We estimate $E[f_j(\text{Input}_i^*, \theta_i)]$ for each j, where f_j refers to the first derivative of the production function f with respect to its jth input, and the expectation is taken across all children i.

When $E[f_j(\text{Input}_i^*, \theta_i)] > 0$, we conclude that on average children will see an improvement in skill if they decide to spend more time on activity j (relative to sleeping), in comparison to their current time. However, that does not necessarily imply that children *should* spend more time on activity j. Indeed, children and their families likely make time allocation choices in order to maximize utility, not skill. To illustrate the implications of this, we show how different children and their parents might choose different levels of time inputs, and how these different choices might lead to different estimates of $f_j(\text{Input}_i^*, \theta_i)$. Assume that children and their parents care about skill (f), non-skill (u), and costs (c) such that

$$U_i = f(\text{Input}_i, \theta_i) - nc(\text{Input}_i, \theta_i, \omega_i)$$

where $nc(\text{Input}_i, \theta_i, \omega_i) := c(\text{Input}_i, \theta_i, \omega_i) - u(\text{Input}_i, \theta_i, \omega_i)$ represent the utility cost net of non-skill benefits, which is allowed to be heterogenous across different time investments.

Intuitively, one can think of c as representing the component of utility related to "costs" and u as representing the component of utility related to "fun", although u can be interpreted more generally to also encompass any mistake in optimization.[18] The first order conditions for an optimum in the interior imply

$$f_j(\text{Input}_i^*, \theta_i) - nc_j(\text{Input}_i^*, \theta_i, \omega_i) = f_{j'}(\text{Input}_i^*, \theta_i) - nc_{j'}(\text{Input}_i^*, \theta_i, \omega_i)$$

where nc_j is defined analogously to f_j. In words, there should be a one-to-one relationship between differences in marginal productivity across two positive inputs j and j' and their corresponding net costs. If time input j is observed to have a greater marginal product than input j', the reason must be that input j is commensurately more costly (net of non-skill utility benefits). In addition, consider a situation where $\text{Input}_i^{*,j} = 0$ and $\text{Input}_i^{*,j'} > 0$. Then it must be the case that

$$f_j(\text{Input}_i^*, \theta_i) - nc_j(\text{Input}_i^*, \theta_i, \omega_i) \leq f_{j'}(\text{Input}_i^*, \theta_i) - nc_{j'}(\text{Input}_i^*, \theta_i, \omega_i).$$

That is, if the optimal choice for input j is zero, then the marginal net return of input j should be lower than the marginal net return of input j', for $\text{Input}_i^{*,j'} > 0$.

Given the discussion above, it is difficult to predict *ex ante* the expected distribution of $f_j(\text{Input}_i^*, \theta_i)$. The effects depend implicitly on the distribution across children of the marginal net costs of each activity, $nc_j(\text{Input}_i^*, \theta_i, \omega_i)$, which are in turn functions of the joint distribution of (θ_i, ω_i).[19]

This framework is useful to understand the role of heterogeneity in shaping our estimates of the effect of time allocation on skills. As discussed in Remark 1 in the paper, the estimates of

[18] For instance, if children and their parents want to maximize the true skill but perceive the production function to be $\tilde{f}(\text{Input}_i, \theta_i, \omega_i)$ instead of $f(\text{Input}_i, \theta_i)$, u can be written as $u := \tilde{f}(\text{Input}_i, \theta_i, \omega_i) - f(\text{Input}_i, \theta_i)$, where in this case ω_i is interpreted as the vector representing the heterogeneity of this misperception across children and their family. If instead they maximize just fun, then $u := u'(\text{Input}_i, \theta_i, \omega_i) - f(\text{Input}_i, \theta_i)$ where u' represents the actual component of the utility representing "fun".

[19] Moreover, non-linearities in the production function can complicate the interpretation even further. If $f(\text{Input}_i^*, \theta_i)$ is non-separable between Input_i^* and θ_i, or if $f(\cdot, \theta)$ is non-linear in inputs, as it appears to be according to our results in Section C, then children with different values of (θ_i, ω_i) should choose different levels of $\text{Input}^*(\theta, \omega)$, leading them to have potentially different values of $f_j(\text{Input}^*(\theta, \omega), \theta)$. Remark 1 in the paper and Remark 2 in the appendix discuss this topic in more detail.

our surviving models should represent an unbiased average of the distribution of $f_j(\text{Input}_i^*, \theta_i)$ across all children. The fact that we find that active time with grandparents has a positive return on cognitive skills suggests that on average, if all children increased the time they spend with grandparents by one hour we would observe an increase in cognitive skills. However, it may be that the cognitive skill of some children would decline with such a reallocation. Our specification of inputs is not detailed enough to capture such heterogeneous effects. To compensate for a lack of data, we ensure the test of exogeneity has power to detect endogeneity from heterogeneous effects that are not captured by our specification of inputs. Thus, we can reasonably conclude that the unobserved heterogeneity not incorporated in our specification of inputs does not generate endogeneity. However, we cannot conclude that this unobserved heterogeneity is small or unimportant for policy. Future investigation of heterogeneous effects of time allocation on skills along dimensions other than the ones we have studied is warranted.

D.3 Relationship with Previous Literature

It is widely believed that child outcomes might improve if more of their time is spent in active activities.[20] However, evaluating this conventional wisdom is difficult because it is not clear which activities are actually productive and what these activities might substitute for. This paper adds to the literature by examining how child cognitive and noncognitive skills are impacted by time use, where time is categorized into comprehensive and precisely defined activities. We find that active time with parents or other activity partners helps children but only in developing math skills. Additional passive time does not hurt and sometimes helps with skill development. Further, schooling helps develop cognitive skills.

Although there is an extensive literature in economics on child skill development, there are only four studies, Del Boca et al. (2013), Del Boca et al. (2016), Fiorini and Keane (2014), and Funk et al. (2016), that estimate the effect of children's time allocation on skill formation. Del Boca et al. (2013) and Del Boca et al. (2016) also use the PSID-CDS, but

[20] According to the American Academy of Pediatrics (AAP), children today spend seven hours a day on entertainment media (a passive activity). The AAP, however, recommends that children and teens should engage with entertainment media for no more than an hour or two a day. It is recommended that more time be allocated to outdoor play, reading, hobbies and free-play, all of which are active activities. See https://www.aap.org for additional details.

do not incorporate all child activities, making it difficult to compare our results to theirs even if all three papers provided unbiased estimates. In contrast, Fiorini and Keane (2014) incorporate a comprehensive list of activities as we do, but Fiorini and Keane (2014) use data from Australia rather than the US, and focus on earlier ages. Thus, it is difficult to make comparisons between our estimates and theirs even if both papers provided unbiased estimates. Indeed, one can think of institutional differences across countries that may lead to different estimates of $E[f_j(\text{Input}_i^*, \theta_i)]$ because w_i is distributed differently for children with the same value of θ_i (e.g., child care costs, female labor supply elasticity, social norm about how children should be raised, etc).[21] Funk et al. (2016) use the PSID-CDS and incorporate all child activities, however their aggregation scheme is vastly different from ours. They categorize activities in more detail, but aggregate across activity partners to a much greater extent.

Nevertheless, for completeness we compare our main findings with those from Fiorini and Keane (2014) and Funk et al. (2016). While our findings regarding the production of noncognitive skills is similar to Fiorini and Keane (2014), our results relating to the production of cognitive skills are quite different.[22] In particular, we find that active time with parents or others in the US has little to no effect on cognitive skill formation, while Fiorini and Keane (2014) find that educational time with parents or others in Australia is quite productive. Using US data, Funk et al. (2016) find that time spent on music is very productive for math and reading skill, but time spent learning or time spent with parents have insignificant effects in a value-added specification. Ultimately, the sources of the differences in results are difficult to pin down, largely because our aggregation scheme for time inputs and the set of controls included in our models are different from theirs. Utilizing different aggregation

[21] The data confirms that the joint distribution of (θ_i, ω_i) in the Australian data is completely different from that in the American data. This can be inferred by the difference in the distribution of $\text{Input}_i^*(\theta, \omega)$ across these two countries as seen in the summary statistics in both papers. For instance, on average American children spend more passive time and less active time with their mother than Australian children do. As discussed in Section D.2, differences in the joint distribution of (θ_i, ω_i) should lead to different estimates of $E[f_j(\text{Input}_i^*, \theta_i)]$ purely due to the presence of heterogeneous effects.

[22] We report the estimates regarding the noncognitive skill production function only in the appendix, since we cannot reasonably argue that they can be interpreted as causal. A common finding across the two studies is that noncognitive skills are relatively unresponsive to parental time inputs. Additionally, the fit of the noncognitive skill regressions in both papers tends to be poor, suggesting that much of the variation in child noncognitive skills remains unexplained. Both studies also find that sleeping is one of the more important activities for noncognitive skill production.

schemes obviously means that we are necessarily estimating the effects of different objects on skill production. However, the different aggregation schemes also affect the extent to which the models account for endogeneity. We provide additional suggestive evidence that the specifications employed by Fiorini and Keane (2014) and Funk et al. (2016) are more likely to suffer from endogeneity (see Tables D.1 and D.2).[23]

To truly understand the differences in findings, and ultimately the role of time allocation in skill development more broadly, much richer data and models of skill production and time allocation are needed. It is not enough to simply estimate more flexible production functions, since as noted above it is difficult to interpret the results without a formal model of time allocation.[24] Such a model would require specifying a utility function, determining the costs associated with each time input, and assessing the information available to children and their parents as they consider these input choices. While such a model is beyond the scope of this paper, we believe our approach and estimates of skill production are an important step towards the creation of this broader framework.

[23]We perform the same diagnostic procedure as in Section 3.4 on the time inputs of Fiorini and Keane (2014) and Funk et al. (2016) using the same set of potential confounders. Results in Table D.1 show that compared to our time inputs, proportion of type (a1) confounders is on average much lower (i.e. 58% (60%) at 5% (10%) significance level) when using Fiorini and Keane (2014)'s time inputs. This suggests that our aggregation of time inputs leads to a more powerful test of exogeneity.

[24]The non-linearity we incorporate in our models is of a relatively modest form, a limitation imposed by the size of our sample.

Table D.1: Type of Controls: Fiorini and Keane (2014) 's Specification

Skills	Significance	Number of Variables	Number of Confounders	Type (a1)	Type (b)	Proportion of Confounders	Proportion of Type (a1)
Math	0.05	91	27	16	11	0.297	0.593
Vocabulary	0.05	91	31	19	12	0.341	0.613
Comprehension	0.05	91	31	19	12	0.341	0.613
Noncognitive	0.05	91	8	4	4	0.088	0.500
Math	0.1	91	30	19	11	0.330	0.633
Vocabulary	0.1	91	32	21	11	0.352	0.656
Comprehension	0.1	91	32	21	11	0.352	0.656
Noncognitive	0.1	91	11	5	6	0.121	0.455

Note: Column 3 shows the total number of variables in our initial pool of potential confounders, which includes lagged test scores, lagged time inputs, child characteristics, parental characteristics, family environmental characteristics, school environmental characteristics, school experience as well as variables related to misreporting of time diaries. Column 4 shows the number of confounders, which are identified if adding a variable significantly change the estimates of time inputs coefficients in a model with only time inputs as regressors (i.e. no controls). Column 5 shows number of type (a1) confounders, which are identified through a regression of a confounder on time inputs and their zero dummy variables: the confounder is of type (a1) if the coefficients of all time input dummies are jointly significantly different from zero. Column 6 shows number of type (b) confounders, which are confounders that do not belong to type (a1). Column 7 shows the ratio of number of confounders (i.e. column 4) over number of variables (i.e. column 3). Column 8 shows the ratio of number of type (a1) confounders (i.e. column 5) over number of confounders (i.e. column 4).

Table D.2: Type of Controls: Funk and Kemper (2016)'s Specification

Skills	Significance	Number of Variables	Number of Confounders	Type (a1)	Type (b)	Proportion of Confounders	Proportion of Type (a1)
Math	0.05	92	22	20	2	0.239	0.909
Vocabulary	0.05	92	24	21	3	0.261	0.875
Comprehension	0.05	92	24	21	3	0.261	0.875
Noncognitive	0.05	92	4	4	0	0.044	1
Math	0.1	92	24	22	2	0.261	0.917
Vocabulary	0.1	92	26	24	2	0.283	0.923
Comprehension	0.1	92	27	24	3	0.293	0.889
Noncognitive	0.1	92	8	6	2	0.087	0.750

Note: Column 3 shows the total number of variables in our initial pool of potential confounders, which includes lagged test scores, lagged time inputs, child characteristics, parental characteristics, family environmental characteristics, school environmental characteristics, school experience as well as variables related to misreporting of time diaries. Column 4 shows the number of confounders, which are identified if adding a variable significantly change the estimates of time inputs coefficients in a model with only time inputs as regressors (i.e. no controls). Column 5 shows number of type (a1) confounders, which are identified through a regression of a confounder on time inputs and their zero dummy variables: the confounder is of type (a1) if the coefficients of all time input dummies are jointly significantly different from zero. Column 6 shows number of type (b) confounders, which are confounders that do not belong to type (a1). Column 7 shows the ratio of number of confounders (i.e. column 4) over number of variables (i.e. column 3). Column 8 shows the ratio of number of type (a1) confounders (i.e. column 5) over number of confounders (i.e. column 4).

E Heterogeneous Effects by Age

In this section, we explore heterogeneity in the impact of time use with respect to age. We estimate the linear model (2) of the paper with interactions between each time input and an age indicator (i.e. whether the child is under 14). The exogeneity test results are presented in Table E.1. Specifications that survive the original exogeneity test in Table 3 (bold in Table E.1) also survive the test here. Table E.2 shows estimates for cognitive skill measures in our preferred model of specification (6). The results indicate that there is some heterogeneity in input effectiveness, particularly as it relates to active time with father and passive time with friends. Overall, our key findings are unchanged in this specification.

Table E.1: Exogeneity Test Results: Heterogenous Effects by Age

	Controls	Math		Vocabulary		Comprehension		Noncognitive	
		F-stat	p-Value	F-stat	p-Value	F-stat	p-Value	F-stat	p-Value
(1)	Lagged Score	3.978	0.000	2.830	0.000	2.920	0.000	**1.048**	**0.402**
(2)	Child Chrs.	1.705	0.044	**1.139**	**0.315**	1.379	0.149	**1.110**	**0.341**
(3)	Mother Demog. Chrs.	1.566	0.076	**1.020**	**0.431**	**1.119**	**0.333**	**1.124**	**0.328**
(4)	Family Demog. Chrs.	**1.345**	**0.167**	**0.899**	**0.565**	**0.950**	**0.507**	**1.117**	**0.335**
(5)	Family Environ. Chrs.	**1.410**	**0.134**	**0.867**	**0.602**	**0.883**	**0.583**	**1.093**	**0.357**
(6)	School Experience	**1.334**	**0.173**	**0.843**	**0.630**	**0.855**	**0.615**	**1.197**	**0.267**

Note: Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) Family environmental characteristics; (6) Child's school experience. See footnote 38 for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

Table E.2: Effects of Children's Time Allocation: Heterogenous Effects by Age

	Math	Vocabulary	Comprehension
Active time with mother	0.005	0.002	0.005
	(0.003)	(0.003)	(0.003)
Passive time with mother	0.004**	0.001	-0.002
	(0.002)	(0.002)	(0.003)
Active time with father	0.013**	-0.001	-0.006
	(0.007)	(0.007)	(0.007)
Passive time with father	-0.004	0.004	0.007
	(0.005)	(0.004)	(0.005)
Active time with grandparents	0.002	0.029	0.034*
	(0.021)	(0.019)	(0.019)
Passive time with grandparents	-0.001	0.001	-0.001
	(0.004)	(0.005)	(0.005)
Active time with siblings	0.001	-0.007	-0.008
	(0.005)	(0.008)	(0.010)
Passive time with siblings	0.004	0.003	0.001
	(0.004)	(0.004)	(0.005)
Active time with friends	0.008**	0.003	0.000
	(0.003)	(0.004)	(0.004)
Passive time with friends	0.001	-0.002	0.002
	(0.003)	(0.003)	(0.003)
Self active time	0.005**	-0.000	0.001
	(0.002)	(0.002)	(0.002)
Self passive time	0.005**	-0.001	0.002
	(0.002)	(0.002)	(0.003)
Active time with others	0.002	-0.006	-0.004
	(0.005)	(0.004)	(0.006)

Table E.2: Effects of Children's Time Allocation: Heterogenous Effects by Age

Passive time with others	-0.000	-0.003	-0.008**
	(0.003)	(0.006)	(0.003)
Don't know or refuse to answer	0.007**	0.001	0.005
	(0.003)	(0.003)	(0.004)
Active time with mother ×Under 14	-0.000	-0.002	-0.007*
	(0.004)	(0.004)	(0.004)
Passive time with mother ×Under 14	0.001	0.001	0.005*
	(0.002)	(0.002)	(0.003)
Active time with father ×Under 14	0.005	0.020**	0.016*
	(0.008)	(0.008)	(0.010)
Passive time with father ×Under 14	0.007	-0.009	0.002
	(0.006)	(0.006)	(0.006)
Active time with grandparents ×Under 14	0.026	-0.006	0.002
	(0.020)	(0.020)	(0.019)
Passive time with grandparents ×Under 14	-0.009*	-0.008	-0.008
	(0.005)	(0.007)	(0.008)
Active time with siblings ×Under 14	-0.011	-0.004	-0.016
	(0.007)	(0.008)	(0.010)
Passive time with siblings ×Under 14	0.004	-0.000	0.007
	(0.004)	(0.005)	(0.006)
Active time with friends ×Under 14	-0.007*	-0.003	-0.003
	(0.004)	(0.004)	(0.005)
Passive time with friends ×Under 14	0.001	-0.012**	-0.012**
	(0.004)	(0.005)	(0.005)
Self active time ×Under 14	0.002	-0.001	0.003
	(0.002)	(0.002)	(0.002)
Self passive time ×Under 14	-0.004	0.001	-0.006

Table E.2: Effects of Children's Time Allocation: Heterogenous Effects by Age

	(0.004)	(0.004)	(0.005)
Active time with others ×Under 14	-0.002	0.001	0.005
	(0.007)	(0.007)	(0.007)
Passive time with others ×Under 14	0.003	-0.003	0.003
	(0.004)	(0.006)	(0.006)
Don't know or refuse to answer ×Under 14	-0.007	-0.006	-0.002
	(0.005)	(0.005)	(0.005)
R-Square	0.664	0.640	0.573
Observations	1698	1698	1698
Exogeneity test F-statistic	1.334	0.843	0.855
Exogeneity test p-value	0.173	0.630	0.615

Note: All estimates are for specification (6). See footnote 38 for a full description of the control variables. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

F Alternative Categorization of Time Inputs

In this section, we consider an alternative aggregation scheme where we treat interactions with multiple partners as separate inputs rather than assigning them based on the hierarchy outlined in Section 2.1. Our decision about which groupings to choose is based on the frequency with which we observe them in the data, and at the same time we keep the number of time inputs manageable. The new categorization of time inputs includes self active/passive time, sleeping or napping, unknown time, active/passive time with mother only, father only, grandparents involved, siblings only, friends only, mother and siblings, parents and siblings, parents, father and siblings, and others. We put time with grandparents involved (i.e. any other partner may or may not be with the child) as a separate category, because time with grandparents alone or with grandparents and one or two other partners is not very common in our dataset.

Table F.1 presents summary statistics for the new time inputs. Similar to Table 1 in the paper, almost every input category has a sizable mass of respondents reporting zero minutes. Other than sleeping or napping and self active/passive time, children spend most time with parents and siblings doing passive activities (e.g. watching TV). Similar to Table 2 in the paper, Table F.2 shows that the confounders of types (a2) and (b) are very unlikely under this categorization. The test results are in Table F.3. We are unable to find surviving specification for non-cognitive skills, so we focus on cognitive skills in Table F.4 where we present the estimates. Estimation results shows that the positive impact of maternal time now works mainly through activities when siblings and/or fathers are present. Also, time with grandparents is estimated to be less productive, a reduction likely driven by the smaller impact of other partners who may be present.

Table F.1: Weekly Time in Each Activity (in Hours)

	Mean	SD	Proportion of Zero
Active time with mother only	1.22	3.32	0.75
Passive time with mother only	3.96	7.54	0.48
Active time with father only	0.44	1.99	0.91
Passive time with father only	1.07	3.17	0.75
Active time with grandparents involved	1.13	3.60	0.83
Passive time with grandparents involved	2.70	8.04	0.78
Active time with siblings only	1.10	3.06	0.79
Passive time with siblings only	2.85	5.75	0.58
Active time with friends only	4.44	7.39	0.55
Passive time with friends only	5.33	8.23	0.37
Self active time	34.81	13.95	0.06
Self passive time	10.91	8.16	0.00
Active time with mother and siblings	1.85	4.06	0.69
Passive time with mother and siblings	5.62	9.18	0.46
Active time with parents and siblings	2.45	5.15	0.66
Passive time with parents and siblings	6.01	9.22	0.52
Active time with parents only	0.89	2.96	0.84
Passive time with parents only	2.49	6.52	0.73
Active time with father and siblings	0.53	2.40	0.91
Passive time with father and siblings	1.10	3.67	0.81
Active time with others	3.42	6.37	0.62
Passive time with others	5.66	9.63	0.30
Sleeping or napping	64.93	10.02	0.00
Refused to answer or do not know	3.10	6.65	0.60

Note: The third column shows the proportion of children who spend zero minutes in a week on the corresponding time category.

Table F.2: Type of Controls (Alternative Specification for Inputs with More than One Partner Present)

Skills	Significance	Number of Variables	Number of Confounders	Type (a1)	Type (b)	Proportion of Confounders	Proportion of Type (a1)
Math	0.05	107	21	20	1	0.196	0.952
Vocabulary	0.05	107	20	19	1	0.187	0.950
Comprehension	0.05	107	18	17	1	0.168	0.944
Noncognitive	0.05	107	0	0	0	0	.
Math	0.1	107	22	21	1	0.206	0.955
Vocabulary	0.1	107	23	22	1	0.215	0.957
Comprehension	0.1	107	20	19	1	0.187	0.950
Noncognitive	0.1	107	0	0	0	0	.

Note: Column 3 shows the total number of variables in our initial pool of potential confounders, which includes lagged test scores, lagged time inputs, child characteristics, parental characteristics, family environmental characteristics, school environmental characteristics, school experience as well as variables related to misreporting of time diaries. Column 4 shows the number of confounders, which are identified if adding a variable significantly change the estimates of time inputs coefficients in a model with only time inputs as regressors (i.e. no controls). Column 5 shows number of type (a1) confounders, which are identified through a regression of a confounder on time inputs and their zero dummy variables: the confounder is of type (a1) if the coefficients of all time input dummies are jointly significantly different from zero. Column 6 shows number of type (b) confounders, which are confounders that do not belong to type (a1). Column 7 shows the ratio of number of confounders (i.e. column 4) over number of variables (i.e. column 3). Column 8 shows the ratio of number of type (a1) confounders (i.e. column 5) over number of confounders (i.e. column 4).

Table F.3: Exogeneity Test Results (Alternative Specification for Inputs with More than One Partner Present)

	Controls	Math		Vocabulary		Comprehension		Noncognitive	
		F-stat	p-Value	F-stat	p-Value	F-stat	p-Value	F-stat	p-Value
(1)	Lagged Score	4.178	0.000	3.336	0.000	2.786	0.000	1.458	0.074
(2)	Child Chrs.	1.391	0.103	1.329	0.136	1.154	0.278	1.503	0.059
(3)	Mother Demog. Chrs.	1.229	0.208	1.212	0.223	0.835	0.689	1.555	0.045
(4)	Family Demog. Chrs.	1.162	0.270	1.172	0.260	0.920	0.571	1.536	0.050
(5)	Family Environ. Chrs.	1.092	0.346	0.996	0.467	0.861	0.653	1.591	0.037
(6)	School Experience	1.138	0.294	0.886	0.619	0.988	0.477	1.594	0.037

Note: Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) Family environmental characteristics; (6) Child's school experience. See footnote 38 for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

Table F.4: Effects of Children's Time Allocation

	Math	Vocabulary	Comprehension
Active time with mother only	0.001	0.002	-0.002
	(0.006)	(0.006)	(0.007)
Passive time with mother only	0.002	-0.003	-0.003
	(0.003)	(0.003)	(0.004)
Active time with father only	-0.002	-0.001	-0.015
	(0.010)	(0.012)	(0.012)
Passive time with father only	0.011*	0.004	0.019**
	(0.006)	(0.005)	(0.008)
Active time with grandparents involved	0.011*	0.008	0.010
	(0.006)	(0.006)	(0.007)
Passive time with grandparents involved	-0.001	-0.004	-0.002
	(0.003)	(0.003)	(0.004)
Active time with siblings only	-0.001	-0.002	-0.011
	(0.007)	(0.007)	(0.008)
Passive time with siblings only	0.006	0.003	0.002
	(0.004)	(0.004)	(0.004)
Active time with friends only	0.005*	0.001	-0.002
	(0.003)	(0.003)	(0.003)
Passive time with friends only	0.002	-0.006**	-0.001
	(0.003)	(0.003)	(0.003)
Self active time	0.005**	-0.002	-0.000
	(0.002)	(0.002)	(0.002)
Self passive time	0.004	-0.001	-0.001
	(0.002)	(0.002)	(0.003)
Active time with others	0.004	-0.005	-0.005
	(0.004)	(0.004)	(0.004)

Table F.4: Effects of Children's Time Allocation

Passive time with others	0.002	-0.002	-0.004
	(0.002)	(0.003)	(0.003)
Active time with mother and siblings	0.009	0.006	0.001
	(0.006)	(0.006)	(0.006)
Passive time with mother and siblings	0.006**	-0.001	-0.005
	(0.003)	(0.003)	(0.004)
Active time with mother, father and siblings	0.007*	0.003	0.002
	(0.004)	(0.004)	(0.004)
Passive time with mother, father and siblings	0.005*	0.002	0.002
	(0.003)	(0.003)	(0.003)
Active time with mother and father	-0.005	-0.005	0.000
	(0.007)	(0.006)	(0.007)
Passive time with mother and father	0.004	0.004	-0.001
	(0.003)	(0.003)	(0.003)
Active time with father and siblings	0.013*	0.005	-0.007
	(0.007)	(0.008)	(0.010)
Passive time with father and siblings	-0.001	-0.004	0.009
	(0.005)	(0.006)	(0.006)
Don't know or refuse to answer	0.003	-0.001	0.004
	(0.003)	(0.003)	(0.003)
R-Square	0.662	0.638	0.568
Observations	1698	1698	1698
Exogeneity test F-statistic	1.138	0.886	0.988
Exogeneity test p-value	0.294	0.619	0.477

Note: All estimates are for specification (6). See footnote 38 for a full description of the control variables. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

G Other Tables and Figures

Table G.1: Effects of Children's Time Allocation: Noncognitive Skill

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother	0.005	0.005	0.005	0.004	0.005	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with mother	0.007**	0.007**	0.007**	0.006**	0.008**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with father	-0.000	-0.001	-0.000	0.001	0.000	-0.001
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Passive time with father	0.011**	0.010**	0.010**	0.010**	0.010**	0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents	0.004	0.006	0.006	0.005	0.006	0.006
	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)	(0.016)
Passive time with grandparents	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Active time with siblings	0.011*	0.011*	0.011*	0.012*	0.013*	0.013**
	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)
Passive time with siblings	0.006	0.005	0.005	0.004	0.006	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Active time with friends	0.003	0.002	0.002	0.001	0.001	0.000
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Passive time with friends	0.004	0.003	0.003	0.003	0.004	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Self active time	0.007**	0.006**	0.006**	0.006**	0.006**	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self passive time	0.009**	0.008**	0.008**	0.008**	0.008**	0.008**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with others	0.003	0.002	0.003	0.002	0.005	0.005
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
Passive time with others	-0.003	-0.002	-0.002	-0.002	-0.001	-0.002
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Don't know or refuse to answer	0.004	0.003	0.003	0.003	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
R-Squared	0.375	0.386	0.388	0.395	0.408	0.418
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	0.913	0.971	0.999	0.994	1.005	1.090
Exogeneity test p-value	0.549	0.484	0.453	0.459	0.447	0.360

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity.

Table G.2: Effects of Children's Time Allocation: Math

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother	0.014**	0.007**	0.006**	0.006**	0.006**	0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with mother	0.005**	0.004**	0.004**	0.004**	0.005**	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Active time with father	0.012**	0.013**	0.013**	0.014**	0.016**	0.015**
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with father	-0.004	-0.003	-0.002	-0.002	0.000	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents	0.021**	0.020*	0.019*	0.020*	0.020*	0.020**
	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
Passive time with grandparents	-0.004	-0.005	-0.006	-0.005	-0.004	-0.004
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with siblings	-0.007	-0.004	-0.003	-0.004	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with siblings	-0.002	0.003	0.004	0.004	0.005*	0.006*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with friends	0.010**	0.008**	0.007**	0.007**	0.007**	0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with friends	-0.000	0.001	0.001	0.001	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time	0.005**	0.006**	0.006**	0.006**	0.006**	0.005**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Self passive time	0.002	0.004	0.003	0.003	0.004	0.004*
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Active time with others	-0.004	-0.002	-0.002	-0.001	0.001	0.001
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)

Passive time with others	0.000	0.000	-0.000	-0.000	0.000	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Don't know or refuse to answer	0.001	0.004	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Child age (months)		-0.011**	-0.009*	-0.009*	-0.010**	-0.010**
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Child age squared		-0.001	-0.002	-0.002	-0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Male		0.049	0.047	0.047	0.053*	0.072**
		(0.031)	(0.031)	(0.031)	(0.032)	(0.031)
Child white		0.064	0.034	0.050	0.033	0.056
		(0.081)	(0.078)	(0.079)	(0.080)	(0.081)
Child black		-0.343**	-0.347**	-0.324**	-0.291**	-0.283**
		(0.083)	(0.081)	(0.081)	(0.083)	(0.084)
Child hispanic		-0.297**	-0.160	-0.144	-0.110	-0.108
		(0.099)	(0.100)	(0.101)	(0.104)	(0.103)
Child birth order		-0.016	-0.014	-0.009	-0.011	-0.006
		(0.015)	(0.016)	(0.016)	(0.016)	(0.016)
Born in US		-0.127	-0.102	-0.114	-0.081	-0.095
		(0.142)	(0.136)	(0.140)	(0.142)	(0.144)
Child BMI		-0.003	-0.002	-0.001	-0.001	-0.002
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mother education			0.042**	0.037**	0.040**	0.037**
			(0.008)	(0.009)	(0.009)	(0.009)
Mother age			-0.043	-0.042	-0.044	-0.052*
			(0.029)	(0.029)	(0.030)	(0.029)
Mother age at child birth			0.000	-0.005	-0.005	-0.003
			(0.006)	(0.007)	(0.007)	(0.007)

Mother age squared	0.001*	0.001*	0.001*	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Mother married at child birth		-0.080	-0.101**	-0.102**
		(0.049)	(0.049)	(0.048)
Total family income (in $10,000s)		0.001	0.0003**	0.002*
		(0.001)	(0.001)	(0.001)
Number of siblings		-0.007	-0.005	-0.004
		(0.005)	(0.005)	(0.005)
No parent lives with child		-0.008	-0.019	-0.007
		(0.039)	(0.038)	(0.038)
Grandparents live with child		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Father education		0.009	0.013	0.008
		(0.009)	(0.009)	(0.009)
Father age		-0.005	-0.006	-0.005
		(0.004)	(0.004)	(0.004)
Father age at child birth		0.008*	0.009**	0.007*
		(0.004)	(0.004)	(0.004)
Annual tutoring cost (in $100s)			-0.017**	-0.017**
			(0.004)	(0.004)
Annual cost of school supplies (in $100s)			-0.005	-0.005
			(0.007)	(0.007)
Annual cost of extracurricular lessons (in $100s)			0.001	0.000
			(0.003)	(0.003)
Annual cost of clothes (in $100s)			-0.001	-0.002
			(0.003)	(0.003)
Musical instrument at home			-0.000**	-0.000
			(0.000)	(0.000)

Desk at home					0.157**	0.131**
					(0.057)	(0.057)
Working TV at home					0.000**	0.000*
					(0.000)	(0.000)
Neighborhood quality rating (1-5)					-0.018	-0.012
					(0.023)	(0.022)
Neighborhood safety rating (1-5)					0.030	0.030
					(0.022)	(0.022)
Number of books mother read last year					-0.011	-0.017
					(0.013)	(0.013)
Number of mother's weekly working hours					-0.001	-0.002
					(0.002)	(0.002)
Number of mother's weekly working days					0.005	0.012
					(0.016)	(0.015)
Ever attended private school						0.042
						(0.045)
Ever joined a gifted program						0.276**
						(0.037)
Number of school changes last year						-0.050
						(0.063)
R-Square	0.503	0.617	0.627	0.631	0.646	0.660
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	5.237**	1.801**	1.611*	1.328	1.334	1.254
Exogeneity test p-value	0.000	0.030	0.064	0.177	0.173	0.224

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity. Estimates for year indicators and grade indicators are not shown in the table above.

Table G.3: Effects of Children's Time Allocation: Vocabulary

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother	0.008**	0.002	0.001	0.001	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with mother	-0.001	-0.000	-0.000	-0.000	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Active time with father	0.004	0.007	0.007	0.007	0.008	0.007
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)
Passive time with father	-0.007*	-0.002	-0.002	-0.001	-0.000	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents	0.022**	0.018	0.020	0.020	0.020*	0.020*
	(0.010)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Passive time with grandparents	-0.005	-0.005	-0.005	-0.004	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Active time with siblings	-0.014**	-0.010*	-0.009	-0.009	-0.009	-0.009
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Passive time with siblings	-0.006	0.001	0.001	0.001	0.003	0.003
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with friends	0.002	0.002	0.002	0.002	0.002	0.001
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with friends	-0.007**	-0.005*	-0.006**	-0.006**	-0.005*	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time	-0.003	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Self passive time	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Active time with others	-0.014**	-0.010**	-0.010**	-0.010**	-0.008*	-0.008*
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)

Passive time with others	-0.009**	-0.006	-0.006*	-0.006	-0.005	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Don't know or refuse to answer	-0.007**	-0.002	-0.002	-0.002	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Child age (months)		-0.020**	-0.017**	-0.017**	-0.019**	-0.019**
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Child age squared		0.000	-0.000	-0.000	0.000	0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Male		-0.060*	-0.067**	-0.070**	-0.061*	-0.057*
		(0.033)	(0.033)	(0.034)	(0.033)	(0.033)
Child white		0.126*	0.102	0.094	0.099	0.116
		(0.073)	(0.073)	(0.074)	(0.073)	(0.072)
Child black		-0.251**	-0.242**	-0.213**	-0.184**	-0.168**
		(0.075)	(0.077)	(0.077)	(0.075)	(0.074)
Child hispanic		-0.312**	-0.174*	-0.202*	-0.161	-0.141
		(0.097)	(0.102)	(0.105)	(0.105)	(0.104)
Child birth order		-0.005	-0.008	-0.006	-0.005	0.000
		(0.018)	(0.020)	(0.021)	(0.021)	(0.021)
Born in US		-0.077	-0.056	-0.059	-0.037	-0.036
		(0.108)	(0.110)	(0.110)	(0.112)	(0.110)
Child BMI		-0.004	-0.003	-0.003	-0.003	-0.004
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mother education			0.039**	0.040**	0.043**	0.041**
			(0.009)	(0.010)	(0.010)	(0.010)
Mother age			-0.045	-0.056*	-0.065*	-0.070**
			(0.033)	(0.034)	(0.033)	(0.033)
Mother age at child birth			0.011	0.011	0.014*	0.014*
			(0.008)	(0.008)	(0.008)	(0.008)

Mother age squared	0.000	0.001*	0.001*	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Mother married at child birth		0.017	0.001	-0.003
		(0.052)	(0.051)	(0.051)
Total family income (in $10,000s)		0.001	0.001	0.001
		(0.002)	(0.002)	(0.002)
Number of siblings		-0.004	-0.003	-0.003
		(0.006)	(0.006)	(0.006)
No parent lives with child		0.004	-0.009	-0.010
		(0.039)	(0.039)	(0.039)
Grandparents live with child		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Father education		-0.004	-0.004	-0.007
		(0.010)	(0.009)	(0.009)
Father age		-0.004	-0.004	-0.002
		(0.004)	(0.004)	(0.004)
Father age at child birth		-0.000	-0.001	-0.002
		(0.005)	(0.005)	(0.005)
Annual tutoring cost (in $100s)			-0.020**	-0.021**
			(0.005)	(0.005)
Annual cost of school supplies (in $100s)			-0.007	-0.008
			(0.007)	(0.007)
Annual cost of extracurricular lessons (in $100s)			0.000	0.000
			(0.002)	(0.002)
Annual cost of clothes (in $100s)			0.006*	0.006*
			(0.003)	(0.003)
Musical instrument at home			-0.000**	-0.000**
			(0.000)	(0.000)

Desk at home					0.052	0.036
					(0.067)	(0.066)
Working TV at home					0.000	0.000
					(0.000)	(0.000)
Neighborhood quality rating (1-5)					0.042*	0.047**
					(0.023)	(0.023)
Neighborhood safety rating (1-5)					-0.018	-0.020
					(0.023)	(0.022)
Number of books mother read last year					-0.035**	-0.039**
					(0.014)	(0.014)
Number of mother's weekly working hours					0.002	0.002
					(0.002)	(0.002)
Number of mother's weekly working days					-0.014	-0.012
					(0.017)	(0.017)
Ever attended private school						0.133**
						(0.042)
Ever joined a gifted program						0.130**
						(0.035)
Number of school changes last year						-0.016
						(0.069)
R-Square	0.509	0.602	0.611	0.613	0.629	0.635
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	3.559**	1.219	1.039	0.899	0.881	0.878
Exogeneity test p-value	0.000	0.249	0.411	0.564	0.585	0.589

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity. Estimates for year indicators and grade indicators are not shown in the table above.

Table G.4: Effects of Children's Time Allocation: Comprehension

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother	0.010**	0.005	0.003	0.002	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with mother	-0.001	-0.001	-0.001	-0.002	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with father	-0.002	-0.001	-0.001	-0.001	0.001	0.000
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Passive time with father	0.000	0.005	0.006	0.007	0.008*	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents	0.031**	0.029**	0.032**	0.032**	0.032**	0.032**
	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)
Passive time with grandparents	-0.007	-0.007	-0.006	-0.006	-0.006	-0.006
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Active time with siblings	-0.019**	-0.017**	-0.016**	-0.016**	-0.015**	-0.015**
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Passive time with siblings	-0.004	0.001	0.001	0.001	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with friends	0.003	0.002	0.001	0.001	-0.000	-0.001
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with friends	0.000	0.000	-0.001	-0.000	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time	0.001	0.002	0.002	0.002	0.001	0.000
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Self passive time	0.002	0.001	0.001	-0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with others	-0.009	-0.008	-0.008	-0.007	-0.005	-0.005
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)

Passive time with others	-0.010**	-0.009**	-0.009**	-0.009**	-0.008**	-0.008**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Don't know or refuse to answer	0.001	0.005	0.004	0.004	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Child age (months)		-0.021**	-0.018**	-0.019**	-0.020**	-0.020**
		(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Child age squared		0.004*	0.003	0.003*	0.004**	0.004**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Male		-0.104**	-0.112**	-0.110**	-0.110**	-0.104**
		(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Child white		0.202**	0.181**	0.172*	0.188**	0.212**
		(0.091)	(0.090)	(0.090)	(0.090)	(0.089)
Child black		-0.181**	-0.157*	-0.083	-0.012	0.007
		(0.091)	(0.090)	(0.090)	(0.091)	(0.089)
Child hispanic		-0.314**	-0.167	-0.157	-0.079	-0.074
		(0.107)	(0.107)	(0.110)	(0.113)	(0.113)
Child birth order		-0.007	-0.021	-0.024	-0.021	-0.018
		(0.018)	(0.019)	(0.020)	(0.020)	(0.020)
Born in US		-0.161	-0.150	-0.155	-0.121	-0.137
		(0.127)	(0.123)	(0.119)	(0.120)	(0.117)
Child BMI		-0.008**	-0.006*	-0.007**	-0.007**	-0.007**
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mother education			0.041**	0.031**	0.035**	0.033**
			(0.009)	(0.010)	(0.010)	(0.010)
Mother age			-0.012	-0.031	-0.030	-0.035
			(0.033)	(0.034)	(0.034)	(0.033)
Mother age at child birth			0.007	0.004	0.002	0.004
			(0.008)	(0.009)	(0.009)	(0.009)

Mother age squared	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Mother married at child birth		0.035	0.016	0.015
		(0.055)	(0.054)	(0.054)
Total family income (in $10,000s)		0.001	0.002	0.001
		(0.001)	(0.001)	(0.001)
Number of siblings		0.009	0.011*	0.010*
		(0.006)	(0.006)	(0.006)
No parent lives with child		0.040	0.030	0.040
		(0.045)	(0.045)	(0.045)
Grandparents live with child		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Father education		0.020*	0.020*	0.015
		(0.011)	(0.011)	(0.011)
Father age		-0.000	-0.001	0.001
		(0.005)	(0.005)	(0.005)
Father age at child birth		0.000	0.001	-0.001
		(0.005)	(0.005)	(0.005)
Annual tutoring cost (in $100s)			-0.012**	-0.012**
			(0.005)	(0.005)
Annual cost of school supplies (in $100s)			-0.005	-0.004
			(0.009)	(0.009)
Annual cost of extracurricular lessons (in $100s)			0.006**	0.005*
			(0.003)	(0.003)
Annual cost of clothes (in $100s)			0.000	-0.001
			(0.004)	(0.004)
Musical instrument at home			-0.000*	-0.000
			(0.000)	(0.000)

Desk at home					0.159**	0.134*
					(0.075)	(0.073)
Working TV at home					0.000	0.000
					(0.000)	(0.000)
Neighborhood quality rating (1-5)					0.021	0.028
					(0.025)	(0.025)
Neighborhood safety rating (1-5)					0.042*	0.044*
					(0.024)	(0.024)
Number of books mother read last year					-0.012	-0.019
					(0.015)	(0.015)
Number of mother's weekly working hours					-0.000	-0.001
					(0.002)	(0.002)
Number of mother's weekly working days					0.016	0.022
					(0.019)	(0.018)
Ever attended private school						0.039
						(0.049)
Ever joined a gifted program						0.250**
						(0.039)
Number of school changes last year						-0.059
						(0.077)
R-Square	0.443	0.516	0.529	0.536	0.554	0.565
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	3.332**	1.548*	1.268	1.111	1.013	1.020
Exogeneity test p-value	0.000	0.081	0.214	0.340	0.438	0.431

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. All standard errors are corrected for heteroskedasticity. Estimates for year indicators and grade indicators are not shown in the table above.

Table G.5: B-spline Estimation Results: Math

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother (0,2.3)	0.044	0.029	0.036	0.028	0.024	0.041
	(0.053)	(0.048)	(0.047)	(0.047)	(0.048)	(0.047)
Active time with mother (2.3,9.5)	0.005	0.001	-0.001	-0.001	0.000	-0.003
	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Active time with mother (9.5,.)	0.014**	0.008**	0.008**	0.007**	0.007*	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Passive time with mother (0,14.6)	0.015**	0.011*	0.011*	0.011*	0.012*	0.013**
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Passive time with mother (14.6,26.9)	0.005	0.005	0.004	0.005	0.004	0.002
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with mother (26.9,.)	0.001	0.001	0.002	0.002	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with father (0,.)	0.011*	0.012**	0.012**	0.013**	0.015**	0.014**
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with father (0,1.0)	-0.039	0.084	0.126	0.147	0.131	0.131
	(0.144)	(0.141)	(0.137)	(0.137)	(0.137)	(0.134)
Passive time with father (1.0,.)	-0.004	-0.002	-0.002	-0.002	-0.000	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents (0,.)	0.023**	0.022**	0.021*	0.021**	0.021**	0.021**
	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
Passive time with grandparents (0,.)	-0.003	-0.004	-0.005	-0.004	-0.004	-0.004
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with siblings (0,.)	-0.006	-0.003	-0.002	-0.002	-0.002	-0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with siblings (0,2.3)	-0.097**	-0.089*	-0.085*	-0.089**	-0.095**	-0.090**
	(0.049)	(0.047)	(0.046)	(0.045)	(0.045)	(0.044)

Passive time with siblings (2.3,.)	0.001	0.006*	0.006*	0.007*	0.008**	0.009**
	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Active time with friends (0,4)	-0.019	-0.006	-0.011	-0.010	-0.012	-0.016
	(0.030)	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)
Active time with friends (4,.)	0.012**	0.009**	0.009**	0.009**	0.009**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with friends (0,5)	-0.043**	-0.032**	-0.034**	-0.031**	-0.029**	-0.032**
	(0.016)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Passive time with friends (5,.)	0.004	0.005	0.004	0.004	0.005*	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time (0,34.6)	0.007*	0.003	0.003	0.004	0.004	0.003
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time (34.6,37.9)	0.015	0.020	0.018	0.019	0.021	0.013
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
Self active time (37.9,.)	0.003	0.007**	0.006**	0.006**	0.007**	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self passive time (0,7.0)	-0.030*	-0.015	-0.014	-0.014	-0.019	-0.019
	(0.016)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
Self passive time (7.0,11.5)	0.003	0.009	0.010	0.011	0.012	0.011
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Self passive time (11.5,.)	0.005	0.004	0.004	0.003	0.004	0.004*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with others (0,.)	-0.005	-0.003	-0.002	-0.001	0.001	0.001
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with others (0,1)	-0.292**	-0.228	-0.233	-0.230	-0.165	-0.210
	(0.145)	(0.148)	(0.144)	(0.144)	(0.139)	(0.134)
Passive time with others (1,.)	0.002	0.002	0.001	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

Don't know or refuse to answer(0,1.25)	-0.178	-0.093	-0.119	-0.122	-0.148	-0.136
	(0.113)	(0.095)	(0.095)	(0.096)	(0.098)	(0.097)
Don't know or refuse to answer(1.25,.)	0.003	0.005	0.005	0.005	0.006*	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
R-squared	0.512	0.623	0.632	0.636	0.652	0.666
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	2.392**	1.431	1.553*	1.487	1.591*	1.561*
Exogeneity test p-value	0.002	0.124	0.079	0.102	0.069	0.077

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. In the first column, the parentheses shown after each time input indicates the time intervals. For example, (0,2.5) means between 0 hours and 2.5 hours per week. Depending on the distribution, some time inputs have less than three time intervals because the time input was not complex enough to accommodate two knots. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

Table G.6: B-spline Estimation Results: Vocabulary

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother (0,2.3)	0.039	0.024	0.029	0.026	0.022	0.031
	(0.052)	(0.048)	(0.047)	(0.047)	(0.048)	(0.047)
Active time with mother (2.3,9.5)	0.012	0.007	0.005	0.005	0.008	0.007
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Active time with mother (9.5,.)	0.005	-0.000	-0.001	-0.001	-0.001	-0.002
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with mother (0,14.6)	0.005	0.001	0.001	0.001	0.003	0.004
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Passive time with mother (14.6,26.9)	-0.001	0.003	0.002	0.002	0.002	0.001
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with mother (26.9,.)	-0.004	-0.003	-0.002	-0.002	-0.001	-0.001
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with father (0,.)	0.004	0.007	0.007	0.007	0.008	0.007
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Passive time with father (0,1.0)	0.064	0.165	0.214	0.213	0.209	0.204
	(0.207)	(0.199)	(0.196)	(0.200)	(0.198)	(0.196)
Passive time with father (1.0,.)	-0.007*	-0.003	-0.002	-0.002	-0.001	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents (0,.)	0.023**	0.019	0.021*	0.021*	0.021*	0.021*
	(0.010)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Passive time with grandparents (0,.)	-0.005	-0.004	-0.004	-0.003	-0.002	-0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Active time with siblings (0,.)	-0.014**	-0.009	-0.009	-0.008	-0.008	-0.008
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Passive time with siblings (0,2.3)	-0.073	-0.072	-0.069	-0.072	-0.084*	-0.083*
	(0.054)	(0.049)	(0.048)	(0.048)	(0.047)	(0.047)

Passive time with siblings (2.3,.)	-0.003	0.004	0.004	0.004	0.006	0.006*
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
Active time with friends (0,4)	-0.014	0.003	-0.005	-0.005	-0.009	-0.011
	(0.031)	(0.031)	(0.030)	(0.031)	(0.030)	(0.030)
Active time with friends (4,.)	0.004	0.003	0.003	0.003	0.003	0.003
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Passive time with friends (0,5)	-0.042**	-0.033**	-0.034**	-0.033**	-0.035**	-0.035**
	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Passive time with friends (5,.)	-0.003	-0.002	-0.003	-0.003	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time (0,34.6)	-0.000	-0.001	-0.000	-0.000	-0.000	-0.001
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time (34.6,37.9)	-0.025	-0.011	-0.012	-0.013	-0.014	-0.017
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Self active time (37.9,.)	-0.001	0.001	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self passive time (0,7.0)	-0.004	0.005	0.006	0.005	-0.000	-0.000
	(0.016)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Self passive time (7.0,11.5)	-0.007	-0.002	-0.001	-0.001	0.002	0.001
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Self passive time (11.5,.)	-0.000	-0.001	-0.002	-0.002	-0.002	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with others (0,.)	-0.014**	-0.010**	-0.010**	-0.010**	-0.008*	-0.008*
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Passive time with others (0,1)	-0.137	-0.078	-0.086	-0.080	0.001	-0.006
	(0.136)	(0.118)	(0.119)	(0.118)	(0.115)	(0.115)
Passive time with others (1,.)	-0.008*	-0.005	-0.006	-0.006	-0.005	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)

Don't know or refuse to answer(0,1.25)	0.024	0.074	0.058	0.071	0.059	0.058
	(0.112)	(0.097)	(0.096)	(0.098)	(0.095)	(0.096)
Don't know or refuse to answer(1.25,.)	-0.007**	-0.002	-0.003	-0.003	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
R-squared	0.513	0.605	0.614	0.616	0.633	0.638
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	1.470	1.234	1.297	1.258	1.263	1.242
Exogeneity test p-value	0.108	0.239	0.195	0.221	0.218	0.233

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. In the first column, the parentheses shown after each time input indicates the time intervals. For example, (0,2.5) means between 0 hours and 2.5 hours per week. Depending on the distribution, some time inputs have less than three time intervals because the time input was not complex enough to accommodate two knots. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

Table G.7: B-spline Estimation Results: Comprehension

	(1)	(2)	(3)	(4)	(5)	(6)
Active time with mother (0,2.3)	0.043	0.013	0.019	0.015	0.015	0.027
	(0.055)	(0.051)	(0.051)	(0.051)	(0.052)	(0.052)
Active time with mother (2.3,9.5)	0.017*	0.014	0.012	0.011	0.012	0.010
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Active time with mother (9.5,.)	0.005	0.000	-0.001	-0.002	-0.003	-0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Passive time with mother (0,14.6)	0.005	0.003	0.002	0.001	0.003	0.004
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Passive time with mother (14.6,26.9)	0.010	0.012**	0.011**	0.011*	0.010*	0.007
	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)
Passive time with mother (26.9,.)	-0.011**	-0.011**	-0.011**	-0.011**	-0.010**	-0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with father (0,.)	-0.003	-0.001	-0.001	-0.001	0.001	-0.000
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Passive time with father (0,1.0)	-0.014	0.093	0.145	0.168	0.116	0.120
	(0.202)	(0.199)	(0.198)	(0.200)	(0.204)	(0.200)
Passive time with father (1.0,.)	0.002	0.006	0.007	0.007*	0.009**	0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with grandparents (0,.)	0.034**	0.032**	0.035**	0.035**	0.035**	0.035**
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)
Passive time with grandparents (0,.)	-0.005	-0.006	-0.004	-0.005	-0.004	-0.004
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Active time with siblings (0,.)	-0.018**	-0.016**	-0.015**	-0.014**	-0.014**	-0.014**
	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Passive time with siblings (0,2.3)	-0.081	-0.071	-0.065	-0.064	-0.071	-0.065
	(0.053)	(0.049)	(0.048)	(0.049)	(0.046)	(0.045)

Passive time with siblings (2.3,.)	-0.000	0.004	0.004	0.004	0.006	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Active time with friends (0,4)	0.017	0.028	0.020	0.020	0.010	0.004
	(0.034)	(0.032)	(0.031)	(0.032)	(0.032)	(0.032)
Active time with friends (4,.)	0.004	0.002	0.002	0.001	0.001	0.000
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Passive time with friends (0,5)	-0.045**	-0.045**	-0.046**	-0.041**	-0.041**	-0.044**
	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Passive time with friends (5,.)	0.006	0.006*	0.005	0.005	0.004	0.004
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self active time (0,34.6)	0.002	0.001	0.002	0.002	0.002	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Self active time (34.6,37.9)	-0.020	-0.010	-0.010	-0.012	-0.013	-0.019
	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Self active time (37.9,.)	0.005	0.005	0.005	0.005	0.005	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Self passive time (0,7.0)	-0.021	-0.017	-0.015	-0.021	-0.024	-0.022
	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)
Self passive time (7.0,11.5)	0.011	0.009	0.009	0.010	0.009	0.008
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Self passive time (11.5,.)	0.003	0.003	0.001	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Active time with others (0,.)	-0.009	-0.007	-0.007	-0.006	-0.005	-0.004
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Passive time with others (0,1)	-0.575**	-0.563**	-0.563**	-0.551**	-0.468**	-0.502**
	(0.186)	(0.184)	(0.182)	(0.181)	(0.166)	(0.162)
Passive time with others (1,.)	-0.006*	-0.005	-0.005	-0.005	-0.004	-0.004
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)

Don't know or refuse to answer(0,1.25)	-0.153	-0.086	-0.105	-0.105	-0.126	-0.108
	(0.124)	(0.116)	(0.116)	(0.120)	(0.123)	(0.124)
Don't know or refuse to answer(1.25,.)	0.004	0.007*	0.006*	0.006*	0.007*	0.006*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
R-squared	0.457	0.530	0.542	0.549	0.565	0.576
Observations	1698	1698	1698	1698	1698	1698
Exogeneity test F-statistic	1.749**	1.373	1.456	1.382	1.296	1.330
Exogeneity test p-value	0.037	0.152	0.114	0.147	0.196	0.175

Note: The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for the lagged corresponding input; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables. In the first column, the parentheses shown after each time input indicates the time intervals. For example, (0,2.5) means between 0 hours and 2.5 hours per week. Depending on the distribution, some time inputs have less than three time intervals because the time input was not complex enough to accommodate two knots. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

Table G.8: Estimation Results: Split Our Active Time as Suggested by Fiorini and Keane (2014)

	Math	Vocabulary	Comprehension
Active time with mother (educational)	0.002	0.001	0.001
	(0.003)	(0.003)	(0.003)
Active time with mother (social)	0.002	0.004	-0.003
	(0.004)	(0.004)	(0.005)
Passive time with mother	0.002	0.001	-0.002
	(0.002)	(0.002)	(0.002)
Active time with father (educational)	0.025**	0.019**	0.004
	(0.007)	(0.008)	(0.010)
Active time with father (social)	0.005	0.000	-0.003
	(0.008)	(0.009)	(0.009)
Passive time with father	-0.003	-0.001	0.007*
	(0.003)	(0.004)	(0.004)
Active time with grandparents (educational)	0.032	0.029	0.063**
	(0.023)	(0.026)	(0.022)
Active time with grandparents (social)	0.010	0.018	0.014
	(0.013)	(0.016)	(0.013)
Passive time with grandparents	-0.007**	-0.003	-0.006
	(0.004)	(0.005)	(0.005)
Active time with siblings (educational)	-0.021**	-0.009	-0.018
	(0.008)	(0.009)	(0.011)
Active time with siblings (social)	0.005	-0.011	-0.021**
	(0.006)	(0.008)	(0.009)
Passive time with siblings	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)
Active time with friends (educational)	-0.009	-0.001	0.004
	(0.011)	(0.010)	(0.010)

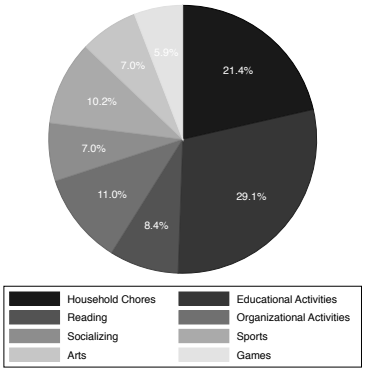
Table G.8: Estimation Results: Split Our Active Time as Suggested by Fiorini and Keane (2014)

Active time with friends (social)	0.003	0.001	-0.002
	(0.003)	(0.003)	(0.003)
Passive time with friends	-0.001	-0.005**	-0.001
	(0.002)	(0.003)	(0.003)
Self active time (educational)	0.002	-0.002	0.001
	(0.002)	(0.002)	(0.003)
Self active time (social)	0.008	0.004	-0.002
	(0.008)	(0.009)	(0.012)
Self passive time	0.002	-0.001	0.001
	(0.002)	(0.002)	(0.002)
Active time with others (educational)	0.007	0.005	-0.003
	(0.010)	(0.008)	(0.011)
Active time with others (social)	-0.003	-0.012**	-0.006
	(0.006)	(0.004)	(0.005)
Passive time with others	-0.002	-0.005	-0.008**
	(0.002)	(0.003)	(0.003)
Don't know or refuse to answer	0.002	-0.001	0.003
	(0.003)	(0.003)	(0.003)
R-Square	0.664	0.638	0.570
Observations	1698	1698	1698
F-statistic	1.739**	1.184	1.182
p value	0.018	0.252	0.254

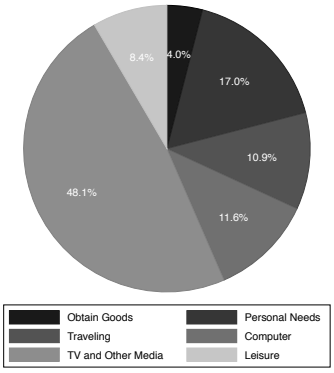
Note: All estimates are for specification (6). See footnote 38 for a full description of the control variables. Standard errors corrected for heteroskedasticity are in parentheses. * Significant at the 10% level. ** Significant at the 5% level.

Figure G.1: Activity Composition

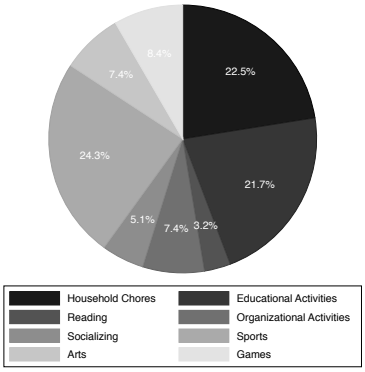
(a) Active Time with Mother



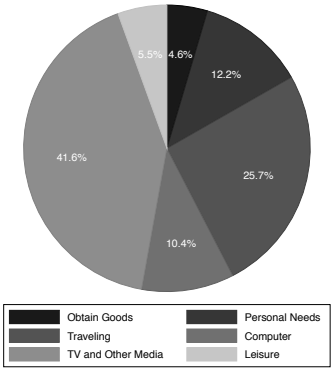
(b) Passive Time with Mother



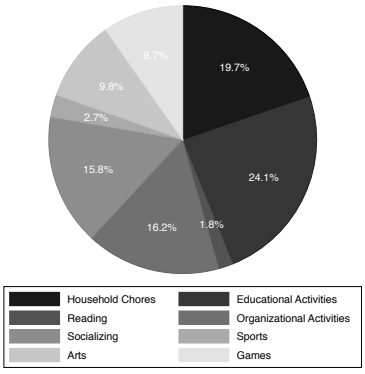
(c) Active Time with Father



(d) Passive Time with Father



(e) Active Time with Grandparents



(f) Passive Time with Grandparents

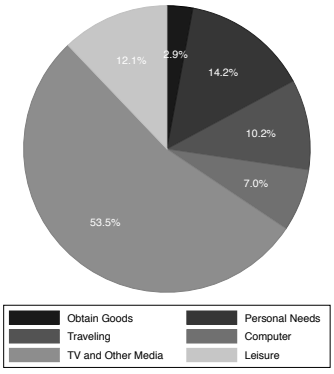
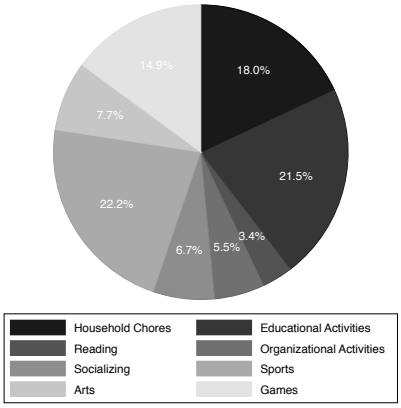
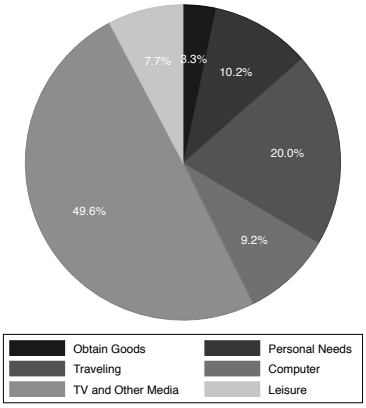


Figure G.2: Activity Composition

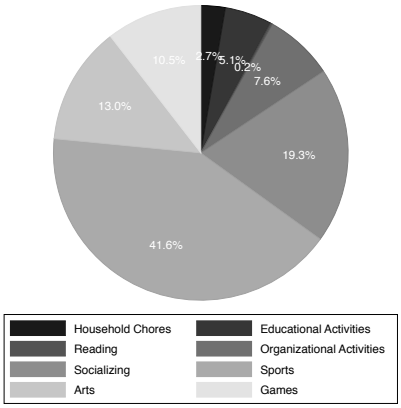
(a) Active Time with Siblings



(b) Passive Time with Siblings



(c) Active Time with Friends



(d) Passive Time with Friends

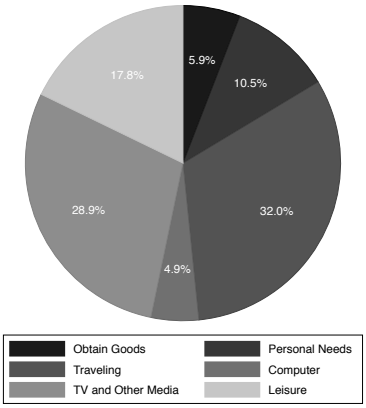
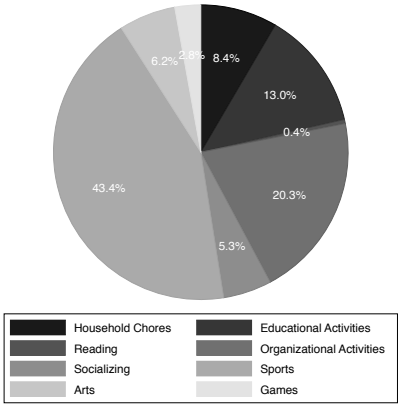
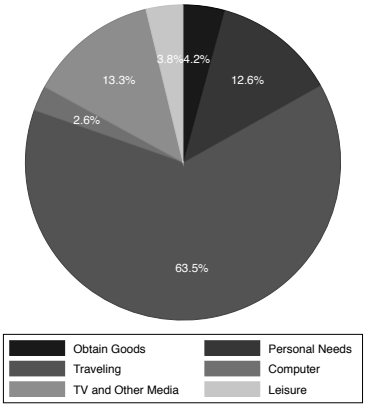


Figure G.3: Activity Composition

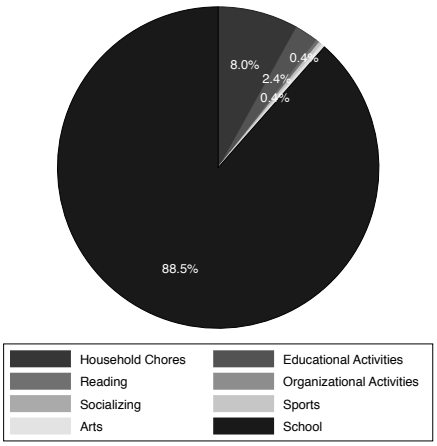
(a) Active Time with Others



(b) Passive Time with Others



(c) Self Active Time



(d) Self Passive Time

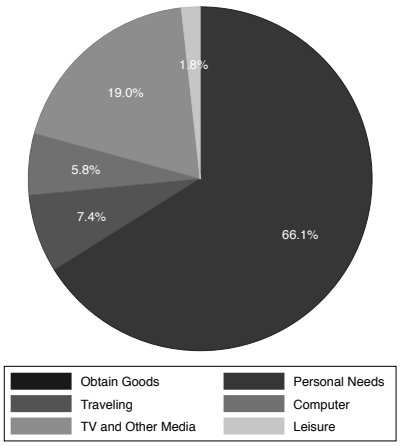
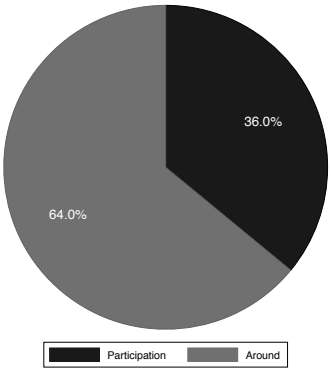
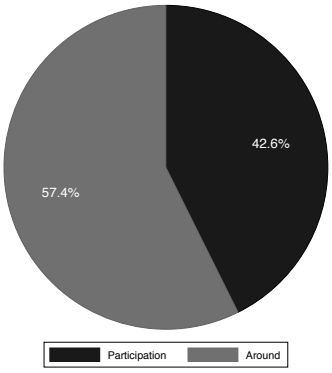


Figure G.4: Participation Time

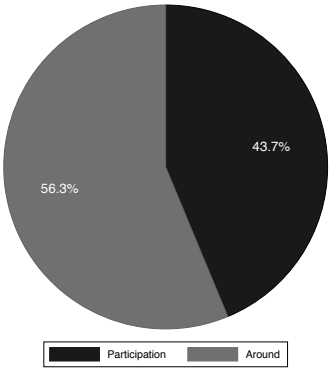
(a) Active Time with Mother



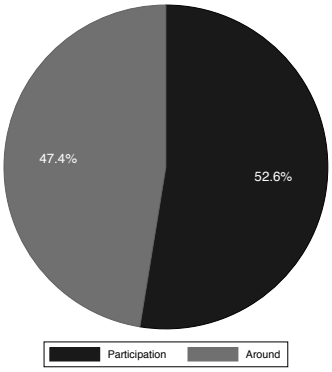
(b) Passive Time with Mother



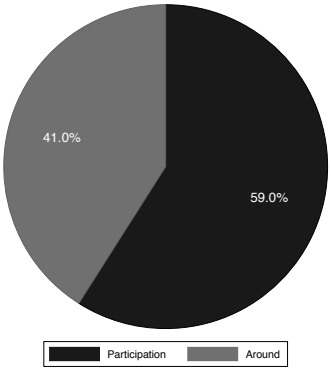
(c) Active Time with Father



(d) Passive Time with Father



(e) Active Time with Grandparents



(f) Passive Time with Grandparents

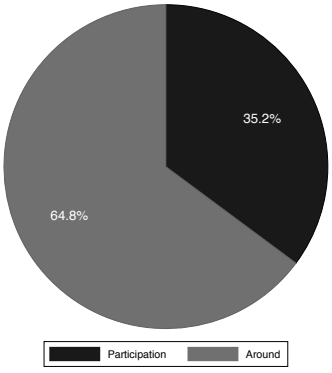
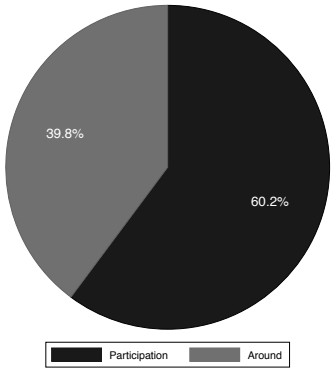
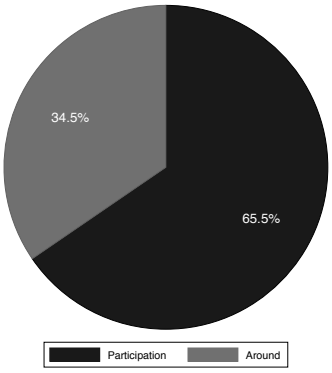


Figure G.5: Participation Time

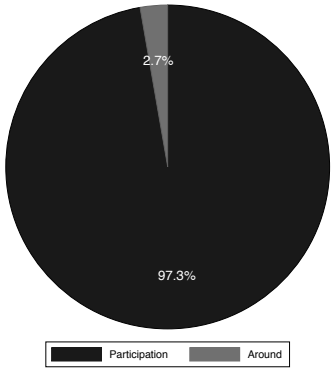
(a) Active Time with Siblings



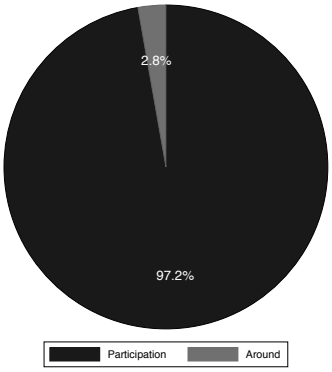
(b) Passive Time with Siblings



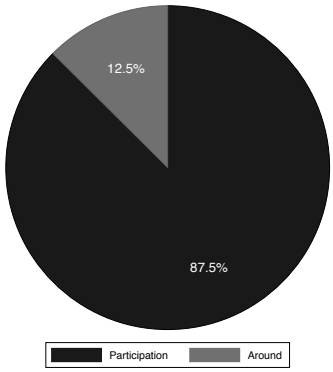
(c) Active Time with Friends



(d) Passive Time with Friends



(e) Active Time with Others



(f) Passive Time with Others

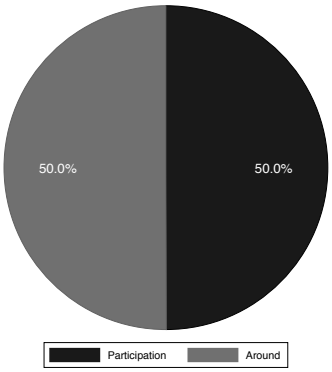
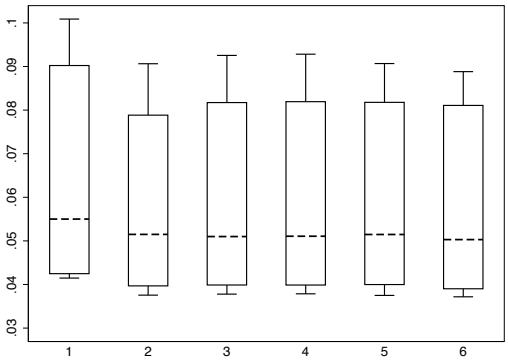
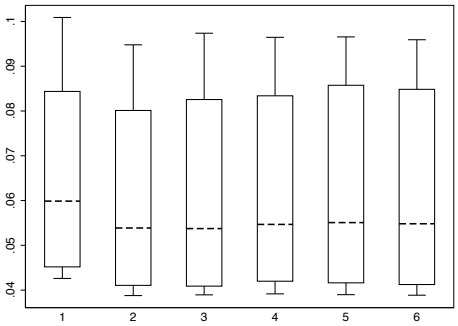


Figure G.6: Average Standard Error of Time Input Indicators

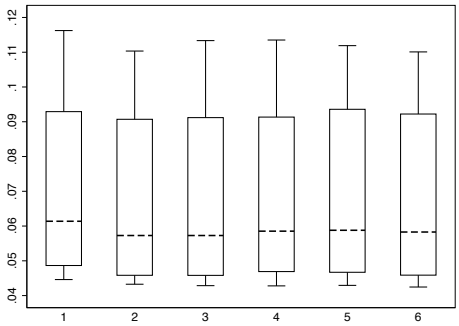
(a) Math Skill



(b) Vocabulary Skill



(c) Comprehension Skill



Note: In each plot, the horizontal axis represents the specifications we specify in the main result section, and the vertical axis represents the distribution of the standard errors of the 15 time input dummy variables for a given specification. The box shows the interquartile range (25th-75th) with median highlighted (i.e. the horizontal line inside the box). The caps show upper adjacent value and lower adjacent value separately (the upper and lower adjacent values are as defined in Tukey 1977). The specifications above refer to the ones used in Section 4 of the paper. Each specification contains different control variables: (1) no controls, except for lagged skill; (2) child characteristics; (3) mother demographic characteristics; (4) family demographic characteristics; (5) family environmental characteristics; (6) child's school experience. See footnote 38 of the paper for a full description of the control variables.