Parental Inputs and Child Development

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Abstract

This thesis contributes to the economics debate on human capital development. It focuses on the role of the *family* and investigates the *consequences* and *determinants* of parental inputs on child development. It consists of three chapters, of which the first two delve into the consequences of parental inputs in early childhood, whereas the third explores the determinants. *Parental inputs* broadly indicate the family environment influencing child development and refer specifically to the choice of family structure - parental divorce in Chapter 1 and parental cohabitation in Chapter 3 - and parental investments and parental skills in Chapter 2.

The first chapter investigates the relationship between parental divorce and child cognitive and socio-emotional skills. Using the UK Millennium Cohort Study - which allows for the control of usually unobserved characteristics of the family - it shows that the disadvantage in skills typically found among children of divorce entirely reflects the selection effect, whereby more disadvantaged parents are more likely to divorce. Parents' education, family financial resources and interparental conflicts are the most important pre-divorce factors accounting for the divorce gaps in children's cognitive and socio-emotional skills up until age 11, leaving no room for a causal impact of divorce.

The second chapter estimates a production model of child socio-emotional skills and investigate how parental investment and parental skills interact with child socio-emotional skills at age 6 in developing skills at 11. Using the UK Millennium Cohort Study, it exploits multiple measures of socio-emotional skills at each age to control for an age-specific child fixed effect which accounts for endogeneity issues. Results indicate that low levels of sensitive parenting, time investments and maternal mental wellbeing can be stressful experiences for the child and their improvements have higher returns for children with higher predisposition to socio-emotional disorders.

The third chapter estimates the causal impact of neighbourhood and workmate peers on parental cohabitation status at first birth. Using the Norwegian administrative data, which enables to observe the complete network of neighbours and workmates for the population of parents' at their first birth, this chapter exploits the partially overlapping peer group approach to identify the peer effects. Results establish positive and statistically significant neighbour and workmate effects of cohabitation at first birth, whereby parents' cohabitation decision is strongly affected by their peers' cohabitation decisions - with neighbours being more influential than workmates. Both imitation of peers and information transmission from peers are mechanisms driving these peer effects.

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Declaration

I, Gloria Moroni, declare that this thesis entitled "Parental Inputs and Child Development" is a presentation of my own original work, except where co-authorship is explicitly acknowledged. Funding for my studies was provided by the 3-year Departmental Ph.D. scholarship. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as references.

Chapter 1 is a single-author paper. An earlier version of this paper was presented in 2016 at the Workshop on Labour and Family Economics in York and the Interdisciplinary Network Economics and Philosophy in York; and in 2017 at the Spring Meeting for Young Economist in Halle, the Royal Economic Society Conference in Bristol, the European Society for Population Economics in Glasgow and the Family Mediators Association in York. This paper has been published in the University of York DERS Working paper series, *Discussion Paper in Economics No. 18/16*, 2018.

Chapter 2 is written in co-authorship with Professor Cheti Nicoletti and Professor Emma Tominey. An earlier version of this paper was presented in 2018 at the NCDS 60 years of our lives in London, the Royal Economic Society Junior Symposium in Brighton, the International Workshop on Applied Economics of Education in Catanzaro, the Summer School on Socioeconomic Inequality in Bonn, the Workshop on Labour and Family Economics in York, and the European Association of Labour Economists in Lyon. I am the lead author of this paper; inspired by the work of my co-authors I contributed to the development of the research idea, I carried out the empirical analysis, wrote the first draft, made some revisions and presented the paper at conferences.

Chapter 3 is written in co-authorship with Professor Cheti Nicoletti, Professor Kjell G. Salvanes and Professor Emma Tominey. I contributed to the elaboration of the research idea upon which the paper develops. I analysed the data, wrote the draft of the paper and made revisions. This chapter makes use of Norwegian Administrative data which is not publicly available. Access was through Emma Tominey. Researchers can gain access by applying to Statistics Norway.

Earlier versions of Chapters 1 and 2 have been presented at the University of York's Applied MicroEconometrics (AME) Seminar Series and at the Thursday Workshop Seminar Series between 2016 and 2019.

"L'ombra di mio padre, due volte la mia,
lui camminava ed io correvo"

- F. De Gregori, *La casa di Hilde*

Introduction

A flourishing literature in economics, epidemiology, and psychology documents the importance of early childhood circumstances in shaping adult outcomes, including labour market, health and crime. A large part of the variability in outcomes observed among people can be explained by differences in outcomes already apparent before starting school (e.g. Cunha et al. 2006). A thorough inquiry of how conditions in childhood affect life outcomes requires, among other aspects, an understanding of the crucial role played by the first environment the child is exposed to: *the family*, and the extent to which family circumstances influence child development.

The seminal papers by Becker and Tomes (1979, 1986) laid the foundation of the family economics literature by formalising family influence and the determinants of social mobility in multiple-generation models, assuming one period of childhood and one period of adulthood. This led to a proliferation of empirical evidence on intergenerational mobility linking parents to children (Solon, 1999), and more recently spurred a growing awareness of the importance of the underlying mechanisms driving these links. A thriving human capital literature (Heckman and Mosso, 2014) extended the pioneering work of Becker and Tomes to model the development of human capital stemming from the interaction between parents and children over different stages of childhood. Particular attention has also been devoted to interventions to compensate for the human capital inequalities emerging in early childhood (Currie and Almond, 2011).

It is at home that child human capital begins to form. Parents influence their children by choosing a family structure, taking investment decisions or adopting a type of parenting style. There is a vast literature in economics as well as other related disciplines investigating the relationship between different features of the home environment and child outcomes. Both the family economics and the human capital formation literatures have contributed to examine many of these aspects and their role in determining child well-being.

Among these aspects, family structure and its implications for children's outcomes has been the focus of many papers in economics as well as sociology and demography - e.g. to try to understand whether living in a non-intact family has adverse consequences for children. As pointed out by Manski et al. (1992), establishing the impact of family structure on children outcomes crucially depends on the availability of prior information about the family. Despite the large amount of effort of researchers to try to account for unobserved processes which jointly determine family structures and children outcomes by adopting different methodologies, no consensus has been achieved yet (McLanahan et al., 2013). The lack

of agreement within the literature calls for further research aiming at reconciling the mixed evidence emerged so far.

Digging deeper within the family and looking at the interactions between parents and children, Cunha and Heckman (2008) and Cunha et al. (2010) formalised a life cycle model of human capital development introducing a technology of skills formation. This new strand of literature has incorporated several revolutionary aspects including (i) the multidimensionality of child's skills, e.g. distinguishing between cognitive and socio-emotional skills[1] and (ii) the modelling of skill development as a cumulative process over multiple stages of childhood, allowing the productivity of parental inputs to change across stages of childhood. Introducing a new framework of human capital accumulation and uncovering the importance of socio-emotional skills (Heckman et al., 2006, 2013), alongside cognitive skills, this new approach has launched a new branch of literature and has built a bridge connecting economics with personality psychology and psychology of human development - thereby opening interesting avenues for research.

Taking a broader perspective, the family itself is an ever changing entity within a society and over time. Social changes, and specifically those characterising the family structure, are another feature of the family environment which is receiving increasing attention in the literature (Lundberg et al., 2016). Family formation has been recently characterised by dramatic social and demographic changes, with increasing trends in non-marital childbearing and potential implications for children outcomes. Economists are showing a growing interest in the relationship between social changes, as well as changes in social norms, and individual behaviour, with particular emphasis on the role of social interactions (Akerlof and Kranton, 2000) and peers (Maurin and Moschion, 2009; Dahl et al., 2014). Understanding the sources of these social changes, whereby parental choices might be influenced by social interactions, is crucial to uncover potential effects on children's outcomes.

Inspired by the streams of literature outlined above - each examining a different feature of the home environment in which the child is brought up - the aim of this thesis is to provide empirical evidence on the importance of family circumstances on child development, with the ultimate purpose of understanding the sources of inequalities that arise in early childhood and persist until adulthood.

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The rest of this introduction outlines the overall thesis and summarise the three chapters included. Each of the three chapters is then enclosed as a self-contained paper, with each providing a study of the family circumstances in which the child grows, by analysing the *consequences* and *determinants* of parental inputs during childhood. *Parental inputs* indicate the family environment experienced by the child, referring specifically to the choice of the family structure in the first and third chapter and to parental investments and parental skills in the second. The first two chapters explore the consequences of parental inputs: Chapter 1 investigates the relationship between parental divorce and children's cognitive and socio-

[1] What we call socio-emotional skills have also been referred to as non-cognitive or soft skills (or abilities).

emotional skills; Chapter 2 narrows the topic to child socio-emotional skills and delves into the role of parental investment and skills in helping the children with low level of socio-emotional skills. Chapter 3 takes a step back, and shifts the attention to the determinants of parental inputs, by focusing on the influence of peers on parental cohabitation at first child's birth. Finally, the thesis concludes with a review of the three chapters, discussing the contributions to the extant literature and outlining potential extensions for future research.

Chapter 1 analyses the relationship between parental divorce and child cognitive and socio-emotional skills. The substantial increase in marital instability over the last few decades has stimulated research across different disciplines to study the relationship between parental divorce and child development, yielding evidence that children of divorce attain lower outcomes compared to children of intact families (McLanahan et al., 2013). There are also considerable differences in the socio-economic status between parents who decide to divorce and those who decide to stay married, implying a parental selection into divorce (Lundberg et al., 2016). This chapter analyses whether the gap in skills between children of intact and disrupted families is due to a causal impact of divorce or due to parental selection into divorce. Thanks to the detailed information on child skills and family environment available in the UK Millennium Cohort Study, an Oaxaca-Blinder decomposition is implemented to analyse the factors driving the divorce skills gaps of children in the short and medium term up until age 11. This chapter provides a thorough comparison of the different driving factors of the divorce gaps between cognitive and socio-emotional skills - including an often unobserved measure of interparental conflicts - together with a first investigation of these gaps across the entire distribution of children's skills.

The main results show that the divorce gaps in cognitive and socio-emotional skills are entirely explained by the parental selection into divorce, whereby more disadvantaged parents are more likely to divorce - therefore implying no causal effect of divorce. Moreover, the results highlight that the factors driving divorce gaps differ across skill dimensions. Cognitive gaps are explained by parental education and family financial resources, but they are almost completely insensitive to any other family characteristics including interparental conflicts. Conversely, socio-emotional gaps are mostly explained by interparental conflicts and family financial resources. Looking at the entire distribution of children skills, results also indicate that children with lower level of socio-emotional skills, i.e. more vulnerable children, present larger divorce gaps, especially among boys.

The results on child socio-emotional skills obtained in Chapter 1 inspired the research question for Chapter 2. Here the attention is restricted to child socio-emotional development with the aim to explore its relationship with the different parental inputs that the child receives at home by interacting with parents, including parental time investment, material investment, parenting style and parents' skills. Despite the recently established importance of child socio-emotional skills, alongside cognitive skills, in predicting long run outcomes (Heckman and Rubinstein, 2001), evidence on the production model of socio-emotional skills remains limited. Gaps in these skills emerge in early childhood and tend to persist until adulthood. This chapter proposes an inquiry on the relevant inputs in the socio-emotional skills production function and on whether the productivity of these inputs varies across early

child skills. The results inform on the effectiveness of potential interventions to reduce socio-emotional skills inequalities.

Using the UK Millennium Cohort Study, Chapter 2 estimates a production model of socio-emotional skills of children between age 6 and 11, a period in which child socio-emotional skills strongly react to environmental stimuli (Cunha and Heckman, 2008). The wealth of parental information available in the dataset enables the inclusion of a large number of parental inputs in the production model. The main interest is in estimating the interaction effects between the parental inputs and the initial level of skills of the child to produce future skills, which sheds light on whether the productivity of parental inputs depends on early child skills. Contrary to previous papers, a very flexible socio-emotional production model which allows each pair of the inputs to have a different interaction effect is considered. The analysis employs a novel empirical strategy that consists of controlling for a child fixed effect that is age specific – i.e. time variant. This strategy allows for the control of any unobserved characteristics potentially correlated with child skills and inputs. The empirical results demonstrate that there are some parental inputs for which the productivity is highest for low skilled children, therefore any intervention targeting these inputs would help to reduce inequalities in socio-emotional skills of children.

Chapter 3 moves the attention to the determinants of parental choice of the family structure and estimates the peer effect of parental cohabitation at the first child's birth. A social multiplier effect, through which an individual cohabitation decision depends on her peers' cohabitation decisions, is likely to be in place and to have accelerated the rise in parental cohabitation characterising the US and all European countries over the last decades. Family outcomes including children's outcomes might be affected by this increasing trend in cohabitation (Brown, 2004). These peer effects can be driven by an imitation mechanism, if individuals imitate their peers to avoid the utility cost from deviating from social norms, but also by an information mechanisms, whereby individuals collect information about the costs and benefits of cohabiting from their peers.

This chapter uses administrative data from Norway to provide the first empirical evidence on the causal impact of peers on parents' cohabitation at first birth. The exceptional availability of information on naturally occurring peers available in the Norwegian administrative dataset allows the implementation of an instrumental variable method which exploits partially overlapping peer groups and allows the identification of such peer effects (Bramoullé et al., 2009; De Giorgi et al., 2010). This econometric method takes advantage of the fact that individuals can be directly affected by their *direct peers* but they cannot be directly affected by their *indirect peers*, i.e. peers of peers with whom they do not directly interact. The focus is on neighbours and workmates which are two groups of peers with meaningful interactions with the parents. The empirical results show a positive and statistically significant neighbour and workmate effects, whereby parents' cohabitation decision is strongly affected by their peers' cohabitation decisions. Imitation of peers and information transmission from the peers appear to be important mechanisms driving the peer effects in cohabitation decisions.

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The three chapters of the thesis examine multiple aspects regarding parental inputs in early childhood. A variety of econometric methods are implemented to provide rigorous answers to the different research questions and address the specific econometric issues encountered. The first chapter adopts a meticulous decomposition analysis, which provides convincing empirical evidence that the gaps in abilities between children of intact and disrupted families is explained by differences in the parental pre-divorce characteristics rather than by the causal effect of divorce. The second and the third chapter implement novel empirical strategies to address several endogeneity issues and provide evidence on the impact of parental investment and parental skills on child socio-emotional skills and on the causal effect of peers on the cohabitation decision of parents. The choice of the dataset varies depending on the research questions and the relevant econometric challenges. The first and the second chapter use survey data from the UK Millenium Cohort Study, which is exceptional in providing a wealth of information about the child and the family environment. The third chapter uses administrative data from Norway, which enables the observation of the entire population and the linking of each individual to his peers - workmates and neighbours.

Motivated by the well documented persistence in outcomes from childhood to adulthood, this thesis adopts a variety of approaches, data and methods to offer further understanding of human capital development from its very beginning. This investigation into *family* as one of the main determinants of child human capital strives to contribute to the debate and stimulate further inquiries in the growing literature of human capital formation as well as in family economics, more generally.

Chapter 1

Explaining Divorce Gaps in Cognitive and Socio-emotional Skills of Children

Are the disadvantages in skills among children of divorce due to a casual effect of divorce or due to selection? Using the UK Millennium Cohort Study - which allows for the control of usually unobserved characteristics - this paper shows that the disadvantage in skills typically found among children of divorce entirely reflects the selection effect, whereby more disadvantaged parents are more likely to divorce. Parents' education, family financial resources and interparental conflicts are the most important pre-divorce factors accounting for the divorce gaps in children's cognitive and socio-emotional skills up until age 11, leaving no room for a causal impact of divorce. Interparental conflicts are often neglected in the literature but are shown to play a major role particularly for socio-emotional skills of children. These results suggest that to reduce the disadvantage in skills among children of divorce, interventions targeting these pre-divorce characteristics would be potentially more effective than policies discouraging divorce.

1 Introduction

The increasing rates of marital instability over the last few decades have sparked political and public debates about the relationship between parental divorce and child development. A shock to the family structure, such as divorce, has the potential to affect the human capital formation of children.[1] A large number of empirical studies find a negative correlation between parental separation and children's achievements, with mixed results when attempting to establish the causality in this relationship.[2] Several identification strategies have been adopted, e.g. quasi-experimental methods which exploit the introduction of changes in divorce law (Corak, 2001; Piketty, 2003; Gruber, 2004; Francesconi et al., 2010), sibling difference approach (Ermisch and Francesconi, 2001; Ermisch et al., 2004; Björklund and Sundström, 2006; Francesconi et al., 2010), instrumental variables (Finlay and Neumark, 2010; Frimmel et al., 2016), difference-in-difference methods (Sanz-de Galdeano and Vuri, 2007) or fixed effect models (Aughinbaugh et al., 2005; Pronzato and Aassve, 2017; Fitzsimons and Villadsen, 2019).[3]

The endogeneity of parental divorce is a well-recognized challenge in the literature (Manski et al., 1992). The divorce decision is not exogenous and there might be unobservables correlated with divorce and children's outcomes which - if not accounted for - would lead to an overestimation of the negative impact of divorce on child outcomes. One of the main threat to the exogeneity of parental divorce is the presence of interparental conflicts, which are often unobservable. The negative relationship between child outcomes and divorce can be due to the detrimental effect of having parents with conflictual relationship rather than to a casual effect of divorce. This paper uses data from the UK Millennium Cohort Study (2000-2011) which allows to thoroughly account for pre-divorce circumstances of the family, including interparental conflicts, to investigate the *divorce skills gap* of children, defined as the mean difference between the skills of children of intact families and children of disrupted families.[4] If the divorce skills gaps are entirely explained by selection, whereby more disadvantaged parents are more likely to divorce, there is no room for a causal impact of divorce.

This paper studies the divorce skills gaps at ages of 3, 5, 7 and 11 of the child when the divorce occurs before the age of 3. In an attempt to explore an area of research that has received less attention to date - compared to the literature on the impact of divorce on child outcomes - this paper answers the following questions: (i) What accounts for the divorce

[1] Family plays a crucial role in shaping child's abilities, through genetics, parental investments, and through the choice of child environment (Cunha and Heckman, 2007; Borghans et al., 2008; Cunha and Heckman, 2009; Almlund et al., 2011). Examples of papers looking at other determinants of children's achievements such as, mother's employment, parental time investment, financial resources can be found in Haveman and Wolfe (1995); Ruhm (2004); Björklund and Salvanes (2011); Almond and Currie (2011); Ermisch et al. (2012); Del Bono et al. (2016); Carneiro et al. (2015).

[2] McLanahan et al. (2013) provide a comprehensive survey of this literature.

[3] Since each of these strategies relies on specific identifying assumptions, which often cannot be tested, some papers have also adopted a multi-method approach in order to account for potential advantages and disadvantages of the different methods (Francesconi et al., 2010).

[4] Note that the terms "skills" and "abilities" are used interchangeably.

gaps in cognitive and socio-emotional skills[5] of children? (ii) Are there any inequalities in the divorce gaps across the children's skills distribution and across gender?

Our first contribution to the literature is to include an often unobserved measure of *inter-parental conflicts* in the list of pre-divorce characteristics,[6] along with a large set of parental and family background variables. Children exposed to interparental conflict are more likely to have behavioural problems such as conduct disorders, aggressive behaviour, anxiety, depression and withdrawal as well as lower academic achievement (Buehler et al., 1998; Amato et al., 1995; Grych and Fincham, 2001). The lack of information on interparental conflicts, in the context of divorce, threatens all the identification strategies adopted so far in the literature. Arguably, even changes in divorce law might be questioned as a valid instrument because they may directly affect the bargaining power within the family with potential implication for the quality of parental relationship and therefore children's outcomes (Stevenson and Wolfers, 2006; Fella et al., 2004; Halla, 2013). Sibling difference approach controls for any common unobservables across siblings but relies on the assumption that parents respond equally to each of their potentially different children's endowments and do not account for the fact that one of the two siblings might be exposed to conflicts for a longer period of time. Fixed effect models do not control for time variant unobservables (e.g. interparental conflicts) and do not allow the production of child human capital to change over the different stages of childhood, something that has been recently established by the human capital formation literature (see for example Heckman 2000). Therefore, neglecting to account for parental conflicts would miss out that part of the divorce skills gap that can be ascribed to this aspect of family environment.

In a second contribution, we capture the multidimensional aspect of child human capital, i.e. cognitive and socio-emotional skills. Previous literature has highlighted the differences in the determinants of child cognitive and socio-emotional abilities.[7] For this reason we expect to find some dissimilarities between the two, either in the size of the divorce skills gaps or in the accounting power of the factors driving these gaps.

Our third contribution is substantive. This is the first study to provide evidence of how the divorce skills gaps varies across the distribution of child skills. In light of the *diathesis stress framework* proposed in the psychological literature (Beck, 1967; Monroe and Simons, 1991; Hilsman and Garber, 1995), we expect children with low levels of socio-emotional skills to have larger gaps than high-skilled children. This is because, a stressful event - e.g. parental divorce - can trigger the manifestation of socio-emotional disorders if the child has a predisposition to such disorder. However, this is not necessarily valid for cognitive skills.

In a fourth contribution, we follow a growing literature documenting gender differences in the development of children's skills and provide comparison between boys and girls of both

[5]Socio-emotional, or noncognitive skills of children are defined as the child ability to understand and handle their own feelings and behaviours and get along with their peers.

[6]There are however few exceptions of recent papers including measures of conflicts. Tartari (2015) includes in her analysis a measure of parental conflicts but focuses exclusively on children cognitive outcomes. Amato et al. (1995), Ribar et al. (2017) and Clark et al. (2015) look at how the impact of divorce on children vary by the level of conflict.

[7]See for example Heckman (2000); Cunha et al. (2006); Almlund et al. (2011); Del Bono et al. (2016)

- the mean divorce skills gap and the divorce skills gaps across the distribution of children's abilities.[8]

The empirical analysis includes two steps. In the first step, we conduct an Oaxaca-Blinder (O-B) decomposition analysis of the divorce skills gaps.[9] Using this approach we decompose the mean child skills gaps in two parts: the first explained by differences in observed characteristics (*explained/compositional effect*) and the second given by the differences in the return to these characteristics (*unexplained/ residual effect*). Then, the compositional effect is further decomposed to establish the contribution of each set of observed characteristics in explaining the divorce gaps.[10] In a second step, to overcome some of the O-B drawbacks, we adopt the methodology introduced by Firpo et al. (2007, 2009) to analyze for the first time the decomposition of the divorce gaps across the children's skills distribution, focusing on the differences between cognitive and socio-emotional skills. This more flexible method allows children at the lower tail of the distribution to present different compositional or residual effects compared to children at the upper tail, which is perfectly plausible in the context of divorce. Similarly to Longhi et al. (2012, 2013) and Nandi and Nicoletti (2014) we address the limits of the O-B decompositions by carrying out a set of sensitivity analysis (i) using the reweighted decomposition method (DiNardo et al., 1996), (ii) changing the counterfactuals in the decomposition and (iii) imposing a common support between the two groups of children.

Overall, results indicate that the mean divorce skills gaps entirely reflect the parental selection into divorce. This is because these gaps are, in most of the cases, completely explained by compositional effects, i.e. by the differences in pre-divorce characteristics between children of intact and disrupted families. In the few cases in which part of this gap is left unexplained, this is due to the difference in the return to these characteristics between children of intact and disrupted families and not due to unobservables - thereby ruling out any causal impact of divorce. In addition, we find that the divorce gap in cognitive and socio-emotional abilities can be ascribed to different factors. Cognitive gaps are largely explained by differences in parents' education (about 35%) and family financial resources (about 60%), whilst socio-emotional gaps are mostly explained by interparental conflicts (about 35%) and financial resources (about 35%). Since parental education largely explains cognitive skills disparities and interparental conflicts largely explain socio-emotional skills disparities, our results suggest that the intergenerational transmission of abilities is an important driver of the gaps. Finally, and consistently with the *diathesis stress framework*, we find that more vulnerable children, i.e. children with lower level of socio-emotional abilities, present larger divorce gaps, especially among boys. On the basis of this evidence, interventions aimed at in-

[8] See Bertrand and Pan (2013) and Baker and Milligan (2016).

[9] The decomposition approach has been extensively used in labour economics to analyze the wage gap between different subsample of the population, e.g. between men and women, between ethnic groups and between disable and non-disable workers. It has also been used to study child development gaps attributed to child health conditions, health gaps by socio-economic status, ratial differences in health insurance. See among others, Blinder (1973); Oaxaca (1973); Blau and Kahn (1992); Doiron and Riddell (1994); Cobb-Clark and Hildebrand (2006); Grove et al. (2011); Longhi et al. (2012, 2013); Pylypchuk and Selden (2008); Salm and Schunk (2012); Johar et al. (2013); Carrieri and Jones (2017).

[10] Given the substantial importance of the differences in observed characteristics, our analysis focuses on the detailed decomposition of the compositional effect. However, we provide also evidence of the detailed decomposition of the residual component when it significantly explains the divorce skills gap of children.

creasing parents' education, reducing interparental conflicts and providing financial support, may more effectively narrow the inequalities between children of intact and disrupted families than policies discouraging divorce.

The outline of the paper is as follows. Section 2 describes the data and Section 3 the empirical strategy. In Section 4 we report our findings of the decomposition of mean skills gaps, the description of the accounting factors of the gap and the decomposition across the distribution of children's skills. Section 5 shows that our results are robust to several sensitivity analyses, conducted to address the main drawbacks of the O-B methodology such as the linearity assumption, the choice of the counterfactual and the common support assumption. Section 6 concludes with a discussion of the results.

2 Description of data

2.1 Millennium Cohort Study

This paper uses data from the UK Millennium Cohort Study (MCS), a multidisciplinary cohort member longitudinal survey which comprises a representative sample of children born in the UK between September 2000 and January 2002. The cohort members are followed across time with interviews conducted in 2000, 2004, 2006, 2008 and 2012, when children are 9 months and ages 3, 5, 7 and 11.[11] Information on both the child and parents is available. The data includes detailed information regarding child cognitive and socio-emotional skills. More precisely, child cognitive skills are assessed by trained interviewers using appropriate tests, whereas child socio-emotional skills are assessed asking questions to the parent, usually the mother. In addition, the survey includes a wide variety of other variables on social, demographic and economic circumstances at parental, child and family level.

The sample is selected to include all singleton children interviewed at 9 months with married or cohabiting natural parents. This selection reduces our original sample size by 31.8 percent, consisting of 13,131 children. We consider a balanced panel of cohort members with non-missing information on a set of variables on family and child characteristics excluding those children whose parents separate after the age 3. Our final sample consist of 5003 observations.

In this study the key variable is the relationship between the natural parents, i.e. whether they are in relationship or separated. Since our analysis comprises both married and cohabiting couples, it follows that, the notion of divorce will include not only legally divorced or legally separated couples, but also cases where one of the two natural parents has left the house. This choice is motivated by the fact that the shock faced by the child in case of parental split-up arises as soon as the two parents separate, that is when they stop living together, regardless of their legal marital status. Among our initial sample of 13,131 children

[11] For details on the survey design, recruitment process and fieldwork consider Dex and Joshi (2005).

at 9 months, 72.29% of them have married parents whilst the rest have cohabiting parents. For the rest of the paper, the notion of divorce and separation will be used interchangeably.[12]

2.2 Children outcomes

2.2.1 Cognitive skills

The dataset offers several measures of cognitive abilities, mainly from the British Ability Scales (BAS), a widely used age-varying test (Elliott et al., 1996, 1997).[13] At age 3, child cognitive skills are evaluated using the BAS Naming Vocabulary Test and the Bracken School Readiness test. The first assesses the child's expressive verbal ability by asking the child to name objects shown in a set of pictures. The second evaluates the understanding of educational concepts in sub-tests or categories such as colours, letters, numbers, sizes, comparisons and shapes.

At 5 years old, child cognitive abilities are assessed using the BAS Naming Vocabulary Test, the BAS Picture Similarity and the BAS Pattern Construction. The Picture Similarity Test measures child's problem solving abilities by asking the child to choose two similar pictures from a row of 4 pictures. The Pattern Construction Test instead asks the child to build a pattern by combining coloured flat squares or solid cubes. This test provides information about child accuracy, speed and spatial awareness as well as dexterity and coordination.

When the child is 7 years old, cognitive abilities are evaluated with three tests, the BAS Pattern Construction test, the BAS Word Reading Test and an adapted version of the National Foundation for Educational Research Progress in Maths Test (NFER). The Word Reading Test assesses child's reading ability by asking the child to read aloud a list of 90 words shown on a card. The NFER test instead is a maths assessment which initially tests all children equally and then, based on their score, they are asked easier, medium or harder questions.[14]

Finally, 11-years-old children's cognitive abilities are measured with the BAS Verbal Similarities Test, which informs about verbal reasoning and verbal knowledge by asking the child to recognise similarities among three words read out by the interviewer. For ease of interpretation all tests at each age are standardized to have mean 0 and standard deviation of 1.[15] Since at ages 3, 5 and 7 we have more than one cognitive ability measure, rather than using them separately, we use latent factor models to reduce the measurement error and to construct a single and more exhaustive measure of cognitive abilities for these ages. Table A.2 in the Appendix shows the corresponding factor loadings (Column 1) and signal (Column 2), i.e. the proportion of the variance for each of the measure explained by the latent factor.

[12] At national level, the number of divorce in England and Wales in 2013 was 114,720, involving 94,864 children under 16. Among these children, 21% were under 5 and 64% were under 11 years old. Detailed information on the institutional background in the UK is provided in the Appendix A.1.

[13] Among the three types of score available for each of the BAS tests, the raw score, the ability score and the T-score, we use the ability score that is a transformation of the raw score which takes into account the difficulty of the specific questions asked to the child.

[14] For the NFER Test we use an adjusted test score which adopts an item response scaling method (Rasch) to adjust the results of the easy, medium and hard subtest scores to the correspondent raw scores.

[15] Table A.1 in the Appendix shows the list of cognitive tests available in our dataset by age of the child. For a detailed description and interpretation of all the tests consider Connelly (2013) and Hansen (2014).

2.2.2 Socio-emotional skills

Socio-emotional skills are derived from the Strengths and Difficulties Questionnaire (SDQ) which is designed to examine children's behaviors and emotions in a number of settings. In each interview starting at age 3, the parent is asked to complete the SDQ questionnaire consisting of 25 items on psychological attributes (Goodman, 1997, 2001). The parent is asked whether the item is 'true', 'somewhat true' or 'not true' in respect to the child and, final scores are such that the higher the score the higher the level of behavioral problems. The 25 items are grouped in five sub scales measuring: (i) Emotional Problems; (ii) Conduct Problems; (iii) Hyperactivity; (iv) Peer Relationship Problems and (v) Pro-social Behavior. These broader subscales are extensively used in the child development literature and have been shown to be valid in the UK setting (e.g., Goodman et al. 2010; Borra et al. 2012; Del Bono et al. 2016). For the sake of comparison with the cognitive measures, the socio-emotional scores are standardized to have mean 0 and standard deviation 1 and are reverse coded, so that positive values mean higher level of socio-emotional skills and negative values mean lower level of socio-emotional skills.[16]

As with cognitive abilities, rather than using many different measures of socio-emotional abilities for each age, we use factor models to reduce the measurement error and combine this information and estimate a unique and more comprehensive measure of socio-emotional skills. The estimated factors represent a comprehensive measure of psychological traits such as anxiety, depression and withdrawal, but also aggression, irritation, conduct problems and pro-social behavior at each age. We take these factors as our measures of socio-emotional abilities for each age (factor loadings and signals shown in Table A.3 in the Appendix).

Table 1.1 features the descriptive statistics of children cognitive and socio-emotional skills as described by the factors and their differences by parental separation, where - for comparability - each measure has mean zero and standard deviation of 1. The table clearly shows the existence of a *divorce skills gap*, both for cognitive and socio-emotional skills, with children of intact families having higher cognitive and socio-emotional skills at every age. A potential explanation for the divorce skills gaps is that the characteristics, experiences and environment of children from disrupted families differ systematically from the characteristics, experiences and environment of children from intact families, in ways that are related to children's cognitive and socio-emotional skills. This study aims at understanding how much of this gap can be explained by these differences, and what the main pre-divorce determinants of these gaps are.

[16]The pro-social behavior subscale, differently from all the other measures, does not need to be reversed to provide a consistent interpretation of higher test score higher socio-emotional abilities.

Table 1.1: Descriptive statistics of the outcome variables, by divorce

	(1) Non divorced		(2) Divorced		(3)
	Mean	sd	Mean	sd	Difference
Cognitive skills (Age 3)	0.195	0.939	-0.055	0.988	0.250***
Cognitive skills (Age 5)	0.216	0.855	-0.004	0.880	0.220***
Cognitive skills (Age 7)	0.192	0.913	-0.162	0.948	0.354***
Cognitive skills (Age 11)	0.153	0.898	-0.113	0.975	0.266***
Socio-emotional skills (Age 3)	0.146	0.915	-0.190	1.154	0.337***
Socio-emotional skills (Age 5)	0.188	0.858	-0.254	1.122	0.443***
Socio-emotional skills (Age 7)	0.204	0.839	-0.299	1.137	0.503***
Socio-emotional skills (Age 11)	0.191	0.868	-0.346	1.193	0.537***
Observations	4666		337		5003

Sources: UK Millennium Cohort Study
Notes: Sample includes all singleton children interviewed at 9 months and ages 3,5,7 and 11, for whom the main respondent is the natural mother and the partner respondent is the natural father, who are either married or cohabiting and that have no missing observations in our set of relevant variables. Column (3) indicates the mean difference between the two groups with statistical significance difference at the 1, 5 and 10 percent levels indicated by ***, ** and *.

2.3 Explanatory variables

2.3.1 Quality of interparental relationship

The quality of interparental relationship, often referred as relationship quality (RQ) or marital conflict, is a crucial aspect in family and child developmental research, especially in the psychology literature. It has been linked to psychological and physical health of the partners (depressive symptoms, eating disorders, male alcoholism), but also with some key aspects of family environment such as domestic violence, lower parenting skills, children's disadvantages, parent-child conflict, and conflict between siblings (Buehler et al., 1998; Grych and Fincham, 2001; Fincham, 2003). Partners satisfied with their relationship are healthier, they communicate more effectively with each other, have higher parenting skills and tend to raise their children authoritatively, using less harsh discipline, spending more time with their children, with less risk of a marital breakup (Jones, 2010).

The MCS provides detailed information about the quality of relationship between parents. It includes a shortened version of the Golombok-Rust Inventory of Marital State (GRIMS, Rust et al. 1986, 1990), a questionnaire to measure the overall quality of a couple's relationship, and retains the content validity of the original version which included 28 items measuring two aspects of the relationship, (1) shared interests, communication, sex, warmth, roles, decision making and coping, and (2) beliefs about and attitudes toward relationships, behavior in the relationship and agreement with the partner (Chiorri et al., 2014). Specifically, the MCS asks each parent separately to rate several items: (i) Partner sensitive and aware of needs (ii) Partner doesn't listen (iii) Sometime lonely when with partner (iv) Relationship full of joy and excitement (v) Wishes was more warmth and affection (vi) Suspect on brink of separation (vii)

Can make up quickly after argument (viii) Frequency go out as a couple (ix) Happy/Unhappy with relationship.[17]

In the case of statements (i)-(vii), respondents indicate whether they strongly agree, agree, neither agree nor disagree, disagree or strongly disagree with the statement (5-Point Likert-type agreement scales). In the case of statement (viii) respondents are asked to indicate how frequently they go out as couple on a 4 points scale, ranging from 'once a week' to 'hardly never'. Question (ix) about happiness in the relationship is measured on a 7 point scale.[18]

Given that we expect the quality of parental relationship to have some accounting power in explaining the divorce skills gaps, it is important to rule out the measurement issues associated with this variable. If conflicts are under/over-reported then the accounting power of conflicts may be over/under-estimated. We use latent factor models to estimate a latent factor measuring interparental conflicts to address measurement problems related to this variable. In addition, the use of factor models allows us to reduce the dimensionality of the measures explaining the interparental conflicts without arbitrarily imposing that all the measures are related to the latent factor with equal weights.[19] Table A.4 reports the factor loadings (Column 1) and the signal, i.e. share of the variance explained by the latent factor for each question (Column 2). We interpret this factor as a measure of interparental conflicts perceived by the mother. The use of latent factor models is motivated by the fact that the amount of information contained in each measures varies across the measures and is much lower than 1, suggesting that measurement error needs to be accounted for.

2.3.2 Other control variables

Our analysis includes a set of child, parental and family variables observed before separation. A fundamental aspect of the MCS is that it includes a large set of background characteristics, thereby making the selection on observables assumption - implicit in simple multivariate regression models - more plausible. The set of variables incorporated in our analysis draws from the human capital formation literature, where parental inputs are the major determinants of child outcomes, as well as from the literature aimed at establishing the impact of divorce on children outcomes. Indeed, we include also explanatory variables that may be a good predictor of divorce but that may also indirectly affect children's abilities. This set of variables consists of: (i) *child characteristics* such as child sex and birth weight; (ii) *demographic characteristics* such as number of siblings, whether parents were cohabiting or married at

[17]These last two items of the quality of interparental relationship are not included in GRIMS but represent additional information on the quality of relationship. Item (ix) for example is an overall measure of satisfaction with the relationship widely used in the literature and included also in other surveys such as, the National Child Development Study (NCDS) in the UK.

[18]Notice that items (ii) (iii) (v) and (ix) are reverse coded in such a way to have the same interpretation in terms of quality of relationship. The higher the score, the lower the quality of their relationship, the higher the level of conflicts.

[19]We use the information reported by the mother to construct our measure of interparental conflict. Related literature on GRIMS questionnaire implemented in the MCS survey showed that women in MCS perceive a higher relationship quality than men(Chiorri et al., 2014; South et al., 2009; Shapiro et al., 2000). This would suggest that, if interparental conflicts are measured with errors, they are possibly under-reported and therefore we might expect the accounting power of the quality of relationship to be at most underestimated.

birth, duration of relationship between the parents at birth, whether the pregnancy was planned, mother's religiosity, parents' age and parents' ethnicity; (iii) *parental education*; (iv) *health characteristics* like parents' general health; and (v) *family financial resources* such as family income, housing tenure, parents' social class based on NS-SEC (National Statistics Socio-Economic Classification).

Table 1.2 reports the descriptive statistics of all the explanatory variables by parental separation. According to the mean tests, the characteristics of children from divorced families are very different from the characteristics of children from intact ones. Children of divorce have, on average, younger, less educated parents with shorter relationships. Non separated parents also have better health. Parental class is dissimilar as well, between the two groups of children, with a higher percentage of parents from divorced families working in routine and manual occupations. Finally, family income also varies between the two groups, with an average equivalised OECD income per week significantly higher for intact families than for disrupted families. Overall, the control variables indicate that children of divorce grow up in more disadvantaged environment than children of intact families. If children who are brought up in more advantaged families are also less likely to experience parental breakup and also perform better at cognitive and socio-emotional tests, either because of higher innate ability or because their environmental background improves these outcomes, then the association between separation and cognitive and socio-emotional skills shown in Table 1.1 might well be spurious and largely explained by these observable differences between the two groups.

Table 1.2: Descriptive statistics of the explanatory variables, by divorce

	(1) Non divorced		(2) Divorced		(3)
	Mean	sd	Mean	sd	Difference
Child characteristics					
Female	0.514	0.500	0.510	0.501	0.004
Birth weight (Kg)	3.448	0.542	3.360	0.564	0.088**
Demographic characteristics					
Number of siblings	0.847	0.920	0.766	0.897	0.081
Cohabitation	0.201	0.401	0.576	0.495	-0.375***
Duration of relationship	5.709	3.829	3.706	3.118	2.003***
Planned pregnancy	0.710	0.454	0.487	0.501	0.223***
Mother's religion	0.617	0.486	0.418	0.494	0.199***
Mother's age	30.649	4.840	26.243	5.808	4.405***
Father's age	32.978	5.528	29.223	6.651	3.756***
Mother's ethnicity					
White	0.931	0.254	0.970	0.170	-0.040***
Mixed	0.004	0.064	0.006	0.077	-0.002
Indian, Pakistani, Bangladeshi, Black	0.055	0.228	0.018	0.132	0.037***
Other	0.010	0.101	0.006	0.077	0.004
Father's ethnicity					
White	0.929	0.256	0.944	0.231	-0.014
Mixed	0.006	0.079	0.006	0.077	0.000
Indian, Pakistani, Bangladeshi, Black	0.057	0.231	0.047	0.213	0.009
Other	0.008	0.089	0.003	0.054	0.005
Mother's education					
GCSE/O-level(or eq)	0.314	0.464	0.475	0.500	-0.161***
A level or more but below university	0.153	0.360	0.178	0.383	-0.025
University degree or higher	0.488	0.500	0.231	0.422	0.256***
No qualification	0.045	0.207	0.116	0.320	-0.071***
Father's education					
GCSE/O-level(or eq)	0.311	0.463	0.427	0.495	-0.117***
A level or more but below university	0.160	0.367	0.190	0.393	-0.030
University degree or higher	0.465	0.499	0.211	0.408	0.254***
No qualification	0.064	0.245	0.172	0.378	-0.108***
Parents' health					
Mother health:Good	0.878	0.328	0.789	0.408	0.089***
Father health:Good	0.881	0.324	0.816	0.388	0.065**
Financial resources					
OECD equivalised income	398.893	206.631	274.561	158.517	124.332***
House tenure					
Own	0.849	0.358	0.493	0.501	0.356***
Rent	0.130	0.336	0.466	0.500	-0.336***
Other	0.021	0.145	0.042	0.200	-0.020
Mother's occupational status					
Managerial and Professional	0.442	0.497	0.187	0.390	0.255***
Intermediate	0.251	0.434	0.193	0.395	0.058**
Routine and manual	0.284	0.451	0.558	0.497	-0.274***
Not in work	0.023	0.148	0.062	0.242	-0.040**
Father's occupational status					
Managerial and Professional	0.493	0.500	0.231	0.422	0.262***
Intermediate	0.182	0.386	0.151	0.359	0.031
Routine and manual	0.315	0.464	0.599	0.491	-0.285***
Not in work	0.010	0.099	0.018	0.132	-0.008
Quality of parental realtionship					
Interparental conflicts	-0.182	0.878	0.589	1.168	-0.771***
Observations	4666		337		5003

Sources: UK Millennium Cohort Study
Notes: Sample includes all singleton children interviewed at 9 months and age 3,5,7 and 11, for whom the main respondent is the natural mother and the partner respondent is the natural father, who are either married or cohabiting and that have no missing observations in our set of relevant variables. Column (3) indicates the mean difference between the two groups with statistical significance difference at the 1, 5 and 10 percent levels indicated by ***, ** and *.

3 Empirical strategy

3.1 Oaxaca-Blinder decomposition

The existence of a gap in mean outcomes between two groups has been often investigated using decomposition analysis to estimate how much of the gap can be attributed to differences in observable characteristics between the two groups. The approach, widely used by labour economists, stems from the seminal papers of Oaxaca (1973) and Blinder (1973), with the original 'Oaxaca-Blinder' (O-B) decomposition using linear regressions estimated separately for the two groups. We use the O-B method to decompose the mean of divorce skills gaps of children into the component explained by differences in observed characteristics (*compositional effect*) and the unexplained component (*residual effect*).

Separate regressions are estimated for each group, so that the mean regression of the cognitive or socio-emotional skills may be expressed as follows:

$$y_{ij} = \mathbf{X}_{ij}\boldsymbol{\beta_j} + \epsilon_{ij} \tag{1.1}$$

where y_{ji} is cognitive or socio-emotional skills for child i at ages 3, 5, 7 and 11 in group j, with j= 0 for non-separated (the reference group) or j= 1 for separated parents (the comparison group), observed when the child is between 9 months and age 3 ; $\mathbf{X}_{ij}$ is a vector of K explanatory variables and a constant, β_j is a vector of parameters for group j including the intercept, and ϵ_{ij} is an error term with mean zero and homoskedastic. Then, using the O-B approach, we can decompose the difference in mean outcomes (overbars denote means) between children of intact and disrupted families as follows:

$$\overline{y}_0 - \overline{y}_1 = \overline{\mathbf{X}}_0\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_1} \tag{1.2}$$

where $\overline{\mathbf{X_j}}$ is the vector of average characteristics for group j (j=0,1) and $\overline{y}_0 - \overline{y}_1$ is the *divorce skill gap*, expressed as a difference between mean outcomes of children of intact families minus mean outcomes of children from disrupted families. This implies that a positive divorce skills gap indicates skill disadvantages for children of divorce compared to children of intact families. To be able to identify the two components of the decomposition, a counterfactual conditional mean, for instance $\overline{\mathbf{X}}_1\boldsymbol{\beta_0}$, is added and subtracted. This counterfactual reflects a situation in which children of intact families have the same mean covariates of children of disrupted families. This implies that:

$$\begin{aligned}\overline{y}_0 - \overline{y}_1 &= \overline{\mathbf{X}}_0\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_1} \\ &= \overline{\mathbf{X}}_0\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_1} + \overline{\mathbf{X}}_1\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_0} \\ &= (\overline{\mathbf{X}}_0 - \overline{\mathbf{X}}_1)\boldsymbol{\beta_0} + \overline{\mathbf{X}}_1(\boldsymbol{\beta_0} - \boldsymbol{\beta_1})\end{aligned} \tag{1.3}$$

where $(\overline{\mathbf{X}}_0 - \overline{\mathbf{X}}_1)\boldsymbol{\beta_0}$ describes the *composition effect* and is the mean differences in covariates $\mathbf{X}$ between the reference and the comparison group, whereas the second component $\overline{\mathbf{X}}_1(\boldsymbol{\beta_0} - \boldsymbol{\beta_1})$ describes the *residual effect*. Moreover, given the additive linearity assumption, we can

compute the detailed decomposition to identify the contribution of each covariate K to the explained component:

$$(\overline{\mathbf{X}}_0 - \overline{\mathbf{X}}_1)\boldsymbol{\beta_0} = \sum_k (\overline{X}_{0k} - \overline{X}_{1k})\beta_{0k} \tag{1.4}$$

where β_{0k} is the parameter for variable X_k for group 0, ($\overline{X}_{0k}$ is its corresponding sample mean) and therefore $(\overline{X}_{0k} - \overline{X}_{1k})\beta_{0k}$ is the contribution of the k_{th} covariate to the composition effect. Such a detailed decomposition is one of the most appealing property of the O-B methodology.

For ease of interpretation of our results, we split X_k into 6 different sets as to include: (i) *child characteristics* such as child sex and birth weight; (ii) *demographic characteristics* such as number of siblings, whether parents were cohabiting or married at birth, duration of relationship between the parents at birth, whether the pregnancy was planned, mother's religiosity, parents' age and parents' ethnicity; (iii) *parental education*; (iv) *parental psychological-health characteristics* like parents' general health and whether child's grandparents were separated; and (v) *family financial resources* such as family income, housing tenure, number of rooms in the house, parents' social class based on NS-SEC (National Statistics Socio-Economic Classification); (vi) and the factor describing the *interparental conflicts*.[20]

Besides the compositional effects of the divorce skills gaps, ascribed to different observed mediating factors available in our data, there can be also residual skills gaps arising from different sources. A few examples are: (i) the detrimental effect of divorce on child development due to the lower time and money investment of the non-residential parent on the child (e.g. Page and Stevens 2004); (ii) failure of cooperative behavior between parents due to union dissolution;[21] (iii) differences in the return to parents' characteristics between children of separated and non-separated parents such as parents' education and interparental conflicts;[22] (iv) differences in unobservables potentially correlated with children's outcomes and parental divorce.

Similarly to the detailed decomposition provided for the compositional effect, we can compute the detailed decomposition of the residual component:

$$\overline{\mathbf{X}}_1(\boldsymbol{\beta_0} - \boldsymbol{\beta_1}) = (\beta_0 - \beta_1) + \sum_k \overline{X}_{1k}(\beta_{0k} - \beta_{1k}) \tag{1.5}$$

where β_0 and β_1 are the estimated intercepts and β_{0k} and β_{1k} are the slope coefficients in the two groups. This residual component accounts for the divorce skills gap attributable to the differences in the return of the covariates between the two groups of children and it also

[20] See Section 2 for description of each of this variable.

[21] The role of institutions is fundamental to compensate for the lower investment of one of the parents and for mitigating the effects of conflictual circumstances between the parents after separation (Del Boca, 2003; González and Özcan, 2013). The Child Maintenance Service that has replaced the CSA in the UK since 2014 represents a typical example of an institution with such an aim. A detailed institutional background for the UK is provided in the Appendix A.1.

[22] For instance, the higher level of education of both parents may be more productive in transmitting abilities when the parents are together rather than when they are separated. Similarly the detrimental effects of interparental conflicts may be exacerbated in non-divorced families because it allows children to perceive them less intensely (Kalil et al., 2011; Barumandzadeh et al., 2016).

accounts for all potential effects of differences in unobservables captured by the difference in the intercepts.

In spite of the popularity of the O-B approach and its appealing property of providing the exact contribution of each variable to the explained and unexplained component, its drawbacks are also well-recognized. First of all, O-B provides the decomposition of the mean gap but, in our setting for example, divorce skills gaps may be larger at the lower tail of the children skills distribution because lower skilled children may be more vulnerable. Secondly, it relies on linearity assumptions between dependent and explanatory variables. The following Sections (Section 3.2 and 3.3) explain the econometric extensions of the basic model used to address these two drawbacks of the O-B methodology.

In addition to that, in Section 5 we also address two other shortcomings of the methodology: (i) the choice of the counterfactual, which may affect the decomposition results and (ii) the common support assumption to avoid out of sample predictions.

3.2 Generalized Oaxaca-Blinder decomposition

To overcome the first limitation of the O-B, the fact that it provides only the decomposition of the mean gap, we apply the decomposition at various quantiles of the children's skills distributions to analyse the divorce skills gaps, by identifying the explained and unexplained component across the entire distribution of children's skills. This extension is based on the Recentered Influence Function (RIF) method of Firpo et al. (2009). Specifically, we use the RIF method to estimate the relationship between separation and children skills and then we use the RIF regression results as a basis to compute the O-B decomposition of the divorce skills gaps.[23]

More specifically, it can be shown that the RIF for the τth quantile q_τ, of a variable y is given by :

$$RIF(y, q_\tau) = q_\tau + \frac{(\tau - d_\tau)}{f_y(q_\tau)} \tag{1.6}$$

where $f_y(q_\tau)$ is the density function of y at quantile q_τ, and d_τ is a dummy that takes value one if $y \leq q_\tau$.[24]

The RIF satisfies two important properties: (i)$E_y[RIF(y, q_\tau)]$=q_τ that is its mean corresponds to the actual τ_{th} quantile of interest; and (ii) $E_X E_y[RIF(y, q_\tau)|X] = q_\tau$. Given these properties, we compute the RIF for each observation y (after replacing $f_y(q_\tau)$ with its kernel density estimate) and we estimate the conditional expectation of the RIF for each group j

[23]While the mean can be decomposed with O-B using OLS, the quantiles cannot be decomposed using the quantile regressions. Similarly to the mean regression model, a quantile regression model for the τth conditional quantile expressed as $q_\tau(X) = X\beta_\tau$, β_τ is the effect of X on the τth conditional quantile of y given X. However, in the case of quantiles, differently from the mean, we cannot apply the law of iterated expectation so $q_\tau \neq E_X[q_\tau(X)] = E(X)\beta_\tau$ (where q_τ is the unconditional quantile) and therefore β_τ does not represent the effect of increasing the mean value of X on the unconditional quantile (Johar et al., 2013). Therefore, the RIF offer a linear approximation of the unconditional quantiles of the outcome variable which permits the application of the law of iterated expectations to the approximated quantile used to estimate the marginal effect of a covariate by regressing the RIF on the covariates X (Carrieri and Jones, 2017).

[24]For estimation of the RIF we use the Stata ado file *rifreg* written by Firpo et al. (2009).

using OLS regression (assuming linearity between the RIF and X) considering the RIF as the dependent variable :

$$RIF(y_{ij}, q_\tau) = \mathbf{X}_{ij}\boldsymbol{\beta_j}(q_\tau) + \nu_{ij} \tag{1.7}$$

where, as before, j is the group indicator (j=0,1), $\mathbf{X}_j$ is a vector of K explanatory variables including the intercepts, $\boldsymbol{\beta}(q_\tau)$ is the vector of coefficients for the quantile τth and ν_j is the error term. Specifically, the conditional expectation of the RIF is what Firpo et al. (2009) call the unconditional quantile regression and therefore we can interpret the coefficient estimated in equation (6) $\boldsymbol{\beta_j}(q_\tau)$ as the marginal effect of X on the unconditional quantile of children outcome. Given the properties of the RIF it can also be shown that:

$$\begin{aligned} q_{0\tau} - q_{1\tau} &= E_y[RIF(y_0, q_\tau|\mathbf{X}_0)] - E_y[RIF(y_1, q_\tau|\mathbf{X}_1)] \\ &= [RIF(Y_0, q_{0\tau})] - [RIF(Y_1, q_{1\tau})] \\ &= \overline{\mathbf{X}}_0\boldsymbol{\beta_0}(q_\tau) - \overline{\mathbf{X}}_1\boldsymbol{\beta_1}(q_\tau) \\ &= (\overline{\mathbf{X}}_0 - \overline{\mathbf{X}}_1)\boldsymbol{\beta_0}(q_\tau) + \overline{\mathbf{X}}_1(\boldsymbol{\beta_0}(q_\tau) - \boldsymbol{\beta_1}(q_\tau)) \end{aligned} \tag{1.8}$$

where the last equivalence follows the O-B decomposition method and shows that the gap in quantiles can be decomposed into two additive components, the composition effects and the residual effects as in the mean O-B. We call this decomposition the *generalized Oaxaca-Blinder method*; this differs from the O-B method only because the dependent variable in the regression model is the RIF rather than y. Similarly to what we had in Equation 3, the first term is the differential in children skills that is explained by differences in observed characteristics between the two groups and the second term measures the unexplained component.

Just as in the basic O-B method, the *generalized Oaxaca-Blinder method* can be used to derive a detailed decomposition and identify the contribution of each variable as:

$$q_{0\tau} - q_{1\tau} = \sum_k (\overline{x}_{0k} - \overline{x}_{1k})\beta_{0k}(q_\tau) + \overline{\mathbf{X}}_1(\boldsymbol{\beta_0}(q_\tau) - \boldsymbol{\beta_1}(q_\tau)) \tag{1.9}$$

This method allows us to overcome the first drawback of the O-B method by providing a decomposition of the gap at different quantiles in addition to the mean. Despite this, the generalized O-B method continues to rely on the linearity assumption and may consider out of sample counterfactuals when the ranges of the covariates differ between the two groups (Barsky et al., 2002). For this reason, as a robustness check we implement the reweighted O-B decomposition as explained in the next section.

3.3 Reweighted Oaxaca-Blinder decomposition

As discussed previuosly, a limitation of the O-B decompositions (as well as the generalized O-B) is that, if the conditional mean function is not linear, the decompositions may not provide consistent estimates of the components. One possible solution to this problem is to compute the decomposition using a reweighting approach as in DiNardo et al. (1996) and Barsky et al. (2002).

Specifically, we use the reweighted decomposition methodology such that we first construct a counterfactual sample of children of intact families weighted to have the same characteristics as children of divorce, and then calculate the explained and unexplained components. Once the appropriate counterfactual has been constructed, then the differences between the children's outcomes from this counterfactual sample of children of divorce represent the true divorce skills gaps, ruling out misspecification error due to the nonlinearity of the underlying conditional expectation (Fortin et al., 2011).

One drawback of this decomposition however, is that it does not offer a simple way of performing a detailed decomposition of the difference in mean and quantiles. For this reason, we combine weights and the generalized O-B methods to appropriately compute counterfactual of the statistic of interest. More precisely, the regression of the RIF for the children of intact families is estimated with weighted least squares:

$$RIF(y_0) = \mathbf{X}_0 \boldsymbol{\beta_0}^{WR} + u_0 \tag{1.10}$$

with weights computed as

$$w(X) = \frac{P(j=1|X)P(j=0)}{P(j=0|X)P(j=1)} \tag{1.11}$$

where j takes value 0 for children of intact families (reference group) and value 1 for children of disrupted families, and $P(j=0|X)$ is the conditional probability of being a child of intact family estimated with a logit model. In other words, we reweight the sample of children of intact families so that the distribution of their characteristics (X) is similar to that of children of divorce. As noted by Roams and Rotnitzky (1995), this method is double-consistent because the estimation of the weighted regression is consistent if either the estimated weights (i.e. the logit model) are correct *or* if the specification of the linear regression model is correct.

Then, we consider as a counterfactual children of intact families (reference group) as if they have the same distribution of characteristics of children of divorce (comparison group), i.e. $\overline{\mathbf{X}_1}\boldsymbol{\beta_0}^{WR}$ and finally compute the reweighted decomposition of the mean gap as follows:

$$\begin{aligned} \overline{y}_0 - \overline{y}_1 &= \overline{\mathbf{X}}_0\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_1} + \overline{\mathbf{X}}_1\boldsymbol{\beta_0}^{WR} - \overline{\mathbf{X}}_1\boldsymbol{\beta_0}^{WR} \\ &= [(\overline{\mathbf{X}}_0\boldsymbol{\beta_0} - \overline{\mathbf{X}}_1\boldsymbol{\beta_0}^{WR}] + [\overline{\mathbf{X}}_1(\boldsymbol{\beta_0}^{WR} - \boldsymbol{\beta_1})] \end{aligned} \tag{1.12}$$

where the two terms in the square brackets represent the composition effect and the residual effect respectively. According to Firpo et al. (2007) and Fortin et al. (2015) the composition effect consists of two parts, i.e. the pure composition effect and the specification error in the linear model. Therefore, if the model is linear, the specification error should be zero. If the composition effect computed with the reweighting approach and the composition effects computed with the generalized O-B are similar, we can rely on the detailed decomposition results provided by the generalized O-B.

The empirical results described in the following section are based on the mean and the generalized O-B decomposition to estimate compositional and residual effects, with the reweighting approach used for robustness checks.

4 Empirical results

This section unfolds all the results from the decomposition analysis. It starts by describing the results of the standard Oaxaca Blinder decomposition and then it lays out the detailed Oaxaca Blinder decomposition in order to disentangle the contribution of each of the factors in explaining the divorce gap. Finally, it reports the results of the divorce skills gap decomposition across the children skills distribution with details on the differences between boys and girls.

4.1 Decomposing the mean divorce skills gaps

Table 1.3 summarises the results of the Oaxaca Blinder decomposition at the mean of the explained (compositional) and unexplained (residual) components for cognitive (Panel A) and socio-emotional skills (Panel B) respectively, both standardized with mean 0 and standard deviation 1. The first rows in both panels show what we call the *divorce skill gap*, i.e. the raw mean gap of cognitive and socio-emotional skills between children of intact and disrupted families. The second rows in both panels report the amount of the divorce skill gap that is explained by the O-B decomposition method which represents the difference between the actual mean and the counterfactual, i.e. the outcomes that the children of intact families would have if they had the same characteristics as the children of divorce. The third rows in both panels show the unexplained part, which is the difference between the mean skill gap and the explained component and represent the difference in the return to the observable characteristics between children of intact and disrupted families.

With regard to cognitive skills, the gaps entirely reflect compositional differences in the covariates between the two groups of children with residual components never statistically significant, in the short or long term.[25] A 3 year old child whose parents divorced during the early childhood (between 9 months and age 3), has on average 25% of a standard deviation lower cognitive skills compared to a child of an intact family. Of this, 22.9 percentage points are explained by differences in the characteristics between the two groups of children, with insignificant unexplained component. Similar results are found at ages 5, 7, and 11 respectively with a raw gap of 22% 35% and 27% of a standard deviation. Of these gaps, 21, 28, 24 percentage points, respectively for ages 5, 7, and 11, are explained by differences in observed characteristics with the unexplained components being insignificant.

To understand how important these gaps are, we can compare our divorce skill gaps with the results of other studies that utilise the MCS to analyse child development. For instance, Del Bono et al. (2016) find that a standard deviation increase in maternal time investment increases cognitive outcomes significantly by 13% of a standard deviation at age 3. Similarly, they show that having a mother with at least a university degree is associated with an increase of cognitive abilities of 33% of a standard deviation compared to having a mother without qualification. Therefore, the magnitude of the divorce cognitive skill gaps found in our analysis, ranging from 22% to 35%, is substantial.

[25] Notice that we consider a balanced panel over time, so that the results across ages are comparable.

Table 1.3: Mean divorce skills gaps, by child age

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.250***	0.220***	0.354***	0.266***
	(0.058)	(0.051)	(0.055)	(0.057)
Decomposition				
Explained	0.229***	0.213***	0.282***	0.242***
	(0.029)	(0.024)	(0.028)	(0.026)
Unexplained	0.022	0.007	0.072	0.024
	(0.059)	(0.054)	(0.057)	(0.060)
Panel B: Socio-emotional skills				
Mean Gap	0.337***	0.443***	0.503***	0.537***
	(0.067)	(0.065)	(0.066)	(0.069)
Decomposition				
Explained	0.358***	0.340***	0.316***	0.360***
	(0.030)	(0.029)	(0.028)	(0.029)
Unexplained	-0.022	0.102	0.187***	0.177**
	(0.067)	(0.067)	(0.068)	(0.069)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are: (i) *child characteristics* that are child sex and birth weight; (ii) *demographic characteristics* which are number of siblings, whether parents were cohabiting or married at birth, duration of relationship between the parents at birth, whether the pregnancy was planned, mother's religiosity, parents age, parents ethnicity; (iii) *parental education*; (iv) *health characteristics* that are parents general health; and (v) *family financial resources* which are family income, housing tenure, parents' social class based on NS-SEC (National Statistics Socio-Economic Classification); (vi) *interparental conflicts.* Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Panel B of Table 1.3 features the mean socio-emotional skills gaps by child age which appear to be larger than the cognitive skills gaps.[26] Socio-emotional skills gaps appear to increase over time, going from 0.337 at age 3 to 0.537 at age 11. This suggests that experiencing divorce in early childhood has a stronger negative association with socio-emotional skills compared to cognitive, and this tends to be exacerbated in the long run. A 3 years old child with divorced parents has 33.7% of a standard deviation lower socio-emotional skills compared to his counterpart from an intact family. Of this gap, the differences in observed characteristics accounts for the gap entirely. The same is valid for the socio-emotional gap observed at age 5. Overall, similar to what we found for cognitive skills, the divorce socio-emotional skills gaps appear to be largely explained by compositional differences. However, some unexplained gap is found at ages 7 and 11, with 18.7 percentage points (pp) and 17.7 pp of the gap left unexplained respectively. The unexplained component represents that part of the decomposition that is attributable to the difference in the return to the characteristics

[26]Both cognitive and socio-emotional skills have been standardised to have mean 0 and standard deviation of 1, hence these results are directly comparable.

between the two groups. The unexplained component includes also the difference in the intercepts between the two groups which - if significant - suggests the presence of unobserved characteristics in explaining the gap which could be attributable to divorce itself. In Table A.5 in the Appendix we show that the difference in the intercepts is never significant therefore suggesting no impact of divorce itself.

4.2 What accounts for the mean divorce skills gaps?

Given the major role played by the *compositional effects* in explaining the divorce skills gaps, appropriate policy responses to narrow the gaps potentially depend on the factors that mainly contribute to explain these differences. We consider six sets of factors such as child characteristics, demographic characteristics, parents' education, parent's health, family financial resources and quality of parental relationship, and we identify the relative importance of these factors in explaining the divorce skills gaps.

We report the detailed decomposition of the explained divorced cognitive skills gaps by age in Panel A of Table 1.4 and the same for socio-emotional skills in Panel B. Starting with cognitive skills, the most notable fact is that, regardless of the age at which the gap is observed, the two groups of variables that appear to contribute mostly to the explained cognitive skills gaps are parents' education and the financial resources of the family. For cognitive skills at age 3 (column 1), differences in parents' education between children of intact and disrupted families account for 8.4 out of 22.9 percentage points of the explained divorce gap. This would mean that if the average differences in parental education between children of intact and disrupted families were removed, the divorce skill gap would be reduced by 33.6% (0.084/0.250= 0.336, other things being equal). Parental education contributes 0.070 out of 0.213, 0.100 out of 0.282, and 0.092 out of 0.242 of the explained gaps in cognitive skills, at ages 5, 7 and 11 respectively (columns 2,3 and 4). Overall, the contribution of parental education to the explained gap is around 35%.

With regard to the set of variables on financial resources, the differences between the two groups of children at age 3 explain a large part of the differences in cognitive skill gaps. This means that if the differences in financial resources between the two groups were removed, the implied reduction in the divorce skill gap would be 57% (0.143 / 0.250= 0.572, other things being equal). For the cognitive skills gap, financial resources explain 0.117 out of 0.213 of explained cognitive skills gap at age 5, 0.163 out of 0.282 at age 7 and 0.109 out of 0.242 at age 11. In general, differences in financial resources account for around 60% of the explained divorce differences in cognitive skills. None of the other groups of variables seems to play any significant role in accounting for the explained divorce cognitive gaps. If significant, their contribution is very little compared to parental education and financial resources.

Table 1.4: Detailed decomposition of the mean divorce skills gaps, by child age

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.250***	0.220***	0.354***	0.266***
	(0.058)	(0.051)	(0.055)	(0.057)
Explained				
Child characteristics	0.012	0.011*	0.012**	0.005
	(0.008)	(0.006)	(0.005)	(0.004)
Demographic characteristics	-0.033	-0.000	-0.017	0.023
	(0.021)	(0.018)	(0.018)	(0.019)
Parent's education	0.084***	0.070***	0.100***	0.092***
	(0.013)	(0.012)	(0.015)	(0.014)
Parent's health	0.006	0.003	0.007	-0.006
	(0.004)	(0.004)	(0.005)	(0.004)
Financial Resources	0.143***	0.117***	0.163***	0.109***
	(0.022)	(0.019)	(0.022)	(0.021)
Interparental conflicts	0.017	0.013	0.018	0.018
	(0.011)	(0.011)	(0.012)	(0.011)
Total	0.229***	0.213***	0.282***	0.242***
	(0.029)	(0.024)	(0.028)	(0.026)
Panel B: Socio-emotional skills				
Mean Gap	0.337***	0.443***	0.503***	0.537***
	(0.067)	(0.065)	(0.066)	(0.069)
Explained				
Child characteristics	0.005	0.004	0.003	0.005
	(0.006)	(0.007)	(0.008)	(0.007)
Demographic characteristics	0.036*	0.034*	0.035**	0.060***
	(0.019)	(0.018)	(0.018)	(0.019)
Parent's education	0.054***	0.025**	0.017	0.044***
	(0.013)	(0.012)	(0.011)	(0.012)
Parent's health	0.020***	0.019***	0.021***	0.031***
	(0.006)	(0.006)	(0.006)	(0.008)
Financial Resources	0.114***	0.120***	0.127***	0.105***
	(0.021)	(0.021)	(0.020)	(0.021)
Interparental conflicts	0.130***	0.138***	0.113***	0.116***
	(0.016)	(0.017)	(0.015)	(0.015)
Total	0.358***	0.340***	0.316***	0.360***
	(0.030)	(0.029)	(0.028)	(0.029)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are: (i) *child characteristics* that are child sex and birth weight; (ii) *demographic characteristics* which are number of siblings, whether parents were cohabiting or married at birth, duration of relationship between the parents at birth, whether the pregnancy was planned, mother's religiosity, parents age, parents ethnicity; (iii) *parental education*; (iv) *health characteristics* that are parents general health; and (v) *family financial resources* which are family income, housing tenure, parents' social class based on NS-SEC (National Statistics Socio-Economic Classification); (vi) *interparental conflicts*. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

There are several mechanisms through which we might explain how these two sets of factors, i.e. parental education and financial resources, are strongly correlated with children's cognitive development and how they account for most of the divorce skills gaps, for example: (i) better financial circumstances may imply higher financial investment on child development; (ii) a higher level of parental education may increase investments in child human capital in terms of access to additional resources or networks; (iii) parents with a higher level of education may have higher parenting skills and therefore may invest more or more effectively in child development; (iv) parental education is likely to be correlated with parental cognitive abilities: if cognitive abilities are transmitted from parents' to children, then parental education is likely to be correlated with children's cognitive skills. This conveys a pattern of intergenerational transmission of cognitive abilities which accounts for a substantial part of the gap.

In Panel B of Table 1.4, we present the detailed decompositions of the explained divorce socio-emotional skills gaps over time. As pointed out earlier, the gap in socio-emotional skills is larger, and unlike for cognitive skills almost all groups of variables contribute significantly in explaining the gap. This is consistent with the higher malleability of socio-emotional skills compared to cognitive skills (Heckman, 2000). Furthermore, it appears that different dimensions of skills have different factors contributing to their corresponding divorce gaps. The sets of factors that mostly contribute to the socio-emotional gaps are the interparental conflicts and the financial resources of the family.

For 3 years old children's socio-emotional skills (column 1), differences in interparental conflicts account for 0.130 out of 0.358 of the explained gap. This suggests that if the average differences in interparental conflicts between the two groups of children were removed, then the divorce socio-emotional skills gap would narrow by 38.5% (0.130/0.337= 0.385, other things being equal). For the socio-emotional skills gap, interparental conflicts explain 0.138 out of 0.340 of explained socio-emotional skills gap at age 5, 0.113 out of 0.316 at age 7 and 0.116 out of 0.360 at age 11. It therefore appears that interparental quality of relationship not only matters but it is able to largely explain the difference in behavioral problems between children of disrupted and intact families and indeed is one of the most important factors contributing to the gap. Overall, interparental conflicts have an explanatory power of around 35% of the explained gap.

What could be the mechanisms that drive these relationships between interparental conflicts and children's socio-emotional development? Few possibilities are (i) families with a better interparental relationship can collaborate in parenting activities more easily and effectively and this is likely to influence parent-child relationship quality and in turn child wellbeing (Adamsons et al., 2007; Fine and Kurdek, 1995; Hanson et al., 1996; Carlson and Magnuson, 2011); (ii) interparental conflicts are likely to be correlated with parental socio-emotional abilities, such as particular personality traits and psychological distress. If socio-emotional abilities are intergenerationally transmitted either directly or indirectly, then the interparental relationship is likely to be correlated with children's socio-emotional skills.[27]

[27]The psychological literature shows that there are various channels through which conflicts may affect children socio-emotional outcomes. For example, the presence of interparental conflict may lead the child to self-blame and develop problems such as anxiety and depression (Grych et al., 2000).

Another set of variables that has consistent explanatory power in terms of the socio-emotional skills gaps, regardless of child age, is that related to financial resources. Financial resources account for 0.114 out of 0.358 of the divorce skills gaps at age 3 with an overall explanatory power of around 35% of the explained component. This implies that, around 70% of the explained divorce socio-emotional skills gaps are accounted for by the quality of parental relationship that the child is exposed to and the financial circumstances of the family before divorce.

Unlike the results for cognitive development, parents' education does not seem to play a major role in explaining the socio-emotional skills gaps. In contrast, the quality of relationship between parents is one of the key variable to account for the divorce socio-emotional gaps.

Our results indicate that neglecting to control for interparental conflicts when trying to establish the impact of separation on child or adolescent or later outcomes may bias the results upwards. This is because, although conflicts appear to impact only child socio-emotional outcomes, there is a consistent evidence in the literature showing that both cognitive and socio-emotional skills are determinants of later outcomes such as education and labour market (Almond and Currie, 2011). This finding may offer an explanation for the mixed results found in the literature on the impact of divorce on children later outcomes.

Taken together, our results indicate that different dimensions of skills have different factors contributing to the corresponding divorce gaps, with interesting patterns emerging. The role of financial resources is significant across cognitive and socio-emotional skills, although the impact is larger for the former. Beyond financial resources, cognitive and socio-emotional divorce skill gaps seem to be driven by different factors. A large part of the gap in cognitive skills is explained by parental education, whilst a large part of the gap in socio-emotional development is explained by the interparental quality of relationship. Since, on the one hand, parental education is highly correlated with parental cognitive abilities and, on the other, interparental conflicts are correlated with parents' socio-emotional skills, there is room for interpreting our results in terms of one the most important mechanisms of intergenerational transmission, which is the transfer of abilities from parents to children.[28]

As pointed out in Section 4.1, there is some statistically significant unexplained component for socio-emotional skills at age 7 and 11, implying that in these cases the return to the characteristics is different between the two groups. Table A.5 in the Appendix shows the detailed decomposition of the unexplained components when significant. Differently from the detailed decomposition of the explained component, there is no clear pattern in the difference of the return to these set of characteristics although they are jointly significant. However, there seems to be some differences in the return of interparental conflicts between the two groups. It appears that the higher the conflicts before separation the lower the unexplained component, which means that the conflicts are more harmful for children of intact families than for children of divorce, possibly because children of divorce are not any more exposed to conflicts once the parents separate.

[28]Similar analysis is provided for divorce occurring at later stages (between age 3 and 5, between age 5 and 7). Results are very similar irrespective of the timing of divorce and therefore are not part of the main analysis but are shown in Table A.6 and A.7.

In an attempt to understand more about the comparison between the explained and unexplained components, it is helpful to compare the unexplained part when significant with the contribution of some sets of factors in explaining the gap. For example, although the unexplained component for child socio-emotional skills at age 7 is of 0.177, looking at the correspondent detailed decomposition of the explained component in Table 1.4 it is clear that, other things being equal, removing the differences between the two groups of children in inter-parental conflicts (0.113) and family financial resources (0.129) would more than compensate for the unexplained divorce gap. Finally, the most notable fact is that the difference in the intercepts between children of intact and disrupted families, the constant in Table A.5, is not statistically significant - thereby suggesting that differences in unobservables between the two groups of children do not significantly explain the divorce skills gaps. This implies that - once accounting for observables - there are no unobserved characteristics significantly contributing to the gap, therefore suggesting no causal impact of divorce.

4.3 Divorce skills gaps across the children's skills distributions

Figure 1.1 features the results of the Oaxaca-Blinder decomposition at the 25th, 50th, 75th, 90th percentile distribution of cognitive and socio-emotional skills and includes total mean differences (circle), the explained component (diamond) and the unexplained component (triangle). The first row of graphs in Figure 1.1 shows the results of the decomposition for cognitive skills over time and the second row for socio-emotional skills.

With regard to cognitive skills, results show that children of intact families score higher on cognitive tests at all quantiles of cognitive skills distribution, consistent with our previous analysis. Looking at the different components of the decomposition, cognitive skills do not seem to have any clear pattern of pronounced inequalities across children cognitive skills' distributions. These results therefore provide a robustness analysis of the mean decomposition suggesting that the average decomposition of the divorce cognitive skills gaps is able to capture the main features characterising the divorce gap. We provide the full table of the correspondent results, including the standard errors in Table A.8 in the Appendix.[29] Consistent with our decomposition results at the mean, the raw gap is mainly explained by compositional differences in covariates with the residual component rarely different from zero at standard significance levels.[30]

[29]The detailed decomposition of the divorce skills gaps across the children's skills distribution confirm that the major set of factors contributing for the cognitive skills gaps are family financial resources and parents' education. These results are not shown for brevity purposes.

[30]The only exception is the decomposition of cognitive skills at age 7 in the 50th and in the 90th quantiles that show some unexplained effect statistically different from zero. However, the difference between the intercepts is insignificant.

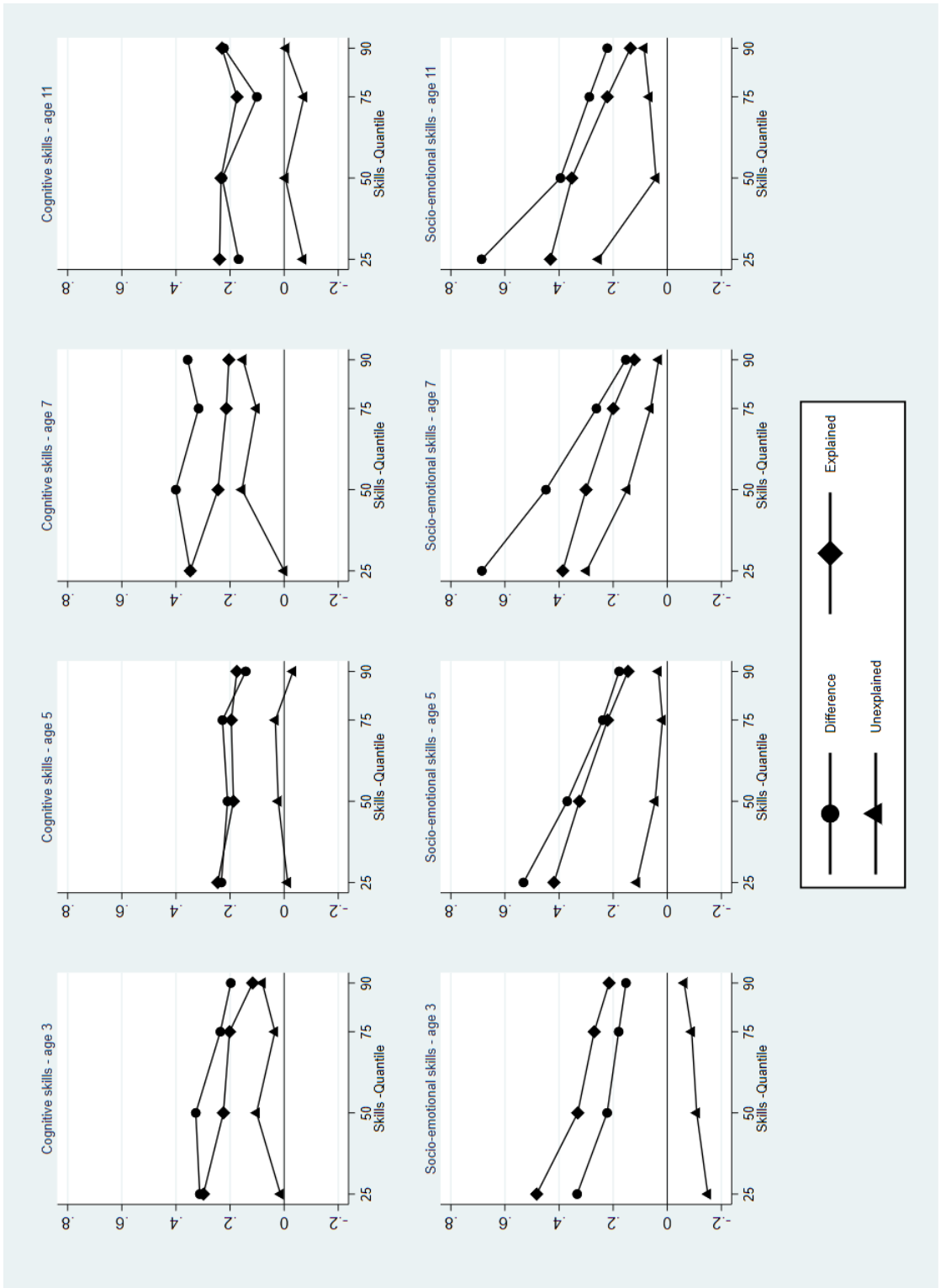


Figure 1.1: Decomposition across the skills distribution

A different pattern arises when looking at socio-emotional skills. As noticed in previous analysis, the divorce socio-emotional gaps are much lager than the cognitive skills gaps, and the decomposition across the distribution show that this is valid at all levels of socio-emotional skills. In addition, this extension of the Oaxaca Blinder decomposition highlights another difference between divorce gaps in cognitive and socio-emotional skills. We find a pronounced pattern of decreasing differentials across the distribution of socio-emotional abilities. [31] The second row of graphs in Figure 1.1 shows that the divorce socio-emotional skills gaps decreases from the 25th quantile to the 90th quantile at all ages. In accord with the results at the mean, the socio-emotional divorce gap increases in the long run from age 3 to age 11. This sharp increase however, is not entirely reflected in the explained component, as at the lower tail of the distribution there is some significant residual part left unexplained at age 7 and 11 at the bottom of the distribution. These results highlight the presence of unexplained component in the socio-emotional skills distribution mainly for children with lower socio-emotional skills due to the different return in the characteristics between the two groups of children.[32] These results can be interpreted in light of the diathesis stress framework (see Beck 1967; Monroe and Simons 1991; Hilsman and Garber 1995) whereby a child's predisposition to behavioral problems manifests in the presence of stressful event, e.g. parental separation.

4.3.1 Gender differences in the divorce skills gaps across the skills distributions

Figures 1.2 and 1.3 depicts the same decomposition across children skills distrubution by gender. Results are similar when comparing by gender the divorce skills gaps in cognitive skills, whereby the gaps appears to be quite homogeneous across child's skills irrespective of the gender. However, there is a clear gender difference in the divorce gaps in socio-emotional skills, with boys showing a more pronounced pattern of decreasing gap across the distribution of socio-emotional skills, and with larger divorce gap among children with high behavioral problems. The raw gap among boys at the 25th percentile is around 80% of a standard deviation whereas for girls is around 60%. The gender differences diminish with the level of socio-emotional skills, with divorce gap of around 20% of a standard deviation for both genders at the 90th percentile.[33] These results are in line with a recent contribution by Bertrand and Pan (2013), which finds that boys have more behavioral problems than girls, especially in broken families. Overall, looking beyond the mean, the decomposition reveals that whilst there are no evident inequalities in the divorce gap across the children's cognitive skills distributions neither for boys nor for girls, the divorce socio-emotional skills gaps are

[31] The full table of the correspondent results, including the standard errors, can be found in the Appendix in Table A.9. The detailed decomposition of the divorce skills gaps across the children's skills distribution confirm that the major set of factors contributing for the socio-emotional skills gaps are family financial resources and interparental conflicts. These results are not shown for brevity purposes.

[32] Notice that, in these cases when there is some unexplained component, the difference between the intercepts is insignificant.

[33] Table A.10 and A.11 in the Appendix reports the results of the decomposition of the mean divorce skills gap by gender. At the mean the gender differences are less evident. However, boys seems to have larger mean socio-emotional skills gaps than girls at younger ages. This is confirmed by the decomposition results across child's skills distribution.

more pronounced at the lower tail of the distribution rather than at the upper tail, especially for boys.

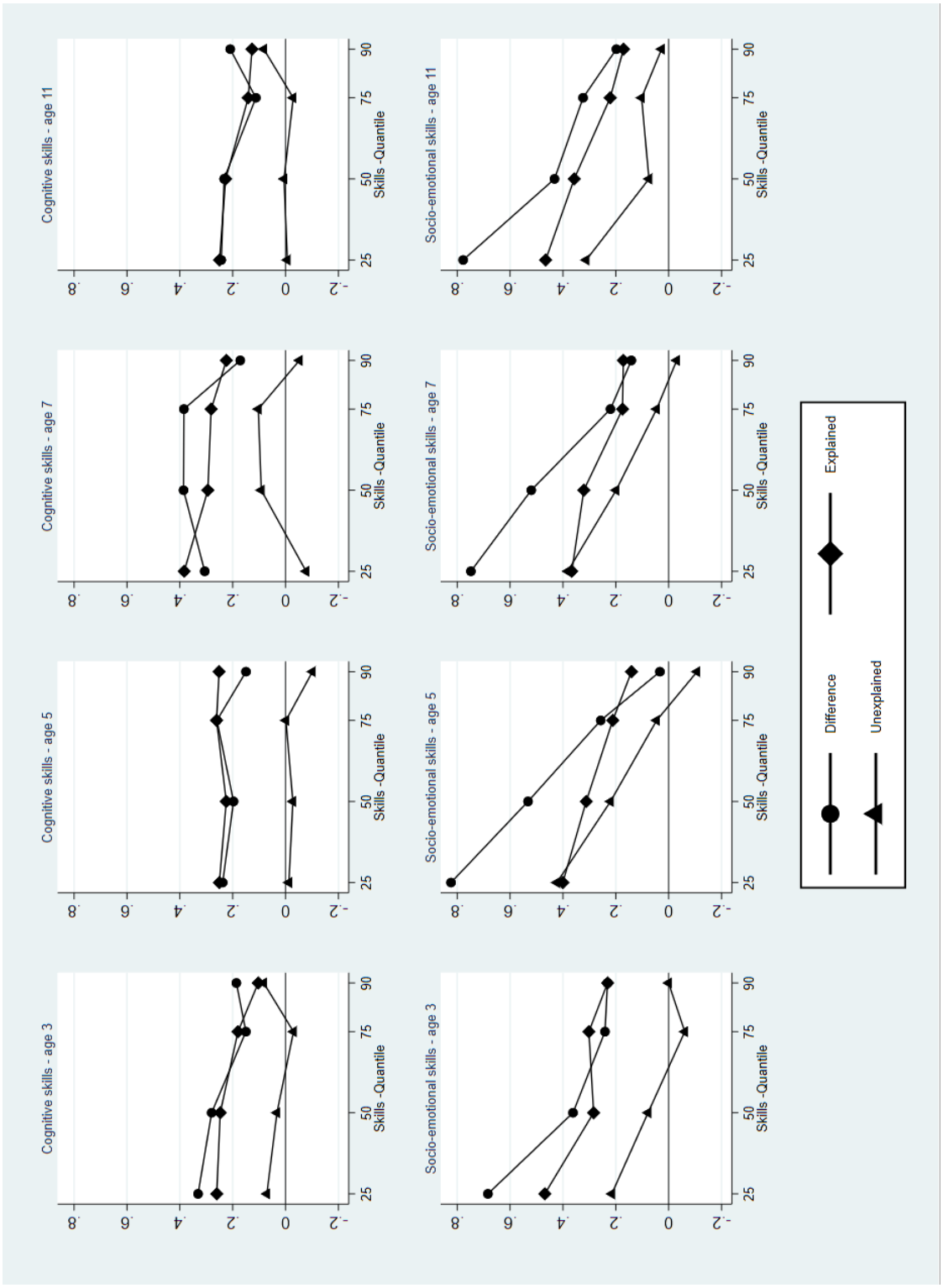


Figure 1.2: Decomposition across the skills distribution - boys

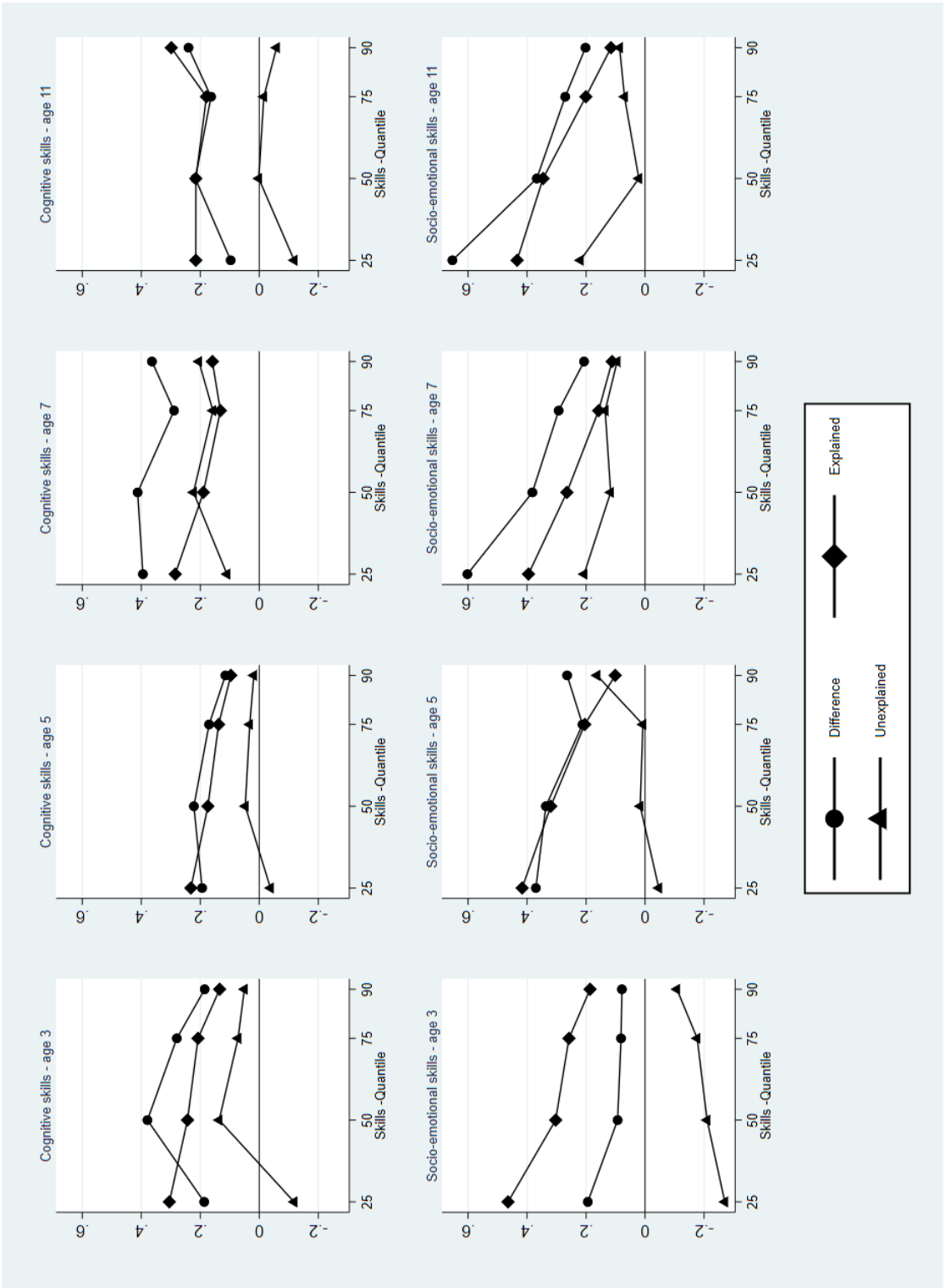


Figure 1.3: Decomposition across the skills distribution - girls

5 Sensitivity analyses

We are concerned about some of the limits of the O-B decomposition and we address them by carrying out a set of sensitivity analyses similar to Longhi et al. (2012, 2013) and Nandi and Nicoletti (2014) by (i) estimating the reweighted O-B decomposition, (ii) changing the counterfactual and (iii) imposing a common support.

5.1 Reweighted Oaxaca-Blinder decomposition

As discussed in Section 3.3, the detailed decomposition of the explained component provided by the O-B method is reliable only if the composition effects estimated with a reweighted O-B method are similar to the composition effects estimated with the unweighted O-B method. We decompose the divorce skills gaps at the mean using the more robust reweighted decomposition methodology (DiNardo et al., 1996; Fortin et al., 2011) to separate composition effects from residual effects.[34] Specifically, we construct a counterfactual sample of children of intact families reweighted to have the same characteristics of children of divorce. Then differences between skills from this counterfactual sample and those of children of intact families represents the true divorce skills gaps, with no misspecification error due to the nonlinearity of the underlying conditional expectation. As explained in Section 3.3, we use a logit model to compute the appropriate weights with the same explanatory variables used in the rest of our analysis.

Table 1.5 reports the results for the mean divorce skills gaps using the reweighted method for cognitive and socio-emotional skills in Panel A and B respectively. Overall, the reweighted method confirms the findings that composition effects largely explain the differences between the two groups of children, for both cognitive and socio-emotional skills. In fact, the reweighted decomposition results indicate that the composition effect over-explains the divorce gap for both cognitive and socio-emotional skills, which suggests that, given the difference in the covariates, children from intact families should have even higher skills compared to children of divorce. The differences between the two models are attributable to some specification error due to the presence of nonlinearity and reweighting error.[35] If anything the composition effects computed with the unweighted methodology would be underestimated, which would suggest that the accounting power of the factors that mainly explain the divorce skills gap might be underestimated. If this is the case, the insights provided in our analysis would largely remain unchanged; indeed it would suggest that the accounting power of some of the factors may be even stronger.

[34] See Longhi et al. (2012, 2013); Nandi and Nicoletti (2014); Fortin et al. (2015) for a recent application of the methodology.

[35] The reweighting error goes to zero in large samples. Ideally the reweighting error should be an order of magnitude smaller. However significant reweighting error is common in case of relatively small sample (see e.g. Fortin et al. 2015).

Table 1.5: Reweighted detailed decomposition of the divorce gap, by child age

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.250***	0.220***	0.354***	0.266***
	(0.058)	(0.051)	(0.055)	(0.057)
Explained				
Child characteristics	0.024**	0.014**	0.015**	0.005
	(0.010)	(0.006)	(0.006)	(0.007)
Demographic characteristics	-0.054	-0.038	-0.110*	0.013
	(0.086)	(0.041)	(0.062)	(0.044)
Parent's education	0.182***	0.157***	0.218***	0.158***
	(0.030)	(0.028)	(0.034)	(0.030)
Parent's health	0.020	0.015	0.015	-0.021*
	(0.014)	(0.012)	(0.013)	(0.012)
Financial Resources	0.166***	0.143***	0.213***	0.193***
	(0.048)	(0.044)	(0.051)	(0.050)
Interparental conflicts	0.057	0.012	0.027	0.044
	(0.039)	(0.028)	(0.029)	(0.031)
Total Explained	0.395***	0.304***	0.379***	0.392***
	(0.111)	(0.060)	(0.083)	(0.070)
Specification error	-0.059	0.013	0.115	0.000
	(0.107)	(0.070)	(0.086)	(0.081)
Total Unexplained	0.026	0.004	-0.011	0.003
	(0.031)	(0.020)	(0.025)	(0.023)
Reweighting error	-0.111**	-0.101***	-0.128***	-0.129***
	(0.044)	(0.021)	(0.032)	(0.027)
Panel B: Socio-emotional skills				
Mean Gap	0.337***	0.443***	0.503***	0.537***
	(0.067)	(0.065)	(0.066)	(0.069)
Explained				
Child characteristics	0.014**	0.013*	0.014*	0.010
	(0.007)	(0.008)	(0.008)	(0.007)
Demographic characteristics	-0.024	0.061	0.020	0.026
	(0.048)	(0.050)	(0.043)	(0.040)
Parent's education	0.096***	0.054**	0.062***	0.075***
	(0.027)	(0.025)	(0.024)	(0.021)
Parent's health	0.027**	0.018**	0.018*	0.031***
	(0.013)	(0.009)	(0.009)	(0.010)
Financial Resources	0.153***	0.142***	0.197***	0.200***
	(0.046)	(0.041)	(0.043)	(0.045)
Interparental conflicts	0.237***	0.263***	0.201***	0.201***
	(0.033)	(0.029)	(0.027)	(0.026)
Total Explained	0.504***	0.550***	0.512***	0.543***
	(0.076)	(0.071)	(0.063)	(0.059)
Specification error	0.002	0.072	0.148*	0.166**
	(0.088)	(0.085)	(0.082)	(0.081)
Total Unexplained	-0.008	0.007	-0.002	-0.011
	(0.024)	(0.022)	(0.021)	(0.021)
Reweighting error	-0.161***	-0.186***	-0.155***	-0.161***
	(0.028)	(0.028)	(0.023)	(0.022)

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

5.2 Choice of the counterfactual

Another limitation of the Oaxaca–Blinder decompositions is that the decomposition results may depend on the chosen reference group. Our choice of the counterfactual - children of intact families with the same mean covariates of children of divorce (see Equation 1.3)- implies that the reference group is the sample of children of intact families. We argue that the children of intact families' skills represent the appropriate counterfactual for the children of divorce's skills in absence of causal impact of divorce on children outcomes.

To test for the robustness of our results that may depend on the choice of the counterfactual, we consider two alternative counterfactuals: (i) children of divorce with the same characteristics of children of intact families, whereby the reference group is the subsample of children of divorce; (ii) decomposition using coefficients from pooled regression, whereby the reference group is the full sample (pooled sample) of children of intact and divorced families. Results are shown in Table 1.6 and 1.7 respectively and are consistent with those from our primary decomposition provided in Table 1.3. These results suggest that our decomposition findings are robust to different choices of the counterfactual.

Table 1.6: Mean divorce skills gaps, by child age - using as reference group the children of divorce

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.250***	0.220***	0.354***	0.266***
	(0.058)	(0.051)	(0.055)	(0.057)
Decomposition				
Explained	0.214***	0.220***	0.348***	0.194***
	(0.075)	(0.068)	(0.069)	(0.062)
Unexplained	0.037	-0.001	0.006	0.072
	(0.089)	(0.081)	(0.078)	(0.076)
Panel B: Socio-emotional skills				
Mean Gap	0.337***	0.443***	0.503***	0.537***
	(0.067)	(0.065)	(0.066)	(0.069)
Decomposition				
Explained	0.441***	0.327***	0.237***	0.353***
	(0.082)	(0.079)	(0.074)	(0.079)
Unexplained	-0.105	0.116	0.266***	0.185**
	(0.080)	(0.082)	(0.087)	(0.093)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table 1.7: Mean divorce skills gaps, by child age - using as reference group the pooled sample of children of intact and divorced families

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.250***	0.220***	0.354***	0.266***
	(0.055)	(0.049)	(0.053)	(0.055)
Decomposition				
Explained	0.224***	0.209***	0.284***	0.237***
	(0.028)	(0.023)	(0.027)	(0.025)
Unexplained	0.027	0.010	0.070	0.029
	(0.056)	(0.051)	(0.055)	(0.057)
Panel B: Socio-emotional skills				
Mean Gap	0.337***	0.443***	0.503***	0.537***
	(0.064)	(0.062)	(0.063)	(0.066)
Decomposition				
Explained	0.368***	0.341***	0.308***	0.360***
	(0.029)	(0.028)	(0.027)	(0.029)
Unexplained	-0.032	0.102*	0.195***	0.178***
	(0.061)	(0.061)	(0.064)	(0.065)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

5.3 Common support

To address the common support concern we repeat our analysis following Dehejia and Wahba (2002) and Słoczyński (2015) and we adopt two different rules in order to improve the overlap. First, we remove from our sample all children of divorce whose estimated propensity score is lower than the minimum or higher than the maximum estimated propensity score for children of intact families. By following this rule, we want to avoid including those children of divorce who have no counterparts among children of intact families in the decomposition. Second, we further restrict our sample by excluding all children of intact families whose estimated propensity score is lower than the minimum or higher than the maximum estimated propensity score for the children of divorce. This is to guarantee that none of the dissimilar children of intact families is used to compute the counterfactual outcome of the children of divorce.

Table 1.8 shows the results of the decomposition when imposing the common support restriction, for cognitive (Panel A) and socio-emotional skills (Panel B) respectively. We find no differences between these results and the main results reported in Table 1.3. This is unsurprising as we only drop very few observations when imposing the common support assumption, which suggests that the distribution of propensities to divorce between the two groups of children largely overlap.

Table 1.8: Mean divorce skills gaps, by child age - common support

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.243***	0.207***	0.341***	0.260***
	(0.058)	(0.051)	(0.055)	(0.057)
Decomposition				
Explained	0.230***	0.209***	0.281***	0.238***
	(0.029)	(0.024)	(0.028)	(0.026)
Unexplained	0.013	-0.002	0.060	0.022
	(0.059)	(0.053)	(0.057)	(0.060)
Panel B: Socio-emotional skills				
Mean Gap	0.330***	0.428***	0.497***	0.533***
	(0.067)	(0.065)	(0.066)	(0.069)
Decomposition				
Explained	0.352***	0.333***	0.311***	0.356***
	(0.030)	(0.029)	(0.027)	(0.029)
Unexplained	-0.022	0.095	0.186***	0.177**
	(0.067)	(0.067)	(0.068)	(0.070)
Observations	4954	4954	4954	4954

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

6 Conclusion

Using the Millennium Cohort Study from the UK, this paper investigates which factors from a set of plausible suspects - child characteristics, demographic characteristics, parents' education and health, family financial resources and interparental conflicts - are relatively more important in accounting for the divorce gaps in cognitive and socio-emotional skills of children. In addition, it explore for the first time in the literature the heterogeneity in the decomposition of the gaps across the distribution of children's abilities. Differently from other studies that focus on the impact of divorce on children's later outcomes, we aim at determining the drivers of the divorce skills gaps in the short and medium term up until age 11. Given the malleability of skills in early childhood and the higher effectiveness of early intervention in reducing inequalities arising in early childhood, it is important to understand the channels through which the divorce skills gaps can be explained.

Our findings show that the divorce gaps in cognitive and socio-emotional skills are entirely explained by parental selection into divorce; therefore ruling out any causal impact of divorce. Our analysis further illustrates that the driving factors of the divorce gaps differ between different skill dimensions. Cognitive gaps are explained by parental education and family financial resources, but they are almost completely insensitive to any other family characteristics including interparental conflicts. Conversely, socio-emotional gap are mostly

explained by interparental conflicts and family financial resources. Adding this measure of interparental conflicts to the set of variables commonly used in the literature does not make a big difference in explaining the disparities in cognitive skills, but it does strongly explain the socio-emotional disparities. This offers much needed insight that, to an extent, reconciles the ambiguous evidence obtained so far in the literature looking at the impact of separation on children, adolescent and adult outcomes. We also go beyond the mean divorce skills gaps by looking at the entire distribution of child abilities, and provide the first evidence that there is a wider gap among low skilled children, particularly among boys with low socio-emotional skills.

In the political, economic and public debate about the relationship between divorce and child development, this paper gives a comprehensive view of the disparities arising between children whose parents are separated and those who decide to stay married. The results highlight the importance of the characteristics that make a family to select into divorce, with differences in parent's education, interparental conflicts and financial resources being the main factors accounting for the gaps. Digging deeper into our results and comparing the determinants of the cognitive and socio-emotional gaps, our results indicate that the intergenerational transmission of skills is one of the main mechanisms for the lower achievements of children of divorce. On the basis of this evidence, our findings suggest that to reduce the disadvantage in skills among children of divorce, policies discouraging divorce are not effective; interventions potentially more efficacious are those targeted to the characteristics driving the parental selection into divorce.

A Appendices

A.1 Institutional background

This section describes the institutional background characterizing the UK and our sample. The most important divorce reform in the UK was the Divorce Reform Act 1969, strengthened in the Matrimonial Causes Act 1973 which still contains the divorce law UK is subject to today. This reform yielded remarkable changes because, in addition to the three grounds of divorce of adultery, behavior and desertion, already present in the previous Matrimonial Causes Act 1937, it adds grounds for divorce, based on two years' consensual separation, or five years' if one of the party is non-consensual. This legislation removed the concept of 'matrimonial offences' and introduced some elements of no-fault divorce, although a formal 'no fault' divorce has not been introduced yet in the UK with a still ongoing debate. The divorce reform, together with the change in attitudes and expectations toward marriage, and the higher women's employment rate[36], has followed by a sharp increase in the number of divorced couples from around 50,000 per year in the early '70s to 150,000 in the '80s.[37] Then the number of divorces remain stable for 20 years until recently, when it has fallen steadily, together with the number of marriages.[38] More precisely, the number of divorcing couples in England and Wales in 2013 was 114,720, involving 94,864 children under 16. Among these children, 21% were under 5 and 64% were under 11 years old.[39]

In addition to the divorce law the UK has implemented, there are other policies indirectly related to divorce, e.g. pro-marriage policies. In 2015 the UK has introduced a new public policy called *Married couples allowance*, aimed to reduce the tax bill each year if a couple is married or in a civil partnership.[40] This policy promotes marriages and civil partnerships and discourages divorce, without considering the possible drawback of reshaping the incentive to divorce and convincing conflictual couples to stay married.[41] If these policies are motivated by promoting two-parents families as the best environment for child development, we need to establish that the negative association between parental separation and children outcomes cannot be entirely explained by selection.

Finally, Child Maintenance policies may indirectly affect divorce decisions (Walker and Zhu 2006 for the UK and Nixon 1997 for the US). During our sample period (2000-2012) child maintenance has been regulated by the Child Support Agency (CSA) introduced in 1993, a reform that mandated child support payment for the first time. In 2003 a simplified scheme was introduced, where the amount of financial support provided by the non-resident parent depend on his/her net weekly income. In addition, this scheme included the possibility of shared care for parents, meaning that the non-resident parent pays lower maintenance

[36] Evidence on no-fault divorce law and female labour supply is provided for US (Genadek et al., 2007).

[37] González and Viitanen (2009) analyze the effect on divorce rate of no-fault divorce reform in Europe and find a sizeable effect of the reform in increasing the divorce rate.

[38] A similar figure characterizes the US (Rotz, 2016).

[39] Source: Office from National Statistics.

[40] A similar policy, the *Temporary Assistance to Needy Families* (TANF) introduced in 1997 can be found in the US.

[41] Consider McLanahan (2007), Amato and Furstenberg (2007), and Frimmel et al. (2014) for evaluation of pro-marriage policies.

if he/she stays with the child for at least 52 nights a year.[42] More recently, the Children and Families Act 2014 replaced the CSA with the Child Maintenance Service which includes the possibility of 50-50 shared parenting and requires the parents to attend a Mediation Information and Assessment Meeting before applying to court.[43] This procedure is aimed at encouraging cooperation between the parents and at reducing conflicts in the best interest of the child. Although this scheme does not regard our sample it is important to mention it for policy implication purposes.

A.2 Further description of data

Table A.1: Assessment, by child age

Assessment	Age 3	Age 5	Age 7	Age 11
Cognitive skills				
Bracken School Readiness Test	X			
BAS Naming Vocabulary	X	X		
BAS Picture Similarity		X		
BAS Pattern Construction		X	X	
BAS Word Reading			X	
BAS Verbal Similarities				X
NFER Number Skills			X	
Socio-emotional skills				
SDQ (Strenght and Difficulties Questionnaire)	X	X	X	X

Table A.2: Cognitive skills - Factor loadings

	(1) Factor Loadings	(2) Signal
Age 3		
BAS Naming vocabulary	0.874	0.764
Braken School Readiness Test	0.874	0.764
Age 5		
BAS Naming vocabulary	0.711	0.506
BAS Pattern construction	0.727	0.528
BAS Picture Similarity	0.735	0.540
Age 7		
BAS Word Reading	0.768	0.590
BAS Pattern construction	0.731	0.534
BAS Mathematical Skills	0.843	0.710

Sources: UK Millennium Cohort Study
Notes: Column (1) shows the factor loading and Column (2) shows the signal that is the proportion of the variance of each measure explained by the latent factor.

[42]Source: www.csa.gov.uk
[43]Source: www.gov.uk

Table A.3: Socio-emotional skills - Factor loadings

	(1) Factor Loadings	(2) Signal
Age 3		
Emotional Symtoms	0.521	0.272
Peer Problems	0.616	0.379
Conduct Problems	0.744	0.554
Hyperactivity Problems	0.699	0.488
Prosocial Behaviour	0.594	0.353
Age 5		
Emotional Symtoms	0.554	0.307
Peer Problems	0.605	0.366
Conduct Problems	0.598	0.358
Hyperactivity Problems	0.707	0.500
Prosocial Behaviour	0.598	0.358
Age 7		
Emotional Symtoms	0.575	0.331
Peer Problems	0.625	0.391
Conduct Problems	0.767	0.588
Hyperactivity Problems	0.725	0.526
Prosocial Behaviour	0.612	0.375
Age 11		
Emotional Symtoms	0.646	0.417
Peer Problems	0.661	0.436
Conduct Problems	0.765	0.586
Hyperactivity Problems	0.742	0.551
Prosocial Behaviour	0.593	0.351

Sources: UK Millennium Cohort Study
Notes: Column (1) shows the factor loading and Column (2) shows the signal that is the proportion of the variance of each measure explained by the latent factor.

Table A.4: Interparental Conflicts - Factor loadings

	(1) Factor Loadings	(2) Signal
Interparental conflicts (age 9 months)		
Partner sensitive and aware of needs	0.728	0.530
Partner doesnt listen	0.721	0.520
Sometime lonely when with partner	0.725	0.526
Relationship full of joy and excitement	0.695	0.483
Wishes was more warmth and affection	0.731	0.535
Suspects on brink of separation	0.561	0.315
Can make up quickly after argument	0.434	0.189
Frequency go out as a couple	0.233	0.054
Happy/Unhappy with relationship	0.608	0.369

Sources: UK Millennium Cohort Study
Notes: Column (1) shows the factor loading and Column (2) shows the signal that is the proportion of the variance of each measure explained by the latent factor.

A.3 Further empirical results

Table A.5: Detailed decomposition of the mean divorce skills gaps, by child age - unexplained component when significant

	(1) Age 7	(2) Age 11
Panel B: Socio-emotional skills		
Unexplained		
Child characteristics	0.309	-0.182
	(0.365)	(0.427)
Demographic characteristics	-0.103	-0.411
	(0.622)	(0.551)
Parent's education	-0.032	0.016
	(0.041)	(0.044)
Parent's health	-0.131	-0.217
	(0.185)	(0.192)
Financial Resources	0.035	-0.167
	(0.173)	(0.181)
Interparental conflicts	-0.059*	-0.015
	(0.035)	(0.035)
Constant	0.168	1.151
	(0.695)	(0.736)
Total	0.187***	0.177**
	(0.068)	(0.069)
Observations	5003	5003

Source: UK Millennium Cohort Study.
Notes: Socio-emotional skills are in standard deviations. The variables used to explain the gap are the same as Table 1.3. The table shows the detailed decomposition of the unexplained component when significant (see Table 1.3). Column (1) corresponds to the detailed decomposition of the unexplained component of the divorce skills gap of socio-emotional skills at age 7 as reported in Table 1.3, Panel B Column (3). Column (2) corresponds to the detailed decomposition of the unexplained component of the divorce skills gap of socio-emotional skills at age 11 as reported in Table 1.3, Panel B Column (4). Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.6: Mean divorce skills gaps, by child age - divorce between age 3 and 5 of the child

	(1) Age 5	(2) Age 7	(3) Age 11
Panel A: Cognitive skills			
Mean Gap	0.138***	0.283***	0.246***
	(0.049)	(0.054)	(0.053)
Explained			
Child characteristics	0.010*	0.011**	0.005
	(0.006)	(0.005)	(0.003)
Demographic characteristics	0.011	-0.004	0.021*
	(0.012)	(0.011)	(0.012)
Parent's education	0.044***	0.058***	0.057***
	(0.009)	(0.011)	(0.010)
Parent's health	0.003	0.006	-0.003
	(0.003)	(0.004)	(0.003)
Financial Resources	0.076***	0.116***	0.070***
	(0.013)	(0.015)	(0.013)
Interparental conflicts	0.007	0.009	0.006
	(0.006)	(0.007)	(0.006)
Total	0.152***	0.195***	0.156***
	(0.019)	(0.021)	(0.019)
Panel B: Socio-emotional skills			
Mean Gap	0.304***	0.362***	0.319***
	(0.057)	(0.063)	(0.056)
Explained			
Child characteristics	0.003	0.001	0.003
	(0.007)	(0.008)	(0.007)
Demographic characteristics	0.014	0.012	0.029**
	(0.010)	(0.010)	(0.011)
Parent's education	0.015**	0.011	0.025***
	(0.008)	(0.007)	(0.008)
Parent's health	0.016***	0.016***	0.024***
	(0.005)	(0.005)	(0.007)
Financial Resources	0.075***	0.086***	0.078***
	(0.013)	(0.013)	(0.013)
Interparental conflicts	0.087***	0.071***	0.066***
	(0.012)	(0.011)	(0.010)
Total	0.210***	0.196***	0.225***
	(0.021)	(0.020)	(0.022)
Observations	6011	6011	6011

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.7: Mean divorce skills gaps, by child age - divorce between age 5 and 7 of the child

	(1) Age 7	(2) Age 11
Panel A: Cognitive skills		
Mean Gap	0.128**	0.102*
	(0.061)	(0.059)
Explained		
Child characteristics	0.007	0.004
	(0.006)	(0.004)
Demographic characteristics	0.003	0.026**
	(0.009)	(0.010)
Parent's education	0.046***	0.045***
	(0.011)	(0.010)
Parent's health	0.002	-0.001
	(0.003)	(0.002)
Financial Resources	0.089***	0.058***
	(0.015)	(0.012)
Interparental conflicts	0.007*	0.004
	(0.004)	(0.003)
Total	0.153***	0.134***
	(0.022)	(0.020)
Panel B: Socio-emotional skills		
Mean Gap	0.253***	0.326***
	(0.061)	(0.060)
Explained		
Child characteristics	-0.000	0.001
	(0.008)	(0.007)
Demographic characteristics	0.003	0.019**
	(0.008)	(0.009)
Parent's education	0.008	0.016**
	(0.007)	(0.007)
Parent's health	0.008*	0.013**
	(0.005)	(0.006)
Financial Resources	0.074***	0.062***
	(0.013)	(0.012)
Interparental conflicts	0.040***	0.037***
	(0.010)	(0.009)
Total	0.133***	0.148***
	(0.021)	(0.021)
Observations	6256	6256

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.8: Decomposition across the cognitive skills distribution, by child age

	(1) 25th Quantile	(2) 50th Quantile	(3) 75th Quantile	(4) 90th Quantile
Panel A: Age 3				
Quantile Gap	0.312***	0.327***	0.236**	0.197*
	(0.073)	(0.066)	(0.092)	(0.116)
Explained				
Total	0.298***	0.225***	0.202***	0.117**
	(0.038)	(0.031)	(0.036)	(0.047)
Unexplained				
Total	0.014	0.102	0.034	0.080
	(0.077)	(0.068)	(0.096)	(0.122)
Panel B: Age 5				
Quantile Gap	0.232***	0.209***	0.228***	0.142*
	(0.070)	(0.060)	(0.065)	(0.080)
Explained				
Total	0.245***	0.187***	0.195***	0.175***
	(0.032)	(0.026)	(0.027)	(0.032)
Unexplained				
Total	-0.013	0.022	0.033	-0.033
	(0.074)	(0.064)	(0.068)	(0.085)
Panel C: Age 7				
Quantile Gap	0.347***	0.401***	0.316***	0.357***
	(0.077)	(0.069)	(0.072)	(0.082)
Explained				
Total	0.347***	0.244***	0.213***	0.204***
	(0.038)	(0.031)	(0.031)	(0.035)
Unexplained				
Total	0.000	0.157**	0.103	0.152*
	(0.081)	(0.073)	(0.076)	(0.086)
Panel D: Age 11				
Quantile Gap	0.168***	0.229***	0.101	0.223**
	(0.060)	(0.062)	(0.065)	(0.097)
Explained				
Total	0.238***	0.233***	0.174***	0.230***
	(0.029)	(0.028)	(0.026)	(0.042)
Unexplained				
Total	-0.070	-0.004	-0.073	-0.008
	(0.064)	(0.065)	(0.069)	(0.104)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children cognitive skills are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.9: Decomposition across the socio-emotional skills distribution, by child age

	(1) 25th Quantile	(2) 50th Quantile	(3) 75th Quantile	(4) 90th Quantile
Panel A: Age 3				
Quantile Gap	0.333***	0.222***	0.180***	0.153**
	(0.109)	(0.080)	(0.067)	(0.072)
Explained				
Total	0.483***	0.331***	0.270***	0.215***
	(0.042)	(0.033)	(0.030)	(0.032)
Unexplained				
Total	-0.150	-0.109	-0.090	-0.062
	(0.109)	(0.082)	(0.071)	(0.077)
Panel B: Age 5				
Quantile Gap	0.531***	0.370***	0.238***	0.178***
	(0.108)	(0.077)	(0.066)	(0.062)
Explained				
Total	0.419***	0.325***	0.220***	0.145***
	(0.039)	(0.031)	(0.024)	(0.024)
Unexplained				
Total	0.113	0.045	0.018	0.033
	(0.109)	(0.079)	(0.068)	(0.066)
Panel C: Age 7				
Quantile Gap	0.685***	0.448***	0.262***	0.153**
	(0.103)	(0.081)	(0.068)	(0.062)
Explained				
Total	0.386***	0.300***	0.200***	0.122***
	(0.038)	(0.029)	(0.022)	(0.019)
Unexplained				
Total	0.299***	0.149*	0.062	0.032
	(0.105)	(0.082)	(0.069)	(0.064)
Panel D: Age 11				
Quantile Gap	0.686***	0.395***	0.288***	0.222***
	(0.138)	(0.075)	(0.061)	(0.058)
Explained				
Total	0.431***	0.353***	0.221***	0.136***
	(0.042)	(0.030)	(0.022)	(0.019)
Unexplained				
Total	0.255*	0.042	0.067	0.086
	(0.136)	(0.075)	(0.063)	(0.060)
Observations	5003	5003	5003	5003

Source: UK Millennium Cohort Study.
Notes: Children socio-emotional skills are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.10: Mean divorce skills gaps, by child age - boys

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.256***	0.257***	0.362***	0.275***
	(0.091)	(0.081)	(0.088)	(0.089)
Decomposition				
Explained	0.211***	0.241***	0.328***	0.223***
	(0.041)	(0.036)	(0.042)	(0.039)
Unexplained	0.046	0.016	0.034	0.051
	(0.092)	(0.085)	(0.090)	(0.094)
Panel B: Socio-emotional skills				
Mean Gap	0.497***	0.535***	0.534***	0.585***
	(0.102)	(0.105)	(0.099)	(0.106)
Decomposition				
Explained	0.365***	0.335***	0.327***	0.383***
	(0.046)	(0.045)	(0.042)	(0.045)
Unexplained	0.132	0.200*	0.207**	0.202*
	(0.104)	(0.108)	(0.104)	(0.109)
Observations	2432	2432	2432	2432

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Table A.11: Mean divorce skills gaps, by child age - girls

	(1) Age 3	(2) Age 5	(3) Age 7	(4) Age 11
Panel A: Cognitive skills				
Mean Gap	0.243***	0.183***	0.347***	0.258***
	(0.076)	(0.068)	(0.074)	(0.076)
Decomposition				
Explained	0.244***	0.185***	0.235***	0.246***
	(0.043)	(0.033)	(0.040)	(0.037)
Unexplained	-0.001	-0.002	0.112	0.012
	(0.083)	(0.072)	(0.079)	(0.082)
Panel B: Socio-emotional skills				
Mean Gap	0.181**	0.352***	0.471***	0.490***
	(0.088)	(0.081)	(0.092)	(0.094)
Decomposition				
Explained	0.336***	0.336***	0.300***	0.341***
	(0.039)	(0.038)	(0.036)	(0.038)
Unexplained	-0.154*	0.016	0.171*	0.149
	(0.090)	(0.087)	(0.097)	(0.096)
Observations	2571	2571	2571	2571

Source: UK Millennium Cohort Study.
Notes: Children cognitive (Panel A) and socio-emotional skills (Panel B) are in standard deviations. The variables used to explain the gap are the same as Table 1.3. Statistical significance at the 1, 5 and 10 percent indicated by ***, ** and *.

Chapter 2

Child Socio-Emotional Skills: The Role of Parents in Helping the Children Left Behind

According to the diathesis-stress framework, child socio-emotional disorders can develop from a predisposition to behavioural disorders combined with a stressful experience. Using the UK Millennium Cohort Study we investigate how inputs in children interact with child socio-emotional skills at age 6 in developing skills at age 11. We measure the predisposition to either internalising or externalising behaviours by considering the within child difference in these behaviours at age 6. Low levels of sensitive parenting, time investments and maternal mental wellbeing can be stressful experiences and indeed we find that their improvements have higher returns for children with higher predisposition to disorders.

1 Introduction

Evidence has shown that gaps in child socio-emotional skills emerge at very young ages, persist across the lifetime and are predictive of adult skills including labour market, health and crime outcomes.[1,2] In this paper we assess whether it is possible to reduce the gap in socio-emotional skills in late childhood[3] by targeting interventions at specific parental inputs. This catch up of socio-emotional skills in late childhood is attainable if there is substitutability between the stock of skills in early life and parental inputs, i.e. if there are some parental inputs in late childhood that have a productivity which is higher for children with low rather than high socio-emotional skills in early childhood.

The main body of the literature on the production of child cognitive skills has found empirical evidence for complementarity (a higher productivity of an input for children with high early cognitive skills) for almost all inputs.[4] This evidence suggests that to efficiently help children to catch up their cognitive skills in late childhood would require interventions during early childhood. On the contrary, we expect a lower degree of complementarity or even an opposite pattern of substitutability between socio-emotional skills and some of the inputs in the production of socio-emotional skills in late childhood. We have two main reasons for this expectation. First, according to the diathesis-stress framework proposed in the psychological literature (see Beck 1967; Monroe and Simons 1991; Hilsman and Garber 1995), the manifestation of a socio-emotional disorder is determined by the interaction of a predisposition to the disorder and a stressful child's environment. Therefore, we expect to find a higher productivity of inputs that reduce the child's stress for children with low socio-emotional skills, i.e. substitutability between stress-reliever inputs and socio-emotional skills. Second, whilst child cognitive skills are malleable only at early stages, socio-emotional skills show malleability into adolescence (Cunha et al., 2006; Almlund et al., 2011). This seems to suggest that, in late childhood, at least some of the inputs must have some degree of substitutability with socio-emotional skills.

In this paper we estimate the production function of socio-emotional skills at age 11 and analyse the complementarity or substitutability between child socio-emotional skills at age 6 and a set of parental inputs including (1) sensitive parenting, (2) routines in parenting, (3) parental time investment; (4) family income, (5) mother's socio-emotional skills, (6) mother's cognitive skills. The stage from 6 to 11 has been found to be a sensitive period, i.e. a period when the development of socio-emotional skills is especially reactive to environmental stimuli (see Cunha and Heckman 2008).

[1] What we call socio-emotional skills have also been referred to as non-cognitive or soft skills (or abilities).

[2] See Heckman and Rubinstein (2001); Carneiro and Heckman (2003); Heckman et al. (2006); Heckman and Kautz (2012); Kautz et al. (2014); Attanasio et al. (2018).

[3] By late childhood we refer in this paper to the pre-adolescence period at around age 11.

[4] Empirical evidence on the degree of complementarity between investments and cognitive skills in the production of future cognitive skills can be found in Cunha et al. (2010), Aizer and Cunha (2012), Attanasio et al. (2015, 2017), Duque et al. (2016) , García and Gallegos (2017), Rossin-Slater and Wüst (2017), Gilraine (2016), Malamud et al. (2016), Nicoletti and Rabe (2014), Johnson and Jackson (2017), Carneiro et al. (2015).

We consider two dimensions of socio-emotional skills which are internalising and externalising behaviours.[5] The concepts of internalising and externalising behaviours were introduced in the psychological literature by Achenbach (1966), who used factor analysis to show that these two socio-emotional traits are the two main latent factors underlying a large set of psychological disorders. Since then, the concepts of internalising and externalising behaviours have been used in more than 75,000 articles in psychology (see Achenbach et al. 2016). Typical examples of internalising behaviours are being withdrawn, anxious and depressed and having somatic symptoms. Externalising behaviours occur when children direct their negative feelings and problems outward by adopting disruptive, hyperactive and aggressive behaviours. We measure these two trait-specific socio-emotional skills by using multiple measures for internalising and externalising behaviours to derive two latent factors, one for each of the two socio-emotional traits, which are free of, or at least less affected by, measurement errors (see Cunha et al. 2010 and Agostinelli and Wiswall 2016 for a similar procedure).[6]

We assume that the two latent socio-emotional traits, externalising and internalising behaviours, follow the same dynamic production model and that a trait-specific socio-emotional skill at 11 depends on the corresponding socio-emotional trait at 6, on a set of inputs and on their interactions. Beside the parental inputs, which are the focus of our analysis, we also control for lagged cognitive skills of the child, as well as inputs outside of the household including measures of neighbourhood capital, social capital, family members' health, mothers labour supply, child care arrangements and fertility decisions. Furthermore, we allow the productivity of each input to vary both across the distribution of child's socio-emotional skills at age 6 and also across the input distribution, asking for example whether the substitutability of an input is stronger when the level of the input is low.

Low levels of some parental inputs can create a stressful home environment for children, e.g. low levels of sensitive parenting (i.e. harsh parenting) or poor mothers' mental health. Improving such types of inputs, when low, is expected to have a greater productivity for low skilled children, who typically are more negatively affected by stressful experiences as suggested by the diathesis stress framework.

The only other papers which have estimated a production function for socio-emotional skills allowing for complementarity/substitutability between inputs and past skills are Cunha et al. (2010) and Attanasio et al. (2015), who have adopted a constant elasticity of substitution production function. What we do not know yet is whether the degree of complementarity/substitutability between inputs and the stock of socio-emotional skills differs across the type of input and across the level of each input.

Our first contribution is to relax the assumption of equal degree of complementarity/ substitutability across inputs by estimating a flexible production model of socio-emotional skills. This allows us to test whether there are some inputs which are substitutes rather than complements for socio-emotional skills. If such inputs exist, then interventions aimed at

[5] Attanasio et al. (2018) also extracted measures of internalising and externalising skills in order to compare how the inequality in child socio-emotional skills has changed across cohorts born in 1970 and 2000.

[6] Similarly we deal with measurement errors in parental inputs by using multiple measures to derive latent factors for each of the following parental inputs: sensitive parenting style, routines parenting style, time investments, mother's mental health, parents' neuroticism and extroversion.

increasing these inputs in late childhood could be effective in reducing the gap between high and low skilled children.

Our second contribution is that we control for unobserved heterogeneity by adopting child fixed effect estimation which exploits the availability of two measures of socio-emotional skills for each child - internalising and externalising.[7] Our identification strategy relies on variation in the deviation of a trait-specific socio-emotional skill from the mean *across* the two traits, i.e. the mean across externalising and internalising behaviours. Whilst variation in the general level of socio-emotional skills across individuals at age 6 is likely to be endogenous, variation in the deviation of a trait-specific skill from the mean is mainly driven by a predisposition to specific socio-emotional issues (Russell et al., 2013). The consistency of this child fixed effect estimation relies neither on the assumption that unobserved inputs be independent of observed inputs nor on the assumption that they be invariant across life stages, age or siblings; which are the most common assumptions imposed by previous papers on child development. The assumption we impose is that unobserved inputs be invariant across the two trait-specific skills. Therefore the only omitted inputs which could cause an issue of endogeneity are the trait-specific socio-emotional skills of the parents, which can be transmitted to children and therefore can affect child trait-specific socio-emotional skills both at age 6 and 11. To assess whether such endogeneity is a concern, we check the robustness of our results to the inclusion of socio-emotional skills of the parents which vary across the two traits.

Finally, we contribute to a growing related literature which provides evidence that the production function for skill development of girls may be different from that of boys (Bertrand and Pan, 2013; Baker and Milligan, 2016), and estimate our model separately by child gender.

Using the UK Millennium Cohort Study, we find evidence of substitutability between socio-emotional skills at 6 and parental inputs that help to reduce the child's stress, for both boys and girls. It is children with low levels of socio-emotional skills and with low levels of these stress-reliever inputs who benefit the most from an increase of such inputs. The productivity of sensitive parenting is higher for children with both poor socio-emotional skills at 6 and low initial values of sensitive parenting (below the median). We also find that the productivity of mothers' mental health and parental time investments is higher for girls with poor socio-emotional skills at 6 and low levels of such inputs (below the median). On the contrary, we find a different pattern when the level of inputs are higher, above the median. There is a degree of complementarity when the initial values of these parental inputs are above the median, which implies that an increase of parental inputs which are already high is more beneficial for high skilled children. For all remaining inputs, we find no variation in the productivity across level of socio-emotional skills.[8] Taken all together, these findings suggest that there are some parental inputs which may help children to catch up their socio-emotional skills, and these seem to be the inputs that are useful to reduce child stress. A back of the envelope calculation shows that if interventions to raise parent inputs were targeted

[7] A similar approach is adopted by Dee (2007), Clotfelter et al. (2010), Del Boca et al. (2017) and Nicoletti and Rabe (2017) using within-student between-subject estimation.

[8] These remaining inputs are: family income, routines parenting style, mother's cognitive skills and child's cognitive skills.

correctly at households with low initial levels of the inputs displaying substitutability, then the gap between children at the bottom - and the top three quartiles of socio-emotional skills distribution at age 6 could be closed by age 11 by up to 34% for boys and 52% for girls.

The remainder of this paper is organized as follows. We introduce the production model and the estimation strategy in Sections 2 and 3 respectively. We then move to describe the data and variables in Section 4 and to present our main empirical results in Section 5. In Section 6 we test the assumption of invariance of our main parameters of interests across internalising and externalising behaviours and present robustness checks to show that there is no bias caused by measurement error, omitted father's characteristics or model specification. Finally, Section 7 concludes.

2 The production model of socio-emotional skills

In this section we lay out our production model that describes the process of development of children's socio-emotional skills between age 6 and 11. We allow children's socio-emotional skills at age 11 to depend on their past socio-emotional and cognitive skills and on their family inputs, as described by the following equation:

$$\theta^N_{i,s,2} = f_2\left(\theta^N_{i,s,1}, \theta^C_{i,1}, \mathbf{I}_{i,2}, \boldsymbol{\theta}_{P,i,2}, \mu^N_{i,2}\right) \tag{2.1}$$

where the subscripts 1 and 2 denote the development stages from 0 to 6 and from 6 to 11; s takes value 1 for internalising and 2 for externalising behaviour; $\theta^N_{i,s,1}$ and $\theta^N_{i,s,2}$ are the unobserved latent trait-specific socio-emotional (non-cognitive) skills of the child i for the trait s at the end of stage 1 and 2, i.e. at age 6 and 11; $\theta^C_{i,1}$ is the child's unobserved latent cognitive skill at the end of stage 1, i.e. at age 6. $\mathbf{I}_{i,2}$ and $\boldsymbol{\theta}_{P,i,2}$ represent two vectors of parental inputs, which are parental investments and skills during stage 2, i.e. between age 6 and 11.[9] $\mathbf{I}_{i,2} = [I^{Sensitive}_{i,2}, I^{Routines}_{i,2}, I^{Time}_{i,2}, I^{Income}_{i,2}]$ is a row vector of four parental investments which are measures of sensitive parenting style, daily routine parenting style, parental time investment and family income; while $\boldsymbol{\theta}_{P,i,2} = [\theta^{Cognitive}_{P,i,2}, \theta^{Socio-emotional}_{P,i,2}]$ is a row vector of parental skills, where mother's cognitive skills are proxied by mother's education and mother's socio-emotional skills are proxied by mother's mental health. $\mu^N_{i,2}$ denotes potential omitted inputs that might affect the socio-emotional development of the child during stage 2. We do not restrict the unobserved component $\mu^N_{i,2}$ and the production function f_2 to be time invariant across different child's life stages, as done in some of previous papers; but we assume invariance of f_2 and $\mu^N_{i,2}$ between the two trait-specific socio-emotional skills.[10]

While the end of stage 1 is set at age 6, the start does not need to be at age 0 and we could divide the development stage from 0 to 6 in different shorter stages, e.g. from 0 to 1, 1 to 2, 2 to 4 and 4 to 6, without any loss of generality for our production model. For all these earlier development stages, we assume that child socio-emotional skills evolve following

[9] We cannot observe these parental inputs for the full period from 6 and 11 and we assume that measures observed when the child is 7 are a good proxy for the parental inputs during stage 2.

[10] We provide empirical evidence to support the model invariance across traits in the empirical section.

a stage-specific dynamic production function, say $\theta^N_{i,s,t} = f_t()$ for each stage $t < 2$, and that all these production functions are twice continuously differentiable in their inputs.

Our main aim is to assess whether there are interaction effects between each of the parental inputs in $[\mathbf{I}_{i,2}, \boldsymbol{\theta}_{P,i,2}]$ and the socio-emotional skill $\theta^N_{i,s,1}$, i.e. to test whether the productivity of each of the six parental inputs varies across levels of the socio-emotional skill at age 6. As highlighted above, there is almost no empirical evidence on the presence of such interactions in the production of socio-emotional skills. The presence of complementarity (a positive interaction effect) between a parental input in stage 2 and the socio-emotional skill at the end of stage 1 would imply the presence of dynamic complementarity between the parental inputs in stage 2 and inputs in earlier stages (see Heckman and Mosso 2014).[11] On the contrary, the presence of substitutability (a negative interaction effect) between a parental input in stage 2 and the socio-emotional skill at the end of stage 1 would imply dynamic substitutability between such input in stage 2 and earlier stages' inputs. Knowing whether there exists substitutability or complementarity is therefore relevant to understand which inputs in stage 2 are most effective to reduce potential gaps in socio-emotional skills.

We allow the production function (2.1) to be flexible enough to accommodate for the presence of interactions between each pair of inputs in the following way:

$$\theta^N_{i,s,2} = m_{2,N}(\theta^N_{i,s,1}) + \sum_{k=1}^{K} m_{2,N,k}(\theta^N_{i,s,1}, Z_{k,i,2}) + \sum_{k=1}^{K} m_{2,k}(Z_{k,i,2}) + \sum_{k=1}^{K}\sum_{\substack{j=2 \\ j>k}}^{K} m_{2,k,j}(Z_{k,i,2}, Z_{j,i,2}) + m_{2,\mu}(\mu^N_{i,2}) + m_{2,N,\mu}(\theta^N_{i,s,1}, \mu^N_{i,2}) + \sum_{k=1}^{K} m_{2,k,\mu}(Z_{k,i,2}, \mu^N_{i,2}), \tag{2.3}$$

where $k = 1, ..., K$, $Z_{k,it}$ denotes the k-th input in the following vector of dimension $K \times 1$ and that we express in deviation from its sample mean,

$$\mathbf{Z}_{k,i,2} = \left(\theta^C_{i,2}, \mathbf{I}_{i,2}, \boldsymbol{\theta}_{P,i,2}\right).$$

The term $m_{2,N}(\theta^N_{i,s,1})$ characterizes the effect of the lagged latent socio-emotional skill when all other inputs are at the mean, i.e. when $Z_{k,i,2} = 0$ for each k; and $m_{2,k}(Z_{k,i,2})$ denotes the effect of the input $Z_{k,i,2}$ when $\theta^N_{i,s,1}$ is at the baseline value[12] and all other variables are at the mean. $m_{2,N,k}(\theta^N_{1,i,s,1}, Z_{k,i,2})$ captures the differential productivity of each input $Z_{k,i,2}$

[11] We can show this by measuring the degree of dynamic complementarity between $I^{Time}_{i,t}$ and $I^{Time}_{i,t-\delta}$ for the production of socio-emotional skills at the end of stage t, $\theta^N_{i,s,t}$, in the following way,

$$\frac{d^2 f_t()}{dI^{Time}_{i,t} dI^{Time}_{i,t-\delta}} = \frac{\partial^2 f_t()}{\partial I^{Time}_{i,t} \partial \theta^N_{i,s,t-1}} \left(\prod_{j=1}^{\delta} \frac{\partial f_{t-\delta+j}()}{\partial \theta^N_{i,s,t-\delta+j-1}} \right) \frac{\partial f_{t-\delta}()}{\partial I^{Time}_{i,t-\delta}}. \tag{2.2}$$

Because $\frac{\partial f_{t-\delta+j}()}{\partial \theta^N_{i,s,t-\delta+j-1}}$ and $\frac{\partial f_{t-\delta}()}{\partial I^{Time}_{i,t-\delta}}$ are generally higher than zero, a strong static complementarity between $I^{Time}_{i,t}$ and $\theta^N_{1,s,i,t-1}$, i.e. a large value for $\frac{\partial^2 f_t()}{\partial I^{Time}_{i,t} \partial \theta^N_{i,s,t-1}}$, will lead to a strong dynamic complementarity between $I^{Time}_{i,t}$ and $I^{Time}_{i,t-\delta}$. Following a similar reasoning we can show also that any early input in $t - \delta$ is complement with a later input in t as long as there is complementarity between this later input in t and the socio-emotional skill in $(t - 1)$.

[12] In our empirical application we consider dummies for the different quartiles of the lagged socio-emotional skill, $\theta^N_{i,s,1}$, where the baseline category is the first quartile.

across levels of the lagged latent socio-emotional skill; $m_{2,k,j}(Z_{k,i,2}, Z_{j,i,2})$ measures the differential productivity of $Z_{k,i,2}$ at different values of the j-th input $Z_{j,it}$; and finally $m_{2,\mu}(\mu^N_{i,2})$, $m_{2,N,\mu}(\theta^N_{i,s,1}, \mu^N_{i,2})$ and $m_{2,k,\mu}(Z_{k,i,2}, \mu^N_{i,2})$ are the effects of unobserved inputs and of their interactions with lagged socio-emotional skills and inputs.

Similar types of child development production functions with interactions between pairs of inputs have been considered by Figlio (1999), Liu et al. (2010), Mueller (2013) and Nicoletti and Rabe (2017) and are more general than the constant elasticity of substitution (CES) and Cobb-Douglas functions (see e.g. Cunha et al. 2010; Del Boca et al. 2013). The advantage of adopting such general production function is that we can allow for self-productivity of socio-emotional skills, for cross-productivity between cognitive and socio-emotional skills and for complementarity/substitutability between each pair of inputs and between each of the inputs $Z_{k,i,2}$ and the socio-emotional skill $\theta^N_{i,s,1}$ without imposing the elasticity of substitution to be the same for all pairs of inputs as imposed by CES models.

3 Estimation of the production model

To estimate consistently the production model we need to take account of potential endogeneity caused by the omission of variables and of measurement error issues. The rest of this section is organized as follow. Section 3.1 introduces our estimation procedure of the production model and explains how we deal with endogeneity issues under the assumption of no measurement errors. In Section 3.2 we describe the measurement model of socio-emotional skills and parental inputs, which we use to derive the latent factors that are theoretically unaffected by measurement errors.

3.1 Estimation

Thanks to the assumption of invariance of the production model (2.3) across the two trait-specific socio-emotional skills, internalising and externalising behaviours, we can exploit the availability of the two trait-specific socio-emotional skills for each child to apply a child fixed-effect estimation. We do this by rewriting the equation (2.3) in deviations from the mean across traits,

$$\ddot{\theta}^N_{i,s,2} = \ddot{m}_{2,N}(\theta^N_{i,s,1}) + \sum_{k=1}^{K} \ddot{m}_{2,N,k}(\theta^N_{i,s,1}, Z_{k,i,2}) + \ddot{m}_{2,N\mu}(\theta^N_{i,s,1}, \mu^N_{i,2}) + \ddot{u}_{i,s,2}, \tag{2.4}$$

where the double dot denotes the deviation from the mean across the two different traits, internalising and externalising. This transformation of $\theta^N_{i,s,2}$ cancels out any potential measurement error in the socio-emotional skills which is shared across traits and likewise any shared error in the lagged socio-emotional skills $\theta^N_{i,s,1}$.[13] This deviation transformation eliminates all the terms in the right hand side of the production model (2.3) that do not vary across the two

[13] If the production model is not linear in $\theta^N_{i,s,1}$, then considering a Taylor approximation of order one of the non-linear function of $\theta^N_{i,s,1}$ around the average of $\theta^N_{i,s,1}$ across traits would still cancel out the shared measurement error through the deviation from the mean transformation.

trait-specific socio-emotional skills, i.e. $m_{t+1,k}(Z_{k,i,2})$, $m_{2,k,j}(Z_{k,i,2}, Z_{j,i,2})$, $m_{2,N\mu}(Z_{k,i,2}, \mu_{i2}^N)$ and $m_{t+1,\mu}(\mu_{i,2}^N)$. Notice that the last two terms depend on the unobservable component $\mu_{i,2}^N$ and eliminating them solves, at least in part, the endogeneity caused by unobservables.

Computing the deviations from the mean across traits does not solve completely the endogeneity issue caused by unobservables $\mu_{i,2}^N$ because it does not eliminate the interactions between the child socio-emotional skills at age 6 and the unobservable parental inputs: $m_{2,S,\mu}(\theta_{i,s,1}^N, \mu_{i,2}^N)$. These unobserved inputs bias our estimation of the productivity of observed parental inputs, $[\mathbf{I}_{i,2}, \boldsymbol{\theta}_{P,i,2}]$, only if both of the following conditions hold: (i) the productivity of the omitted inputs varies across the distribution of socio-emotional skills at age 6; (ii) there is correlation between the observed parental inputs and the omitted inputs. Previous papers on socio-emotional development have not considered the possibility of such bias. On the contrary, we control for this potential bias by including the interactions between $\theta_{i,s,1}^N$ and a rich set of additional observed inputs, which can proxy for the unobserved inputs. In particular, we consider neighbourhood capital (measured by an indicator for the quality of the neighbourhood), social capital (a set of dummy variables for living close to relatives or friends), health capital (a set of measures of family members health), mother's labour supply, child care arrangements and fertility decisions.

We denote each of these additional inputs with $W_{g,i,2}$, where $g = 1, ...G$ denotes each of the G inputs, and we assume that the interaction term between the lagged socio-emotional skills and the unobservable component $\mu_{i,2}^N$, $m_{2,S,\mu}(\theta_{i,s,1}^N, \mu_{i,2}^N)$, can be replaced by a set of interactions between the lagged socio-emotional skills and each of the additional variables $W_{g,i,2}$, $m_{2,N,g}(\theta_{i,s,1}^N, W_{g,i,2})$, so that our production model expressed in deviations from the mean across traits becomes

$$\ddot{\theta}_{i,s,2}^N = \ddot{m}_{2,N}(\theta_{i,s,1}^N) + \sum_{k=1}^{K} \ddot{m}_{2,N,k}(\theta_{i,s,1}^N, Z_{k,i,2}) + \sum_{g=1}^{G} \ddot{m}_{2,N,g}(\theta_{i,s,1}^N, W_{g,i,2}) + \ddot{u}_{i,s,2}. \tag{2.5}$$

In the following we impose some parametric assumptions on model (2.5), but we keep the specification flexible enough to allow for a differential productivity of the inputs across different levels of $\theta_{i,s,1}^N$. Ultimately we adopt the following model specification:

$$\ddot{\theta}_{i,s,2}^N = \alpha + \ddot{\theta}_{i,s,1}^N \rho + \sum_{k=1}^{K} \sum_{q=2}^{4} \sum_{p=0}^{1} [\ddot{D}_{s,q} D_{k,p} Z_{k,i,2} \beta_{k,q,p}] + \sum_{g=1}^{G} \sum_{q=2}^{4} [\ddot{D}_{s,q} W_{g,i,2} \gamma_{g,q}] + \ddot{u}_{i,s,2}, \tag{2.6}$$

where the double dot still denotes the deviation from the mean across the two different socio-emotional traits; $D_{s,q}$ is a dummy taking value 1 if the observed $\theta_{i,s,1}^N$ lies between the (q-1)-th and q-th quartile and 0 otherwise, and $\ddot{D}_{s,q}$ is its deviation from the mean across traits; $D_{k,0}$ is a dummy variable taking value 1 for values of $Z_{k,i,2}$ below its median, while $D_{k,1} = 1 - D_{k,0}$ is a dummy variable taking value 1 for values of $Z_{k,i,2}$ above its median; $Z_{k,i,2}$ and $W_{g,i,2}$ are measured in deviations from their sample mean; α is the intercept; ρ is a scalar parameter measuring the self-productivity (persistence) of socio-emotional skills, i.e. the effect of an increase in $\theta_{i,s,1}^N$ while all other inputs are held at their mean; $\beta_{k,q,p}$ is a scalar parameter measuring the differential productivity of input $Z_{k,i,2}$ when children have lagged

socio-emotional skills in the q-th quarter rather than in the first (baseline) quarter of the distribution and have values of $Z_{k,i,2}$ below its median if $p = 0$ and above it if $p = 1$, while all other inputs are held constant at their mean; finally $\gamma_{g,q}$ is a scalar parameter measuring the differential productivity of $W_{g,i,2}$ for children in the q-th quarter of the distribution of $\theta^N_{i,s,1}$ with respect to the bottom quarter, while all other inputs are held at their mean. In Section 6 we allow for even more flexible specifications of the production model and provide empirical evidence that the parametric assumptions imposed in equation (2.6) are not too restrictive.

Estimating equation (2.6), which is expressed in deviations from the mean across traits, is equivalent to adopting a child fixed effect estimation. Similar types of child fixed effect estimations have been used in several previous papers, e.g. to estimate the effect of lagged cognitive abilities, teachers characteristics, class size, homework and school peers on cognitive abilities or educational achievements.[14] While we exploit variation within child across socio-emotional traits, previous papers exploit variation within child across subject-specific test scores, across course results or across different dimensions of cognitive abilities. The main difference with these previous papers is that we consider a production model for socio-emotinal skills rather than for cognitive skills or educational achievements. Furthermore, we allow for complementarities between inputs and lagged socio-emotional skills, similarly to Nicoletti and Rabe (2014) who consider complementarities between school investments and cognitive ability at the end of primary school in the production of cognitive abilities in secondary school.

Differently from previous papers that have used dynamic factor models to estimate the production function of cognitive and socio-emotional skills (e.g. Cunha et al. 2010; Attanasio et al. 2015; Agostinelli and Wiswall 2016), we identify the effect of lagged socio-emotional skills in the production model by using exclusively variation coming from the differences between trait-specific latent socio-emotional skills, i.e. differences between $\theta^N_{i,s,1}$ and $\theta^N_{i,s',1}$ for $s \neq s'$, rather than variation coming from the general latent socio-emotional skill. This matters because, while variation in the general level of socio-emotional skills across individuals at age 6 is likely to be endogenous, variation in $\theta^N_{i,s,1}$ across traits is mainly explained by variation in an innate predisposition to specific socio-emotional issues. E.g. a child with a genetic predisposition to attention deficit and hyperactivity disorders may tend to have more externalising behavioural issues than internalising ones; whereas a child with an innate tendency to separation anxiety disorders or depressive disorders might have more internalising behavioural issues than externalising ones (Russell et al. 2013 provide some empirical evidence on this).

Part of the variation in $\theta^N_{i,s,1}$ across traits could be related to trait-specific unobserved inputs and therefore potentially endogenous. In particular, children may learn or imitate internalising and externalising socio-emotional behaviours from parents based on their trait-specific socio-emotional skills. To check if such an endogeneity issue could be a concern in our estimation, we run some robustness checks by including as further inputs measures of trait-specific socio-emotional skills for the parents, with results that confirm our main conclusions.

[14] E.g. Dee 2007; Clotfelter et al. 2010; Bandiera et al. 2010; Eren and Henderson 2011; Lavy et al. 2012; Del Boca et al. 2017; Nicoletti and Rabe 2017.

Because the variation $\theta^N_{i,s,1}$ is related to child's innate predispositions to trait-specific socio-emotional behavioural disorders of internalising and externalising, we expect inputs related to environmental stressors to exacerbate these predispositions, i.e. to have a larger negative effect on children with low levels of $\theta^N_{i,s,1}$. Similarly, we expect inputs that help in attenuating the effect of environmental stressors, such as a change from harsh to a more positive parenting style, to be effective in improving socio-emotional skills especially for children with low levels of $\theta^N_{i,s,1}$. For this reason we anticipate some substitutability rather than complementarity between child's socio-emotional skills at age 6 and inputs that are negatively related to environmental stress factors or that attenuate the effect of such stressors.

3.2 Measurement models of socio-emotional skills and parental inputs

We have multiple measures for each of the two socio-emotional traits - internalising and externalising behaviours. We allow each of the observed measures of socio-emotional skills to be affected by two types of measurement error, a measurement error which is shared across the two *traits* and across all *measures*, and a measurement error which is instead trait- and measure- specific.

Because the observed traits of internalising and externalising behaviours are derived from the Strength and Difficulty Questionnaire which is administered to mothers, we could have a systematic error shared across all observed socio-emotional traits if mothers systematically under-report or over-report behavioural issues of their child. To allow for such shared measurement error across different observed traits of socio-emotional skills, we allow the observed trait-specific socio-emotional skill $\theta^N_{i,s,t}$ to depend on a shared measurement error in the following way:

$$\theta^N_{i,s,t} = \vartheta^N_{i,s,t} + v_{i,t}, \tag{2.7}$$

where $\vartheta^N_{i,s,t}$ is the true trait-specific latent skill and $v_{i,t}$ is the measurement error which is common across socio-emotional traits in stage t ($t = 1, 2$). Note that while the variation in $\theta^N_{i,s,t}$ is in part spurious and caused by the measurement error $v_{i,t}$; the variation of $\vartheta^N_{i,s,t}$ within child and across the two traits does not depend on $v_{i,t}$. In our estimation model we correct for the shared error $v_{i,t}$ by considering the deviations of $\theta^N_{i,s,t}$ from its mean across traits.

A second type of measurement error is within traits and across *measures*. We can deal with this because for each trait (internalising and externalising behaviour) we can observe multiple measures at the end of stage t, i.e. at age 6 for $t = 1$ and at age 11 for $t = 2$. Following previous papers on the technology of skill formation (see Cunha et al. 2010 and Agostinelli and Wiswall 2016), we assume the following relationship between each of the observed measures of a trait-specific socio-emotional skills and the unobserved latent trait-specific socio-emotional skill $\theta^N_{i,s,t}$:

$$Y^{N,m}_{i,s,t} = \lambda^m_{s,t} + \alpha^m_{s,t}\theta^N_{i,s,t} + e^m_{i,s,t}, \tag{2.8}$$

where $Y^{N,m}_{i,s,t}$ is the m-th observed measure of the s trait-specific socio-emotional skill at the end of stage t (at 6 or at 11), $m = 1, ..., M_{s,t}$, $s = 1$ for internalising and 2 for externalising, $\lambda^m_{s,t}$ and $\alpha^m_{s,t}$ are the intercepts and factor loadings specific for the measure m. $e^m_{i,s,t}$ is the measure-

specific measurement error which has mean zero and is assumed to be uncorrelated with $\theta^N_{i,s,t}$ and independently distributed across children and measures. The latent trait-specific socio-emotional skill $\theta^N_{i,s,t}$ can be identified only up to scale and location parameters. By setting the mean of $\theta^N_{i,s,t}$ to 0 and $\alpha^1_{s,t} = 1$, we fix the location and scale so that we can identify the parameters in $\lambda^m_{s,t}$ and $\alpha^m_{s,t}$ for any trait s and t and we can extract the latent factor. We use measures of peer problems and emotional symptoms for internalising behaviours, and measures of hyperactivity and conduct problems for externalising behaviours. We use these measures observed at 5 and 7 as proxies for measures at 6; whereas we use only measures observed at age 11 as proxies for internalising and externalising at 11.[15]

We consider measurement models similar to (2.8) also for the following parental inputs: sensitive parenting style, routine parenting style, parental time investment and mother's mental health. For each of these parental inputs which we denote with the subscript h, we consider the measurement model

$$I^m_{i,h,2} = \lambda^{I,m}_{h,2} + \alpha^{I,m}_{h,2} I_{i,h,2} + e^{I,m}_{i,h,2}, \tag{2.9}$$

where $I^m_{i,h,2}$ is the m-th observed measure of the h parental input at end of stage 2; $m = 1, ..., M_{h,2}$; $h = 1$ for sensitive parenting style, 2 for routine parenting style, 3 for parental time investment and 4 for mother's mental health; $\lambda^{I,m}_{h,2}$ and $\alpha^{I,m}_{h,2}$ are the intercepts and factor loadings specific for the measure m; $e^{I,m}_{i,h,2}$ is the measure-specific measurement error which has mean zero and is assumed to be uncorrelated with $I_{i,h,2}$ and independently distributed across children, measures and inputs.[16] We identify and extract each of the latent factor $I_{i,h,2}$ by setting the factor mean to 0 and $\alpha^{I,1}_{h,2}$ to 1.

We estimate the production model by using directly the factors $\theta^N_{i,s,1}$, $\theta^N_{i,s,2}$ and $I_{i,h,2}$ for $h = 1, ..., 4$, which are theoretically free of measurement error once expressed the model in deviation for the mean across traits.

4 Description of data

We use the UK Millennium Cohort Study (MCS), a cohort member longitudinal survey covering a sample of about 19000 children born in the UK between September 2000 and January 2002. Interviews on the children and the family members are collected when the children are at 9 months, 3, 5, 7, 11 and 14 years old.[17] The MCS includes a wealth of information about the child, his/her household members and the home environment.

The sample consists of singleton children whose parents are either married or cohabiting and analysis is restricted to children for whom we observe socio-emotional skills reported by the mother, cognitive skills, parental inputs and parental skills. Our final sample consists of 6452 children. Table B.1 in the Appendix shows the demographic characteristics of the sample of children at age 7. The average age of the child in the sample is 86.6 months, with

[15] See Section 4 for more details.

[16] Two parental inputs, family income and mothers' education, are directly used in our estimation without considering any factor model.

[17] More information on survey design, recruitment process and fieldwork can be found in Dex and Joshi (2005).

an average number of siblings of 1.5 and the mother being 37 years old. 93% of children are white; 36% of children have mothers in a managerial or professional occupation, 29% in an intermediate occupation and 32% in a routine or manual occupation.

4.1 Child's skills

4.1.1 Socio-emotional skills

We use the Strengths and Difficulties Questionnaire (SDQ) included in the MCS to construct our measures of socio-emotional skills. The SDQ is an international standardised test measuring children's behaviours and emotions in several contexts (Goodman, 1997, 2001). It is largely used in psycology as well as in the human capital literature within economics, and it shows correlations with Diagnosis of Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD) (Russell et al., 2013). The questionnaire, administered to parents since age 3 of the child, consists of 25 items on child psychological attributes. Each of the 25 items are related with a statement on the child and the parent has to indicate whether the statement is 'true', 'somewhat true' or 'not true'. From the 25 items, five scales measuring (i) Emotional Problems, (ii) Conduct Problems, (iii) Hyperactivity, (iv) Peer Relationship Problems and (v) Pro-social Behaviour are created.[18] The scales can be either used separately to inform about specific behavioural problems or combined to create two different traits of socio-emotional skills such as internalising and externalising behaviour.

The internalising trait combines emotional symptoms and peer problems and the externalising trait combines conduct problems and hyperactivity problems. Pro-social behaviour is excluded from our analysis as it represents a different dimension of socio-emotional skills which cannot be combined with internalising or with externalising behaviour. Table 2.1 details the items included in each of the trait used in our analysis. The top panel of Table 2.2 reports the descriptive statistics of the four scales of socio-emotional skills of the child at age 5, 7 and 11 respectively for boys and girls. For ease of interpretation each scale is reverse coded, with higher values associated with higher levels of socio-emotional skills (or lower levels of socio-emotional problems). With the exception of emotional symptoms measured at age 5 and 7, girls have statistically significant higher socio-emotional skills and are less likely to have emotional, peer, conduct or hyperactivity problems.[19] This gender gap is more pronounced for externalising behaviour and especially for hyperactivity problems.

As explained in Section 3.2, we use factor models to derive the two specific traits of internalising and externalising behaviour. The correspondent factor loadings of the latent factors, i.e. internalising and externalising traits, can be found in Tables B.2 and B.3 in the Appendix, respectively for boys and girls.

[18] These scales are largely used in the human capital formation literature. Examples of their application in the UK setting can be found in Goodman et al. (2010); Borra et al. (2012); Del Bono et al. (2016); Moroni (2018).

[19] Among papers that have also found a gender gap in socio-emotional skills there are Silverman (2003), Beaman et al. (2006), Entwisle et al. (2007) and Bertrand and Pan (2013).

Table 2.1: SDQ Questionnaire. Details on items for each scale.

Scale	Items within scale
1) Emotional symptoms	
	a. Complaints of headaches/stomach aches/sickness
	b. Often seems worried
	c. Often unhappy
	d. Nervous or clingy in new situations
	e. Many fears, easily scared.
2) Peer Problems	
	a. Tends to play alone
	b. Has at least one good friend*
	c. Generally liked by other children*
	d. Picked on or bullied by other children
	e. Gets on better with adults.
3) Conduct problems	
	a. Often has temper tantrums
	b. Generally obedient*
	c. Fights with or bullies other children
	d. Can be spiteful to others
	e. Often argumentative with adults.
4) Hyperactivity	
	a. Restless, overactive, cannot stay still for long
	b. Constantly fidgeting
	c. Easily distracted
	d. Can stop and think before acting*
	e. Sees tasks through to the end*.

Notes: * denotes items that are reversed when computing the total score for each type of behavioural problem (scale). Each of the 4 scales can be used alone or together to create: (i) total difficulties score when 1-4 are taken together ; (ii) an internalising behavioural score combining 1 and 2 ; (iii) an externalising behavioural score combining 3 and 4.

Table 2.2: Descriptive statistics of child's skills - raw measures

	Boys		**Girls**		**Test diff**
	mean	sd	mean	sd	p-value
Socio-emotional skills age 5					
Internalising behaviour					
Emotional Symptoms	8.813	1.474	8.765	1.434	0.181
Peer Problems	8.976	1.369	9.128	1.226	0.000
Externalising behaviour					
Conduct Problems	8.605	1.401	8.827	1.295	0.000
Hyperactivity Problems	6.718	2.297	7.406	2.098	0.000
Socio-emotional skills age 7					
Internalising behaviour					
Emotional Symptoms	8.699	1.621	8.631	1.575	0.090
Peer Problems	8.973	1.444	9.100	1.288	0.000
Externalising behaviour					
Conduct Problems	8.704	1.440	8.983	1.286	0.000
Hyperactivity Problems	6.539	2.437	7.445	2.243	0.000
Socio-emotional skills age 11					
Internalising behaviour					
Emotional Symptoms	8.424	1.857	8.234	1.910	0.000
Peer Problems	8.810	1.604	8.938	1.508	0.001
Externalising behaviour					
Conduct Problems	8.693	1.514	8.937	1.349	0.000
Hyperactivity Problems	6.759	2.457	7.698	2.134	0.000
Cognitive skills age 5					
BAS: Picture similarities	82.669	10.995	83.906	10.886	0.000
BAS: Reading abilities	111.198	14.769	111.750	13.986	0.123
BAS: Pattern construction	89.204	18.492	91.604	16.848	0.000
Cognitive skills age 7					
NFER: Maths test	10.119	2.706	9.977	2.511	0.029
BAS: Reading abilities	108.986	30.615	112.721	26.530	0.000
BAS: Pattern construction	118.040	16.432	119.474	15.167	0.000
Observations	3217		3235		6452

Notes: Last column reports the p-value of the test for the equality of means between boys and girls. Data: UK Millennium Cohort Study, Main Sample.

4.1.2 Cognitive skills

Cognitive abilities are mainly derived from the British Ability Scales (BAS), which tests child's skills differently depending on the age of the child (Elliott et al., 1996; Hansen et al., 2012). At age 5, child cognitive abilities are measured by three tests. Child's problem solving abilities are assessed with the Picture Similarity test in which the child has to pick the two most similar pictures among four. Child's expressive verbal ability is measured with the Naming Vocabulary test in which the child has to name the objects present in the pictures. Child's spatial awareness is assessed with the Pattern Construction test in which the child has to construct a design by putting together coloured flat squares or solid cubes. At age 7, cognitive abilities are also measured by three tests. Child's maths skills are assessed with

the National Foundation for Educational Research Progress in Maths Test (NFER). Reading abilities are measured with the BAS Work Reading Test in which the child has to read aloud a set of 90 words shown on a card. Child's spatial awareness is measured with the BAS Pattern Construction test similar to the corresponding test at age 5.[20]

The bottom panel of Table 2.2 reports the descriptive statistics of the different measures of child's cognitive skills at age 5 and 7 respectively for boys and girls. Girls have statistically significantly higher cognitive skills than boys for all the measures, with the exception of reading abilities measured at age 5 when there is no statistically significant gender difference and maths at age 7 where boys outperform girls. Similarly to socio-emotional skills and as explained in Section 3.2, we use factor models to derive the latent cognitive skills of children. The correspondent factor loadings of the latent factors, can be found in Tables B.4 and B.5 in the Appendix.

4.2 Main inputs

The importance of considering a multiplicity of parental inputs when estimating the substitutability and/or complementarity between the inputs and the skills has been recently recognized by García and Gallegos (2017). We consider six main parental inputs grouped in two categories: parental investments and parental skills. We capture parental investments using measures of sensitive parenting style, routines parenting style, time investment and family income. We capture parental skills using measures of mothers' cognitive and socio-emotional skills.

4.2.1 Parental Investments

The different types of parental investment included in our analysis capture various facets of parent-child interactions. Parenting style has recently been recognised as a distinct parental input from the usual material and time investments (Cobb-Clark et al., 2016). Mainly in the psychology literature (Baumrind, 1971; Glasgow et al., 1997), but recently also in economics (Doepke et al., 2019; Doepke and Zilibotti, 2017; Fiorini and Keane, 2014; Cobb-Clark et al., 2016), different categories of parenting style have been used to measure how warm/communicative and how strict/controlling a parent is. We construct two domains of parenting styles capturing respectively the degree of sensitive parenting style and routines in parenting style.

The degree of sensitive parenting style is measured using the Straus' Conflict Tactics Scale included in the MCS (Straus and Hamby, 1997). The mother indicates her reaction - on a 5 point scale ranging from 'never' to 'daily'- to the following questions: (i) How often sends child to bedroom/naughty chair; (ii) How often takes away treats from child when naughty; (iii) How often ignores child when naughty; (iv) How often smacks child when naughty; (v) How often shouts at child when naughty; (vi) How often tells child off when naughty; (vii) How often bribes child when naughty. Questions (i)-(ii) captures the non-violent discipline

[20] More details on the tests administered to the child can be found in Hansen et al. (2012).

(e.g. explanation, time out, deprivation of privilege) and questions (iii)-(vii) the psychological aggression (e.g. parents' reaction provoking child's psychological distress or fear). Reporting high-frequencies on these practices can be interpreted as the degree of harsh parenting.

We use latent factor models as explained in Section 3.2 to estimate the latent factor measuring sensitive parenting style which captures how harsh-sensitive a parent is when the child misbehaves.[21] The latent variable for sensitive parenting style is reverse coded such that it can be interpreted as a positive input going from harsh to sensitive parenting, with higher values associated with more sensitive parenting. Table B.6 shows the factor loadings (Column 1) and the signal, i.e. percentage of the variance explained by the latent factor (Column 2). There is considerable variation in the amount of information captured by each measure of the same factor ranging from 11% to 50%. The fact that no measure has a signal close to 100% emphasizes the importance of accounting for measurement error through the latent factor model.

The second domain of parenting style, i.e. routines in parenting style, accounts for the parental rules based on daily routines. The survey includes four questions on daily routines set by the parent on bedtime and watching TV including (i) How often child has regular bedtime on term-time weekdays[22] ; (ii) Bedtime on term-time weekdays[23] ; (iii) Whether or not they have rules about timed watching TV and (iv) Whether or not they have rules about hours watching TV.[24] These four measures are used to estimate the latent factor measuring the routines in parenting style. In Table B.6 the correspondent factor loadings (Column 1) and the signal (Column 2) are reported. We interpret this factor such that, the higher the value the stricter the daily routines. The largest signal comes from bedtime rules, whilst little signal comes from TV rules.

The third type of parental investment considered in our analysis aims at capturing the parental time investment by using 6 questions regarding how often the mother spends time in formative activities with the child including: (i) Frequency draw and paint with child; (ii) Frequency tell stories to child; (iii) How often does musical activities with child; (iv) Frequency play active games with child; (v) Frequency play indoor games with child; (vi) Frequency takes the child to park or playground. For all the statements the mother reports how frequently she plays these activities with the child in a scale ranging from 'Every day or almost every day' to 'Not at all'.[25] The estimated factor loadings and signal are reported in Table B.6. The interpretation of the factor is such that the higher the value, the higher the time investment. The signal in time investment variables measures ranges from 15.9% to 44.0%, suggesting a substantial amount of measurement error in each of the reported measure. Finally, a fourth type of parental investment is included in our set of inputs to capture the material investment,

[21] The same questionnaire has recently been used to study whether harsh parental discipline drives the effects of environmental adversities on emotional and behavioural problems of children (Flouri and Midouhas, 2017)

[22] The parent reports on a 4 point scale ranging from never to always.

[23] From the bed time we construct a 3 point scale measure from soft to strict rules on the base of distibutional quantiles.

[24] Similar measures of parental rules have been used by Del Bono et al. (2016); Fiorini and Keane (2014).

[25] Similar measures of parental time investment have been used by Del Bono et al. (2016).

measured with the household weekly income equivalised using the OECD scale[26] reported in the MCS.

4.2.2 Parental Skills

The second group of parental inputs consists of parental skills. We include mother's cognitive skills, proxied by mother's education (the age mothers left school) and mother's socio-emotional skills captured by mother's mental health. Specifically, mother's mental health is assessed with the Mental Health – Kessler (K6) Scale (Kessler et al., 2002) a questionnaire intended to collect information on mothers' psychological distress. The mother indicates how frequently she experience feelings such as being (i) depressed, (ii) hopeless, (iii) restless, (iv) that everything was an effort, (v) worthless or (vi) nervous in the last 30 days ranging from 'All of the time' and 'None of the time'.[27] Similarly to the procedure followed for the other parental investments, we use latent factor model as described in Section 3.2 to estimate the latent factor measuring mother's mental health. Table B.7 reports the factor loadings (Column 1) and the signal, i.e. percentage of the variance explained by the latent factor (Column 2).

As additional measure of parental skills we include trait specific parents' socio-emotional skills, of both mothers' and fathers'. These measures will be used in our sensitivity analysis to show that the intergenerational transmission of trait-specific socio-emotional skills does not represent a threat for our identification strategy. They are derived using the questions of the OCEAN Personality Test included in the MCS (Costa and McCrae, 1989). Parental neuroticism is a proxy for parental internalising behaviour, whereas parental extroversion is a proxy for parental externalising behaviour. Notice that parental neuroticism is reversed so that can be interpreted as the higher the score, the lower the parental neuroticism, therefore the higher the parental internalising skills. Table B.8 reports the corresponding factor loadings (Column 1) and the signal (Column 2) for the mother and the father.

4.3 Other inputs

Our production model of socio-emotional skills accounts for the fact that the child is exposed to other inputs, coming not only from the family environment but also from the external environment. We include in our production model of socio-emotional skills, a number of additional inputs such as health capital (including mother's general health, reported by the mother as excellent, good, fair or poor, and indicators of child and father's long-standing illness), neighbourhood capital (proxied by the local income decile) and social capital (measured as the presence of family and/or friends nearby). Finally, we include as additional controls other family decisions that might have be taken jointly with the parental investment decisions.

[26] The OECD equivalised income is defined as the household income divided by the OECD equivalent scale, which counts the first adult as 1, each additional adult as 0.5 and each child (aged under 15) as 0.3 equivalent adults.

[27] Flouri et al. (2017) has shown that maternal psychological distress affects child emotional and behavioural problems and the main channel is the decrease in productivity of time investment. Similar evidence for cognitive skills can be found in Ronda (2016).

These include (i) mother's labour supply, measured as the number of hours worked; (ii) child care, measured by the number of daily hours the child is looked after not by parents (e.g. nursery, child minder, nanny, grandparents) and the number of daily hours the child spend in breakfast or afternoon club, (iii) mother's fertility, i.e. whether the mother has given birth between age 5 and 7 of the cohort child.

Table 2.3: Descriptive statistics of all the inputs in stage 2, by gender

	Boys		**Girls**		**Test diff**
	mean	sd	mean	sd	p-value
Main inputs					
Parental investment					
Sensitive parenting style	-0.128	0.996	0.126	0.989	0.000
Routines parenting style	0.007	0.981	-0.006	1.016	0.600
Time investment	-0.042	1.010	0.041	0.988	0.001
Family income	496.994	242.311	496.796	245.115	0.974
Parental skills					
Mother's education	18.142	2.605	18.138	2.563	0.944
Mother's mental health	-0.003	0.989	-0.000	1.014	0.932
Mother's general health					
Excellent	0.257	0.437	0.250	0.433	0.500
Good	0.649	0.477	0.655	0.476	0.633
Fair	0.074	0.262	0.075	0.264	0.862
Poor	0.020	0.139	0.020	0.140	0.883
Health Capital					
Child longstanding illness					
Yes	0.201	0.401	0.147	0.354	0.000
Father longstanding illness					
Yes	0.228	0.420	0.236	0.425	0.447
Neighbourhood Capital					
Income decile area	5.958	2.856	5.891	2.895	0.351
Social Capital					
Any family and/or friends nearby					
Yes friends	0.234	0.423	0.226	0.418	0.475
Yes family	0.041	0.198	0.044	0.204	0.610
Yes both	0.682	0.466	0.697	0.460	0.191
No	0.043	0.203	0.033	0.179	0.034
Other Family decisions					
Non-parental Child care (Hours)	4.573	8.489	4.813	8.701	0.263
Hours Club	0.461	0.992	0.443	0.963	0.459
Working hours per week	17.439	14.027	17.477	14.664	0.916
Fertility	0.134	0.340	0.142	0.349	0.321
Observations	3217		3235		6452

Notes: Sensitive parenting style, Routines parenting style, Time investment, Mother's mental health and Child's cognitive skills are obtained from factor models. They are standardized to have mean 0 and standard deviation 1. Family income, that is the OECD equivalised weekly family income, is adjusted at 2012 prices. Last column reports the p-value of the test for the equality of means between boys and girls. Data: UK Millennium Cohort Study, Main Sample.

4.4 Descriptive statistics of the inputs

Table 2.3 details the mean and standard deviation by gender of the main inputs - parental investments and parental skills - and all the other inputs described above. All these inputs are measured when the child is 7 years old.

All the latent inputs that have been estimated with factor models - sensitive parenting style, routines in parenting style, time investment, mothers' mental health and parents' socio-emotional skills - have been standardized to have mean 0 and standard deviation of 1. The descriptive statistics show that there exist a statistical significant difference between boys and girls in the parental inputs that they receive. Parents adopt a harsher (less sensitive) parenting style with boys than with girls and invest more time in girls than in boys. On the contrary, there is no statistical gender difference in parental daily routines, mother's mental health and parental socio-emotional skills. On average family OECD equivalised income is £497 and mothers are on average 18 years old when they leave education, with no differences between boys and girls.

Looking at the descriptives of the other inputs, 90% of the mothers report to have either excellent or good health, whilst 20%, 15% and 23-24% of boys, girls and fathers report a long-standing illness respectively. The areas where children live are on average ranked between the fifth and the sixth income decile (neighbourhood capital) and 69% of children live near family and friends (social capital). Finally, on average boys and girls spend 4.6 and 4.8 hours per day looked after by someone that is not the parent and they spend half an hour per day in either breakfast or afternoon club. The average number of hours worked by the mother is 17.4 per week and 13% and 14% of mothers of boys and girls respectively has had another child when the cohort child was between 5 and 7 years old.

5 Estimation results

We estimate the production model for socio-emotional skills at age 11 as described in equation (2.6). The dependent variable $\theta^N_{i,s,2}$ is the trait-specific socio-emotional skill of the child at the end of stage 2 (age 11), which is a measure of internalising behaviour for $s = 1$ and of externalising behaviour for $s = 2$.[28] The right hand side variables are the trait-specific socio-emotional skills of the child at the end of stage 1 (age 6), $\theta^N_{i,s,1}$; the child cognitive skills at the end of stage 1 (age 6); the main parental inputs during stage 2, i.e. between age 6 and 11, which are sensitive parenting style, routines in parenting style, time investment, family income, mother's education and mothers' mental health, and a set of other controls which we use as proxy for potential omitted inputs to make sure that there is no endogeneity. These extra control variables are an indicator for the quality of the neighbourhood (neighbourhood capital), dummy variables for living close to relatives or friends (social capital measure), a set of measures of family members health (health capital), mother's hours worked, child care arrangements (non-parental care and hours spent in school clubs) and fertility decisions (the

[28] To be more precise, $\theta^N_{i,1,2}$ and $\theta^N_{i,2,2}$ are factors derived from the measurement models described in Section 3.2.

birth of another sibling). Our model estimates the interaction effect between input and the quartiles of child socio-emotional skills at age 6. For the main parental inputs - parental investment and parental skills - the interaction effect varies between high and low levels of the parental input defined as levels above and below the median.

Table 2.4 reports our benchmark results for boys and girls - estimated separately - in Panel A and B respectively. By column, we report the differential productivity of each input at the second (Column 1), third (Column 2) and fourth (Column 3) quartiles of the lagged socio-emotional skills relative to the first quartile.[29] By row, we report these differential effects for each of the parental inputs and separately for level of the parental input below and above the median. Each differential productivity coefficient reported in Table 2.4 measures the differential effect at a specific quartile (which is reported in the column heading) on socio-emotional skills at 11. Coefficients are expressed in standard deviations for an increase of one standard deviation in the parental input (reported at the start of the row). A negative (positive) differential productivity at higher quartiles with respect to the first quartile indicates the presence of substitutability (complementarity). At the bottom of each of the two panels we report the self-productivity or persistence parameter for socio-emotional skills; this is computed keeping all other inputs at the mean and it represents the effect of one standard deviation increase of socio-emotional skills at 6 on socio-emotional skills at 11, also expressed in standard deviations.

Looking at boys (Table 2.4, Panel A), a distinctive pattern arises for sensitive parenting style. The first row suggests substitutability between sensitive parenting style and child lagged socio-emotional skills when the sensitive parenting is at a low level. An increase in sensitive parenting by one standard deviation for harsh parents (parents with a sensitive parenting style below the median) raises skills at age 11 by 13%, 30% and 27.5% of a standard deviation less for children in the second, third and fourth quartile of socio-emotional skills at age 6 compared to those in the first quartile, although only the latter two differential effects are statistically significant.[30] This implies that a change from harsh to sensitive parenting is more productive for children with low socio-emotional skills, in the bottom two quartiles, compared to the third or fourth quartile. These results are consistent with the diathesis-stress psychological framework, as low levels of sensitive parenting, i.e. harsh parental discipline such as smacking or shouting at the child, can increases the child's stress, which can affect especially children who have low socio-emotional skills.

On the other hand, a change in parenting style for parents initially adopting a more sensitive style of parenting (sensitive parenting style above the median) would not indicate a movement away from a stressful environment. As such in the second row of Table 2.4, the effect of an improvement in sensitive parenting on socio-emotional skills at 11 is higher for children with relatively high socio-emotional skills at age 6. An improvement in sensitive parenting raises age 11 socio-emotional skills by around 50% and 45.9% of a standard deviation more for boys in the third and fourth quartile of the distribution at age 6 compared to those in

[29]The q-th quartile refers to values of the lagged socio-emotional skills in the q-th quarter of the distribution. Notice that the quartiles are defined separately for boys and girls.

[30]For brevity we refer to statistical significance at standard level of 5% simply as "statistical significance".

the first quartile, and these differential effects are statistically significant. For children not exposed to stressful levels of harsh parenting styles, this evidence suggests complementarity between parenting style and the stock of child skills.

Table 2.4: Production model of socio-emotional skills (between age 6 and 11), by gender.

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Sensitive parenting style ≤ median	-0.128	-0.300***	-0.275***
	(0.089)	(0.091)	(0.097)
Sensitive parenting style > median	0.247	0.504***	0.459***
	(0.170)	(0.168)	(0.171)
Mother's mental health ≤ median	-0.067	-0.001	-0.099
	(0.067)	(0.061)	(0.090)
Mother's mental health > median	0.032	-0.141	-0.006
	(0.198)	(0.194)	(0.217)
Time investment ≤ median	0.059	-0.010	0.068
	(0.084)	(0.083)	(0.087)
Time investment > median	0.008	0.022	-0.095
	(0.151)	(0.154)	(0.162)
Socio-emotional skills (age 6)		0.470***	
		(0.045)	
σ^2 (fixed effect)		0.467	
Observations		6434	
Panel B: Girls			
Sensitive parenting style ≤ median	-0.022	-0.121	-0.245***
	(0.096)	(0.108)	(0.110)
Sensitive parenting style > median	0.060	0.185	0.353***
	(0.162)	(0.169)	(0.170)
Mother's mental health ≤ median	-0.209***	-0.198***	-0.183***
	(0.057)	(0.069)	(0.074)
Mother's mental health > median	0.589***	0.596***	0.253
	(0.185)	(0.196)	(0.200)
Time investment ≤ median	-0.111	-0.093	-0.180*
	(0.090)	(0.093)	(0.096)
Time investment > median	0.235	0.112	0.345**
	(0.162)	(0.160)	(0.166)
Socio-emotional skills (age 6)		0.307***	
		(0.047)	
σ^2 (fixed effect)		0.467	
Observations		6470	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. The results for the remaining variables are reported in Table B.9 and B.10 in the Appendix. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, Main Sample.

Considering the other inputs, we find no evidence of complementarity and/or substitutability in time investment, routine parenting style, income, mother's and child's cognitive skills

and mother's mental health, which imply that those inputs do not have a heterogenous effect by socio-emotional skills.[31,32] Finally, results indicate that socio-emotional skills of boys are self-productive (see the bottom of Panel A in Table 2.4) as a standard deviation increase in socio-emotional skills at age 6 raises socio-emotional skills at age 11 by 47% of a standard deviation.

The pattern in the productivity of sensitive parenting style for girls is similar to the one observed for boys. We find substitutability between sensitive parenting style and early socio-emotional skills for levels of the parental input below the median and complementarity for levels above the median (see first two rows of Panel B in Table 2.4). Notice that the productivity of sensitive parenting style at the first quartile is not statistically significantly different from the productivity at the second and third quartiles; but it is statistically significantly different than the productivity at the top quartile. Therefore, we still interpret these results as evidence of substitutability for levels of sensitive parenting below the median and complementarity for levels above the median. For girls, we find also a pattern in the productivity of time investment which is very similar to the one observed for sensitive parenting (see last two rows in the top part of Panel B in Table 2.4).

Finally, for girls, we find even stronger evidence of substitutability between maternal mental health and early socio-emotional skills for level of mental health below the median. The effect of an increase in mothers' mental health is 18-21% higher for girls with early socio-emotional skills in the bottom quartile compared to the top three quartiles. On the contrary, if the maternal mental health is above the median, an increase of the maternal input would be more beneficial for girls in the second or third quartile of the socio-emotional skills distribution at 6, compared to those in the bottom quartile. That the differential effect of mothers' mental health at the bottom quartile of the child socio-emotional skills is statistically significant only for girls and not for boys is consistent with previous empirical studies which have found the intergenerational transmission of mental health to be stronger from mothers to girls than from mothers to boys. E.g. Powdthavee and Vignoles (2008) find a statistically insignificant effect of maternal negative emotional stress on boys, but a strong effect on girls, when the children are in adolescence.

Taken all together, these results are in line with the diathesis-stress framework. For girls, low levels of maternal mental health, sensitive parenting style and parental time investments will increase the stress environment with negative consequences on their socio-emotional development during late childhood, especially for girls with low level of socio-emotional skills

[31]For brevity the table reports the coefficients only on inputs for which we found either substitutability or complementarity, for boys and/or for girls. However, the estimated model allows the effect of the interactions between each of the parental inputs and the dummies for quartiles of the socio-emotional skills to differ between level of the parental inputs below and above the median. Results for the remaining parental inputs are reported in Appendix Table B.9, whereas results for the remaining control variables are reported in Appendix Table B.10.

[32]The school inputs, e.g. teacher years of experience, are not included in the benchmark estimation because this variable is available only for a smaller sample. However, when included, the results show that the school inputs do not have a differential effect across the socio-emotional skills at age 6 and we cannot reject the null hypothesis that the coefficients are jointly equal to zero at standard significance level. Because school inputs do not have differential return by the level of socio-emotional skills at age 6, our fixed effect model already controls for it.

at 6. Similarly boys with low level of sensitive parenting are likely to experience a more stressful home environment and this has a negative effect on their socio-emotional skills at 11, especially for boys with low socio-emotional skills at 6.

Ultimately, our findings suggest that we can help children who are lagging behind in terms of socio-emotional skills with interventions in late childhood aiming at improving specific parental inputs but only if these interventions are targeted to parents with low level of such inputs. To provide some information on the size of the potential effect of these interventions, we adopt a "back on the envelope" computation. This makes use of our estimated coefficients in Table 2.4 to predict the reduction in the socio-emotional skills gap at 11 caused by an increase in each inputs. The predicted reduction is computed comparing the predicted gap in socio-emotional skills at 11 with and without assuming an increase in a specific parental input. In Table 2.5 we show the predicted reduction in the gap in socio-emotional skills at 11 caused by an increase of 1 standard deviation of the parental input (reported at the start of the row), for parents with a level of the input below the median and holding all other inputs at their mean. The gaps are the differences in socio-emotional skills at 11 between a child who was at the second (column 1), third (column 2) and fourth quartile (column 3) of the socio-emotional skills at 6 with respect to a child at the bottom quartile. When considering a child in the q-th quartile of the socio-emotional skills at 6, we assume that his/her level of socio-emotional skills is equal to the average level observed for children in the q-th quartile.

Table 2.5: Predicted reduction in the gap in socio-emotional skills at 11 for an increase in inputs below the median of 1 standard deviation, by gender

	Percentage reduction in the gap between children at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	and the 1st Quartile of socio-emotional skills at age 6		
Panel A: Boys			
Sensitive parenting style	20.8%	33.7%	24.2%
	(14.914)	(11.049)	(9.020)
Mother's mental health	10.9%	0.1%	8.7%
	(10.960)	(6.813)	(7.994)
Time investment	-9.7%	1.2%	-5.9%
	(13.733)	(9.342)	(7.718)
Panel B: Girls			
Sensitive parenting style	5.5%	20.7%	33.2%
	(24.073)	(19.016)	(16.155)
Mother's mental health	52.3%	33.8%	24.8%
	(17.023)	(13.171)	(10.900)
Time investment	27.8%	15.9%	24.3%
	(23.086)	(15.994)	(13.414)

Notes: Percentage reductions in gaps are computed as the difference between the predicted gap with and without an increase of one standard deviation in the input. The predictions are computed using our benchmark model estimated coefficients and keeping all other inputs at the mean. Standard errors in parenthesis.

Looking at results for boys in Table 2.5, we find large reductions in the gaps when considering an increase in sensitive parenting which range between 21% and 34%, but much more modest reductions when considering equivalent increases in the mother's mental health or in the parental time. Results for girls suggest that an increase by one standard deviation in sensitive parenting style, mother's mental health and parental time investments leads to substantial reductions in the gaps in socio-emotional skills at 11 for girls. This is especially

true when increasing the mother's mental health which could close up to 52% of the gap. In conclusion, results of this "back on the envelope" computation provides further evidence that interventions aiming at increasing certain parental inputs, when they are low, could be cost-effective to help children to catch-up their socio-emotional skills.

6 Sensitivity analysis

To ensure there is no residual endogeneity to threaten our identification strategy, we run several robustness checks where we (i) include parents' trait-specific socio-emotional skills to control for the intergenerational transmission of predisposition; (ii) use mother and teacher reports to correct for measurement error; (iii) test for differences in self-productivity across quartiles of socio-emotional skills at age 6; (iv) test the equivalence of the model between the two traits of socio-emotional skills; (v) anchor socio-emotional skills to a real-life measure.

By adopting the child fixed effect estimation we control for the effect of any stage-variant and trait-invariant unobserved inputs. The only endogenous variation that could be left in the socio-emotional skills at age 6 is intergenerational transmission of a predisposition to internalising and externalising behaviours. Our first sensitivity analysis includes as additional controls the mothers' and fathers' trait-specific socio-emotional skills to control for such intergenerational transmission (see Panel A and B in Table 2.6 for boys and girls respectively).[33] The conclusions from our benchmark results are unchanged and we find very similar patterns of variation in the productivity of sensitive parenting style, maternal mental health and parental time investments across quartile of the child socio-emotional skills at 6 and across levels of the inputs below and above the median. We conclude that the intergenerational transmission of predisposition between parents and children does not represent a threat for our identification.

A second sensitivity analysis controls for the measurement error in the child socio-emotional skills reported by the mother. The mother reports could be systematically biased and correlated with mothers mental health as found by Del Bono et al. (2017).[34] We do not find evidence for such bias in our estimation when using teachers and mothers reports to derive child's trait-specific socio-emotional skills which are less affected by measurement errors (see Table 2.7). Controlling for the measurement error in the child socio-emotional skills, by using both mother's and teacher's reports to derive the latent factors for internalising and externalising behaviours, does not seem to cause any large change in the estimated coefficients. However, they are not identical and are less precisely estimated, most likely due to the smaller sample size. We conclude that there is no systematic empirical bias for our benchmark results. This is probably because our benchmark estimates are based on the child fixed effect estimation which uses variation in socio-emotional skills within child and across traits and therefore correct for any potential measurement error which is shared across different measures of socio-emotional skills reported by the mother.

[33]The subsample with details on both father and mother trait-specific skills is smaller. Table B.11 shows descriptive statistics for such subsample.

[34]We use latent factor model to combine measures of socio-emotional skills using the repeated measures reported by the mother at age 5 and 7 and the measures reported by the teacher at age 7.

Table 2.6: Production model of socio-emotional skills (between age 6 and 11), by gender. Controlling additionally for mother's and father's trait-specific socio-emotional skills (Sensitivity 1)

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Sensitive parenting style ≤ median	-0.159	-0.262**	-0.287***
	(0.103)	(0.104)	(0.109)
Sensitive parenting style > median	0.246	0.469**	0.453**
	(0.194)	(0.191)	(0.194)
Mother's mental health ≤ median	-0.042	-0.026	-0.104
	(0.077)	(0.067)	(0.092)
Mother's mental health > median	-0.044	-0.157	-0.005
	(0.224)	(0.217)	(0.240)
Time investment ≤ median	0.032	-0.024	0.059
	(0.096)	(0.095)	(0.099)
Time investment > median	0.014	0.022	-0.077
	(0.176)	(0.178)	(0.185)
Socio-emotional skills (age 6)		0.467***	
		(0.051)	
Mother's Socio-emotional skills		-0.014	
		(0.013)	
Father's Socio-emotional skills		-0.002	
		(0.013)	
σ^2 (fixed effect)		0.463	
Observations		5252	
Panel B: Girls			
Sensitive parenting style ≤ median	-0.003	-0.178	-0.220*
	(0.111)	(0.122)	(0.120)
Sensitive parenting style > median	0.113	0.260	0.327*
	(0.187)	(0.192)	(0.191)
Mother's mental health ≤ median	-0.250***	-0.220***	-0.258***
	(0.073)	(0.083)	(0.094)
Mother's mental health > median	0.720***	0.666***	0.469**
	(0.212)	(0.222)	(0.231)
Time investment ≤ median	-0.102	-0.056	-0.095
	(0.107)	(0.104)	(0.109)
Time investment > median	0.281	0.100	0.287
	(0.191)	(0.183)	(0.190)
Socio-emotional skills (age 6)		0.337***	
		(0.054)	
Mother's Socio-emotional skills		-0.015	
		(0.015)	
Father's Socio-emotional skills		0.016	
		(0.014)	
σ^2 (fixed effect)		0.476	
Observations		5140	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors clustered are at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, subsample with details on mother's and father's trait specific socio-emotional skills.

Table 2.7: Production model of socio-emotional skills between age 6 and 11, by gender. Combining mother's and teacher's reports to measure child socio-emotional skills (Sensitivity 2)

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Sensitive parenting style ≤ median	0.001	-0.221*	-0.202*
	(0.128)	(0.117)	(0.113)
Sensitive parenting style > median	0.038	0.342*	0.350*
	(0.213)	(0.204)	(0.191)
Mother's mental health ≤ median	-0.150*	-0.018	-0.176**
	(0.082)	(0.079)	(0.087)
Mother's mental health > median	0.271	0.062	0.134
	(0.234)	(0.231)	(0.241)
Time investment ≤ median	-0.073	-0.038	-0.002
	(0.104)	(0.099)	(0.102)
Time investment > median	0.145	-0.025	-0.010
	(0.195)	(0.186)	(0.192)
Socio-emotional skills (age 6)		0.413***	
		(0.056)	
σ^2 (fixed effect)		0.446	
Observations		4426	
Panel B: Girls			
Sensitive parenting style ≤ median	0.084	-0.058	-0.042
	(0.127)	(0.125)	(0.140)
Sensitive parenting style > median	-0.066	0.108	0.176
	(0.204)	(0.199)	(0.215)
Mother's mental health ≤ median	-0.162**	-0.168**	-0.132
	(0.075)	(0.081)	(0.084)
Mother's mental health > median	0.404*	0.384	-0.007
	(0.232)	(0.239)	(0.240)
Time investment ≤ median	0.059	0.051	-0.106
	(0.117)	(0.111)	(0.111)
Time investment > median	0.016	0.094	0.290
	(0.209)	(0.199)	(0.199)
Socio-emotional skills (age 6)		0.228***	
		0.059	
σ^2 (fixed effect)		0.462	
Observations		4413	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, subsample with details on teacher's reports of socio-emotional skills.

Our third sensitivity analysis relaxes the assumption of linearity in the socio-emotional skills at 6 imposed by our benchmark model (2.6) by allowing the self-productivity coefficient ρ to vary across different quartiles of the socio-emotional skills at 6. Results of this specification are shown Table B.12 in the Appendix for boys and girls, in Panel A and B respectively. We

do not reject the hypothesis of equality of the self-productivity coefficient across quartile at 5% level of significance, therefore the linearity assumption in our benchmark model is not rejected.[35]

The fourth robustness analysis relaxes the assumption of invariance of our model across the two trait-specific socio-emotional skills, internalising and externalising, by allowing the self-productivity coefficient and the differential productivity effects of sensitive parenting, mother's mental health and time investments to differ between internalising and externalising skills. The rest of the model remains the same as in our benchmark model (2.6). Our results, shown in Table B.13 for boys and Table B.14 for girls in the Appendix, suggest that the parameters are similar across the two traits.[36]

Finally, the lack of a natural metric of our socio-emotional skills implies that our results might be sensitive to arbitrary scaling of socio-emotional skills. This is especially an issue when regressing an arbitrarily scaled outcomes on arbitrarily scaled lagged outcomes (see Cunha and Heckman 2008; Cunha et al. 2010; Bond and Lang 2013, 2018).[37] We follow Cunha et al. (2010) and Nicoletti and Rabe (2017) and re-scale socio-emotional skills by anchoring them to a measure with a well defined scale, which in our case is smoking behaviour at age 14. Using the latest wave of the MCS, we construct an indicator of whether the child has ever smoked at age 14, taking value 0 if the child has smoked and 1 if the child has never smoked. We regress the smoking dummy separately on internalising and externalising behaviour at ages 6 and 11 using linear spline regression. Then we import the estimated coefficients into our estimation sample and perform our analysis on socio-emotional skills transformed into the probability of non-smoking.

Table B.15 in the Appendix displays the results for boys and girls, in Panel A and B respectively. Looking at the degree of self-productivity, we find an increase in socio-emotional skills at age 6 that corresponds to 1 percent increase in the probability of non-smoking raises the socio-emotional skills at age 11 of an amount that corresponds to an increase in the probability of non-smoking of 0.44 percentage points for boys and of 0.30 percentage points for girls. These results confirm that the higher self-productivity observed among boys compared to girls in our benchmark results is not affected by the scale of the observed measures. The anchoring exercise confirms all our benchmark results including the evidence on substitutability and complementarity between the parental inputs and socio-emotional skills at age 6 in producing socio-emotional skills at age 11.

[35]For boys (Panel A), the p-value for the test of equality of coefficients is 0.632 when comparing the second and the third quartile, 0.253 when comparing the second and the fourth quartile, 0.738 when comparing the third and the fourth quartile. For girls (Panel B), the p-value for the test of equality of coefficients is 0.422 when comparing the second and the third quartile, 0.426 when comparing the second and the fourth quartile, 0.909 when comparing the third and the fourth quartile.

[36]The test for the equality of the coefficients between the two trait-specific socio-emotional skills rejects the equality at 5% level of significance; but the majority of the univariate tests for the equality of the coefficients is not rejected at 5% significance level (25 out of 38 cases).

[37]Notice that arbitrary rescaling is less of an issue when considering the different quartiles of the socio-emotional skills at age 6 given that any monotonic transformation of the socio-emotional skills would yield the same values for each of these quartiles.

7 Conclusions

Existing empirical evidence suggest that inequalities in socio-emotional and cognitive skills are present before children start schooling and persist across their childhood. However, socio-emotional skills tend to be malleable much further into childhood than cognitive skills, which suggests that these early life differences can be attenuated through interventions in late childhood such as public policies that support parents to improve their parenting behaviour.

To assess the potential usefulness of such interventions in late childhood and to identify which types of parental inputs should be targeted, we evaluate the degree of complementarity or substitutability between different types of parental inputs and socio-emotional skills at age 6 in producing socio-emotional skills at age 11. In particular, we test whether there is heterogeneity across quartiles of socio-emotional skills at age 6 in the productivity of the following six parental inputs: sensitive parenting style, routines parenting style, time investment, family income, mother's cognitive skills and mother's mental health.

We find evidence of substitutability between socio-emotional skills at 6 and parental inputs that help reducing child's stress, for both boys and girls. For both boys and girls an increase in sensitive parenting has a larger productivity for children with lower socio-emotional skills at 6 when the initial values of sensitive parenting are below the median. This result suggests that a policy aiming at reducing harsh (increasing sensitive) parenting and targeted to parents whose level of sensitive parenting is below the median, would be effective in reducing gaps in socio-emotional skills for both boys and girls. Looking at girls, we find also evidence that interventions aiming at increasing maternal psychological health and parental time investments, when these are below the median, would help in shrinking gaps in socio-emotional skills for girls.

Our results are robust to several sensitivity checks which we run to control for: (i) the transmission of trait-specific socio-emotional skills from parents to children; (ii) measurement errors in the children's socio-emotional skills reported by the mother; (iii) non-linearities in the lagged socio-emotional skills; (iv) validity of the assumption of invariance of the dynamic production model between the two trait-specific socio-emotional skills, which are internalising and externalising skills; (v) arbitrary scaling of our measures of socio-emotional skills by anchoring our results to real-life outcomes.

Coming back to our initial question of whether interventions in late childhood can be effective to narrow the gaps in socio-emotional skills, the short answer is yes. Nevertheless, to be cost-effective such interventions should be aimed at raising parental inputs that reduce stressful environment experiences for the child, such as sensitive parenting, and should be targeted exclusively to parents with low level of such parental inputs.

B Appendices

B.1 Further description of data

Table B.1: Descriptive statistics of demographic characteristics in stage 2 of the main sample.

	mean	sd
Demographic characteristics		
Age in months	86.611	2.870
Number of Siblings	1.510	0.964
Mother age	37.076	5.304
Mother's etnicity		
White	0.929	0.256
Mixed	0.005	0.068
Indian	0.019	0.137
Pakistani Bangladeshi	0.023	0.151
Black	0.014	0.116
Other	0.010	0.100
Mother's occupational status		
Managerial and professional	0.364	0.481
Intermediate	0.290	0.454
Routine and manual	0.316	0.465
Never worked	0.030	0.170
Observations	6452	

Notes: The demographic characteristics in stage 2 are measured around age 7 of the child. Data: UK Millennium Cohort Study, Main Sample.

Table B.2: Factor loadings of internalising and externalising behaviour - boys

	(1) Factor Loadings	(2) Signal
Internalsing behaviour		
Peer problems (age 5)	1.000	0.479
Peer problems (age 7)	1.062	0.487
Emotional symptoms (age 5)	0.894	0.332
Emotional symptoms (age 7)	1.059	0.384
Externalising behaviour		
Hyperactivity problems (age 5)	1.000	0.637
Hyperactivity problems (age 7)	1.084	0.665
Conduct problems (age 5)	0.489	0.408
Conduct problems (age 7)	0.513	0.428

Notes:Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.3: Factor loadings of internalising and externalising behaviour - girls

	(1) Factor Loadings	(2) Signal
Internalsing behaviour		
Peer problems (age 5)	1.000	0.393
Peer problems (age 7)	1.024	0.374
Emotional symptoms (age 5)	1.144	0.376
Emotional symptoms (age 7)	1.304	0.405
Externalising behaviour		
Hyperactivity problems (age 5)	1.000	0.607
Hyperactivity problems (age 7)	1.103	0.641
Conduct problems (age 5)	0.492	0.386
Conduct problems (age 7)	0.497	0.400

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.4: Factor loadings of child's cognitive skills - boys

	(1) Factor Loadings	(2) Signal
BAS: Picture similarities (age 5)	1.000	0.220
BAS: Reading abilities (age 5)	1.420	0.245
BAS: Pattern construction (age 5)	2.396	0.445
NFER: Maths test (age 7)	0.360	0.470
BAS: Reading abilities (age 7)	3.398	0.327
BAS: Pattern construction (age 7)	2.099	0.433

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.5: Factor loadings of child's cognitive skills - girls

	(1) Factor Loadings	(2) Signal
BAS: Picture similarities (age 5)	1.000	0.210
BAS: Reading abilities (age 5)	1.444	0.265
BAS: Pattern construction (age 5)	2.124	0.395
NFER: Maths test (age 7)	0.354	0.494
BAS: Reading abilities (age 7)	2.929	0.302
BAS: Pattern construction (age 7)	2.088	0.471

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.6: Factor loadings of parental investments

	(1) Factor Loadings	(2) Signal
Sensitive parenting style		
How often tells child off when naughty	1.000	0.502
How often smacks at child when naughty	0.473	0.175
How often shouts at child when naughty	0.974	0.421
How often sends child to bedroom/naughty chair	0.996	0.398
How often takes away treats from child when naughty	0.890	0.380
How often bribes at child when naughty	0.533	0.107
How often ignores at child when naughty	0.696	0.161
Routines parenting style		
Regular bedtime on term-time weekdays	1.000	0.289
What bedtime on term-time weekdays	1.317	0.254
Rules about timed watching TV	0.331	0.131
Rules about hours watching TV	0.370	0.083
Time investment		
Frequency draw and paint with child	1.000	0.372
Frequency tell stories to child	0.958	0.191
How often does musical activities with child	0.868	0.183
Frequency play active games with child	1.091	0.347
Frequency play indoor games with child	1.089	0.440
Frequency take child to park or playground	0.617	0.159

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.7: Factor loadings of mother's skills

	(1) Factor Loadings	(2) Signal
Mother's mental health		
How often felt depressed in last 30 days	1.000	0.623
How often felt hopeless in last 30 days	0.983	0.703
How often felt restless in last 30 days	0.826	0.359
How often felt everything an effort in last 30 days	1.038	0.465
How often felt worthless in last 30 days	0.947	0.618
How often felt nervous in last 30 days	0.747	0.303

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium cohort Study, Main Sample.

Table B.8: Factor loadings of parents' trait specific socio-emotional skills

	(1) Factor Loadings	(2) Signal
Mother's neuroticism		
I get stressed out easily	1.000	0.520
I get angry easily	0.746	0.373
I feel threatened easily	0.617	0.306
I get overwhelmed by emotions	0.860	0.414
I take offence easily	0.741	0.362
I get caught up in my problems	0.908	0.535
I grumble about things	0.627	0.254
Mother's extroversion		
I don t talk a lot	1.000	0.280
I talk to a lot of different people at parties	1.363	0.419
I bottle up my feelings	1.072	0.241
I am a very private person	1.015	0.244
I wait for others to lead the way	0.928	0.253
I feel at ease with people	1.077	0.455
I am skilled in handling social situations	1.019	0.345
Takes charges	0.446	0.076
Father's neuroticism		
I get stressed out easily	1.000	0.528
I get angry easily	0.775	0.387
I feel threatened easily	0.670	0.351
I get overwhelmed by emotions	0.688	0.307
I take offence easily	0.674	0.315
I get caught up in my problems	0.860	0.464
I grumble about things	0.649	0.236
Father's extroversion		
I don t talk a lot	1.000	0.382
I talk to a lot of different people at parties	0.984	0.352
I bottle up my feelings	0.825	0.236
I am a very private person	0.739	0.215
I wait for others to lead the way	0.586	0.192
I feel at ease with people	0.782	0.377
I am skilled in handling social situations	0.680	0.267
Takes charges	0.172	0.021

Notes: Column (2) indicates for each of the measures the fraction of the variance explained by the latent. Data: UK Millennium Cohort Study, subsample with details on mother's and father's trait specific socio-emotional skills.

B.2 Further estimation results

Table B.9: Production model of socio-emotional skills (between age 6 and 11), by gender. Remaining inputs effects.

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Routines parenting style ≤ median	-0.081	-0.054	-0.097
	(0.074)	(0.075)	(0.075)
Routines parenting style > median	0.014	0.014	0.152
	(0.162)	(0.166)	(0.164)
Family income ≤ median	0.001	0.065	0.098*
	(0.047)	(0.049)	(0.052)
Family income > median	0.013	-0.054	-0.099
	(0.069)	(0.070)	(0.073)
Cognitive skills (age 6) ≤ median	0.027	0.064	-0.023
	(0.081)	(0.088)	(0.098)
Cognitive skills (age 6) > median	0.071	-0.100	0.141
	(0.162)	(0.161)	(0.165)
Mother's education ≤ median	0.018	0.021	0.007
	(0.050)	(0.050)	(0.051)
Mother's education > median	0.003	-0.028	-0.019
	(0.068)	(0.066)	(0.068)
Observations		6434	
Panel B: Girls			
Routines parenting style ≤ median	0.113	0.000	0.028
	(0.072)	(0.071)	(0.080)
Routines parenting style > median	-0.310**	0.049	-0.124
	(0.156)	(0.157)	(0.163)
Family income ≤ median	0.064	-0.037	-0.029
	(0.049)	(0.050)	(0.051)
Family income > median	-0.067	-0.007	0.005
	(0.072)	(0.070)	(0.071)
Cognitive skills (age 6) ≤ median	0.065	-0.042	-0.012
	(0.100)	(0.097)	(0.101)
Cognitive skills (age 6) > median	-0.083	0.089	0.083
	(0.186)	(0.182)	(0.195)
Mother's education ≤ median	-0.060	-0.009	0.029
	(0.053)	(0.054)	(0.054)
Mother's education > median	0.057	0.040	-0.018
	(0.074)	(0.074)	(0.073)
Observations		6470	

Notes: The table shows the full set of interactions of the benchmarck model shown in Table 2.4. Data: UK Millennium Cohort Study, Main Sample.

Table B.10: Production model of socio-emotional skills (between age 6 and 11), by gender. Remaining controls.

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Mother General Health - Excellent	-0.363	0.251	-0.214
	(0.355)	(0.350)	(0.341)
Mother General Health - Good	-0.298	0.280	-0.097
	(0.346)	(0.341)	(0.336)
Mother General Health - Fair	-0.348	0.254	-0.334
	(0.393)	(0.391)	(0.377)
Mother General Health - Poor	-0.155	0.356	-0.247
	(0.533)	(0.537)	(0.518)
Child longstanding illness	-0.070	-0.072	-0.190
	(0.134)	(0.129)	(0.125)
Father longstanding illness	-0.058	-0.152	0.113
	(0.125)	(0.122)	(0.120)
Income decile area	-0.005	-0.030	-0.020
	(0.019)	(0.019)	(0.019)
Friends nearby - Yes	-0.000	-0.153	-0.137
	(0.278)	(0.264)	(0.244)
Family nearby - Yes	0.193	-0.118	0.046
	(0.328)	(0.338)	(0.302)
Family and friends nearby - Yes	0.044	-0.284	-0.081
	(0.266)	(0.251)	(0.230)
Non-parental child care	0.002	0.006	0.006
	(0.006)	(0.006)	(0.006)
Hours club	-0.055	-0.011	-0.006
	(0.047)	(0.061)	(0.056)
Working hours per week	0.005	0.002	0.003
	(0.004)	(0.004)	(0.004)
Fertility	0.040	-0.074	-0.073
	(0.146)	(0.153)	(0.159)
Observations		6434	
Panel B: Girls			
Mother General Health - Excellent	-0.350	-0.434	-0.447
	(0.331)	(0.344)	(0.333)
Mother General Health - Good	-0.301	-0.492	-0.357
	(0.315)	(0.325)	(0.315)
Mother General Health - Fair	-0.380	-0.299	-0.083
	(0.368)	(0.392)	(0.383)
Mother General Health - Poor	-0.100	-0.028	-0.181
	(0.462)	(0.507)	(0.674)
Child longstanding illness	-0.045	0.223*	0.089
	(0.135)	(0.134)	(0.140)
Father longstanding illness	-0.001	-0.040	0.019
	(0.120)	(0.119)	(0.130)
Income decile area	-0.019	-0.005	-0.011
	(0.018)	(0.019)	(0.019)
Friends nearby - Yes	0.093	0.092	0.187
	(0.241)	(0.250)	(0.245)
Family nearby - Yes	0.283	0.614	0.166
	(0.309)	(0.309)	(0.326)
Family and friends nearby - Yes	0.259	0.116	0.242
	(0.229)	(0.237)	(0.232)
Non-parental child care	-0.004	-0.004	-0.005
	(0.005)	(0.006)	(0.006)
Hours club	-0.023	0.003	-0.014
	(0.042)	(0.050)	(0.056)
Working hours per week	-0.005	-0.002	-0.001
	(0.004)	(0.004)	(0.004)
Fertility	0.090	0.020	-0.102
	(0.136)	(0.137)	(0.143)
Observations		6470	

Notes: The table shows the full set of interactions of the benchmarck model shown in Table 2.4. Data: UK Millennium Cohort Study, Main Sample.

B.3 Further sensitivity analysis

Table B.11: Descriptive statistics of the father's subsample, by gender

	Boys		**Girls**		**Test diff**
	mean	sd	mean	sd	p-value
Father's socio-emotional skills					
Father's neuroticism (-)	-0.016	0.987	0.016	1.014	0.254
Father's extroversion	0.013	1.003	-0.014	0.998	0.336
Observations	2626		2570		5196

Notes: Last column indicates the p-value mean test of the difference in each variables between boys and girls. Data: UK Millennium Cohort Study, Father Sample.

Table B.12: Production model of socio-emotional skills (between age 6 and 11), by gender. Allowing for differential self-productivity of socio-emotional skills across quartiles (Sensitivity 3).

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Sensitive parenting style ≤ median	-0.128	-0.299***	-0.272***
	(0.089)	(0.091)	(0.097)
Sensitive parenting style > median	0.245	0.504***	0.466***
	(0.170)	(0.168)	(0.171)
Mother's mental health ≤ median	-0.068	-0.001	-0.100
	(0.067)	(0.061)	(0.090)
Mother's mental health > median	0.031	-0.142	-0.006
	(0.198)	(0.194)	(0.217)
Time investment ≤ median	0.060	-0.011	0.068
	(0.084)	(0.083)	(0.087)
Time investment > median	0.008	0.023	-0.093
	(0.151)	(0.155)	(0.162)
Socio-emotional skills (age 6)	0.052	-0.043	-0.105
	(0.124)	(0.170)	(0.100)
σ^2 (fixed effect)		0.466	
Observations		6434	
Panel B: Girls			
Sensitive parenting style ≤ median	-0.023	-0.121	-0.248**
	(0.096)	(0.108)	(0.110)
Sensitive parenting style > median	0.065	0.184	0.354**
	(0.162)	(0.169)	(0.170)
Mother's mental health ≤ median	-0.209***	-0.199***	-0.183**
	(0.057)	(0.069)	(0.074)
Mother's mental health > median	0.595***	0.600***	0.256
	(0.185)	(0.197)	(0.200)
Time investment ≤ median	-0.110	-0.092	-0.179*
	(0.091)	(0.093)	(0.096)
Time investment > median	0.236	0.110	0.344**
	(0.162)	(0.160)	(0.166)
Socio-emotional skills (age 6)	-0.144	0.029	0.005
	(0.155)	(0.167)	(0.140)
σ^2 (fixed effect)		0.466	
Observations		6470	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, Main Sample.

Table B.13: Production model of socio-emotional skills between age 6 and 11 - boys. Equivalence of the model across socio-emotional traits (Sensitivity 4)

	Differential effect of the input at the		
	(1)	(2)	(3)
Boys	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Internalising			
Sensitive parenting style ≤ median	-0.444***	-0.484***	-0.433***
	(0.100)	(0.104)	(0.108)
Sensitive parenting style > median	0.315	0.355	0.292
	(0.212)	(0.222)	(0.220)
Mother's mental health ≤ median	-0.182	-0.070	-0.155*
	(0.084)	(0.081)	(0.093)
Mother's mental health > median	0.326	0.122	0.206
	(0.237)	(0.230)	(0.246)
Time investment ≤ median	-0.073	-0.168*	0.088
	(0.099)	(0.097)	(0.100)
Time investment > median	0.190	0.278	-0.193
	(0.183)	(0.182)	(0.188)
Socio-emotional skills (age 6)		0.495***	
		(0.048)	
Panel B: Externalising			
Sensitive parenting style ≤ median	-0.213**	-0.402***	-0.341***
	(0.104)	(0.111)	(0.124)
Sensitive parenting style > median	0.263	0.493**	0.310
	(0.220)	(0.223)	(0.234)
Mother's mental health ≤ median	-0.040	-0.027	-0.075
	(0.081)	(0.079)	(0.118)
Mother's mental health > median	0.177	0.026	0.081
	(0.236)	(0.233)	(0.262)
Time investment ≤ median	0.074	-0.025	-0.100
	(0.102)	(0.101)	(0.104)
Time investment > median	-0.071	-0.020	0.155
	(0.185)	(0.187)	(0.191)
Socio-emotional skills (age 6)		0.221***	
		(0.060)	
σ^2 (fixed effect)		0.535	
Observations		6434	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, Main Sample.

Table B.14: Production model of socio-emotional skills between age 6 and 11 - girls. Equivalence of the model across socio-emotional traits (Sensitivity 4)

	Differential effect of the input at the		
	(1)	(2)	(3)
Girls	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Internalising			
Sensitive parenting style ≤ median	-0.209**	-0.184	-0.003
	(0.103)	(0.127)	(0.124)
Sensitive parenting style > median	-0.150	-0.196	-0.442*
	(0.212)	(0.230)	(0.227)
Mother's mental health ≤ median	-0.205***	-0.162**	-0.255***
	(0.068)	(0.081)	(0.081)
Mother's mental health > median	0.418*	0.359	0.294
	(0.220)	(0.228)	(0.236)
Time investment ≤ median	-0.198*	-0.187*	-0.292***
	(0.102)	(0.103)	(0.101)
Time investment > median	0.261	0.267	0.544***
	(0.185)	(0.186)	(0.183)
Socio-emotional skills (age 6)		0.308***	
		(0.054)	
Panel B: Externalising			
Sensitive parenting style ≤ median	0.391**	0.180	-0.242*
	(0.126)	(0.131)	(0.145)
Sensitive parenting style > median	-0.737**	-0.504**	-0.014
	(0.238)	(0.235)	(0.239)
Mother's mental health ≤ median	-0.231***	-0.266***	-0.133
	(0.074)	(0.090)	(0.095)
Mother's mental health > median	0.582**	0.660***	0.031
	(0.239)	(0.247)	(0.244)
Time investment ≤ median	-0.245**	-0.190*	-0.229**
	(0.110)	(0.109)	(0.115)
Time investment > median	0.563***	0.279	0.429**
	(0.205)	(0.190)	(0.196)
Socio-emotional skills (age 6)		0.252***	
		(0.059)	
σ^2 (fixed effect)		0.530	
Observations		6470	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, Main Sample.

Table B.15: Production model of socio-emotional skills between age 6 and 11, by gender. Anchoring socio-emotional skills to 'non-smoking' at age 14 (Sensitivity 5).

	Differential effect of the input at the		
	(1)	(2)	(3)
	2nd Quartile	3rd Quartile	4th Quartile
	relative to the 1st Quartile of socio-emotional skills		
Panel A: Boys			
Sensitive parenting style ≤ median	-0.104	-0.284***	-0.207**
	(0.080)	(0.081)	(0.088)
Sensitive parenting style > median	0.147	0.401**	0.310*
	(0.159)	(0.158)	(0.165)
Mother's mental health ≤ median	-0.059	0.075	-0.090
	(0.056)	(0.050)	(0.075)
Mother's mental health > median	-0.075	-0.427*	-0.095
	(0.175)	(0.164)	(0.187)
Time investment ≤ median	0.053	-0.038	0.038
	(0.071)	(0.073)	(0.075)
Time investment > median	-0.024	0.069	-0.049
	(0.139)	(0.140)	(0.145)
Socio-emotional skills (age 6)		0.438***	
		(0.048)	
σ^2 (fixed effect)		0.470	
Observations		5658	
Panel B: Girls			
Sensitive parenting style ≤ median	0.012	-0.141	-0.183*
	(0.087)	(0.097)	(0.101)
Sensitive parenting style > median	0.066	0.250	0.320**
	(0.144)	(0.155)	(0.157)
Mother's mental health ≤ median	-0.176***	-0.131**	-0.146**
	(0.052)	(0.064)	(0.066)
Mother's mental health > median	0.508***	0.509***	0.189
	(0.167)	(0.177)	(0.180)
Time investment ≤ median	-0.053	-0.093	-0.135
	(0.083)	(0.086)	(0.087)
Time investment > median	0.139	0.107	0.261*
	(0.146)	(0.145)	(0.151)
Socio-emotional skills (age 6)		0.299***	
		(0.051)	
σ^2 (fixed effect)		0.462	
Observations		5742	

Notes: The dependent variable socio-emotional skills at age 11 and the explanatory variable socio-emotional skills at age 6 are both expressed in standard deviations. All inputs are demeaned. The full set of control variables are listed in Table 2.3. Standard errors are clustered at child level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Data: UK Millennium Cohort Study, subsample with details on child's socio-emotional skills at age 14.

Chapter 3

Cohabiting Parents at Childbirth: Do Peers Matter?

The US and all European countries have experienced dramatic changes in family formation in recent decades, with a sharp increase in parental cohabitation over time. The rise in parental cohabitation may have been amplified by a social multiplier effect, whereby the effect of any triggering event which raises parental cohabitation can be magnified through the peer effects. This paper is the first to estimate the causal impact of peers on the parental cohabitation decision at the first childbirth. We use Norwegian administrative data which allow to observe the complete network of neighbours and workmates for the population of parents at their first childbirth. This allows us to exploit the partially overlapping peer group approach to identify the peer effects. We find positive and statistically significant peer effects, with neighbours being more influential than workmates. There is some suggestive evidence that the peer effects are driven by both an imitation mechanism, where individuals imitate their peers to avoid the utility cost from deviating from social norms, and an information transmission mechanism, whereby individuals look to their peers for information about the benefits and costs of cohabiting.

1 Introduction

The US and all European countries have experienced dramatic changes in family formation in recent decades, with an increase in the cohabitation rate and a decrease in the marriage rate. In this paper we focus on Norway, where these changes have been sharper and faster than in most of the other developed countries. In the mid-1980s around 20% of Norwegian children were born out of marriage, whereas in 2010 this figure rose to 55%, with 42% of new births from cohabiting couples, 13% from single mothers and only 45% from married couples.[1] A similar but slower trend characterized the US, with the proportion of children born out of marriage increasing from 20% in the 1980s to 43% in the 2010s, with 25% of new births from cohabiting couples and 18% from single mothers.[2] With the US and other countries in Europe following similar but weaker positive trends in cohabitation at birth, the changes in Norway from the 1980s to 2010 can be seen as a precursor to change in other developed countries.

The rapid institutional changes introduced in Norway to minimize legal differences between cohabitation and marriage (see Syltevik 2015) - together with other historical changes such as the sharp increase in female labour force participation (see Becker 1981; Becker et al. 1988) - may have triggered the rise of cohabitation. This trend is likely to have been amplified by a social multiplier effect, whereby parental cohabitation decisions have spillover effects on peers. For example, having a child whilst cohabiting has historically been associated with a social stigma, which can lead individuals to *imitate* their peers' cohabitation decisions at birth to avoid the cost from deviating from the social norms (Akerlof and Kranton, 2000). In addition, cohabitors can affect their peers by transmitting *information* about the costs or advantages of being married or cohabiting, such as information on policy changes which have increased or decreased the cost of cohabitation.

This paper aims at providing evidence on the causal effect of neighbours and work colleagues on parental cohabitation decisions at birth and investigating the role of imitation and information as potential underlying mechanisms. The interest in studying peer effects in the economics literature has been recently increasing and evidence has been already provided for many individual outcomes.[3] Despite the fact that peer effects are likely to have amplified the recent positive trends in cohabitation, empirical studies on peer effects on family formation are still scant and unable to provide evidence on the causal effect of peers.[4] Our main contri-

[1] Source: OECD Statistics and SSB Norway Statistics.

[2] See Manning et al. (2015) for evidence on the US. European countries follow similar patterns of increasing rate of new births outside marriage, with Germany going from 12% to 34% and the UK going from 11% to 46% from 1980 to 2010 (Source Eurostat - Live births by legal marital status)

[3] Few examples are school performance (e.g. Sacerdote 2001), program participation (e.g. Dahl et al. 2014), mother's labour supply (e.g. Nicoletti et al. 2018), probability of finding a job (e.g.Calvo-Armengol and Jackson 2004), obesity (e.g. Cohen-Cole and Fletcher 2008), smoking behaviour (e.g. Gaviria and Raphael 2001), alcohol consumption (e.g. Clark and Lohéac 2007), early pregnancy (e.g. Monstad et al. 2011) and criminal activities (e.g. Glaeser et al. 1996).

[4] There are only few empirical studies on the peer effects on marital decisions, but with no causal evidence provided (Murray, 2013; Adamopoulou, 2012; Billari et al., 2008). Among them, only Adamopoulou (2012) attempts to identify a causal peer effect on marital decisions by focusing on friends. Friends' marital decisions is instrumented with their average characteristics (e.g. religiosity, beauty, relationship duration, maternal education, mother's age at first marriage). Average characteristics of peers are usually included as control variables in peer effects models and are for this reason questionable instruments.

bution is to provide the first empirical estimation of the causal effect of peers on cohabitation decisions.

We focus on the causal effects of neighbours and workmates which are two groups of peers with meaningful interactions. The importance of the neighbours has been largely established in the peer effect literature (see Mota et al. 2016; Ioannides and Datcher Loury 2004), with evidence provided specifically for decisions taken by mothers around child's birth (see Aizer and Currie 2004).[5] Workmates spend a large proportion of their time together and they have been found to have an effect on work related outcomes such as productivity (see Mas and Moretti 2009), wages (see Cornelissen et al. 2017) and paternity leave take up (see Dahl et al. 2014). However, the high level of communication and social interactions among colleagues might also affect decisions outside the workplace, e.g. cohabitation.[6]

Understanding the determinants of the family formation decision is important given that the rising rate of cohabitation can have implications on several family outcomes (Lundberg et al., 2016). There exist several empirical papers which highlight the importance of family structure on child outcomes, whereby divorce and cohabitation are correlated with worse achievements for affected children (Brown, 2004; Björklund and Sundström, 2006; Artis, 2007; Francesconi et al., 2010; McLanahan et al., 2013; Goodman and Graves, 2010). Other family outcomes which might be affected include women's labour supply (see Genadek et al. 2007) and the bargaining power between partners (see Pollak 2019).

Using Norwegian administrative data that provides information on the entire population of Norway, we identify individuals' neighbours and workmates using postcode of residence and plant identifiers[7]. This enables us to exploit the availability of information from the full networks of neighbours and workmates to identify the causal impact of the neighbours and workmates on parental cohabitation decisions at first birth.

When it comes to identifying causal peer effects, the three main challenges to be faced are *reflection*, *omitted variables*, and *endogenous peer membership* (Manski, 1993; Moffitt et al., 2001).

To address potential *reflection and omitted variables issues* we take advantage of the partially overlapping peer groups approach and use instrumental variables (IV) estimation (Bramoullé et al., 2009; Lee et al., 2010; De Giorgi et al., 2010; Nicoletti et al., 2018). This method exploits the fact that individuals can be directly affected by their own *direct peers* (for example their workmates or neighbours) but they cannot be directly affected by the peers of their peers, whom we call *indirect peers*, who they do not interact directly with. To estimate the effect of workmates, we use as instruments the characteristics of the workmates' neighbours; while, to estimate the effect of neighbours, we consider details on the neighbours' workmates.

[5]Using data from Vital Statistics data from California for 1989–2000 Aizer and Currie (2004) find that the publicly-funded prenatal care use by mothers is highly correlated whitin networks of neighbourhoods with the same ethicity. Other examples of prominent research on neighbour effects can be found in Granovetter (2005); Ioannides (2013); Topa and Zenou (2015).

[6]Notice that whenever we refer to workmates, we always indicate the father's workmates so that we avoid the potential bias caused by the non-random selection into the labour market of mothers.

[7]Plants are units of a firm which can operate in different locations.

As an example of this identification strategy for the *neighbour effect*, consider a situation where my neighbour imitates her workmates' cohabitation decisions to avoid the social stigma of deviating from social norms. My neighbour's cohabitation status is meaningfully influenced by the social interactions with her workmates, and my cohabitation status is indirectly influenced by my neighbour's workmates through my neighbour's behaviour. The correspondent example for the *workmate effect* would instead be that my workmate imitates her neighbours' decisions to avoid deviating from social norms. My workmate's cohabitation status is directly affected by these interactions with her neighbours, and my cohabitation status is indirectly affected through my workmate's behaviour.

The *endogenous peer membership* problem can arise when the sorting of people into neighbourhoods and into workplaces depends on unobservables that can affect also the decision to cohabit. This could be an issue for our estimation because parents' neighbours and parents' neighbours' workmates could have some common unobserved characteristics and similarly parents' workmates could share some similar unobserved characteristics with parents workmates' neighbours. Similarly to Nicoletti et al. (2018), we control for the potential bias from shared unobservable traits by including in the model for the workmates (neighbours) effect the proportion of parents' neighbours (parents' workmates) who are cohabiting at birth and excluding the parents themselves. This type of additional control is often referred to as the 'individual IV' (see von Hinke et al. 2019) and in our case it is equivalent to controlling for a workplace (neighbourhood) fixed effect.[8] The inclusion of this 'individual IV' controls also for the endogeneity in our instrumental variable caused by the fact that some of the indirect peers may be direct peers, e.g. some of the parents' neighbours' workmates are also parents' workmates.

To control for the *exogenous (contextual) and correlated effects* (Manski, 1993) we include a large set of parents' characteristics along with the average of these characteristics across the relevant peer group, which can affect the cohabitation decision of parents. Finally, to account for any macro and time effects, we include local labour market dummies and cohort dummies[9]. These macro and time effects may influence areas that are larger than the neighbourhood and workplace - therefore potentially influencing the parents, their peers and their peers of peers.

Our results show that the parental decision to cohabit is statistically significantly influenced by neighbours and workmates, with a stronger peer effect from neighbours compared to workmates. Exploring the mechanisms driving the peer effects, our results suggest that both peer effects are driven by imitation of social norms, whereby the peer effect is higher where the stigma attached to cohabitation decisions is stronger. We also find evidence of an information mechanism characterizing both the peer effects, whereby individuals look at their peers' decisions for information about the costs and benefits of cohabitation. To show the robustness of our results we perform a set of placebo tests, by pairing parents with fictitious peers with similar characteristics as the actual peers.

[8] Caeyers and Fafchamps (2016) show that controlling the individual IV can additionally control for exclusion bias.

[9] These dummies refer to the birth cohort year of the first child.

To estimate the magnitude of the peer effects we quantify the social multiplier effect with a back of the envelope calculation. This takes into account the fact that events or policy changes which raise the cohabitation rate, will affect parents' cohabitation decision through the influence of peers in both a direct and an indirect way. Our results indicate that the social multiplier is equal to 1.2 and 1.1 for neighbours and workmate effect respectively. This implies that, if the introduction of a policy directly increase cohabiting couples by 1%, the total effect of the policy will be given by 1.2% and 1.1% respectively.

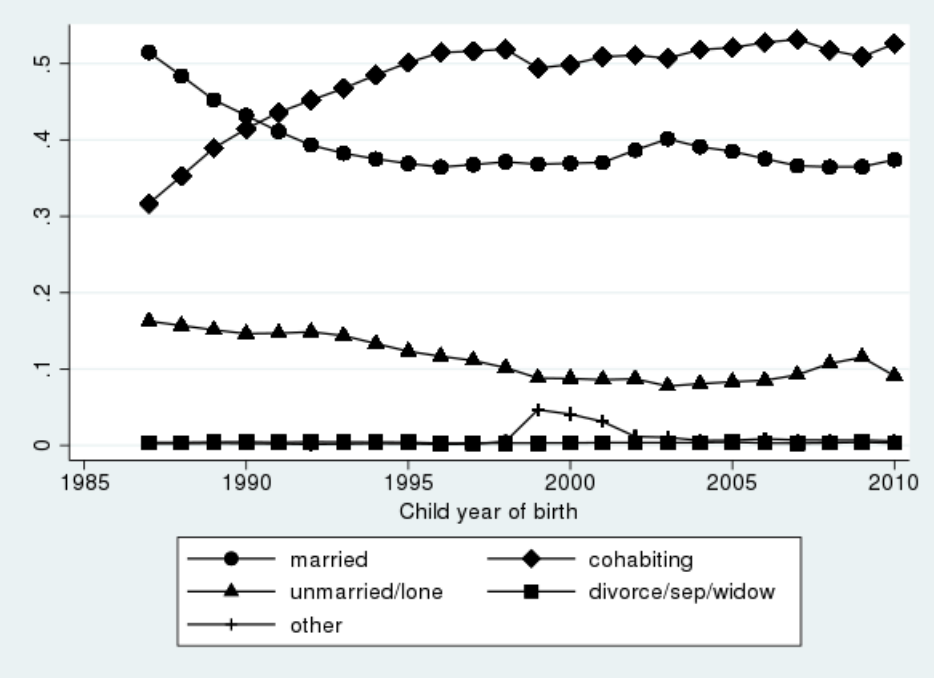
The rest of the paper is organized as follows. In Section 2 we provide an overview of the institutional background in Norway and international comparison of the legal approaches to cohabitation adopted in different countries. In Section 3 we lay out our estimation method which takes into account the potential biases due to the omission of peer group characteristics, the reflection issue, and endogeneity problems. In Section 4 we describe our data and sample. In Section 5 we show our main results and quantify the magnitude of the peer effects and in Section 6 we explore the mechanisms driving the peer effects. In Section 7 we test the robustness of our results and Section 8 concludes.

2 Institutional background and international comparison

The institutional context and cultural changes characterizing Norway in the last few decades represent the ideal scenario to investigate the effect of peers on cohabitation decisions. Until 1972 cohabitation was still illegal in Norway. In that year, the abolishment of the concubinage paragraph enshrined the institutionalization of cohabitation in the Norwegian law. The process focussed on housing first, whereby in case of death the cohabitant had the right to continue living in their shared home. Reforms on tax inheritance and shared parental responsibility were introduced during the 2000s. Politicians' attitudes towards relationships have considerably changed over time and the state and policies have considered married and cohabiting couples as increasingly equal (Syltevik, 2015).

The institutionalization process has clearly been combined with a rapid increase in cohabitation in Norway. Norway became a *land of cohabitation* in a few decades (Syltevik, 2010). In 1970s there was a high proportion of married couples at birth, whereas only a few were children born outside of wedlock and few couples lived together outside marriage. Nowadays, 90% of couples decide to cohabit before marriage, with 43% of new births in 2012 from cohabiting parents (SSB, 2012, 2013). This pattern is even more pronounced among first births where the proportion of families cohabiting at first birth overtook the proportion of married couples at first birth as early as 1991 as shown in Figure 3.1. The percentage of cohabitation at first birth increases steadily until 1997 when it stabilizes at around 50 percent. Interestingly, the acceptance of such relationships was very quick as well. The percentage of Norwegians who were against cohabitation dropped from 70% to 47% between 1977-1982 (Noack, 2001; Syltevik, 2015).

Figure 3.1: Marital status at first birth (Percent). Changes over time



Data: Norwegian administrative data.

Norway is one of the countries, along with Sweden, that has gone the furthest in minimizing the differences between cohabitation and marriage in terms of the legal standing of individuals cohabiting, according to Perelli-Harris and Gassen (2012).[10] The main difference between the two is that Sweden explicitly legislates in fewer policy areas than Norway. This is because the Swedish approach is neutral between marriage and cohabitation (Bradley, 2001). Instead, Norway introduced policies in order to protect the rights of the cohabiting unions and mainly the weaker party in the union (Ryrstedt, 2005). In addition - and more importantly for the purpose of this paper - the focus in Norway has been to provide protection to cohabiting couples with children. Indeed, the Children Act - originally introduced in 1915 then reformed in 1981 - was continuously amended over time and today completely equates cohabitants with spouses.[11]

[10] Among the other countries considered in Perelli-Harris and Gassen (2012), the Netherlands stands out as it equalizes the legal status of married and registered cohabiting unions in most of the policy areas. Nevertheless, this is not valid for unregistered cohabitation - which form a large part of Dutch cohabiting unions - that remain effectively unregulated. A similar approach of distinguishing between registered and unregistered unions is adopted by France. However, the French approach is completely different from the Dutch, as France continues to consider marriage a superior institution compared to cohabitation (Bradley, 2001)

[11] The Children Act applies to parental responsibility, the rights and duties of children and parents in case of parental disputes and contact arrangements (Source: Government.no).

3 Identification and estimation of peer effects

We are interested in two distinct direct peer effects in cohabitation decisions at the birth of the first child: (i) *neighbour effect* and (ii) *workmate effect*. The two peer effects are estimated separately but using the same estimation methodology.[12]

For brevity, the estimation method is presented using a general notation which fits for both the estimation of workmates and neighbour effects. We define the direct peers as peers of type A and the peers of peers (indirect peers) as peers of type AB, i.e. the A peers' B peers. This means that when estimating the *neighbour effect*, the direct peers of type A are the neighbours and the indirect peers of type AB are the neighbours' workmates; whereas when estimating the *workmate effect*, the direct peers of type A are the workmates while the indirect peers of type AB are workmates' neighbours. To construct the network of the relevant direct and indirect peers, we follow Mota et al. (2016) and Nicoletti et al. (2018) and we consider homogeneous peers, i.e. peers who are more relevant and likely to interact with the individual of interest. More precisely, we consider only neighbours and workmates who have the first child shortly before the parent and with the same level of education.[13]

Our outcome of interest is a dummy variable for cohabitation, y_i, which takes value one if the i-th pair of parents cohabit at the birth of their first child and zero if they are married, and $i = 1, \ldots, n$ where n is the number of parents pairs in our sample. Let y_i^* be a latent continuous variable that measures the unobserved latent propensity to cohabitation of the parents pair i. We assume that

$$y_i = \begin{cases} 1 & \text{if} \quad y_i^* > 0 \\ 0 & \text{if} \quad y_i^* \leq 0 \end{cases} \tag{3.1}$$

and that y_i^* obeys the following linear model

$$y_i^* = \alpha + \overline{y}_{-i,A}\rho + \mathbf{X}_i\boldsymbol{\beta} + \overline{\mathbf{X}}_{-i,A}\boldsymbol{\gamma} + \overline{y}_{-i,B}\delta + \sum_{t=1993}^{2010} d_{i,t}\eta_t + \sum_{q=2}^{46} l_{i,q}\theta_q + \epsilon_i, \tag{3.2}$$

where the explanatory variables are given by:

- $\overline{y}_{-i,A} = \frac{\sum_{j \epsilon P_{-i,A}} y_j}{n_{-i,A}}$, the cohabitation dummy averaged across the direct peers of type A and excluding the parents pair i with P_{A_i} and n_{Ai} denoting the set and number of these direct peers of type A;
- $\mathbf{X}_i$, a row vector of parental characteristics (parents' years of education and their squares, parents' age and their squares, working status of the parents one year before birth and father's earnings one year before birth);

[12] Notice that whenever we refer to workmates, we always refer to father's workmates. We do not consider mother's workmates to avoid the potential selection bias caused by restricting the sample to mothers who work. This selection is not an issue for men as 99% of men in our sample work.

[13] Education is defined using a binary indicator for degree of the mother when defining homogeneous neighbours and degree of the father when defining homogeneous workmates.

- $\overline{\overline{\mathbf{X}}}_{-i,A} = \frac{\sum_{j \epsilon P_{-i,A}} X_j}{n_{-i,A}}$, the corresponding parental variables averaged across the direct peers of types A;
- $\overline{y}_{B,(-i)}$, the cohabitation dummy averaged across the direct peers of type B and excluding the parents pair i;
- $d_{i,t}$, a dummy for the child birth cohort t, with $t = 1993, ..., 2010$;[14]
- $l_{i,q}$, a dummy for the labour market area q with $q = 2, ..., 46$;

The coefficients of these explanatory variables are: ρ, the *endogenous peer effect*; $\boldsymbol{\beta}$, the vector of effects of parental characteristics; $\boldsymbol{\gamma}$, the vector of *exogenous (or contextual) peer effects* as defined by Manski (1993); δ, the coefficient of $\overline{y}_{-i,B}$; and η_t and θ_q the birth cohort (time) and labour market area effects. Finally, α is the intercept and ϵ_i is the error term.

By assuming that the error term is normally distributed with mean zero and variance one, model (3.2) is a probit model which can be estimated using maximum likelihood (probit MLE). Because the coefficients in model (3.2) measure the effect of the explanatory variables on the latent variable y_i^*, which is the unobserved propensity to cohabitation, we also estimate the marginal effects of these variables on the probability of cohabitation by multiplying each the coefficients by the average of

$$\phi(\alpha + \overline{y}_{-i,A}\rho + \mathbf{X}_i\boldsymbol{\beta} + \overline{\overline{\mathbf{X}}}_{-i,A}\boldsymbol{\gamma} + \overline{y}_{-i,B}\delta + \sum_{t=1993}^{2010} d_{i,t}\eta_t + \sum_{q=2}^{46} l_{i,q}\theta_q) \tag{3.3}$$

computed over all parents pairs in our sample, say $\overline{\phi}$ and where ϕ is the density of a normal with mean zero and variance 1. Our main parameter of interest is then the average of the marginal endogenous peer effect, i.e. $(\rho \cdot \overline{\phi})$.

The maximum likelihood estimation of our parameter of interest $(\rho \cdot \overline{\phi})$ could be biased by reverse causality and omitted variables issues. To take account of these endogeneity issues, we follow the identification approach recently implemented by Nicoletti et al. (2018), which exploits the partial overlapping of different groups of peers.[15] More precisely, we assume that each pair of parents interact with their direct peers of type A (and B), but they do not interact directly with their peers of peers, i.e. with their indirect peers of type AB (and BA). This implies that the cohabitation choices of the indirect peers of type AB affect the parents pair only through the direct peers of type A, meaning that we can instrument the endogenous average of the cohabitation dummy across the direct peers of type A, $\overline{y}_{-i,A}$, by using the A peers average of the average cohabitation dummy across the A peers' B peers, i.e. $\overline{\overline{y}}_{-i,AB} = \frac{\sum_{j \epsilon P_{-i,A}} \overline{y}_{-j,B}}{n_{-i,A}}$.

[14] To take account of the effects of having a specific proportions of A peers with children born in different periods, in our empirical application we also include the average of $d_{i,t}$ across the A peers and excluding individual i.

[15] For other papers using a similar type of strategy see Kelejian and Prucha (1998); Lee (2003, 2007); Bramoullé et al. (2009); Calvó-Armengol et al. (2009); Lin (2010); De Giorgi et al. (2016).

We implement this instrumental variable approach by estimating by maximum likelihood the model (3.2) jointly with the following model

$$\overline{y}_{-i,A} = \alpha_2 + \overline{\overline{y}}_{-i,AB}\rho_2 + \mathbf{X}_i\boldsymbol{\beta_2} + \overline{\mathbf{X}}_{-i,A}\boldsymbol{\gamma_2} + \overline{y}_{-i,B}\delta_2 + \sum_{t=1993}^{2010} d_{i,t}\eta_{2,t} + \sum_{q=2}^{46} l_{i,q}\theta_{2,q} + \epsilon_{2,i}, \qquad (3.4)$$

which includes the same explanatory variables used in the main model plus the instrumental variable $\overline{\overline{y}}_{-i,AB} = \frac{\sum_{j\epsilon P_{-i,A}} \overline{y}_{-j,B}}{n_{-i,A}}$, and an error $\epsilon_{2,i}$ which is normally distributed with mean zero and variance $\sigma^2_{\epsilon_1}$ and which we allow to be correlated with the error term in (3.2).

We make sure that the peers' cohabitations decisions used to compute our instrumental variable $\overline{\overline{y}}_{-i,AB}$ are predetermined by considering the cohabitation decisions of peers that had their first child birth between 1 and 5 years earlier than the parents. This eliminates any concern of reflection, i.e. of reverse causality going from parents' indirect peers to parents. Parents' decisions to cohabit in year t cannot affect their indirect peers' cohabitation decisions because (i) parents are unlikely to have meaningful interactions with their indirect peers, i.e. their neighbour's workmates or their workmate's neighbours are unlikely to directly influence a couple's decision to cohabit, (ii) the parents' decision to cohabit at the birth of their first child occurs in the future with respect to the cohabitation decisions of their indirect peers.

We would like to emphasize that the maximum likelihood estimation of both probit model (probit MLE) and joint model (Joint MLE) take account of the *correlated effects*, i.e. the tendency of a group of peers to behave likewise because of similar individual characteristics and similar institutional environments (see Manski 1993). This is because we control for parents' characteristics $\mathbf{X}_i$ that are relevant to explain their cohabitation decision and for a set of labour market areas and time dummies which capture potential effects of an institutional environment shared by the parents and their direct and indirect peers. By including among the explanatory variables the average of the direct peers' characteristics, $\overline{\mathbf{X}}_{-i,A}$, the probit MLE and the joint MLE also control for *exogenous peer effects*, i.e. the fact that the parents' decision of cohabiting varies with exogenous characteristics of their direct peers.

Another problem which can bias the estimation of the endogenous peer effect is the *endogenous peer membership* issue, which can arise when the sorting of people into neighbourhoods and into workplaces depends on unobservables that can affect the decision to cohabit. This could be an issue for the joint MLE if the parents' A peers sort into B peers groups with similar unobserved characteristics to the parents' direct peers B, e.g. parents' neighbours could sort into workmates groups with similar unobserved characteristics to the parents' workmates. Nevertheless, we solve this problem by controlling for the average cohabitation dummy of the parents' B peers, $\overline{y}_{-i,B}$. Notice that controlling for $\overline{y}_{-i,B}$ does not solve the endogenous peer membership in the probit MLE because there could be still an issue of parents sorting in groups of peers A based on unobservable characteristics that also explain the parents' cohabitation decision. The variable $\overline{y}_{-i,B}$ is sometimes called individual instrumental variable and omitting it would cause a bias even in absence of endogenous peer membership issues (see von Hinke et al. 2019 for details on such bias).[16] The inclusion of the individual IV controls

[16] Notice also that including $\overline{y}_{-i,B}$ is equivalent to controlling for a group fixed effect for the B peers. Caeyers and Fafchamps (2016) show that controlling for the individual IV can additionally control for exclusion bias.

also for the fact that some of the indirect peers may be direct peers, e.g. some of the parents' neighbours' workmates are also parents' workmates.

4 Data

We use data from the Norwegian administrative register for the period 1987–2010, provided by Statistics Norway. The data allow the identification of neighbours within the same postcode (zip code), workmates within the same plant (a plant is defined as a firm site), information on marital status at birth, the year of birth and demographic and economic variables including age, education, earnings and labour market status of the parents and the possibility of following each individual across time.

The birth register identifies the newborn's mother and father for all births. The birth register data include information on the parental marital status, where individuals are asked to report the marital status at child's birth as married; cohabiting; unmarried or lone parent; divorced, separated or widow; or other. Although the marital status has always been collected in the data (since the first collection in 1967), cohabitation started to be reported only from 1984. We select only mothers' who are either married or cohabiting at birth, so that our dependent variable is a dummy variable taking value 0 if married and 1 if cohabiting. The other types of family structure (unmarried or lone parent, divorced separated or widow) are excluded from the analysis as their rates are low and quite stable across the period of observation (Figure 3.1). As the decreasing rate of married couples mirrors the increasing rate of cohabiting couples (see Figure 3.1), our focus is to compare married and cohabiting couples at child's birth. In addition, we restrict the attention to marital status at birth of the first child, where cohabitation is more prevalent, the uncertainty over decision is at its largest and consequently individuals are more likely to be influenced by their peers when making their decision. In contrast, cohabitation at later births might depend on learning from the first birth, which would be difficult to disentangle from the peer effect.

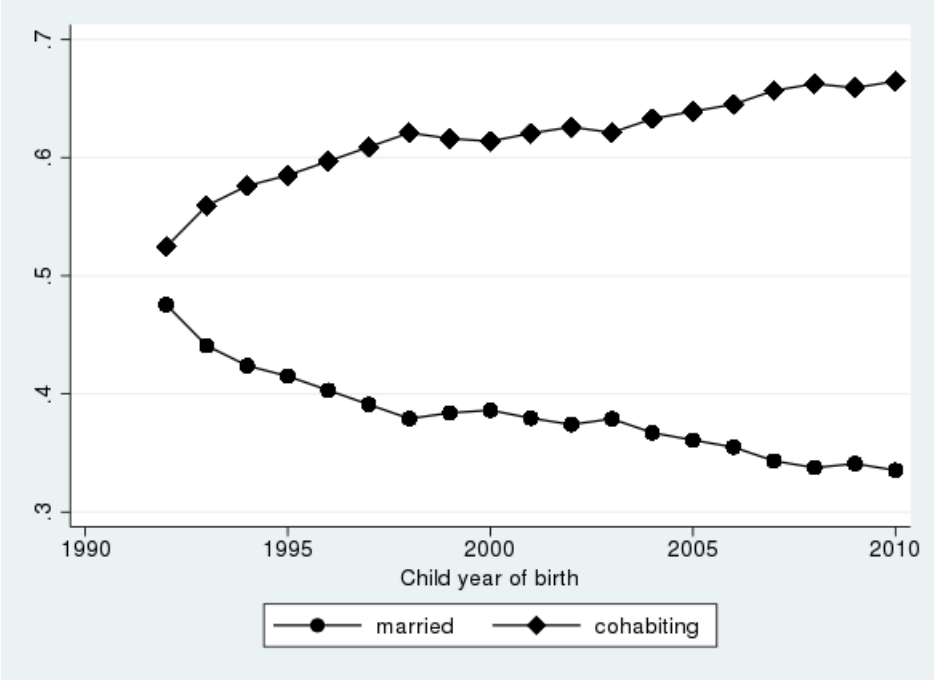
The second crucial source of information relates to the parental networks of neighbours and workmates. Information on the neighbourhood is given by the postcode where parents live (available from 1987); whereas information on the workplace of parents is given by the plant identifier of the individual, i.e. the combination of the firm and location where the individual works (available from 1986). This information is used to derive the network peer groups, i.e. the group of *direct and indirect peers*. We construct the neighbours (direct peers) by connecting each parent to all other parents living within the same zip code in the year before birth, and restricting the network to those neighbours giving birth to a first child between one and five years earlier than the parent. In addition, our neighbour network includes only homogeneous neighbours, thereby including only parents within the same zip code with the same level of education (defined by degree status of the mother). Peers with similar level of education have been found to lead to stronger peer effects suggesting that homogenous peers have more relevant interactions (Mota et al., 2016). We follow a similar procedure when constructing the workmate peer group. We link each father to all other fathers working in

the same plant in the year before birth, and we select only those workmates having a first child between one and five years earlier than the father. Similarly to the neighbour peers, we consider homogeneous workmate peers, with fathers working in the same plant and having the same degree status.

Our empirical strategy outlined in Section 3 requires also the construction of the *indirect peer groups*, that are the peers of peers groups. These are constructed following exactly the same procedure as the direct groups, taking neighbours' workmates and workmates' neighbours respectively.

We restrict our data to the period for which we can observe details on cohabitation, workplace and neighbourhood, which is the period from 1987-2010. Furthermore, to be able to observe the cohabitation decisions of parents' peers at the birth of the first child (i.e. between one and five year earlier than the parents birth year of their first child) our empirical analysis focuses on the population of parents who gave birth to their first child in the period between 1992 and 2010. Parents who gave births before 1992 are used to construct the peer groups and to collect information at peer level (direct and indirect). Our final sample consist of 174,274 parents pairs who have a first child between 1992 and 2010 and for whom we can observe at least one neighbour, one father's workmate, one neighbour's workmate and one workmate's neighbour.[17]

Figure 3.2: Cohabitation at first birth (Percent). Changes over time. Estimation sample



Data: Norwegian administrative data.

Figure 3.2 shows the proportion of cohabiting and married couples at birth over time in our estimation sample. Since 1992 the percentage of cohabiting couples at first birth is always

[17]About 50% of the original sample is dropped due to the lack of direct peers or indirect peers. However, the estimation sample and the original sample are not statistically different when comparing the mean of their characteristics (see Table C.1 in the Appendix for descriptive statistics of the original sample).

larger than the married couples at first birth. The positive changes across time in the rate of cohabiting couples are of similar magnitude but opposite sign to the changes in the rate of married couples, which suggests that the increasing rate of cohabitation came at the expense of the marriage rate.

To explain the cohabitation decision of parents at the birth of their first child, we consider the following variables: mother's and father's education; their age at birth; their working status one year before birth (a dummy which takes the value one if the parent worked and zero otherwise); the father's earnings one year before birth; a set of dummies for the year of birth of the first child; and a set of dummies for the local labour market area.

Table 3.1 reports the descriptive statistics of our sample. The first row reports the size of the peer groups. On average the size of the homogeneous neighbours group consist of 51.019 neighbours living in the same zip code. On average the homogeneous workmates groups are smaller with 19.726 fathers' workmates working in the same plant. The parents' age at first birth is on average about 31 and 28 years, for fathers and mothers respectively. The average years of schooling is about 14 and 13, for mothers and fathers respectively. On average 83.5 percent of mothers work in the year before the first childbirth, while nearly all fathers (99.9 percent) work. The average yearly earnings of the fathers is 412856,127 Norwegian krone.[18] Looking at the marital status of parents at their first child birth, 62.1% of parents cohabit while 37.9% are married.

Table 3.1: Descriptive statistics of the sample

	mean	sd	min	max
Neighbourhood group size	51.019	66.255	1	701
Father's Workmate group size	19.726	63.412	1	862
Father's age	30.963	5.305	17	71
Mother's age	27.664	4.542	16	49
Mother's education	13.629	2.407	9	21
Father's education	13.180	2.469	9	21
Mother's employment	0.835	0.371	0	1
Father's employment	0.999	0.033	0	1
Father's earnings	412856.127	241701.209	0	2.88e+07
Child year of birth	2001.506	5.413	1992	2010
Cohabiting at birth	0.621	0.485	0	1
Observations	174274			

Notes: Norwegian administrative data. Mother's employment, father's employment and father's earnings refer to 1 year before birth. The rest of the variables are at child's birth.

Table 3.2 reports the differences in the observed characteristics between parents who decide to cohabit and parents who are married at first birth. Married couples are more advantaged than cohabiting couples and have on average higher education and earnings.

[18] Earnings are adjusted at 2010 prices.

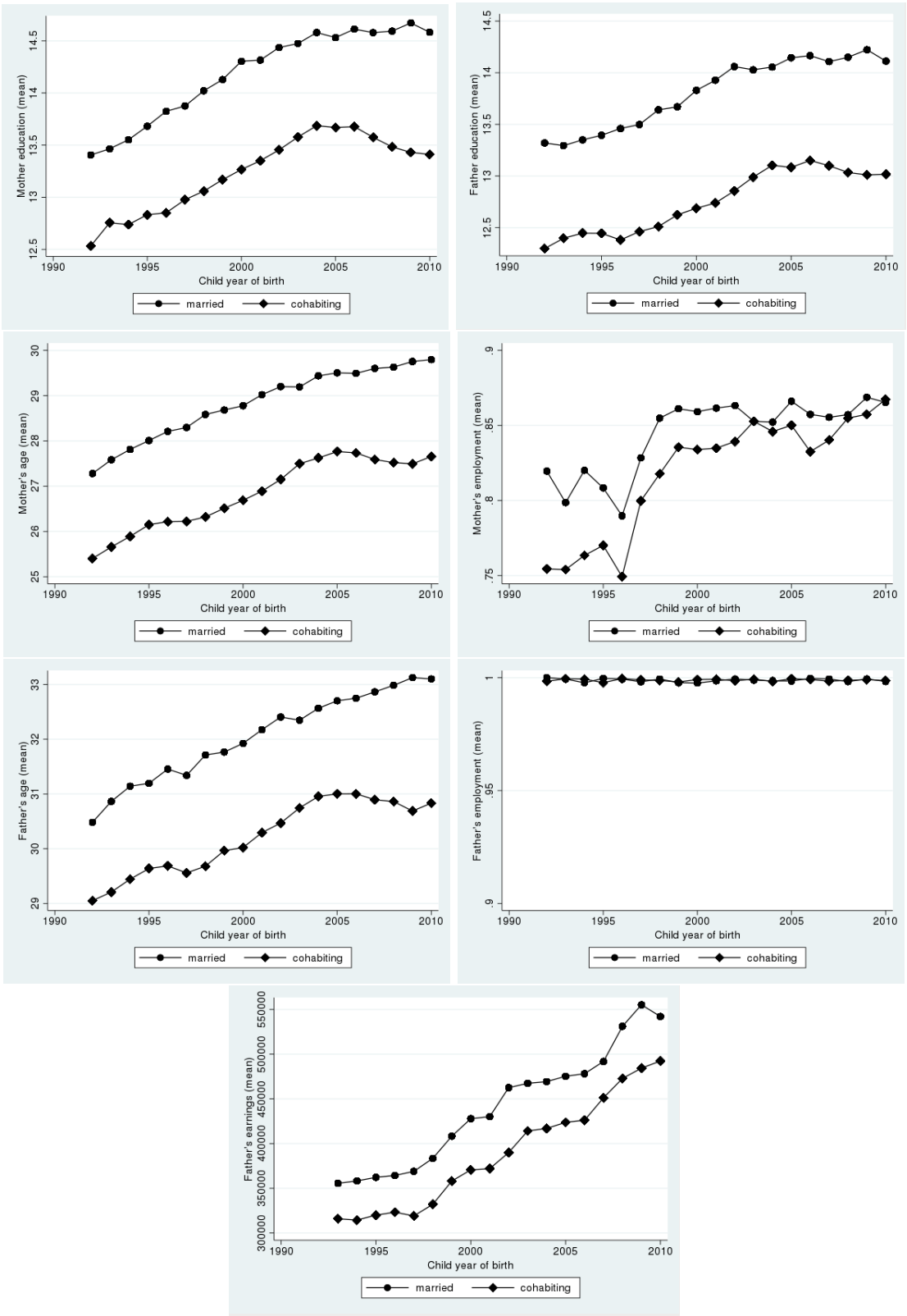
Table 3.2: Descriptive statistics by cohabitation status

	(1) Married		(2) Cohabit		(3)
	Mean	sd	Mean	sd	Difference
Mother's education	14.196	2.426	13.282	2.327	0.914***
Mother's employment	0.847	0.360	0.828	0.378	0.020***
Father's earnings	441163.826	265538.626	395852.327	224469.686	45311.499***
Father's employment	0.999	0.034	0.999	0.033	-0.000
Father's age	32.054	5.083	30.297	5.328	1.758***
Mother's age	28.842	4.083	26.944	4.657	1.898***
Observations	66102		108172		174274

Notes: Norwegian administrative data. Mother's employment, father's employment and father's earnings refer to 1 year before birth. The rest of the variables are at child's birth.

Beside the sharp increase in cohabitation rates across time, there could be also changes across time in the type of people who select into cohabitation or marriage. Figure 3.3 shows the changes over time of the average characteristics of the parents by their marital status at birth. There is a clear positive time trend in parents' education, parents' age at birth, mother's employment and fathers' earnings for both married and cohabiting couples. Differences in characteristics between married and cohabiting parents seem quite stable over time except perhaps for parents' education for which we observe an increase in the gap after 2005 with a decrease in education for cohabiting parents.

Figure 3.3: Parental characteristics by marital status. Changes over time



Data: Norwegian administrative data.

5 Estimation results

5.1 Neighbour and workmate effects

We begin with the estimation of the neighbour effect on the probability of parents cohabiting at birth of their first child by considering the maximum likelihood estimation of the probit model (3.2) (probit MLE). Column (1) of Table 3.3 reports the average marginal (endogenous) neighbour effect on the probability of parents cohabiting at the birth of their first child. The remaining controls variables are reported in Section 3 and in the note of Table 3.3. The corresponding full list of average marginal effects are reported in column (1) of Table C.2 in the Appendix.

The estimated marginal neighbour effect suggests that a 10 percentage point growth in the rate of cohabitation of parents' neighbours leads to a 1.9 percentage point increase in the probability of the parents cohabiting.

Table 3.3: Estimation results of the neighbour effect on parental cohabitation at birth

	(1) Probit MLE	(2) Joint MLE
Neighbours cohabitation at birth	0.192***	0.186***
	(0.013)	(0.059)
Correlation between errors in models (3.2) and (3.4)		-0.104
Exogeneity Test (p-value)		0.000
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors included are: mother's education and its square, parents' age and their squares, parents' working status, father's earnings and the average of these set of covariates across neighbours; individual IV (workmates rate of cohabitation at birth); child year of birth dummies and the average of these dummies across neighbours; labour market area dummies. Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

The probit MLE could be biased by reflection, omitted variables and endogenous peer membership issues (see Section 3 for details). To control for such issues we consider the joint MLE of the model (3.2) for the probability of parents cohabiting and the model (3.4) for the rate of cohabitation of parents' neighbours. We instrument the cohabitation rate of the parents' neighbours with the rate of cohabitation of the neighbour's workmates averaged across the parents' neighbours. Note that we consider only peers (neighbours and workmates) who have given birth to their first child between 1 and 5 years earlier; therefore, we avoid any reverse causality going from the parents' peers of peers to the parents, even in the unlikely situation where the parents might have relevant interactions with their peers' of peers'.

We find a correlation of -0.104 between the errors in the models (3.2) and (3.4), which is statistically different from zero at both 5 and 1% level and indicates that the rate of cohabitation of parents' neighbours is endogenous and the probit model estimation is biased

and inconsistent (see first and second rows of the bottom panel of Table 3.3). In light of this result, we choose the joint MLE as our preferred estimation. In Table 3.3 column (2) we display the joint MLE estimate of the average marginal neighbour effect, which remains of similar magnitude to the probit estimate. The full set of average marginal effects for the control variables are reported in column (1) of Table C.2 in the Appendix; whereas the full set of estimated coefficients of the model (3.4) for the rate of cohabitation of parents' neighbours are displayed in column (1) of Table C.4 in the Appendix.

In Table 3.4 we display the corresponding probit and joint MLE results for the workmate effects. The specification of the probit model is identical to the specification adopted in Table 3.3 but with the role of neighbours and workmates reverted because we are now interested in estimating the average marginal effect of the father's workmates rather than the parents' neighbours. In the joint MLE we estimate the model for the probability of parents cohabiting jointly with the model for the rate of cohabitation of the father's workmates, and we instrument the rate cohabitation of the father's workmates with the rate of cohabitation of the workmate's neighbours averaged across the father's workmates.

Table 3.4: Estimation results of the workmates effects on parental cohabitation at birth

	(1) Probit MLE	(2) Joint MLE
Father's Workmates cohabitation at birth	0.071***	0.068*
	(0.003)	(0.035)
Correlation between errors in models (3.2) and (3.4)		-0.180
Exogeneity Test (p-value)		0.000
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors included are: mother's education and its square, parents' age and their squares, parents' working status, father's earnings and the average of these set of covariates across workmates; individual IV (neighbours rate of cohabitation at birth); child year of birth dummies and the average of these dummies across workmates; labour market area dummies. Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

We report the estimated average marginal workmate effect corresponding to the probit MLE and joint MLE in Table 3.4 columns (1) and (2) respectively. The remaining controls are listed in the note of Table 3.4 and their average marginal effects are reported in Appendix in Table C.3.[19] Both the probit and joint ML estimates of the workmate effect suggests that a 10 percentage points increase in the rate of cohabitation of the workmates is associated with an increase in the probability of parents cohabiting of 0.7 percentage points. When looking at the correlation between the error terms in the models (3.2) and (3.4), we find again that we strongly reject the zero correlation and therefore the exogeneity of the cohabitation ratio

[19]The full set of estimated coefficients of the model (3.4) for the rate of cohabitation of father's workmates are displayed in column (2) of Table C.4 in the Appendix.

of the workmates in the probit model (see first and second rows of the bottom panel of Table 3.4). For this reason, we choose again the joint MLE as our preferred estimation.

We present a set of robustness checks to provide evidence on the validity of our instrumental variable approach (the joint MLE) for both the neighbour and the workmate effects estimations in Section 7.

5.2 Comparing the neighbour and workmate effects

The comparison between the two peer effects suggests that neighbours are more influential than workmates in the parental decision to cohabit. The average marginal neighbour effect is almost three times the workmate effect, 1.9 and 0.7 percentage points respectively. Arguably, because the definition of the workmates only considers father's workmates, this result might be explained by the fact that fathers are less influenced by their peers compared to mothers. To test whether our results depend on the definition of the workmates, we define the workmate group by considering both mother's and father's workmates. For mothers who do not work we consider only the father's workmates so that we avoid any issue of selection of mothers in to labour market participation.

Table 3.5: Peer effects on parental cohabitation at birth. Pooling together mother and father's workmates

	(1) Probit MLE	(2) Joint MLE
Panel A: Neighbour effect		
Neighbourhood cohabitation at birth	0.190***	0.182***
	(0.012)	(0.043)
Exogeneity Test (p-value)		0.000
Observations	174274	174274
Panel B: Workmate effect		
Parents' Workmates cohabitation at birth	0.095***	0.092*
	(0.006)	(0.054)
Exogeneity Test (p-value)		0.000
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors of Panel A are the same as in Table 3.3. Regressors of Panel B are the same as in Table 3.4. The workmates groups are constructed pooling together mother's and father's workmates. See Section 7 for details. Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

Results of this new definition of the workmates are reported in Table 3.5 in Panel A and B for neighbour effects and workmate effects respectively. Our findings on the neighbour effect (Panel A) are not sensitive to the change of the definition of the workmate peer group.[20] Our

[20]The average marginal effects estimated in Table 3.5, Panel A are not statistically different from the average marginal effects estimated in Table 3.3. The tests for the equality of the coefficients have p-values of 0.910 and 0.956 respectively for the model in columns (1) and (2).

results for the workmate effect (Panel B) is just slightly higher.[21] These results are consistent with the hypothesis that mothers could be more influenced by their peers compared to fathers. Nevertheless and more importantly, these additional results still confirm the evidence that the neighbours are more influential than workmates in the parental decision to cohabit.

An explanation for this stronger effect of neighbours might be that interactions among colleagues do not necessarily affect outcomes outside the workplace such as cohabitation. This is consistent with several empirical papers providing evidence on a significant effect of neighbours on a large set of individual outcomes and decisions, including decisions around child's birth (Aizer and Currie, 2004), and a sparsity of evidence on the effect of workmates on these decisions.

5.3 The social multiplier effect

The institutionalization process of cohabitation occurring in Norway since 1972 is probably one of the triggering events that have led to an increase in the cohabitation. However, the influence of peers on cohabitation decisions can amplify the effect of such triggering events and may ultimately be the reason for the rapid increase in cohabitation in Norway. To assess whether the direct effect of institutional, cultural or policy changes raising cohabitation in Norway have been amplified through the indirect effect of peers influence, we compute the so called social multiplier effect by using the joint ML estimates of the neighbour and workmate (endogenous) effects respectively.

The multiplier effect is calculated as $\frac{1}{1-\rho \cdot \overline{\phi}_{(\overline{y}_{-i,A}=0)}}$, where ρ is the endogenous peer effect in model (3.2) and $\overline{\phi}_{(\overline{y}_{-i,A}=0)}$ is computed as the average of the normal density (3.3) but holding $\overline{y}_{-i,A} = 0$. It is straightforward to prove that this is an adaptation of the multiplier formula used in linear models to probability models once we approximate the probability of cohabitation using a first-order Taylor expansion around $\overline{y}_{-i,A} = 0$.

By using the joint MLE results, we find a multiplier effect of 1.2 for the neighbour effect and 1.1 for the workmate effect. This implies that if a policy raises directly the probability of cohabitating at birth by 10 percentage points, it has also an indirect additional effect through the neighbours of 2 percentage points and through the workmates of 1 percentage points.

[21] The average marginal effects estimated using the probit ML (see Table 3.5, Panel B) are statistically different from the average marginal effects estimated in Table 3.4. The tests for the equality of the coefficients have p-value of 0.000. On the contrary, the average marginal effects are not statistically different when considering the joint MLE (see columns 2), with p-value of 0.709.

6 Mechanisms of peer effects

In this Section we explore whether imitation and/or information are potential channels driving the peer effects in cohabitation documented in Section 5.

6.1 Imitation

Imitation is one of the potential mechanisms through which the spillover effect of cohabitation at birth may take place. Individuals may imitate their peers to avoid the utility cost of deviating from social norms (Akerlof and Kranton, 2000). The more a behaviour is socially accepted, the higher the probability of adopting that behaviour (Nechyba, 2001).[22] In our empirical context, a higher stigma of cohabitation may lead people to decide to prefer marriage over cohabitation and, ultimately, it can lead to a smaller cohabitation rate. In the previous section we have shown that the parental decision to cohabit is influenced by their peers. To what extent the stigma attached to cohabitation explains the effect of peers remains an open question.

If an important mechanism behind the peer effects in cohabitation is imitation to avoid the utility cost from deviating from social norms, then we would expect a larger effect of peers in highly religious communities. This is because religiosity is often associated with a larger social stigma of cohabitation. We use information on religious practices by municipality to investigate this imitation mechanism. We allow the peer effect to vary depending on the level of local religiosity (stigma). We use information on the annual percentage of baptised children by municipality during our period of interest 1992-2010[23] to construct an indicator of attachment to religion based on the distribution of the percentage of newly baptised in the population in the year before the child's birth. This takes the value of one if the percentage of baptised is above the median and zero otherwise.[24] The aim is to capture the differences across municipalities in the role played by religion in determining family arrangements.[25]

In each of the models estimating the neighbour and workmate effects, we allow the peer effect to be heterogeneous between low and high levels of religious attachment, with the correspondent IVs constructed accordingly. Given that the stigma mechanism can affect all the direct peers, we also allow the 'individual IV' to be different between individuals in municipalities with low and high level of religious attachment. Table 3.6 shows the probit and

[22] Nechyba (2001) provides a good example of how social stigma affect individual decisions. Challenging the relationship between Aid to Family with Dependent Children and the increase in illegitimacy in the US, he suggests that reduction of social stigma may explain the spread of illegitimacy.

[23] The missing years (1994-1995-2003-2004-2006) are estimated via interpolation.

[24] The median value of newly baptised is 1 percent.

[25] Notice that using the percentage of baptised new births as proxy for religious attachment implies that the stigma captured is mainly the one from the peers, i.e. new mothers in the same municipality deciding to baptise their children. Extending this mechanism of capturing the stigma, not just from the peers, but for the society as a whole - e.g. using the percentage of church goers, would proxy for the stigma created by the entire society. This can be particularly relevant for cohabitation, a decision potentially affected by older generation norms. This is an interesting aspect that will be worth investigating in future extension of this paper.

joint MLE results for the neighbour and workmate effects, in Panel A and B respectively.[26] Consistent with the imitation mechanism, we find that the stronger the attachment to religion - i.e. the stronger the stigma - the stronger the peer effects.[27] This is because in municipalities where the religious practices are more followed, the stigma from deviating from social norms is stronger and therefore the imitation is larger. These findings suggest that the peer effect is at least in part driven by the imitation mechanism.

Table 3.6: Peer effects on parental cohabitation at birth by level of religiosity. Imitation mechanism

	(1) Probit MLE	(2) Joint MLE
Panel A: Neighbour effect		
Neighbours cohabitation at birth (Low religiosity)	0.151***	0.157**
	(0.011)	(0.072)
Neighbours cohabitation at birth (High religiosity)	0.241***	0.214***
	(0.015)	(0.059)
Exogeneity Test (p-value)		0.000
Test High religiosity > Low Religiosity (p-value)	0.999	0.722
Observations	163815	163815
Panel B: Workmate effect		
Workmates cohabitation at birth (Low religiosity)	0.060***	0.060
	(0.005)	(0.047)
Workmates cohabitation at birth (High religiosity)	0.080***	0.074**
	(0.006)	(0.037)
Exogeneity Test (p-value)		0.000
Test High religiosity > Low Religiosity (p-value)	0.999	0.686
Observations	163815	163815

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Panel A (B) reports the average marginal effects of the neighbours (workmates) cohabitation separately for municipalities with high and low level of religiosity while controlling for the same set of variables used in Table 3.3 (3.4) (see Section 6.1 for details). Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

Because other determinants of the parents' cohabitation decision could have an effect which varies between municipalities with low and high level religiosity, the differential effect of peers by level of religiosity could be a spurious result caused by the differential effects of other explanatory variables. To check if this is the case, we allow all the exogenous parents' characteristics to change by the level of religiosity and we show that the results remain unchanged (see Table C.6 in the Appendix).[28]

[26]The sample size is smaller than in our main sample because of the religiosity information is missing for some municipalities.

[27]The single tail z-test for the hypothesis that peer effect in high religiosity larger than the peer effect in low religiosity cannot be rejected (see Table 3.6 for p-values).

[28]Results in Table C.6 are not statistically different at standard significance levels from results in Table 3.6.

6.2 Information transmission

Parents may look at their peers to acquire information about the consequences of their decisions, e.g. on the legal consequences of cohabiting in comparison with being married. In presence of reforms that make marriage and cohabitation increasingly equal, such information mechanism might play an important role in driving the peer effect.

From being illegal until the 1970s to being the prevailing practise in the 1990s, the increase in cohabitation in Norway is a marked change in the formation of families. As shown in Figure 3.1, cohabitation at birth increased rapidly since the 1980s and then started to slow down in 1997. The trigger for such an increase was potentially the institutionalization process starting with the abolishment of the concubinage paragraph in 1972. We have shown that this increasing trend in cohabitation has been amplified by a social multiplier effect, with neighbours and workmates significantly affecting parents' decision to cohabit at childbirth. If an information mechanism from peers is in place, we would expect the peer effect to be larger during the transition period (before 1997), i.e. before the cohabitation rate starts to stabilize, as that is when individuals are more likely to obtain information about cohabitation from their peers.

To investigate such mechanism we estimate our models for neighbour and workmate effects allowing the peer effects to differ between the periods up to 1996 and from 1997 onward, i.e. during and after the transition period. We construct the IVs accordingly allowing the effect to be different during and after the transition period (before 1997 and from 1997 onward). Given that the information transmission can affect all the direct peers, we also allow the 'individual IV' to be different in the two time periods. Results of the neighbour and workmate effects for the two periods are shown in Table 3.7, Panel A and B respectively.

The probit and joint MLE results indicate that both peer effects tend to be larger in the transition period, therefore providing suggestive evidence that the information transmission mechanism plays a role in driving the spillover effects on peers.[29]

Similarly to what we have done for the imitation mechanism, we allow the effect of all exogenous parents' characteristics to differ between the periods up to 1996 and from 1997 onward. Results shown in Table C.7 in the Appendix suggest that the changes in the peer effects in cohabitation are not driven by changes in the effects of the explanatory variables across time.[30]

[29] The single tail z-test for the hypothesis that peer effect during the transition period (before 1997) is larger than the peer effect after the transition period (from 1997 onward) cannot be rejected (see Table 3.7 for p-values).

[30] Results in Table C.7 are not statistically different at standard significance levels from results in Table 3.7.

Table 3.7: Peer effects on parental cohabitation at birth during the transition period. Information mechanism

	(1) Probit MLE	(2) Joint MLE
Panel A: Neighbour effect		
Neighbours cohabitation at birth (1992-1996)	0.213***	0.202***
	(0.028)	(0.061)
Neighbours cohabitation at birth (1997-2010)	0.185***	0.181***
	(0.011)	(0.061)
Exogeneity Test (p-value)		0.000
Test (1992-1996) > (1997-2010) (p-value)	0.857	0.722
Observations	174274	174274
Panel B: Workmate effect		
Workmates cohabitation at birth (1992-1996)	0.084***	0.077
	(0.009)	(0.054)
Workmates cohabitation at birth (1997-2010)	0.067***	0.065*
	(0.004)	(0.034)
Exogeneity Test (p-value)		0.000
Test (1992-1996) > (1997-2010) (p-value)	0.956	0.627
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Panel A (B) reports the average marginal effects of the neighbours (workmates) cohabitation separately for before 1997 adn 1997 onwards while controlling for the same set of variables used in Table 3.3 (3.4) (see Section 6.2 for details). Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

7 Placebo and robustness checks

In this section we provide empirical evidence on the validity of our estimation method by considering some placebo and robustness checks. Our joint MLE relies on the validity of our instruments, which are the rate of cohabitation of the workmate's neighbours averaged across the father's workmates, to estimate the effect of workmates, and the rate of cohabitation of the neighbour's workmates averaged across the parents' neighbours, to estimate the effect of neighbours.

When estimating the neighbour effect, the instrument is constructed at the workplace level; therefore there may be unobservable traits correlated with both the characteristics of the parent and of his neighbours' workmates. Similarly, when estimating the workmate peer effect the instrument is defined at the neighbourhood level and there may be unobservables correlated with both the father's characteristics and of his workmates' neighbours. Following the procedure implemented by Nicoletti et al. (2018) we run two types of placebo tests to check for the presence of these potential issues: the first placebo tests whether the peer effects are spuriously determined by potential similar characteristics among members of each peer group; the second checks whether the peer effects are driven by a year effect or a time trend

in cohabitation. Each of the two placebo tests are run for both the neighbour effect and the workmate effect, following the same procedure.

To run the first placebo test, we construct a network of random peers by linking each parent to fictitious peers having common characteristics with the true peers. For the neighbour effect, we divide the sample into groups, based on mother's neighbours' education (below and above the mean of 13.6 years), age (below and above the mean of 27.7 years old), and work status one year before birth (below and above the mean employment status one year before the first childbirth). We then replace each neighbour of a mother with the neighbour of a randomly selected mother within the same group and estimate the benchmark model for the neighbour effect using the average cohabitation at birth for these fictitious neighbours (and their characteristics) instrumented with the fictitious neighbours' workmates. This random allocation of neighbours within groups is repeated 100 times to provide 100 estimates of the neighbour peer effect. Following the same procedure, we perform the corresponding placebo test for the workmate peer effect by randomly linking each parent to a fictitious network of workmates having common characteristics with the real workmates. Table 3.8, Panel A shows the percentage of statistically significant estimated peer effects out of the 100 random replications, for neighbours and workmate effects in column (1) and (2) respectively. The peer effects are never statistically significant (0% percent of cases) when using randomly allocated peers with the same characteristics as the true peers. Therefore, the placebo tests suggest that our benchmark estimates of the neighbour and workmate effects are not spuriously determined by similar characteristics among neighbours and workmates.

Table 3.8: Placebo Tests

	(1) Neighbour effect Joint MLE	(2) Workmate effect Joint MLE
Panel A		
Placebo 1: Random assignment of peers by education, age at birth, working status		
% of significant peer effect	0.0%	0.0%
Panel B		
Placebo 2: Random assignment of peers by year of the child birth		
% of significant peer effect	0.0%	0.0%

Notes: Panel A and B consider two different placebo tests consisting of 100 replications obtained by randomly assigning peers to parents and computing for each replication the peer effect using the joint maximum likelihood. The values reported are the percentages of cases out of 100 replications where the hypothesis of a zero peer effect is rejected at 5% level of significance with the neighbour and workmate effects results reported in column (1) and (2) respectively. See Section 5.2 for details. Norwegian administrative data.

To implement the second placebo test and check whether our estimated peer effects are driven by the year of birth effect or time trends in cohabitation, we follow a similar procedure as the first test and we group the sample of parents by the child's year of birth and we randomly link fictitious neighbours (workmates) to parents by randomly assigning parents within the same group. These network of fictitious neighbours (workmates) are used to estimate the neighbour (workmates) effect with the correspondent instruments. We randomly repeat this

allocation of peers within group 100 times. Like the first placebo test, the peer effects are never statistically significant (0% percent of cases) when using fictitious peers suggesting that our benchmark estimates are not driven by year of birth effects or time trends in cohabitation (Table 3.8, Panel B).

To provide some additional evidence to support our IVs, we show that the association between IVs and parents' characteristics is very small and in most cases not significant once controlled for the covariates used in model 3.2 (see Table C.5 in the Appendix). There is no statistically significant correlation between the instrument for the neighbours' cohabitation rate and the parental characteristics conditional on the remaining variables, which suggest that parents' outcomes and behaviour are not explained by neighbours' workmates' behaviour (see column 1); whereas there is a statistically significant correlation between the instrument for the workmates' cohabitation rate and the parents' characteristics but only for three variables (see column 2).

8 Conclusions

This paper shows how the influence of parents' peers can exacerbate the effect of institutional, cultural or policy changes affecting family arrangements and in particular the decision of whether to cohabit or marry at the birth of the first child. By estimating the causal neighbour and workmate effects on parents' cohabitation decisions at first childbirth, we find large and statistically significant peer effects. An increase of 10 percentage points in the rate of cohabitation of peers raises the parents' probability to cohabit by 1.9 and 0.7 percentage points when considering neighbours and workmates respectively. These results show that neighbours have a larger influence on the decision of parents to cohabit than workmates.

We estimate that the social multiplier is equal to 1.2 and 1.1 for the neighbour and workmate effects respectively. This implies that any intervention yielding a direct effect on the parental cohabitation probability of 1 percentage point would have also an additional indirect raising effect of 0.2 and 0.1 percentage points through the peers. This is because for any pair of parents directly affected by the policy change, there is also a spillover effect on their peers which magnifies the effect of the policy. Our findings suggest that the dramatic and fast increase in cohabitation at birth in Norway is explained by the institutionalization process of cohabitation and potential other policy and cultural changes happened in Norway and by the amplification of the effects of these triggering events through the peers.

We find also some suggestive evidence that two of the channels through which peers can affect parents' decisions to cohabit are the imitation mechanism, whereby parents imitate their peers to avoid the utility cost from deviating from social norms, and the information mechanism, i.e. that fact that parents look at their peers for information about the cost associated with cohabitation and marriage especially during the transition period from 1992 to 1996.

C Appendices

C.1 Further results

Table C.1: Descriptive statistics of the original sample

	mean	sd	min	max
Father's age	30.681	5.658	17	74
Mother's age	27.257	4.677	16	53
Mother's education	13.478	2.412	9	21
Father's education	12.963	2.444	9	21
Mother's employment	0.784	0.411	0	1
Father's employment	0.979	0.144	0	1
Father's earnings	353952.230	260853.101	0	2.88e+07
Child year of birth	2001.084	5.526	1992	2010
Cohabiting at birth	0.624	0.484	0	1
Observations	362123			

Notes: Mother's employment, father's employment and father's earnings refer to 1 year before birth. The rest of the variables are at child's birth. Norwegian administrative data.

Table C.2: Model for the probability of cohabiting: estimation results - neighbour effect

	(1) Probit MLE	(2) Joint MLE
Endogenous effect of neighbours		
Neighbours cohabitation at birth	0.192***	0.186***
	(0.013)	(0.059)
Effect of parental covariates		
Mother's education	0.032***	0.032***
	(0.007)	(0.007)
Mother's education squared	-0.001***	-0.001***
	(0.000)	(0.000)
Father's education	-0.022***	-0.022***
	(0.007)	(0.007)
Father's education squared	0.000	0.000
	(0.000)	(0.000)
Mother's employment	0.033***	0.033***
	(0.005)	(0.005)
Father's earnings	-0.000	-0.000
	(0.000)	(0.000)
Father's employment	0.007	0.007
	(0.030)	(0.030)
Father's age	-0.025***	-0.025***
	(0.002)	(0.002)
Mother's age	-0.113***	-0.113***
	(0.003)	(0.003)
Mother's age squared	0.002***	0.002***
	(0.000)	(0.000)
Father's age squared	0.000***	0.000***
	(0.000)	(0.000)
Average of parental covariates across neighbours (Exogenous peer effects)		
Mother's education	-0.033	-0.035
	(0.022)	(0.021)
Mother's education squared	0.001	0.001
	(0.001)	(0.001)
Father's education	-0.009	-0.008
	(0.014)	(0.014)
Father's education squared	0.000	0.000
	(0.001)	(0.001)
Mother's employment	-0.021	-0.021
	(0.013)	(0.013)
Father's earnings	-0.000***	-0.000***
	(0.000)	(0.000)
Father's employment	0.000	-0.002
	(0.039)	(0.039)
Father's age	0.012*	0.012
	(0.007)	(0.007)
Mother's age	-0.001	-0.001
	(0.010)	(0.010)
Mother's age squared	0.000	0.000
	(0.000)	(0.000)
Father's age squared	-0.000	-0.000
	(0.000)	(0.000)
Individual IV		
Father's Workmates cohabitation at birth	0.071***	0.071***
	(0.004)	(0.004)
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors included are: mother's education and its square, parents' age and their squares, parents' working status, father's earnings and the average of these set of covariates across neighbours; individual IV (workmates rate of cohabitation at birth); child year of birth dummies and the average of these dummies across neighbours; labour market area dummies. Column (1) reports the average marginal effects of the above listed variables of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effects of the joint maximum likelihood estimation of models (3.2) and (3.4). Norwegian administrative data.

Table C.3: Model for the probability of cohabiting: estimation results - workmate effect

	(1) Probit MLE	(2) Joint MLE
Endogenous effects of workmates		
Father's Workmates cohabitation at birth	0.071***	0.068*
	(0.003)	(0.035)
Effect of parental covariates		
Mother's education	0.024***	0.024***
	(0.005)	(0.005)
Mother's education squared	-0.001***	-0.001***
	(0.000)	(0.000)
Father's education	-0.016**	-0.016**
	(0.007)	(0.008)
Father's education squared	0.000	0.000
	(0.000)	(0.000)
Mother's employment during pregnancy	0.033***	0.033***
	(0.005)	(0.005)
Father's earnings	-0.000	-0.000
	(0.000)	(0.000)
Father's employment	0.002	0.003
	(0.029)	(0.030)
Father's age	-0.025***	-0.025***
	(0.002)	(0.002)
Mother's age	-0.112***	-0.112***
	(0.003)	(0.003)
Mother's age squared	0.002***	0.002***
	(0.000)	(0.000)
Father's age squared	0.000***	0.000***
	(0.000)	(0.000)
Average of parental covariates across workmates (Exogenous peer effect)		
Mother's education	-0.006	-0.002
	(0.008)	(0.008)
Mother's education squared	0.000	0.000
	(0.000)	(0.000)
Father's education	-0.014*	-0.013*
	(0.008)	(0.008)
Father's education squared	0.000	0.000
	(0.000)	(0.000)
Mother's employment	0.014***	0.014***
	(0.004)	(0.004)
Father's earnings	0.000**	0.000**
	(0.000)	(0.000)
Father's employment	0.028	0.028
	(0.029)	(0.029)
Father's age	0.001	0.001
	(0.003)	(0.003)
Mother's age	0.000	-0.000
	(0.004)	(0.005)
Mother's age squared	-0.000	-0.000
	(0.000)	(0.000)
Father's age squared	-0.000	-0.000
	(0.000)	(0.000)
Individual IV		
Neighbours cohabitation at birth	0.192***	0.189***
	(0.011)	(0.011)
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors included are: mother's education and its square, parents' age and their squares, parents' working status, father's earnings and the average of these set of covariates across workmates; individual IV (neighbours rate of cohabitation at birth); child year of birth dummies and the average of these dummies across workmates; labour market area dummies. Column (1) reports the average marginal effects of the above listed variables of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effects of the joint maximum likelihood estimation of models (3.2) and (3.4). Norwegian administrative data.

Table C.4: Models for the neighbours and workmates cohabitation rates: joint maximum likelihood estimation results

	(1) Neighbours cohabitation at birth	(2) Workmates cohabitation at birth
Instrumental variable		
Neighbours' workmates cohabitation at birth	0.154***	
	(0.008)	
Workmates' neighbours cohabitation at birth		0.333***
		(0.014)
Effect of parental covariates		
Mother's education	-0.010**	0.005
	(0.004)	(0.004)
Mother's education squared	0.000**	-0.000
	(0.000)	(0.000)
Father's education	0.001	-0.002
	(0.001)	(0.003)
Father's education squared	0.000	0.000
	(0.000)	(0.000)
Mother's employment	0.002*	0.005***
	(0.001)	(0.002)
Father's earnings	0.000	0.000
	(0.000)	(0.000)
Father's employment	-0.005	-0.060 ***
	(0.007)	(0.018)
Father's age	0.000	0.002*
	(0.001)	(0.001)
Mother's age	0.001	-0.002
	(0.001)	(0.002)
Mother's age squared	-0.000	0.000
	(0.000)	(0.000)
Father's age squared	-0.000	-0.000
	(0.000)	(0.000)
Average of parental covariates across peers of type A (Exogenous peer effect)		
Mother's education	-0.072**	0.020***
	(0.019)	(0.007)
Mother's education squared	0.002***	-0.001***
	(0.001)	(0.000)
Father's education	-0.042*	-0.030***
	(0.024)	(0.007)
Father's education squared	0.001	0.000
	(0.001)	(0.000)
Mother's employment	0.047**	0.022***
	(0.019)	(0.006)
Father's earnings	-0.000***	-0.000**
	(0.000)	(0.000)
Father's employment	0.220 ***	0.107***
	(0.042)	(0.024)
Father's age	-0.028***	-0.030***
	(0.006)	(0.003)
Mother's age	-0.079***	-0.091***
	(0.007)	(0.005)
Mother's age squared	0.001***	0.001***
	(0.000)	(0.000)
Father's age squared	0.000***	0.000***
	(0.000)	(0.000)
Individual IV		
Father's Workmates cohabitation at birth	0.014***	
	(0.001)	
Neighbours cohabitation at birth		0.062***
		(0.007)
Observations	174274	174274

Notes: Column (1) and (2) reports the joint maximum likelihood estimation of model (3.4) for neighbour and workmate effect respectively. Results in Column (1) include year of birth dummies, their averages across neighbours and labour market area dummies. Results in Column (2) include year of birth dummies, their averages across workmates and labour market area dummies. Norwegian administrative data.

Table C.5: Regressions of the instrumental variables: estimation results

	(1) Cohabitation at birth of Neighbour's workmates averaged across neighbours	(2) Cohabitation at birth of Workmate's neighbours averaged across workmates
Mother's education	0.000	0.003**
	(0.003)	(0.001)
Mother's education squared	-0.000	-0.000
	(0.000)	(0.000)
Father's education	0.002	-0.002
	(0.001)	(0.002)
Father's education squared	-0.000	0.000
	(0.000)	(0.000)
Mother's employment	0.001	-0.001
	(0.001)	(0.001)
Father's earnings	-0.000	-0.000***
	(0.000)	(0.000)
Father's employment	-0.001	-0.018**
	(0.009)	(0.008)
Father's age	0.000	0.000
	(0.001)	(0.001)
Mother's age	-0.001	-0.001
	(0.001)	(0.001)
Mother's age squared	0.000	0.000
	(0.000)	(0.000)
Father's age squared	-0.000	0.000
	(0.000)	(0.000)
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Column (1) reports the regression results of the rate of cohabitation of the neighbour's workmates averaged across the parents' neighbours (the IV for the neighbour effect model) on all the covariates included in model (3.2). Column (2) reports the regression results of the rate of cohabitation of the workmate's neighbours averaged across the father's workmates (the IV for the workmate effect model) on all the covariates included in model (3.2). Norwegian administrative data.

C.2 Further results on mechanisms

Table C.6: Peer effects on parental cohabitation at birth by level of religiosity. Imitation mechanism

	(1) Probit MLE	(2) Joint MLE
Panel A: Neighbour effect		
Neighbours cohabitation at birth (Low religiosity)	0.158***	0.164**
	(0.011)	(0.076)
Neighbours cohabitation at birth (High religiosity)	0.233***	0.205***
	(0.016)	(0.060)
Exogeneity Test (p-value)		0.000
Test High religiosity > Low Religiosity (p-value)	0.999	0.833
Observations	163815	163815
Panel B: Workmate effect		
Workmates cohabitation at birth (Low religiosity)	0.063***	0.063
	(0.006)	(0.052)
Workmates cohabitation at birth (High religiosity)	0.078***	0.070*
	(0.006)	(0.041)
Exogeneity Test (p-value)		0.000
Test High religiosity > Low Religiosity (p-value)	0.958	0.597
Observations	163815	163815

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors are the same as in Table 3.6 Panel A and B for the neighbour and workmate effects respectively. We additionally allow all the covariates - not only the endogenous peer effect and the Individual IV - to have a different effect between low and high level of religion attachment. Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

Table C.7: Peer effects on parental cohabitation at birth during and after the transition period. Information mechanisms.

	(1) Probit MLE	(2) Joint MLE
Panel A: Neighbour effect		
Neighbours cohabitation at birth (1992-1996)	0.204***	0.194***
	(0.030)	(0.061)
Neighbours cohabitation at birth (1997-2010)	0.187***	0.183***
	(0.011)	(0.063)
Exogeneity Test (p-value)		
Test (1992-1996) > (1997-2010) (p-value)	0.722	0.605
Observations	174274	174274
Panel B: Workmate effect		
Workmates cohabitation at birth (1992-1996)	0.085***	0.078
	(0.008)	(0.056)
Workmates cohabitation at birth (1997-2010)	0.067***	0.064*
	(0.004)	(0.034)
Exogeneity Test (p-value)		
Test (1992-1996) > (1997-2010) (p-value)	0.977	0.626
Observations	174274	174274

Notes: Standard errors in parentheses clustered by municipality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Regressors are the same as in 3.7 in Panel A and B for the neighbour and workmate peer effects respectively. We additionally allow all the covariates - not only the endogenous peer effect and the Individual IV - to have a different effect before and after 1997. Column (1) reports the average marginal effect of the maximum likelihood estimation of the probit model (3.2). Column (2) reports the average marginal effect of the joint maximum likelihood estimation of models (3.2) and (3.4). The table also reports the p-value of the Exogeneity Test for H_0: no correlation between the error terms in models (3.2) and (3.4) - i.e. no endogeneity of the endogenous peer effect. Norwegian administrative data.

Conclusions

This thesis investigates the *consequences* and *determinants* of parental inputs during childhood. By adopting various methodological approaches and data settings to answer the research questions, this thesis provides further elements to understand the importance of early circumstances in shaping child development. The focus is on the family environment in which the child grows including, the family structure (Chapters 1 and 3) and the parental investments and skills (Chapter 2). This conclusion takes stock of the contributions of this thesis in light of the current related literature, outlines the implications of the results and, finally, discusses possibilities for future research.

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Chapter 1 delved into the relationship between parental divorce and child development by providing a thorough analysis of the driving factors of the divorce skills gaps, i.e. the gap in cognitive and socio-emotional skills arising between children of intact and disrupted families. Results revealed that the divorce skills gaps can be entirely ascribed to the selection effect, by which divorce is more likely to occur among disadvantaged parents. This implies that - once accounting for usually unobserved characteristics, e.g. interparental conflicts - there is no evidence of a causal effect of divorce. These results suggest that, to reduce the divorce skills gap, interventions targeting the pre-divorce characteristics that make parents more likely to divorce would be potentially more effective than policies discouraging divorce.

Considerable differences were found between divorce gaps in children's cognitive and socio-emotional skills. Cognitive gaps are largely explained by differences in parents' education (about 35%) and family financial resources (about 60%), whilst socio-emotional disparities are mostly explained by interparental conflicts (about 35%) and financial resources (about 35%). Given the importance of interparental conflicts for socio-emotional skills and socio-emotional skills for long run outcomes, future research should take into account that the omission of conflicts would lead to an overestimation of the impact of divorce on children's later outcomes. Moreover, this study provided for the first time an investigation of the divorce skills gap across the distribution of children's skills. Heterogeneity across children's abilities highlighted another interesting contrast between the divorce gaps in cognitive and socio-emotional abilities, with larger divorce gaps observed among children with low level of socio-emotional skills, especially among boys. Such heterogeneity was not found in cognitive skills. This finding is consistent with the *diathesis stress framework*, a theory in psychology where, child socio-emotional disorders can develop from a predisposition to the disorder combined

with a stressful home environment. These results highlight the importance of considering heterogeneity across children with high and low level of socio-emotional abilities when family environments are analysed.

Chapter 2 investigated the role of parental investment and parental skills in the development of child socio-emotional skills. Adopting an age-specific child fixed effect which addresses endogeneity issues, this chapter estimated a production model of socio-emotional skills between age 6 and 11 of the child and demonstrated that the productivity of parental inputs depends on child's past skills, on the type and level of the inputs and on the child gender. Results revealed that for low levels of sensitive parenting, mother's mental health and parental time investments, improvements in these inputs have higher returns for low skilled children. For high levels of these inputs, their increase is more productive for high rather than low skilled children. These results suggest that interventions in late childhood targeted at parents with low levels of these inputs can still be effective to narrow the gaps in socio-emotional skills.

This chapter makes considerable strides in the current literature on human capital development. First, despite the increasing literature documenting the importance of socio-emotional abilities on later outcomes, estimation of the production of socio-emotional skills compared to cognitive skills remains limited; this study provided a better understanding of the formation of these skills and showed that - in contrast to cognitive skills - interventions in late childhood can still be effective in shrinking inequalities in children's socio-emotional skills. Second, unobserved heterogeneity was controlled for by adopting child fixed effect estimation which exploits the availability of two measures of socio-emotional skills for each child - internalising and externalising; therefore relaxing the often imposed assumption of independence between unobserved and observed inputs. Third, this paper demonstrated the importance of allowing for the productivity of the inputs to vary across the level of past socio-emotional skills of the child, the type of the inputs, the level of the inputs and child gender. Future research on socio-emotional skills should try to incorporate such flexibility into their models, as less flexible models are likely to hide the high degree of heterogeneity in the productivity of the inputs.

The results obtained in Chapter 2 - similarly to the results of Chapter 1 - are consistent with the *diathesis stress framework*, whereby children with low levels of socio-emotional skills are more sensitive to stressful experiences and therefore they would benefit the most from interventions aimed at reducing the child's stress. More precisely, the empirical findings suggest that the gap in socio-emotional skills at age 11 between children at the bottom and the top three quartiles of child socio-emotional skills at age 6 can be reduced up to 34% for boys and 52% for girls by interventions aiming at helping parents to adopt less harsh parenting, improving maternal mental health and increasing the time parents spend interacting with their children. This implies that such interventions would be effective in reducing inequalities in children's socio-emotional skills in late childhood. All together, results from the first and second chapter emphasize the importance of considering heterogeneity across the distribution of children's socio-emotional abilities, with particular attention to children facing a stressful home environment.

Chapter 3 estimated the causal peer effect on parents' cohabitation decision at first child's birth. The Norwegian administrative register data covering the entire population was used to adopt the *partially overlapping peer groups approach* based on an instrumental variable strategy which enabled identifying the peer effect of parental cohabitation at child's birth. The focus was on neighbour and workmate effects of cohabitation. Results showed that there are large and significant workmates and neighbour effects on parental cohabitation at birth, with larger peer effect within neighbourhood networks. Finding evidence of causal peer effect of parental cohabitation at child's birth implies that the effect of any policy directly affecting the parental decision to cohabit would be exacerbated via the indirect effect of peers. More precisely, any intervention yielding a direct effect on the parental cohabitation probability of 1 percentage point would raise of an additional 0.2 and 0.1 percentage points via the indirect effect of neighbours and workmates respectively.

An exploration of the channels through which the peer effects take place revealed that both *imitation* and *information transmission* contribute to explain the peer effects of cohabitation. Parents imitate their peers to avoid the utility cost from deviating from social norms: the peer effect being stronger in religious regions, suggests that when the cost of deviating from social norms is particularly high, an imitation mechanism drives the peer effect. Moreover, parents collect information about the cost and benefits of cohabitation from their peers, especially during the transition period in which the uncertainty toward cohabitation choice is larger.

This chapter shed new light on the causal determinants of one of the most striking change in recent decades such as the formation of families. Motivated by the recent dramatic increase in cohabitation in the US and all European countries, this chapter demonstrated that this trend has been amplified by the spillover effects on peers. The findings and strategy used in this study can be extended in future research to identify the effect of cohabitation on children outcomes; the application of partially overlapping peer groups can be taken further and used as a tool to establish the *causal impact of cohabitation on child outcomes*, whereby parents' cohabitation decision can be instrumented with the parents' peers of peers cohabitation decision. This further step would represent a natural extension of the research in this thesis and offer additional insights on how the choice of the family environment influence child development.

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Abilities developed in the early stages of life explain a large fraction of lifetime inequality. Designing strategies to reduce disparities in human capital requires identifying their origins, and focusing on where crucial abilities first develop - within the family. It is at home that children are exposed to a specific environment and receive different types of inputs influencing their development: parents choose a family structure, take investment decisions, adopt a type of parenting style and influence children through their skills. This thesis contributes to the understanding of how family shapes child development by investigating both the consequences of the variety of inputs the child receives at home and the determinants of these inputs. This inquiry enhances our knowledge of both of these crucial elements and stresses the need for further research along these lines to aid the design of interventions aimed at tackling inequality.

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