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The allocation of after-school time and child socio-emotional skills

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Abstract

In this paper, we study the effect of the allocation of after-school time 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 outside of school into seven groups of activities and evaluate their impact on five socio-emotional skills drawn from the Strength and Difficulties questionnaire, taking advantage of the panel structure of the data. We then test the robustness of our estimates against endogeneity issues. Time spent on sports, studying, reading, tidying up, and active time with parents have beneficial effects, while video-screen time and extra hours at school have harmful ones.

Keywords: child time use, extra-curricular activities, non-cognitive development, socio-emotional skills, omitted variable bias, reverse causality

JEL codes: J13, J24, I24, D10

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The authors declare that they have no conflict of interest.

1. Introduction

Increasingly, scientists from different disciplines are studying how childhood conditions contribute to individual development in terms of educational attainment, social behaviour, labour market prospects, and health conditions. Both families and play a vital role in this process by bolstering or harming children's skills, which are predictors of later outcomes in several domains (Lundberg 1993, Hill et al. 2001, Case et al. 2005, Leschied et al. 2008, Francesconi et al. 2010).

The effects on younger children of attending formal childcare have been thoroughly investigated, as have the effects of school quality on older children.[1] However, children are also exposed to other opportunities for development. The hours between the end of school and bedtime are often filled with a variety of activities that can promote different skills. These activities may be more or less structured (e.g., participating in team sports vs. playing freely in the park), be geared towards educational enrichment or social activities, and they can be carried out alone, with other children (friends, siblings, cousins), or with adults (parents, grandparents, instructors). Understanding the effects of such activities is important because they contribute to the development of children and may be possible sources of inequality among children from different socio-economic backgrounds. Notably, it has been shown that inequality in socio-emotional skills has increased in the UK over the past 30 years, with the socio-economic status of mothers being a significant contributing factor (Attanasio et al. 2020).

As part of the broader discussion of the importance of childhood conditions for the development of an individual, the key question at the heart of our analysis is how the allocation of after-school time influences children's non-cognitive development. More specifically, we study the effects of the use of after-school time on emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour at ages 7-11, using data from the Millennium Cohort Study (UK). After-school time includes time spent with parents, extra-curricular activities (music, sports, extra classes) as well as less structured activities, such as going to the library, attending religious services, reading, watching TV, playing electronic games, and doing small chores around the house, such us tidying up or caring for pets.

[1] A partial list for formal care includes Card and Krueger (1992), Duncan and Magnuson (2013) (review), Elango et al. (2016) (review), Brilli et al. (2016), Del Boca et al. (2018), and for school quality Rivkin et al. (2005), Ding and Lehrer (2007), Deming et al. (2014).

To study the effects of the use of after-school time on child non-cognitive outcomes at ages 7 and 11, we apply a cumulative value-added model. We then test the sensitivity of our results to possible endogeneity issues resulting from unobserved variables, reverse causality, and the measurement error due to the inclusion of past behavioural indicators in the model. To deal with the omitted variable bias, we apply a method developed by Oster (2019) to produce bias-adjusted estimates and to bound the coefficients of interest in the presence of such omitted variable bias; to address reverse causality, we take advantage of the panel dimension of the data, including only lagged activities; finally, the bias due to the inclusion of lag outcomes is handled through an instrumental variable approach. We present the results for each age that are robust to the different specifications and the different endogeneity issues. Finally, we complement our analysis with a fixed-effects approach, which allows us to take unobservable time-invariant characteristics into account but does not permit estimation of age-specific effects. The results show that sports, time spent studying, reading, doing small chores around the house, and time spent actively with parents are beneficial for the development of children's socio-emotional skills, while video-screen time and extra hours spent at school are detrimental. To the best of our knowledge, this is the first paper indicating that the allocation of children's time is important not only for cognitive but also for non-cognitive development, in line with some of the results on parental inputs (Moroni et al. 2019) and with studies on the impact of individual activities (e.g., Hille and Schupp 2015). Further work is needed to gain a better understanding of the relationship between children's time allocation and skill formation.

Although we explore possible heterogeneities in the effects of some child characteristics (socio-economic status, gender, nationality, and family composition), we find no relevant differences. However, if children from different socio-economic background have different access to activities, the overall benefits may be unequally distributed across children. Thus, the final part of our research addresses the question of which of the child characteristics influence participation in the various activities. The findings show that there are specific background, household, and personal characteristics that lead to inequitable access to activities for children. Consequently, differences in the use of time by children from different family backgrounds should be taken into account as an additional source of inequality.

This paper contributes to the literature in three specific ways: focusing on non-cognitive outcomes (rather than cognitive ones); studying the effects of several activities (rather than a single activity); considering activities carried out not only with parents, but also independently and with other children.

Focusing on non-cognitive development is crucial and forms the basis of this study. The literature documents that these skills are at least as important as cognitive ones for future educational and labour market outcomes, but also for adolescent risky behaviour and health-related outcomes (Heckman and Rubinstein 2001, Cunha and Heckman 2008, Prevoo and ter Weel 2015, Attanasio et al. 2020). Non-cognitive skills also influence learning abilities and cognitive development (Almlund et al. 2011). The seminal work by Heckman and Rubinstein (2001) led empirical research to investigate the impact of childhood conditions on non-cognitive development. In particular, it has been shown that non-cognitive skills are improved by good parental investments such as income and material resources, cognitive stimulation, parental interpersonal skills, parenting style, and breastfeeding (Cunha and Heckman 2008, Borra et al. 2012, Cunha et al. 2013, Heckman and Kautz 2013, Fletcher and Wolfe 2016, Doyle et al. 2017, Moroni et al. 2019). Mixed evidence is found on the effect of formal care, usually leading to positive effects for children coming from disadvantaged families (Baker et al. 2015, Chor et al. 2016, Felfe and Lalive 2018).

Studying the relationship between after-school time and non-cognitive development is important, because non-cognitive skills can be highly sensitive to the impact of after-school activities. Indeed, qualitative research suggests that since the emphasis at school is on academic attainment, out-of-school activities provide children who do not perform well at school with opportunities for feeling capable, thus increasing their self-esteem wellbeing (Callanan et al. 2016). It also allows children to make and interact with new friends, and this may have possible consequences on social outcomes. Therefore, understanding if there is a link between the allocation of after-school time and non-cognitive development is highly relevant, as it could shape the way policy-makers and educational institutions intervene in designing the supply of such activities. Moreover, the increasing importance of after-school activities may have different impacts according to socio-economic background, and thus a source of increased socio-emotional inequalities that call for intervention by policy-makers.

The second focus of the paper is on the effects of several activities, whereas it is more common in the literature to find studies considering a single activity (e.g., reading, sport, music, or computer and TV use).[2] A few studies make use of data from children's time use diaries to

[2] Beneficial effects of reading, music, participating in religious activities are found in Anderson et al. (1988), Taylor et al. (1990), Hale et al. (2011), Kalb and Van Ours (2014) [reading]; Hille and Schupp (2015) [music]; Eccles et al. (2003), Mendolia et al. (2019) [religious activities]. Mixed results about the effects of sport (positive or no effect) are found in Lechner (2009), Pfeifer and Cornelißen (2010), Rees and Sabia (2010), Cuffe et al. (2017), Felfe et al. (2016), Ransom and Ransom (2018). Mixed results are reported for computer and TV use (negative effects, no effect, or positive effects for migrant children), see Zavodny (2006), Gentzkow and Shapiro

explore the full range of activities, such as the one by Hofferth and Sandberg (2001), Fiorini and Keane (2014) and Caetano et al. (2019). Hofferth and Sandberg (2001) use data from the 1997 US Child Development Supplement to the Panel Study of Income Dynamics (PSID) (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 use diaries from the Longitudinal Study of Australian Children (around 1,300 children aged 4-9) to consider the impact of time use overall and, therefore, to 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 on educational activities, particularly with parents, is the most productive for cognitive skill development. However, they find that non-cognitive skills are insensitive to the alternative time allocations. Caetano et al. (2019) also use the time diaries from the Child Development Supplement of the 2002 and 2007 PSID to estimate the effect of family time inputs on cognitive skills, applying an exogeneity test developed by Caetano (2015). [3] Their study provides a different classification of activities from those in previous studies (and our own), aggregating them into active and passive time with different individuals. They report that active time with an adult family member (parents or grandparents) leads to an increase in cognitive skills.[4] Hofferth and Sandberg (2001), Fiorini and Keane (2014), and Caetano et al. (2019) represent the ideal benchmark for our study, but unluckily we do not have time use diaries at our disposal. This means that – even though we do look at a large set of different activities - we lack the data to be able to evaluate the trade-off between them. Differences between our results and previous findings in the literature are discussed in the Results section.

The third point of the paper is to consider the effects of parental time on child development. Todd and Wolpin (2007) use data from the National Longitudinal Survey of Youth to estimate the effect of parental and school inputs on child cognitive abilities. Parental input is represented by an index that considers parental stimulation and involvement and the toys and learning materials available. The results show that parental inputs have positive effects on children's

(2008), Munasib and Bhattacharya (2010), Huang and Lee (2010), Kearney and Levine (2019), Hernæs (2019) [TV]; Subrahmanyam et al. (2000), Fairlie and Kalil (2017).

[3] Unfortunately, the test of exogeneity proposed by Caetano (2015) cannot be applied in our setting because of the metric of our independent variables.

[4] The authors also investigate the impact on non-cognitive skills. However, as the exogeneity test does not have enough power to detect endogeneity, they do not comment upon these skills in the paper.

cognitive development. The effect of parental time is also the focus of three studies using data from the Child Development Supplement to the Panel Study of Income Dynamics (US). Carneiro and Rodriguez (2009) find that children (especially 3-6-year-olds) who spend more time with their mothers perform better on cognitive tests. Hsin and Felfe (2014) find that working mothers spend less time with their children, but only on unstructured activities, and what counts instead for child cognitive development and positive behaviour is the time spent together engaged in educational activities. Finally, Del Boca et al. (2017) consider the combined effect on children of different ages of spending time doing beneficial activities independently or together with their parents. They find that time spent independently on these activities in adolescence has a positive effect on cognitive outcomes, whereas time spent with the mother is more important for younger children.

Among the studies of parental time inputs, the most similar to the study presented here is Del Bono et al. (2016), both in terms of data and analysis techniques. Using data from the Millennium Cohort Study for children up to age 7, the authors find that educational and recreational time (two components extracted with a principal component analysis from the list of activities done by children and parents together) have significant effects on children's cognitive, but not non-cognitive, development. Our study is different from theirs in that it includes older children as well, considers additional forms of time inputs beyond parental ones, and considers the different behavioural dimensions of the child separately, rather than treating them as a single, non-cognitive measure.

The paper is organised as follows: Section 2 describes the Millennium Cohort Study, the selection of the sample, and the variables used throughout the analyses; Section 3 presents the methods employed for the empirical analysis; Section 4 contains the results and the robustness checks. Conclusions follow in Section 5.

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

The Millennium Cohort Study (MCS) is a longitudinal survey that tracks the lives of a sample of about 19,000 babies born in the UK in 2000/2001. The survey was conducted in different waves: we use information from surveys for cohort-children aged about 9 months, 3, 5, 7, and 11 years old. 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 birth, which may provide important data to control for.

The initial wave 1 sample is composed of 18,818 children, but around 10% of the sample is lost due to attrition at each new wave. We only consider children in families participating in the survey up to wave 4 or 5, when the children are 7 and 11 years old. In addition, we 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 consist of 10,570 children in wave 4 (children aged 7) and 9,438 in wave 5 (children aged 11). Table A1 in the Appendix shows how the final samples analysed differ from the initial sample in wave 1 because of attrition and sample selection. 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 non-cognitive outcomes and contains rich information about parental socio-economic background, employment status, childcare arrangements, and specific parental inputs at various points in time. Of particular interest to the present research are the variables reporting after-school 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 socio-emotional skills derived from the Strength and Difficulties Questionnaire included in the MCS, which highlights both positive and undesirable behaviours.[5] As with most of the variables, the respondent to questions regarding activities and child socio-emotional skills is virtually always the mother.[6]

Ideally, one would like to investigate the impact of after-school activities on both cognitive and non-cognitive outcomes; however, in the MCS no cognitive indicator is measured over the three waves, and between age 7 and 11 no one is measured over two waves. Therefore, the empirical strategies would be different from the one implemented in the paper, limiting the scope of comparison between results on cognitive and non-cognitive outcomes. Considering the scarce research existing on the relationship between activities and socio-emotional development, we have found it more valuable and interesting to focus on non-cognitive outcomes.

[5] In the economic literature, non-cognitive skills encompass several characteristics that have an impact on school and labour market performance not measured by IQ and achievement tests. They include behaviour and socio-emotional development, personality traits, goals, motivation, self-control, locus of control, etc. (Heckman and Kautz 2013). The five dimensions measured by the SDQ (emotional, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour) measure emotional and behavioural aspects, and we alternatively refer to them as behaviour/behavioural dimensions or socio-emotional dimensions.

[6] In wave 1, in 18,515 of the 18,552 families the respondent to the main questionnaire is the natural mother (for more information about the respondents see also the MCS Guide to the Datasets (Hansen 2012)).

The 25 items on the Strength and Difficulties Questionnaire ask parents about the behavioural attributes of their child and measure five child socio-emotional dimensions (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour).[7] Each dimension is derived from five items, such as "Shares readily with other children (treats, toys…)" (Goodman 1997). For each item, the possible answers are "not true" (0 points), "somewhat true" (1), and "certainly true" (2). The groups of five answers are combined in a total score for each socio-emotional dimension, ranging from 0 to 10. Lower scores identify positive traits for the first four dimensions, while a higher score identifies more positive traits in terms of prosocial behaviour. Table 1 summarises the dependent variables for children aged 7 and 11 years old, while their distribution of the outcomes is presented in Figure A1.[8]

Table 1 about here

The main independent variables in our analysis are the activities undertaken by children in their after-school time. The data provides information about a large range of activities, including (but not limited to) playing a musical instrument, going to the library, attending religious services and classes, participating in sports, reading, watching TV, playing electronic games. In wave 3 and 4 (at age 5 and 7), we also have information about 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 on each activity, but just a measure of frequency (e.g., more than once a week / once a week / once a month). We recode the activities as dummy variables, where 1 indicates that the activity is carried out at least once a week. The only exceptions are represented by homework and video-screen activities, where 1 indicates at least one hour per day. All of the activities are listed and described in Table 2. We report activities at age 7 and 11, ages at which we study their effects on socio-emotional skills, but also at age 5, since we will use past activities as further controls (see Section 3). The first three columns of Table 2 (columns (1) to (3)) provide an overview of both the activities recorded over time and the more age-specific. Among the activities recorded over time, we see an increase in the time devoted to sport (without parents) and computer use. Columns 4 and 5 in the Table report the proportion of children changing their participation in

[7] The questions included in the Strength and Difficulties Questionnaire are shown in Appendix B, together with a comparison with international normative data (Table B1).
[8] Instead, in the analysis, we use standardized values of the five variables.

each activity between the different waves: switching from doing the activity in wave *w* to not doing it in wave *w+1*, or vice versa.[9]

Table 2 about here

With so many variables of interest, interpreting the results can be quite challenging, especially as some of the reported variables are likely to capture types of activities that are relatively similar to each other. We therefore implement a principal component analysis (PCA), aimed at developing better insight into the number of common latent dimensions that the different activities may share.[10]

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 seven components. In Table 3, we summarise the grouping of activities in the different components, which we have called: 1) activities with parents; 2) sports; 3) library and religious activities; 4) video-screen time 5) reading caring and tidying-up (which covers reading, caring for pets and looking after an elderly household member, and tidying up); 6) Extra hours at school (including after school and before school classes); 7) school-related activities (including homework and extra classes). No components express extra hours at school, school-related activities or reading/caring activities for children when they are 5 years old. As can be seen, in applying the PCA, similar activities are grouped together, as one would do without statistical methods, so we end up with activities performed by parents, sport and outdoor activities, computer and TV, and so on.

Some activities are clearly related to one particular components, and are always associated to the same component over the three waves, like watching TV or playing with the computer, and the four activities related to the extra-hours at school and school-related activities. Other activities are highly related with more than one component, such as "parents play active games": in wave 3, the highest loading is into the "sport" component (0.549), but is also high into the components related to "activities done with parents" (0.526); and indeed, in wave 4 and 5 it is more related to this latter component. Similarly, the activity "sport with parents" enters

[9] For instance, the share of children *playing* sport with friends when they were 7 and *not playing* them 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.

[10] 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.

the "sport" component in wave 3, and in the "activity with parents" one in wave 4 (although having a quite high loading also to the "sport" component). Importantly, the activities which are present both when the child is 7 and when the child is 11 (our main ages of interest) are allocated to the same components in the two waves.

Table 3 about here

3. Empirical methods

Our aim is to estimate the effects of a set of children's after-school on five socio-emotional outcomes. For the main specification, we choose a cumulative value-added model (Section 3.1), whose results are shown for socio-emotional outcomes at age 7 and at age 11. In order to test their robustness to possible endogenous issues, we deal with the risk of omitted variable in Section 3.2, with the risk of reverse causality in Section 3.3, and with the risk of measurement error bias due to the inclusion of past values of the dependent variable in Section 3.4. Finally, in Section 3.5, we propose a fixed-effect model, which allows us to take unobservable time-invariant characteristics into account, although it does not permit estimation of age-specific effects. In Section 3.6, we explore possible heterogenous effects and sketch out a simple regression model that could be useful for policy considerations.

3.1 The cumulative value-added model

With the cumulative value-added model, for each child socio-emotional skill, we estimate the following linear equation with OLS, once for outcomes at age *t*=7, once for outcomes at age *t*=11:

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

where *Y* represents one of the five child socio-emotional outcomes for child *i* at age *t*, vector *A* indicates the components expressing different uses of time, vector *Z* the control variables of child *i* at age *t* or before age *t*. The subscript *m* is equal to 2 when we estimate the effects at age 7, including time-use components and outcomes measured at age 5; it is equal to 4 when we estimate the effects at age 11, including time-use components and outcomes measured at age 7. β_1, is the coefficient 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 non-cognitive outcome in the previous wave, which can control for most of the differences across children.[11] The inclusion of past values of the output in the model should capture all unobservable past inputs and unobservable characteristics of the child, e.g., her temperament, talents and preferences. This model is equivalent to comparing the socio-emotional skills of two children at age 7 (11) who used to have the same skill 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 ages 5 and 7 (7 and 11).

The assumption underlying model (1) 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 unobservable characteristics of the child, that the effect of unobserved inputs and child's characteristics declines with age at the rate β_3, and that there is no remaining unobserved heterogeneity which correlates with after-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, parent and family characteristics, and socio-economic circumstances. The detailed descriptive statistics are reported in Table A5 (panel A to C): we first consider variables that describe the environment/context that children are faced with, which we call *environmental variables* (Table A5, panel A). They are measured at the same wave as the main outcomes (at age 7 and 11) and are related to the household dimension (presence in the household of mother, father, siblings, grandparents; parental hours of work). A second set of variables accounts for previous *parental investments* (before age 7), and are fixed over time (Table A5, 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 old, father's involvement with the child when the child was 9 months old, and parental education.

We then include a number of *socio-demographic* control variables concerning the child, the parents and the household (Table A5, panel C) which may be correlated with the use of after-school time and may affect the outcomes. Control variables about the child are all measured in the first wave: gender, nationality, birth weight, age, number of siblings at birth,

[11] For the estimation of the effects of interest we follow Todd and Wolpin (2003, 2007) and Fiorini and Keane (2014). Instead of the cumulative value-added model (CUVA), one could use contemporaneous inputs only, contemporaneous and lagged inputs (cumulative model - CU), or contemporaneous inputs and lagged output (value-added model - VA). See Todd and Wolpin (2003) for a discussion of the different assumptions underlying each model. In particular, the inclusion of the lagged dependent variable in the VA and CUVA may give rise to endogeneity problems. We present results from these specifications as robustness checks in Section 4.2. However, as most of the results are confirmed using the different models, we decided to focus on the cumulative value-added model, which is the most restrictive one, and whose results are always confirmed in other models.

hospitalizations and accidents, three indicators of child development in the first year of life,[12] 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,[13] locus of control of the mother,[14] mother's personality type,[15] and parents' mental wellbeing.[16,17] In terms of 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 the child's development at 9 months, to take into account the correlation between the different abilities of the child as s/he grows older, we include one variable measuring the child's cognitive ability during the previous wave, which is derived through principal component analysis of the cognitive items available in the survey (see Table A7 in the Appendix).[18] 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).

Despite the fact that we are able to control for a large set of variables using the cumulative value-added model, causal interpretation of the results remains tentative, as discussed and addressed hereafter.

3.2 Risk of variable omission

Although the model includes the lag of the dependent variable and a large set of control variables, there may still be unobservable characteristics of the child/family that correlate with

[12] The three indicators of child development in the first year of life refer to the communication, motor, and motion dimensions. They are derived – through principal component analysis – from information in wave 1 (see Table A6 in the Appendix).

[13] 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 (Johnson et al. 2015, page 56)).

[14] Measured in wave 1. It is a dummy variable on the mother's locus of control that corresponds to her statement "I usually have a free choice and control over my life".

[15] The two variables are measured in wave 4 and regards the mother's being extrovert and neurotic (see Johnson et al. 2015, page 63).

[16] Measured with the Kessler K6 Scale in each wave (see Johnson et al. 2015, pages 57-61).

[17] For robustness, we also estimate the models without the independent variables explained in notes 13-16. Results are similar in size and significance and are available upon request.

[18] As mentioned earlier, no cognitive indicator is repeated over the three waves, and no one is repeated between wave 4 and 5. Nevertheless, the principal component analysis suggests that the cognitive indicators capture a unique component, which can be considered a latent cognitive skill.

after-school time use and child behaviours. For example, a young boy might be very shy and therefore less likely to engage in sports and more likely to be bullied by school-mates.

We deal with the risk of omitted variable bias by applying a method designed to assess the stability of coefficients in the presence of unobservable selection (Oster 2019) to the cumulative value-added model. This method, building on the previous work by Altonji et al. (2005), evaluates the robustness of results against omitted variable 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 variable bias. To proceed in this fashion, 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, one needs to choose a bound of R_{max}, and Oster (2019) 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 (2019). We then 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 corresponds to the assumption of equal selection between observed and unobserved variables, as suggested by Oster (2019).

3.3 Risk of reverse causality

As for reverse causality, all of the estimates control for past socio-emotional problems, so this issue is already partially solved. However, it is still possible that even under the same value of socio-emotional skills at age 7, reverse causality emerges in the relationship between socio-emotional skills and activities at age 11. Thus, to test our results against the risk of reverse causality, we decide to include in the regressions only the value of past engagement in the different activities on current socio-emotional skills.

3.4 Risk of measurement error

The estimated model, which includes lagged values of the dependent variables, implicitly considers omitted past inputs and controls for unobservable characteristics of the child, e.g., her temperament, talents, and preferences. However, there could be a problem if past outcomes are

measured with error, as this can lead to biased estimates. Therefore, to address the issue of measurement error in the lagged outcomes, we use the instrumental variable method: using a two-period lagged outcome as an instrument for the one-period lagged outcome is an acknowledged solution to the measurement error issue in value added models (Arellano and Bond 1991, Andrabi et al. 2011; Del Bono et al. 2016).

3.5 The fixed-effect model (FE)

To take into account the unobservable characteristics fixed over time, an alternative strategy is to estimate the model with individual fixed effects. The fixed-effects model is useful when we want to relax the assumption about no unobserved heterogeneity which correlates with extra school activities at age *t*. For this specification, using data from both waves, we estimate the following equation:

$$Y_{i,t} = \alpha_t + A'_{i,t}\beta_t + Z'_{i,t}\theta_t + \upsilon_i + e_{i,t} \quad (2)$$

With this model, including child fixed-effects υ_i, we can observe whether a change in the frequency of activities carried out between ages 7 and 11 explains part of the difference in the child's socio-emotional skills over time, expunging the effect of the unobservable characteristics fixed over time, but also of other unobserved family characteristics fixed over time. In this model, vector Z includes only time-varying covariates, i.e., only the controls presented in panel A of Table A5 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 cumulative value-added 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 from the effect of the same activity in the past. With the child fixed-effects model, we assume instead that input effects are age invariant.

3.6 Heterogenous effects and inequalities

We investigate the possible heterogeneous effects of the use of after-school time, to assess possible sources of inequalities. Specifically, we look at the different impacts of after-school time according to the socio-economic status of the family (education and income), the structure of the family (presence of both parents in the household and 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 more structured activities (like sport) to be more beneficial for children from disadvantaged families. We also suppose that different family structures may characterise activities with parents and in the household differently, with consequential heterogeneous effects. Finally, for non-British children, better comprehension of the language (through TV) may also improve relationships with peers and adults. Empirically, we simply estimate equation (1) for sub-groups of the sample.

Finally, we can expect that children from different contexts have a different likelihood of spending time on these activities. If so, even under homogeneous effects, inequalities in socio-emotional development would arise across different groups, as suggested by Attanasio et al. (2020). In particular, it is policy-relevant to consider whether children with fewer economic and cultural resources have the same opportunities in their after-school time as children with more resources. Once we take into account economic resources, 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.

Thus, to complement the above analysis, and to enrich the debate, we analyse the association between child and household characteristics and children's uses of time (grouped as before). We perform a set of OLS regressions in which after-school activities are estimated as a function of the relevant variables.[19] This is done by pooling together the two waves when children are 7 and 11 years old. [20]

4. The effects of after-school time allocation

4.1 Main results

The effects of the after-school activities – represented as different components – on the five socio-emotional skills are presented in Tables 4-8. For each outcome, and separately at ages 7-11, the tables report the effects of the activities obtained with the cumulative value-added model (columns 1 and 5), the Oster bounds (columns 2 and 6), the effects of the lagged activities (columns 3 and 7), and the effects of the activities when dealing with the endogeneity of the

[19] We do not employ fixed-effect models since we are not interested here in recovering a causal relationship between family characteristics and use of time, but aim at discerning those families in need of policy intervention.
[20] Results are no different when considering separate estimations for the two waves. Results available upon request.

lagged dependent variable (columns 4 and 8). The last column reports the effects estimated when employing the fixed-effect model and the whole sample. A negative sign of the coefficient indicates that the activity reduces that behavioural problem, and thus has a "beneficial" effect, or vice versa. The only exception is the pro-social dimension, which must be read backwards (a negative sign of the coefficient indicates a detrimental effect). When reading the effects of the lagged activities, we need to keep in mind that some activities are not observed at age 5, and therefore their effect at age 7 cannot be estimated (column 3).

Overall, we find that time with parents, sports, school-related activities, reading and caring/tidying up have beneficial effects, while extra hours at school and video-screen time have harmful effects. No effects are found for participating in religious activities or going to the library. Prosocial behaviour proves to be the dimension most responsive to the use of after-school time, which improves children's ability to share with others and be helpful. All non-cognitive dimensions are strongly correlated over time.

We now comment on the strongest results, namely those found in our main specification and confirmed by the subsequent robustness checks. Both the dependent and independent variables are standardized, which makes it easier to read the results.

Pro-social behaviour is influenced positively by several activities (Table 4): time spent with parents on reading, playing, and playing games, at both ages; this is confirmed by the fixed-effect model; reading and caring/tidying up (at both ages and confirmed with the fixed-effect model), a category which includes a number of activities, carried out at home, independently: reading, but also tidying up the room, playing with / taking care of pets, playing and chatting with younger siblings or older relatives; doing sports at the age of 11; time spent doing homework and extra classes (school-related activities) at both ages.

Conduct problems are reduced by reading and caring/tidying up at both ages (also confirmed with the fixed-effect model), and at age 11 by time spent with parents and on school-related activities (Table 5). Peer problems are reduced by sport activities at both ages, confirmed also by the fixed-effect model (Table 6). Emotional symptoms are mitigated by reading and caring/tidying up at age 7 and by sport activities at age 11 (Table 7). On the other hand, screen time has a detrimental effect on the emotional sphere of the child at age 11.

Both reading and caring/tidying up decrease inattention problems at both ages, as also confirmed by the fixed-effect model. Children aged 11 who spend more active time with their parents present fewer hyperactivity/inattention problems (Table 8). Instead, spending more time at school at younger ages increases this type of problem.

In summary, time spent with parents on reading, playing, and playing games has a beneficial effect on pro-social behaviour, conduct problems, and inattention problems. Reading and caring/tidying up have a positive influence on pro-social behaviour and decrease inattention, conduct, and emotional problems. Time spent on homework and doing extra-curricular activities at school improves prosocial behaviour and improves problems with conduct. Sport has beneficial effects on pro-social behaviour, peer problems, and emotional symptoms. By contrast, video screen time has a detrimental effect on the emotional sphere of older children, and extra time spent at school may increase hyperactivity issues in younger children

Tables 4 to 8 about here

To better understand the size effects, we make some predictions. If we compare, for example, a child (aged 11 years old) who does sport, also with friends, and goes biking at least once a week with a child – with the same characteristics – but who does not carry out these activities or does them with a lower frequency, we observe the mother of the first child will provide – on average – minus 0.51 (2.19-1.68) negative answers when asked about the emotional sphere of child, minus 0.80 (1.87-1.07) negative answers when asked about peer problems, plus 0.23 (8.91-8.68) positive answers when asked about the prosocial behaviour. On the other hand, a child who both watches TV and uses PC more than 1 hour per day has a mother who will give plus 0.10 (1.83-1.73) positive answers to emotional problems.

Most of the beneficial effects we find on the child's socio-emotional skills are in line with previous findings on the cognitive dimensions of children. In addition to the positive influence of doing sports and activities with parents on many educational outcomes found in previous studies, here we also find positive effects on non-cognitive outcomes. New evidence is then provided for the beneficial effects of time spent on activities carried out at home, such as reading, doing homework, and taking care of pets and other people.

Our results are different from those of Fiorini and Keane (2014) and Del Bono et al. (2017) since neither of those papers finds effects on non-cognitive outcomes. Fiorini and Keane (2014) suggest that differences may be due to institutional differences across the two countries, to different sample sizes and the age-range considered, as well as to different econometric specifications. The paper by Del Bono et al. (2017) is much more similar to ours, but they only look at time spent with parents (distinguishing between educational and recreational time) on a unique non-cognitive outcome (putting together the four "problematic" dimensions). If we

conglomerated those five dimensions, we too would find non-significant effects of time spent with parents. [21]

The results are consistent with psychological research on child non-cognitive development, which underlines the beneficial effects of active and dynamic uses of time versus the detrimental effects of passive activities. Sport, active time with parents and doing things at home is better than spending time watching TV or using PC and tablets. While dynamic uses of time imply effort and perseverance and therefore provide feelings of satisfaction for the child, this is not the case for inactive uses of time (Veenhove 1984, Emmons 2003). Another interesting finding is the substantial influence of several activities on the prosocial behaviour of the child, which can be considered as a sort of feeling of empathy towards other people. This is an attitude that is expected to grow with the individual, a non-cognitive 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). It is plausible that this ability can 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 on doing homework (which may also be time shared with parents), taking extra classes (with a tutor), and spending active time within the household (which may also be time shared with other family members). We also find that sports have a beneficial effect on prosocial behaviour and on peer problems; this effect may also be due to another mechanism: the need for collaboration (Lichtenberg et al. 2012). In order to "succeed", in fact, the child needs to interact proficiently with his/her companions.

4.2 Robustness checks

As mentioned above, instead of including lagged inputs and outputs as control variables, as is done in the cumulative value-added model (CUVA), one could use contemporaneous inputs only, contemporaneous and lagged inputs (cumulative model - CU), or contemporaneous inputs and lagged output (value-added model - VA).

Tables A8 to A12 in the Appendix present the results of these different models: (i) the simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); (ii) the value-added model; (iii) the cumulative model (CU); as well as the cumulative-value added model (CUVA), the main specification of the paper. Most of the results are confirmed in the different models; most importantly, all the results in the CUVA model are

[21] Results available upon request.

also present in the other specification, with the CUVA specification showing the smallest coefficient (with only three exceptions), confirming CUVA to be the most restrictive model. The results discussed in the previous section, robust to the different endogeneity issues, are always confirmed.

4.3 Sources of inequality: heterogeneous effects and different opportunities across children

We find evidence of beneficial effects on child socio-emotional skills of time spent with parents, doing sports, caring/tidying up and reading, and school-related activities. Extra time spent at school and video-screen time are found to have detrimental effects.

We investigate the possible heterogeneous effects of the use of after-school time, to assess possible sources of inequalities. Specifically, we look at the different impacts of after-school time by the socio-economic status of the family (education and income), the structure of the family (presence of both parents in the household and presence of siblings), the ethnic background of the child (British/other), and the gender of the child. However, we find no strong evidence for any heterogeneous effect. [22]

Nevertheless, we can expect that children from different contexts have a different likelihood of spending time on these activities and assess if this is indeed the case. Table 9 reports the results. This exercise is useful to evaluate the observable characteristics associated with participation in different activities.

From an inequality point of view, we observe that children from more advantaged backgrounds in terms of parental education and income are more exposed to enriching uses of their time (sports, school-related activities) and are less exposed to detrimental ones (TV and videos-screen time) but more likely to spend extra hours at school. Moreover, 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 or any other activities. The family structure influences two uses of time in an opposing but compensatory way: an only child spends more time with her parents, whilst a child with siblings spends more time on reading and caring activities. Having siblings also decreases the probability of doing sport and of doing homework / receiving extra-classes. The presence of the father (or of a stepfather) does not influence the use of after-school time, while the presence of grandparents results in children spending more time on "quiet" activities (TV, computers,

[22] Results available from the authors upon request.

religious services, and going to the library) and results in children spending fewer extra hours at school. British children spend more time with their parents and on sport activities, while children from ethnic minorities spend more time on homework, caring activities in the household, and going to the library and participating in religious services. From a gender point of view, most of the results are expected: girls are more likely to spend time on school-related activities, reading and caring/tidying up, and are less likely to engage in sports and TV or computer use. Less intuitive is the positive effect of being a girl on the number of extra hours spent at school.

5. Conclusions

In this paper, we study the relationship between the use of after-school time and children's social, emotional, and behavioural skills, using UK longitudinal data, and testing the robustness of our results to different endogeneity issues. We find that different after-school activities influence the non-cognitive development of the child. Overall, sports, school-related activities, reading and caring/tidying up activities, and time spent with parents tend to reduce socio-emotional problems, whereas video-screen time has detrimental effects for older children and extra hours at school are harmful for younger ones. No effects are found for participating in religious activities or going to the library. The largest positive effect of after-school time is observed in prosocial behaviour in the form of sharing with others and being helpful. Most of the beneficial effects we find on the child's socio-emotional skills confirm previous findings on her/his cognitive development. To our knowledge, however, this is the first study to highlight the beneficial effects of child' time allocation on non-cognitive development.

We observe that children from different family backgrounds are not afforded the same opportunities for their use of after-school time. We find a negative relationship between the presence of siblings and sport (probably for logistical reasons) and an expected positive relationship between income and sport, which is one of the few paid-for activities among those considered. From a policy point of view, these two findings call for the provision of free/low-cost extra-curricular sports activities to be held after school. Differences by socio-economic background also emerge in terms of school-related activities, with the children of richer and more educated parents more often taking part. More time devoted to school-related activities and less time spent on TV and screen time may also be achieved by expanding after-school programs at school or other public places for older children, for whom we do not observe negative consequences of extra time spent at school. Other sources of differences in the use of

after-school time (parental education, gender of the child, ethnicity) seem to be more cultural and may be susceptible to parenting courses, which are becoming more and more common not only around the birth 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 actually spends on any of 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, to better interpret the results obtained for children's non-cognitive development, it would be useful to know more details about the activities carried out. For example, to understand the level of passivity involved in activities under the video-screen category, we would need to know whether children are watching a movie/cartoon or an interactive cartoon, playing video-games, watching other people playing those video-games, singing or dancing whilst watching music videos, or searching for commercial videos online (e.g., the unboxing of toys). Finally, we don't have a full description of the use of after-school time. We therefore lack information about other important ways children spend their time, such as "pure" playtime (playing by themselves or with siblings/cousins), time spent at dinner or social events, sleeping routines, and the management of boredom and waiting-time. Future research should investigate such factors to completely unveil the relationship between children's time use and their non-cognitive development.

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Tables

Table 1: Children's socio-emotional skills (main outcomes)

	Age 7 (wave 4)		Age 11 (wave 5)	
	Mean	Sd	Mean	Sd
Emotional symptoms	1.48	1.72	1.81	1.96
Conduct problems	1.33	1.50	1.31	1.51
Hyperactivity/inattention problems	3.28	2.49	3.01	2.43
Peer relationship problems	1.14	1.50	1.27	1.63
Prosocial behaviour	8.63	1.60	8.85	1.49
Observations	10,570		9,438	

Note: socio-emotional skills, derived from the Strength and Difficulties questionnaire. The SDQ is composed of 25 items asking parents about the behavioural attributes of their child; each dimension is derived from five items (Goodman 1997 – see Appendix B for the questionnaire). For each item, e.g., "Shares readily with other children", possible answers are "not true" (0 points), "somewhat true" (1), and "certainly true" (2). The groups of five answers are summed up in a total score for each socio-emotional dimension, ranging from 0 to 10. Lower scores identify positive traits for emotional symptoms, conduct problems, hyperactivity problems, peer relationship problems, while a higher score identifies more positive traits in terms of prosocial behaviour.

Table 2: After-school activities

	Age 5 (wave 3)	Age 7 (wave 4)	Age 11 (wave 5)	Δ age 5-age 7	Δ age 7-age 11
	(1)	(2)	(3)	(4)	(5)
Parents read to child (1 pw)	0.95 (0.21)	0.90 (0.29)		0.11	
Parents tell story (1 pw)	0.56 (0.50)	0.46 (0.50)		0.33	
Parents play music (1 pw)	0.87 (0.34)	0.77 (0.42)		0.21	
Parents draw (1 pw)	0.66 (0.47)	0.43 (0.50)		0.38	
Parents play indoors (1 pw)	0.86 (0.35)	0.69 (0.46)	0.45 (0.50)	0.27	0.41
Parents talk to child (1 pw)			0.97 (0.17)		
Evenings/weekend with family at home (1pw)	0.96 (0.21)	0.97 (0.18)		0.06	
Parents at the park-playground (1 pw)	0.61 (0.49)	0.50 (0.50)		0.35	
Parents play active games (1 pw)	0.60 (0.49)	0.50 (0.50)	0.30 (0.46)	0.36	0.39
Sport-physical activities with parents (1 pw)	0.70 (0.46)	0.78 (0.41)		0.34	
Sport-physical activities with friends (1 pw)		0.94 (0.23)	0.91 (0.28)		0.12
Sport-physical activities (1 pw)	0.27 (0.44)	0.44 (0.50)	0.77 (0.42)	0.33	0.42
Club (1 pw)		0.14 (0.35)			
Bike (1 pw)			0.50 (0.50)		
Library (1 pw)	0.09 (0.29)	0.08 (0.28)	0.08 (0.28)	0.12	0.13
Religious activities (1 pw)	0.19 (0.39)	0.21 (0.41)	0.20 (0.40)	0.13	0.13
Watches TV/videos (1 h pd)	0.79 (0.41)	0.80 (0.40)	0.83 (0.37)	0.24	0.23
Uses computer (1 h pd)	0.22 (0.42)	0.35 (0.48)	0.45 (0.50)	0.32	0.39
Reads (1 pw)		0.83 (0.37)			
Plays a music instrument (1 pw)			0.42 (0.49)		
Tidying up and caring for pets (1 pw)		0.79 (0.40)	0.79 (0.40)		0.23
Looks after elderly family members (1 pw)			0.09 (0.29)		
Homework (1 h pd)		0.64 (0.48)	0.85 (0.36)		0.36
Extra classes (1 pw)		0.05 (0.21)	0.19 (0.40)		0.19
After school class (1pw)		0.21(0.41)	0.30 (0.46)		0.34
Before school class (1pw)		0.12 (0.33)	0.14 (0.35)		0.16
Observations	10,570	10,570	9,438		

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". Standard deviations in parentheses. In the last two columns, we report the proportion of children changing the participation into the single activities between the different waves, i.e., from not doing an activity to doing it, or vice versa.

Table 3: Principal component analysis for activities in the three waves

Variables	Age 5 (wave 3)	Age7 (wave 4)	Age 11 (wave 5)
Parents read to child (1 pw)	C1	C7	
Parents tell story (1 pw)	C1	C1	
Parents play music (1 pw)	C1	C1	
Parents draw (1 pw)	C1	C1	
Parents play indoors (1 pw)	C1	C1	C1
Parents talk to child (1 pw)			C1
Evenings or weekend with family at home (1pw)	C1	C1	
Parents at the park-playground (1 pw)	C2	C1	
Parents play active games (1 pw)	C2	C1	C1
Sport with parents (1 pw)	C2	C1	
Sport with friends (1 pw)		C2	C2
Sport activities (1 pw)	C2	C2	C2
Club (1 pw)		C2	
Bike (1 pw)			C2
Library (1 pw)	C3	C3	C3
Religious activities (1 pw)	C3	C3	C3
Watches TV/videos (1h pd)	C4	C4	C4
Uses computer (1h pd)	C4	C4	C4
Reads (1 pw)		C5	
Plays a music instrument (1 pw)			C4 (neg)
Tidying up and caring for pets (1 pw)		C5	C5
Looks after elderly family members (1 pw)			C5
Homework (1h pd)		C7	C7
Extra classes (1 pw)		C7	C7
After school class (1 pw)		C6	C6
Before school class (1 pw)		C6	C6

Components:

C1: Activities with parents

C2: Sports

C3: Library and religious activities

C4: Video-screen time

C5: Reading and caring/tidying up

C6: Extra hours at school

C7: School-related activities

Notes: C1-C7 identify to which component the variable is most correlated with. The correlations between the activities (first columns) and the extracted components are all positive, except for music, which is negatively correlated with the component "video-screen time" in wave 5. Grey cells correspond to activities that are not present in that wave. "1 pw" stands for "at least once per week"; "1h pd" stands for "at least one hour per day".

Table 4: The effects of children's after-school time on pro-social behaviour

	Age 7				Age 11				Ages 7-11
	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Fixed-effect model
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Activities with parents	0.030**	[0.007, 0.030]	0.034***	0.029**	0.054***	[0.041, 0.054]	0.044***	0.047***	0.029***
	(0.012)		(0.011)	(0.013)	(0.011)		(0.012)	(0.012)	(0.011)
Sports	0.009		0.007	0.002	0.035***	[0.029, 0.035]	0.021*	0.027**	0.008
	(0.011)		(0.009)	(0.012)	(0.012)		(0.011)	(0.012)	(0.010)
Library and religious activities	0.011		0.004	0.008	-0.012		0.028***	-0.008	-0.006
	(0.011)		(0.009)	(0.012)	(0.011)		(0.011)	(0.012)	(0.009)
Video-screen time	-0.011		0.009	-0.009	-0.021**	[-0.021, 0.005]	-0.003	-0.014	-0.009
	(0.009)		(0.010)	(0.010)	(0.011)		(0.010)	(0.011)	(0.010)
Reading and caring/tidying up	0.066***	[0.031, 0.066]		0.041***	0.069***	[0.060, 0.069]	0.066***	0.060***	0.029***
	(0.010)			(0.011)	(0.010)		(0.011)	(0.011)	(0.009)
At school	-0.001			-0.000	0.026***	[0.024, 0.026]	0.011	0.027***	0.012
	(0.009)			(0.010)	(0.010)		(0.010)	(0.010)	(0.009)
School-related activities	0.031***	[0.023, 0.031]		0.018*	0.053***	[0.036, 0.053]	0.034***	0.043***	0.017**
	(0.009)			(0.010)	(0.011)		(0.010)	(0.012)	(0.009)
Pro-social behaviour (lag)	0.439***		0.444***	0.810***	0.407***		0.412***	0.681***	
	(0.011)		(0.011)	(0.030)	(0.012)		(0.012)	(0.025)	
Observations	10,570	10,570	10,570	10,246	9,438	10,570	9,438	9,438	18,876

Notes: The outcome variable (pro-social behaviour) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more positive traits; thus, positive coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). The main model (columns 1 and 5) is the cumulative added-value model. Columns 2-5 and 6-8 presents the robustness of the results to different possible sources of endogeneity issues (see Section 3 of the paper). Columns 2 and 6: Oster (2019) applied to deal with possible omitted variable bias; the resulting coefficients bounds are presented, estimated for the significant coefficients of the variables of interest (activities). Columns 3 and 7: model with only lagged activities and not contemporaneous ones, to deal with possible reverse causality issues; blank cells in column 3 (age 7) mean that the corresponding variable is not available in the previous wave (age 7). Columns 4 and 8: model with lagged behaviour instrumented with the two-lagged one to deal with measurement error; fewer observations in column 4 are due to missing observations for the two-lagged behaviour (observed at age 3 – not considered when defining the main sample). Column 9 presents the results of a model with individual fixed effects, accounting for time-invariant unobservables.

Other control variables are included but not reported (child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5), full results are available upon request.

Robust standard errors in parentheses; Oster (2019) bounds in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: The effects of children's after-school time on conduct problems

	Age 7				Age 11				Ages 7-11
	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Fixed-effect model
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Activities with parents	-0.014		-0.002	-0.017	-0.031***	[-0.031, -0.016]	-0.024**	-0.022**	-0.003
	(0.011)		(0.010)	(0.012)	(0.010)		(0.011)	(0.011)	(0.010)
Sports	-0.027***	[-0.027, 0.012]	0.005	-0.022**	-0.015		-0.022**	-0.010	-0.001
	(0.010)		(0.008)	(0.011)	(0.010)		(0.011)	(0.011)	(0.008)
Library and religious activities	-0.017*	[-0.017, -0.001]	-0.001	-0.010	0.027***	[0.006, 0.027]	-0.007	0.021*	0.006
	(0.010)		(0.008)	(0.011)	(0.010)		(0.010)	(0.011)	(0.009)
Video-screen time	-0.008		0.010	-0.015	0.031***	[-0.011,0.031]	-0.010	0.020**	0.010
	(0.009)		(0.009)	(0.009)	(0.009)		(0.009)	(0.010)	(0.008)
Reading and caring/tidying up	-0.037***	[-0.037, -0.003]		-0.016*	-0.028***	[-0.038, -0.028]	-0.016	-0.022**	-0.021***
	(0.009)			(0.010)	(0.010)		(0.010)	(0.010)	(0.008)
Extra hours at school	0.027***	[0.025, 0.027]		0.016*	0.007		-0.007	0.008	0.017**
	(0.008)			(0.009)	(0.009)		(0.009)	(0.010)	(0.008)
School-related activities	-0.015*	[-0.015, 0.001]		-0.001	-0.048***	[-0.048, -0.014]	-0.023**	-0.037***	-0.013
	(0.009)			(0.009)	(0.010)		(0.009)	(0.010)	(0.008)
Conduct problems (lag)	0.490***		0.494***	0.839***	0.468***		0.472***	0.753***	
	(0.011)		(0.011)	(0.034)	(0.012)		(0.012)	(0.025)	
Observations	10,570	10,570	10,570	10,304	9,438	9,438	9,438	9,438	18,876

Notes: The outcome variable (Conduct problems) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits; thus, negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). The main model (columns 1 and 5) is the cumulative added-value model. Columns 2-5 and 6-8 presents the robustness of the results to different possible sources of endogeneity issues (see Section 3 of the paper). Columns 2 and 6: Oster (2019) applied to deal with possible omitted variable bias; the resulting coefficients bounds are presented, estimated for the significant coefficients of the variables of interest (activities). Columns 3 and 7: model with only lagged activities and not contemporaneous ones, to deal with possible reverse causality issues; blank cells in column 3 (age 7) mean that the corresponding variable is not available in the previous wave (age 7). Columns 4 and 8: model with lagged behaviour instrumented with the two-lagged one to deal with measurement error; fewer observations in column 4 are due to missing observations for the two-lagged behaviour (observed at age 3 – not considered when defining the main sample). Column 9 presents the results of a model with individual fixed effects, accounting for time-invariant unobservables.

Other control variables are included but not reported (child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5), full results are available upon request.

Robust standard errors in parentheses; Oster (2019) bounds in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: The effects of children's after-school time on peer relationship problems

	Age 7				Age 11				Ages 7-11
	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Fixed-effect model
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Activities with parents	-0.004		0.006	-0.015	0.014		-0.004	0.003	-0.008
	(0.011)		(0.010)	(0.012)	(0.011)		(0.011)	(0.011)	(0.010)
Sports	-0.063***	[-0.063, -0.010]	-0.011	-0.049***	-0.107***	[-0.107, -0.076]	-0.043***	-0.082***	-0.031***
	(0.011)		(0.009)	(0.012)	(0.011)		(0.012)	(0.012)	(0.009)
Library and religious activities	0.011		-0.003	0.009	0.016		0.012	0.008	-0.001
	(0.011)		(0.009)	(0.012)	(0.011)		(0.011)	(0.011)	(0.010)
Video-screen time	0.001		0.013	0.002	0.013		0.014	0.012	0.002
	(0.009)		(0.009)	(0.010)	(0.010)		(0.010)	(0.011)	(0.009)
Reading and caring/tidying up	-0.012			-0.005	0.012		-0.006	0.010	-0.003
	(0.010)			(0.011)	(0.010)		(0.010)	(0.010)	(0.009)
Extra hours at school	0.011			0.011	0.000		0.007	0.004	0.003
	(0.009)			(0.009)	(0.010)		(0.009)	(0.010)	(0.009)
School-related activities	-0.010			-0.003	-0.013		-0.017*	-0.004	-0.003
	(0.009)			(0.010)	(0.011)		(0.010)	(0.011)	(0.008)
Peer relationship problems (lag)	0.446***		0.449***	0.731***	0.419***		0.429***	0.681***	
	(0.012)		(0.012)	(0.033)	(0.013)		(0.013)	(0.027)	
Observations	10,570	10,570	10,570	10,238	9,438	9,438	9,438	9,438	18,876

Notes: The outcome variable (Peer relationship problems) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits, i.e., negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). The main model (columns 1 and 5) is the cumulative added-value model. Columns 2-5 and 6-8 presents the robustness of the results to different possible sources of endogeneity issues (see Section 3 of the paper). Columns 2 and 6: Oster (2019) applied to deal with possible omitted variable bias; the resulting coefficients bounds are presented, estimated for the significant coefficients of the variables of interest (activities). Columns 3 and 7: model with only lagged activities and not contemporaneous ones, to deal with possible reverse causality issues; blank cells in column 3 (age 7) mean that the corresponding variable is not available in the previous wave (age 7). Columns 4 and 8: model with lagged behaviour instrumented with the two-lagged one to deal with measurement error; fewer observations in column 4 are due to missing observations for the two-lagged behaviour (observed at age 3 – not considered when defining the main sample). Column 9 presents the results of a model with individual fixed effects, accounting for time-invariant unobservables.

Other control variables are included but not reported (child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5), full results are available upon request.

Robust standard errors in parentheses; Oster (2019) bounds in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: The effects of children's after-school time on emotional symptoms

	Age 7				Age 11				Ages 7-11
	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Fixed-effect model
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Activities with parents	0.016		0.012	0.018	0.017*	[0.017, 0.019]	-0.011	0.009	0.009
	(0.012)		(0.011)	(0.013)	(0.010)		(0.011)	(0.011)	(0.010)
Sports	-0.027**	[-0.027, 0.011]	0.008	-0.015	-0.066***	[-0.066, -0.040]	-0.013	-0.049***	-0.024**
	(0.011)		(0.009)	(0.011)	(0.011)		(0.011)	(0.012)	(0.009)
Library and religious activities	-0.003		0.001	0.004	-0.004		-0.003	-0.010	-0.006
	(0.011)		(0.009)	(0.011)	(0.011)		(0.011)	(0.011)	(0.010)
Video-screen time	0.013		0.006	0.012	0.034***	[0.014, 0.034]	-0.002	0.036***	0.034***
	(0.009)		(0.009)	(0.010)	(0.010)		(0.010)	(0.010)	(0.009)
Reading and caring/tidying up	-0.047***	[-0.047, -0.031]		-0.036***	-0.001		-0.017*	-0.009	-0.021**
	(0.010)			(0.010)	(0.010)		(0.010)	(0.011)	(0.009)
Extra hours at school	-0.002			0.003	-0.003		-0.000	0.002	-0.000
	(0.009)			(0.009)	(0.010)		(0.009)	(0.010)	(0.009)
School-related activities	0.003			0.007	-0.003		0.009	-0.003	-0.019**
	(0.009)			(0.010)	(0.011)		(0.010)	(0.011)	(0.008)
Emotional symptoms (lag)	0.433***		0.435***	0.739***	0.399***		0.402***	0.680***	
	(0.011)		(0.011)	(0.031)	(0.012)		(0.012)	(0.026)	
Observations	10,570	10,570	10,570	10,293	9,438	9,438	9,438	9,438	18,876

Notes: The outcome variable (Emotional symptoms) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits, i.e., negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). The main model (columns 1 and 5) is the cumulative added-value model. Columns 2-5 and 6-8 presents the robustness of the results to different possible sources of endogeneity issues (see Section 3 of the paper). Columns 2 and 6: Oster (2019) applied to deal with possible omitted variable bias; the resulting coefficients bounds are presented, estimated for the significant coefficients of the variables of interest (activities). Columns 3 and 7: model with only lagged activities and not contemporaneous ones, to deal with possible reverse causality issues; blank cells in column 3 (age 7) mean that the corresponding variable is not available in the previous wave (age 7). Columns 4 and 8: model with lagged behaviour instrumented with the two-lagged one to deal with measurement error; fewer observations in column 4 are due to missing observations for the two-lagged behaviour (observed at age 3 – not considered when defining the main sample). Column 9 presents the results of a model with individual fixed effects, accounting for time-invariant unobservables.

Other control variables are included but not reported (child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5), full results are available upon request.

Robust standard errors in parentheses; Oster (2019) bounds in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: The effects of children's after-school time on hyperactivity / inattention

	Age 7				Age 11				Ages 7-11
	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Main model	Robustness for variable omission [Bounds]	Robustness for reverse causality	Robustness for measurement error	Fixed-effect model
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Activities with parents	-0.012		-0.007	-0.012	-0.030***	[-0.030, -0.020]	0.000	-0.029***	-0.024***
	(0.010)		(0.009)	(0.011)	(0.009)		(0.009)	(0.009)	(0.008)
Sports	-0.030***	[-0.030, 0.006]	0.000	-0.025**	0.010		-0.012	0.016*	0.012
	(0.009)		(0.008)	(0.010)	(0.009)		(0.009)	(0.009)	(0.007)
Library and religious activities	-0.016*	[-0.016, 0.006]	-0.013*	-0.011	0.012		-0.002	0.006	-0.000
	(0.009)		(0.008)	(0.010)	(0.009)		(0.009)	(0.009)	(0.008)
Video-screen time	0.014*	[-0.014, 0.014]	0.002	0.012	0.023***	[-0.034, 0.023]	-0.014*	0.017**	0.018**
	(0.008)		(0.008)	(0.009)	(0.009)		(0.008)	(0.009)	(0.007)
Reading and caring/tidying up	-0.062***	[-0.062, -0.014]		-0.043***	-0.021**	[-0.030, -0.021]	-0.035***	-0.023***	-0.014**
	(0.008)			(0.009)	(0.009)		(0.009)	(0.009)	(0.007)
Extra hours at school	0.025***	[0.018, 0.025]		0.017**	-0.008		0.012	-0.008	-0.005
	(0.008)			(0.008)	(0.008)		(0.008)	(0.008)	(0.007)
School-related activities	-0.006			-0.002	-0.029***	[-0.029, 0.004]	-0.013	-0.024***	-0.009
	(0.008)			(0.008)	(0.009)		(0.008)	(0.009)	(0.007)
Hyperactivity/inattention (lag)	0.585***		0.591***	0.828***	0.580***		0.581***	0.774***	
	(0.009)		(0.009)	(0.020)	(0.009)		(0.009)	(0.016)	
Observations	10,570	10,570	10,570	10,225	9,438	9,438	9,438	9,438	18,876

Notes: The outcome variable (Hyperactivity/inattention problems) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits, i.e., negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). The main model (columns 1 and 5) is the cumulative added-value model. Columns 2-5 and 6-8 presents the robustness of the results to different possible sources of endogeneity issues (see Section 3 of the paper). Columns 2 and 6: Oster (2019) applied to deal with possible omitted variable bias; the resulting coefficients bounds are presented, estimated for the significant coefficients of the variables of interest (activities). Columns 3 and 7: model with only lagged activities and not contemporaneous ones, to deal with possible reverse causality issues; blank cells in column 3 (age 7) mean that the corresponding variable is not available in the previous wave (age 7). Columns 4 and 8: model with lagged behaviour instrumented with the two-lagged one to deal with measurement error; fewer observations in column 4 are due to missing observations for the two-lagged behaviour (observed at age 3 – not considered when defining the main sample). Column 9 presents the results of a model with individual fixed effects, accounting for time-invariant unobservables.

Other control variables are included but not reported (child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5), full results are available upon request.

Robust standard errors in parentheses; Oster (2019) bounds in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Determinants of the use of after-school time

	Activities with parents	Sports	Library & Religious	Video-screen time	Reading and caring/ tidying up	Extra hours at school	School – related activities
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
British	0.103***	0.275***	-0.624***	0.022	-0.088***	0.015	-0.283***
	(0.022)	(0.022)	(0.025)	(0.022)	(0.023)	(0.022)	(0.025)
Girl	0.017	-0.136***	0.006	-0.312***	0.258***	0.046***	0.060***
	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Siblings	-0.102***	-0.039***	0.001	0.010	0.043***	-0.006	-0.018**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
New-born	-0.061**	-0.022	0.024	-0.047*	0.066***	-0.018	-0.040
	(0.024)	(0.025)	(0.024)	(0.025)	(0.026)	(0.026)	(0.026)
Mother tertiary educ.	0.024	0.082***	0.028*	-0.215***	0.022	0.054***	0.078***
	(0.015)	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)
Breastfeeding	0.024*	0.060***	0.046***	-0.161***	0.017	-0.009	0.053***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)	(0.015)
Mum work early	-0.033**	0.028**	-0.033***	0.056***	0.034**	0.047***	0.022
	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)
Father in the HH	-0.106	-0.220	-0.163	0.051	-0.287	0.080	0.301
	(0.213)	(0.200)	(0.231)	(0.112)	(0.255)	(0.215)	(0.188)
Stepfather in HH	-0.096	-0.323	-0.317	0.076	-0.270	0.140	0.196
	(0.212)	(0.198)	(0.229)	(0.109)	(0.253)	(0.213)	(0.186)
Grandparents HH	0.013	-0.054	0.065*	0.124***	0.011	-0.084**	0.052
	(0.030)	(0.034)	(0.033)	(0.032)	(0.040)	(0.033)	(0.036)
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)	(0.000)	(0.000)
Dad 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)	(0.000)	(0.000)
HH income	-0.016***	0.040***	-0.026***	-0.038***	-0.024***	0.019***	0.039***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Age of the child	-0.082	-0.120	0.242	0.202	0.036	-0.636***	-0.036
	(0.208)	(0.214)	(0.209)	(0.208)	(0.222)	(0.213)	(0.210)
Age squared	0.001	0.001	-0.002	-0.002	-0.000	0.006***	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
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)	(0.000)	(0.000)
Wales	0.063***	0.026	0.041**	-0.011	-0.043**	0.230***	-0.253***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.020)	(0.022)	(0.019)
Scotland	-0.025	0.084***	0.110***	0.059***	0.087***	-0.140***	-0.101***
	(0.019)	(0.019)	(0.020)	(0.022)	(0.021)	(0.020)	(0.020)
Northern Ireland	-0.100***	0.189***	0.518***	-0.159***	0.129***	-0.167***	0.218***
	(0.022)	(0.021)	(0.023)	(0.024)	(0.024)	(0.022)	(0.024)
Constant	2.155	5.443	-9.362	-7.952	-0.912	25.186***	0.430
	(8.344)	(8.590)	(8.386)	(8.350)	(8.876)	(8.556)	(8.428)
Observations	18,876	18,876	18,876	18,876	18,876	18,876	18,876

Notes: The outcomes are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3). We include only children present in both waves 4 and 5. HH stands for household. "Breastfeeding" stands for the variable "Child breastfed for at least 1 month"; "Mum work early" stands for the variable "Mother was back to work by six months of the child".

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendices

Appendix A: Additional tables

Table A1: Sample selection, selected variables

	9 months old (wave 1)		7 years old (wave 4)		11 years old (wave 5)	
Variable	Mean	SD	Mean	SD	Mean	SD
Mother highly educated	0.33	0.47	0.39	0.49	0.40	0.49
Father highly educated (if present in the HH)	0.36	0.48	0.39	0.49	0.40	0.49
Mother back to work within 6 months of birth	0.35	0.48	0.38	0.49	0.39	0.49
British	0.81	0.39	0.85	0.36	0.85	0.36
Girl	0.49	0.50	0.49	0.50	0.50	0.50
Birthweight	3.36	0.58	3.38	0.57	3.38	0.58
England	0.62	0.48	0.63	0.48	0.63	0.48
Wales	0.15	0.36	0.15	0.36	0.15	0.36
Scotland	0.13	0.33	0.12	0.32	0.12	0.32
Northern Ireland	0.10	0.30	0.10	0.30	0.10	0.30

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

Table A2: Factor loading of the principal component analysis on activities at age 5 of the child (wave 3)

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

Notes: correlation between the variables expressing activities and the extracted components (in columns). 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 loading of the principal component analysis on activities at age 7 of the child (wave 4)

Activities	Activities with parents	Sports	Library / religious activities	Video-screen	Reading and caring / tidying up	Extra hours at school	School – related activities	Uniq.
Parents read to child (1 pw)	0.448	0.099	-0.041	-0.078	0.148	0.045	**0.539**	0.467
Parents tell story (1 pw)	**0.531**	-0.192	0.196	-0.045	0.190	0.045	0.131	0.585
Parents play music (1 pw)	**0.550**	-0.023	-0.170	-0.068	0.294	0.149	0.089	0.546
Parents draw (1 pw)	**0.713**	-0.202	0.057	-0.058	0.088	-0.039	0.129	0.419
Parents play indoors (1 pw)	**0.772**	0.030	-0.053	0.014	0.119	-0.015	0.070	0.380
Evenings or weekend with family at home (1pw)	**0.461**	0.225	-0.029	0.082	0.321	-0.107	-0.023	0.615
Parents at the playground (1 pw)	**0.592**	0.093	0.238	0.036	-0.148	-0.002	-0.130	0.544
Parents play active games (1 pw)	**0.754**	0.223	-0.013	-0.043	-0.032	0.006	-0.069	0.375
Sport with parents (1pw)	**0.565**	0.523	-0.108	0.019	0.005	-0.009	0.058	0.392
Sport with friends (1pw)	0.088	**0.714**	-0.154	0.111	0.077	-0.087	0.157	0.408
Sport (1pw)	0.012	**0.642**	0.026	-0.204	0.002	0.146	0.172	0.494
Club (1pw)	-0.051	**0.515**	0.438	-0.186	0.119	0.173	-0.087	0.455
Library (1pw)	0.211	-0.196	**0.596**	0.103	0.017	0.035	0.085	0.542
Religious activities (1pw)	-0.086	-0.021	**0.735**	-0.076	0.137	-0.173	-0.067	0.393
Watches TV/videos (1h pd)	-0.052	-0.057	-0.070	**0.803**	0.035	0.017	-0.020	0.342
Uses computer (1h pd)	-0.005	0.009	0.013	**0.778**	-0.088	-0.002	-0.016	0.386
Reads (1pw)	0.086	0.107	0.168	-0.036	**0.719**	0.003	0.098	0.425
Tidying up and caring for pets (1 pw)	0.179	-0.016	0.008	-0.086	**0.592**	0.055	0.156	0.582
After school class (1 pw)	-0.021	0.116	0.012	-0.026	0.016	**0.779**	0.088	0.371
Before school class (1 pw)	0.017	-0.061	-0.093	0.037	0.006	**0.805**	-0.070	0.333
Homework (1h pd)	-0.005	0.179	-0.032	0.014	0.132	-0.013	**0.748**	0.390
Extra classes (1 pw)	-0.021	-0.016	0.452	-0.115	-0.406	0.026	**0.461**	0.404

Notes: correlation between the variables expressing activities and the extracted components. 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 loading of the principal component analysis on activities at age 11 of the child (wave 5)

Activities	Activities with parents	Sports	Library / religious activities	Video-screen time	Reading and caring / tidying up	Extra hours at school	School – related activities	Uniq.
Parents play indoors (1 pw)	**0.852**	0.032	0.064	0.054	0.085	0.028	-0.024	0.258
Parents talk to child (1 pw)	**0.583**	-0.051	-0.413	-0.047	0.052	0.086	0.160	0.449
Parents play active games (1 pw)	**0.785**	0.185	0.157	-0.065	0.010	-0.008	-0.023	0.320
Sport with friends (1pw)	0.101	**0.795**	-0.140	-0.084	0.033	0.051	0.064	0.324
Sport (1pw)	0.017	**0.623**	-0.115	-0.143	-0.186	0.291	0.236	0.403
Bike (1pw)	0.127	**0.656**	0.206	0.115	0.169	-0.136	-0.178	0.418
Library (1pw)	0.202	-0.065	**0.742**	-0.062	0.012	0.105	0.017	0.388
Religious activities (1pw)	-0.022	-0.130	**0.504**	-0.112	0.238	0.007	0.462	0.446
Watches TV/videos (1h pd)	-0.020	-0.062	-0.146	**0.718**	0.040	0.111	0.051	0.442
Uses computer (1h pd)	0.029	-0.026	0.045	**0.739**	-0.132	-0.031	-0.056	0.429
Plays music (1 pw)	0.084	0.079	0.030	**-0.451**	-0.159	0.117	0.234	0.689
Tidying up and caring for pets	0.189	0.064	-0.234	-0.274	**0.644**	0.065	0.151	0.389
Looks after elderly (1 pw)	0.025	0.008	0.164	0.075	**0.794**	0.009	-0.040	0.335
After school class (1 pw)	0.041	0.033	-0.011	-0.012	-0.027	**0.811**	0.099	0.329
Before school class (1 pw)	0.012	0.054	0.097	0.056	0.086	**0.769**	-0.157	0.360
Homework (1h pd)	0.129	0.162	-0.249	-0.004	0.005	-0.010	**0.620**	0.511
Extra classes (1pw)	-0.097	0.024	0.216	-0.020	0.007	-0.054	**0.659**	0.506

Notes: correlation between the variables expressing activities and the extracted components. 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: control variables

	Age 7 (wave 4)	Age 11 (wave 5)
Environmental variables (panel A)		
Mother in the HH	0.99 (0.09)	0.98 (0.13)
Father in the HH	0.77 (0.42)	0.65 (0.48)
Stepfather in the HH	0.05 (0.21)	0.06 (0.24)
At least 1 sibling in the HH	0.88 (0.32)	0.88 (0.32)
At least 1 grandparent in the HH	0.06 (0.24)	0.03 (0.16)
At least 1 other adult in the HH	0.06 (0.23)	0.04 (0.19)
Mother's hours of work (per week)	16.36 (14.92)	19.30 (15.71)
Father's hours of work (per week)	39.31 (15.34)	39.45 (16.77)
Parental investments variables (panel B)		
Mother with tertiary education	0.40 (0.49)	0.42 (0.49)
Father with tertiary education	0.40 (0.49)	0.41 (0.49)
Child breastfed for at least 1 month	0.49 (0.50)	0.50 (0.50)
Mother was back to work by six months of the child	0.39 (0.49)	0.40 (0.49)
Father looks after the child on his own	0.61 (0.49)	0.61 (0.49)
Formal childcare when the child was 30 months old	0.30 (0.46)	0.29 (0.46)
Other child, parents, household's characteristics (panel C)		
Age child (in months)	86.71 (2.95)	133.97(3.89)
Girl	0.49 (0.50)	0.50 (0.50)
Birthweight	3.39 (0.58)	3.39 (0.58)
British	0.87 (0.33)	0.88 (0.33)
Had injuries (9 months old)	0.09 (0.30)	0.08 (0.29)
Ever gone to hospital (9 months old)	0.17 (0.55)	0.17 (0.56)
Communicative development (9 months old)	-0.05 (0.97)	-0.06 (0.97)
Motor development (9 months old)	0.02 (0.96)	0.02 (0.96)
Motion development (9 months old)	0.07 (0.82)	0.07 (0.81)
Cognitive development, lag	0.11 (0.95)	0.11 (0.95)
Number of siblings at birth	0.90 (1.10)	0.89 (1.00)
Mother locus of control	0.80 (0.40)	0.81 (0.39)
Mother conflicts (PIANTA scale)	17.05 (5.85)	17.01 (5.82)
Mother closeness (PIANTA scale)	33.62 (2.25)	33.65 (2.22)
Mother being neurotic (OCEAN scale)	23.63 (4.80)	23.64 (4.78)
Mother being extrovert (OCEAN scale)	19.56 (4.61)	19.55 (4.61)
Maternal mental well-being	3.00 (3.74)	3.77 (4.18)
Paternal mental well-being	2.87 (3.33)	3.70 (3.73)
Presence of new-borns	0.11 (0.32)	0.05 (0.21)
Weekly HH Equivalent Income	343 (194)	422 (160)
Holiday outside UK	0.50 (0.50)	0.47 (0.50)
England	0.62 (0.49)	0.62 (0.49)
Wales	0.16 (0.36)	0.15 (0.36)
Scotland	0.12 (0.33)	0.12 (0.32)
Northern Ireland	0.10 (0.30)	0.10 (0.30)
Observations	10,570	9,438

Note: HH stands for household. Child's development variables (communicative, motor, and motion) are factor points derived from principal component analyses (see Table A6); Cognitive development reports factor points derived from principal component analyses of the three available cognitive outcomes for the previous wave (see Table A7).

Table A6: Factor loading of the principal component analysis on development indicators in the first year of life (wave 1)

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 components. Higher correlations are in bold.

Table A7: Factor loading of the principal component analysis on children's cognitive tests (wave 3 and 4)

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

Notes: correlation between the variables expressing cognitive skills and the extracted component.

Table A8: The effects of children's after-school time on pro-social behaviour, contemporaneous, value-added, cumulative, and value-added cumulative models

	Age 7				Age 11			
	Contemp. (1)	VA (2)	CU (3)	CUVA (4)	Contemp. (5)	VA (6)	CU (7)	CUVA (8)
Activities with parents	0.063***	0.035***	0.043***	0.030**	0.084***	0.064***	0.066***	0.054***
	(0.012)	(0.011)	(0.013)	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)
Sports	0.021*	0.008	0.020*	0.009	0.052***	0.038***	0.046***	0.035***
	(0.012)	(0.011)	(0.012)	(0.011)	(0.013)	(0.011)	(0.013)	(0.012)
Library and religious activities	0.017	0.009	0.018	0.011	-0.015	-0.009	-0.018	-0.012
	(0.011)	(0.010)	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)
Video-screen time	-0.014	-0.008	-0.016	-0.011	-0.037***	-0.023**	-0.032***	-0.021**
	(0.010)	(0.009)	(0.011)	(0.009)	(0.011)	(0.010)	(0.011)	(0.011)
Reading and caring/tidying up	0.105***	0.067***	0.100***	0.066***	0.097***	0.077***	0.083***	0.069***
	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)
Extra hours at school	0.003	-0.000	0.002	-0.001	0.028***	0.029***	0.025**	0.026***
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
School-related activities	0.050***	0.032***	0.047***	0.031***	0.078***	0.059***	0.069***	0.053***
	(0.010)	(0.009)	(0.010)	(0.009)	(0.012)	(0.011)	(0.012)	(0.011)
Pro-social behaviour (lag)		0.439***		0.439***		0.412***		0.407***
		(0.011)		(0.011)		(0.012)		(0.012)
Observations	10,570	10,570	10,570	10,570	9,438	9,438	9,438	9,438
Other controls:								
Lagged activities			YES	YES			YES	YES
Other control variables	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The outcome variable (pro-social behaviour) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more positive traits; thus, positive coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3 of the paper).

Columns 1 and 5 present results of a simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); columns 2 and 6 presents results of a value-added model (VA), which additionally control for the lagged outcome; columns 3 and 7 presents the results of the cumulative model (CU), which controls for lagged activities but not the lagged outcome; finally, columns 4 and 8 presents the results of the cumulative-value added model (CUVA), the main specification of the paper (they correspond to columns 1 and 5 of Table 4). For a discussion, see Todd and Wolpin (2003). Other control variables are always included but not reported (lagged cognitive skills; child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5).

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A9: The effects of children's after-school time on conduct problems, contemporaneous, value-added, cumulative, and value-added cumulative models

	Age 7				Age 11			
	Contemp.	VA	CU	CUVA	Contemp.	VA	CU	CUVA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Activities with parents	-0.021*	-0.008	-0.013	-0.014	-0.053***	-0.035***	-0.046***	-0.031***
	(0.011)	(0.010)	(0.012)	(0.011)	(0.011)	(0.010)	(0.012)	(0.010)
Sports	-0.036***	-0.027***	-0.032***	-0.027***	-0.026**	-0.017*	-0.023*	-0.015
	(0.011)	(0.010)	(0.012)	(0.010)	(0.011)	(0.010)	(0.012)	(0.010)
Library and religious activities	-0.028***	-0.016*	-0.032***	-0.017*	0.037***	0.028***	0.038***	0.027***
	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)	(0.012)	(0.010)
Video-screen time	0.007	-0.006	0.003	-0.008	0.048***	0.028***	0.049***	0.031***
	(0.010)	(0.008)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
Reading and caring/tidying up	-0.070***	-0.036***	-0.068***	-0.037***	-0.041***	-0.029***	-0.037***	-0.028***
	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)
Extra hours at school	0.037***	0.027***	0.038***	0.027***	0.007	0.005	0.007	0.007
	(0.009)	(0.008)	(0.009)	(0.008)	(0.010)	(0.009)	(0.011)	(0.009)
School-related activities	-0.036***	-0.014*	-0.034***	-0.015*	-0.071***	-0.049***	-0.066***	-0.048***
	(0.010)	(0.008)	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)
Conduct (lag)		0.490***		0.490***		0.469***		0.468***
		(0.011)		(0.011)		(0.012)		(0.012)
Observations	10,570	10,570	10,570	10,570	9,438	9,438	9,438	9,438
Other controls:								
Lagged activities			YES	YES			YES	YES
Other control variables	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The outcome variable (conduct problems) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits; thus, negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3 of the paper).

Columns 1 and 5 present results of a simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); columns 2 and 6 presents results of a value-added model (VA), which additionally control for the lagged outcome; columns 3 and 7 presents the results of the cumulative model (CU), which controls for lagged activities but not the lagged outcome; finally, columns 4 and 8 presents the results of the cumulative-value added model (CUVA), the main specification of the paper (they correspond to columns 1 and 5 of Table 5). For a discussion, see Todd and Wolpin (2003). Other control variables are always included but not reported (lagged cognitive skills; child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5).

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A10: The effects of children's after-school time on peer relationship problems, contemporaneous, value-added, cumulative, and value-added cumulative models

	Age 7				Age 11			
	Contemp.	VA	CU	CUVA	Contemp.	VA	CU	CUVA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Activities with parents	0.008	-0.003	0.013	-0.004	0.030***	0.013	0.032***	0.014
	(0.011)	(0.010)	(0.013)	(0.011)	(0.011)	(0.010)	(0.012)	(0.011)
Sports	-0.094***	-0.064***	-0.090***	-0.063***	-0.154***	-0.111***	-0.148***	-0.107***
	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	(0.013)	(0.011)
Library and religious activities	0.012	0.008	0.011	0.011	0.033***	0.018*	0.028**	0.016
	(0.011)	(0.010)	(0.012)	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)
Video-screen time	0.004	0.003	-0.001	0.001	0.019*	0.016*	0.015	0.013
	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)
Reading and caring/tidying up	-0.022**	-0.011	-0.022**	-0.012	0.018*	0.013	0.017	0.012
	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)
Extra hours at school	0.011	0.012	0.011	0.011	-0.004	0.002	-0.006	0.000
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
School-related activities	-0.025**	-0.009	-0.023**	-0.010	-0.030***	-0.015	-0.027**	-0.013
	(0.010)	(0.009)	(0.010)	(0.009)	(0.012)	(0.010)	(0.012)	(0.011)
Peer problems (lag)		0.446***		0.446***		0.421***		0.419***
		(0.012)		(0.012)		(0.013)		(0.013)
Observations	10,570	10,570	10,570	10,570	9,438	9,438	9,438	9,438
Other controls:								
Lagged activities			YES	YES			YES	YES
Other control variables	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The outcome variable (peer relationship problems) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits; thus, negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3 of the paper).

Columns 1 and 5 present results of a simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); columns 2 and 6 presents results of a value-added model (VA), which additionally control for the lagged outcome; columns 3 and 7 presents the results of the cumulative model (CU), which controls for lagged activities but not the lagged outcome; finally, columns 4 and 8 presents the results of the cumulative-value added model (CUVA), the main specification of the paper (they correspond to columns 1 and 5 of Table 6). For a discussion, see Todd and Wolpin (2003). Other control variables are always included but not reported (lagged cognitive skills; child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5).

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A11: The effects of children's after-school time on emotional symptoms, contemporaneous, value-added, cumulative, and value-added cumulative models

	Age 7				Age 11			
	Contemp.	VA	CU	CUVA	Contemp.	VA	CU	CUVA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Activities with parents	0.024**	0.020**	0.021	0.016	0.026**	0.014	0.030***	0.017*
	(0.011)	(0.010)	(0.013)	(0.012)	(0.010)	(0.010)	(0.011)	(0.010)
Sports	-0.041***	-0.027**	-0.038***	-0.027**	-0.091***	-0.066***	-0.090***	-0.066***
	(0.012)	(0.010)	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)
Library and religious activities	-0.007	-0.002	-0.011	-0.003	0.003	-0.005	0.004	-0.004
	(0.011)	(0.010)	(0.012)	(0.011)	(0.011)	(0.010)	(0.012)	(0.011)
Video-screen time	0.016*	0.013	0.015	0.013	0.031***	0.032***	0.030***	0.034***
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
Reading and caring/tidying up	-0.063***	-0.046***	-0.066***	-0.047***	0.006	-0.003	0.011	-0.001
	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)
Extra hours at school	-0.007	-0.001	-0.007	-0.002	-0.011	-0.003	-0.009	-0.003
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
School-related activities	-0.001	0.004	-0.002	0.003	-0.004	-0.002	-0.003	-0.003
	(0.010)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.011)
Emotional symptoms (lag)		0.433***		0.433***		0.399***		0.399***
		(0.011)		(0.011)		(0.012)		(0.012)
Observations	10,570	10,570	10,570	10,570	9,438	9,438	9,438	9,438
Other controls:								
Lagged activities			YES	YES			YES	YES
Other control variables	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The outcome variable (emotional symptoms) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits; thus, negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3 of the paper).

Columns 1 and 5 present results of a simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); columns 2 and 6 presents results of a value-added model (VA), which additionally control for the lagged outcome; columns 3 and 7 presents the results of the cumulative model (CU), which controls for lagged activities but not the lagged outcome; finally, columns 4 and 8 presents the results of the cumulative-value added model (CUVA), the main specification of the paper (they correspond to columns 1 and 5 of Table 7). For a discussion, see Todd and Wolpin (2003). Other control variables are always included but not reported (lagged cognitive skills; child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5).

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A12: The effects of children's after-school time on hyperactivity/inattention, contemporaneous, value-added, cumulative, and value-added cumulative models

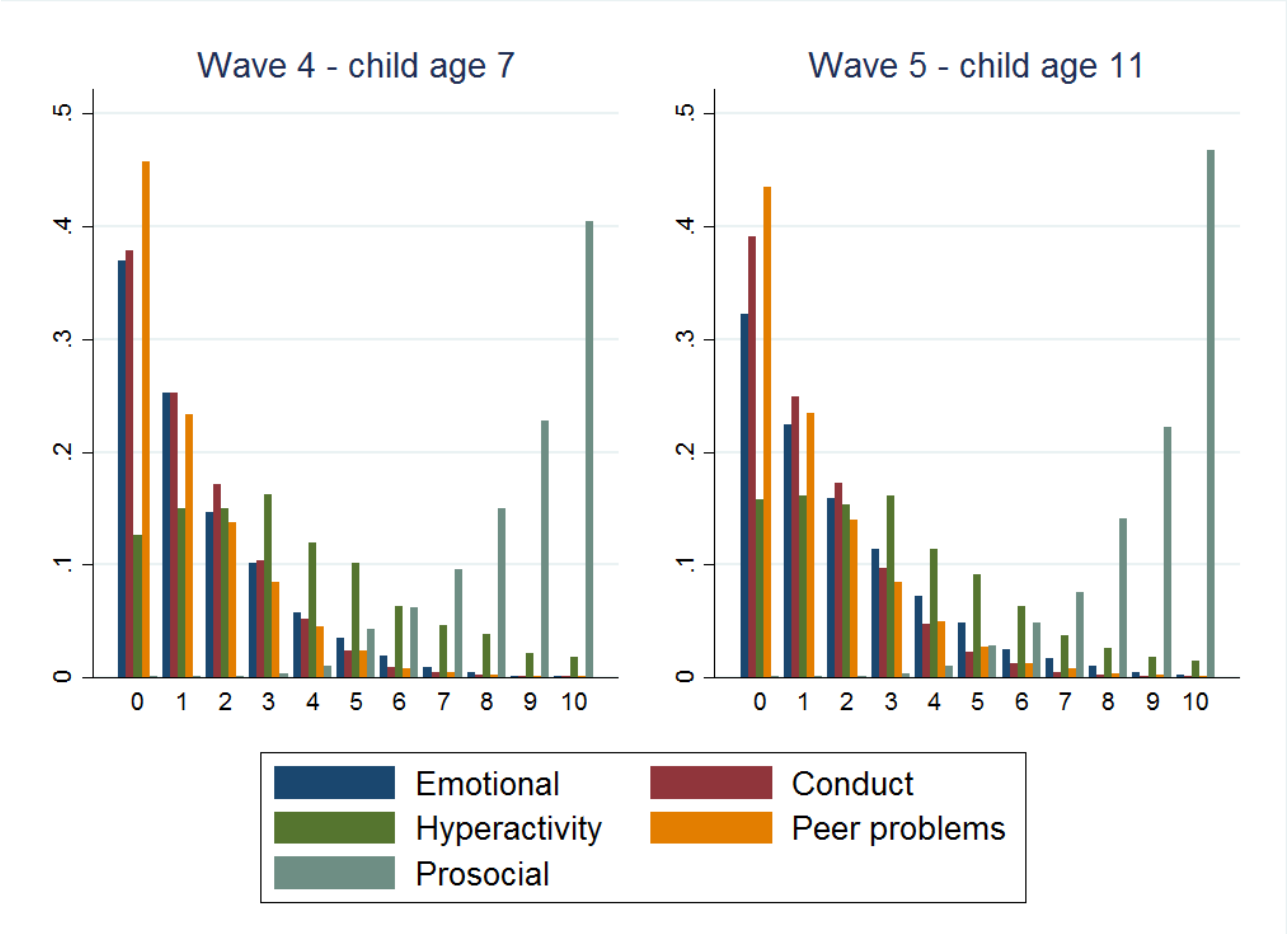
	Age 7				Age 11			
	Contemp.	VA	CU	CUVA	Contemp.	VA	CU	CUVA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Activities with parents	-0.023**	-0.010	-0.006	-0.012	-0.038***	-0.028***	-0.032***	-0.030***
	(0.011)	(0.009)	(0.012)	(0.010)	(0.010)	(0.008)	(0.011)	(0.009)
Sports	-0.041***	-0.029***	-0.038***	-0.030***	-0.010	0.011	-0.008	0.010
	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)
Library and religious activities	-0.034***	-0.017**	-0.030***	-0.016*	0.028***	0.014	0.028**	0.012
	(0.011)	(0.009)	(0.011)	(0.009)	(0.010)	(0.009)	(0.011)	(0.009)
Video-screen time	0.019**	0.012	0.017*	0.014*	0.044***	0.020**	0.042***	0.023***
	(0.009)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.009)
Reading and caring/tidying up	-0.110***	-0.062***	-0.107***	-0.062***	-0.026**	-0.023***	-0.016	-0.021**
	(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.009)
Extra hours at school	0.043***	0.025***	0.043***	0.025***	-0.005	-0.006	-0.010	-0.008
	(0.009)	(0.008)	(0.009)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)
School-related activities	-0.011	-0.006	-0.007	-0.006	-0.051***	-0.030***	-0.044***	-0.029***
	(0.009)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)	(0.011)	(0.009)
Hyperactivity (lag)		0.585***		0.585***		0.583***		0.580***
		(0.009)		(0.009)		(0.009)		(0.009)
Observations	10,570	10,570	10,570	10,570	9,438	9,438	9,438	9,438
Other controls:								
Lagged activities			YES	YES			YES	YES
Other control variables	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The outcome variable (hyperactivity/inattention) and its lagged corresponding variable are standardized to have 0 mean and 1 standard deviation; higher scores indicate more problematic traits; thus, negative coefficients identify beneficial effects. The variables of interests are the seven components (standardized) resulting from the principal component analysis of the single activities at each wave (see Table 3 of the paper).

Columns 1 and 5 present results of a simple OLS model, which estimates the contemporaneous effect of activities on the outcome (Contemp.); columns 2 and 6 presents results of a value-added model (VA), which additionally control for the lagged outcome; columns 3 and 7 presents the results of the cumulative model (CU), which controls for lagged activities but not the lagged outcome; finally, columns 4 and 8 presents the results of the cumulative-value added model (CUVA), the main specification of the paper (they correspond to columns 1 and 5 of Table 8). For a discussion, see Todd and Wolpin (2003). Other control variables are always included but not reported (lagged cognitive skills; child's characteristics and early development; presence of family members; parental hours of work, education, and care; maternal non-cognitive characteristics and parental mental wellbeing; household income - see Table A5).

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A1: Children's socio-emotional skills



Notes: the five colours represent the five socio-emotional 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's non-cognitive 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 prosocial behaviour.

Appendix B: Strengths and Difficulties Questionnaire

The Strength and Difficulties questionnaire (SDQ) is a brief emotional and behavioural screening questionnaire for children and young people (aged 4 to 16 years old), first developed by Goodman (1997) to measure psychological adjustment. One version of the questionnaire is designed to be filled out individually by parents, teachers, and older children. It can be used for various purposes, including clinical assessment, evaluation of outcomes, research and screening. The questionnaire used in the paper, from the Millennium Cohort Study, is filled out individually by the parents at different waves.

The SDQ contains 25 items, divided across 5 scales of 5 items each (the emotional symptoms subscale, conduct problems subscale, hyperactivity/inattention subscale, peer relationships problem subscale, and prosocial behaviour subscale). The five subscales have been refined through exploratory factor analyses (Goodman 1997) and supported by subsequent analysis.

Parents are asked to think about the behaviour of their child over the previous six months, and for each item, answer according to a 3-point response scale ("Not true" = 0, "Somewhat true" = 1, "Certainly true" = 2). The groups of five answers are combined into a single total score for each socio-emotional dimension, ranging from 0 to 10. Lower scores identify positive traits for the first four dimensions, while a higher score identifies more positive traits in terms of prosocial behaviour.

Table B.1 below presents compares the normative data of the SDQ for some countries, compared to our sample.

The 25 questions of the questionnaire are as follows:

[Cohort child name]

1. Considerate of other people's feelings
2. Restless, overactive, cannot stay still for long
3. Often complains of headaches, stomach-aches or sickness
4. Shares readily with other children (treats, toys, pencils etc.)
5. Often has temper tantrums or hot tempers
6. Rather solitary, tends to play alone
7. Generally obedient, usually does what adults request
8. Many worries, often seems worried
9. Helpful if someone is hurt, upset or feeling ill
10. Constantly fidgeting or squirming
11. Has at least one good friend
12. Often fights with other children or bullies them
13. Often unhappy, down-hearted or tearful
14. Generally liked by other children

15. Easily distracted, concentration wanders
16. Nervous or clingy in new situations, easily loses confidence
17. Kind to younger children
18. Often lies or cheats
19. Picked on or bullied by other children
20. Often volunteers to help others (parents, teachers, other children)
21. Thinks things out before acting
22. Steals from home, school or elsewhere
23. Gets on better with adults than with other children
24. Many fears, easily scared
25. Sees tasks through to the end, good attention span

Table B1: Normative data for the Strengths and Difficulties Questionnaire, selected countries

	Australia		Great Britain		Japan	U.S.A.		MCS UK Our sample	
Age group	7-17	7-10	5-15	5-10	4-15	4-7	8-10	7	11 y.o.
Emotional symptoms	2.1	2.3	1.9	1.9	1.4	1.6	1.5	1.5	1.8
	(2.0)	(2.0)	(2.0)	(2.0)	(1.7)	(1.8)	(1.9)	(1.7)	(2.0)
Conduct problems	1.5	1.3	1.6	1.6	1.8	1.3	1.3	1.3	1.3
	(1.6)	(1.5)	(1.7)	(1.7)	(1.5)	(1.6)	(1.7)	(1.5)	(1.5)
Hyperactivity/inattention	3.1	2.6	3.5	3.6	2.8	2.8	2.9	3.3	3.0
	(2.4)	(2.2)	(2.6)	(2.7)	(2.1)	(2.5)	(2.6)	(2.5)	(2.4)
Peer problems	1.6	1.5	1.5	1.4	1.4	1.4	1.5	1.1	1.3
	(1.9)	(1.9)	(1.7)	(1.7)	(1.6)	(1.5)	(1.6)	(1.5)	(1.6)
Prosocial behaviour	8.3	8.7	8.6	8.6	6.3	8.6	8.8	8.6	8.9
	(1.7)	(1.6)	(1.6)	(1.6)	(2.2)	(1.8)	(2.7)	(1.6)	(1.5)
N	910	197	10,298	5,855	4,800	9,878	2,064	10,570	9,438

Source: Standard deviation in parentheses. Normative data from Mellor (2005) (Australia), Meltzer et al. 2000 (Great Britain), Moriwaki and Kamio (2014) (Japan), National Health Interview Survey (NHIS) for the USA.

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