Use of extra-school time and child behaviour

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Abstract

In this paper, we study the effects of extra-school activities on children's non-cognitive development, using data from the Millennium Cohort Study (UK) and focusing on children aged 7-11 years old. We classify the time spent out of school into six homogenous groups of activities, using principal component analysis, and estimate the relationship thereof with five behavioural dimensions drawn from the Strength and Difficulties questionnaire, exploiting the panel structure of the data. Results show the beneficial effects on children's behaviour of sports, school-related activities, time with parents and household chores, while a small detrimental effect of video-screen time is detected. We test the robustness of our estimates against omitted variable bias, and the results are confirmed.

Keywords: child time use, extra-curricular activities, Strengths and Difficulties questionnaire, Millennium Cohort Study, non-cognitive development, omitted variable bias

JEL codes: J13, D1

1. Introduction

Increasingly, scientists from different disciplines are dedicating their efforts to understanding how childhood conditions influence the development of an individual. Both the school and the family play a relevant role in this process, by making children able to fully enhance their potential abilities. In particular, interest has grown in the role of early care. "Good" stimuli when the child is below age 6 have been shown to be very effective for later development (Ruhm 2004; Heckman et al. 2010; Brilli et al. 2016; Del Boca et al. 2018). Over time and across regions, there has been considerable heterogeneity in the way very young children are looked after, especially given the differences in the labour market participation of women, the availability of crèches, social policies, and the geographic proximity of grandparents. After the age of 3, about 85% of children in Europe are enrolled in kindergarten or pre-school (OECD 2014). Apart from differences in the quality of the (pre) kindergarten and schools attended, the effects of which having already been thoroughly investigated (Card and Krueger 1992; Elango et al. 2016), children are exposed to other heterogeneous sources of development opportunities. In particular, between the end of the day at school and bedtime at home, there is time-lag which can be used for more or less structured activities, such as playing sport in a team, rather than playing freely in the park. Also, children can take part in these activities with other children (friends, siblings, cousins), or with other adults (non-working parents, grandparents, instructors).

This paper aims to study how the use of extra-school time influences child behaviour in the European context and, consequently, whether differences in the use of time between children from different family backgrounds should be seriously taken into account as an additional source of inequality.

Very little is known about how children from different family backgrounds spend this time and what consequences it can have on their development and wellbeing. Moreover, little is known about the determinants of children's participation in structured extra-curricular activities, such as sport and music. A child's participation depends on his/her parents' preferences, time and income constraints, the child's own inclinations and talents, and even on which activities the child's peers take part in. Parents may hold different beliefs about the importance of such extra-curricular activities for their children; alternatively, even if convinced of their values, they may not be able to afford them, as most activities are costly, or to manage the logistics. In families with children of different ages, the situation is even more complicated. It is thus easy to expect that children from different family backgrounds have access to different opportunities, which can impact their development (Putnam, 2015).

To date, there is no comprehensive European study on the implications of extra-school activities for child development. The only (non-European) studies which make use of data from children's time use diaries and, thus, explore the full range of activities that are carried out, use American and Australian data. Hofferth and Sandberg (2001) use data from the 1997 Child Development Supplement to the Panel Study of Income Dynamics (around 2,000 children aged 0-12) and find that time devoted to learning activities such as reading is positively correlated with high school achievement, as is structured time spent playing sports or social activities. Also, time spent eating meals with the family is associated with fewer behavioural problems. Fiorini and Keane (2014) use time-diaries from the Longitudinal Study of Australian Children (around 1,300 children aged 4-9) to consider the impact of time use as a whole and, therefore, study the trade-off between the benefits of alternative activities. The result of their research is a ranking of activities (from the most to the least beneficial): time spent in educational activities, particularly with parents, is the most productive for cognitive skill development.

We contribute to the topic by studying the effects of the use of extra-school time on child social, emotional, and behvioural outcomes", using UK longitudinal data. We use available information on child assessments and on child time use up to the age of 11 from the Millennium Cohort Study. At the European level, the Millennium Cohort Study is one of the best sources of information currently available, tracking the lives of a sample of about 19,000 babies born in the UK in the year 2000/2001. The dataset has two great advantages: first, many of the questions and child indicators are repeated over time; second, it provides ample information about the child and the child's family from the time of the birth, information that may prove important to control for. We study the effects of different weekly activities in children's extra-school time on the on the non-cognitive dimensions, employing statistical techniques that exploit the available longitudinal information, limiting endogeneity issues. Moreover, we complement our analysis with a fixed effects approach and we also test the sensitivity of our results to possible biases due to unobserved variables, applying the method developed by Oster (2017) to produce bias-adjusted estimates and to bound the coefficients of interest in the presence of such omitted variables bias. Results are robust to the different specifications and to the possibility of omitted variables bias.

We focus on non-cognitive outcomes, which are not widely studied in the literature, and that we think should be more sensitive to the impact of extra school activities. Indeed, qualitative research suggests that, since during the school-day the emphasis is on academic attainment, out of school activities provide children who don't highly achieve at school with the opportunity to feel that they are capable, thus increasing their self-esteem: this is the main

mechanisms through which extra-school activities may influence children's wellbeing, (Callanan et al. 2016). Also, children have the opportunity to socialise with new friends, with possible consequences on social outcomes. Moreover, non-cognitive skills have been shown to be at least as important as cognitive ones for future school-related outcomes and labour market outcomes (Cuhna and Heckman 2008, Prevoo and ter Weel 2015)), and to influence also cognitive skills (Almlund et al. 2011).

Along this line, we find that sports, school-related activities, time with parents and household chores have beneficial effects on children's behaviour, in particular on prosocial behaviour, while a small detrimental effect of video-screen time is detected. We explore possible heterogeneities in the effects on a number of child characteristics (socio-economic status, gender, nationality, and family composition), but we don't detect relevant differences.

The paper is organised as follows: in Section 2 we review the related literature, Section 3 describe the Millennium Cohort Study, the selection of the sample, and the variables used throughout the analyses; in Section 4 we present the methods employed for the empirical analysis; Section 5 and 6 comprise the results and the robustness checks. Conclusions follow (Section 7).

2. Literature review

With the exception of the two papers mentioned in the previous section (Hofferth and Sandberg, 2001 and Fiorini and Keane, 2014), the majority of the studies in this area consider single activities and focus on cognitive outcomes or school attainment. Across the large span of activities we cover in our study, previous work have mainly investigated the effect of reading, music, sport, and computer and TV use.

There is consistency amongst the findings for the studies that have examined the effects of reading and music. Several papers find beneficial effects on cognitive and behavioural development of parents reading to young children (Hale et al. 2011, Kalb and Van Ours 2014) and of the children's time spent reading (Anderson et al. 1988, Taylor et al. 1990). Hille and Schupp (2015) show that long-term music training during childhood and youth positively influences adolescents' development, in terms of cognitive skills and school grades, but also in terms of non-cognitive development (they are more conscientious, open and ambitious). Eccles et al. (2003) find that participation in service and religious activities predicts lower rates of drinking and drug use.

Despite few recent researches do not find evidence of sport participation on academic performances, education, and labour market outcomes (Rees and Sabia, 2010; Ransom and

Ransom 2018), a large literature highlights the positive effects of sport participation on outcomes at different age, such as children's skill development, degree attainment expectations, educational attainment, school absenteeism, earnings, health, and subjective well-being when adults (Lechner 2009, Pfeifer and Cornelißen 2010, Cuffe et al. 2014, Felfe et al. 2016),

More controversial are the results concerning the effect of computer use and of watching TV. Pre-school exposure to television has been found to have negative effects on cognitive abilities (Hernæs 2019), to no effect (Zavodny 2006, Munasib and Bhattacharya 2010, Huang and Lee 2010), to positive effect on reading, larger for children from households in which English is not the primary language, for children whose mothers have less than high school education, and for non-white children (Gentzkow and Shapiro 2008, Kearney and Levine 2019). Some of the differences in results stem from the type of program (i.e. commercial TV vs. TV program specifically designed with educational purposes), time spent watching TV per day, and the group of children considered.

For computer use, Subrahmanyam et al. (2000), in a review of the literature, report that using a computer is potentially linked to slightly better academic performance (see also Fiorini, 2010). However, access to computers decreases the amount of time children spend on other activities, putting children at risk of obesity. In addition, the use of computers to play games and the use of the Internet seem to be linked to fewer friendships. On the contrary, more recent studies find that children who have a computer to use at home are indeed more likely to have a social network profile, but also to have greater interaction with friends in person. In addition, no substitution effect with other activities, such as sports or club participation, is found (Fairlie and Kalil, 2017).

The main limitation of studies on single activities is that the category of comparison is undefined, and what the child does instead of, e.g., doing sport may imply very different results. We try to overcome this, by considering the whole set of activities that can be done by children when not in school.

3. Data, sample selection, and main variables of interest

The Millennium Cohort Study is a longitudinal survey conducted by the Centre for Longitudinal Studies, which tracks the lives of a sample of about 19,000 babies born in the UK in the year 2000/2001. The survey is conducted in different waves, with the first wave concentrating on the circumstances of pregnancy and birth, the first few months of life, and the socio-economic background of the family into which the child is born. Families and children were re-interviewed when the cohort-child reached about 3, 5, 7, and 11 years of age.

The initial wave 1 sample is composed by 18,818 children in 18,552 families; interviews took place when the children were roughly 9 months old. Not all families participated for the entire duration of the survey: around 10% of the sample is lost between the second and third wave, along with another 10% percent between the third and the fourth wave. Slightly less of the sample was lost between the fourth and fifth wave. Because of the information we need for the analyses, we consider only children in families participating in the survey up to wave 4 or 5, when child non-cognitive outcomes are observed. In addition, we decide to exclude twins due to the possibility of different timings in their development with respect to single-birth children (Mowrer 1954; Mittler 1971). The sample is further restricted to children with non-missing information on the dependent variables. Our final samples consisted of 10,597 children in wave 4 (children aged 7 years old) and 9,462 in wave 5 (children aged 11 years old). Table A1, in the Appendix, shows how the final samples we analyse differ from the initial sample in wave 1 because of attrition. It turns out that the final samples include more educated and work-attached parents than the general population interviewed in wave 1.

The Millennium Cohort Study has repeated measurements of a child's cognitive and non-cognitive outcomes and contains rich information about parental socio-economic background, employment status, child care arrangements, and specific parental inputs at various points in time. Of particular interest to the present research are the variables reporting extra-curricular activities and indicators of the child's development and wellbeing when s/he is 5, 7 and 11 years old**.** We focus on non-cognitive outcomes, specifically on child behaviour indicators derived from the Strength and Difficulties questionnaire.

The Strength and Difficulties questionnaire is composed of 25 items that ask parents about the behavioural attributes of their child. Devised by UK child psychiatrist Robert Goodman (Goodman 1997), this questionnaire is used to screen for emotional and behavioural problems in children and adolescents aged 3-16. The 25 items measure five child behavioural dimensions (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationships problems, and prosocial behaviour); each dimension is derived from five items. The *emotional symptoms* subscale contains items referring to fears, worries, misery, nerves, and somatic symptoms; the *conduct problems* subscale enquiries about tantrums, obedience, fighting, lying, and stealing; and the *hyperactivity/inattention* subscale covers restlessness, fidgeting, concentration, distractibility, and impulsivity. The *peer relationships* subscale items include questions about popularity, victimisation, isolation, friendship, and ability to relate to children as compared to adults. The *prosocial* subscale covers consideration of others, ability to share, kindness to younger children, helpfulness when other children are distressed, and

willingness to volunteer to comfort. An example is going to show how a quantitative indicator for each child behavioural dimension is usually derived. Take the item "Shares readily with other children", referring to the extent the mother believes her child tends to share things with other children. Possible answers are given on a three-point scale with the following labels: "not true", "somewhat true", and "certainly true". The answers are then converted into numerical values of 0, 1 or 2. Groups of five answers are summed up in a total score, ranging from 0 to 10. Lower scores are "good" for the first four behavioural dimensions, while a higher score is "good" for prosocial behaviour. The distributions of the outcomes when children are aged 7 and 11 are reported in Figure A1. In the Figure, we notice that, for each of the outcomes, roughly 30 to 40% of children do not show any problem (an exception being hyperactivity, regarding which, almost the entire sample demonstrates some problems). Not only, although these scores seem continuous variables, they do not really express quantities. Therefore, we decided to further recode these variables into dummies, which take a value of 1 if the child has a score larger than 0 for conduct, emotional and peer relation problems and lower than 10 for the prosocial behaviour. For hyperactivity problem, the dummy variable we built takes value 1 if the child has a score larger than 1, to ensure enough variability in the outcome. In a more straightforward way, the dummies indicate the presence of "problematic" behaviour in each of the five dimensions, and we have thus re-labelled "anti-social behaviour" the last dimension. Table 1 summarises the dependent variables for children aged 7 and 11 years old.

Table 1: Child behaviours (main outcomes)

	Age 7 (wave 4)	**Age 11 (wave 5)**
Emotional symptoms	0.62	0.67
Conduct problems	0.62	0.60
Hyperactivity / inattention	0.71	0.67
Peer relationship problems	0.53	0.56
Anti-social behaviour	0.59	0.53
Observations	10,597	9,462

Notes: proportion of children with behavioural issues.

The main independent variables in our analysis are the activities undertaken by children in their extra-school time. The data provide information about a large number of activities: playing a musical instrument, going to the library, attending religious services and classes, doing sport activities, doing household chores, watching TV, playing electronic games, etcetera. In wave 4 (at age 7), we also have information on other activities carried out with the parents: parents reading to the child, playing music with the child, and drawing with the child.

Unfortunately, the data does not provide the number of minutes/hours spent in each activity, but only an indication of the frequency (e.g., more than once per week / once per week / once per month). We recode the activities in dummy variables, where 1 indicates that the activity is carried out at least once per week. The only exceptions are represented by homework and video-screen activities, where 1 indicates at least one hour per day. All activities are listed and described in Table 2. We report activities at age 7 and 11, ages at which we study their effects on behaviours, but also at age 5, since we will use past activities as further controls (see Section 3). The first three columns of Table 2 (column (2) to (4)) provides an overview of both the activities recorded over time (e.g., sport activities) and the more age-specific ones (e.g., parents reading to the child). Among the activities recorded over time, we observe an increase in time devoted to sport (without parents) and computer use. In the last two columns of the Table (column (5) and (6)), we report the share of children changing their participation to each activity between the different waves: switching from doing the activity in wave *w* to not do it in wave *w+1*, or vice-versa. For instance, the share of children *playing* sport with friends when they were 7 and *not playing* anymore when they are 11, plus the share of children that were *not playing* sport with friends when they were 7 but *playing* sports with friends when they are 11, is 12% of the sample.

Table 2: Extra-school activities

	Age 5 (wave 3)	Age 7 (wave 4)	Age 11 (wave 5)	Δ age 5-age 7	Δ age 7-age 11
Parents read to child (1 pw)	0.95	0.90		0.11	
Parents tell story (1 pw)	0.56	0.46		0.33	
Parents play music (1 pw)	0.87	0.77		0.21	
Parents draw (1 pw)	0.66	0.44		0.38	
Parents play indoors (1 pw)	0.86	0.69	0.45	0.27	0.41
Parents talk to child (1 pw)			0.97		
Evenings or weekend with family at home (1pw)	0.96	0.97		0.06	
Parents at the park-playground (1 pw)	0.61	0.50		0.35	
Parents play active games (1 pw)	0.60	0.50	0.30	0.36	0.39
Sport with parents (1 pw)	0.70	0.78			
Sport with friends (1 pw)		0.94	0.91		0.12
Sport activities (1 pw)	0.27	0.44	0.77	0.33	0.42
Club (1 pw)		0.14			
Bike (1 pw)			0.50		
Library (1 pw)	0.09	0.08	0.08	0.12	0.13
Religious activities (1 pw)	0.19	0.21	0.20	0.13	0.13
Watches TV/videos (1 h pd)	0.79	0.80	0.83	0.24	0.23
Uses computer (1 h pd)	0.22	0.35	0.45	0.24	0.23
Reads (1 pw)		0.83			
Plays a music instrument (1 pw)			0.42		
HH chores (1 pw)		0.79	0.79		0.23
Looks after elderly family members (1 pw)			0.09		
Homework (1 h pd)		0.66	0.85		0.36
Extra classes (1 pw)		0.05	0.19		0.19
Observations	10,597	10,597	9,462		

Notes: In the first three columns we report the proportion of children doing certain activities; "1 pw" stands for "at least once per week"; "1h pd" stands for "at least one hour per day". In the last two columns we report the share of children changing the participation into the single activities between the different waves, i.e. from not doing an activity to doing it, or *viceversa.*

Figure 1: Factor analyses for activities in the three waves

Variables	Age 5 (wave 3)	Age7 (wave 4)	Age 11 (wave 5)
Parents read to child (1 pw)	F1	F6	
Parents tell story (1 pw)	F1	F1	
Parents play music (1 pw)	F1	F1	
Parents draw (1 pw)	F1	F1	
Parents play indoors (1 pw)	F1	F1	F1
Parents talk to child (1 pw)			F1
Evenings or weekend with family at home (1pw)	F1	F1	
Parents at the park-playground (1 pw)	F2	F1	
Parents play active games (1 pw)	F2	F1	F1
Sport with parents (1 pw)	F2	F1	
Sport with friends (1 pw)		F2	F2
Sport activities (1 pw)	F2	F2	F2
Club (1 pw)		F2	
Bike (1 pw)			F2
Library (1 pw)	F3	F3	F3
Religious activities (1 pw)	F3	F3	F3
Watches TV/videos (1h pd)	F4	F4	F4
Uses computer (1h pd)	F4	F4	F4
Reads (1 pw)		F5	
Plays a music instrument (1 pw)			F4 (neg)
HH chores (1 pw)		F5	F5
Looks after elderly family members (1 pw)			F5
Homework (1 h pd)		F6	F6
Extra classes (1 pw)		F6	F6

Factors:

F1: Activities with parents
F2: Sports
F3: Library and religious activities
F4: Video-screen time
F5: Household chores
F6: School-related activities

Notes: the correlations between the activities (first columns) and the extracted factors (expressed through different colours, see the legend) are all positive, with the exception of music, which is negatively correlated with the factor "video-screen time" in wave 5. Grey cells correspond to activities not present in that wave.

With so many variables of interest, the interpretation of results can prove to be difficult, especially as some of the reported variables are likely to capture types of activities that are relatively similar to each other. Thus, we implement a principal component analysis (PCA), aimed at developing better insight into the number of common latent dimensions that the different activities may share. Given the binary nature of the variables, we use polychoric

correlations to construct the covariance matrix from which the eigenvalues and eigenvectors are calculated. To choose the number of components retained, we apply the Kaiser criterion, selecting a number of components equal to the number of eigenvalues greater than 1. Finally, to facilitate the interpretation of the extracted components, we rely on orthogonal rotation using the varimax approach.

Tables A2, A3, and A4 in the Appendix report the principal component analysis. In wave 3, we obtain four components, while in wave 4 and 5 we obtain six components. In Figure 1, we summarise the grouping of activities in the different components, which we name: 1) activities with parents; 2) sports; 3) library and religious activities; 4) video-screen time 5) household chores; 6) school-related activities. There are no factors expressing school-related and household chores activities for children when they are 5 years old.

4. Empirical methods

Our aim is to estimate the effects of the whole set of activities done by children outside school, on their five behavioural traits mentioned above. We can define a generic production function for outcome *Y*, of child *i* observed at age *t* as:

$$Y_{it} = X'_{i\{Kxt\}}\beta_{\{Kxt\}} + \gamma_t\mu_i + \varepsilon_{it} \quad (1)$$

where *X* is the matrix of *K* inputs from age *t* backward, μ_i is the innate ability of child *i* (unobserved) and ε_{it} is the age specific error term. In this specific case, vector *X* is composed by two elements, vector *A*, including the four (or six) factors associated to the set of activities done by children, and vector *Z* including all the remaining inputs, which will be discussed below.

To estimate the production function expressed in (1), we follow Todd and Wolpin, (2003, 2007) and Fiorini and Keane (2014) focusing on two main models: in a first specification, by including in the regressions lagged factors of the extra school activities and lagged behavioural dimensions (value-added cumulative model); in a second specification, by employing child fixed-effects regressions. In addition, we test our results from the first specification to robustness to omitted variables following Oster (2017), relating selection on unobservables with selection observables to estimates bounds for the estimated effects.[1]

[1] In settings like ours, it would be not feasible to implement other strategies, such as instrumental variables, as it is barely impossible to find a set of instruments, one for each of the activities considered.

With the value-added cumulative model, for each child behavioural dimension, we first estimate the following linear equation, once for outcomes at age t=7, once for outcomes at age t=11:

$$Y_{i,t} = \alpha_t + A'_{i,t}\beta_{1t} + A'_{i,t-m}\beta_{2t} + \beta_{3t}Y_{i,t-m} + Z'_{i,t}\beta_{4t} + \varepsilon_{i,t} \qquad (2)$$

where *Y* represents one of the five child behavioural dimensions, the vector *A* indicates the factors expressing different uses of time, the vector *Z* the control variables of the child *i* at the age *t* or before age *t*. The subscript *m* is equal to 2 when we estimate the effects age 7, including time-use factors and outcomes measured at age 5; it is equal to 4 when we estimate the effects age 11, including time-use factors and outcomes measured at age 7. $\beta_1, \beta_2, \beta_3$,are the effects we are interested in measuring, with $\beta_1$being the principal coefficients of interest. In this model we include information regarding the past use of the child's time (allowing for a "lagged" effect) and information on the child's behavioural outcome in the previous wave, which can control for most of the differences across children.[2] The inclusion of past values of the output in the model should capture all unobservable past inputs and the baseline unobserved ability μ_i. This model is equivalent to compare the behaviour of two children at age 7 (11) who used to have the same behaviour indicator at age 5 (7) and the same time inputs at age 5 (7), but may have used their time in a different way between age 5 and 7 (7 and 11).

The assumption behind model (2) is that the information contained in vector *Z* and in $Y_{i,t-m}$ is a good proxy of any unobserved inputs as well as of innate ability μ_i, that the effect of unobserved inputs and ability μ_i decline with age at the rate β_3, and there is no remaining unobserved heterogeneity which correlates with extra school activities at age t (see Fiorini and Keane, 2014 and Kassenboehmer et al, 2018, for details about these assumptions).

Examples of variables that are contained in vector Z, are: personal characteristics, parents' and family characteristics, and socioeconomic circumstances. The detailed descriptive statistics are reported in Table 3 (panel A to C): we first consider a number of variables that describe the environment/context that children face when not at school and not involved in the extra-school activities, which we call *environmental variables* (Table 3, panel A). They are

[2] There exist different models to estimate the effect of interest. In particular, instead of the value-added cumulative model, one could use contemporaneous inputs only, contemporaneous and lagged inputs (cumulative model), or contemporaneous inputs and lagged output (value-added model). See Todd and Wolpin (2003) for a discussion of the different assumptions underneath each model. As most of the results are confirmed using the different models, we decided to present the value-added cumulative model (contemporaneous and lagged inputs, plus lagged output), which is the most restrictive one: all the results we find with this model were also present in the other three specifications that we do not report for the sake of brevity.

measured at the same wave as the main outcomes (at age 7 and 11) and are related to the school dimension (attendance of pre/after school) or to the household dimension (presence in the household of mother, father, siblings, grandparents; parental hours of work). A second set of variables takes into consideration previous *parental investments* (before age 7), and are fixed over time (Table 3, panel B): whether the child was breastfed, how long the mother stayed at home after birth, type of childcare when the child was 30 months, father's involvement with the child when the child was 9 months, and parental education.

Table 3: Control variables

	Age 7 (wave 4)	Age 11 (wave 5)
Environmental variables (panel A)		
Mother in the HH	0.99	0.98
Father in the HH	0.77	0.65
Step father in the HH	0.05	0.06
At least 1 sibling in the HH	0.88	0.88
At least 1 grandparent in the HH	0.06	0.03
At least 1 other adult in the HH	0.06	0.04
Mother's hours of work (per week)	16.34	19.28
Father's hours of work (per week)	39.25	39.36
After school - hours per week	0.83	0.61
Before school - hours per week	0.40	0.46
Parental investments variables (panel B)		
Mother with tertiary education	0.40	0.42
Father with tertiary education	0.40	0.41
Child breastfed for at least 1 month	0.49	0.50
Mother was back to work by six months of the child	0.39	0.40
Father looks after the child on his own	0.61	0.61
Formal childcare when child was 30 months old	0.30	0.29
Other child, parents, household's characteristics (panel C)		
Age child (in months)	86.71	133.98
Girl	0.49	0.50
Birthweight	3.39	3.39
British	0.88	0.88
Injuries	0.09	0.08
Hospital	0.17	0.17
Communicative development (9 months old)	-0.05	-0.06
Motor development (9 months old)	0.02	0.03
Motion development (9 months old)	0.07	0.07
Cognitive development, lag	0.11	0.11
Number of siblings at birth	0.90	0.89
Mother locus of control	0.80	0.81
Mother conflicts (PIANTA scale)	17.05	17.01
Mother closeness (PIANTA scale)	33.62	33.65
Mother being neurotic (OCEAN scale)	23.63	23.64
Mother being extrovert (OCEAN scale)	19.56	19.55
Maternal mental well-being	3.00	3.77
Paternal mental well-being	2.87	3.70
New-borns	0.11	0.05
Weekly HH Equivalent Income	404	563
Holiday outside UK	0.50	0.47
England	0.62	0.62
Wales	0.16	0.15
Scotland	0.12	0.12
Northern Ireland	0.10	0.10
Observations	10,597	9,462

We then include more *socio-demographic* control variables concerning the *child*, the *parents* and the *household* (Table 3, panel C). Control variables about the child are all measured in the first wave: gender, nationality, birth weight, age, number of siblings at birth, hospitalizations and accidents, three indicators of child development in the first year of life,[3] which capture child endowments at an early age and are known to be predictive of later development (Hernández-Alava and Popli, 2017). We include the following variables concerning the parents: quality of the child-mother relationship,[4] locus of control of the mother,[5] mother's personality type,[6] and parents' mental wellbeing.[7] Concerning the household, we include the presence of new-borns and household equivalent income (both measured at the current wave), household location (England, Scotland, Wales, Northern Ireland), and whether the child has been on holidays outside the UK in the past year.

Finally, in addition to child's development at 9 months, in order to take into account the correlation between the different abilities of the child as he/she grows older, we include one variable measuring the child's cognitive ability at the previous wave, which is derived through a factor analysis of the cognitive items available in the survey (see Table A6 in the Appendix). At age 7, we consider past measures of abilities in giving names to objects, in coordinating figures in the spatial dimension, and in problem solving (measured at age 5). For age 11, we have past measures of abilities in reading, in math, and in coordinating figures in the spatial dimension (measured at age 7).

To complement this model, an alternative strategy is to estimate the model with individual fixed effects. The fixed effect model is useful in the case we want to relax the assumption about no unobserved heterogeneity which correlates with extra school activities at age t. For this second specification, using data from both waves, we estimate the following equation:

$$Y_{i,t} = \alpha_t + A'_{i,t}\beta_t + Z'_{i,t}\theta_t + \upsilon_i + e_{i,t} \qquad (3)$$

[3] The three indicators of child development in the first year of life refer to the communication, motor, and motion dimensions. They are derived – through factor analysis – from information in wave 1 (see Table A5 in the Appendix).
[4] Two variables are included (measured in wave 2) that regard child-mother's closeness and conflicts (see the MCS Guide to the Psychological, Developmental and Health Inventories (IOE 2012, page 38)).
[5] Measured in wave 1. It is a dummy variable on mother's locus of control that corresponds to her statement "I usually have a free choice and control over my life".
[6] The two variables are measured in wave 4 and regards mother's being extrovert and neurotic (see IOE 2012, page 45).
[7] Measured with the Kessler K6 Scale in each wave (see IOE 2012, pages 41-43).

With this second model, including child fixed-effects v_i, we can observe whether a change in the frequency of activities carried out between age 7 and 11 explains part of the difference in the child's behavioural dimension over time, cleaning out the effect of the child's preferences and talents or innate ability (μ_i, in the production function (1)), but also of other family unobserved characteristics fixed over time. In this model, the vector Z includes only time varying covariates, i.e. only the control presented in panel A of Table 3 and the time varying controls in panel C: the presence of new-borns, household equivalent income, holidays outside the UK in the past year, and child's cognitive ability at the previous wave.

The value-added cumulative model and the child fixed-effects model rely on different assumptions about the relationship between the child's time use and outcomes. In the first case, the model allows for a temporal adjustment, and the present effect of an activity can be different to the effect of the same activity in the past. For example, when studying the emotional sphere of the child at age 11, we could find that spending a lot of time engaged in video-screen activities at age 7 is bad, while at age 11 there is no additional detrimental effect of the current quantity of time dedicated to video-screen activities. With the child fixed-effects model, we assume instead that input effects are age invariant, e.g. the effect of video-screen time is constant over time. At first sight, the value-added cumulative model seems more informative. However, the child fixed-effects model deals also with the unobservable characteristics of the child and the family fixed over time. Given the assumptions, we will only consider the results provided by the fixed-effects estimator when the two value-added cumulative models indicate there to be a similar effect of a certain activity at ages 7 and 11.

5. The effects of the use of extra-school time

The effects of the extra-school activities – summarised through factors – on the five behavioural dimensions are presented in Tables 4-8. For each outcome, the Tables report the results of the value-added cumulative model at age 7 (second column), at age 11 (third column), and the results of the fixed-effects model (last column). Given that the dependent variables assume value 1 if there is a behavioural problem, a negative sign of the independent variable indicates that the activity reduces the probability of having behavioural problems, thus has a "beneficial" effect, and *viceversa*.

Overall, we find there to be a beneficial effect of sports, school-related activities, time with parents, and household chores, all of which tend to reduce behavioural problems, while we detect a detrimental effect of video-screen time. No effects are found for participating in religious activities and going to the library. The child dimension, which can be more easily

influenced by the use of extra-school time, is the prosocial behaviour: the ability to share with others and to be helpful. On the contrary, the weakest effects are found for problems related to the hyperactivity and inattention of the child. Lagged activities have less effect than contemporaneous ones. All behavioural dimensions are strongly correlated over time and, interestingly, we observe that better cognitive abilities correspond to better behavioural dimensions. The only exception is represented by the prosocial behaviour, which definitely appears to be the most malleable, irrespective of the cognitive development of the child. It is also interesting to note that, for some activities, a significant effect emerges only at age 11 and that, in most cases, when a beneficial effect is detected at age 7, it is also present at age 11; it is rare that a relationship between time use and behaviour detected at age 7 subsequently disappears.

Table 4: The effects of child's extra-school time on Emotional symptoms

	Value-added cumulative model (age 7)	**Value-added cumulative model (age 11)**	**Child fixed-effects model (age 7 and 11)**
Activities with parents	0.022	0.014	0.012
	(0.014)	(0.013)	(0.013)
Sports	-0.011	-0.058***	-0.014
	(0.014)	(0.013)	(0.013)
Library and religious activities	-0.019	-0.003	-0.007
	(0.016)	(0.017)	(0.016)
Video-screen time	0.031***	0.021*	0.027**
	(0.012)	(0.012)	(0.012)
Household chores	-0.031**	0.010	-0.018
	(0.014)	(0.014)	(0.013)
School-related activities	-0.003	0.008	-0.000
	(0.012)	(0.013)	(0.012)
Cognitive ability, lag	-0.009*	-0.027***	0.009
	(0.005)	(0.005)	(0.007)
Emotional symptoms, lag	0.318***	0.258***	
	(0.010)	(0.010)	
Activities with parents, lag	0.016	-0.013	
	(0.016)	(0.013)	
Sports, lag	-0.004	-0.003	
	(0.011)	(0.015)	
Video-screen time, lag	0.013	0.005	
	(0.013)	(0.012)	
Library and religious activities, lag	-0.003	-0.017	
	(0.014)	(0.016)	
Household chores, lag		-0.008	
		(0.014)	
School-related activities, lag		-0.008	
		(0.013)	
Observations	10,597	9,462	18,924

Notes: Standard errors in parentheses; significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; other control variables are included but not reported (see Table 3).

Table 5: The effects of child's extra-school time on Conduct problems

	Value-added cumulative model (age 7)	Value-added cumulative model (age 11)	Child fixed-effects model (age 7 and 11)
Activities with parents	-0.003	-0.039***	-0.005
	(0.013)	(0.013)	(0.013)
Sports	-0.009	-0.017	-0.002
	(0.014)	(0.013)	(0.013)
Library and religious activities	-0.024	0.014	-0.014
	(0.016)	(0.017)	(0.016)
Video-screen time	0.008	0.033***	0.004
	(0.011)	(0.012)	(0.011)
Household chores	-0.042***	-0.031**	-0.030**
	(0.013)	(0.014)	(0.012)
School-related activities	-0.007	-0.044***	0.002
	(0.012)	(0.013)	(0.011)
Cognitive ability, lag	-0.022***	-0.019***	0.002
	(0.005)	(0.005)	(0.006)
Conduct problems, lag	0.362***	0.347***	
	(0.010)	(0.011)	
Activities with parents, lag	-0.027*	-0.011	
	(0.015)	(0.013)	
Sports, lag	0.006	-0.006	
	(0.011)	(0.015)	
Video-screen time, lag	0.016	-0.010	
	(0.012)	(0.012)	
Library and religious activities, lag	0.014	-0.014	
	(0.014)	(0.017)	
Household chores, lag		0.004	
		(0.014)	
School-related activities, lag		-0.037***	
		(0.013)	
Observations	10,597	9,462	18,924

Notes: Standard errors in parentheses; significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; other control variables are included but not reported (see Table 3).

Table 6: The effects of child's extra-school time on Hyperactivity / inattention

	Value-added cumulative model (age 7)	Value-added cumulative model (age 11)	Child fixed-effects model (age 7 and 11)
Activities with parents	-0.001	-0.037***	-0.019
	(0.012)	(0.012)	(0.012)
Sports	-0.026**	0.017	0.008
	(0.013)	(0.012)	(0.012)
Library and religious activities	-0.005	0.010	0.002
	(0.015)	(0.016)	(0.014)
Video-screen time	0.008	0.019*	0.009
	(0.010)	(0.011)	(0.010)
Household chores	-0.066***	-0.015	-0.016
	(0.011)	(0.013)	(0.011)
School-related activities	0.024**	-0.006	0.006
	(0.011)	(0.012)	(0.010)
Cognitive ability, lag	-0.031***	-0.061***	-0.014**
	(0.004)	(0.005)	(0.006)
Hyperactivity/inattention, lag	0.356***	0.365***	
	(0.011)	(0.011)	
Activities with parents, lag	-0.018	-0.015	
	(0.014)	(0.012)	
Sports, lag	-0.016	-0.018	
	(0.010)	(0.014)	
Video-screen time, lag	0.010	-0.008	
	(0.011)	(0.011)	
Library and religious activities, lag	-0.023*	-0.013	
	(0.013)	(0.016)	
Household chores, lag		-0.038***	
		(0.013)	
School-related activities, lag		-0.013	
		(0.012)	
Observations	10,597	9,462	18,924

Notes: Standard errors in parentheses; significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; other control variables are included but not reported (see Table 3).

Table 7: The effects of child's extra-school time on Peer relationship problems

	Value-added cumulative model (age 7)	Value-added cumulative model (age 11)	Child fixed-effects model (age 7 and 11)
Activities with parents	0.008	0.015	-0.002
	(0.014)	(0.013)	(0.014)
Sports	-0.067***	-0.108***	-0.024*
	(0.015)	(0.014)	(0.014)
Library and religious activities	0.025	0.032*	0.011
	(0.016)	(0.017)	(0.017)
Video-screen time	-0.008	0.027**	-0.005
	(0.012)	(0.012)	(0.012)
Household chores	0.005	0.014	-0.010
	(0.014)	(0.014)	(0.013)
School-related activities	-0.011	-0.021	0.006
	(0.013)	(0.014)	(0.012)
Cognitive ability, lag	-0.022***	-0.020***	-0.014**
	(0.005)	(0.005)	(0.007)
Peer relationship problems, lag	0.308***	0.287***	
	(0.010)	(0.010)	
Activities with parents, lag	-0.002	-0.005	
	(0.016)	(0.014)	
Sports, lag	-0.020*	-0.067***	
	(0.011)	(0.015)	
Video-screen time, lag	0.011	0.028**	
	(0.013)	(0.012)	
Library and religious activities, lag	-0.020	-0.002	
	(0.015)	(0.017)	
Household chores, lag		0.000	
		(0.015)	
School-related activities, lag		-0.018	
		(0.013)	
Observations	10,597	9,462	18,924

Notes: Standard errors in parentheses; significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; other control variables are included but not reported (see Table 3).

Table 8: The effects of child's extra-school time on Anti-social behaviour

	Value-added cumulative model (age 7)	Value-added cumulative model (age 11)	Child fixed-effects model (age 7 and 11)
Activities with parents	-0.057***	-0.075***	-0.036***
	(0.014)	(0.014)	(0.014)
Sports	-0.038**	-0.042***	-0.018
	(0.015)	(0.015)	(0.014)
Library and religious activities	-0.005	-0.001	0.007
	(0.016)	(0.018)	(0.017)
Video-screen time	0.023**	0.026**	0.017
	(0.012)	(0.013)	(0.012)
Household chores	-0.085***	-0.094***	-0.037***
	(0.014)	(0.015)	(0.014)
School-related activities	-0.039***	-0.076***	-0.030**
	(0.013)	(0.014)	(0.012)
Cognitive ability, lag	0.001	-0.009*	0.004
	(0.005)	(0.005)	(0.007)
Anti-social behaviour, lag	0.313***	0.281***	
	(0.010)	(0.010)	
Activities with parents, lag	-0.019	-0.044***	
	(0.016)	(0.014)	
Sports, lag	0.006	-0.024	
	(0.012)	(0.016)	
Video-screen time, lag	-0.015	-0.016	
	(0.013)	(0.013)	
Library and religious activities, lag	-0.000	-0.006	
	(0.015)	(0.018)	
Household chores, lag		-0.068***	
		(0.015)	
School-related activities, lag		-0.027*	
		(0.014)	
Observations	10,597	9,462	18,924

Notes: Standard errors in parentheses; significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; other control variables are included but not reported (see Table 3).

We now comment on the strongest results, in terms of both econometric robustness and time consistency (i.e. when we find significant effects on behaviours at both ages 7 and 11), as confirmed by taking into account the unobservable characteristics of the child/family fixed over time. For these results, we also provide the size of effects on the probability of behaving in a certain way when doing more/less frequently certain activities, which is otherwise difficult to interpret, given that we are using factor variables.

We find sport to have a beneficial cumulative-time effect on children's problems in terms of relationships with peers (Table 7). If we compare two similar children where the first one does sports, active games and goes to the playground at least once per week, and the second one carries out these activities less often, we observe that the probability of having problems with peers is six percentage points lower for the first child than for the second (the probability increases from 45% (first child) to 51% (second child)). Time spent with parents in reading, playing and doing games has a beneficial cumulative-time effect on the prosocial behaviour of the child (Table 8). The probability of acting in an anti-social way decreases from 60% to 46% for children who have regular opportunities to spend time with their parents. Children who carry out household chores more often have fewer conduct problems (Table 5) and better prosocial behaviour (Table 8). The probability of problems in conduct decrease from 67% to 62%, while the probability of anti-social behaviour drops from 47% to 36% for children who help more in the household. Finally, we find a beneficial effect of school-related activities on anti-social behaviour (Table 8). More time spent doing homework implies a decrease of four percentage points (the probability of acting in an anti-social way drops from 49% to 45%).

Video-screen time has the expected detrimental effect (both long-lasting and cumulative) on the emotional dimension of the child (i.e. whether the child looks worried and unhappy) (Table 4). The effect is however quite small: the probability increase of being worried and sad for children who spend more time on TV and PC is of two percentage points (rising from 61% to 63%).

Most of the beneficial effects we find on child's behaviours are in line with previous findings on the cognitive dimensions of children. In addition to the positive influence of sports and of activities with parents on many educational outcomes detected by previous studies,[8] in this paper we find positive effects on non-cognitive outcomes, especially on relationships with peers and prosocial behaviour. Completely new evidence is instead provided for the beneficial effects of time spent in household chores and in school-related activities. Time spent using TV

[8] Among the others, Spreitzer and Pugh (1973), Lechner (2009), Pfeifer and Cornelißen (2010), Cuffe et al. (2014), Fiorini and Keane (2014), Felfe et al. (2016).

and PC has the expected detrimental effect on the emotional sphere of the child. When looking at cognitive outcomes, previous literature found that time on TV has either no effects (Zavodny 2006, Munasib and Bhattacharya 2010), or even positive effects for immigrant or non-white children (Gentzkow and Shapiro 2008, Kearney and Levine 2019). On the other hand, the psychological literature has shown that watching TV below age 2 has negative effects the child cognitive and especially non-cognitive development, while after age 5 the relationship changes, largely depending on the content, with interactive programs possibly having a positive impact (Medina 2010), in line with the results by Kearney and Levine (2019). Unfortunately, we do not have information on the contents.

The results are coherent with psychological research on child behavioural development, which underlines the beneficial effects of active and dynamic uses of time versus the detrimental effects of passive activities. Among the different uses of time considered in this paper, the only one with detrimental effects is time spent on TV/PC, which is also the only "passive" activity considered. While dynamic uses of time imply effort and perseverance and, consequently, bring feelings of satisfaction to the child, this is not the case for inactive uses of time (Veenhove 1984; Emmons 2003). The dimension mostly negatively influenced by video-screen time (Emotional symptoms) is, in fact, the most intimate, the one which most concerns the personal dimension of the child. Another interesting finding is the substantial influence of several activities on the prosocial behaviour of the child, which we can consider as a sort of feeling of empathy towards other people. This is an attitude that is expected to grow with the individual, a behavioural dimension that measures the passage from "childhood" (when behaviours are motivated by the need for attachment) to "adulthood" (when behaviours are motivated by the feeling of looking after someone else) (Solomon and George 1996; Nuttall et al. 2015). Probably, this ability could be learnt by spending time with parents and other caring adults, and by observing them. In fact, we find positive effects on children's empathy of time spent with parents, time spent in doing homework (that could be shared with parents), receiving extra-classes (with a tutor), and in helping with household chores (that can be shared with other family members). We also find a beneficial effect of sports on prosocial behaviour, an effect which could be due to another mechanism, the need for collaboration (Lichtenberg et al. 2012). In order to "succeed", in fact, the child needs to interact in a proficient way with his/her companions.

We investigate the possible heterogeneous effects of the use of extra-school time. Specifically, we look at the different impacts of extra-school time by the socio-economic status of the family (education / income), the structure of the family (presence of both parents in the

household / presence of siblings), the ethnic background of the child (British/other), and the gender of the child. We test these hypotheses since we can expect that more structured activities (like sport) could be more beneficial for children from disadvantaged families. We also suppose that different family structures may characterise activities with parents and household chores differently, with consequential heterogeneous effects. Finally, for non-British children a better comprehension of the language (through TV) can also improve relationships with peers and adults. However, we do not find strong evidence for any heterogeneous effect. [9]

5.1 Robustness to omitted variables bias

When studying the relationship between uses of time and the child's behaviours, we are able to control for a rich set of variables, past child behaviour values, and unobserved child and family characteristics, as fixed over time. This should help in interpreting our results in a casual way. However, there is still the possibility that other time-varying factors influence both the use of time and behaviour, biasing our estimates. For example, parents may observe their child as having difficult relationships with peers, and then choose to enrol him/her in a sport activity.

We deal with this issue by applying a method designed to assess the stability of coefficients in the presence of unobservable selection (Oster 2017) to our value-added cumulative model. This method, building on previous work by Altonji et al. (2005), evaluates the robustness of results against omitted variables bias, assuming that the relationship between the treatment and the unobservables can be recovered from the relationship between the treatment and the observables, and allows the coefficient of interest to be bound in the presence of such omitted variables bias.

In order to work with this procedure, we need to choose a level of R_{max}, which corresponds to the *R*-squared from a hypothetical regression of the outcome on the treatment and both observed and unobserved controls. If the outcome could be fully explained by the treatment and full controls set, then R_{max} would be 1; however, in many empirical settings, it seems likely that the outcome cannot be fully explained, even if the full control set is included (e.g. due to measurement error). Therefore, ones need to choose a bound of R_{max}, and Oster (2017) proposes to focus on bounds that are a function of the observed *R*-squared of the regression with a full set of *observable* controls. We choose a $R_{max} = 1.3$ *R*-squared, as suggested by Oster (2017).[10]

[9] Results available from the authors upon request.

[10] This value has been calculated so that at least 90% of randomised results would survive and at least 45% of non-randomised results would survive.

Table 9: Robustness analyses against omitted variables bias

Wave (1)	Outcome (2)	Activity - Factor (3)	Beta (4)	Se (5)	r2 (6)	Bounds (7)	Delta (8)
4	**Anti-social**	**HH**	-0.085	(0.014)	0.174	**[-0.085, -0.053]**	2.28
4	**Anti-social**	**Parents**	-0.057	(0.014)	0.174	**[-0.057, -0.043]**	2.67
4	**Anti-social**	**School**	-0.039	(0.013)	0.174	**[-0.039, -0.032]**	4.15
4	Anti-social	Sport	-0.038	(0.015)	0.174	[-0.045, -0.038]	-13.51
4	Anti-social	TV	0.023	(0.012)	0.174	[0.010, 0.023]	1.66
4	**Conduct**	**HH**	-0.042	(0.013)	0.247	**[-0.042, -0.003]**	1.07
4	Emotional	HH	-0.031	(0.014)	0.183	[-0.031, -0.019]	2.25
4	**Emotional**	**TV**	0.031	(0.012)	0.183	**[0.021, 0.031]**	2.77
4	Hyperactivity	HH	-0.066	(0.011)	0.247	[-0.066, -0.023]	1.45
4	Hyperactivity	School	0.024	(0.011)	0.247	[0.024, 0.034]	-2.94
4	Hyperactivity	Sport	-0.026	(0.013)	0.247	[-0.026, 0.003]	0.91
4	**Peer problem**	**Sport**	-0.067	(0.015)	0.204	**[-0.067, -0.004]**	1.05
5	**Anti-social**	**HH**	-0.094	(0.015)	0.166	**[-0.094, -0.086]**	8.03
5	**Anti-social**	**Parents**	-0.075	(0.014)	0.166	**[-0.075, -0.062]**	3.95
5	**Anti-social**	**School**	-0.076	(0.014)	0.166	**[-0.076, -0.070]**	6.21
5	Anti-social	Sport	-0.042	(0.015)	0.166	[-0.042, -0.039]	6.88
5	Anti-social	TV	0.026	(0.013)	0.166	[0.000, 0.026]	1.01
5	**Conduct**	**HH**	-0.031	(0.014)	0.240	**[-0.045, -0.031]**	-2.61
5	Conduct	Parents	-0.039	(0.013)	0.240	[-0.039, -0.028]	2.99
5	Conduct	School	-0.044	(0.013)	0.240	[-0.044, -0.017]	1.56
5	Conduct	TV	0.033	(0.012)	0.240	[-0.005, 0.033]	0.88
5	Emotional	Sport	-0.058	(0.013)	0.168	[-0.058, -0.033]	2.13
5	**Emotional**	**TV**	0.021	(0.012)	0.168	**[0.008, 0.021]**	1.55
5	Hyperactivity	Parents	-0.037	(0.012)	0.266	[-0.037, -0.030]	3.81
5	Hyperactivity	TV	0.019	(0.011)	0.266	[-0.033, 0.019]	0.37
5	Peer problem	Library	0.032	(0.017)	0.192	[0.017, 0.032]	1.89
5	**Peer problem**	**Sport**	-0.108	(0.014)	0.192	**[-0.108, -0.077]**	2.91
5	Peer problem	TV	0.027	(0.012)	0.192	[-0.004, 0.027]	0.87

Notes: robustness analyses are reported only for significant coefficients from the valued-added cumulative models (Tables 4-8). Outcomes, activities and bounds of coefficients that are significant in all three models (Tables 4-8, commented in Section 4) are displayed in bold.

Then, we calculate the bounds of the estimated coefficients, for different values of the relative degree of the selection on observed and unobserved variables (δ). We focus on $\delta = 0$, corresponding to the original estimates, and $\delta = 1$ as the upper bound, which correspond to the assumption of equal selection between observed and unobserved variables, as suggested by Oster (2017).

The bounds are reported in Column (7) of Table 9.[11] We observe that the 0 is rarely included in the calculated bounds, except for sport on hyperactivity (wave 4) and video-screen time on conduct, hyperactivity and peer problem outcomes in wave 5. This implies that most of our estimates are robust regarding the presence of omitted variable bias, as the estimates are never equal to 0.

To confirm our results, we also report the value of δ such that β would be 0 given the assumed R_{max}, and we see that this is greater than 1 in all cases (again except for the cases mentioned above). A δ greater than 1 would imply that unobservables are more important than all the observables in explaining selection into treatment. Such values of the bounds and of δ suggest that the effects of the activities on the outcomes that we find are robust, even in the presence of other possible omitted variables that we cannot observe in our data.[12]

6. Extra-school time opportunities across children

We find evidence of the beneficial effects on child behaviours of time spent with parents, doing sports, household chores and school-related activities, while the detrimental effects of video-screen time are also recognised. We do not find strong heterogeneous effects of these uses of time, but we can expect that children from different contexts may have a different likelihood of spending time in these activities: if this is the case, even under homogeneous effects, inequalities in behavioural development would arise across different groups.

In particular, it is policy relevant to consider whether children with fewer economic and cultural resources have the same opportunities in their extra-school time as children with more resources. Once we take into account economic resources, the family composition may also play a role: a large number of siblings or the absence of one of the two parents in the household could influence the logistics of some activities. Finally, whether determined by preference or culture, the gender of the child may affect the use of their time.

To account for the effects of child and family characteristics on children's uses of time (grouped under the same factors as before), we perform a set of regressions in which extra-school activities are estimated as a function of the relevant variables. Table 10 reports the results.

[11] Estimations are done in Stata with *psacacl*.

[12] A negative delta means that if the observables are positively correlated with the treatment, the unobservables have to be negatively correlated with the treatment to get a $\beta = 0$.

Table 10: Determinants of the use of extra-school time

	(1) Activities with parents	(2) Sports	(3) Library & Religious	(4) Video-screen	(5) Household chores	(6) School
British	0.047***	0.103***	-0.238***	0.010	-0.047***	-0.097***
	(0.010)	(0.008)	(0.009)	(0.010)	(0.008)	(0.010)
Girl	0.009	-0.056***	-0.003	-0.154***	0.095***	0.034***
	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.005)
Siblings	-0.047***	-0.017***	0.000	0.005	0.018***	-0.005
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
New-borns	-0.026**	-0.011	0.005	-0.020	0.029***	-0.013
	(0.011)	(0.010)	(0.008)	(0.011)	(0.009)	(0.010)
Mother tertiary educ.	0.011	0.034***	0.016***	-0.097***	0.007	0.035***
	(0.007)	(0.006)	(0.005)	(0.007)	(0.006)	(0.006)
Breastfeeding	0.010	0.024***	0.021***	-0.072***	0.007	0.020***
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Mum work early	-0.017***	0.012**	-0.012**	0.022***	0.015***	0.010
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Father in the HH	-0.048	-0.078	-0.046	0.022	-0.083	0.091
	(0.093)	(0.071)	(0.084)	(0.055)	(0.095)	(0.076)
Step-father in HH	-0.045	-0.123	-0.113	0.035	-0.073	0.052
	(0.093)	(0.070)	(0.083)	(0.054)	(0.094)	(0.075)
Grandparents in HH	0.005	-0.017	0.027**	0.054***	-0.001	0.010
	(0.014)	(0.013)	(0.012)	(0.014)	(0.014)	(0.014)
Mum working hours	-0.000***	0.000	-0.000**	-0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Father working hours	0.000	0.000	0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HH income	-0.009***	0.019***	-0.009***	-0.017***	-0.009***	0.017***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Age of the child	-0.019	-0.052	0.090	0.102	-0.008	0.007
	(0.091)	(0.082)	(0.073)	(0.092)	(0.080)	(0.083)
Age squared	0.000	0.001	-0.001	-0.001	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age cubed	-0.000	-0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Wales	0.034***	0.015**	0.012	-0.011	-0.029***	-0.083***
	(0.008)	(0.007)	(0.006)	(0.008)	(0.007)	(0.008)
Scotland	-0.017	0.035***	0.045***	0.029***	0.027***	-0.031***
	(0.009)	(0.008)	(0.007)	(0.009)	(0.008)	(0.008)
Northern Ireland	-0.044***	0.071***	0.222***	-0.064***	0.052***	0.085***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.009)	(0.009)
Observations	18,924	18,924	18,924	18,924	18,924	18,924

Notes: Standard errors in parentheses, ** $p < 0.05$, *** $p < 0.01$. We include only children present in both waves 4 and 5.

From an inequality point of view, we observe that children from a more advantaged background, in terms of parental education and income, are more exposed to enriched uses of their time (sports, school activities) and are less exposed to detrimental ones (TV and computer). On the other hand, richer parents and labour-market attached mothers spend less time with their children. Interestingly, the number of hours worked by the father does not influence the probability of activities with parents, nor other activities. The family structure influences two uses of time in an opposite but compensatory way: an only child spends more time with their parents, whilst a child with siblings spends more time helping in household chores. Having siblings also decreases the probability of doing sport, probably for logistic reasons (since income is controlled for). The presence of the father (or of a stepfather) does not influence the use of extra-school time, while the presence of grandparents leads children to more "quiet" activities (TV, computer, religious services, and library). British children spend more time with their parents and in sport activities, while children from ethnic minorities spend more time doing homework, helping in the household, and attending the library and religious services. From a gender point of view, the results are as expected: girls are more likely to spend time on school-related activities and in household chores and are less likely to engage in sport and TV/computer use.

7. Conclusions

In this paper, we study the relationship between the use of extra-school time and child behaviours, using UK longitudinal data, and we find that different extra-school activities influence the behavioural development of the child. Time with parents, time spent in household chores, school-related activities and sports have beneficial effects, whereas time spent watching TV and using a computer have a detrimental effect. The more easily influenced dimension is the prosocial behaviour of the child. We also show that our results are robust with regard to possible omitted variables bias.

Most of the beneficial effects we find on child's behaviours confirm previous findings on the cognitive dimensions of the child. In addition to the positive influence of sports and of time with parents on many educational outcomes, in this paper, we detect positive effects thereof on relationships with others. Completely new evidence is provided for the beneficial effects of time spent engaged in household chores and school-related activities.

We observe that children from different family backgrounds do not face the same opportunities in their extra-school time. We find a negative relationship between the presence of siblings and sport (probably for logistic reasons) and an expected positive relationship

between income and sport, which is one of the few to-pay activities among those included. From a policy point of view, these two findings call for the provision of free/low-cost sport activities to be held at school, after regular time. Differences by socio-economic background also emerge in terms of school-related activities, which the children of richer and more educated parents being more likely to engage thereof. More time devoted to school-related activities and less time spent on TV-computer could also be achieved with the expansion of after-school programs, at school or other public places. Other sources of differences in the use of extra-school time (parental education, gender of the child, ethnicity) seem to be more cultural and may be influenced through parenting courses, which are becoming more and more common, not only around the births of children, but also at later stages.

There are three main limitations to this study. First, we do not know how much time the child spends in the activities. Not only would this be another important source of heterogeneity across children, but it could also reveal the non-linear effects of these activities. Second, in order to better interpret the results we obtain for children's non-cognitive development, it would be useful to know more details of the activities carried out. For example, to understand the level of passiveness of activities under the video-screen category, we should know whether children are watching a movie/cartoon, a cartoon with interactions, playing video-games, watching other people playing those video-games, singing or dancing whilst watching musical videos, or searching for commercial videos (e.g., the unboxing of toys). Finally, we don't have a full description of the use of extra-school time; thus, we are missing important children's activities, such as "pure" playtime (playing by themselves or with siblings/cousins), time at dinner and social events, sleeping routines, and the management of moments of boredom and of waiting-time. Future research should investigate such factors to completely unveil the relationship between the child's time use and the child's non-cognitive development.

Compliance with Ethical Standards:

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Appendix

Table A1. Sample selection, selected variables

	9 months old (wave 1)	7 years old (wave 4)	11 years old (wave 5)
	Mean	Mean	Mean
Mother highly educated	0.33	0.39	0.40
Father highly educated (if present in the HH)	0.36	0.39	0.40
Mother back to work within 6 months of birth	0.35	0.38	0.39
British	0.81	0.85	0.85
Girl	0.49	0.49	0.50
Birthweight	3.36	3.38	3.38
England	0.62	0.63	0.63
Wales	0.15	0.15	0.15
Scotland	0.13	0.12	0.12
Northern Ireland	0.10	0.10	0.10

Notes: means of the selected variables in the initial sample ("wave 1") and in the analysed samples ("wave 4", "wave 5"). HH stands for household.

Table A2. Factor analysis on activities at age 5 of the child (wave 3)

Activities	With parents	Sports	Video-screen	Library / religious	Uniq.
Parents read to child (1 pw)	**0.585**	0.278	-0.171	0.097	0.542
Parents tell story (1 pw)	**0.599**	0.038	0.056	0.329	0.529
Parents play music (1 pw)	**0.709**	0.093	-0.050	-0.043	0.485
Parents draw (1 pw)	**0.714**	0.188	0.036	0.087	0.446
Parents play indoors (1 pw)	**0.755**	0.233	0.007	-0.038	0.374
Evenings or weekend with family at home (1pw)	**0.599**	0.016	0.001	-0.067	0.637
Parents at the playground (1 pw)	0.246	**0.630**	0.112	0.161	0.505
Parents play active games (1 pw)	0.526	**0.549**	-0.030	-0.015	0.421
Sport with parents (1pw)	0.266	**0.689**	-0.125	-0.105	0.428
Sport (1pw)	-0.015	0.489	-0.416	0.044	0.585
Library (1pw)	0.024	0.323	0.172	**0.698**	0.379
Religious activities (1pw)	0.026	-0.230	-0.215	**0.743**	0.349
Watches TV/videos (1h pd)	0.034	-0.114	**0.742**	-0.124	0.419
Uses computer (1h pd)	-0.061	0.047	**0.774**	0.061	0.391

Notes: correlation between the variables expressing activities and the extracted factors. Higher correlations are in bold. "1 pw" stands for "at least once per week"; "1h pd" stands for "at least one hour per day".

Table A3. Factor analysis of children's activities at age 7 (wave 4)

Activities	With parents	Sports	Library / religious	Video-screen	HH chores	School	Uniq.
Parents read to child (1 pw)	0.439	0.107	-0.074	-0.078	0.168	**0.546**	0.458
Parents tell story (1 pw)	**0.530**	-0.186	0.183	-0.051	0.193	0.150	0.589
Parents play music (1 pw)	**0.544**	-0.014	-0.193	-0.081	0.298	0.110	0.559
Parents draw (1 pw)	**0.712**	-0.204	0.043	-0.060	0.092	0.144	0.416
Parents play indoors (1 pw)	**0.772**	0.030	-0.056	0.017	0.125	0.068	0.380
Evenings or weekend with family at home (1pw)	**0.466**	0.220	-0.003	0.092	0.321	-0.065	0.619
Parents at the playground (1 pw)	**0.596**	0.093	0.246	0.033	-0.149	-0.122	0.538
Parents play active games (1 pw)	**0.754**	0.225	-0.009	-0.044	-0.030	-0.065	0.374
Sport with parents (1pw)	**0.563**	0.529	-0.098	0.026	0.013	0.038	0.392
Sport with friends (1pw)	0.085	**0.718**	-0.140	0.125	0.085	0.120	0.421
Sport (1pw)	0.006	**0.650**	-0.006	-0.220	0.003	0.194	0.491
Club (1pw)	-0.052	**0.514**	0.408	-0.214	0.105	-0.048	0.507
Library (1pw)	0.210	-0.188	**0.588**	0.092	0.015	0.129	0.549
Religious activities (1pw)	-0.081	-0.026	**0.765**	-0.067	0.125	-0.068	0.383
Watches TV/videos (1h pd)	-0.050	-0.055	-0.063	**0.800**	0.035	-0.032	0.349
Uses computer (1h pd)	-0.006	0.007	0.007	**0.770**	-0.094	-0.001	0.398
Reads (1pw)	0.081	0.109	0.173	-0.038	**0.721**	0.080	0.423
HH chores	0.173	-0.006	0.008	-0.087	**0.595**	0.157	0.584
Homework (1h pd)	-0.014	0.197	-0.047	0.035	0.162	**0.708**	0.430
Extra-classes (1pw)	-0.026	-0.004	0.421	-0.117	-0.401	**0.507**	0.391

Notes: correlation between the variables expressing activities and the extracted factors. Higher correlations are in bold. "1 pw" stands for "at least once per week"; "1h pd" stands for "at least one hour per day".

Table A4. Factor analysis of children's activities at age 11 (wave 5)

Activities	With parents	Sports	Video-screen	Library / religious	School	HH chores	Uniq.
Parents play indoors (1 pw)	**0.852**	0.027	0.052	0.069	-0.022	0.086	0.259
Parents talk to child (1 pw)	**0.590**	-0.028	-0.038	-0.396	0.246	0.029	0.432
Sport with parents (1pw)	**0.781**	0.177	-0.061	0.165	-0.051	0.023	0.325
Sport with friends (1pw)	0.102	**0.807**	-0.063	-0.110	0.044	0.050	0.319
Sport (1pw)	0.027	**0.694**	-0.115	-0.055	0.229	-0.179	0.417
Bike (1pw)	0.116	**0.593**	0.113	0.167	-0.247	0.215	0.487
Library (1pw)	0.199	-0.052	-0.047	**0.755**	-0.038	0.002	0.384
Religious activities (1pw)	-0.033	-0.123	-0.110	**0.553**	0.411	0.230	0.444
Watches TV/videos (1h pd)	-0.008	-0.044	**0.727**	-0.132	0.077	0.032	0.445
Uses computer (1h pd)	0.025	-0.043	**0.741**	0.042	-0.072	-0.125	0.426
Plays music (1 pw)	0.090	0.129	**-0.431**	0.082	0.260	-0.184	0.682
HH chores	0.196	0.072	-0.280	-0.205	0.182	**0.635**	0.400
Looks after elderly (1 pw)	0.029	-0.017	0.068	0.162	-0.054	**0.793**	0.336
Homework (1h pd)	0.115	0.181	0.003	-0.199	**0.638**	0.007	0.507
Extra-classes (1pw)	-0.119	0.033	-0.015	0.267	**0.619**	0.026	0.529

Notes: correlation between the variables expressing activities and the extracted factors. Higher correlations are in bold. "1 pw" stands for "at least once per week"; "1h pd" stands for "at least one hour per day".

Table A5: Factor analysis of development indicators in the first year of life

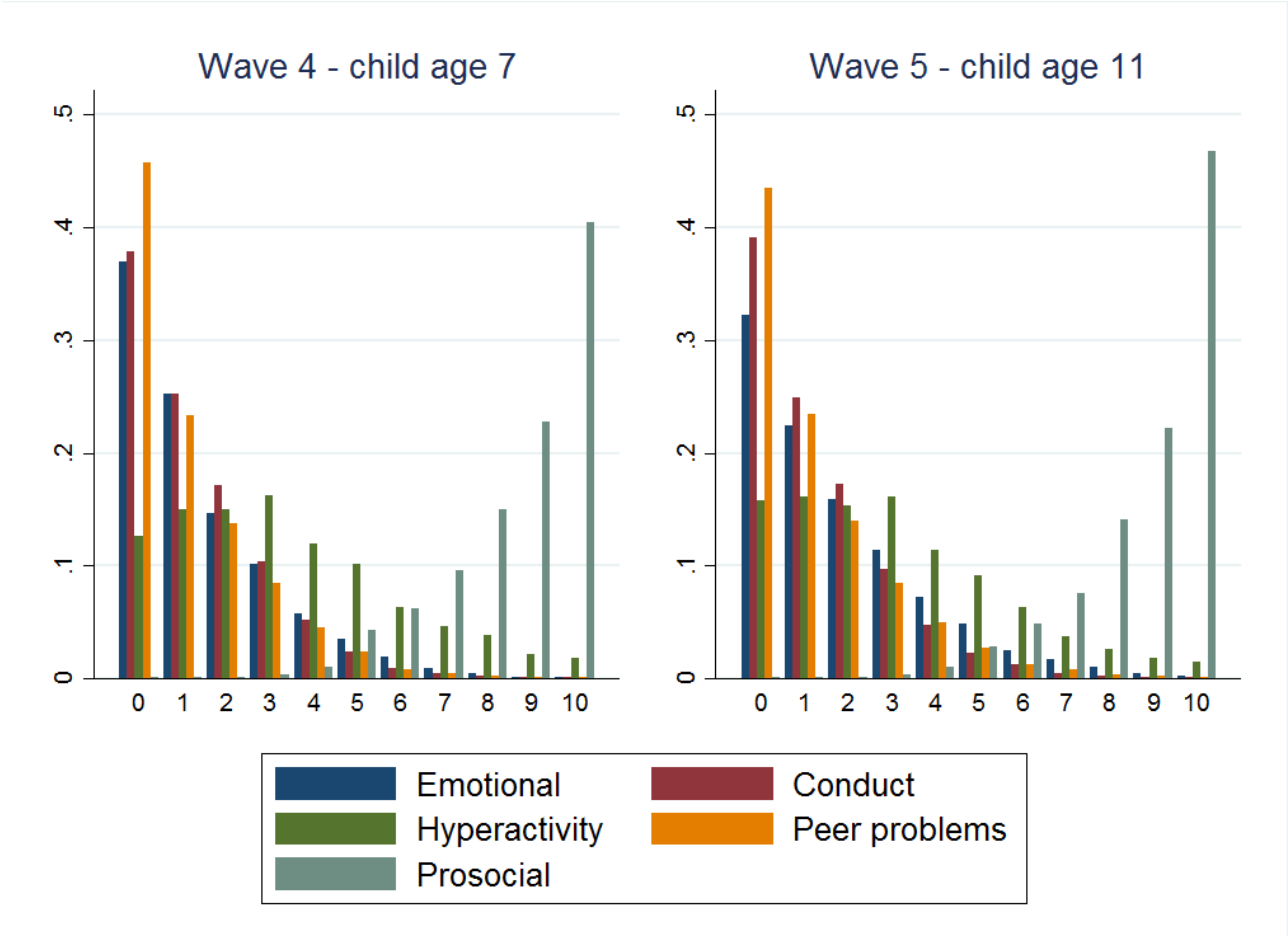
Ability	Communication development	Motor development	Motion development
Smiles	-0.133	0.068	**0.424**
Sits up	0.058	**0.496**	0.358
Stands up holding on	0.171	**0.755**	0.016
Hands together	**0.394**	-0.008	0.255
Grabs objects	-0.036	0.048	**0.665**
Holds small objects	0.218	0.154	**0.423**
Passes a toy	0.145	-0.036	**0.637**
Walks a few steps	0.326	**0.352**	-0.160
Gives toys	**0.579**	0.206	0.186
Waves bye-bye	**0.657**	0.152	0.058
Extends arms	**0.380**	0.309	0.122
Nods for yes	**0.611**	-0.100	-0.113
Can move from place to place	-0.082	**0.663**	-0.014

Notes: correlation between the variables expressing abilities and the extracted factors. Higher correlations are in bold.

Table A6: Factor analyses of child cognitive tests

Tests – age 5	Factor	Uniqueness
Naming Vocabulary	0.743	0.448
Pattern Construction	0.761	0.420
Picture Similarity	0.741	0.451
Tests – age 7	**Factor**	**Uniqueness**
Word Reading	0.770	0.407
Pattern Construction	0.745	0.444
Maths	0.852	0.274

Figure A1. Child behavioural indicators



Notes: the five colours represent the five behavioural indicators (Emotional symptoms, Conduct problems, Hyperactivity / inattention, Peer relationship problems, Prosocial behaviour). Each indicator goes from 0 to 10, depending on the answers the caregivers give to the five questions for each child behavioural dimension. 0 means "absence of problems" and 10 "presence of all problems" for the first four indicators, while 10 means "absence of problems" and 0 "presence of all problems" for the Prosocial behaviour.