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Abstract

Although it is widely acknowledged that non-cognitive skills matter for adult outcomes, little is known about the role played by family environment in the formation of these skills. We use a longitudinal survey of children born in the UK in 2000–2001, the Millennium Cohort Study by the Centre for Longitudinal Studies, to estimate the effect of family size on socio-emotional skills, measured by the Strengths and Difficulties Questionnaire. To account for the endogeneity of fertility decisions, we use a well-known instrumental approach that exploits parents' preference for children's gender diversity. We show that the birth of a third child negatively affects the socio-emotional skills of the first two children in a persistent manner. However, we show that this negative effect is entirely driven by girls. We provide evidence that this gender effect is partly driven by an unequal response of parents' time investment in favour of boys and, to a lesser extent, by an unequal demand for household chores.

JEL classification: I20, J13, J16

Keywords: Non-cognitive skills; Family size; Birth order; Child development

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1 Introduction

It is now broadly recognized that non-cognitive skills are key determinants of adult outcomes. Over the last 15 years, several studies have shown that they are as important as cognitive skills in determining a variety of outcomes, including educational attainment, labour market outcomes, crime rates, and health outcomes (Nyhus and Pons, 2005; Heckman *et al.*, 2006; Conti *et al.*, 2010; Lindqvist and Vestman, 2011; Cobb-Clark and Tan, 2011; Fletcher, 2013). A recent study by Deming (2017) showed that the returns of non-cognitive skills in the labour market are even greater for newer cohorts.

Childhood is generally considered to be a critical period in the acquisition of non-cognitive skills. Due to complementarities across periods, high levels of skills early in childhood lead to greater productivity of investments later in childhood (Cunha and Heckman, 2007). While the literature has extensively explored the childhood determinants of cognitive skills, comparatively little is known about the determinants of the formation of non-cognitive skills. We already know that the latter are influenced by maternal time (Del Bono *et al.*, 2016), parenting style (Fiorini and Keane, 2014), maternal education (Carneiro *et al.*, 2013), and family income (Fletcher and Wolfe, 2016). Björklund and Jäntti (2012) and Grönqvist *et al.* (2017) found evidence supporting the existence of an intergenerational transmission of non-cognitive skills, while Black *et al.* (2017) showed that birth order predicts socio-emotional skills and occupational choices.

We complement these studies by asking whether family size influences the formation of children's socio-emotional skills. The popular quantity–quality model (Becker, 1960; Becker and Lewis, 1973; Becker and Tomes, 1976) and resource-dilution theory are often used in the literature to explain the negative correlation between family size and individual's outcomes (Björklund and Salvanes, 2011). However, the number of studies rejecting a quantity–quality trade-off regarding the formation of cognitive skills based on quasi-experimental variations is growing (Black *et al.*, 2005; Cáceras-Delpiano, 2006; Angrist *et al.*, 2010; Aslund and Grönqvist, 2010; Angrist *et al.*, 2010; Black *et al.*, 2010). Black *et al.* (2010) found a negative effect of an increase in family size instrumented by twin birth, while Aslund and Grönqvist (2010) found a small negative impact on children's grades in compulsory and secondary school, but only for vulnerable children, as defined by low parental education, large sibships, and high birth order.

Here, we investigate whether an increase in family size has a negative impact on the accumulation of non-cognitive skills, as predicted by the Beckerian quantity–quality model and resource-dilution theory. The net effect of an increase in family size is ambiguous because we may also expect social interactions between siblings to affect the acquisition of non-cognitive skills. An extensive literature in psychology demonstrates that sibling relationships can, depending on the context, lead to either more aggressive behaviours (Slomkowski *et al.*, 2001; Stauffacher and DeHart, 2006) or warmer attitudes that foster the development of social skills (Volling and Belsky, 1992; Stormshak *et al.*, 1996).

We empirically address this question by using a longitudinal dataset of children born in the UK in 2000–2001, namely the Millennium Cohort Study (MCS) by the Centre for Longitudinal Studies at the University of London, to study the effect of an increase in family size on the formation of socio-emotional skills. The main identification challenge is that fertility decisions are unlikely to be randomly distributed across families. Indeed, these decisions depend on both observable and unobservable family characteristics, such as parents' socio-economic status, their life satisfaction, their own non-cognitive skills, and their parenting style, that are likely to be correlated with the formation of socio-emotional skills during childhood. To account for the endogeneity of fertility decisions, we use a well-known instrumental approach developed by Angrist and Evans (1998), which exploits the fact that parents whose first two children are of the same sex are more likely to have an additional child than parents whose children are of opposite sex. Contrary to most of the studies using this instrumental approach, we are able to follow children over time and observe how they behave *before* and *after* an increase in family size. The richness of this cohort study data enables us to confirm that there are no pre-existing differences between children from families whose first two children are of the same sex and children from families whose first two children are of opposite sex. Finally, we provide evidence that there is no parental preference for one gender as regards fertility decisions in our data.

Using the parental preferences for child sex variety as a natural source of variation in fertility decisions, we show that the birth of a third child negatively affects the formation of socio-emotional skills for both the first- and the second-born. In particular, we find that this effect is stronger if the birth occurs when the children are young (under six years old). More surprisingly, we find no effect of the birth of a third child for boys: The negative effect of

the birth of a third child is entirely driven by girls. Investigating the potential mechanisms at play, we provide evidence that this differential effect across gender is partly driven by an unequal response of parents' time investment in favour of boys and, to a lesser extent, to an increase in the demand for household chores for girls. We also show that the negative effects of family size persist even 11 years after the event.

To the best of our knowledge, only two previous studies are similar to ours. Using different methods and, respectively, UK and US data, Silles (2010) and Juhn *et al.* (2015) found negative associations between family size and the development of non-cognitive skills of children, as measured by the British Social Adjustment Guide and the Rutter B scale in the former, and by the National Longitudinal Study of Youth's Behavior Problem Index in the latter. Our paper contributes to the literature in several key aspects. First, we make use of the Strengths and Difficulties Questionnaire (SDQ), a well-established measure in psychology, to study the impact of an increase in family size not only on behavioural and emotional skills but also on pro-social behaviour. As shown in Layard *et al.* (2014) and Clark and Lepinteur (2019), behavioural and emotional skills have different influences on future adult outcomes (e.g., unemployment experience, educational attainment, well-being). Second, we use an instrumental variables approach to estimate the causal impact of family size on the different dimensions of the SDQ and provide a thorough examination of the potential sources of heterogeneity and channels. More specifically, we are the first to show that there is a family-size penalty for girls regarding the development of behavioural, emotional and pro-social skills. We explain this penalty by exploring channels already investigated in Juhn *et al.* (2015), that is, parental investment, but we also provide evidence of a new channel: As family size increases, girls tend to be more likely than boys to perform household chores. Silles (2010) and Juhn *et al.* (2015), respectively, rely on generations born in 1958 and at the end of the 1980s. We provide evidence for a much younger cohort, the MCS cohort, born in 2000–2001, for whom the acquisition of non-cognitive skills is of higher importance than previous generations (Deming, 2017).

The remainder of this paper is organized as follows. Section 2 describes the dataset and the main measure of socio-emotional skills exploited in this paper. Section 3 presents our instrumental approach and provides evidence on the validity of the identifying assumption. Section 4 shows the effect of an increase in family size on children's non-cognitive skills, and

Section 5 concludes.

2 Data and the measurement of socio-emotional skills

2.1 The MCS

The estimation sample used in this paper is based on the MCS. This longitudinal birth cohort study tracks the lives of 19,517 children born in the UK in 2000–2001. One of the main advantages of the MCS is that it covers children from across the UK. The sample was designed to be representative of the total population of all regions of the UK, but also to provide sufficient observations to study ethnic minorities and areas of high child poverty.

Since the beginning of the survey, the cohort members have been surveyed six times: at age 9 months and 3, 5, 7, 11, and 14 years old. Interviewers visited the cohort members' homes and conducted face-to-face interviews with resident parents. Parents also answered some questions via self-completion. The survey has collected rich information on family background (parental education, parental health, parenting activities), family structure (family composition, employment and income), and diverse aspects of the lives of the cohort members (health, schooling, well-being, cognitive and non-cognitive development).

2.2 Measuring socio-emotional skills

Our measures of socio-emotional skills come from the SDQ, which is a behavioural-screening questionnaire for children about 3 to 16 years old and consists of 25 questions that are answered by an adult regarding the child's concentration span, temper tantrums, happiness, and worries and fears, and whether the child is obedient, often lies or cheats, is kind to younger children, and so on.

The answers to these questions can be used to produce five sub-scales (each consisting of five items) relating to emotional health, behavioural problems, hyperactivity/inattention, peer-relationship problems, and pro-social behaviour. Following Goodman *et al.* (2010), we first use two broader sub-scales that can be summed up to form the total SDQ: *externalizing* and *internalizing* behaviour. The internalizing behaviour score is the sum of the emotional and peer sub-scales and can be used to measure emotional health, while externalizing behaviour is made up of the behavioural problems and hyperactivity sub-scales and relates to behaviour

(see Table OA.1 in the Online Appendix for a complete description of the questionnaire). Both internalizing and externalizing SDQ answers are scored on a 0–20 scale; we reversed the scales so that higher values indicate better outcomes. We also use the score for pro-social behaviours as an additional outcome of interest. This score is from 0 to 10, where the larger the score, the better the behaviour of the cohort member. All of the outcomes are standardized by age for a mean of zero and a standard deviation of one.[1] The SDQ in the MCS is reported by the primary care giver in waves 2 to 6 (age 3 to 15 years).[2]

The SDQ, developed by psychologists, is a popular measure of socio-emotional skills. An extensive literature in psychology supports its validity and predictive power.[3] The SDQ reported by the primary care giver is highly correlated with different measures of non-cognitive skills, such as the Rutter questionnaires (Goodman, 1997), the Child Behaviour Checklist (Goodman and Scott, 1999), and the clinician-rated Health of the Nation Outcome Scales for Children and Adolescents Mathai *et al.* (2003). Here, we follow Clark *et al.* (2019) and interpret the externalizing SDQ and the internalizing SDQ as a measure of behavioural skills and emotional skills, respectively.

In recent years, economists have widely exploited the different dimensions of the SDQ as measures of non-cognitive skills (Gupta and Simonsen, 2010; Nghiem *et al.*, 2015; Fleche, 2017; Kuehnle and Oberfichtner, 2017; Attanasio *et al.*, 2018; Cornelissen and Dustmann, 2018). Using the socio-emotional skills reported by the mother during childhood, based on the SDQ, recent studies have shown that socio-emotional skills are the most important predictors of adulthood life satisfaction (Layard *et al.*, 2014; Clark *et al.*, 2019) and labour market outcomes: Clark and Lepinteur (2019) demonstrated that better socio-emotional skills in childhood significantly reduce time spent unemployed during active life.

[1] We replicated our analysis with the raw score of the SDQ and found no difference from the estimates provided in this paper. Results are available upon request.

[2] Non-cognitive skills are also measured by teachers, but are provided only for the fourth wave. Moreover, parents had to give their consent, which drastically reduces the sample size and raises concerns of selection regarding the remaining observations (see Cornelissen and Dustmann, 2018).

[3] See Pike *et al.* (2006) and Hartas (2011) for a longer discussion.

3 Empirical strategy

3.1 Instrumental strategy: Parents' preference for children's sex diversity

Our objective is to estimate the impact of an increase in family size on the development of children's socio-emotional skills between 3 and 15 years of age. The main identification challenge is that fertility decisions are unlikely to be randomly distributed across families. Indeed, these decisions depend on both observable and unobservable family characteristics (parents' socio-economic status, parenting style, parents' life satisfaction, parents' non-cognitive skills) that are likely to be correlated with the formation of socio-emotional skills during childhood.

To account for the endogeneity of fertility decisions, we use an instrumental variables approach developed by Angrist and Evans (1998). Under the assumption of parental preferences for children's sex diversity, parents whose first two children are of the same sex are more likely to have an additional child than parents whose two children are of opposite sex. Since the sex of a child is random by nature, the sex composition of the first two children is arguably randomly distributed across families with two children. This instrument has been used extensively in the literature to assess the impact of family size on a variety of outcomes (Angrist *et al.*, 2010; Black *et al.*, 2010; Cools and Hart, 2017), and we provide additional evidence on the validity of this instrument in Section 3.3.

Here, we consider families with two children in wave 2, and we instrument an increase in family size (i.e., the birth of a third child) in waves 3–6 by the sex composition of the first two children. We first note our initial period of observation, t_0 (i.e., wave 2). Given our instrumental approach, we restrict our initial sample to families with two children in t_0, and we construct an instrumental variable, $same\ sex_{i0}$, which equals one if the first two children in the family are of the same sex and zero if they are of opposite sex. Note that $same\ sex_{i0}$ is time invariant; hence, we cannot use individual or family fixed effects. We then use $same\ sex_{i0}$ as an instrument for an increase in family size in subsequent waves. We use wave 2 only to construct our instrument, and all regressions are estimated using waves 3–6. Wave 2 can here be seen as a "pre-treatment" period. Formally, we estimate the following model using a two-stage least-squares procedure:

$$Third\ Child_{it} = \alpha_1 same\ sex_{i0} + \gamma_1 X_{it} + \delta_t + \beta_1 Y_{i0} + \epsilon_{it}$$

$$Y_{it} = \alpha_2 \widehat{Third\ Child}_{it} + \gamma_2 X_{it} + \delta_t + \beta_2 Y_{i0} + \mu_{it} \quad (1)$$

where $Third\ Child_{it}$ is a dummy equal to one if there is a third child in the family, that is, if the birth of a third child took place in child i's family between t_0 and t, with $t > t_0$;[4] Y_{it} represents the socio-emotional skills of child i in period t; X_{it} is a vector of controls, including the child's individual characteristics (sex, age, birth order, month of birth, age of mother at birth) and family characteristics (income, marital status, presence of father, age of mother at first birth);[5] and δ_t is the full set of wave dummies.

Since our measures of children's socio-emotional skills are reported by the mother, there may be the possibility of reporting biases correlated with the decision to have a third child. To tackle this issue, we control for children's socio-emotional skills in t_0 in both equations. The introduction of this term, Y_{i0}, is sufficient to neutralize mothers' reporting bias, under the assumption that this bias is constant over time. Note that we replicated our empirical analysis without including Y_{i0}, and the results, available upon request, are similar.

3.2 Estimation sample

Given that our instrumental variables strategy is based on the sex composition of the first two children, we restrict the analysis to children from families with two children in our initial period of observation (t_0). We then keep all observations from this sample for which the dependent variables, the sex composition of the first two siblings and the set of controls are not missing between the third and the sixth wave.

This produces a sample of 5,983 children from 5,907 families in t_0. Table OA.2 in the Online Appendix reports descriptive statistics on children's and family characteristics for all cohort members in our sample in wave 2. The average (reversed) total SDQ score is 30.77, and the average behavioural skills (externalizing SDQ) and emotional skills (internalizing SDQ) scores are 13.46 and 17.31, respectively. The average score for pro-social behaviour is slightly above 7 (over 10). Children are, on average, 3.15 years old in t_0, and female cohort members

[4] Alternatively, rather than using a dummy "Third Child", we also decided to instrument the size of the family (as measured by the size of the sibship) and found results that are qualitatively similar to our baseline estimates (available upon request).

[5] The question may arise: Why do we not control for the birth spacing between the first two children? The reason is that as we already control for the age of the mother at the birth of the cohort member and the age of the mother at the first birth, the birth spacing is a linear combination of these two variables for the second-born (60% of our estimation sample). Note that we also replicated our results controlling for the birth spacing, and the results remain the same.

represent half of the estimation sample in wave 2. Finally, 40% of our sample are first-borns, while 60% are second-borns.[6]

We then track all of the cohort members from our sample in wave 2 to create our estimation sample.[7] This produces an estimation sample of 20,131 observations. Table 1 reports descriptive statistics on children's and family characteristics for all cohort members in this estimation sample. The average (reversed) total SDQ score is now 32.08. This is, unsurprisingly, slightly higher than in wave 2 since the SDQ score improves as children grow up (Meltzer *et al.*, 2003). This is mostly explained by a drop in behavioural issues, as revealed by the increase in the behavioural skills score (see Table OA.2 in the Online Appendix and Table 1). Consistent with the drop in behavioural issues due to age, the average score for pro-social behaviour is also slightly higher. Figures 1 and 2 show the distribution of total SDQ score of the estimation sample and the distribution of internalizing and externalizing SDQ scores, respectively. The different types of SDQ are skewed towards high values, indicating that primary care givers report on average a limited number of behavioural and emotional problems. Figure 3 shows the distribution of the pro-social behaviour score. The distributions of total SDQ, internalizing SDQ, externalizing SDQ, and pro-social behaviour scores are consistent with previous findings from the psychology literature (Meltzer *et al.*, 2003).

Note that 4,439 cohort members are left in our estimation sample in wave 6. This implies that we lose about a quarter of the initial individuals by the end of the period of observation. This may look like a large attrition rate, but it is standard with cohort studies (see Mostafa and Ploubidis, 2017, for technical details regarding attrition in the MCS). We address concerns due to attrition by taking two different approaches. First, we replicated our analysis using an inverse probability weighting procedure that accounts for the initial level of SDQ scores and family characteristics as well as the probability that the first two children are of the same sex. Our results are shown in panel A of Table OA.3 in the Online Appendix and are consistent with our baseline estimates. We report in Table OA.4 in the Online Appendix the probit we used to build our attrition weights. Note that we used different sets of controls to build the weights in alternative specifications, and the results remain the same. Second, we used only

[6] This imbalance between first-born and second-born children is a consequence of our identification strategy. To be included in our estimation sample, a child has to come from a family with two children in t_0 when the child is three years old. For first-born children, this automatically implies selecting families who have had two children *over the last three years* (i.e., between the birth of the first child and t_0), while for second-borns, there is no such selection. This results in a larger proportion of second-born children in our sample.

[7] The estimation sample thus corresponds to the same children observed at periods $t > t_0$.

those children who were observed in every wave. Our findings always remain the same and lead us to conclude that attrition has little to do with our results (see panel B of Table OA.3 in the Online Appendix for detailed results).

It may be argued that our *ThirdChild* dummy confounds the effect of the birth of a third child and the effect of the birth of children of higher birth order. We should stress that only 3.25% of the families in our estimation sample experienced the birth of a fourth child. Excluding families with four children or more, the results remain strictly unchanged.

3.3 Instrument validity

Our instrumental approach relies on the assumption that parents of two children of the same sex are more likely to have a third child than parents of two children of different sex (Angrist and Evans, 1998). The key identification assumption here is that having a sibling of the same sex or having a sibling of the opposite sex has no direct effect on children's socio-emotional development. Although we cannot directly test our exclusion restriction, we provide evidence that there is no pre-existing difference between children from families with two children of the same sex and children from families with children of opposite sex. To do so, we check that there is no imbalance between the two kinds of families in terms of individual and family characteristics in t_0, *before* any potential birth has occurred in subsequent periods. According to Table A.1, there is no significant difference between the two types of families regarding both a child's socio-emotional skills and a large set of characteristics. These balancing tests suggest that growing up with a sibling of the same sex or with a sibling of a different sex is orthogonal to the development of a child's non-cognitive skills and to other family characteristics potentially influencing these skills.[8]

To make sure that our instrument reflects parental taste only for diversity in the gender composition of children and not an absolute taste for a specific gender, we regress the proba-

[8]We constructed an additional test to provide further evidence on the absence of a direct effect of growing up with a sibling of the same sex on children's non-cognitive development. To construct this test, we restricted our sample to families with two children of opposite sex in t_0 who will have a third child in subsequent waves, and we looked at the effect of having a third sibling of the same sex (compared with having a third sibling of the opposite sex) on children's socio-emotional skills, exploiting the fact that the sex of the third child is random. This allowed us to capture the effect of having a sibling of the same sex while keeping the family size constant. The results, available in Table A.2, indicate that children in families with two children of opposite sex in t_0 and who experience an increase in family size in subsequent periods are not affected by the sex of the third child. Again, this suggests that the gender composition of the siblings has no direct impact on children's non-cognitive development. Having a brother might have a negative effect for boys; in that case, we would overestimate the effect of family size on boys.

bility of having a second child in $t \geq t_0$ on a dummy that equals one if the first child is female in the sample of families with one child in wave 2. The estimate in Table A.3 shows that the sex of the first child has no effect on the probability of having a second child. In line with this result, we further show that the probability of having a third child is similar in families whose first two children are girls and families whose first two children are boys (cf. Table A.4). In summary, we find no evidence of parental absolute preference for one gender in our data. We provide further discussion of possible differences across same-sex families and opposite-sex families in terms of gender attitudes in Section 4.2.3.[9]

4 The effect of the birth of a third child on children's socio-emotional skills

4.1 Main results

Before discussing the effect of the birth of a third child on children's socio-emotional skills, we first ask whether our instrument produces sufficient exogenous variation in fertility decisions. To address this issue, we look at the estimate of the first stage, in the top panel of Table 2. Consistent with previous findings from the literature, our instrument $same\ sex_{i0}$ predicts a statistically significant increase in the probability of having a third child. Note that we also show the Cragg-Donald Wald F-statistics at the bottom of Table 2, and they are always approximately 80, much greater than 10, which is usually considered a rule of thumb for discarding concerns about weak instruments.

Table 2 shows the effect of the birth of a third child on children's socio-emotional skills based on the estimation of Eq. (1) using our estimation sample. As can be seen in column

[9] Another way of instrumenting the family size, suggested by Angrist and Evans (1998), is to use twin birth. When implementing this instrumentation strategy, the F-statistic is approximately two. Indeed, the limited number of multiple births reduces our statistical power (we observed fewer than 1,000 twins). The instrument is therefore too weak to be able to draw any strong conclusions from it. For reasons of comparison, this method has been used in Black *et al.* (2005); Cáceras-Delpiano (2006), and Aslund and Grönqvist (2010) with estimation samples 16 to 40 times larger.

Note that we also investigated the possibility of using *in vitro fertilization* treatment as in Lundborg *et al.* (2017). However, we could observe only whether the mother "already received a fertility treatment" before the birth of the cohort member. In line with our suspicions, this measure is not precise enough to capture a significant variation in the probability of having a third child. We do not find a significant correlation between the probability of having a third child and the exposure to past fertility treatment, and the F-statistic is roughly equal to 0.7. All of our results from using the different instrumental variables are available upon request.

(1), this produces a decrease in the total SDQ score of 0.650 standard deviations, statistically significant at the 6% level. This is equivalent to twice the estimate we found for the dummy "not having the natural father in the household anymore" or to 10 times the effect of a 1 standard deviation increase in time spent with the mother on educational activities or on recreational activities at age 7 years (Del Bono *et al.*, 2016).

Another question that may arise is whether the internalizing and externalizing SDQ respond differently to a change in family size. Columns (2) and (3) of Table 2 address this concern by reporting the effect of an increase in family size separately on behavioural skills and emotional skills. Column (4) shows the effect of the birth of a third child on the pro-social behaviour score. While the estimate only on emotional skills is statistically different from zero at the 10% level, the estimates on behavioural skills and pro-social skills are smaller, but still negative.[10] We also look at the impact of having a third child on each sub-component of SDQ in Table OA.7 in the Online Appendix. The dimensions "hyperactivity" and "emotion" are the ones that are significantly affected by the birth of a third child. The other estimates are also negative, but not significantly different from zero at conventional levels.

The negative effects of an increase in family size on children's non-cognitive development outlined in this paper are consistent with the idea that parents have a limited amount of resources (time and money) to invest in their children (Becker, 1960; Becker and Lewis, 1973; Becker and Tomes, 1976). The birth of a new child in the family may remove some parental resources from previous children, who may, consequently, end up with lower socio-emotional skills than they would otherwise.

4.2 Heterogeneity analysis

The average causal effect of the birth of a third child is significantly different from zero at the 10% level. This is a conventional level, but it may also mix groups of children whose accumulation of non-cognitive skills is more sensitive to changes in family size than others. In

[10] We report the ordinary least-squares (OLS) estimates for the same estimation sample in Table OA.5 in the Online Appendix. While the estimates are qualitatively consistent with those in Table 2, the OLS coefficients are much smaller. This suggests a positive selection on unobserved characteristics, consistent with Silles (2010) and Juhn *et al.* (2015) and with the assumption that having more children might be correlated with unobserved characteristics that vary over time, such as better mental health, a higher life satisfaction, or higher non-cognitive skills, that are positively correlated with a child's non-cognitive skills. In addition, note that we find consistent results when we consider the whole sample of MCS cohort members and estimate the linear effect of family size on non-cognitive skills (including all possible values of family size, rather than only two versus three), using an OLS approach (see Table OA.6 in the Online Appendix).

this section, therefore, we ask whether the effect of an additional child differs across different groups. We define T as a dummy equal to one if the child belongs to a sub-group of interest, zero otherwise. Following the method described in chapter 6 of Wooldridge (2002), we use an interaction term, instrumented itself by the interaction of the instruments *same sex* and T. We estimate this model formally as follows:

$$Third\ Child_{it} = \alpha_1 same\ sex_{i0} + \gamma_1 X_{it} + \delta_t + \beta_1 Y_{i0} + \epsilon_{it}$$

$$Third\ Child_{it} \times T_{it} = \alpha_2 same\ sex_{i0} \times T_{it} + \gamma_2 X_{it} + \delta_t + \beta_2 Y_{i0} + \epsilon_{it}$$

$$Y_{it} = \alpha_3 \widehat{Third\ Child}_{it} + \alpha_3 \widehat{Third\ Child}_{it} \times T_{it} + \gamma_3 X_{it} + \delta_t + \beta_3 Y_{i0} + \mu_{it} \quad (2)$$

Note that, again, the F-statistics are greater than 20 and remain larger than the standard threshold of 10 in every case (see the bottom of each panel in Table 3), confirming that our identification strategy is not subject to weak instrument concerns.[11] Finally, we report the main estimates per sub-scale of SDQ in Table OA.8 in the Online Appendix.

4.2.1 The effect of the birth of a third child by birth spacing

Here, we ask whether our main results depend on the age of the cohort member at the time of the third child's birth. In this section, T is a dummy equal to one if the child is at least six years old at the time of the birth of the third child. T can be seen as birth spacing. As parental resources are limited, an increase in family size is likely to reduce the amount of resources per child and, as such, limit the development of non-cognitive skills. However, the effect of limited parental resources could differ at different stages of childhood. Several studies have highlighted the importance of parental time in early childhood (see Del Bono *et al.*, 2016; Del Boca *et al.*, 2017; Cunha and Heckman, 2008), and Cunha *et al.* (2010) emphasized the existence of sensitive periods in the formation of non-cognitive skills.

The first column of panel A in Table 3 shows that the birth of a third child has a much stronger—and negative—effect for cohort members under six years of age at the time of the birth. The total SDQ score decreases by approximately 0.8 standard deviations. The interaction term attracts a positive and significant estimate. This means that cohort members who were more than six years old at the time of the birth are significantly less affected than

[11] We also used a sample-split approach and found consistent results (available upon request).

cohort members who were younger. The sum of the two estimates is reported at the bottom of panel A. While the effect of a birth is statistically lower for cohort members who were at least six years old at the birth of their new sibling, the net effect of the birth on the total SDQ score remains negative and significant at the 10% level. We observe a similar pattern in columns (2), (3) and (4) when we separately consider behavioural, emotional skills and social skills. To better understand this differential effect, we decompose the SDQ into its four original sub-scales of "conduct", "hyperactivity", "emotion", and "peer" and re-run our main regression. The results, in panel A of Table OA.8 in the Online Appendix, show that this effect is mainly driven by hyperactivity and emotional issues.[12] These results are in line with the literature showing that early childhood is a key period in the development of socio-emotional skills.

4.2.2 The effect of the birth of a third child by birth order

We know that first-born children have, on average, better educational attainments (Black *et al.*, 2005).[13] Moreover, the main results outlined in Section 4.1 might confound heterogeneous responses due to birth order. For this reason, here, we ask whether the effect of the birth of a third child is the same for the first- and second-born, with T as a dummy equal to one if the child is a second-born and zero otherwise.

As shown in panel B of Table 3, although having a third child negatively affects both the total SDQ score and the two SDQ sub-scales of the first two children, the interaction term does not attract a significant estimate. Therefore, there is no difference in terms of birth order, and our results above most likely reflect an age-at-birth effect.[14] The absence of heterogeneity regarding birth order is also in line with the findings of Price (2008). Parents allocate the same amount of time to each child at any point in time; therefore, the first-born and second-born will have the same amount of time and consequently face the same decrease in parental time. Looking more closely at behavioural skills and emotional skills in columns

[12] In addition, we consider birth spacing as a continuous variable. We find similar results, suggesting no effect of having a third child in the household for children above the age of six years.

[13] Reassuringly, we find that first-born children in our sample exhibit much higher levels of non-cognitive skills (see Table OA.6 in the Online Appendix).

[14] However, it should be noted that even though we conclude that there are no large differences in the effect of the birth of a third child between first- and second-born children, this result must be interpreted with caution. In particular, as previously mentioned, our estimation sample includes a selected sub-sample of first-born children whose parents had two children in a short period of time (i.e., three years), while there is no such selection for second-born children.

(2) and (3), it seems that first-borns suffer more from a birth in terms of their emotional skills, but less in terms of their behavioural skills. Considering the four original sub-scales ("conduct", "hyperactivity", "emotion", and "peer"), the results in panel B of Table OA.8 in the Online Appendix suggest that the larger effect on the behavioural skills of second-borns is largely driven by hyperactivity issues, while first-borns are more affected in terms of both emotional and peer problems. Note that we find no significant difference when we consider pro-social skills.

4.2.3 The effect of the birth of a third child by child's gender

We now ask whether the birth of a third child affects the accumulation of non-cognitive skills of boys and girls differently. To do so, we assign a value of one to T if the cohort member is a girl and zero if the cohort member is a boy.

The heterogeneous effects of the birth of a third child on boys and girls are presented in panel C of Table 3. We find negative and statistically significant estimates only for girls for every dimension of the SDQ. The effect of the birth of a third child is positive but not statistically different from zero for boys. Looking at the four original sub-scales ("conduct", "hyperactivity", "emotion", and "peer"), the results in panel C of Table OA.8 in the Online Appendix show that the difference between girls and boys is mostly driven by a higher sensitivity of "hyperactivity" and "peer" issues of girls to increases in family size. Note that we also find a positive and significant effect for boys on the "peer" scale, which supports the idea that boys have better relationships with children of the same age when they have a new sibling.

In this section, we estimate the effect of the birth of a third child differentially on families with two girls and families with two boys. One concern may be that differential effects between two-girl and two-boy families may reflect differences in the composition or preferences of the compliers in these two sub-groups of families. In particular, compliers in two-girl families are, by definition, parents who want to have at least one son and who may favour more traditional gender roles. Although we cannot identify individually the compliers of each sub-group of families, we provide some evidence that they are unlikely to differ greatly.

First, as highlighted in Section 3.3, we find no evidence of parental preference for sons

(or daughters), in line with the recent literature on this topic in developed countries.[15] In particular, the fact that our first stage is identical for two-girl and two-boy families suggests that these two types of family do not comply differently to the instrument. Second, we find no difference in socio-economic background or gender attitudes across family types (two-girl, two-boy, and mixed-gender) before the arrival of a third child (cf. Table A.5). Third, we might think that with the arrival of a son, parents with two girls might change their behaviour and adopt parenting attitudes in favour of this new son, which would be detrimental for their daughters. However, again, Table OA.9 in the Online Appendix does not show any evidence of such an effect. Families with two girls with a third child differ, on average, from families with no third child, but no difference emerges according to the sex of the third child. This is consistent with the idea that it is indeed the arrival of the child that affects girls more than boys, and not the arrival of a desired son. Ultimately, using an individual fixed-effect model gives estimates that are consistent with our instrumental variables model: Girls' emotional and social skills are more affected by the birth of a third child.[16]

This is the first piece of evidence of a gendered effect of family size on the development of socio-emotional skills.[17] In the next section, we investigate two potential mechanisms that may drive this heterogeneous effect: unequal parental times and unequal demand for participation in household chores.

4.3 Potential mechanisms explaining the gender effect

In this section, we investigate potential mechanisms explaining why boys and girls are differentially affected by the birth of a third child in their family. Specifically, we ask whether differential parental behaviours may be the source of such heterogeneity. From a theoretical perspective, we may expect differential parental behaviour for at least two reasons.[18] First,

[15] For example, Blau *et al.* (2020) showed that in spite of a strong stated preference in the USA for sons, there is no effect of child gender on fertility decisions for recent cohorts. This result is mirrored in related studies of developed countries, including the UK (Andersson *et al.*, 2006; Ichino *et al.*, 2014; Choi and Hwang, 2015).

[16] Results are available upon request.

[17] Juhn *et al.* (2015) also investigated whether family size has a different effect on boys and girls and found no significant differences in the effect of family size on children's behavioural skills. This might seem at odds with our results, but note that our analysis differs in several key aspects. First, Juhn *et al.* (2015) did not use an instrumental variables approach to study the gender differences as we do. Second, the population under study is different as Juhn *et al.* (2015) looked at children born in the late 1980s in the USA, while we look at children born between 2000 and 2002 in the UK.

[18] See Lundberg (2005) and Baker and Milligan (2016) for an extended discussion.

parents may have a preference for sons over daughters regarding the allocation of resources within the family, even in the absence of parental preference for sons as regards fertility decisions.[19] Second, girls and boys may be unequally endowed to face the arrival of a new child in the family. Indeed, compared with boys, girls tend to develop both cognitive (Halpern, 2013) and non-cognitive skills (Duckworth and Seligman, 2006; Bertrand and Pan, 2013; Cornwell *et al.*, 2013) at earlier stages of their life. As a consequence, even in the absence of parental preference for sons, parents may adopt compensating behaviours in favour of boys after the birth of a new child, particularly if they want to equalize outcomes as much as possible across their children (Price, 2010). To empirically assess the prevalence of such mechanisms, we focus on two kinds of parental behaviour: the allocation of parental time and the demand for household chores.

First, parents may spend relatively more time with their sons than with their daughters after the birth of a new child in the family, particularly if they anticipate stronger detrimental effects on boys. Such compensating behaviours could explain why we observe negative effects among only girls. We test this hypothesis by measuring the extent to which an increase in family size affects parental time in our estimation sample. Following Del Bono *et al.* (2016), we look at educational and recreational time with the primary care giver (usually the mother).[20] These variables are available in only waves 2, 3, and 4. Table 4 reports the effect of the birth of a third child on parental time and the differences between boys and girls in columns (1) and (2). The results suggest that the primary care giver spends relatively more time in educational activities with their sons when there is a third child, but this compensation effect is not observed for daughters. The primary care giver spends more time with their children in recreational activities, but again, girls benefit less from this increase. On average, girls do not benefit from compensations as boys do after the birth of a third child. Since maternal time has a large and long-term impact on non-cognitive skills, particularly in early childhood (Del Bono *et al.*, 2016), this may partly explain the heterogeneous effects by children's gender outlined in the previous section .

[19] See, for example, Choi and Hwang (2015).

[20] Following Del Bono *et al.* (2016), we use a principal component analysis to build two measures of maternal time, one picking up educational activities such as reading to the child or helping them with homework; the second one catching recreational activities such as outdoor recreation, drawing, or playing games. We must note that in the second wave, the questions related to time spent with the primary care giver or other household members. Del Bono *et al.* (2016) provide some validity of these measures. They also show that these two measures are determinants of a child's socio-emotional skills.

A second possible explanation relates to gender norms and the intra-household allocation of housework and care-giving activities. Previous studies have shown that female children spend more time than male children doing housework or taking care of other members of the family, and tend to reproduce their parents' household chores division (Raley and Bianchi, 2006; Solaz and Wolff, 2015). Doing more household tasks may distract children from activities that are more productive for the formation of socio-emotional skills, such as educational activities or parental quality time (Price, 2008).

We explore this hypothesis in our estimation sample by checking whether the birth of a third child affects children's contribution to household tasks. From wave 5 onwards, parents are asked the extent to which cohort members are involved in household chores. The results in the last column of Table 4 suggest that an increase in family size increases the probability of contributing to household tasks only for girls. Although the coefficient for girls is not significantly different from zero at the conventional level, the sign of the estimate is consistent with our predictions. Using more complete time-use surveys, such as time-use diaries, would arguably increase the precision of our estimates.

Overall, our findings suggest that parents try to compensate for the detrimental effects of a birth in the family only for their sons. These compensating behaviours are consistent with a large body of evidence showing gender discrimination within families in developed countries in favour of boys (see Bharadwaj *et al.*, 2014, for a review).

4.4 Persistence of the effect

In this section, we ask whether the negative effects of the birth of a third child persist after the time of the shock. Following Jacobson *et al.* (1993), we estimate the following model:

$$Y_{it} = \alpha_0 + \sum_{k\geq -3}^{-1} birth_{it}^{k}\theta_k + \gamma X_{it} + \delta_t + \beta Y_{i0} + \mu_{it} \tag{3}$$

where $birth_{it}^{k}$ indicates that the child had a sibling k periods earlier. We estimate this model only on children from families with a third child, that is, the birth has occurred. Having a sibling in period $k = 0$ is the benchmark. Here, θ_k measures the difference in the effect of the birth on a child's non-cognitive skills k periods following this event, compared with just after the event. To account for the endogeneity of the event, we treat the selection bias through

the Heckman selection model. This model assumes an underlying relationship between two regressions: the outcome equation (3) and the following selection equation. Individuals are selected only if there was a birth in their family, that is, under the following condition (the selection equation):

$$Third^*_{it} = b_0 + b_1 same\ sex_{i0} + \epsilon_{it}, \qquad Third_{it} = \begin{cases} 1\ if\ Third^*_{it} > 0 \\ 0\ if\ Third^*_{it} \leq 0 \end{cases}$$

Table 5 shows the results. None of the estimates is statistically different from zero, which suggests that an increase in family size is a shock whose negative effects persist over time, even 11 years after the event.

5 Conclusion

This paper has evaluated the effect of the birth of a third child on the development of children's socio-emotional skills on a recent cohort of first- and second-born children from the MCS. To account for the endogeneity of fertility decisions, we used a well-known instrumental approach that exploits parents' preferences for gender diversity in their children, which consists of using the sex composition of the first two children as an instrument for an increase in family size.

We find that having a third child has a significant and negative effect on the formation of both behavioural and emotional skills for the first- and second-born. Further, the birth of a third child has a much larger impact when the siblings are under six years of age. We also find that the birth of a third child negatively affects the development of non-cognitive skills only for girls. An investigation of the potential mechanisms suggests that this negative effect observed only for girls may be explained by both the compensating behaviours of parents and the gendered allocation of housework and care-giving activities within the family. Finally, we find no evidence of significant recovery across periods following the increase in family size, suggesting that the negative effects on child's non-cognitive skills persist over time.

The negative effects of family size on children's non-cognitive skills observed in this paper may translate into worse adult outcomes. From previous studies, we can estimate the negative effects on girls' behavioural and emotional skills to translate into decreases of 0.12 and 0.25

standard deviations, respectively, in their life satisfaction (Layard *et al.*, 2014). Looking at labour market outcomes, these effects may translate into a 15% decrease in earnings for women (Lundborg *et al.*, 2014; Lindqvist and Vestman, 2011), while the effect on girls' social skills may decrease their wages by 7.5% (Deming, 2017). Finally, the decreases observed in girls' behavioural and emotional skills may result in 1.1% and 0.7% decreases, respectively, in their probability of employment (Clark and Lepinteur, 2019).

Our findings may aid understanding of the negative gradient between family size in childhood and adult outcomes. Although only a small number of studies support the quantity–quality trade-off argument based on quasi-experimental variations in terms of cognitive skills, our finding of a negative effect of family size on children's socio-emotional skills may partially explain the negative correlation observed between family size and adult outcomes.

Moreover, given the crucial role that non-cognitive skills play in determining labour market outcomes, one implication of our findings is that the discriminatory behaviours adopted by parents after the birth of a third child may contribute to gender inequalities in the labour market. Indeed, the detrimental effects of the birth of a third child on girls' non-cognitive skills may translate into worse schooling choices or occupational choices in adulthood (Heckman *et al.*, 2006), which may in turn reduce their labour market opportunities. However, recent studies by Gelber and Isen (2013) and Attanasio *et al.* (2020) show that well-designed childhood interventions based on psychosocial stimulation via regular home visits or pre-school attendance can lead to increased parental investments and better socio-emotional skills in children. Together with our results, these studies stress the importance of designing similar policies with a higher focus on girls, especially in large families.

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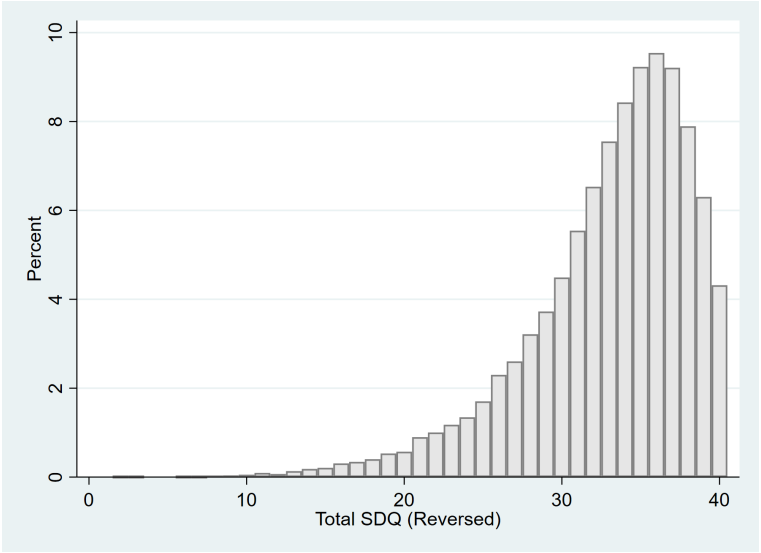
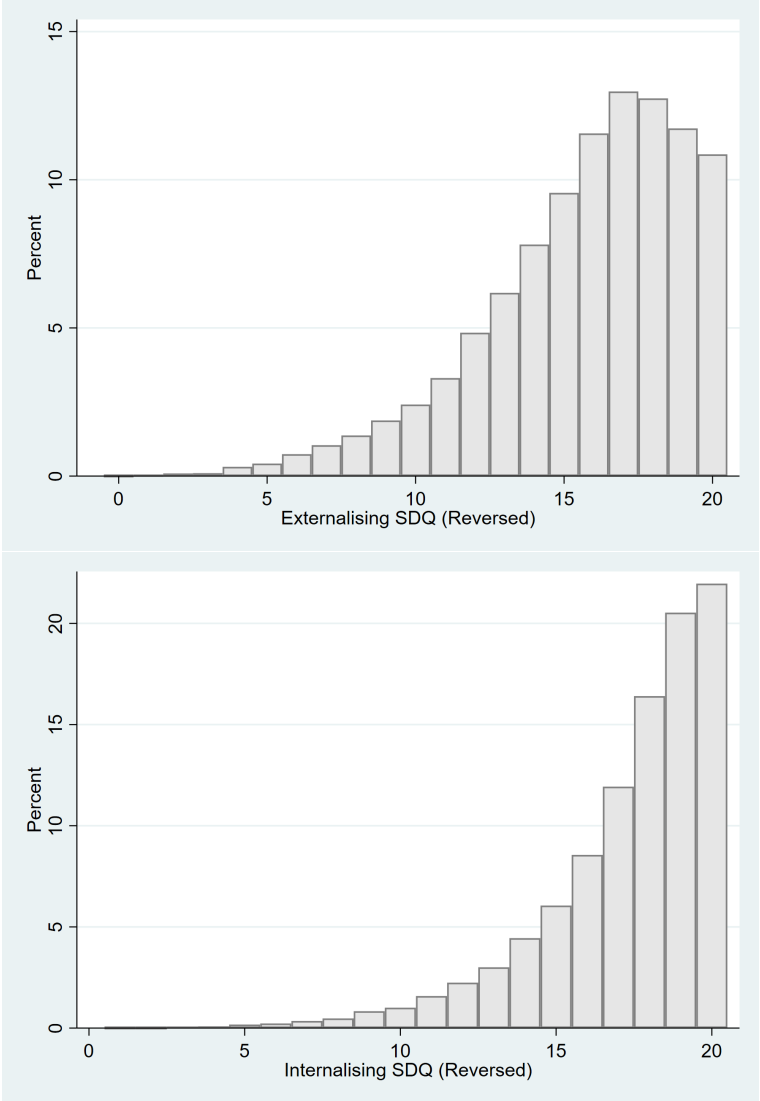
Figures and Tables

Figure 1: Distribution of Total SDQ - Estimation Sample



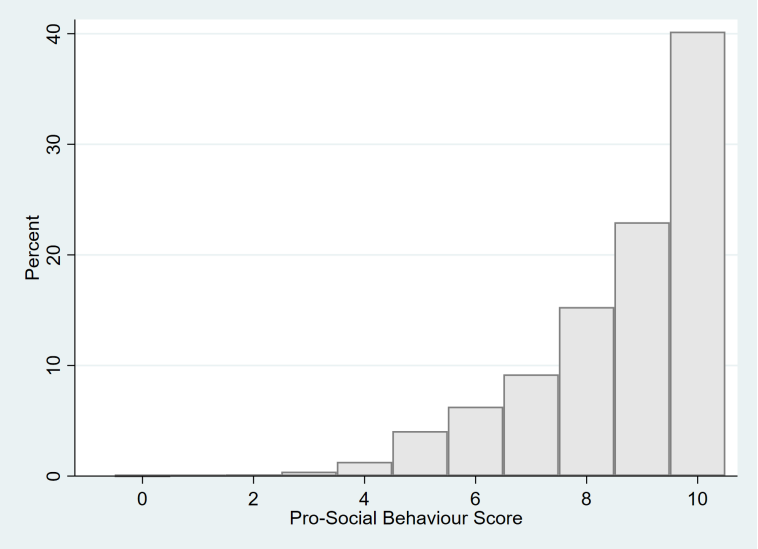
Source: Estimation Sample drawn from the Millennium Cohort Study. Notes: The scales of the SDQ variables have been reversed such that the higher the SDQ, the better the non-cognitive skills of the cohort member. Note that there are 20,131 observations for 5,983 individuals in 5,907 families.

Figure 2: Distribution of Externalising and Internalising SDQ - Estimation Sample



Source: Estimation Sample drawn from the Millennium Cohort Study. Notes: The scales of the SDQ variables have been reversed such that the higher the SDQ, the better the non-cognitive skills of the cohort member. Note that there are 20,131 observations for 5,983 individuals in 5,907 families.

Figure 3: Distribution of Pro-Social Behaviour Score - Estimation Sample



Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: Note that there are 20,131 observations for 5,983 individuals in 5,907 families.

Table 1: Descriptive Statistics: Estimation Sample

	Mean	SD	Min	Max
Cohort Member Characteristics:				
Non Cognitive Skills (Total SDQ)	32.98	5.23	2	40
Behaviour Skills (Externalising SDQ)	17.28	2.81	1	20
Emotional Skills (Internalising SDQ)	15.70	3.40	0	20
Pro-Social Behaviour	8.27	1.80	0	10
Female	0.50		0	1
Age	9.25	3.50	4	16
Age of Mother	29.77	5.31	15	52
First born	0.41		0	1
Second born	0.59		0	1
Wave 3	0.28		0	1
Wave 4	0.26		0	1
Wave 5	0.25		0	1
Wave 6	0.22		0	1
Family Characteristics:				
Age of Mother at first birth	29.77	5.31	15	52
Household Income (in logs)	6.98	1.93	2.84	11.16
Natural Father in Household	0.79		0	1
Parents are Married	0.68		0	1
Observations	20131			

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The scales of the SDQ variables have been reversed such that the higher the SDQ, the better the non-cognitive skills of the cohort member. Note that there are 20,131 observations for 5,983 individuals in 5,907 families.

Table 2: Family Size and Non-cognitive skills: 2SLS Results

First Stage:	Third Child	Third Child	Third Child	Third Child
	(1)	(2)	(3)	(4)
Same Sex	0.051***	0.051***	0.051***	0.051***
	(0.009)	(0.009)	(0.009)	(0.009)
Second Stage:	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.650*	-0.496	-0.627*	-0.360
	(0.342)	(0.340)	(0.354)	(0.347)
Observations	20131	20131	20131	20131
F-Statistics	88.765	89.910	87.896	88.332

Source: Estimation Sample drawn from the Millennium Cohort Study.

Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table 3: Family Size and Non-cognitive skills: 2SLS Results - Heterogeneity Analysis

Panel A: Age at Birth	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.799*	-0.601	-0.780*	-0.424
	(0.428)	(0.421)	(0.443)	(0.429)
Third Child X Age 6 at birth or older	0.591*	0.420	0.602*	0.254
	(0.320)	(0.314)	(0.332)	(0.321)
Observations	20131	20131	20131	20131
F-statistic	37.529	38.149	36.947	37.254
Total effect for children:				
Before age 6 at birth	-0.799*	-0.601	-0.780*	-0.424
	(0.428)	(0.421)	(0.443)	(0.429)
After age 6 at birth or older	-0.208*	-0.181	-0.178	-0.170
	(0.121)	(0.120)	(0.125)	(0.120)
Panel B: Birth Order	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.688*	-0.329	-0.837**	-0.335
	(0.359)	(0.330)	(0.393)	(0.366)
Third Child X Second Born	0.106	-0.468	0.591	-0.072
	(0.718)	(0.751)	(0.731)	(0.733)
Observations	20131	20131	20131	20131
F-statistic	22.336	22.343	21.995	21.864
Total effect for:				
First-Born	-0.688*	-0.329	-0.837**	-0.335
	(0.359)	(0.330)	(0.393)	(0.366)
Second Born	-0.582	-0.797	-0.246	-0.406
	(0.653)	(0.707)	(0.646)	(0.666)
Panel C: Gender	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	0.343	0.451	0.195	0.469
	(0.473)	(0.489)	(0.468)	(0.526)
Third Child X Female	-2.040***	-1.945**	-1.687**	-1.705**
	(0.775)	(0.764)	(0.759)	(0.739)
Observations	20131	20131	20131	20131
F-statistic	40.153	40.164	39.588	39.493
Total effect for:				
Boys	0.343	0.451	0.195	0.469
	(0.473)	(0.489)	(0.468)	(0.526)
Girls	-1.696***	-1.494**	-1.491**	-1.236**
	(0.631)	(0.602)	(0.615)	(0.546)

Source: Estimation Sample drawn from the Millennium Cohort Study.

Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table 4: Family Size and Mechanisms: 2SLS Results

	Maternal Educational Time (1)	Maternal Recreational Time (2)	Household Tasks Contribution (3)
Third Child	1.911**	0.949	-0.005
	(0.953)	(0.717)	(0.236)
Third Child X Female	-2.041*	-0.450	0.368
	(1.237)	(1.071)	(0.335)
Observations	10657	10657	14470
F-statistic	12.395	13.395	36.175

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. "Education Time" and "Recreational Time" are computed following Del Bono *et al.* (2016). "Household Tasks contribution" is a dummy equal one if the cohort member is contributing to chores at least once per week.

Table 5: Persistence of the Effect of Family Size on Non-Cognitive skills

	Total SDQ (1)	Behaviour Skills (2)	Emotional Skills (3)	Social Skills (4)
Birth (-1)	0.052	0.049	0.051	-0.025
	(0.037)	(0.038)	(0.041)	(0.045)
Birth (-2)	0.033	0.065	0.010	0.024
	(0.059)	(0.062)	(0.061)	(0.064)
Birth (-3)	0.079	0.077	0.088	0.104
	(0.089)	(0.092)	(0.089)	(0.091)
Third Child				
Same sex	0.187***	0.189***	0.184***	0.184***
	(0.036)	(0.036)	(0.037)	(0.037)
Constant	-1.002***	-1.003***	-1.000***	-1.000***
	(0.026)	(0.026)	(0.026)	(0.026)
Observations	19479	19479	19479	19478

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

A. Appendix

Table A.1: Difference in Observable Characteristics between Family Type: Estimation Sample in t_0

	Families with 2 children of:		
	Different Sex	Same Sex	Gap b/se
Cohort Member Characteristics:			
Non Cognitive Skills (Total SDQ)	0.07	0.06	0.01
			(0.02)
Behaviour Skills (Externalising SDQ)	0.05	0.03	0.02
			(0.03)
Emotional Skills (Internalising SDQ)	0.08	0.09	-0.01
			(0.02)
Pro-social Behaviour Score	-0.04	-0.04	-0.00
			(0.03)
Female	0.50	0.49	0.01
			(0.01)
Age	3.16	3.15	0.01
			(0.01)
Age of Mother	29.54	29.56	-0.02
			(0.14)
1st born	0.40	0.41	-0.01
			(0.01)
2nd born	0.60	0.59	0.01
			(0.01)
Observations	5983		
Family Characteristics:			
Age of Mother at first birth	29.54	29.56	-0.01
			(0.12)
Household Income (in logs)	5.71	5.70	0.01
			(0.02)
Natural Father in Household	0.88	0.88	0.00
			(0.01)
Parents are Married	0.72	0.73	-0.01
			(0.01)
Observations	5907		

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The scales of the SDQ variables have been reversed such that the higher the SDQ, the better the non-cognitive skills of the cohort member. Note that there are 5,983 individual observations for 5,907 families. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table A.2: Instrument Validity: Any own gender effect?

	Boys			
	Total SDQ	Behaviour Skills	Emotional Skills	Social Skills
Same sex 3rd child	-0.174*	-0.132	-0.170*	-0.231**
	(0.098)	(0.100)	(0.099)	(0.110)
Observations	930	930	930	929
Nb of clusters	344	344	344	343
	Girls			
	Total SDQ	Behaviour Skills	Emotional Skills	Social Skills
Same sex 3rd child	0.047	0.091	-0.016	-0.037
	(0.077)	(0.077)	(0.078)	(0.068)
Observations	927	927	927	927
Nb of clusters	326	326	326	326

Source: Estimation Sample drawn from the Millennium Cohort Study, focusing on families with two children of opposite sex in the second wave (t_0).
Notes: Dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. Standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to 1 if a birth of a third child happens between t_0 and t. We control for individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, parents' marital status, and the presence of a father, the age of mother at first birth) and include wave fixed-effects. We also control for the non-cognitive skill in wave 2 to account for the measurement error of the mother. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table A.3: Probability to have a second child and the sex of the first-born: OLS results

	Having a second child
	(1)
First child is a girl	0.012
	(0.018)
Observations	3134

Source: Families with only one child in t_0 from the Millennium Cohort Study.
Notes: The dependent variable is a dummy equal one if the family had at least a second child between the wave 2 and wave 6. The standard errors in parentheses are clustered at the family level. No controls are added. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table A.4: Probability to have a third child and the sex of the first-two born: First-stage results

	Having a third child	
	(1)	(2)
Same sex	0.051***	
	(0.009)	
Two boys		0.054***
		(0.013)
Two girls		0.048***
		(0.013)
Observations	20131	20131

Source: Estimation Sample drawn from the Millennium Cohort Study.

Notes: The standard errors in parentheses are clustered at the family level. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the total SDQ in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table A.5: Difference in Observable Characteristics between Family Type: Estimation Sample in t_0

	Families with 2 children of:		
	Different Sex	Same Sex Boys	Same Sex Girls
Family Characteristics:			
Age of Mother at first birth	29.54	29.60	29.52
	[5.40]	[5.42]	[5.52]
Household Income (in logs)	5.71	5.71	5.71
	[0.71]	[0.70]	[0.68]
Natural Father in the Household	0.88	0.88	0.87
	[0.33]	[0.32]	[0.33]
Parents are Married	0.72	0.74	0.72
	[0.45]	[0.44]	[0.45]
Parenting Styles and Attitudes:			
Maternal Education Time	0.00	0.01	-0.00
	[1.00]	[0.99]	[0.99]
Maternal Recreational Time	-0.00	0.00	-0.00
	[1.00]	[0.99]	[0.99]
Child has regular bedtimes	3.23	3.24	3.27
	[0.87]	[0.85]	[0.86]
Child has regular meal times	3.41	3.40	3.40
	[0.67]	[0.67]	[0.70]
Hours a day child watches tv/videos	2.93	2.94	2.90
	[0.63]	[0.66]	[0.67]
How often do you read to the child	1.67	1.69	1.62
	[1.06]	[1.09]	[1.02]
Anyone else read to the child	0.87	0.86	0.89^{+}
	[0.33]	[0.35]	[0.31]
Anyone at home take child to the library	0.45	0.44	0.49^{+o}
	[0.50]	[0.50]	[0.50]
Anyone at home help child to learn sport	0.79	0.82^{+}	0.78
	[0.41]	[0.38]	[0.42]
Anyone at home help child to learn alphabet	0.81	0.79	0.84^{+o}
	[0.40]	[0.41]	[0.37]
Anyone at home teach child counting	0.97	0.97	0.97
	[0.18]	[0.18]	[0.17]
Anyone at home try teach child songs etc	0.97	0.97	0.97
	[0.17]	[0.18]	[0.16]
Does child paint/draw at home	0.98	0.98	0.97
	[0.12]	[0.14]	[0.08]
Age left full-time education	17.97	17.81	17.97
	[2.55]	[2.55]	[2.61]
Child suffers mother works before starts school	3.36	3.32	3.30
	[1.12]	[1.13]	[1.14]
Family life suffers when woman has full-time job	3.06	3.08	3.05
	[1.17]	[1.19]	[1.18]
Mother and family happier if she goes to work	3.36	3.36	3.37
	[0.90]	[0.89]	[0.93]
Fathers involvement in upbringing	1.65	1.62	1.67
	[0.79]	[0.81]	[0.78]
Age left full-time education	17.99	17.82	17.82
	[2.88]	[2.87]	[2.82]
Child suffers mother works before starts school	3.10	3.03	3.09
	[1.18]	[1.19]	[1.17]
Family life suffers when woman has full-time job	3.08	2.99^{+}	3.08
	[1.18]	[1.15]	[1.19]
Mother and family happier if she goes to work	3.40	3.43	3.44
	[0.94]	[0.91]	[0.94]
Fathers involvement in upbringing	1.52	1.49	1.52
	[0.69]	[0.63]	[0.67]

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: There are 3,030 children from families with mixed gender siblings, 1,441 from families with two boys and 1,512 from families with two girls. All the variables are observed in wave 2 except gender attitudes that are observed in wave 1. $^{+}$ and ^{o} indicate a difference at the 10% level respectively with the first and second column. We use a principal component analysis to build the maternal education time and the maternal recreational time as in Del Bono *et al.* (2016).

B. Online Appendix

Table OA.1: Strengths and Difficulties Questionnaire (SDQ) in the Millennium Cohort Study

Please give your answers on the basis of cohort member's behaviour over the last six months.		Not True	Somewhat True	Certainly True
Considerate of other people's feelings	[S]	1	2	3
Restless, overactive, cannot stay still for long	[E]	1	2	3
Often complains of headaches, stomach-aches or sickness	[E]	1	2	3
Shares readily with other children (treats, toys, pencils etc.)	[S]	1	2	3
Often has temper tantrums or hot tempers	[E]	1	2	3
Rather solitary, tends to play alone	[I]	1	2	3
Generally obedient, usually does what adults request	[E]	1	2	3
Many worries, often seems worried	[I]	1	2	3
Helpful if someone is hurt, upset or feeling ill	[S]	1	2	3
Constantly fidgeting or squirming	[E]	1	2	3
Has at least one good friend	[I]	1	2	3
Often fights with other children or bullies them	[E]	1	2	3
Often unhappy, down-hearted or tearful	[I]	1	2	3
Generally liked by other children	[I]	1	2	3
Easily distracted, concentration wanders	[E]	1	2	3
Nervous or clingy in new situations, easily loses confidence	[I]	1	2	3
Kind to younger children	[S]	1	2	3
Often lies or cheats	[E]	1	2	3
Picked on or bullied by other children	[I]	1	2	3
Often volunteers to help others	[S]	1	2	3
Thinks things out before acting	[E]	1	2	3
Steals from home, school or elsewhere	[E]	1	2	3
Gets on better with adults than with other children	[I]	1	2	3
Many fears, easily scared	[I]	1	2	3
Sees tasks through to the end, good attention span	[I]	1	2	3

Notes: [E], [I] and [S] respectively indicate the externalising SDQ (Behaviour Skills) questions, the internalising SDQ (Emotional Skills) questions and the Pro-social scale questions.

Table OA.2: Descriptive Statistics: Estimation Sample in t_0

	Mean	SD	Min	Max
Cohort Member Characteristics:				
Non Cognitive Skills (Total SDQ)	30.77	5.10	8	40
Behaviour Skills (Externalising SDQ)	13.46	3.74	0	20
Emotional Skills (Internalising SDQ)	17.31	2.38	5	20
Pro-social Behaviour	7.30	1.85	0	10
Female	0.49		0	1
Age	3.15	0.37	2	5
Age of Mother	29.55	5.41	15	52
1st born	0.40		0	1
2nd born	0.60		0	1
Observations	5983			
Family Characteristics:				
Age of Mother at first birth	29.55	5.40	15	52
Family Size	2.00		2	2
Household Income (in logs)	5.71	0.70	3	7
Natural Father in Household	0.88		0	1
Parents are Married	0.73		0	1
Same Sex	0.49		0	1
Same Sex : girls	0.24		0	1
Same Sex : boys	0.25		0	1
Observations	5907			

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The scales of the SDQ variables have been reversed such that the higher the SDQ, the better the non-cognitive skills of the cohort member.

Table OA.3: Family Size and Non-cognitive skills: 2SLS Results - Accounting for Attrition

Panel A: Attrition weights	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.652*	-0.505	-0.611*	-0.351
	(0.348)	(0.348)	(0.356)	(0.348)
Observations	20131	20131	20131	20131
F-Statistics	87.363	88.065	87.117	87.513
Panel B: Balanced Panel	Total SDQ	Behaviour Skills	Emotional Skills	Pro-Social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.880**	-0.645*	-0.907**	-0.312
	(0.376)	(0.366)	(0.394)	(0.363)
Observations	15008	15008	15008	15008
F-Statistics	85.548	86.804	83.943	84.595

Source: Estimation Sample drawn from the Millennium Cohort Study.

Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. Panel A uses weights estimated from a probit regression for which the results are available in Table OA.4.

Table OA.4: Inverse Probability Weights for Attrition: Probit results

	Probability to be in the survey in the next sweep			
	Total SDQ	Behaviour Skills	Emotional Skills	Pro-social Behaviour
	(1)	(2)	(3)	(4)
Same Sex	-0.017	-0.016	-0.017	-0.017
	(0.021)	(0.021)	(0.021)	(0.021)
Female	0.029	0.025	0.038*	0.044**
	(0.022)	(0.022)	(0.021)	(0.022)
2nd born	-0.091***	-0.086***	-0.088***	-0.087***
	(0.031)	(0.031)	(0.031)	(0.031)
Age of Mother at first birth	0.023***	0.023***	0.022***	0.025***
	(0.006)	(0.006)	(0.006)	(0.006)
Age of Mother at birth	0.002	0.002	0.003	0.002
	(0.006)	(0.006)	(0.006)	(0.006)
Initial Total SDQ	0.043***			
	(0.011)			
Initial Externalising SDQ		0.051***		
		(0.011)		
Initial Internalising SDQ			0.009	
			(0.011)	
Initial Pro-social behaviour score				0.023**
				(0.011)
Observations	20131	20131	20131	20131

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The dependent variable is a dummy indicating if the cohort member is still in the survey in the next sweep. The standard errors in parentheses are clustered at the family level. The controls also include month of birth and wave dummies. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table OA.5: Family Size and Non-cognitive skills: OLS Results

	Total SDQ	Behaviour Skills	Emotional Skills	Pro-social Behaviour
	(1)	(2)	(3)	(4)
Third Child	-0.044**	-0.043**	-0.022	-0.111***
	(0.021)	(0.022)	(0.022)	(0.022)
Observations	20131	20131	20131	20131
Adjusted R^2	0.296	0.306	0.162	0.137

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table OA.6: Family Size and Non-cognitive skills: OLS Results - Whole MCS Sample

	Total SDQ	Behaviour Skills	Emotional Skills	Pro-social Behaviour
	(1)	(2)	(3)	(4)
Family Size	-0.084***	-0.097***	0.014	-0.072***
	(0.023)	(0.015)	(0.012)	(0.007)
First Born	0.505***	-0.035	0.540***	0.019
	(0.060)	(0.039)	(0.032)	(0.020)
Observations	61655	61655	61655	61655
Adjusted R^2	0.125	0.157	0.073	0.109

Source: Estimation Sample drawn from the whole universe of Millennium Cohort Study.
Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table OA.7: Family Size and SDQ Subscales: 2SLS Results - Main Results

	Behavioural Skills		Emotional Skills	
	Conduct	Hyperactivity	Emotion	Peer
	(1)	(2)	(3)	(4)
Third Child	-0.077	-0.757**	-0.729**	-0.266
	(0.327)	(0.375)	(0.371)	(0.337)
Observations	20131	20131	20131	20131
F-statistic	90.255	88.545	87.978	87.549

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table OA.8: Family Size and SDQ Subscales: 2SLS Results - Heterogeneity Analysis

	Behavioural Skills		Emotional Skills	
Panel A: Age at Birth	Conduct	Hyperactivity	Emotion	Peer
	(1)	(2)	(3)	(4)
Third Child	-0.075	-0.932**	-0.906*	0.327
	(0.401)	(0.472)	(0.467)	(0.416)
Third Child X Age 6 at birth	-0.006	0.693**	0.702**	0.242
	(0.299)	(0.353)	(0.349)	(0.310)
Observations	20131	20131	20131	20131
F-statistic	38.394	37.367	37.079	36.825
Total effect for:				
Before age 6 at birth	-0.028	-0.932**	-0.906*	0.327
	(0.456)	(0.472)	(0.467)	(0.416)
After age 6 at birth or older	-0.081	-0.240*	-0.204	-0.085
	(0.115)	(0.132)	(0.131)	(0.119)
Panel B: Birth Order	Conduct	Hyperactivity	Emotion	Peer
	(1)	(2)	(3)	(4)
Third Child	-0.042	-0.438	-0.869**	-0.439
	(0.327)	(0.354)	(0.408)	(0.365)
Third Child X Second Born	-0.095	-0.898	0.395	0.486
	(697)	(0.866)	(0.765)	(0.704)
Observations	20131	20131	20131	20131
F-statistic	22.854	21.792	22.007	21.954
Total effect for:				
First-Born	-0.042	-0.438	-0.869**	-0.439
	(0.327)	(0.354)	(0.408)	(0.365)
Second Born	-0.137	-1.335	-0.475	0.046
	(0.647)	(0.832)	(0.681)	(0.632)
Panel C: Gender	Conduct	Hyperactivity	Emotion	Peer
	(1)	(2)	(3)	(4)
Third Child	-0.028	0.442	-0.520	1.069*
	(0.456)	(0.522)	(0.481)	(0.550)
Third Child X Female	-0.099	-2.463***	-0.429	-2.741***
	(0.632)	(0.891)	(0.724)	(0.843)
Observations	20131	20131	20131	20131
F-statistic	39.211	40.181	39.315	39.507
Total effect for:				
Boys	-0.028	0.442	-0.520	1.069*
	(0.456)	(0.522)	(0.481)	(0.550)
Girls	-0.127	-2.021***	-0.948*	-1.672**
	(0.453)	(0.732)	(0.558)	(0.657)

Source: Estimation Sample drawn from the Millennium Cohort Study.

Notes: The dependent variables are reported by the primary care giver and have been standardized by age group (mean of 0 and standard deviation of 1). The scale of the dependent variables has been reversed to ease the interpretation. The standard errors in parentheses are clustered at the family level. Third Child is a dummy equal to one if a birth of a third child happens between t_0 and t. The controls include individual characteristics (sex, age, birth order, month of birth, the age of the mother at birth), family background (income, marital status of the parents, the presence of the natural father, the age of mother at first birth) and wave fixed-effects. We also control for the dependent variable in wave 2. *, **, *** indicate significance at the 10%, 5% and 1% levels respectively.

Table OA.9: Difference in Observable Characteristics across Two-Girls Families: Wave 4

	Families with 2 girls and:		
	No other sibling	A little brother	A little sister
Parenting Styles and Attitudes:			
How often mother reads to the child	5.03	4.84^{+}	4.82^{+}
	[1.14]	[1.24]	[1.16]
How often mother tells stories	3.24	3.30	3.30
	[1.54]	[1.60]	[1.45]
How often mother teaches music	4.66	4.51	4.62
	[1.33]	[1.33]	[1.33]
How often mother teaches drawing	3.47	3.43	3.41
	[1.12]	[1.20]	[1.17]
How often mother plays game outside	3.36	3.37	3.23
	[1.23]	[1.27]	[1.71]
How often mother plays game inside	3.88	3.72	3.88
	[1.11]	[1.17]	[1.07]
How often mother takes child to the park	3.41	3.56^{+}	3.62^{+}
	[1.01]	[1.07]	[1.10]
Anyone else help with reading	1.62	1.92	1.92
	[2.04]	[1.85]	[1.98]
Anyone else help with writing or spelling	1.26	1.42	1.51
	[1.90]	[1.84]	[1.91]
Anyone else help with mathematics	0.87	0.99	1.84
	[1.76]	[1.75]	[1.89]
Extra lessons in reading etc.	0.11	0.12	0.11
	[0.31]	[0.33]	[0.31]
Mother been to parents meeting	0.79	0.83	0.78
	[0.40]	[0.38]	[0.42]

Source: Estimation Sample drawn from the Millennium Cohort Study.
Notes: All the variables are observed in wave 4. There are 966 children from families with only two girls, 158 families with two girls and a younger brother and 288 families with two girls and a younger sister. $^{+}$ and ^{o} indicate a difference at the 10% level respectively with the first and second column.