Essays on the Spillovers of the Household Environment on Childhood Development: Domestic Violence, Health and Education, and Maternal Working Hours on Children's Wellbeing

Melcior Rosselló Roig

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Melcior Rosselló Roig
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Department of Economics
City, University of London
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Abstract

This thesis contains three chapters that each study the spillover effects of two aspects of the child's household environment, Domestic Violence (chapter one and two) and Maternal Working Hours (chapter three). The first chapter looks at Children's Health, the second at Education Outcomes and the third looks at children's Well-Being. Understanding what influences a child's early development is of paramount importance as it explains future job market performance and success in life in general. All chapters exploit the data set UK Millennium Cohort Study (MCS), a longitudinal survey following around 19,000 children born in the UK in 2000-01.

The first chapter studies the effect of Domestic Violence on children's health production function. We use waves 4 and 5 of the MCS, when children are aged 7 and 11, respectively. We find that there is a strong negative externality of living in a household where there is violence on children's parental-assessed health outcomes. Simultaneity between the child's health and the existence of Domestic Violence in the household makes it difficult to establish a causal relationship, so we use an instrumental approach to address the potential bias caused by this.

In particular, our results show that children exposed to Domestic Violence appear to be between 55% and 61% less likely to have their health rated as Excellent. Our results are robust and statistically significant across all specifications. Our paper not only sheds light on the negative impact of Domestic Violence on children's health but provides a robust quantification of this effect. This chapter is co-authored with Prof. Jofre-Bonet and Dr. Serra-Sastre.

The second chapter studies the spillover effect on children's educational attainment of living in a household in which mothers are subject to Domestic Violence. To do so, we exploit measurements of the child's educational performance in English, Science, Mathematics, Physical Education, Creativity, and Information and Technology by the age of 7 and 11, available in the MCS. Our results suggest that growing up in a household where there is Domestic Violence has a negative impact on all educational outcomes. Our results are robust and hold when addressing several potential sources of sample selection bias. Children from domestically abused mothers lose around 0.20 standard deviations in English and 0.30 standard deviations in Mathematics scores at an age as early as 11 years. The cumulative negative effect is heterogenous across academic areas, being more pronounced for those subjects where past knowledge acquisition is essential (i.e., Mathematics and Science). This chapter is co-authored with Prof. Jofre-Bonet and Dr. Serra-Sastre.

The third chapter investigates how maternal working status is connected to children's well-being at ages 7 and 11. The rapid increase of female participation in the labour market, along with

the impact that well-being levels during childhood has on their psychological development and labour market outcomes later in adulthood, calls for a closer examination of this topic. To do so, we also exploit the MCS, which contains a very complete set of children's well-being outcomes and the intensity of the engagement of mothers with the labour market. To our knowledge, this is the first paper to use such a full array of children's well-being indicators and relate it to maternal labour supply. Our results show that in households in which mothers work full-time, children are, on average, happier, less worried, as well as less likely to lose their temper. Further, we investigate whether child obesity, which has been related to children's well-being, is associated to the mother's working hours, the mother's commuting time and the father's employment status. We find that higher the number of working hours of the mother increases the likelihood of the child being obese at 7 and 11 years of age, in line with previous literature. This chapter is co-authored with Prof. Jofre-Bonet and Dr. Serra-Sastre.

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This thesis is dedicated to my sweetheart, Elisa Pettorino, whom I profoundly love.

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1) The Blow of Domestic Violence on Children's Health Outcomes

This chapter has been presented by Prof. Jofre-Bonet at a seminar at King's College London. King's college Health Economics.

This chapter has been circulated as a working paper in the following series: City, University of London. Department of Economics. http://openaccess.city.ac.uk/15071/ London School of Economics and Political Science. http://www.lse.ac.uk/LSEHealthAndSocialCare/pdf/Workingpapers/LSEHWP46.pdf

2) Falling off the cliff: Domestic Violence and Children's Educational Attainment

This chapter has been presented by Prof. Jofre-Bonet at the Economics of Domestic Violence Workshop University of Leicester. This chapter has also been presented by Prof. Jofre-Bonet and Melcior Rossello-Roig at the 2017 Economic Catalonian Society.

Chapter 1

Introduction

This dissertation is a collection of three individuals chapters in applied microeconometrics that focus on children's health, academic performance and well-being. Understanding what influences a child's early development is of paramount importance as it explains future job market performance and success in life in general. In this thesis, I focus on two areas related to the child's household environment: Domestic Violence (restricted to violence against the mother by her partner) and Maternal Labour Intensity. In the first two chapters, I explore the spillover effect of living in a household where Domestic Violence exists on two children's outcomes: health (Chapter 1) and academic performance (Chapter 2). The last essay (Chapter 3) investigates the connection between maternal labour supply and an array of child's well-being outcomes.

The research presented in this thesis explores and relies on the Millennium Cohort Study (MCS, henceforth), a national survey that tracks the lives of nearly 19,000 children born in

the UK over the period 2000-2001. The first wave was collected when children were 9 months old and consecutive interviews were gathered at different intervals (3, 5, 7 and 11 years old). Trained interviewers carried out a set of multipurpose questionnaires which are intended to capture not only the cognitive and physical attributes of the child, but also the socioeconomic and demographic environment.

The aim of the first two chapters is to explore whether a causal relation exists between the childhood development and living in a household where domestic violence exists. We examine whether there are spillover effects of Domestic Violence on children's health and academic performance. In the 2013/2014 release of the Crime Survey for England and Wales (CSEW)[1] there were 8.5% of women (approximately 1.4 million) reporting any type of domestic abuse[2] and 6.8% (roughly 1.1 million) reporting having experienced any type of partner abuse. Domestic Violence leads to an average of two women being murdered each week and 30 men per year in the UK. Further, it accounts for 16% of all violent crime in the UK (CSEW 2004/2005 report), but it is the violent crime least likely to be reported and it is cited as the main reason for becoming homeless (Cramer & Carter 2002). The costs to the criminal justice system, health services, social care and housing have been estimated to be about $23 billion annually (Walby 2004). An equal opportunities commission report in 2007 estimated that around 750,000 children witness

[1]http://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice

[2]Domestic abuse in the CSEW survey includes: partner/ex-partner abuse (non-sexual), family abuse (non-sexual) and sexual assault or stalking carried out by a current or former partner or other family member.

Domestic Violence in the form of intimate partner abuse in the United Kingdom.

To capture the existence of violence in the household we use information on whether the mother experiences Domestic Violence. In particular, the MCS questionnaire includes the following question: *People often use force in a relationship - grabbing, pushing, shaking, hitting, kicking etc. Has your husband ever used force on you for any reason?*. One of the major limitations of using self-assessed Domestic Violence data is under-reporting, which may generate a downward bias in our coefficients and; thus, our estimates are a lower-bound of the effects. Among the leading causes of under-reporting found in the CSEW (2013/2014) are *embarrassment* (22.25% of the sample) and *it was a private matter* (12.92%).

The first chapter, *"The Blow of Domestic Violence on Children's Health Outcomes"*, finds that there is a strong negative externality of household violence on children's health outcomes. Simultaneity between child health and Domestic Violence makes it difficult to identify a causal effect, so we use an instrumental approach to address the potential bias. Children living in a household in which there is Domestic Violence appear to be between 46% and 52% less likely to have their health rated as Excellent. Our results are robust and statistically significant across all specifications. This study not only exposes the negative impact of Domestic Violence on children's health but provides a robust quantification of this effect. Domestic Violence is associated with mental health problems like depression (Carlson et al. 2003) or anxiety (Mertin & Mohr 2001). Indeed, Domestic

Violence increases the risk of suffering major depressive disorders, post traumatic disorders and substance abuse disorders in women (Ehrensaft et al. 2006). Victimized mothers also tend to be impulsive and use harsh punishment on their children (Osofsky 1987).

The second chapter, *"Falling off the cliff: Domestic Violence and Children's Educational Attainment"*, studies the spillover effect on children's educational attainment of living in a household in which mothers are subject to Domestic Violence. We use measurements of the child's educational performance in English, Science, Mathematics, Physical Education, Creativity, and Information and Technology by the age of 7 and 11. We perform our analysis using two definitions of Domestic Violence: Contemporaneous (current sampling wave) and Ever (if they report any Domestic Violence in any sampling wave, current or past). Our estimates suggest that living in a family where there is Domestic Violence has a negative impact across all educational outcomes when children are aged 11. Results are robust across a number of specifications that address several potential sources of sample selection bias. Children from domestically abused mothers lose around 0.20 standard deviations in English scores and 0.30 standard deviations in Math scores at an age as early as 11 years. Once we compare the size of the effect using both Domestic Violence definitions, *Contemporaneous* and *Ever*, we observe that the effect remains stable for English, nevertheless there is a change in the magnitude of the effect for Maths and, above all, Science. The cumulative effect that Domestic Violence has on educational attainment reflects the importance of

ensuring a progressive knowledge acquisition during childhood free of any traumatic interference from living in a household where Domestic Violence exists.

The third chapter, *"Children's well-being and maternal labour supply"*, examines the association between the maternal labour supply and children's well-being outcomes at ages 7 and 11 in the UK. The female role in the labour force has changed dramatically. Over the last four decades there has been an increase in participation of women (aged 16 to 64) in the labour force. In the period from April to June 2013 around 67% of women aged 16 to 64 were in work, an increase from 53% in 1971. In 2013, 42% were working part-time [3] (full-time women worked around 40 hours per week on average). For females aged 25-35, the employment rate for those without children was above the threshold of 80%, whilst for those with children the employment rate was around 60%. For older females aged 35-49, both employment rates for those with and without children were similar (around 80%). For single mothers whose youngest child was aged up to three, just 39% were in work, compared to 65% of those young living with a partner. For mothers whose youngest child was at primary school age, between four and ten years , employment rates were higher, 74% for those in a couple and 61% for those who were a single parent. [4]

We use a number of subjective and objective child wellbeing

[3]In the period from April to June 2013, there were around 13.4 million women aged 16 to 64 in work.See references in note 2

[4]See http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemploye types/articles/womeninthelabourmarket/2013-09-25#women-in-the-labour-market

measures. One of the major contributions of this paper is to use as a measure of happiness a composite measure that takes into account three different points of view (child, parents and school teacher). This strategy limits the cognitive bias in solely relying on the children's responses. Results show that in households in which mothers work full-time, children are, on average, happier, less worried as well as less likely to lose their temper. We additionally analyse if the biological father's employment status is directly associated to the children's well-being. Further, we investigate whether the probability of children being overweight and obese, which is related to children's well-being, is associated with the mother's working hours and our estimates suggest there is a positive relationship between these two.

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Chapter 2

The Blow of Domestic Violence on Children's Health Outcomes

2.1 Introduction

In the 2013/2014 release of the Crime Survey for England and Wales (CSEW)[1] 8.5% of women (approximately 1.4 million) reported some type of domestic abuse[2] and 6.8% (roughly 1.1 million) reporting having experienced any type of partner abuse. Domestic violence (DV) leads to an average of two women being murdered each week and 30 men per year in the UK. Further, it accounts for 16% of all violent crime in the UK (CSEW 2004/2005 report), but it is the violent crime least likely to be

[1]Crime Survey for England & Wales: http://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice

[2]Domestic abuse in the CSEW survey includes: partner/ex-partner abuse (non-sexual), family abuse (non-sexual) and sexual assault or stalking carried out by a current or former partner or other family member.

reported and it is cited as the main reason for becoming homeless (Cramer & Carter 2002) . The costs to the criminal justice system, health services, social care and housing have been estimated to be about $23 billion annually (Walby 2004).

Intimate Partner Abuse (IPA) has proven to be harmful for victims' labour outcomes, mental health problems and sense of self-worth and integrity (Chapman & Monk 2015). Parenting is obviously affected by this environmental stressor. IPA is associated with parental mental health problems such as depression (Carlson et al. 2003) and anxiety (Mertin & Mohr 2001). Indeed, for women, IPA increases the risk of suffering major depressive stress disorders, post traumatic disorders and substance abuse disorders (Ehrensaft et al. 2006). Victimized mothers also tend to be more impulsive and use harsh punishment on their children (Osofsky 1987).

Violence is seen as a way to coerce the victim in order to align their attitude with respect to the ones of the perpetrator. This may be explained in various ways, from a lack of self-esteem for the aggressor or as a source of gratification (Tauchen et al. 1991) to an instrument to extract money from the victim (Bloch & Rao 2002). Identifying the person who has control over resources is key to understanding IPA. However, so far, in the economic literature there is no consensus on the role of violence in the distribution of resources inside the household. Although common factors throughout economic models point out that policies that increase the outside utility of victims also increase their bargaining power, the relationship of income and violence still remains unclear (Hidrobo & Fernald 2013).

In this paper, we study if there are spillover effects of DV on children's health. An equal opportunities commission report in 2007 estimated that around 750,000 children witness DV in the form of IPA in the United Kingdom. Paediatric literature suggests that those children suffer from a cumulative disadvantage because of living in a hostile environment (Culross 1999). Exposure may have detrimental effects on their well-being and interpersonal functioning development (Ehrensaft et al. 2003). Those witnessing DV are prone to antisocial behaviour (such as delinquency and running away) (Dubowitz & King 1995, Wolfe & Korsch 1994), as well as having problems self-regulating themselves, in terms of mood, emotional expressiveness, aggressive behaviour and hostile reactivity (Ehrensaft & Cohen 2012). Research highlights the fact that they are more likely to have poor self-esteem and are at greater risk of substance abuse later on in life (Holtrop et al. 2004). In addition, evidence shows that aggressive behaviour during infancy may lead to rejection by their school peers (Dodge et al. 2003). A major negative consequence of IPA is the children's mimicking process. Children may internalize the use of violence as a normal means of achieving their aims. Psychiatric literature has established that children who witness DV are more likely to use physical or psychological violence against their future partners (Magdol et al. 1998).

Overall, it is difficult to determine a separate mechanism for how DV can affect child's health. Instead, there may be different factors, such as the purely biological consequences of living under stressful and fearful environments. There is increasing evidence that stress early in life may induce changes in multi-

ple neurochemical systems (Kaufman et al. 2000) and promote multiple alterations in the serotonergic system and reduce of the hippocampal volume (Kaufman et al. 2004). Depression, subsequent poor quality of parenting, higher risk taking and antisocial behaviours have been reported in adults that were exposed to early life stressors such as living in a household with DV (Holtrop et al. 2004).

In work related to our analysis, Aizer (2011) provides evidence of the negative effect on birthweight of children born to mothers suffering DV while pregnant. In particular, hospitalization episodes of pregnant women due to violent assault reduces the birthweight of their babies by an average of 163 grams. In an innovative study, Carrell & Hoekstra (2010) review the bad apple hypothesis and point out that children who witness DV at home also show poor academic performance and generate negative externality effects from the performance of their peers. The analysis highlights that the presence of children exposed to IPA in their household, is associated with an increase in misbehaviour in their classroom, as well as a significant decrease in the school performance of their classmates (maths and reading test scores, specifically).

Balsa (2008) examines the future labour market performance of children whose parents suffer from heavy drinking problems. The author selects those children who have been exposed while child during their late 30s and mid-40s, so not likely to be affected by retirement decisions or returns to schooling. Results point to longer periods of being unemployed and low wages for men and longer period of time out of the labour force for female

observations. Thus, in our case, the quality of the human capital accumulation can be threatened due to an early stressor such as being exposed to a DV environment while child and have lasting effects on their labour performance later on.

While the evidence in the paediatric literature highlights a cumulative disadvantage on children's socio-emotional development, the economic literature has not yet succeeded in quantifying the effect of IPA on a child's health production function. The objective of this study is to obtain estimates of the effect on child health of living in a disruptive violent environment. In the literature, the terms Intimate Partner Abuse (IPA) and Domestic Violence (DV) are often used interchangeably but hereafter we will use the term DV to refer to domestic abuse.

Our paper uses the Millennium Cohort Study (MCS) to estimate the impact on children health of growing up in a household in which there is DV. We exploit questions designed to capture the use of force of fathers on biological mothers. In our identification strategy we first examine the relationship between DV and the child's health production with a naive specification, controlling for possible child heterogeneity and attrition bias. Secondly, we use an instrumental approach to control for the endogeneity of environmental factors that might affect both DV and child health, which is parental reported. Our instruments draw on the affective relation between the fathers and the paternal grandparents, as well as on the difference in the regional unemployment levels between men and women. We estimate our specifications by means of a non-linear recursive system of equations. In line with previous results, our findings provide evidence

of the existence of a large, negative and significant spillover effect that translates into a child's health being between 55% and 61% less likely to be rated as *Excellent* when he/she is exposed to parental DV.

This paper extends the existing literature by providing evidence of the significance and magnitude of the negative spillover effect of DV on the child's health production function. The remainder of the paper is structured as follows. The next section introduces the MCS data, presents the variables of interest and some descriptive statistics. Section III outlines the naive empirical strategy examining the relationship between a child's health and DV and provides a first set of results. Section IV extends the analysis to a bivariate model that controls for endogeneity, includes a discussion of the instruments used in this specification and shows the corresponding results. Section V concludes.

2.2 Millennium Cohort Study

The Millennium Cohort Study (MCS) is a survey following nearly 19,000 children born in the UK in 2000-2001. The first wave was collected when these children were 9 months old. Consecutive waves were gathered when they were 3, 5, 7 and 11 years old. In this study, we use waves 3, 4 and 5 of the MCS, which were run when the children were aged 5, 7, and 11, respectively. As our interest is on the effect of DV on children's health, we specifically focus on children living with both their biological parents

to avoid potentially distorting confounding factors.[3] Our data contains information on whether there exists DV in the household and on the children's health status over time, along with a variety of socio-demographic characteristics of the children and their parents, and basic features of the household and the environment they live in.

2.2.1 Main variables of interest

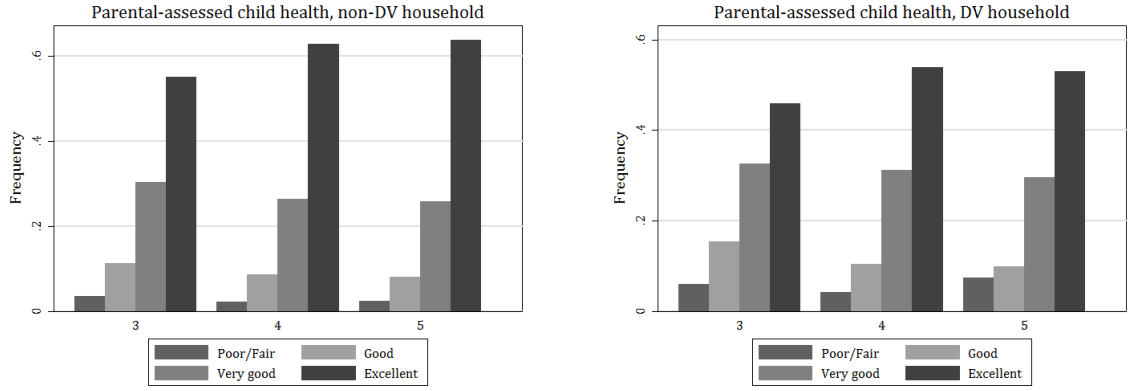
Child health information

The MCS contains data on children's general health - elicited from parents from wave 3 onward - as well as parents' health-related variables and also information on whether the child suffers from specific medical conditions. The general health question asks to rate the child's health according to five possible statuses: *Poor (5), Fair (4), Good (3), Very Good (2),* and *Excellent (1).* Parents are also asked whether their child suffers difficulties from: *vision, hearing impairment, mobility, dexterity,*

[3]Table A10 in the appendix includes the three most frequent types of families (both biological parents living together, single mother and mother and stepfather) in the MCS classified into four definitions of domestic violence; constrained, broad, ever constrained and ever broad. Constrained definitions only considers those biological mothers who answered yes or no and Broad definition retypes as an affirmative answer those mothers who responded 'do not want to answer" . To simplify we tabulated only considering two parameters family type and DV definition. We do not exclude the variables that are missing which we build up summary tables in the main analysis. The table A10 shows an expected trend in which single mothers and mother with a new partner increase across time. This table also shows how little information there is about single mother with domestic violence information.

learning or understanding, memory, mental health, stamina or breathing or fatigue, social or behavioral. For the child's parental reported health, we merge the *Fair* and *Poor* categories because of their low frequency throughout the period considered. Additionally, to ease interpretation, we invert the numerical order so that higher values of the health variable represent better health states.

Figure 1 below summarizes the frequency distribution of parent-reported child-health in waves 3 to 5 in households with and without DV. It is noticeable that for children in households where there exists DV, the frequency of *Excellent* health category is consistently lower across the three waves.



(I) (II)

Figure 2.1: Parental-reported child health

In this study, we consider the parental-reported child health as a health-proxy as commonly done in the literature (Kuehnle 2014).[4] Case et al. (2002) have showed that parental-reported

[4]Also as in Kuehnle (2014) we merge poor and fair parental-reported health ratings.

child health and physician reports are highly correlated and therefore parental-report is a good proxy for child's health. The parent's ability to report their child's health may be questioned if they suffer themselves from a health condition, consequently introducing some bias in the response. However, the literature has reported consistent evidence on the parents' ability to provide accurate information with respect to their child's health. McCormick et al. (1989), in a study carried out in New York, showed how a depressed mother can accurately discriminate between their own reported health and that of their child. Pulsifer et al. (1994) examined maternal estimates concerning the developmental age of their child and the mothers' judgments were in line with objective measures of the child's development. Interestingly, whilst there is some skepticism among clinicians about the reliability of parental concern on child health (Diamond & Squires 1993), Glascoe et al. (1991) find that if the methodology to recover child health information from parents is collected systematically by using standardized surveys, there is a high correlation between survey information and factual outcomes.

We focus on parental-reported health for two reasons. First, although parents are asked if the child suffers from specific health conditions, there is a very low prevalence of diseases for children included in the study period as they are aged between 5 and 11 years old. Second, we do not have complete administrative data on the child's health care use for the last two waves. For the first three waves, administrative data on the child's health care consumption was merged into the survey retroactively but this is not available for waves 4 and 5 (Mostafa & Wiggins 2015).

Relation ICD-10 codes and Domestic violence

MCS provides information on whether children suffer from long-standing illness. The Centre for longitudinal studies, Institute of Education coded the reported health conditions using the tenth revision of the International Statistical Classification of Diseases and related health problems, also known as ICD-10 codes.[5]

Table A11 in the appendix shows the summary statistics of the distribution of health related conditions (coded as ICD-10 codes letters) in two samples, DV and non-DV respectively. This table also uses four domestic violence definitions, *broad definition* which is a binary variable coded as 0 if the biological mother responded *no* to the question on whether she suffers intimate partner abuse,[6] and 1 if the response was *yes* or *do not want to an-*

[5]ICD codes is the international statistical classification of diseases and related health problems (ICD) proposed by the World Health Organization. The list includes codes for diseases and health related circumstances such as symptoms and abnormal findings, among others. We regrouped the codes by letter, so for instance if a child has A80 (which is the code for Acute poliomyelitis) and another child has A03 (which is the code for Shigellosis) we gave to both observations the letter A. The rationale of doing so it is to ease the interpretation since there are about 99 possible subdivisions per letter of the abecedary and each subdivision has their own divisions, which is not available at the MCS. These letters are divided by Chapters of thematic diseases. We used the ICD - 10 code revised in 2010. Information about the WHO disease codification can be found here http://apps.who.int/classifications/icd10/browse/2010/en and we also provide a table in the appendix (see table A12) that provides a relation between health condition letters and Chapters

[6]for more information about the phrasing of the question, please refer to page 17

swer. Instead, the *conservative* approach is also a dichotomous variable coded as 0 if the response was *no* and 1 if *yes*. Thus, in this case we just consider those cases in which the mother answered without hesitation.Table A12 also in the appendix provides a comprehensive summary relation between ICD-10 codes and infectious-disease thematic areas. Given the difficulty of having enough observations in a given letter we expanded our data sample by just restraining the universe of observations to only houses where both biological parents cohabitate, instead of considering whether they have missing values in other variables as we do for the remaining tables in this study.

Across all DV employed definitions, those children who happens to live under a roof of violence are more likely (and statistically significant) to have a long standing illness. In particular is striking that around age 5 they are more likely to suffer from mental and behavioural disorders and respiratory system diseases. At age 7, we also observe that children of DV parents sub-sample are more likely to have diseases of the skin and subcutaneous tissue and to suffer from certain long standing conditions originated during the perinatal period.

Domestic Violence Information

To capture the existence of violence in the household we use information on whether the mother experiences DV. In particular, the questionnaire[7]

[7]Parental questionnaire was interviewer administered (known as Computer Assisted Personal Interviewing (CAPI) questions), though more personal or sensitive question were self-completed by one parent at a

includes the following question: *People often use force in a relationship - grabbing, pushing, shaking, hitting, kicking etc. Has your husband ever used force on you for any reason?*. The mother has three options: *1 (Yes), 2 (No) and 3 (Don't want to answer)*. We define a dichotomous variable DV that equals 1 if the biological mother answers *Yes* and 0 if the answer is *No*. If the respondent answers *Don't want to answer* this is considered as a missing value. In this case the frequency of DV in our data is 3.80%, 3.46% and 3.61% for waves 3, 4 and 5, respectively. If we are counting those answers as *Yes*, the percentage of households with DV goes up to 6.46% , 6.07% and 5.40%, respectively. Although the latter figures are more in line with the statistics from the 2013/2014 CSEW, we take a conservative approach and present the results estimated using the specifically reported *Yes* and *No* answers.

One of the major limitations of using self-assessed DV data is the existence of under-reporting, which may generate a downward bias in our coefficients and thus restrict our estimates to be in a lower-bound of the effects. Among the leading causes of under-reporting found in the CSEW (2013/2014) are *embarrassment* (22.25% of the sample) and *it was a private matter* (12.92%). The timing of DV reporting by mothers also matters with regards to the long-term influence on the child's behaviour.

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time, so to lessen the misreporting effect (these type of questions in the MCS are known as CASI (Computer Assisted Self-Interviewing) questions). For further details we suggest the reader to have a look to any of the user guides of each sweep. See for instance for the first sweep http://www.cls.ioe.ac.uk/page.aspx?&sitesectionid=854&sitesectiontitle=The+age+9-months+survey+of+the+MCS+(2001-02

The earlier the mothers report the existence of DV, the lower the impact on the child's development and consequently the lower effect that child's behaviour has on classroom disruption (Carrell & Hoekstra 2010).

2.2.2 Relevant control variables

Child-related control variables

Currie (2009)'s survey of the literature on the relation between child health, income and parental education provides guidance on the possible pathways on how the socioeconomic environment might affect the child health production function. Therefore, we follow Currie (2009) and include health-related, environmental and socio-economic factors, transmitted inter-generationally or not, that might affect child's health.

Child-specific variables included in the empirical strategy are age, gender (=1 if female) and a dummy on whether the child was born with low birthweight (2.5kg or below). We include information on the child's BMI and apply Saxena et al. (2004) gender-age specific BMI thresholds to define two dummies for obesity and overweight. Ethnicity has also been linked to a child's health. For instance, Dearden et al. (2006), also using the MCS, find that Asian and Black babies are 5% and 6% respectively more likely to be of low birth weight than white babies and this may affect their health later on in life. Thus, we control for ethnicity using a set of indicator variables that take value 1 if the child is of White, Bangladeshi/Indian/Pakistani, Black or Other background. Table A1 in the Appendix gives a

summary of the control variables and their definition. Table 2.1 below reports the mean of the child's parental-reported health and control variables for each of the waves included in the study.

Table 2.1: Child Summary Statistics

	Age 5			Age 7			Age 11		
	DV			DV			DV		
	No	Yes	*Statistically different*	No	Yes	*Statistically different*	No	Yes	*Statistically different*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Health distributions									
(1) FairPoor	0.03	0.06	***	0.02	0.04	***	0.02	0.04	***
(2) Good	0.10	0.10		0.07	0.10	+	0.06	0.07	
(3) Very Good	0.29	0.34		0.25	0.31	+	0.24	0.31	+
(4) Excellent	0.59	0.50	***	0.66	0.54	***	0.68	0.57	**
Female	0.49	0.52		0.49	0.49		0.50	0.43	+
Obese	0.05	0.05		0.05	0.08	+	0.06	0.07	
Overweight	0.15	0.13		0.14	0.17		0.19	0.20	
Low birthweight	0.06	0.10	**	0.06	0.05		0.05	0.06	
White	0.93	0.90		0.92	0.92		0.92	0.92	
Bang/Ind/Pak	0.03	0.03		0.03	0.03		0.03	0.03	
Black	0.01	0.00		0.01	0.01		0.01	0.01	
Other	0.03	0.06	+	0.03	0.04		0.03	0.04	
Age	5.28	5.28		7.28	7.25		11.28	11.31	
N	5926	221		5221	185		4028	134	

Note: Averages calculated using data of children living with both biological parents for which there are no missing values for gender, race, birth weight, weight, month born, mother was a teenager when pregnant, parental long standing illness, parental smoking habits, parental education, parental age, parental working status, household income and type of dwelling. N refers to the number of observations in each group. Means are adjusted for the reference population weights given in each of the three MCS waves used for both the non-DV and the DV samples. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Parental-related control variables

The empirical specification includes health- and non-health related variables taken from the parental questionnaire across the three waves. Table A2 in Appendix contains a list of all parental controls included.We include information on whether any of the

parents have any long-term health conditions, whether they suffer from depression and also if they are current smokers. Tables A10 and A4 in Appendix shows the summary statistics for maternal and paternal characteristics. Mothers that suffer from DV also suffer more frequently from chronic conditions, they are more likely to have been diagnosed with depression in every sampling period (50%, 49% and 55% in waves 3, 4 and 5, respectively) and report a higher percentage of smoking in any given sampling period. In the case of the male counterpart, the level of depression and smoking are statistically higher in a violent household across the last three waves available at the time of the study (26%, 27% and 31% for depression and 35%, 36% and 23% for smoking in waves 3, 4 and 5, respectively).

We also select a number of controls for parents' characteristics such as age and parental education. Cutler & Lleras-Muney (2010) highlight that education influences cognitive ability and is associated with healthy behaviours. Educated parents are more likely to engage in stimulated discussion with their children as well as having a better network in case of health problems (if educated parents do not know a doctor directly, it is likely that they know somebody who knows one). In our case, fathers and mothers in both samples have a similar education distribution (as seen in Tables A10 and A4 in the Appendix).

Whether the father is unemployed may have some effects on the frequency of DV. The literature points out that the father being unemployed increases the likelihood of the mother being battered (Farmer & Tiefenthaler 1996) although recent evidence actually suggests that the husband may limit abuse while un-

employed (Anderberg et al. 2016). Therefore, we also include an indicator variable, *In-work*, that reflects the father's employment status.

The last of the parental characteristics included is a dummy on whether the mother was a teenager at the time of the birth of her child. Empirical evidence shows that being a teenage mother has an effect on the offspring's health. Berthoud & Robson (2001) find that 40% of teenage mothers were living in poverty by the time their child was 10 years of age while only 11% of the older mothers were. Pevalin et al. (2003) looks at the 1970 British Cohort Study and finds that children from younger mothers are more likely to be pre-term babies and to be born with low weight (less than 2.5Kg.).

Household control variables

A causal effect of neighborhood characteristics on health has been recently highlighted. Bilger & Carrieri (2013) examine the negative effect of crime, pollution and noise of the neighborhood on self-assessed health, presence of chronic conditions and limitations to daily activities. In another study, Jacob et al. (2013) show a decline of child mortality when the household is relocated to a less distressed neighborhood. In our study, we do not have specific information regarding the neighborhood where the child lives. However, we are able to control by whether the family lives in a Council house or Housing Association. This may be a good proxy as council houses are likely to be in areas of higher poverty (Atkinson & Kintrea 2001). Not capturing properly the neighborhood effect would mean that our DV estimate on child's

health is likely to have an upward-bias.

Finally, our specification includes household income. There is a clear positive relationship between parental income and child health (Currie 2009, Violato et al. 2009, Kuehnle 2014). In the MCS income is defined as the combined annual income in a household from all sources after deductions and is given in thresholds levels. We take the midpoint of each reported interval and use the annual average consumer price index provided by the Office of National Statistics (ONS) to convert it into real income with base year 2005. As it is common in the literature, we take the natural logarithm of income to avoid estimation problems caused by its non-normality. The bottom panel in Tables A10 and A4 in the Appendix present the summary statistics at household level for both the council house dummy and income variables. Around 10 to 15% of the families who are living in a violent environment, i.e. the mother reports being subjected to DV, live in a council house or in a housing association in every sampling period. Income is also lower in such violent environments across all three sampling periods.

The next section presents the model through which we base our empirical strategy and a first set of results.

2.3 A model of child health and domestic violence

We investigate the existence and magnitude of the impact of living in a household with DV on the child's health production function. We start by estimating a naïve non-linear pooled spec-

ification controlling for unobserved heterogeneity and attrition. The basic model specifies the child health production function as:

$$H_{it} = f(DV_{it}, X^c_{it}, X^m_{it}, X^f_{it}, X^H_{it}) \tag{2.1}$$

where H_{it} is the categorical variable of parental-reported child health with four possible values: *Fair/Poor (1), Good (2), Very Good (3)* and *Excellent (4).* Our first approach looks at the relationship of child health and DV using a simple Univariate Ordered Probit model. We define a latent health variable, H^*_i, as:

$$H^*_{it} = X_{it}\beta + c_i + \epsilon_{it}, \tag{2.2}$$

where i and t denote the child identifier and time period respectively; H^*_i is the health latent variable, X_{it} is the vector of variables $(DV_{it}, X^m_{it}, X^f_{it}, X^H_{it}, X^c_{it})$ defined as above, c_i are random individual-specific effects, that is, time-constant individual unobserved characteristics of the child that could potentially affect the child's health (e.g.genetics or environmental factors like childcare setting), and ϵ_{it} is a normally distributed idiosyncratic error, i.e. $\epsilon_{it}|X_{it}, c_i \sim Normal(0, 1)$.

At each point in time, we do not observe the latent health variable, H^*_i, but the parent-reported categorical answer about the child's health, $j = 1, 2, 3, 4$. The observed category is j if the latent health lies between certain thresholds, i.e. $\alpha_{j-1} < H^*_i < \alpha_j$, where the thresholds, α_j, are to be estimated along with β. Formally:

$$Pr(H_i = j) = F(\alpha_j - X_i\beta - c_i) - F(\alpha_{j-1} - X_i\beta - c_i), \quad (2.3)$$

where *F(.)* is the cumulative normal distribution function.

A major concern of a pooled specification like the one in (2) is that identification relies on the unrealistic assumption that the time varying covariates in X_{it} are uncorrelated with the individual-specific effects, c_i . To address this concern, we apply the Chamberlain-Mundlak device (CM hereafter), based on Chamberlain (1979) and Mundlak (1978) and regresses child fixed effects, c_i, on the average over all periods of a set of the exogenous time-varying variables, Z_{it}, i.e.:

$$c_i = \psi + \bar{Z}_i\eta + a_i \quad (2.4)$$

The underlying rationale for applying the CM correction is that it replaces the child unobserved individual effect, c_i, for its linear projection onto the mean of the exogenous variables ($\bar{Z}_i$), a scalar ψ and a normally distributed projection error a_i uncorrelated with $\bar{Z}_i$ by construction, i.e. $a_i \sim Normal(0, \sigma_a^2)$. By substituting equation (4) into (2) we define a random effects structure.

2.3.1 Attrition bias

One of the major threats to the validity of our specification is the non-random attrition from one survey sweep to another as it may lead to biased estimates. In particular, we expect the bias to be downwards because children with worse health conditions and/or from lower socio-economic backgrounds are more likely

to drop out of the sample, possibly mitigating the effect of DV on children's health outcomes.

We correct for attrition by implementing the Inverse Probability Weighting (IPW) estimator to the pooled ordered probit (Wooldridge 2010, 2002).[8] As in Contoyannis et al. (2004), we estimate probit equations for responses to the fourth and fifth waves of the survey, i.e. ($\xi_{it} = 1$) versus non-response ($\xi_{it} = 0$), against a set of covariates that are observed in the first wave (wave 3) of our study period. The inverse of the predicted probability is obtained, $\hat{p_{it}}$, and used to weigh observations in waves 4 and 5 of the maximum likelihood estimation for both the pooled and the CM-adjusted ordered probit.[9] The validity of this approach relies on the set of covariates chosen to produce the probability of response. In this case, we assume that the same set of covariates used for each of the models to follow are good predictors for the missing data.

$$logL = \sum_{i}^{n} \sum_{t}^{T} (\xi_{it}/\hat{p_{it}}) logL_{it} \tag{2.5}$$

2.3.2 Results of the basecase model

Table 2.2 presents estimates of the effect of DV on child health when we use naïve pooled ordered probit specifications. See Table A5 in the Appendix for a full list of results of all covariates

[8]Table A15 and A16 provide the parameter estimates of the probit specification to calculate the correction weights (IPW)

[9]Following Contoyannis et al. (2004) and Wooldridge (2005), we do not adjust the standard errors of the estimation in order to avoid oversized standard errors.

included in the specifications. The estimates of our baseline ordered probit model are presented in column (1), which is obtained by pooling data across the last three available sampling waves and controls only for socieconomic and parental health variables. Column (2) presents the estimates of the CM-device ordered probit model correcting for unobserved individual heterogeneity. In columns (3) and (4), we present the results when we apply the IPW to the simple pooled ordered probit and the CM-corrected pooled ordered probit.

Table 2.2: Naïve Ordered Probit Models

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Domestic violence	-0.151^{***}	-0.153^{***}	-0.168^{***}	-0.146^{**}
	(0.057)	(0.058)	(0.061)	(0.06)
Controls	X	X	X	X
Cut1	-0.337	-0.456	-0.2828	-0.438
	(0.244)	(0.346)	(0.254)	(0.365)
Cut2	0.447^{+}	0.331	0.4967	0.348
	(0.243)	(0.345)	(0.253)	(0.364)
Cut3	1.430^{***}	1.318^{***}	1.481^{***}	1.334^{***}
	(0.243)	(0.345)	(0.253)	(0.364)
N	15,713	15,713	14,991	14,991
ll	-1.41e+04	-1.41e+04	-1.47e+04	-1.42e+04

Notes: Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using an unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include inverse probability weights (IPW) weights. *Controls* include the set of variables for the child, parental and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Overall, results in Table 2.2 indicate that there is a negative and significant effect of DV on the child's health production function. Nevertheless, based on the coefficient estimates, we cannot comment on the sign and magnitude of the effect of DV on child health. To do so we need to obtain the Average Partial Effects (APEs) of DV on the probability of reporting the child's health status as any of the four categories *Poor/Fair (1), Good (2), Very Good (3)* and *Excellent (4)*. Since the only cut-off point significant at 99% across all specifications is the third one, which divides the parental-reported child health levels *Very Good* and *Excellent*, we only report the APE of DV on the probability of reporting child's health as *Excellent*. Later in the paper, we will exploit the fact that only the last threshold level - dividing the *Very good* and *Excellent*- is signficant and will model the child health variable as a dichotomous indicator variable that takes value 1 if parents rate the health of their child as *Excellent* and 0 otherwise.[10]

Table 2.3: Average Partial Effects: Probability Excellent Health

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Domestic violence	-0.057^{***}	-0.057^{***}	-0.063^{***}	-0.055^{**}
	(0.022)	(0.022)	(0.023)	(0.023)

Notes: Standard errors in parentheses. Standard errors calculated by Delta method. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

[10]Table A13 provides parameter Ordered probit estimates without those variables that are susceptible of being endogenous.

Table 2.3 summarises the APEs that correspond to each of the univariate models presented in Table 2.2. As indicated above, the reported APEs refer to the impact of DV on the probability of reporting health as *Excellent*. The impact is negative and similar in magnitude across all specifications. Whilst the effect for the unweighted estimation (columns (1) and (2)) is the same, the impact differs among specifications once we correct for sample attrition. Column (3) presents the effect of DV as being 6.3% less likely to report a child's health as *Excellent*. Nevertheless, once we control for the influence of child's unobserved heterogeneity, the effect decreases to 5.5%. Table A6 in the Appendix provides the APEs of all variables included in the univariate model specifications.

2.4 Breaking the simultaneity

While the negative impact of DV on the child health production is significant throughout all the above specifications, causation becomes a critical concern as, potentially, there exist unobserved factors endogenously affecting both DV and parental reported child's health. Our strategy to be able to establish causality between DV and child's health relies on making use of a recursive system of non-linear equations that addresses the potential endogeneity. To do so, we specify a system of two simultaneous reduced form equations for DV and child's health using a bivariate semi-ordered probit model. The first equation models parental-reported child's health while the second equation models the dichotomous indicator variable DV. It has been shown

that this system can be identified if both equations contain the same set of regressors as long as there is enough data variation (Wilde 2000, Bridges & Disney 2010). However, to reinforce our identification strategy, we follow Maddala (1983) and include some variables in the second DV equation which are not used in the first parental-reported child's health equation.

Our empirical identification strategy is based on the use of two instruments in the DV equation that are related to DV but not to parental-reported child health. The first instrument aims at correcting for familiar self-selection into a violent environment. Pollak (2004), for instance, establishes that there is intergenerational transmission of DV. Also, there is evidence that adults that grew up witnessing DV have emotional attachment problems (Dodge et al. 2003) that includes estrangement from their own parents (Sousa et al. 2011, Egeland et al. 2002). Building on these facts, we use an index variable that reflects the affective relationship between the father and his own parents. We do so by estimating latent class model (Lanza et al. 2013) that identifies father-to-own-parents affective relationship types (or clusters) in our panel, which we refer to as *relation index* hereafter. The latent class model exploits the answers to three questions asked in the first sampling period: (a) the frequency that the biological father sees his father; (b) the frequency that the biological father sees his mother; and, (c) whether the biological father receives any economic support from his parents. Table 4 below shows the model fit criteria from which we can select the optimal number of types as per father-to-own-parents affective relationship. The Akaike Information Criteria (AIC),

the Schwarz Bayesian Information Criteria (BIC), the Adjusted Schwarz Bayesian Criteria (Adjusted BIC), and the Entropy index (Entropy R^2) coincide in identifying 6 as the optimal number of different types. This is also corroborated by the G^2 index which suggests that the more types, the better. However, using more than 6 father types leads our specification into negative degree of freedom and higher AIC, BIC and Adjusted BIC. Thus, we chose a classification of fathers that groups them in 6 types according to their father-to-own-parents affective relationship. The grouping is captured by the variable *relation index*.[11][12]

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of the AIC and BIC.To estimate the posterior probability for a specific relationship the methodology developed by Lanza et al. (2013) uses the Bayes' rule. So

$$P(L = c|Z = z) = \frac{(\prod_{s=1}^{S} \prod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)})\gamma_c}{\sum_{c=1}^{c} \gamma_c \prod_{s=1}^{S} \prod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)}}$$

[11]Higher values of the relationship index are linked to higher frequencies of either parental contact or financial support. The two levels of a more intense contact with both parents of the biological father represents an average of 89% (grandfather) and 99% (grandmother) of the observations for the sixth level of the relation index. The same holds for the parental financial support, almost an average of 84% of the observation of the sixth level of the relation index receives some kind of financial support. Here we reported the average across sampling waves.

[12]The LCA is a probability model based on cluster analysis method. LCA identifies homogenous clusters of data from the heteregoneous relation of the biological father with his parents. In order to maximize the resemblance within the cluster and to minimize the likeness among different clusters. LCA assumes that the data is from a mixture model of different probability distributions (Lanza et al. 2013). It assumes that there is a latent variable that divides the data into mutually exclusive homogenous subdivisions. To identify the latent classes based on paternal relationships and following a

Table 2.4: Index of clusters father-to-own-parents affective relationships

n. latent class	G^2	df	AIC	BIC	Adjusted BIC	Entropy R^2
3	4938.85	36	5008.85	5262.94	5151.72	0.82
4	2078.45	24	2172.45	2513.6	2364.29	0.88
5	500.31	12	618.31	1046.63	859.14	0.87
6	21.97	0	163.97	679.41	453.78	0.84
7	9.82	−12	175.82	778.37	514.61	0.84
8	8.16	−24	198.16	887.83	585.93	0.79
9	6.18	−36	220.18	996.97	6565.94	0.70
10	0.10	−48	238.10	1102.01	7234.84	0.68

Note: The term *n.latent class* stands for the number of possible analyzed latent classes. G^2 is the likelihood ratio statistic (the deviance between the likelihood from the reduced model and the saturated one). *df* are the degree of freedom. *AIC* is the Akaike information criteria. *BIC* is the Schwarz bayesian information criteria. *Adjusted BIC* is the adjusted Schwarz bayesian information criteria. *Entropy* R^2 is an overall measure of fuzziness, i.e. it reflects the distinguishability of the types ranging from 0 (fuzzy and suggesting no difference among latent classes) to 1 (types clearly different) (Ramaswamy et al. 1993, Kaplan & Keller 2011).

similar notation as in (Lanza et al. 2013). Let γ_c represents latent class membership for latent class cluster c (c=1,2,...,c number of clusters). Suppose that each relationship between the biological father and his parents can be characterized with S attributes (in our case the three questions), Z_i represents relation's i's attribute of characteristic s and Z_i ia a categorical variable from 1,..., r_s. ρ indicates the probability that "relationship" i has the attribute in terms of all the S characteristics conditional on latent class membership. So

$$\rho_{s,r_s|c}^{I(z_s=r_s)}$$

represents the probability that a relationship has attribute r_s of characteristic S, conditional on membership in latent class c.The indicator function, I($z_s = r_s$), equals 1 when the attribute of the characteristic S equals r_s, and equals zero, otherwise. The probability of observing a particular vector of responses

$$P(Z = z) = \sum_{c=1}^{c} \gamma_c \prod_{s=1}^{S} \prod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)}$$

The most suitable number of clusters "c" –or type of relation- is unknown beforehand. Instead, the user should examine multiple models by using different numbers of clusters and choose the appropriate number on the basis

Our second instrument is based on the insights provided by several economic publications that explain the existence of DV using a game-theoretical approach. Tauchen et al. (1991) develop and estimate a non-cooperative household model of violence in which DV is seen as both a source of gratification and as a way to coerce the victim. Violence increases the husband's utility, directly, as well as indirectly by means of controlling his wife's behavior. Violence in equilibrium depends on the level of control over resources by each partner and on whether the reserve utility is binding, that is, whether there exists available options instead of cohabitation. In general, the higher a woman's income women's, greater prospect of employment and policies that increase available living options provide a higher bargaining power for women and are associated with a lower prevalence of DV (Farmer & Tiefenthaler 1996, 1997).

To account for women's bargaining power and their alternative available options, as a second instrument we use the difference between men and women's unemployment rates by region using data from the Office of National Statistics (ONS).[13] Anderberg et al. (2016) develop a dynamic game model in which females do not know beforehand whether their partner are of a violent type. Wives only infer their husband type after observing

[13]The rate of UK unemployment measured by the ONS-Labour Force Survey (LFS) uses the definition of unemployment specified by the International Labour Organisation. Unemployed people are those without a job who have been actively seeking work in the past 4 weeks and are available to start work in the next 2 weeks. It also includes those who are out of work but have found a job and are waiting to start it in the next 2 weeks. *https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment*

their behaviour. Their model predicts that higher risk of male (female) unemployment decreases (increases) the likelihood of domestic abuse. Their theoretical prediction is supported empirically in their analysis of how disparities in gender-specific unemployment rates in England and Wales affect the rate of intimate partner abuse in the period 2004 - 2011. They further examine the impact of the gender unemployment gap and find that a wider gender gap is also related to a higher likelihood of intimate partner abuse. This holds even after addressing the potential problem of endogeneity using an IV approach.

The choice of the unemployment gap as an instrument is based on Anderberg et al. (2016) and the impact this gap had on DV. Differences between male and female unemployment rates decrease during economic contractions and it is also determined by other regional factors such as gender composition of economic activity in the regions' main sectors. Therefore, we expect our instrument to be systematically correlated with the current DV variable but not with children's health. To corroborate this we analyse the correlation between the gender unemployment gap and the sub-domain of Health from each regional Index of Multiple Deprivation (IMD).[14] The size of the partial correlation is

[14]The IMD is a measure of deprivation computed for England, Wales, Scotland and Northern Ireland. Definitions to compute these indexes are not standardised across countries; however, we are interested in comparisons across regions between a sub-domain of Health from the IMD and the gender unemployment gap. In England the score is ranked from least to most deprived on seven domains: "Income", "Employment", "Health and Disability", "Education", "Crime", "Barriers to Housing and Services", and "Living Environment Deprivation". In Wales, the score is ranked across: "Income",

small, adding validity to our assumption of no systematic correlation between regional gender unemployment gap and health deprivation.

2.4.1 Identification Strategy

We estimate the relation between DV and child health using a simultaneous non-linear equations recursive system (Greene & Hensher 2010). The system of equations can be expressed as follows:

$$\begin{aligned} H^*_{it} &= DV_{it,1}\delta_1 + \Psi_{it,1}\beta_1 + c^h_i + e_{it} = j \quad \text{if } \alpha_{\mathrm{j}-1} < \mathrm{H}^*_{\mathrm{it},1} < \alpha_{\mathrm{j}}, \quad \mathrm{j} = 1,2,3,4 \\ DV^*_{it} &= Z_{it,1}\delta_2 + \Psi_{it,2}\beta_2 + c^{dv}_i + e^{dv}_{it} \quad \mathrm{DV_{it}} = 1(\mathrm{DV^*_{it}} > 0) \end{aligned} \tag{2.6}$$

"Employment", "Health", "Education", "Access to Services", "Housing", "Physical Environment". In Scotland, the score is ranked across the following domains: "Income", "Employment", "Health", "Education, Skills and training", "Housing", "Geographic Access and Telecommunications". In Northern Ireland, the index is weighted across the domains of: "Income", "Employment", "Health, deprivation and disability", "Education, Skills and Training ", "Crime and Disorder ", "Living Environment ". Each domain ranks the area of analysis from most to least deprived. At the time of the study, we do not have available geographical linked data for the fifth wave. We calculate the partial correlation between the unemployment difference and the sub-domain of Health across regions, we find a partial correlation of -0.0660 and -0.0585 for the third and fourth wave, respectively. In our specification, we control for two lags of health domains in previous wave and we bound our analysis into families where both parents cohabitate, since we are interested in the contemporaneous relation so we control for past IMD health in order to lessen the possible bias towards previous waves.

$$\begin{pmatrix} e_{it}^{dv} \\ e_{it} \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right] \tag{2.7}$$

Subscripts 1 and 2 refer to the first and second equation, respectively. H_{it}^{*} is the latent variable for the parental-reported child health as outlined in section 3. DV_{it}^{*} is the latent variable for the existence of DV in the household and, thus, the observed DV is equal to one whenever $DV_{it}^{*} > 0$. The vector $Z_{it,1}$ contains the set of instruments unrelated to child health. $\Psi_{it,1}$ and $\Psi_{it,2}$ are the set of controls for both functions. Terms c_i^h and ci_i^{dv} are child individual effects. The error terms e_{it} and e_{it}^{dv} are identically distributed, with a bivariate normal distribution, with a mean of zero, unit variance and correlation coefficient equal to ρ as in (7), i.e. $Corr(e_{it}^{dv}, e_{it}) = \rho$. If ρ is equal to zero, the bi-probabilistic model becomes a pair of unrelated probabilistic models. If ρ is found to be statistically different from zero, this implies that there is correlation between the unobservable characteristics in the two equations. As shown in the results reported in the next section, ρ is positive and statistically significant. Thus, the joint modelling approach is preferred as it allows to correct for the endogeneity of DV on the health production function.

We also incorporate the CM device to correct for the existence of unobserved heterogeneity by estimating the individual effects as:

$$\begin{aligned} c_i^h &= \psi^h + bar\Psi_{i,1}^h \eta + a_i^h \\ c_i^{dv} &= \psi^{dv} + \bar{\Psi}_{i,2}^{dv} \eta + a_i^{dv} \end{aligned} \tag{2.8}$$

where $\bar{\Psi}_{i1}^{h}$ and $\bar{\Psi}_{i2}^{dv}$ are the means of the exogenous variables for the sample period, ψ^{h} and ψ^{dv} are scalars and a_i^h and a_i^{dv} are projection errors with zero mean and variances σ_a^{h2} and σ_a^{dv2}, respectively. Finally, we also adjust both specifications applying the IPW estimator presented in section 3 in order to correct for attrition bias.

2.4.2 Results Instrumental Variable Approach

In this section we present the results from estimating the semi-ordered bivariate probit model as in (8). Table 2.5 shows the estimates obtained using a two stage approach and instrumenting DV. For parsimony, we only present the coefficients for the DV variable on the latent parental-reported child's health and the estimated coefficients of the instruments on the probability of suffering DV. Table A7 in the Appendix reports all estimated coefficients of the semi-ordered bivariate probit. The top panel in Table 2.5 refers to the estimates of the impact of DV on child's health and the bottom panel presents the estimates of the second-stage probit model of the mother being subjected to DV.

First of all, the results in the first panel showing the point estimates of DV on children's health are very robust across all specifications and, when compared to the results in the previous section, they show that controlling for endogeneity of DV increases the magnitude of the coefficient of DV on health. Second, in the DV equation we observe that both instruments used to predict the likelihood of suffering DV are significant and negative

across all specifications. This confirms that there is a negative association between DV and the type of affective relationship between the biological father and his own parents and with the relative weaker position of women in the regional job market.[15]

The Wald test indicates that we can reject the null hypothesis of ρ being equal to zero across all specifications. This implies that the error terms in both equations are not independently distributed and therefore a bivariate approach is appropriate. The estimated ρ is positive and indicative that there are unobserved characteristics that drive up both the child's health and the likelihood of experiencing DV. The fact that ρ is positive could be explained by the presence of unobserved variables that influence positively both these variables, i.e. compensatory nurturing behaviour of the battered mother towards the child or closer health and social services monitoring of the child given the household context.

[15]Table A14 in the Appendix investigates the performance of individual instruments across DV definitions- Contemporaneous and Ever

Table 2.5: Semi-ordered bivariate probit model

	Pooled Bioprobit (1)	CM Bioprobit (2)	IPW Pooled Bioprobit (3)	IPW CM Bioprobit (4)
	Ordered Probit Child Health			
Domestic violence	-0.9178^{***}	-0.8881^{***}	-1.0074^{***}	-0.9635^{***}
	(0.3355)	(0.3225)	(0.3384)	(0.3641)
Controls	X	X	X	X
	Probit Domestic Violence			
Relation index	-0.030^{**}	-0.029^{**}	-0.031^{**}	-0.0280^{+}
	(0.014)	(0.015)	(0.015)	(0.015)
Unemployment difference	-0.066^{**}	-0.065^{**}	-0.060^{**}	-0.055^{+}
	(0.028)	(0.029)	(0.030)	(0.030)
Controls	X	X	X	X
Cut11	-0.4599^{+}	-0.6748^{+}	-0.4150	-0.6187
	(0.2522)	(0.3575)	(0.2632)	(0.3790)
Cut12	0.3187	0.1079	0.3581	0.1656
	(0.2513)	(0.3563)	(0.2622)	(0.3776)
Cut13	1.2981^{***}	1.0919^{***}	1.3346^{***}	1.1435^{***}
	(0.2516)	(0.3560)	(0.2626)	(0.3774)
Cut21	1.4159^{***}	1.7591^{***}	1.4650^{***}	1.8772^{***}
	(0.5321)	(0.7506)	(0.5641)	(0.7820)
N	14569	14569	14025	14025
LL	$-1.50e+04$	$-1.49e+04$	$-1.62e+04$	$-1.57e+04$
ρ (Wald test)	0.3512^{**}	0.3375^{**}	0.3795^{**}	0.3697^{**}
	(0.1603)	(0.1541)	(0.1642)	(0.1764)

Notes: Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using the unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include inverse probability weights (IPW) weights. *Controls* include the set of variables for the child-, parental- and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Cut11, Cut12 and Cut13 are the estimated thresholds for the ordered probit and Cut21 is the threshold for the DV probit. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

2.4.3 Extension: the likelihood of *Excellent* child health and DV

Due to the low percentage of cases of DV in the child health categories of *Fair/Poor* and *Good*, we define a new dichotomous variable *Excellent health* that equals to 1 if the child's parental-reported health is rated as *Excellent* and 0 otherwise. As per the results presented in Tables 2.2 and 2.5, the only significant cut-off point across all specifications is the third one, i.e. the threshold that divides parent-reported child health levels *Very Good* and *Excellent*. This provides support for redefining the child reported health variable as a dichotomous variable.

Figure 2.2 shows the plot of the proportion of children whose health was rated as *Excellent* in both the DV and non-DV household samples. Note that across the three waves there is a consistent gap of around 10 percentage points among the share of families that rate the health of their children as excellent between both types of families.

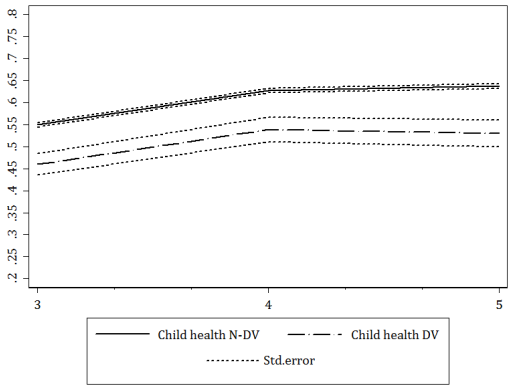

Figure 2.2: Proportion of children with *Excellent* parental-reported health

We model the relation between latent *Excellent* health, Eh^*, and latent DV, DV^*, as a recursive bivariate probit (Greene & Hensher 2010). Our identification strategy is based on the same set of instruments as in the semi-ordered bivariate ordered probit case:

$$\begin{aligned} EH^*_{it} &= DV_{it,1}\delta_1 + \Psi_{it,1}\beta_1 + c^h_i + e^h_{it}, \qquad \mathrm{EH_{it}} = 1(\mathrm{EH^*_{it}} > 0), \\ DV^*_{it} &= Z_{it,2}\delta_2 + \Psi_{it,2}\beta_2 + c^{dv}_i + e^{dv}_{it}, \qquad \mathrm{DV_{it}} = 1(\mathrm{DV^*_{it}} > 0) \end{aligned} \tag{2.9}$$

where EH^*_{it} is the latent dichotomous variable for the parent-reported child health, being 1 if *Excellent* and 0 otherwise and DV^*_{it} is the latent variable for DV. Terms $\Psi_{it,1}$ and $\Psi_{it,2}$ are the set of controls for both functions and c^h_i and c^{dv}_i are child unobserved individual factors. Error terms e^h_{it} and e^{dv}_{it} are identically distributed, with a bivariate normal distribution, with a mean of zero and unit variance and correlation coefficient ρ. The value of ρ works as in the semi-ordered probit section.

Table 2.6 provides the results for the bivariate recursive probit. The top panel provides the DV estimates for the first stage equation, i.e. that the child health is rated *Excellent*. The coefficient for DV is negative and statistically significant as in all previous estimation results. The second panel shows the estimates of the likelihood of the mother experiencing DV. The set of instruments used to estimate this equation are significant and negative, consistent with results in Table 2.5. Table 2.6 also shows the results for the Wald test. Again, we reject the null hypothesis for ρ being equal to zero in all specifications. Table A8 in the Appendix shows all estimated coefficients for the first equation on the ordered probit for parental-reported child's

health and the second equation on the likelihood of DV.

Table 2.6: Bivariate Probit Models

	Pooled Biprobit (1)	CM Biprobit (2)	IPW Pooled Biprobit (3)	IPW CM Biprobit (4)
		Probit Excellent health		
Domestic Violence	-1.5832^{***}	-1.6425^{***}	-1.7047^{***}	-1.7654^{***}
	(0.2789)	(0.2582)	(0.2791)	(0.2778)
Controls	X	X	X	X
		Probit Domestic violence		
Relation index	-0.0322^{***}	-0.0314^{***}	-0.0323^{***}	-0.0297^{***}
	(0.0138)	(0.0138)	(0.0147)	(0.0145)
Unemployment difference	-0.0727^{***}	-0.0707^{***}	-0.0681^{***}	-0.0599^{**}
	(0.0273)	(0.0279)	(0.0286)	(0.0282)
Controls	X	X	X	X
N	14569	14569	14025	14025
ll	$-1.12e+04$	$-1.12e+04$	$-1.22e+04$	$-1.17e+04$
ρ (Wald test)	0.7496^{***}	0.7987^{***}	0.8302^{***}	0.9024^{***}
	(0.2010)	(0.1968)	(0.2232)	(0.2426)

Notes: Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using the unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include inverse probability weights (IPW) weights. *Controls* include the set of variables for the child-, parental- and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Significance levels $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 2.7 presents the summary of APEs of DV on the child's health production function associated to the bivariate recursive probit models presented in Table 2.6. All partial effects are significant at a level of 1% and negative. The APEs are only reported for the probability of reporting *Excellent* health as specified in the first equation of the bivariate model. All other APEs of the set of controls included in the specifications can be found in Table A9 in the Appendix.

Table 2.7: Average Partial Effects: Probability *Excellent* Health

	Pooled Biprobit (1)	CM Biprobit (2)	IPW Pooled Biprobit (3)	IPW CM Biprobit (4)
Domestic Violence	-0.5573^{***}	-0.5751^{***}	-0.5965^{***}	-0.6149^{***}
	(0.0951)	(0.0877)	(0.0945)	(0.0937)

Notes: Standard errors in parentheses. Standard errors calculated by Delta method. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

These estimates indicate that children growing up in families in which the mother is battered by the father are between 55% (pooled bivariate recursive model, column (1)) and 61% (IPW bivariate recursive model, column (4)) less likely to have their health rated as *Excellent*. Thus, correcting for the endogeneity of DV has only increased the notably of the magnitude of its impact on the parental reported child's health.

2.5 Concluding Remarks

This paper looks at the relationship between DV and child health, using data from the Millennium Cohort Study, a large longitudinal and exhaustive sample of children representative for the UK. In this study, we bound the definition of DV to cases where a biological mother is battered by the biological father. We overcome several potential sources of bias in our identification strategy. We break the simultaneity between the two variables of interest (parental child-reported health and self-reported maternal DV) and correct for sample attrition and endogeneity given the categorical nature of the variables.

Exploiting a number of different specifications, we provide robust evidence of the existence of a *negative and significant effect* of DV on the parental-reported child health. First, this result is suggested by our basecase ordered probit model. As this naïve strategy does not account for factors that affect simultaneously DV and child health, we address the endogeneity bias and estimate a bivariate recursive semi-ordered probit. To identify causality, we make use of of two instruments in the probit equation of DV. The first instrument is a proxy for the type of affective relationship between the father and his own parents. The second instrument is the regional difference in unemployment between men and women. The results of the instrumental variable approach corroborate the notably negative and the highly significant effect of DV on the child's health.

Further, to examine the robustness and more precise magnitude of the DV effect on reported child's health, we make use of

a bivariate recursive probit model. To do so, we redefine child's health as a dichotomous variable, i,e, being rated as *Excellent* versus not. We base this simplifying approach on results of the ordered probit indicating that only the cut-off between *Excellent* and any other worse health category is sufficient to discriminate child's health. According to the estimates, children living in a household in which there is DV, are between 55% and 61% less likely to have their health rated as *Excellent*.

The main contribution of this paper is to examine and quantify the negative spillover effect of DV on a child's health production function. Recent literature highlights the relationship between child's health and income and/or parental education yet, little was known about the full extent of environmental stressors such as DV on a child's health. Our results are in line with the scarce existing literature connecting children's health outcomes and DV. DV has been established to have an impact at such on early stage as birth, with newborns of battered mothers having a significantly lower weight (Aizer 2011). Our results emphasize that DV has a negative impact on children's health that goes beyond the compelling negative impact of DV on newborn birth weight and persist later in childhood. Growing up in a family in which the mother is battered has overwhelming effects on a child's health and these results are consistent across all specifications even when we control for potential endogeneity of DV and child's health.

2.6 Appendix

Table A1: Child specific variables definition

Variable	Definition
Child health	Parental-reported child health:1 if fair/poor, 2 if good, 3 if very good, 4 if excellent
Female	1 if female, 0 otherwise
Obese	1 if obese, 0 otherwise
Overweight	1 if overweight (and not obese), 0 otherwise
Low birthweight	1 if the child birth weight was lower or equal 2,5 Kg., 0 otherwise
White	1 if child race was white, 0 otherwise
Bang/Ind/Pak	1 if child race was Bangladesi,Indian or Pakistani, 0 otherwise
Black	1 if child race was black, 0 otherwise
Other	1 if child race was stated as other, 0 otherwise
Age	Age in years at 31st December of the current sampling period

Table A2: Parental (mother and father) specific variables definition

Variable	Definition
Long term health conditions	1 if the parent suffers chronic condition, 0 otherwise
Depression	1 if the parent has ever been diagnosed depression, 0 otherwise
Smoking	1 if the parent smoke tobacco, 0 otherwise
Teen mother	1 if mother was a teenager at the time of the child birth
Ever	1 if mother has ever suffered DV
Overweight	1 if the parent has a BMI between 25-29.9 kg/m^2 , 0 otherwise
Obese	1 if the parent has a BMI higher or equal than 30.0 kg/m^2 , 0 otherwise
GCSE grades (D-G) or equivalent	1 if the parent has the GCSE grade (D-G), 0 otherwise
O level or equivalent	1 if the parent has the O level, 0 otherwise
A level or equivalent	1 if the parent has the A level, 0 otherwise
First degree or equivalent	1 if the parent has the First degree, 0 otherwise
Higher degree or equivalent	1 if the parent has a Higher degree, 0 otherwise
Age	Age in years at 31st December of the current sampling period
In work	1 if the parent is working at the time of the questionnaire, 0 otherwise

Table A3: Mother summary statistics

	Age 5			Age 7			Age 11		
	Domestic violence			Domestic violence			Domestic violence		
	No	Yes	*Statistically Significant*	No	Yes	*Statistically Significant*	No	Yes	*Statistically Significant*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Health-related variables									
Long term health problems	0.22	0.31	***	0.23	0.32	***	0.17	0.26	***
Depression	0.27	0.50	***	0.30	0.49	***	0.32	0.55	***
Smoking	0.16	0.24	***	0.14	0.32	***	0.12	0.22	***
Education									
GCSE grades (D-G) or equivalent	0.06	0.09	**	0.06	0.07		0.05	0.09	**
O level or equivalent	0.28	0.25		0.27	0.25		0.24	0.29	
A level or equivalent	0.17	0.18		0.17	0.24	**	0.18	0.19	
First degree or equivalent	0.42	0.39		0.43	0.35	**	0.45	0.32	***
Higher degree or equivalent	0.07	0.08		0.07	0.09		0.09	0.11	
Other socioeconomic variables									
Age	35.50	35.43		37.57	37.04		41.79	41.60	
Teen mother	0.41%	0.47%		0.49%	0.00%		0.35%	0.00%	
In work	0.72	0.72		0.77	0.77		0.82	0.72	***
Households characteristics									
Income	10.32	10.26		10.38	10.24	***	10.39	10.24	***
Council House	0.07	0.12	***	0.06	0.15	***	0.05	0.10	**
N	5840	212		5142	182		3979	134	

Notes: The entries are means of family data who do not have missing values for gender, race, birth weight, weight, month born,mother was a teenager when pregnant,parental long standing illness, parental smoking habits, parental education (GCSE grades (D-G) to Higer Degree or Equivalent), parental age, parental working status, housing income and whether the family lives in a council house or in a housing association.Our sample only includes families where parents are cohabiting. N stands for the number of observations. Columns (3), (6) and (9) show the hypotheses testing for the difference in means of each variable between the DV and the non-DV households sub-samples. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table A4: Father summary statistics

	Age 5			Age 7			Age 11		
	Domestic violence			Domestic violence			Domestic violence		
	No	Yes	*Statistically Significant*	No	Yes	*Statistically Significant*	No	Yes	*Statistically Significant*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Other health-related variables									
Long term health problems	0.23	0.25		0.23	0.30	**	0.16	0.23	**
Depression	0.11	0.26	***	0.14	0.27	***	0.17	0.31	***
Smoking	0.21	0.35	***	0.19	0.36	***	0.15	0.23	**
Education									
GCSE grades (D-G) or equivalent	0.06	0.07		0.06	0.06		0.06	0.08	
O level or equivalent	0.29	0.32		0.27	0.31		0.27	0.32	
A level or equivalent	0.18	0.19		0.18	0.15		0.17	0.15	
First degree or equivalent	0.38	0.34		0.38	0.38		0.39	0.37	
Higher degree or equivalent	0.09	0.08		0.10	0.10		0.12	0.08	
Other socioeconomic variables									
Age	37.82	37.70		39.77	40.12		43.99	44.58	
In work	0.96	0.94		0.96	0.93	+	0.96	0.90	***
Households characteristics									
Income	10.32	10.26		10.38	10.24	***	10.39	10.24	***
Council House	0.07	0.12	***	0.06	0.15	***	0.05	0.10	**
N	5840	212		5142	182		3979	134	

Note: Refer to notes in Table A10. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table A5: Univariate model results

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Domestic violence	-0.1514^{***}	-0.1526^{***}	-0.1682^{***}	-0.1464^{**}
	(0.0574)	(0.0577)	(0.061)	(0.0603)
Child's Characteristics				
Age	0.02660^{***}	0.007269	0.02700^{***}	-0.002413
	(0.0047)	(0.0422)	(0.0048)	(0.0442)
Low birth weight	-0.1727^{***}	-0.1701^{***}	-0.1742^{***}	-0.1621^{***}
	(0.0515)	(0.0515)	(0.0535)	(0.0534)
Female	0.1070^{***}	0.1069^{***}	0.1081^{***}	0.1108^{***}

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Table A5: Univariate Model Results – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.0243)	(0.0244)	(0.0252)	(0.0255)
Bang/Ind/Pak	−0.6076***	−0.5929***	−0.5820***	−0.5789***
	(0.059)	(0.0602)	(0.0636)	(0.0652)
Black	−0.3287***	−0.3166***	−0.2454**	−0.2331**
	(0.1071)	(0.1078)	(0.1084)	(0.1079)
Other	−0.2051***	−0.1943***	−0.1880***	−0.1671**
	(0.0669)	(0.0672)	(0.071)	(0.0725)
Obese	−0.3284***	−0.1306**	−0.3190***	−0.1745**
	(0.0461)	(0.0631)	(0.0484)	(0.0693)
Overweight	−0.06360**	−0.09729**	−0.05880+	−0.1006**
	(0.0301)	(0.0397)	(0.0313)	(0.0421)
Mother's Characteristics				
Long-term health conditions	−0.2401***	−0.2402***	−0.2478***	−0.2408***
	(0.0271)	(0.0273)	(0.0281)	(0.0285)
Depression	−0.1574***	−0.1559***	−0.1525***	−0.1559***
	(0.0265)	(0.0267)	(0.0275)	(0.0277)
Smoking	−0.05457	−0.0194	−0.04906	−0.05564
	(0.0348)	(0.0562)	(0.0366)	(0.059)
O level or equivalent	−0.02752	−0.03601	−0.04849	−0.04759
	(0.0511)	(0.0514)	(0.0539)	(0.0545)
A level or equivalent	0.07801	0.0645	0.05747	0.05805
	(0.0549)	(0.0552)	(0.0574)	(0.0581)
First degree or equivalent	0.1052**	0.08704+	0.08522	0.07659
	(0.0517)	(0.0523)	(0.0544)	(0.0552)
Higher degree or equivalent	0.02365	0.006052	0.008497	-0.00862
	(0.0662)	(0.0669)	(0.0694)	(0.0704)
Age	0.003047	0.02287	0.001926	0.01157

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Table A5: Univariate Model Results – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.0033)	(0.0283)	(0.0034)	(0.0293)
Teen mother	0.4241**	0.4055**	0.4395**	0.4065+
	(0.185)	(0.1856)	(0.212)	(0.2123)
In work	0.1023***	0.02589	0.1080***	0.03845
	(0.0266)	(0.0353)	(0.0279)	(0.0367)
Father's Characteristics				
Long-term health conditions	−0.1314***	−0.1345***	−0.1349***	−0.1436***
	(0.0272)	(0.0274)	(0.0282)	(0.0288)
Depression	−0.06434+	−0.06487+	−0.04776	−0.04916
	(0.0343)	(0.0347)	(0.0356)	(0.0363)
Smoking	−0.01643	−0.002883	−0.02372	−0.008549
	(0.0318)	(0.0464)	(0.0333)	(0.0496)
O level or equivalent	0.1041**	0.09987+	0.1075+	0.1108**
	(0.0523)	(0.0527)	(0.0552)	(0.0555)
A level or equivalent	0.1125**	0.1042+	0.1139**	0.1130+
	(0.0551)	(0.0554)	(0.0577)	(0.0582)
First degree or equivalent	0.1214**	0.1066**	0.1292**	0.1249**
	(0.0532)	(0.0538)	(0.0558)	(0.0562)
Higher degree or equivalent	0.2454***	0.2224***	0.2414***	0.2290***
	(0.065)	(0.0658)	(0.068)	(0.0686)
Age	0.002232	0.03799**	0.001805	0.03211+
	(0.0029)	(0.0166)	(0.003)	(0.0184)
In work	−0.07508	−0.08638	−0.06549	−0.08442
	(0.0563)	(0.0689)	(0.0589)	(0.0724)
Household Characteristics				
Linc couple	0.1316***	0.007713	0.1428***	0.02844
	(0.023)	(0.0301)	(0.024)	(0.0322)

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Table A5: Univariate Model Results – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Council house	−0.04965	0.09754	−0.05599	0.06864
	(0.0495)	(0.139)	(0.053)	(0.1403)
Cut1	−0.3366	−0.4564	−0.2828	−0.4381
	(0.2438)	(0.3459)	(0.2543)	(0.3654)
Cut2	0.4468^{+}	0.3306	0.4969^{**}	0.3483
	(0.243)	(0.3452)	(0.2534)	(0.3644)
Cut3	1.4297^{***}	1.3177^{***}	1.4815^{***}	1.3337^{***}
	(0.2428)	(0.345)	(0.2534)	(0.3641)
N	15,713	15,713	14,991	14,991
pseudo R2	0.034	0.0372	0.0337	0.0372
Log likelihood	$-1.41E+04$	$-1.40E+04$	$-1.47E+04$	$-1.42E+04$

Notes: Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using the unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of any of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include inverse probability weights (IPW) to adjust for attrition. *Controls* include the set of variables for the child-, parental- and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A6: APEs Probability Excellent Health: Univariate models

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Domestic violence	-0.057^{***}	-0.057^{***}	-0.063^{***}	-0.055^{**}
	(0.022)	(0.022)	(0.023)	(0.023)
Child's Characteristics				
Age	0.010^{***}	0.003	0.010^{***}	-0.001
	(0.002)	(0.016)	(0.002)	(0.017)
Low birth weight	-0.065^{***}	-0.064^{***}	-0.065^{***}	-0.061^{***}
	(0.019)	(0.019)	(0.020)	(0.020)
Female	0.040^{***}	0.040^{***}	0.040^{***}	0.041^{***}
	(0.009)	(0.009)	(0.009)	(0.009)
Bang/Ind/Pak	-0.228^{***}	-0.222^{***}	-0.218^{***}	-0.217^{***}
	(0.022)	(0.023)	(0.029)	(0.024)
Black	-0.123^{***}	-0.119^{***}	-0.092^{**}	-0.087^{**}
	(0.040)	(0.040)	(0.041)	(0.040)
Other	-0.077^{***}	-0.073^{***}	-0.070^{***}	-0.063^{**}
	(0.025)	(0.025)	(0.027)	(0.027)
Obese	-0.123^{***}	-0.049^{**}	-0.120^{***}	-0.065^{**}
	(0.017)	(0.024)	(0.018)	(0.026)
Overweight	-0.024^{**}	-0.036^{**}	-0.022^{+}	-0.038^{**}
	(0.011)	(0.0145)	(0.018)	(0.017)
Mother's Characteristics				
Long-term health conditions	-0.090^{***}	-0.090^{***}	-0.092^{***}	-0.090^{***}
	(0.010)	(0.010)	(0.011)	(0.011)
Depression	-0.059^{***}	-0.058^{***}	-0.057^{***}	-0.058^{***}
	(0.010)	(0.010)	(0.010)	(0.010)

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Table A6: APEs Probability Excellent Health: Univariate models – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Smoking	-0.020	-0.007	-0.018	-0.021
	(0.013)	(0.021)	(0.014)	(0.022)
O level or equivalent	-0.010	-0.014	-0.018	-0.018
	(0.019)	(0.019)	(0.020)	(0.020)
A level or equivalent	0.029	0.024	0.022	0.022
	(0.021)	(0.021)	(0.021)	(0.022)
First degree or equivalent	0.039^{**}	0.033^{+}	0.032	0.029
	(0.019)	(0.020)	(0.020)	(0.021)
Higher degree or equivalent	0.009	0.002	0.003	-0.003
	(0.025)	(0.025)	(0.026)	(0.026)
Age	0.001	0.009	0.001	0.004
	(0.001)	(0.011)	(0.001)	(0.011)
Teen mother	0.159^{**}	0.152^{**}	0.164^{**}	0.152^{+}
	(0.069)	(0.069)	(0.079)	(0.079)
In work	0.038^{***}	0.010	0.040^{***}	0.014
	(0.010)	(0.013)	(0.010)	(0.014)
Father's Characteristics				
Long-term health conditions	-0.049^{***}	-0.050^{***}	-0.050^{***}	-0.054^{***}
	(0.010)	(0.010)	(0.011)	(0.011)
Depression	-0.024^{+}	-0.024^{+}	-0.018	-0.018
	(0.013)	(0.013)	(0.013)	(0.014)
Smoking	-0.006	-0.001	-0.009	-0.003
	(0.012)	(0.017)	(0.012)	(0.019)
O level or equivalent	0.039^{**}	0.037^{+}	0.040^{+}	0.041^{**}
	(0.020)	(0.020)	(0.021)	(0.021)
A level or equivalent	0.042^{**}	0.039^{+}	0.043^{**}	0.042^{+}
	(0.021)	(0.021)	(0.022)	(0.028)

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Table A6: APEs Probability Excellent Health: Univariate models – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
First degree or equivalent	0.046**	0.040**	0.048**	0.047**
	(0.020)	(0.020)	(0.021)	(0.021)
Higher degree or equivalent	0.092***	0.083***	0.090***	0.086***
	(0.024)	(0.025)	(0.025)	(0.026)
Age	0.001	0.014**	0.001	0.012^{+}
	(0.001)	(0.006)	(0.001)	(0.007)
In work	-0.028	-0.032	-0.025	-0.032
	(0.0211)	(0.026)	(0.022)	(0.027)
Household characteristics				
Linc couple	0.049***	0.003	0.053	0.011
	(0.009)	(0.011)	(0.009)	(0.012)
Council house	-0.019	0.037	-0.021	0.027
	(0.019)	(0.052)	(0.020)	(0.056)

Notes: Standard errors in parentheses. Standard errors calculated by Delta method. Coefficients of the averaged exogenous variables in the CM device are estimated but not reported here. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table A7: Semi-ordered probit

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	Ordered Probit Excellent Health			
Domestic violence	-0.9178^{***}	-0.8881^{***}	-1.0074^{***}	-0.9635^{***}
	(0.3355)	(0.3225)	(0.3384)	(0.3641)
Child's Characteristics				
Age	0.02591^{***}	-0.00357	0.02585^{***}	0.0001057
	(0.0049)	(0.0443)	(0.005)	(0.0466)
Low birth weight	-0.1420^{***}	-0.1415^{***}	-0.1409^{**}	-0.1298^{**}
	(0.0529)	(0.053)	(0.0553)	(0.0559)
Female	0.1018^{***}	0.1014^{***}	0.1008^{***}	0.1034^{***}
	(0.0253)	(0.0254)	(0.0262)	(0.0266)
Bang/Ind/Pak	-0.5617^{***}	-0.5473^{***}	-0.5475^{***}	-0.5376^{***}
	(0.0622)	(0.0634)	(0.0668)	(0.0687)
Black	-0.3097^{***}	-0.2943^{**}	-0.2225^{+}	-0.2267^{+}
	(0.1162)	(0.1172)	(0.1251)	(0.1275)
Other	-0.1808^{**}	-0.1716^{**}	-0.1676^{**}	-0.1362^{+}
	(0.0725)	(0.0728)	(0.0759)	(0.0767)
Obese	-0.3043^{***}	-0.1135^{+}	-0.2897^{***}	-0.1548^{**}
	(0.0483)	(0.066)	(0.051)	(0.0726)
Overweight	-0.05730^{+}	-0.1012^{**}	-0.04332	-0.09284^{**}
	(0.0313)	(0.0412)	(0.0325)	(0.0442)
Mother's Characteristics				
Long-term health conditions	-0.2270^{***}	-0.2294^{***}	-0.2331^{***}	-0.2345^{***}
	(0.0292)	(0.0293)	(0.0303)	(0.0308)
Depression	-0.1366^{***}	-0.1362^{***}	-0.1253^{***}	-0.1300^{***}
	(0.0284)	(0.0285)	(0.0295)	(0.0299)

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Table A7: Semi-ordered probit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Smoking	−0.04828	−0.04433	−0.04014	−0.09262
	(0.0367)	(0.0584)	(0.0386)	(0.0626)
O level or equivalent	−0.06073	−0.06652	−0.06785	−0.04642
	(0.0536)	(0.0539)	(0.056)	(0.057)
A level or equivalent	0.05592	0.04668	0.05471	0.0797
	(0.0571)	(0.0574)	(0.0594)	(0.0604)
First degree or equivalent	0.07395	0.06253	0.07286	0.09065
	(0.054)	(0.0546)	(0.0563)	(0.0576)
Higher degree or equivalent	−0.005385	−0.01553	−0.004737	0.001508
	(0.0695)	(0.0702)	(0.0727)	(0.0738)
Age	0.003309	0.01815	0.002517	−0.003112
	(0.0035)	(0.0296)	(0.0036)	(−0.031)
Teen mother	0.5654**	0.5537**	0.6350**	0.5790+
	(0.2107)	(0.212)	(0.2476)	(0.2405)
In work	0.09964***	0.02098	0.1070***	0.03771
	(0.0278)	(0.0367)	(0.0291)	(0.0385)
Father's Characteristics				
Long-term health conditions	−0.1130***	−0.1168***	−0.1151***	−0.1183***
	(0.0285)	(0.0287)	(0.0294)	(0.0301)
Depression	−0.03695	−0.03976	−0.01638	−0.01964
	(0.0367)	(0.0369)	(0.0381)	(0.0387)
Smoking	0.004109	0.02184	−0.0003034	0.01032
	(0.0333)	(0.0485)	(0.0349)	(0.0526)
O level or equivalent	0.09998+	0.09788+	0.1043+	0.1045+
	(0.0543)	(0.0546)	(0.0571)	(0.0566)
A level or equivalent	0.1153 ∗ ∗	0.1090+	0.1167+	0.1100+
	(0.057)	(0.0573)	(0.0598)	(0.0593)

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Table A7: Semi-ordered probit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
First degree or equivalent	0.1387**	0.1289**	0.1479**	0.1421**
	(0.0551)	(0.0557)	(0.0575)	(0.0572)
Higher degree or equivalent	0.2522***	0.2361***	0.2476***	0.2293***
	(0.068)	(0.0688)	(0.071)	(0.071)
Age	0.00249	0.04999***	0.002073	0.04496**
	(0.0031)	(0.0177)	(0.0032)	(0.0197)
In work	−0.08978	−0.07785	−0.08363	−0.07758
	(0.0588)	(0.0723)	(0.0631)	(0.076)
Household Characteristics				
Linc couple	0.1211***	0.02261	0.1282***	0.03287
	(0.0238)	(0.0315)	(0.0247)	(0.0339)
Council house	−0.04639	0.0412	−0.02404	0.03343
	(0.0539)	(0.1471)	(0.0578)	(0.1523)
	Probit Domestic Violence			
Relation index	−0.03031**	−0.02928**	−0.03054**	−0.02799+
	(0.0144)	(0.0146)	(0.0154)	(0.0154)
Unemployment difference	−0.06563**	−0.06523**	−0.05969**	−0.05355+
	(0.0281)	(0.0289)	(0.0295)	(0.0293)
Child's Characteristics				
Age	−0.01703+	−0.2189***	−0.02062+	−0.2215**
	(0.0102)	(0.0835)	(0.0108)	(0.0902)
Low birth weight	0.03785	0.0117	0.05522	0.02823
	(0.1037)	(0.106)	(0.1123)	(0.1161)
Female	−0.05842	−0.05629	−0.05233	−0.05408
	(0.0527)	(0.0534)	(0.0565)	(0.0565)
Bang/Ind/Pak	0.1302	0.1525	0.03112	0.05222

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Table A7: Semi-ordered probit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.1376)	(0.1404)	(0.1368)	(0.1368)
Black	−0.154	−0.1678	−0.1149	−0.1765
	(0.2437)	(0.2394)	(0.2454)	(0.2423)
Other	0.173	0.177	0.1804	0.1737
	(0.1262)	(0.1279)	(0.1327)	(0.1327)
Obese	0.1595+	0.173	0.2101**	0.1776
	(0.0961)	(0.1147)	(0.1052)	(0.1278)
Overweight	0.01236	0.04455	0.02109	0.0676
	(0.0669)	(0.0789)	(0.0725)	(0.0849)
Mother's Characteristics				
Long-term health conditions	0.1491***	0.1425***	0.1598***	0.1371**
	(0.0528)	(0.0529)	(0.0574)	(0.0571)
Depression	0.2970***	0.2912***	0.3054***	0.3223***
	(0.0548)	(0.0553)	(0.0589)	(0.0586)
Smoking	0.2001***	−0.0843	0.2220***	−0.09717
	(0.067)	(0.1065)	(0.0725)	(0.1182)
O level or equivalent	−0.2521**	−0.2497**	−0.2531**	−0.2435+
	(0.1169)	(0.1191)	(0.1252)	(0.1271)
A level or equivalent	−0.0828	−0.07984	−0.08877	−0.04252
	(0.1231)	(0.1258)	(0.1319)	(0.1343)
First degree or equivalent	−0.1924	−0.1808	−0.1859	−0.1739
	(0.1212)	(0.1241)	(0.1298)	(0.1337)
Higher degree or equivalent	−0.01516	−0.0045	0.004374	−0.00187
	(0.1412)	(0.144)	(0.1511)	(0.1534)
Age	0.00137	−0.01184	−0.0001963	−0.01347
	(0.0073)	(0.0522)	(0.008)	(0.057)
Teen mother	−0.3417	−0.4287	−0.4199	−0.5187

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Table A7: Semi-ordered probit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.4622)	(0.4612)	(0.4589)	(0.4748)
In work	0.03567	−0.07826	0.05264	−0.05888
	(0.0577)	(0.0762)	(0.0627)	(0.0827)
Father's Characteristics				
Long-term health conditions	0.01213	0.00626	0.001162	−0.004783
	(0.057)	(0.0582)	(0.0613)	(0.0619)
Depression	0.2746***	0.2568***	0.3035***	0.2760***
	(0.0653)	(0.0667)	(0.0705)	(0.0717)
Smoking	0.1724***	−0.03045	0.1618**	−0.04939
	(0.0622)	(0.1003)	(0.0662)	(0.1074)
O level or equivalent	0.07559	0.0698	0.1014	0.03766
	(0.0996)	(0.1)	(0.1072)	(0.1059)
A level or equivalent	−0.03449	−0.03059	−0.007374	−0.03322
	(0.1091)	(0.11)	(0.1184)	(0.117)
First degree or equivalent	0.05429	0.06408	0.0819	0.06951
	(0.1022)	(0.1027)	(0.1092)	(0.1081)
Higher degree or equivalent	−0.03815	−0.01777	0.003646	−0.02156
	(0.1313)	(0.1323)	(0.1388)	(0.1376)
Age	0.007907	0.1051***	0.01158	0.09495**
	(0.0065)	(0.0366)	(0.0073)	(0.0392)
In work	−0.03841	0.1062	−0.04425	0.08278
	(0.1092)	(0.135)	(0.1194)	(0.139)
Household Characteristics				
Linc couple	−0.05941	−0.04453	−0.06588	−0.06833
	(0.0478)	(0.0585)	(0.052)	(0.0646)
Council house	0.09199	−0.2202	0.1403	−0.1691
	(0.0994)	(0.1626)	(0.1071)	(0.2008)

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Table A7: Semi-ordered probit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Cut11	-0.4599^{+}	-0.6748^{+}	-0.4150	-0.6187
	(0.2522)	(0.3575)	(0.2632)	(0.379)
Cut12	0.3187	0.1079	0.3581	0.1656
	(0.2513)	(0.3563)	(0.2622)	(0.3776)
Cut13	1.2981^{***}	1.0919^{***}	1.3346^{***}	1.1435^{***}
	(0.2516)	(0.356)	(0.2626)	(0.3774)
Cut21	1.4159^{***}	1.7591^{***}	1.4650^{***}	1.8772^{***}
	(0.5321)	(0.7506)	(0.5641)	(0.7820)
N	14569	14569	14025	14025
ll	$-1.50E+04$	$-1.49E+04$	$-1.62E+04$	$-1.57E+04$

Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using the unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of any of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include weights to adjust for attrition. *Controls* include the set of variables for the child-, parental- and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental self-assessed health, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Significance levels $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A8: Biprobit

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
		Probit Excellent Health		
Domestic violence	-1.5832^{***}	-1.6425^{***}	-1.7047^{***}	-1.7654^{***}
	(0.2789)	(0.2582)	(0.2791)	(0.2778)
Child's Characteristics				
Age	$0.02695 * **$	-0.01356	$0.02670 * **$	-0.004258
	(0.0052)	(0.0469)	(0.0053)	(0.0492)
Low birth weight	$-0.1163 * *$	$-0.1174 * *$	$-0.1163 * *$	$-0.1023+$
	(0.0556)	(0.0556)	(0.0582)	(0.0583)
Female	$0.1012 * **$	$0.1013 * **$	$0.09845 * **$	$0.1023 * **$
	(0.0263)	(0.0264)	(0.0272)	(0.0275)
Bang/Ind/Pak	$-0.5991 * **$	$-0.5792 * **$	$-0.5928 * **$	$-0.5726 * **$
	(0.0748)	(0.0756)	(0.0789)	(0.0806)
Black	$-0.3159 * *$	$-0.3000 * *$	$-0.2363+$	$-0.2581+$
	(0.1286)	(0.1302)	(0.1419)	(0.1444)
Other	$-0.1481 * *$	$-0.1375+$	$-0.1288+$	-0.09172
	(0.0737)	(0.0737)	(0.0766)	(0.0754)
Obese	$-0.2826 * **$	-0.07839	$-0.2652 * **$	-0.119
	(0.0527)	(0.0731)	(0.0559)	(0.0793)
Overweight	$-0.06469 * *$	$-0.09911 * *$	-0.05128	$-0.09013 * *$
	(0.0327)	(0.0434)	(0.0339)	(0.0458)
Mother's Characteristics				
Long-term health conditions	-0.1863^{***}	-0.1870^{***}	-0.1902^{***}	-0.1901^{***}
	(0.0303)	(0.0304)	(0.0314)	(0.0320)
Depression	-0.1232^{***}	-0.1227^{***}	-0.1099^{***}	-0.1168^{***}
	(0.0293)	(0.0293)	(0.0303)	(0.0308)

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Table A8: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
Smoking	−0.0153	−0.0357	−0.01055	−0.08271
	(0.0378)	(0.0621)	(0.0396)	(0.0666)
O level or equivalent	−0.08120	−0.08687	−0.09161	−0.06462
	(0.0567)	(0.0572)	(0.0589)	(0.0607)
A level or equivalent	0.05511	0.04676	0.05277	0.08396
	(0.0601)	(0.0606)	(0.0622)	(0.0638)
First degree or equivalent	0.06541	0.05496	0.06724	0.09046
	(0.0571)	(0.0577)	(0.0592)	(0.0614)
Higher degree or equivalent	−0.01116	−0.01982	−0.006216	0.003441
	(0.0730)	(0.0736)	(0.0762)	(0.0776)
Age	0.002505	0.01463	0.001746	−0.002817
	(0.0037)	(0.0318)	(0.0038)	(0.0329)
Teen mother	0.5406**	0.5214**	0.6057**	0.5426**
	(0.2165)	(0.2157)	(0.2615)	(0.2523)
In work	0.07344**	0.01857	0.07683 * *	0.03756
	(0.0292)	(0.0397)	(0.0305)	(0.0421)
Father's characteristics				
Long-term health conditions	−0.1245***	−0.1273***	−0.1236***	−0.1288***
	(0.0297)	(0.0299)	(0.0308)	(0.0316)
Depression	−0.03578	−0.03802	−0.01462	−0.0143
	(0.0384)	(0.0386)	(0.0399)	(0.0404)
Smoking	0.004428	0.01859	0.006878	−0.007868
	(0.0345)	(0.0534)	(0.0360)	(0.0585)
O level or equivalent	0.08124	0.07928	0.08027	0.08486
	(0.0549)	(0.0552)	(0.0569)	(0.0573)
A level or equivalent	0.06292	0.05513	0.05905	0.05732
	(0.0581)	(0.0584)	(0.0602)	(0.0607)

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Table A8: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
First degree or equivalent	0.1014^{+}	0.09112	0.1016^{+}	0.1045^{+}
	(0.0556)	(0.0562)	(0.0574)	(0.0580)
Higher degree or equivalent	0.2213^{***}	0.2040^{***}	0.2108^{***}	0.1941^{***}
	(0.0684)	(0.0691)	(0.0708)	(0.0718)
Age	0.0022	0.06381^{***}	0.001914	0.05273^{**}
	(0.0033)	(0.0191)	(0.0034)	(0.0213)
In work	−0.09214	−0.08025	−0.09299	−0.0966
	(0.0615)	(0.0820)	(0.0656)	(0.0852)
Household characteristics				
Linc couple	0.1135^{***}	0.01207	0.1236^{***}	0.01724
	(0.0246)	(0.0344)	(0.0255)	(0.0368)
Council house	−0.05608	0.06208	−0.0254	0.05738
	(0.0578)	(0.1681)	(0.0615)	(0.1750)
	Probit Domestic violence			
Relation index	$-0.03222**$	-0.03142^{**}	-0.03233^{**}	-0.02967^{**}
	(0.0138)	(0.0138)	(0.0147)	(0.0145)
Unemployment difference	-0.07272^{**}	-0.07071^{**}	-0.06812^{**}	-0.05985^{**}
	(0.0273)	(0.0279)	(0.0286)	(0.0282)
Child's characteristics				
Age	-0.01823^{+}	-0.2277^{***}	-0.02204^{**}	-0.2310^{***}
	(0.0100)	(0.0822)	(0.0105)	(0.0883)
Low birth weight	0.02878	−0.001551	0.04213	0.01236
	(0.1004)	(0.1025)	(0.1090)	(0.1127)
Female	−0.05916	−0.05539	−0.05242	−0.05232
	(0.0513)	(0.0518)	(0.0546)	(0.0544)
Bang/Ind/Pak	0.1361	0.1639	0.04322	0.07112

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Table A8: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.1342)	(0.1369)	(0.1344)	(0.1337)
Black	−0.1629	−0.1741	−0.1504	−0.179
	(0.2491)	(0.2435)	(0.2393)	(0.2436)
Other	0.1637+	0.1628^{+}	0.1730^{+}	0.1623
	(0.1220)	(0.1233)	(0.1273)	(0.1261)
Obese	0.1550	0.1483	0.1946+	0.1443
	(0.0952)	(0.1112)	(0.1050)	(0.1229)
Overweight	0.01996	0.05023	0.033	0.07793
	(0.0652)	(0.0759)	(0.0703)	(0.0812)
Mother's characteristics				
Long-term health conditions	0.1517 ∗ ∗∗	0.1428 ∗ ∗∗	0.1611 ∗ ∗∗	0.1371 ∗ ∗
	(0.0516)	(0.0515)	(0.0557)	(0.0551)
Depression	0.2935 ∗ ∗∗	0.2874 ∗ ∗∗	0.2998 ∗ ∗∗	0.3150 ∗ ∗∗
	(0.0537)	(0.0540)	(0.0581)	(0.0578)
Smoking	0.2078 ∗ ∗∗	−0.07555	0.2342 ∗ ∗∗	−0.07592
	(0.0662)	(0.1030)	(0.0712)	(0.1124)
O level or equivalent	−0.2567 ∗ ∗	−0.2577 ∗ ∗	−0.2606 ∗ ∗	−0.2562 ∗ ∗
	(0.1138)	(0.1156)	(0.1215)	(0.1218)
A level or equivalent	−0.08768	−0.09043	−0.09517	−0.05562
	(0.1191)	(0.1214)	(0.1270)	(0.1275)
First degree or equivalent	−0.2018+	−0.1958	−0.1998	−0.1951
	(0.1173)	(0.1198)	(0.1250)	(0.1265)
Higher degree or equivalent	−0.01868	−0.01092	−0.006704	−0.01388
	(0.1370)	(0.1394)	(0.1457)	(0.1470)
Age	0.001911	−0.0163	0.0007257	−0.0106
	(0.0072)	(0.0519)	(0.0079)	(0.0560)
Teen mother	−0.2467	−0.332	−0.2986	−0.3915

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Table A8: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
	(0.4477)	(0.4439)	(0.4418)	(0.4504)
In work	0.03265	−0.08546	0.05037	−0.06169
	(0.0561)	(0.0762)	(0.0603)	(0.0827)
Father's characteristics				
Long-term health conditions	−0.001559	−0.01168	−0.01043	−0.02251
	(0.0560)	(0.0570)	(0.0597)	(0.0604)
Depression	0.2617 ∗ ∗∗	0.2394 ∗ ∗∗	0.2852 ∗ ∗∗	0.2560 ∗ ∗∗
	(0.0656)	(0.0668)	(0.0716)	(0.0724)
Smoking	0.1636 ∗ ∗∗	−0.063	0.1482 ∗ ∗	−0.09117
	(0.0618)	(0.0998)	(0.0658)	(0.1072)
O level or equivalent	0.06114	0.05147	0.08112	0.01257
	(0.0983)	(0.0980)	(0.1069)	(0.1037)
A level or equivalent	−0.05162	−0.05043	−0.03411	−0.0631
	(0.1073)	(0.1075)	(0.1177)	(0.1148)
First degree or equivalent	0.04277	0.05076	0.06425	0.04871
	(0.1006)	(0.1005)	(0.1085)	(0.1057)
Higher degree or equivalent	−0.02971	−0.00781	0.003309	−0.01988
	(0.1291)	(0.1297)	(0.1361)	(0.1339)
Age	0.008793	0.1007 ∗ ∗∗	0.01250+	0.08430 ∗ ∗
	(0.0064)	(0.0364)	(0.0070)	(0.0391)
In work	−0.02962	0.1729	−0.04115	0.1568
	(0.1087)	(0.1376)	(0.1170)	(0.1423)
Household characteristics				
Linc couple	−0.07498	−0.07878	−0.08451+	−0.1054+
	(0.0465)	(0.0575)	(0.0504)	(0.0623)
Council house	0.0792	−0.225	0.1243	−0.1677
	(0.0980)	(0.1601)	(0.1057)	(0.2016)

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Table A8: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
N	14569	14569	14025	14025
ll	$-1.12E+04$	$-1.12E+04$	$-1.22E+04$	$-1.17E+04$

Notes: Standard errors in parentheses. Standard errors are robust to heteroskedasticity and clustered at child level in order to allow for repeated observations over time. Models are estimated using the unbalanced sample. Specifications in columns (2) and (4) include the parameterisation of the individual fixed effect as the mean of any of the exogenous independent variables, as indicated in equation (4). Columns (3) and (4) include weights to adjust for attrition. *Controls* include the set of variables for the child-, parental- and household-related variables: child race, whether the child born with low weight, whether the child is obese or overweight, parental self-assessed health, parental long-standing illness, parental depression, parental smoking, parental education, parental working status, teen mother, parental age, logarithm of household income, whether the family lives in a council house (or in a housing association). Reference category for child's ethnicity is White. Reference category for parental education is No Education. Time dummies for years corresponding to each wave are also included. Significance levels $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A9: APEs Probit Excellent Health: Biprobit

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IP O
Domestic violence	−0.5572775 ∗ ∗∗	−0.5751322 ∗ ∗∗	−0.5964716 ∗ ∗∗	−0.61
	(0.0951114)	(0.0876518)	(0.0944581)	(0.0
Child's characteristics				
Age	0.0094873 ∗ ∗∗	−0.0047476	0.0093411 ∗ ∗∗	−0
	(0.001838)	(0.0164252)	(0.0018531)	(0.0
Low birth weight	−0.0409524 ∗ ∗	−0.041099 ∗ ∗∗	−0.0406902 ∗ ∗	−0.03
	(0.0195814)	(0.0194627)	(0.0203582)	(0.0
Female	0.0356235 ∗ ∗∗	0.0354547 ∗ ∗∗	0.0344487 ∗ ∗∗	0.035
	(0.0092459)	(0.009229)	(0.0095233)	(0.0
Bang/Ind/Pak	−0.2108687 ∗ ∗∗	−0.2028115 ∗ ∗∗	−0.2074025 ∗ ∗∗	−0.19
	(0.0262313)	(0.0263802)	(0.0274818)	(0.0
Black	−0.1111791 ∗ ∗∗	−0.1050319 ∗ ∗∗	−0.0826964+	−0.08
	(0.0452366)	(0.0455451)	(0.0496151)	(0.0
Other	−0.0521137 ∗ ∗	−0.0481512 ∗ ∗	−0.0450616 ∗ ∗	−0.
	(0.0259452)	(0.025832)	(0.0268164)	(0.0
Obese	−0.0994731	−0.027448	−0.0927943 ∗ ∗∗	−0.
	(0.0185309)	(0.0255845)	(0.0195368)	(0.0
Overweight	−0.0227703 ∗ ∗	−0.0347034 ∗ ∗	−0.0179442+	−0.0
	(0.0115002)	(0.0151842)	(0.0118619)	(0.0
Mother's characteristics				
Long term health conditions	−0.0655675 ∗ ∗∗	−0.065489 ∗ ∗∗	−0.0665373 ∗ ∗∗	−0.06
	(0.0106757)	(0.0106464)	(0.0110118)	(0.0
Depression	−0.0433822 ∗ ∗∗	−0.0429497 ∗ ∗∗	−0.0384429 ∗ ∗∗	−0.04
	(0.0103294)	(0.0102719)	(0.0106333)	(0.0
Smoking	−0.005385	−0.012502	−0.0036911	−0.
	(0.013304)	(0.0217275)	(0.013845)	(0.0

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Table A9: APEs Probit Excellent Health: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IPW CM Oprobit (4)
O level or equivalent	−0.028582+	−0.0304173+	−0.0320547+	−0.0225067
	(0.0199503)	(0.0200138)	(0.0206034)	(0.0211278)
A level or equivalent	0.0193983	0.0163748	0.0184654	0.0292424
	(0.0211567)	(0.0212099)	(0.0217514)	(0.0222295)
First degree or equivalent	0.0230227	0.0192438	0.0235283	0.0315087+
	(0.0200779)	(0.0202128)	(0.0207054)	(0.0213988)
Higher degree or equivalent	−0.003928	−0.0069392	−0.0021751	0.0011985
	(0.025681)	(0.0257784)	(0.0266481)	(0.0270166)
Age	0.0008818	0.0051224	0.0006109	−0.0009811
	(0.0012861)	(0.0111352)	(0.0013356)	(0.0114715)
Teen mother	0.1902741 * *	0.1825797 * *	0.2119376 * *	0.1889817+
	(0.076287)	(0.0755519)	(0.0915323)	(0.0879412)
In work	0.0258518 * **	0.0065015	0.0268811 * **	0.013082
	(0.0102638)	(0.0138903)	(0.0106509)	(0.0146796)
Father's characteristics				
Long term health conditions	−0.0438244 * **	−0.0445819 * **	−0.0432448 * **	−0.0448529 * *
	(0.0104581)	(0.0104594)	(0.0107498)	(0.0110042)
Depression	−0.0125929	−0.0133117	−0.0051142	−0.0049794
	(0.0135218)	(0.0135225)	(0.0139636)	(0.0140868)
Smoking	0.0015585	0.0065102	0.0024066	−0.0027406
	(0.0121435)	(0.0186866)	(0.0126003)	(0.020382)
O level or equivalent	0.0285943+	0.027762+	0.0280863+	0.0295577+
	(0.0193011)	(0.0193221)	(0.0198946)	(0.0199615)
A level or equivalent	0.0221478	0.0193034	0.0206609	0.019966
	(0.0204516)	(0.0204557)	(0.0210548)	(0.0211264)
First degree or equivalent	0.0356832+	0.0319084+	0.0355619 * *	0.0364039 * *
	(0.0195699)	(0.0196672)	(0.0200766)	(0.0202007)

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Table A9: APEs Probit Excellent Health: Biprobit – Continued

	Pooled Oprobit (1)	CM Oprobit (2)	IPW Pooled Oprobit (3)	IP O
Higher degree or equivalent	0.0778886 * **	0.0714194 * **	0.0737748 * *	0.067
	(0.024062)	(0.0241946)	(0.0247398)	(0.0
Age	0.0007745	0.0223429 * **	0.0006696	0.018
	(0.0011512)	(0.0066797)	(0.0011945)	(0.0
In work	−0.0324336	−0.0280989	−0.032538	−0.
	(0.0216474)	(0.0287244)	(0.0229432)	(0.0
Household's characteristics				
Linc couple	0.0399338 * **	0.0042254	0.0432501 * *	0.0
	(0.0086422)	(0.0120434)	(0.0089028)	(0.0
Council house	−0.0197385	0.0217391	−0.0088891	0.0
	(0.0203463)	(0.0588658)	(0.0215376)	(0.0

Notes: Standard errors in parentheses. Standard errors calculated by Delta method. Coefficients of the second equation and the averaged exogenous variables in the CM device are estimated but not reported here. Significance levels $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A10: Family type summary statistics

Family type			Wave 3	Wave 4	Wave 5	Total
Both natural parents	N		11,614	10,134	8,886	30,634
Conservative approach		No	10,117	8,964	7,806	
		Yes	420	323	297	
Conservative approach ever		No	10,564	9,238	8,071	
		Yes	711	681	671	
Broad approach		No	10,117	8,964	7,806	
		Yes	708	569	448	
Broad approach ever		No	10,195	8,827	7,668	
		Yes	1,173	1,144	1,105	
Single mother	N		2,968	2,832	2,971	8,771
Conservative approach		No	3	na	1	
		Yes	0	na	0	
Conservative approach ever		No	1,099	1,335	1,690	
		Yes	143	213	258	
Broad approach		No	3	na	1	
		Yes	0	na	1	
Broad approach ever		No	1,075	1,293	1,614	
		Yes	233	309	375	
Natural mother and stepfather	N		580	695	1,084	2,359
Conservative approach		No	528	626	980	
		Yes	16	31	39	
Conservative approach ever		No	516	602	933	
		Yes	50	80	136	
Broad approach		No	528	626	980	
		Yes	31	48	53	
Broad approach ever		No	499	569	880	
		Yes	72	118	193	
Total	N		15,162	13,661	12,941	41,764

Notes: The conservative approach only considers responses yes or no. Ever stands whether they have responded yes in previos (and current) wave. Broad approach includes do not want to answer as an affirmative response.

Table A11: ICD code and Domestic violence

	Broad DV			Conservative DV			Mean difference	Broad Ever DV			Mean difference	Conservative Ever DV			Mean difference
Wave 3															
	Yes	No		Yes	No			Yes	No			Yes	No		
Long illness	0.230226	0.1817193	***	0.2166667	0.1817193	+		0.223176	0.1794897	***		0.2277228	0.1804354	***	
Letter A	0	0.0000989		0	0.0000989			0	0.0000985			0	0.0000951		
Letter B	0.0014124	0.0008903		0.002381	0.0008903			0.0008584	0.0009851			0.0014144	0.0009507		
Letter C	0.0014124	0.0005935		0.002381	0.0005935			0.0008584	0.0005911			0.0014144	0.0005704		
Letter D	0.0042373	0.0014838	´+	0.002381	0.0014838			0.0034335	0.0017732			0.0014144	0.0019013		
Letter E	0.0070621	0.0030666	´+	0.002381	0.0030666			0.006867	0.0032509	´+		0.0070721	0.0034224		
Letter F	0.0141243	0.0052429	***	0.0190476	0.0052429	***		0.0103004	0.0053197	**		0.0127298	0.0054188	**	
Letter G	0.0084746	0.003759	*	0.0047619	0.003759			0.006867	0.003645	+		0.0056577	0.0038026		
Letter H	0.0310734	0.0226531		0.0309524	0.0226531			0.0300429	0.0217713	+		0.0339463	0.0220553	**	
Letter I	0.0014124	0.0010881		0.002381	0.0010881			0.0008584	0.0010836			0.0014144	0.0010457		
Letter J	0.0875706	0.0696409	+	0.097619	0.0696409	**		0.0841202	0.0690572	+		0.0891089	0.069113	**	
Letter K	0.009887	0.0073202		0.0071429	0.0073202			0.0103004	0.0070929			0.0070721	0.00713		
Letter L	0.0367232	0.0327431		0.0214286	0.0327431			0.0377682	0.031918			0.0353607	0.0320373		
Letter M	0.0042373	0.003759		0.0047619	0.003759			0.0042918	0.0037435			0.0042433	0.0037076		
Letter N	0.0042373	0.005045		0.0071429	0.005045			0.0025751	0.0050241			0.0042433	0.0048484		
Letter O	0	0		0	0			0	0			0	0		
Letter P	0	0		0	0			0	0			0	0		
Letter Q	0.009887	0.0069245		0.0095238	0.0069245			0.0085837	0.0067974			0.0084866	0.0069398		
Letter R	0.009887	0.0119695		0.0119048	0.0119695			0.0128755	0.011723			0.0127298	0.0118833		
Letter S	0.0028249	0.0006925	+	0.002381	0.0006925			0.0017167	0.0007881			0.0014144	0.0008556		
Letter T	0.0042373	0.006331		0.0047619	0.006331			0.0051502	0.0061078			0.0070721	0.0059892		
Letter Z	0.0014124	0.0006925		0	0.0006925			0.0008584	0.0009851			0	0.0010457		
N	708	10109		420	10109			1165	10151			707	10519		
Wave 4															
	Yes	No		Yes	No			Yes	No			Yes	No		
Long illness	0.2003515	0.1727293	+	0.2167183	0.1727293	**		0.2005254	0.1704235	**		0.2161765	0.170546	***	
Letter A	0.0017575	0.0004463		0	0.0004463			0.0008757	0.0004554			0.0014706	0.0004351		
Letter B	0.0017575	0.0008927		0.003096	0.0008927			0.0008757	0.0009107			0.0014706	0.0008701		
Letter C	0	0.0006695		0	0.0006695			0.0008757	0.0005692			0	0.0006526		
Letter D	0.0017575	0.0017853		0.003096	0.0017853			0.002627	0.0018215			0.0014706	0.001849		
Letter E	0.0035149	0.0036822		0.006192	0.0036822			0.003643	0.0052539			0.0088235	0.0034805	**	
Letter F	0.0105448	0.0093729		0.0154799	0.0093729			0.0122592	0.0091075			0.0161765	0.0090276	+	
Letter G	0.0052724	0.0063602		0.0092879	0.0063602			0.0078809	0.005806			0.0088235	0.0058734		
Letter H	0.029877	0.021089		0.0309598	0.021089			0.0323993	0.020378	***		0.0308824	0.0211007	+	
Letter I	0.0017575	0.001339		0	0.001339			0.002627	0.0011384			0.0014706	0.0013052		
Letter J	0.0685413	0.0708547		0.0681115	0.0708547			0.0674256	0.0714936			0.0779412	0.070372		
Letter K	0.0087873	0.0079223		0.0154799	0.0079223			0.0113835	0.0076275			0.0132353	0.0077224		
Letter L	0.0492091	0.0319125		0.0495356	0.0319125	+		0.0464098	0.03051	***		0.0544118	0.0306722	***	
Letter M	0.0035149	0.0059139		0	0.0059139			0.0035026	0.0061475			0.0014706	0.0061997		
Letter N	0.0017575	0.0049096		0	0.0049096			0.0043783	0.0048953			0.0014706	0.0050033		
Letter O	0	0		0	0			0	0			0	0		
Letter P	0.0017575	0.0001116	***	0	0.0001116			0.0017513	0	***		0	0.0002175		
Letter Q	0.0105448	0.0066949		0.0154799	0.0066949	+		0.0087566	0.0063752			0.0117647	0.0063085	+	
Letter R	0.0158172	0.0127204		0.0185759	0.0127204			0.0113835	0.0129781			0.0147059	0.0127257		
Letter S	0	0.0003347		0	0.0003347			0	0.0003415			0	0.0003263		
Letter T	0.0098192	0.0052724		0	0.0098192	+		0.0113835	0.0091075			0.0102941	0.0092452		
Letter Z	0.0017575	0.0015622		0	0.0015622			0.002627	0.0013661			0.0014706	0.0015227		
N	569	8962		323	8962			1142	8784			680	9194		

Notes: The *conservative*(column 2) approach only considers responses yes or no to the intimate partner abuse question. *Broad*(column 1) definition also merge as affirmative responses those biological mother who did not want to answer the question. *Ever* definition stands whether biological mothers affirmatively answered in previous (and current) waves. For the *Ever* definition, we also use both approaches, conservative(column 4) and broad (column 3).

Table A12: Chapter ICD-10 2010 revision

Chapter	Letter
I Certain infectious and parasitic diseases	A and B
II Neoplasms	C and D (C – D48)
III Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	D (D50-D89)
IV Endocrine, nutritional and metabolic diseases	E
V Mental and behavioural disorders	F
VI Diseases of the nervous system	G
VII Diseases of the eye and adnexa	H (H00-H59)
VIII Diseases of the ear and mastoid process	H (H60-H95)
IX Diseases of the circulatory system	I(I00-I95)
X Diseases of the respiratory system	J (J00-J99)
XI Diseases of the digestive system	K (K00-K93)
XII Diseases of the skin and subcutaneous tissue	L and K
XIII Diseases of the musculoskeletal system and connective tissue	M
XIV Diseases of the genitourinary system	N
XV Pregnancy, childbirth and the puerperium	O
XVI Certain conditions originating in the perinatal period	P
XVII Congenital malformations, deformations and chromosomal abnormalities	Q
XVIII Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	R
XIX Injury, poisoning and certain other consequences of external causes	T and S
XX External causes of morbidity and mortality and V	

Notes:This table presents a relation between letters and thematic areas. In those cases that a letter belong to a more than one chapter we make explicit the subdivision in brackets. In our chapter this subdivision does not really matter.

Table A13: Without endogenous variables

	Oprobit	IPW Oprobit	OProbit CMundlak	IPW OProbit CMundlak
	(1)	(2)	(3)	(4)
Contemporaneous (1)	-0.234^{***}	-0.259^{***}	-0.232^{***}	-0.232^{***}
	(0.058)	(0.061)	(0.058)	(0.061)
Ever (2)	-0.187^{***}	-0.182	-0.185^{***}	-0.178^{***}
	(0.046)	(0.047)	(0.046)	(0.047)

Notes:This table replicates the regressions in Table 2.2, though we do not include the following set of variable that are susceptible of being endogenous: parental depression, parental long standing illness, parental smoking habits, household income and whether the child is overweight or obese. Row (1) uses the *Contemporaneous* DV definition. Row (2) uses the *Ever* DV definition.

Table A14: Instrument robustness check. Biprobit

	Biprobit		MDBiprobit		IPW MD Biprobit	
	Unemployment only	Relation only	Unemployment only	Relation only	Unemployment only	Relation only
	(1)	(2)	(3)	(4)	(5)	(6)
(1)Contemporaneous	-1.480^{***}	-1.502^{***}	-1.498^{***}	-1.604^{***}	-1.570^{***}	-1.729^{***}
	(0.316)	(0.345)	(0.305)	(0.292)	(0.330)	(0.031)
(2) Instrument	-0.066^{**}	-0.034^{**}	-0.063^{**}	-0.033^{**}	-0.055^{**}	-0.031^{**}
	(0.026)	(0.014)	(0.027)	(0.014)	(0.027)	(0.0146)
(3) N	15,709	14,573	15,709	14,573	14,987	14,029
(4) rho	0.594^{***}	0.597^{***}	0.603^{***}	0.645^{***}	0.639	0.867^{***}
	(0.137)	(0.150)	(0.132)	(0.125)	(0.142)	(0.128)
(5) Ever	-1.021^{***}	-1.005	-1.115^{***}	-1.150^{***}	-1.173^{***}	-1.293^{***}
	(0.370)	(0.369)	(0.321)	(0.312)	(0.339)	(0.306)
(6) Instrument	-0.045^{+}	-0.0267^{+}	-0.043^{+}	-0.026^{+}	-0.038^{+}	-0.025^{+}
	(0.025)	(0.013)	(0.025)	(0.013)	(0.0249)y	(0.013)
(7) N	16,088	14,910	16,088	14,910	15,413	14,421
(8) rho	0.447^{**}	0.493^{**}	0.496^{***}	$0,512^{***}$	0.529^{***}	0.581^{***}
	(0.137)	(0.177)	(0.154)	(0.149)	(0.161)	(0.145)

Notes:Columns (1), (3) and (5) only use the unemployment difference as exclusion restriction. Columns (2), (4) and (6) only use the relation index as exclusion restriction. Rows (1) to (4) employs the contemporaneous DV definition. Rows (5) to (8) uses the ever DV definition.

Table A15: Probit of the inverse probability weighting

	IPW bioprobit		MD IPW bioprobit	
	Contemporaneous	Ever	Contemporaneous	Ever
	(1)	(2)	(3)	(4)
Domestic violence	-0.3839113 ***	-0.2153955 ***	-0.1930113 +	-0.0543886
	(0.0881479)	(0.069959)	(0.105097)	(0.0853995)
Teen mother	-0.6218956 **	-0.6462275 **	-0.3607488	-0.4680059
	(0.2621717)	(0.2553567)	(0.3102794)	(0.3078391)
Father depression	-0.0310308	-0.0106059	0.0580239	0.0980726
	(0.0543689)	(0.0536591)	(0.0649173)	(0.0653012)
Mother depression	0.0427405	0.0443829	0.0600288	0.057473
	(0.0400058)	(0.0396015)	(0.0479179)	(0.0481236)
Father long illness	0.0179849	0.0151675	0.0105225	-0.0057458
	(0.0421191)	(0.0416907)	(0.0500877)	(0.0502097)
Mother long illness	0.0124865	0.0122341	0.045323	0.0355917
	(0.0422416)	(0.0418045)	(0.0505766)	(0.0507404)
Father smoker	-0.0228047	-0.0176598	0.0577355	0.0218821
	(0.0459585)	(0.045415)	(0.1077377)	(0.1081594)
Age mother	0.0138206 ***	0.0130588 ***	-0.3585308 ***	-0.3868892 ***
	(0.004764)	(0.0047039)	(0.054832)	(0.0548198)
Age father	-0.0246812 ***	-0.0249091 ***	-0.8340133 ***	-0.8782769 ***
	(0.00398)	(0.003933)	(0.0327958)	(0.0331669)
Mother smoker	-0.1470621 ***	-0.1598322 ***	0.1880541	0.12492
	(0.0515565)	(0.0508385)	(0.1233941)	(0.1236445)
Mother education				
II	-0.0338995	-0.0276568	0.0090948	0.0142441
	(0.0766022)	(0.0753859)	(0.0902301)	(0.0902681)
III	0.0312693	0.0283936	-0.0171634	-0.0277549
	(0.0817387)	(0.0805698)	(0.096156)	(0.0963462)
IV	-0.0348922	-0.0147844	-0.1416497	-0.1202702
	(0.0776222)	(0.0765614)	(0.091368)	(0.0916886)
V	-0.1295243	-0.0965814	-0.1772329	-0.1477183
	(0.1012821)	(0.1004744)	(0.11988)	(0.1207701)
Father education				
II	-0.0023237	-0.0390829	-0.0418577	-0.0850123
	(0.0736547)	(0.0727006)	(0.0902791)	(0.0910211)
III	0.0456482	0.0117683	-0.0306824	-0.0767234
	(0.0781308)	(0.0772107)	(0.095326)	(0.0961117)
IV	0.1899369	0.1479934 **	0.0924809	0.0464457
	(0.0759052)	(0.0748987)	(0.0932912)	(0.0939636)
V	0.1764097 **	0.147854	0.0478639	0.0117689
	(0.0940021)	(0.0932893)	(0.1141106)	(0.1152233)
L income couple	0.0814627 **	0.0655721 +	-0.1580393 **	-0.1929519
	(0.0360305)	(0.0356407)	(0.0797818)	(0.0815782)
council house	-0.1668115 **	-0.1498508 **	-0.3451956	-0.3361651
	(0.0713166)	(0.0699385)	(0.3044928)	(0.3032913)
Father inwork	0.0799069	0.0011141	0.1046694	0.0764567
	(0.0885355)	(0.0872716)	(0.1741736)	(0.1770784)
Mother inwork	0.0847447 **	0.1022642 ***	-0.1131002	-0.10444
	(0.039326)	(0.0388425)	(0.0895697)	(0.0900139)
Children age	0.087293 **	0.0796695 **	0.577719 ***	0.5850398 ***
	(0.037754)	(0.0374106)	(0.0802802)	(0.0803613)
Low birth weight	-0.1726608 **	-0.1696239	-0.0576568	-0.0590617
	(0.0691172)	(0.0682826)	(0.0832137)	(0.0831675)
Female	0.0001006	-0.0045631	-0.0226832	-0.0322543
	(0.0345878)	(0.0342682)	(0.0414076)	(0.0416293)

Table A16: Probit of the inverse probability weighting II

	IPW bioprobit		MD IPW bioprobit	
	Contemporaneous	Ever	Contemporaneous	Ever
Bang/Ind/Pak	-0.3899173 **	-0.3376336 ***	-0.5016223 ***	-0.4711656 ***
	(0.0955085)	(0.0906102)	(0.1133455)	(0.1095117)
Black	-0.2353479	-0.3925621 **	-0.1460599	-0.2557988
	(0.1794092)	(0.1674531)	(0.2032727)	(0.1934745)
Other	-0.1724094 +	-0.1393233	-0.1458622	-0.122218
	(0.0920405)	(0.0913117)	(0.1097897)	(0.1103968)
Obese	-0.0959699	-0.042398	0.2484301	0.3483275 **
	(0.0790745)	(0.078218)	(0.1533369)	(0.1551333)
Overweight	-0.0246048	-0.0311936	-0.0047002	0.0000639
	(0.0487829)	(0.0480976)	(0.092553)	(0.0927726)
Constant	-0.3842863	-0.037323	-1.291645 ***	-0.7974309
	(0.4314638)	(0.4260208)	(0.5934341)	(0.5928672)
M age mother			0.3578427 ***	0.384836 ***
			(0.0546413)	(0.0546261)
M smoking mother			-0.3418265 ***	-0.2588756 +
			(0.1487857)	(0.1498009)
M smoking father			0.0102957	0.0784606
			(0.1458448)	(0.1476361)
M age father			0.7994245 ***	0.8420117 ***
			(0.0322206)	(0.0325607)
M father inwork			-0.0285509	-0.1284883
			(0.207574)	(0.2070277)
M mother inwork			0.2785226 ***	0.3067482 ***
			(0.1111897)	(0.1112884)
M obese			-0.4978121 ***	-0.5403605 ***
			(0.1810724)	(0.1815297)
M overweight			0.0470298	0.0215972
			(0.1233327)	(0.1238535)
M children age			-0.5309065 ***	-0.5589609 ***
			(0.0669405)	(0.0669579)
M L income			0.3407122 ***	0.3569502 ***
			(0.0922882)	(0.0938199)
M council house			0.2858496	0.3056283
			(0.3227269)	(0.320647)
N. of observation	6,147	6,311	6,147	6,311
Pseudo-r2	0.0261	0.0232	0.3522	0.3713

Notes:Results from tables A15 and A16 are the parameters estimates of the Probit specification to estimate the weight to correct for attrition. Columns (1) and (3) uses the *Contemporaneous* DV definition and columns (2) and columns (4) uses the *Ever* DV definition. Columns (3) and (4) includes the Chamberlain- Mundlak device.

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Chapter 3

Falling off the cliff: Domestic Violence and Children's Educational Attainment

3.1 Introduction

According to the 2013/2014 Crime Survey for England and Wales (CSEW), around 1.1 million of women have suffered Intimate Partner Abuse in the period 2012/2013, and more than 1 in 4 women had experienced some sort of domestic abuse since the age of sixteen.[1] This paper focuses on a particular spillover effect of living in a household where mothers are battered by their partners: its impact on children's educational attainment.

Radford et al. (2013) look at the prevalence and impact of child maltreatment and other types of victimization using a representative sample in the UK across three age ranges (under 11, 11-17, and 18-24 years of age). The

[1]Domestic abuse in CSEW includes/combines partner abuse (non-sexual), family abuse (non-sexual) and sexual assaults or stalking carried out by a current or former partner or other family member

likelihood of being exposed to DV increases with age, being as high as 23.7 % in the age range 18-24. However, the exposure to DV is different across genders (19.5% for men and 28% for women). Living in a troubled family might come along with other types of victimization, this phenomenon is coined in the literature as polyvictimization (e.g. maltreated by parents/caregivers and/or siblings) with a higher prospect of being left with traumatic symptoms.

The extant paediatric literature highlights the multi-dimensional spillover effect from witnessing a violent parental relationship. In particular, most studies (Margolin & Gordis 2000) highlight the negative effect of DV for the socio-emotional development of the child, which has damaging consequences in the future, not only in terms of interpersonal relationships but also in the lack of academic knowledge acquisition. Several psychological studies highlight the adverse effects of living in troubled families. Children might internalize violence as a way to impose their will on others. Magdol et al. (1998) show how children who witness the abuse are prone to exercise force against their potential partners. These children are also more likely to engage in antisocial behaviors (e.g.delinquency), to have problems self-regulating their mood, as well as suffering a lack of self-esteem.

The parenting process might also get affected by domestic violence (DV henceforth). Battered mothers are likely to suffer from depressive attacks, post traumatic stress disorders and substance abuse addictions (Ehrensaft et al. 2006) and tend to be more impulsive and to use harsh punishments in response to their child's misconduct (Osofsky 1987).

The economic literature that relates to our purpose is scarce. There are few studies tackling the issue of DV from an economic perspective, Carrell & Hoekstra (2010) study the negative spillover effect of children exposed to DV at home on the child's own school performance and on the academic performance of the child's peers. The presence of one more child troubled by DV in a classroom of 20 students reduces the average performance in Maths and Reading scores at the classroom level by 0.69 percentage points and increases disciplinary infractions by 17 %. In a related study, Carrell & Hoekstra (2012) analyse whether the timing of reporting physical abuse to the police might also matter to both the child's own learning process and

the spillover effects on his/her class peers. Their analysis relies on a unique data set that links a child's class academic variables to public records on intimate partner abuse. Results from the study point out that the sooner DV is reported to the police, the better it could be for lessening the pernicious effects on the child's and his peers' performance.

In line with Carrell & Hoekstra (2010, 2012), we examine the detrimental effect on children's educational outcomes of living in a household u where there exists DV. Our paper differs from the (scarce) previous literature in several ways. We focus our analysis on children who are 7 and 11 years old and study how the impact of DV evolves between these two ages. Second, we examine the effect of being contemporaneously exposed to DV but also to any exposure to DV on the children's learning process. Further, we provide robustness to our results by including specifications that take into account two different sources of potential biases. First, the bias introduced by having children for which the teacher completed an academic record versus those for which there is no such teacher's record. Second, we also investigate the bias introduced by the self-selection process of parents admitting to being involved in a violent relationship. Finally, we estimate the effect of DV on children's educational outcomes comparing children exposed to DV to their most related peers by means of the Average Effect of Treatment on the Treated, where treatment is exposure to DV.

We find DV has a statistically significant effect only by the age of 11 although it is already negative by the age of 7. This result is consistent across specifications. We further observe what we call a *heterogenous cumulative impact* across academic areas, that is, the lasting impact of DV is not the same for all subjects. Our results indicate that DV does have a significant effect in academic areas such as Maths and Science, for which the role of previous knowledge seems more essential to progress in comparison to other subjects in which cumulative knowledge is not as relevant (Creativity, for instance).

The paper is organized as follows: section II introduces the data set and variables considered; section III presents the econometric strategy; section IV provides the results and section V concludes.

3.2 Millennium Cohort Study

The main data set used is the Millennium Cohort Study (MCS), a national survey that tracks the lives of nearly of 19,000 children born in United Kingdom over the period 2000-2001. The first wave was collected when children were 9 months old and consecutive interviews were gathered at different intervals (3, 5, 7 and 11 years old). Trained interviewers carried out a set of multipurpose questionnaires which are intended to capture not only the cognitive and physical attributes as such, but also the socioeconomic and demographic environment of the child. In this study, we focus on a sample of children where both biological parents are cohabiting over the last two available waves at the time of the study, when children are around 7 and 11 years old, respectively.

3.2.1 Dependent Variables: Educational Outcomes

The MCS contains information regarding the teacher assessment on children's school performance. In this research we focus on key ability areas as specified in the National School Curriculum in the UK, which is a set of compulsory guidelines on critical areas for the educational development of the child. There are four different key stages: the first when the child is between 5 and 7 years of age, the second when he/she is between 7 and 11, the third when he/she is between 11 and 14, and, finally, when he/she is between 14 and 17 years old. In the analysis that follows, we focus on the effect of DV by the time children are about 7 and about 11 years old (waves 4 and 5, respectively).

For the MCS, children's teachers are contacted contingent on parental consent.[2] Teachers rated student performance with respect to all other chil-

[2]For waves 4 and 5, consent and sufficient information to contact a teacher was obtained for 12,655 out of 14,043 children aged around seven, and for 9,610 out of 10,506 children of about 11 years of age. This resulted in 8,876 and 7,430 usable surveys for waves 4 and 5, respectively. In the fifth wave,

dren in the same class or school, and also with respect to the national academic threshold requirements for children of the same age. Responses are categorical and coded from 1: *being well above the average* to 5: *well below the average*. We inverse the coding of the teacher's scores and standardize it, i.e. we transform scores into a variable with mean zero and a standard deviation of one.

In Table 3.1, we present summary statistics of subjective teacher's scores for children at the ages of 7 and 11, differentiating those households without DV (non-DV sample) in columns (1) and (4), and households in which there is DV (DV sample) in columns (2) and (5). Columns (3) and (6) report the results of testing whether the different subject means are statistically different among DV and non-DV samples. English at age 7 is broken down in three sub-areas: *Reading, Writing and Speaking and listening* but at age 11 it is not. Figures in Table 3.1 show that children from battered mothers lose on average around 0.20 to 0.30 standard deviations in English in each age period, and over the threshold of 0.30 standard deviations in Maths and Science by the age 11.

Table 3.1: Summary of child's ability scores by subject

	Age 7			Age 11		
	No DV	Yes DV	*Diff in Means*	No DV	Yes DV	*Diff in Means*
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking and listening (English)	0.008	-0.229	***	✗	✗	
Reading (English)	0.009	-0.234	***	✗	✗	
Writing (English)	0.008	-0.224	***	✗	✗	
English	✗	✗		0.011	-0.289	***
Science	0.006	-0.153	+	0.015	-0.396	***
Maths and numeracy	0.007	-0.203	**	0.013	-0.321	***
Physical education	0.007	-0.180	**	0.004	-0.111	
Information and Communication Technology (ICT)	0.007	-0.202	**	0.013	-0.325	**
Expressive and Creative Arts	0.005	-0.128		0.009	-0.236	**
N	3630	133		2662	104	

Note: The entries are means of pupil-level data for those students in the MCS with non missing values for gender, race, birth weight, weight, month born,teacher subjective scores, parental long standing illness, parental smoking habits, parental education, parental age, parental working status, housing income and whether the family lives in a Council house or in a housing association. Our sample only includes families where parents are cohabiting. N stands for the number of observations. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

the teacher's questionnaire was only available for England and Wales.

3.2.2 Domestic Violence

We are able to identify a proxy variable for DV in the MCS. In each wave, biological mothers are asked the following question: *People often use force in a relationship - grabbing, pushing, shaking, hitting, kicking etc. Has your husband ever used force on you for any reason?*. The respondent has three alternatives: 1 (Yes), 2 (No) and 3 (Don't want to answer). Thus, we define two DV variables: *Contemporaneous DV* equals 1 if the biological mother answers yes to this question referring to that period/wave, and 0 otherwise. We also define *Ever DV* which equals 1 if the biological mother has ever answered yes to the question and 0 otherwise.

Documenting the effect of intimate partner abuse is complicated by the lack of consistent information. According to the 2013/2014 CSEW,[3] 8.5% of women (or about 1.4 million) reported some type of domestic abuse (including partner or ex-partner abuse (non-sexual), family abuse (non-sexual) and sexual assault or stalking carried out by a current or former partner or other family member) and 6.8% (or 1.1 million) declared having experienced some type of partner abuse. These figures are likely to be at the lower bound of the real ones as women tend to shy away from reporting domestic abuse. The major drawback of relying on survey-elicited DV information is the potential under-reporting which may lead to a downward bias of the estimates. Grounds for under-reporting given by respondents in the CSEW (2013/2014) are *embarrassment* (22.25% of the sample) and it being a *private matter* (12.92%). This is especially problematic given that the timing of DV reporting by mothers matters with regards to its long-term influence on children (Carrell & Hoekstra 2010). As in the CSEW, our analysis is also akin to measurement error due to under-reporting.

3.2.3 Covariates

As child controls, we include the most plausible exogenous explanatory variables. In line with the evidence on gender differences in academic achievement, we control for the child's gender. There is evidence that girls lose

[3]see http://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice

more than two tenths of a standard deviation relative to males during the first years of schooling in Mathematics (Fryer & Levitt 2010). We also incorporate a dummy variable that captures whether the child was born with low birth weight given the increasing body of literature reporting a long lasting negative effect of low birth weight on later job performance (Alderman & Behrman 2006, Almond et al. 2004). We additionally control for the child's ethnic background. Dearden et al. (2006) examines the relation between birth weight and race using the first wave of the MCS. Findings in the study point out that Asian and Black babies are 5% and 6% respectively more likely to be of low birth weight than white babies.

In England, Wales and Northern Ireland the academic year starts on September 1st and ends on August 31st. Whereas Scottish children start on the 15th of August (and ends the 14th of August). Pupils born in the first months of the academic year (September-December) tend to perform better than those born in the summer (Thomas 1995, Alton & Massey 1998). Thus, if a child born in September 2001, she may end up with children born up to August 2002. In that sense, there is a premium for being born during the first part of the academic year. We incorporate a dichotomous variable on whether the child belongs to the older group of her class, i.e. she was born between September-December.

Finally, to control for the lifestyle and the type of upbringing experienced by the child, we also include indicators on whether the child is overweight or obese (and not overweight). For this, we use age and gender Body Mass Index (BMI) specific thresholds as in Saxena et al. (2004). While BMI is a proxy for both lean and fat mass, it does not reveal a child's body composition. There is a range of physiological indices that can tackle better the definitions of obesity and overweight in children, such as waist and hip circumferences or subcutaneous fat measurements like triceps skinfold (Saxena et al. 2004). Still, these approaches are subject to potential sources of bias due to measurement error and do not provide absolute measures of fat mass. Table 3.2 presents children summary statistics. There is practically no statistically significant difference between both groups.

Table 3.2: Child Summary Statistics

	Age 7			Age 11		
	No DV	Yes DV	*Diff in Means*	No DV	Yes DV	*Diff in Means*
	(1)	(2)	(3)	(4)	(5)	(6)
Female	0.493	0.534		0.502	0.442	
Low birthweight	0.059	0.045		0.054	0.048	
Obese	0.047	0.105	***	0.058	0.029	
Overweight	0.132	0.143		0.190	0.202	
White	0.920	0.932		0.902	0.865	
Bang/Ind/Pak	0.033	0.023		0.042	0.048	
Black	0.011	0.008		0.016	0.010	
Other	0.036	0.038		0.040	0.077	**
Born September-December	0.359	0.353		0.337	0.365	
N	3630	133		2662	104	

Note: The entries are means of pupil-level data for those students in the MCS who do not have missing values for gender, race, birth weight, weight,month born, teacher subjective scores, parental long standing illness, parental smoking habits, parental education, parental age, parental working status, housing income and whether the family lives in a council house or in a housing association. Our sample only includes families where parents are cohabiting. N stands for the number of observations. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

As part of *parental* aspects, we include covariates for health, age, education and working status. We include indicator variables for whether the mother and father suffer from long term health conditions, have been diagnosed with depression and whether they smoke. Cutler & Lleras-Muney (2010) looks at the linkage between health behaviours and education. Although unable to establish a causal linkage, the correlation between health behaviours and education is large even after controlling for age, gender and parental background. Better educated people are less likely to smoke, to be obese or to be heavy drinkers as well as more likely to use preventive care. Interestingly in Cutler & Lleras-Muney (2010), education seems to influence cognitive ability that in turn leads to healthier behaviors, weighing more on how one process the information rather how much one knows. Along these lines, better educated parents are likely to engage in more stimulating conversations with their children as well as having a better network in case of ill-health. If more educated parents do not know a doctor directly, it is likely that they know somebody who knows one (Putnam 2016). We incorporate

into our specification the highest educational (vocational or academic) level attained by the parents: *GCSE grades (D-G) or equivalent*, *O level or equivalent*, *A level or equivalent*, *First degree or equivalent* and *Higher degree or equivalent*. Our specification also includes an indicator variable that captures whether parents are working.

In Table A7 we present parental summary statistics. The impact of DV is examined in two ways. One using the contemporaneous presence of intimate partner abuse (as outlined in 3.2.2) and a second one in which we explore the historical presence of DV (not necessarily in levels). Interestingly, we have a 2.5% (column (1)) and 4.5% (column (4)) of women who declared having suffered DV in previous waves but do not report it at the time of the current interview.

The percentage of depression, long term health conditions and smoking are statistically higher for parents in a DV household, as shown in columns (2) and (4). There is a larger proportion of mothers with a first degree in the non-DV sample. However, the proportion of mothers who obtained some kind of postgraduate education is higher in the DV sample and that pattern holds across both sampling periods. There are no statistical differences regarding the father's education when children are at age 7. There is a statistically significant difference in the proportion of fathers with a below degree education between both samples at the age of 11. In terms of unemployment, we observe that the proportion of unemployed individuals is always statistically higher in the DV sample.

Table 3.3: Parental Summary Statistics

	Age 7			Age 11		
	No DV	Yes DV	*Diff in Means*	No DV	Yes DV	*Diff in Means*
	(1)	(2)	(3)	(4)	(5)	(6)
Mother characteristics						
Ever DV effect	0.029	1	***	0.045	1	***
Depression	0.312	0.534	***	0.322	0.529	***
Long term health problems	0.223	0.361	***	0.169	0.221	
Smoking	0.143	0.316	***	0.112	0.202	***
Age	37.566	37.113		41.843	41.635	
GCSE grades (D-G) or equivalent	0.056	0.075		0.043	0.096	***
O level or equivalent	0.272	0.278		0.249	0.308	
A level or equivalent	0.167	0.226	**	0.173	0.125	
First degree or equivalent	0.437	0.308	***	0.444	0.356	**
Higher degree or equivalent	0.067	0.113	***	0.091	0.115	
In work	0.774	0.759		0.830	0.721	***
Father characteristics						
Depression	0.133	0.278	***	0.172	0.269	***
Long term health problems	0.233	0.278		0.163	0.240	**
Smoker	0.192	0.346	***	0.139	0.288	***
Age	39.772	40.504		44.138	44.385	
GCSE grades (D-G) or equivalent	0.057	0.045		0.057	0.087	
O level or equivalent	0.270	0.331		0.260	0.337	**
A level or equivalent	0.177	0.150		0.171	0.096	**
First degree or equivalent	0.394	0.361		0.391	0.404	
Higher degree or equivalent	0.101	0.113		0.122	0.077	
In work	0.963	0.947		0.950	0.856	***
Household characteristics						
Ln Income	10.400	10.278	**	10.415	10.255	***
Council house	0.061	0.150	***	0.058	0.125	***
N	3630	133		2662	104	

Note: Refer to Table 3.2. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

With regards to *household covariates*, Bilger & Carrieri (2013) find there is long-lasting, damaging impact on the health production function (self-assessed health, presence of chronic conditions and limitations to daily activities) of crime, pollution and noise in the neighbourhood. In another study, Jacob et al. (2013) looks at the causal effect on child mortality of moving into a less distressed neighbourhood. There is a positive effect from moving, though the drawback of this study is the low statistical power of the parameter estimates due to the low number of observations. In our study, we do not have specific information regarding the neighbourhood for every wave. However, we use as a proxy for the neighbourhood environment whether the family lives in a Council house or in a Housing Association. Council

houses are more likely to be in areas of geographically concentrated poverty (Atkinson & Kintrea 2001).

The effect of income on education in the existing literature is unclear. For instance, Blau (1999) looks at the income effect on childhood development, which is defined through cognitive, social and emotional dimensions. He finds that permanent income (averaged across all periods) has a small impact on child outcomes and highlights that other factors, like parental education background or home environment have a more significant effect. Findings in Dooley & Stewart (2007) are also in line with Blau (1999) but they argue that parental style introduces heterogeneity that is difficult to control for and might bias the income effect. Violato et al. (2011) looks at the income gradient on school outcomes using the MCS dataset, and their results are consistent with the above studies. In addition to income levels, household income instability may also affect school behavior. Gennetian et al. (2015) stress that an abrupt income change is related to a lower likelihood of adolescents engaging at school as well as more likely to be expelled, particularly among low-income household level and racial minority children.

The literature therefore highlights the relevance of income on child's behaviour and consequently we include income as a control variable. Nevertheless, as our specification does not control for all the range of parenting styles and unobserved child ability, our specification may produce an overestimate of the impact of income on educational outcomes. In the MCS, income is given in threshold levels and is defined as the combined annual income from all sources after deductions. We took the midpoint of the reported range and then converted it into real prices using the annual average consumer price index provided by the Office of National Statistics with 2005 as a base. We took the natural logarithm of the income in order to avoid non-linearities problems (Kuehnle 2014). The household summary statistics presented at the bottom of Table A7 show that DV households are statistically significant poorer and likely to live in council house accommodation in comparison to the non-DV household sample.

3.3 Econometric Strategy

Our primary approach to estimate the impact of DV on educational attainment is to use OLS methods as specified in the following equation:

$$score_{it} = \alpha + \delta DV_{it} + X_{it}\beta + \varepsilon_{it} \tag{3.1}$$

where *score* refers to the performance of each learning dimension for child i at sampling wave t, α is a constant term and ε is an idiosyncratic error normally distributed (0,1). The vector of control variables, denoted X_{it}, includes an array of covariates at three levels: child's, parental and household's. Our variable of interest is DV_{it}, which indicates whether the mother of child i reported suffering DV using two definitions: (1) the contemporaneous DV takes value 1 if the mother reports DV in the current survey at t; and, (2) ever DV takes value 1 if she has ever suffered DV either currently or in the past, at t or at any previous wave *t-j, for* $j < t$.

3.3.1 Accounting for Unobservable Characteristics

There exists potential identification challenges affecting the OLS specification in equation 3.1. In this section, we explore and try to address theses challenges.

We first start by examining the effect of the sample selection bias introduced by the availability of teacher's scores. Thus, we test whether households with teacher's scores differ from households for which we do not have these academic records. We analyse this issue by relying only on observables because we do not have a variable related to the decision of the teacher to fill out the survey and/or the decision of the parents to give consent. Thus, our sample selection correction strategy in this case does not incorporate an exclusion restriction.

Secondly, we explore the self-selection into violent relationships. For this issue, we argue that DV is driven by unobservables that our specification in equation (1) should account for. Thus, we propose a control function ap-

proach in which we model DV as a function of control variables and variables reflecting the female bargaining power at regional market level.

Are families with reported teaching assessment different to families for which the teacher did not fill in the questionnaire?

There are two instances for which the teaching assessment questionnaire was not filled: either due to teachers failing to fill it in or parents not giving consent for the teacher filling in the questionnaire. To explore the channels in which the difference of non-reported and reported teaching questionnaires might bias our DV parameter estimates, we estimate a sample selection model. We define a participation indicator, y, that is equal to 1 if we have the teacher questionnaire available and 0 otherwise.[4] We assume that the participation indicator may depend on the same set of covariates as equation (1). As we cannot determine why the questionnaire was not returned complete, the number of completed questionnaires should be inversely correlated to the error term.

$$y_i = \begin{cases} 1 & if \quad y_i^* > 0 \\ 0 & if \quad y_i^* \leq 0 \end{cases} \tag{3.2}$$

where

$$y_i = 1[(\psi + \varphi DV_i + \Theta_i \Gamma + v_i) > 0] \tag{3.3}$$

where DV_i id the indicator variable for DV and Θ_i is the set of covariates as included in equation 3.1. Teacher's children scores are observed when $y_i = 1$, so:

$$score_i = \begin{cases} score_i^* = \alpha + \delta DV_i + X_i\beta + \varepsilon_i & if \quad y_i = 1 \\ - & if \quad y_i = 0 \end{cases} \tag{3.4}$$

[4]Note that for the fifth wave our sample is constrained to those observations from England and Wales

The errors (ε, v) are assumed to be distributed as a bivariate normal with mean zero, $Var(\varepsilon) = \sigma_1^2$, $Cov(\varepsilon, v)$ and $Var(v) = 1$. Therefore,

$$\begin{pmatrix} \varepsilon \\ v \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & 1 \end{pmatrix} \right]$$

As we can only observe the density function $f(score|y = 1, \Theta)$, we estimate a partial likelihood of the model that includes only observations from children with school performance records. The corresponding likelihood function is:

$$L = \prod_{i=1}^{n} \{Pr(y_i = 0)\}^{1-y_i} \{f(score_i|y = 1, \Theta) x Pr(y_i = 1)\}^{y_i} \tag{3.5}$$

The model presented above might be identified without exclusion restrictions. In Table 3.4 and Table 3.5 we present summary statistics at children's and at parental-household's level respectively for the covariates used in the regression analysis. Columns (1) and (4) show the statistics for those respondents for which there is no teacher questionnaire available and columns (2) and (5) the stats for which the questionnaire is filled in by the teacher. As in our first OLS specification (equation 3.1), we restrict our analysis to those children who do not have any missing values and are living as a family unit in which both parents are living under the same roof. As can be seen in Table 3.4, there are statistically significant differences across samples on ethnicity across both waves. The percentage of obese children is also higher across both sampling waves in the Available Teacher Questionnaire sample. At age 7 the proportion of children born in September to December is higher for the sample with the teacher questionnaire.

Table 3.4: Child Summary Statistics by Availability of Teaching Questionnaire

	Age 7			Age 11		
	N.A.	A.	*Diff in Means*	N.A.	A.	*Diff in Means*
	(1)	(2)	(3)	(4)	(5)	*Diff in Means*
	(1)	(2)	(3)	(4)	(5)	(6)
Low birth weight	0.059	0.058		0.065	0.054	
Female	0.495	0.495		0.493	0.500	
White	0.899	0.921	***	0.882	0.900	***
Bang/Ind/Pak	0.041	0.033		0.064	0.042	***
Black	0.022	0.011	***	0.012	0.016	
Other	0.038	0.036		0.040	0.042	
Obese	0.061	0.049	**	0.083	0.057	***
Over weight	0.153	0.132	**	0.175	0.191	
Born Sept-Dec	0.326	0.358	***	0.335	0.338	
N	1836	3763		807	2766	

Note: *N.A.* and *A.* stand for whether the teacher questionnaire is not available or available, respectively. The entries are means of pupil-level data for those students in the MCS who do not have missing values for gender, race, birth weight, weight, month born, parental long standing illness, parental smoking, parental education, parental age and parental working status, housing income and whether the family lives in a Council house or in a housing association. *N* stands for the number of observations. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

As for the parental level variables in Table 3.5, parents from the available teacher questionnaire sample for waves four and five seem to have healthier habits, they are less likely to smoke for both sampling waves. They are also, on average, older and wealthier. At the same time, children from the Available Teacher Questionnaire sample are less likely to reside in council house accommodation.

Table 3.5: Parental/Household Statistics by Availability of Teaching Questionnaire

	Age 7			Age 11		
	N.A.	A.	*Diff in Means*	N.A.	A.	*Diff in Means*	
	(1)	(2)	(3)		(4)	(5)	(6)
Mother characteristics							
DV effect	0.032	0.035			0.037	0.038	
Ever DV effect	0.062	0.063			0.081	0.081	
Depression	0.308	0.320			0.333	0.329	
Long term health problems	0.231	0.228			0.150	0.171	
Age	37.276	37.550	+		41.266	41.835	***
Smoking	0.156	0.149			0.135	0.116	**
GCSE grades (D-G) or equivalent	0.059	0.057			0.069	0.045	***
O level or equivalent	0.294	0.273			0.273	0.251	
A level or equivalent	0.179	0.169			0.170	0.171	
First degree or equivalent	0.397	0.432	**		0.394	0.441	+
Higher degree or equivalent	0.071	0.069			0.094	0.091	
In work	0.754	0.773			0.818	0.826	
Father characteristics							
Depression	0.151	0.138			0.178	0.176	
Long term health problems	0.219	0.234			0.149	0.166	+
Age	39.453	39.798	**		43.423	44.147	***
Smoking	0.221	0.197	**		0.185	0.145	***
GCSE grades (D-G) or equivalent	0.071	0.057	**		0.074	0.058	+
O level or equivalent	0.289	0.272			0.302	0.262	**
A level or equivalent	0.180	0.176			0.161	0.168	
First degree or equivalent	0.356	0.393	***		0.368	0.392	
Higher degree or equivalent	0.103	0.102			0.094	0.120	**
In work	0.946	0.963	***		0.950	0.946	
Household characteristics							
Ln income	10.308	10.395	***		10.312	10.409	***
Council house	0.095	0.064	***		0.084	0.060	**
N	1836	3763			807	2766	

Note: Refer to Table 3.4. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table 3.6 presents Fisher's Z transformation of the correlation from the Maximum Likelihood estimation of equation 3.5 between error terms (ε and v).[5] The results presented in Table 3.6 control for the most comprehensive set of covariates (child, parental and household level covariates). Column (1) and (3) presents the Fisher's Z transformation of the contemporaneous DV definition whereas columns (2) and (4) presents the Ever DV definition. All Fisher's Z transformation of the correlation are positive, suggesting that our OLS estimates are upward biased. Nevertheless, the level of significance differs across ages. Results at age 7 are statistically significant for most of educational areas whereas at age 11 the level of significance almost disappears for all subjects.

[5]Fisher's Z transformation also known as the arc-hyperbolic tangent of the correlation is widely used to estimate the Maximum Likelihood and is defined as $\frac{1}{2}ln\frac{(1+\rho)}{1-\rho)}$ where ρ is the correlation between error terms and is bounded between [-1,1]. When ρ is not equal to zero, its sampling distribution is skewed. Fisher's Z transformation of the correlation behaves as a normal distribution and allows us to make inference between the correlation of both samples, from available and non-available teachers records.

Table 3.6: Fisher's Z transformation of the correlation

	Age 7		Age 11	
	Cont.	Ever	Cont.	Ever
	(1)	(2)	(3)	(4)
Speaking and listening (English)	0.02733	0.02458	X	X
	(0.0311)	(0.0311)		
Read(English)	0.03522^{**}	0.03250^{**}	X	X
	(0.0170)	(0.0163)		
Writing(English)	0.05768	0.05074	X	X
	(0.0454)	(0.0430)		
English	X	X	0.01203	0.01328
			(0.0433)	(0.0430)
Science	0.8664^{***}	0.8667^{***}	0.005728	0.008238
	(0.1244)	(0.1242)	(0.0940)	(0.0883)
Maths	0.04238^{+}	0.03890^{+}	0.02540‡	0.02271‡
	(0.0226)	(0.0220)	(0.0820)	(0.0950)
Physical education	1.2325^{***}	1.2337^{***}	0.9362^{***}	0.9379^{***}
	(0.0665)	(0.0665)	(0.1301)	(0.1307)
Information and Technology	1.1294^{***}	1.1271^{***}	−0.02084	−0.01079
	(0.0814)	(0.0812)	(0.1348)	(0.2054)
Creativity	1.0637^{***}	1.0626^{***}	0.9436^{***}	0.9388^{***}
	(0.0713)	(0.0717)	(0.0893)	(0.0897)

Note: The entries are the values of Fisher's Z transformation of the ρ (*see* footnote 4) from the sample selection model and robust standard errors are in parenthesis and clustered at child levels. Child control variables: child race, child sex , whether the child born with low weight, whether the child born between September-December, whether the child is obese or overweight. Mother variables: age, whether she has ever been diagnosed of depression, whether she suffers from chronic conditions, whether she is in work. The highest educational level attained (academic or vocational) :*GCSE grades (D-G) or equivalent*,*O level or equivalent*, *A level or equivalent*, *First degree or equivalent* or *Higher degree or equivalent*. Father variables: age, whether he has ever been diagnosed of depression, whether the biological father suffers from chronic conditions, whether he is in work. The highest educational level attained (academic or vocational) :*GCSE grades (D-G) or equivalent*,*O level or equivalent*, *A level or equivalent*, *First degree or equivalent* or *Higher degree or equivalent*. Household variables: Whether the family lives in a Council house (or in a housing association). We exclude the variable income due to non-converging Maximum Likelihood. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Do parents self-select into a violent relationship?

We turn our analysis to inspect the self-selection process into a violent relationship. The related literature highlights that the prototypical battered woman is more likely to come from a minority and a lower socioeconomic background and more likely to engage in risky behaviours (Aizer 2011). In particular, from Table A7 households in which there is DV, both parents are more likely to suffer depression, to live in a council house, to be poorer (in terms of average income) and more likely to smoke. This figure prevails across both sampling waves. Striking differences between samples might suggest that there are unobserved factors related to self-selection into a violent relationship, so our parameter estimates are down-ward biased.

Less is known in the literature on what drives a man to exercise violence against his partner. Understanding the perpetrator's experiences is relevant to design policy measures that could both avoid, or at least lessen, violence against women and highlight those areas in which clinicians should focus on while treating those men (Whiting et al. 2014). DV against women frequently entails a mixture of abusive behaviours including physical, sexual and psychological aggressions. Johnson (2010) distinguishes two type of intimate partner violence: situational and intimate violence. The first stands when a disagreement escalates into physical violence which can be perpetrated from both sexes. The latter is recognized as "battering" and implies high amounts of coercive controlling behaviour. Intimate violence is more likely perpetrated by a man (Whiting et al. 2014).

It is difficult to isolate a unique cause for DV from the perspective of a perpetrator. There are many confounders like the men's gender role during socialization, alcohol/drug abuse, economic hardship, experiencing or witnessing violence in the family-of-origin, stress, gender-inequality and psychopathology (Coker et al. 2000, DeMaris et al. 2003, Holtzworth-Munroe et al. 2000). Being bullied during childhood might contribute to cognitive distortion regarding the need to dominate or control (Jennings & Murphy 2000). This may be one of the reasons why men who feel vulnerable are more likely to react by seeking to control or dominate (Lisak 1995).

Clinical literature establishes some distinctive features among abusers.

The perpetrator has an inaccurate perspective of attending or giving meaning to experience (Barriga et al. 2000), thus he suffers a cognitive distortion (Eckhardt & Dye 2000). Typical distortions are denial, blame, justification and minimization in order to kind of downplay actions (Holtzworth-Munroe et al. 2000). Another common ground among perpetrators is that they are likely to have control problems of anger and have irrational beliefs that non-violent men do not have (Eckhardt et al. 1998).

Pollak (2004) proposes an intergenerational model of DV in which behavioral strategies are transmitted from one generation to another. The model suggests that in violent families both parents self-select themselves into the relationship. We attempt to address this source of bias in order to identify the effect of DV on educational attainment. As in Aizer (2011), we propose a control function approach to tackle the issue of self-selection into a violent relationship (Lee 1982, Heckman 1977) .

$$score_i = \alpha + \delta DV_i + X_i\beta + \varepsilon_i \tag{3.6}$$

$$DV_i^* = 1[\theta + \varpi Z_i + X_i\eta + \nu_i] \tag{3.7}$$

Equation 3.6 is the equation of interest and equation 3.7 accounts for the determinants of the selection into a relationship with DV. The dependent variable in equation 3.7 is an indicator variable where $DV = 1$ if $DV^* > 0$ and $DV = 0$ if $DV^* \leq 0$. We need to include a restriction variable in the control function, or at least as a proxy for variables that are related to the existence of DV or connected to the motivation that "triggers" DV. Therefore, Z is a vector of variables not included in equation 3.6, which affect DV but not children scores. We estimate equation 3.7 using a probit model and then build an inverse Mill's ratio to be included in equation 3.6 to generate consistent estimates of β and δ.

We are interested in variables related to the various insights provided by the economic literature to explain the existence of DV. Aizer (2011) uses a proxy value for the enforcement policies as a source of exogenous variation. In her study the value of Z is the lagged ratio of arrests for DV to the number of 911 calls to the police reporting DV in a given year. We do not dispose of the above breakdown for the UK and we base our restriction variable "Z" given

the insights provided by the game-theoretical approach adopted in Tauchen et al. (1991) and Farmer & Tiefenthaler (1996). Tauchen et al. (1991) develop and estimate a non-cooperative household model of violence in which DV is seen as both a source of gratification and as a way to coerce the victim's behaviour. Violence increases the husband's utility directly, and indirectly by controlling his wife's behavior. Violence in equilibrium depends on the level of control over resources by each partner and on whether available options alternative of cohabitation exist. Farmer & Tiefenthaler (1996) analyze the relation of care services for battered women and the prevalence of DV. Results indicate that policies that increase alternative options to a violent household environment provide a higher bargaining power to women and are associated with lower DV prevalence.

In a related study, Anderberg et al. (2016) examines how variations in gender-specific unemployment rates across regions affect the frequency of intimate partner abuse in England and Wales along the period 2004 - 2011. In this paper, the authors develop a dynamic game model in which wives do not know whether their partners are prone to violence. They can only infer their husbands' type once they see their conduct. In the equilibrium of the game, a violent husband can either reveal or hide his true nature, it depends on each partners' future earnings, which turn to be related to both unemployment risk and potential wages. Their model allows the authors to test two main predictions: (1) Higher risk of male unemployment and lower wages for men are related to lower risk of intimate partner abuse; and, (2) Higher risk of female unemployment and lower wages for women relates to a higher risk of intimate partner abuse. Findings in the study corroborate that violence is related to the "relative" position of each spouse in the market (across both dimensions: potential wages and unemployment risk). Thus, by using an array of specifications they show how a better male relative to women economic position accounts for a higher likelihood of Domestic Violence in a given region. They present two main specifications: (1) including both gender regional unemployment rates; and, (2) looking at the difference among both gender unemployment rates (referred in the paper as female-male unemployment gap). They find that higher male unemployment is related to a lower likelihood of domestic violence and higher female unem-

ployment is related to a higher risk of physical abuse whereas, a wider gender gap is also related to a higher likelihood of Domestic violence. Nevertheless, they acknowledge the possibility of two shortcomings that might bias their parameter estimates: omitted variables and simultaneity among unemployment figures and domestic violence. Thus, to make their strategy sensible to uncontrolled factors that might be correlated to unemployment figures and affect the incidence of domestic violence, they include a set of regional characteristics such as measures of violent and non-violent crimes per capita, police force manpower, regional hospitalisation rates for alcohol-related conditions, and per capita measures of drugs possession in order to control for omitted variables. The marginal effect of the gender gap remains practically unaffected once the authors include these variables. They tackle the simultaneity between unemployment and domestic abuse by instrumenting the gender-unemployment gap by constructing industry specific gender unemployment rates, and again, their results show that the effect of the gender gap remains unchanged. Such results seem to imply that the unemployment gap seems to have an effect on the incidence of domestic physical abuse.

Given all the above, we construct a variable capturing the difference between men and women's regional unemployment rates based on data from the Office of National Statistics (ONS) [6] and include it as exclusion restriction in Equation 3.7. Figure 3.1 presents the regional difference among unemployment rates between men and women across England, Wales, Scotland and Northern Ireland at each survey interview period whereas, in Figure 3.2 we present the proportion of *Ever*-DV cases in the last two surveys of the MCS. One of the major concerns when choosing a proper instrument is that it should vary across regions. This concern is met, as confirmed by the

[6]The rate of UK unemployment measured by the ONS-Labour Force Survey (LFS) uses the definition of unemployment specified by the International Labour Organisation. Unemployed people as those without a job who have been actively seeking work in the past 4 weeks and are available to start work in the next 2 weeks. It also includes those who are out of work but have found a job and are waiting to start it in the next 2 weeks. *see https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment*

graphical representation in Figure 3.1. In those areas where the difference is near zero, there is also a proportionally higher record of DV cases in the MCS, which is in line with the work of Anderberg et al. (2016).

Figure 3.1: Regional unemployment difference= %unempl.men - % unempl.women

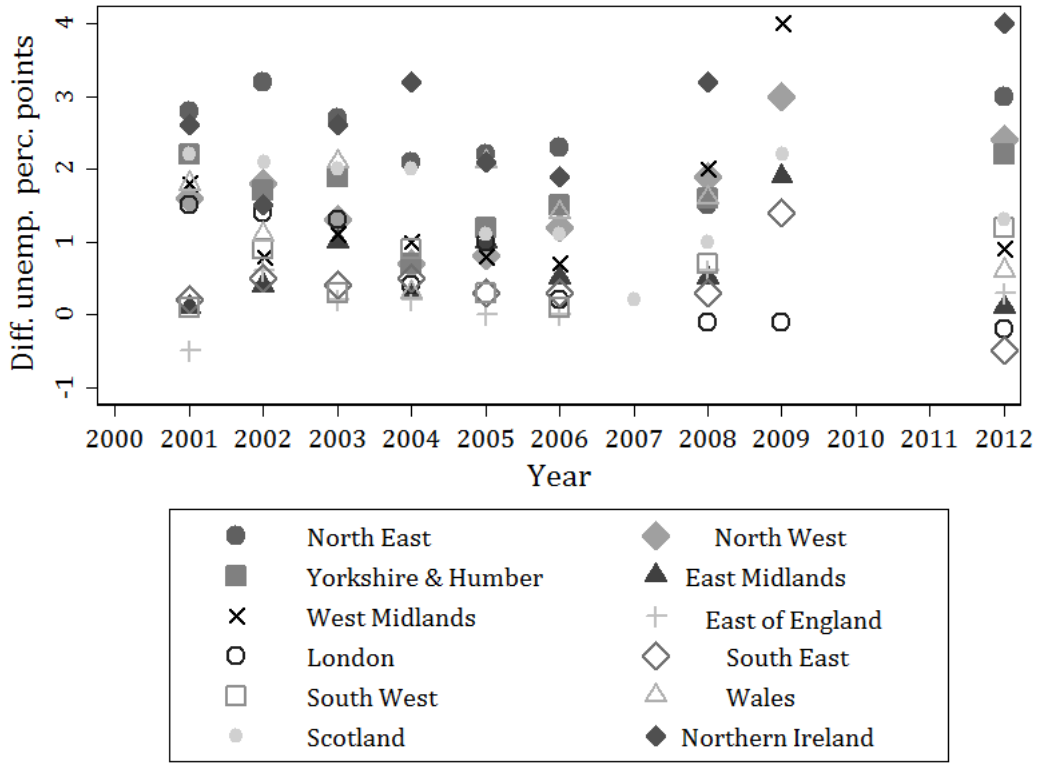
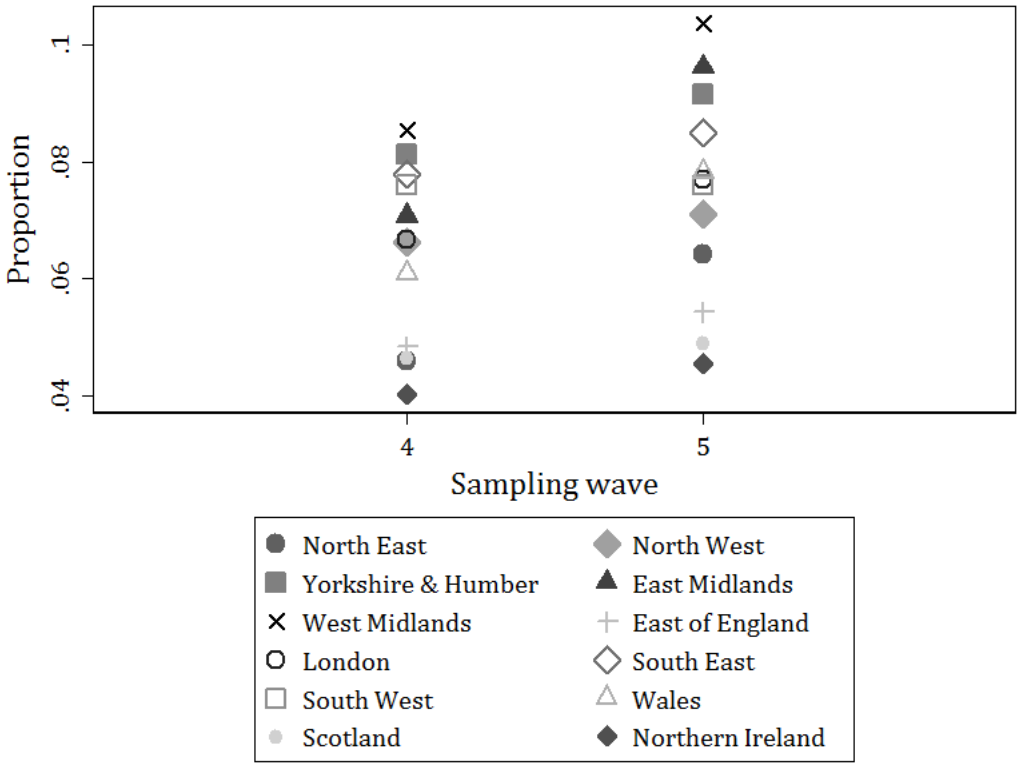


Figure 3.2: Proportion of *Ever*DV cases at the MCS



The regional unemployment difference corresponds to the unemployment gap that existed during the first wave of the MCS. We chose the first period to remove the chance that contemporaneous "differences" might affect the relative bargaining power of women inside a household at the time of the recording of children's academic performance by affecting the intra-household resource allocation decision.

Despite this, a major threat to the validity of our instrument is that the relative difference might also affect the child's learning process. In principle, as shown in Table 3.7 where we present the parameter estimates from a probit function for Equation 3.7, the regional difference is significant across all specifications using both DV definitions (*contemporaneous* and *ever*). Columns (1) and (4) from Table 3.7 control for child characteristics. The following columns take into account a more comprehensive set of covariates. In all regressions the coefficient is negative and significant. By controlling for variables that proxy "quality time with children"- such as *time with children in previous waves* and *maternal education*-, we already correct for the simultaneity of the child learning process and the maternal relative bargaining power in the household. Thus, our instrument is not masked by the parental effect on the academic performance, when if not accounted for the statistical relevance would only be significant in columns (1) and (4), where we just control for child covariates.

Table 3.7: First stage: Probit of Suffering DV

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Contemporaneous						
Difference unemployment	-0.0969^{***}	-0.1083^{***}	-0.1012^{***}	-0.1176^{***}	-0.1192^{***}	-0.1125^{***}
	(0.0363)	(0.0374)	(0.0372)	(0.0412)	(0.0418)	(0.0425)
Ever						
Difference unemployment	-0.0553^{+}	-0.0664^{**}	-0.0590^{+}	-0.0561^{+}	-0.0635^{+}	-0.0582^{+}
	(0.0311)	(0.0315)	(0.0316)	(0.0331)	(0.0337)	(0.0341)
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Maternal	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*

Notes: Each row corresponds at the effect of the unemployment difference between male and female on the probability of suffering DV across both waves 4 and 5. The difference in unemployment used is the one recorded at the first wave of the MCS (2001-2002). We evaluate the effect by using both definitions of DV, contemporaneous and accumulated. Standard errors in parentheses.$^{+}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$

3.3.2 Propensity score matching

In addition to extending the OLS model to account for the self-selection problems above, we estimate the Average Effect of Treatment on the Treated (ATT) where the treatment group is children in the DV sample and the treatment is DV itself.

We identify the average effect on children's school outcomes from troubled families in comparison to their nearest comparison group. In this setting, the counterfactual is the household with the same set of baseline characteristics as in troubled families, such as neighbourhood, parental level of education covariates but, excluding the fact of the mother being battered. The average treatment over the treated (DV sample) is defined as follows:

$$ATT = E[score(DV = 1) - score(DV = 0)|X, DV = 1] \tag{3.8}$$

Where X is the set of covariates we match control and treated samples. Hypothetically, we would like to randomly allocate children to troubled and non-troubled families with the same set of baseline characteristics and compare the average school outcome of the two groups. The major concern is that troubled families might be different from other families. For instance,

troubled families might come from a lower socioeconomic background than other families in our data set. In such a scenario, the correlation between troubled families and lower school outcomes would be cofounded with the socioeconomic background of the family. Thus, the spillover effect of living in a household where DV is present might not be homogeneous across families, but rather might vary as a function of the covariates of the families.

We rely on matching methods in order to pair DV-troubled families (treated) with non-troubled families (controls) that have analogous characteristics. Restricted on the sample set of covariates, the counterfactual distribution of school outcomes of children from DV-troubled families is the same as the school outcome distribution of children from non-troubled families. Matching methods rely on the assumption that there is no-selection into treatment on the basis of unobservables.

Our objective here is to build a control group up by identifying covariates that are similar to those of the treatment. Matching DV and non-DV families on the basis of the covariates is equivalent to matching them using a balancing score B(x) (Rosenbaum & Rubin 1983). The simplest balancing score is the propensity score B(x). This method assumes that the counterfactual distribution of children school outcomes from DV-affected families is the same as for children from non-DV families.

We estimate propensity score matching using a probit model of the probability that the mother suffers DV. We use this model to predict the propensity that the mother in a family will experience DV. We do not rely on a linear probability model because the skewness of the distribution of DV might lead to values beyond the [0,1] interval. Due to the balance properties requirements, we have to find a common support of covariates that are equivalent between both groups. As can be seen in Table 3.8, we have to reduce the number of variables in the model and redefine a few binary indicators. Table 3.8 presents the set of characteristics based on which we achieved balanced groups. We are able to match 237 observations and 223 observations at the age of 7 and 11, respectively. We use the nearest neighbour propensity score algorithm with replacement (Wooldridge 2010, Caliendo & Kopeinig 2008).

Table 3.8: Matched control covariates

Variable	Definition
Child characteristics	
Female	1 if female, 0 otherwise
Low birthweight	1 if the child birth weight was lower or equal 2,5 Kg., 0 otherwise
White	1 if child race was white, 0 otherwise
born September-December	1 if child was born between September and December, 0 otherwise
Mother characteristics	
Depression	1 if the parent has ever been diagnosed depression, 0 otherwise
Education	1 if the parent has a Higher degree or a First Degree, 0 otherwise
In work	1 if the parent is working at the time of the questionnaire, 0 otherwise
Father characteristics	
Education	1 if the parent has a Higher degree or a First Degree, 0 otherwise
In work	1 if the parent is working at the time of the questionnaire, 0 otherwise
Household characteristics	
Council house	1 if the family lives in a council house or in a housing association, 0 otherwise

3.4 Results

In this section we present results for both definitions of DV, using the *Contemporaneous* DV variable in Table 3.9 and the *Ever* DV variable in Table 3.10. The estimates from columns (1)-(3) correspond to the econometric estimation at age 7 and columns (4)-(6) correspond to the econometric estimation at age 11. The first and fourth column in Tables 3.9 and 3.10 provide the OLS specification estimates, the second and fourth columns provide the sample selection correction and the third and sixth columns provide the results obtained when applying the control function correction. We include the inverse Mills ratio in each control function column and bootstrap the standard errors. All provided estimates were obtained controlling for the most comprehensive set of covariates: children, mother, father and household covariates. Tables A1, A2, A3, A4, A5 and A6 in the Appendix provide the results when the specification progressively includes child, parental and household controls for the OLS, sample selection and control function approaches.

In Table 3.9, the results at age 7 consistently show that the contemporaneous DV definition is not statistically either through analyzed academic dimensions or across the various regressions strategies. English at age 7 is broken down into three main dimensions: *"Speaking and listening"*,*"Reading"* and *"Writing"*. At age 11 English is captured by one dimension. Results at age 11 are almost always statistically significant across all regression strategies. It is interesting to note the heterogeneity of the impact between academic dimensions. The impact of the Contemporaneous-DV definition on academic attainment is larger for technical-related areas like Science (and it is equal to around -0.31 Standard Deviations (SD) throughout all specifications), Maths (approximately to -0.24SD) and Information and Technology (about to -0.26SD lower). However, in the English-dimension the effect is lower (-0.17SD). In the areas of Physical Education and Creativity the effect is not statistically significant. The size of the effect and the statistical relevance of the parameter estimates do not change across the range of specifications. This suggests that the unobserved variables do not have a large at significant impact on children's academic outcomes.

Table 3.9: Estimated DV gap - Contemporaneous DV

	Age 7			Age 11		
	OLS	Sample selection	Control function	OLS	Sample selection	Control function
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking and listening (English)	-0.1374	-0.1363	-0.135	X	X	X
	(0.0913)	(0.0909)	(0.0938)			
Read (English)	-0.1393	-0.1929^{+}	-0.1399^{+}	X	X	X
	(0.0937)	(0.1091)	(0.0849)			
Writing (English)	-0.1291	-0.1268	-0.1288	X	X	X
	(0.0901)	(0.0898)	(0.0792)			
English	X	X	X	-0.1738^{**}	-0.1736^{**}	-0.1734^{+}
				(0.0887)	(0.0882)	(0.0906)
Science	-0.02886	0.0015	-0.03153	-0.3158^{***}	-0.3157^{***}	-0.3153^{***}
	(0.0861)	(0.0942)	(0.0718)	(0.0996)	(0.0719)	(0.1025)
Maths	-0.1001	-0.0984	-0.1034	-0.2445^{**}	-0.2440^{**}	-0.2463^{**}
	(0.0910)	(0.0906)	(0.0840)	(0.1045)	(0.1039)	(0.1011)
Physical education	-0.0723	-0.0236	-0.0739	-0.0588	-0.03999	-0.0577
	(0.0890)	(0.1040)	(0.0828)	(0.0980)	(0.1064)	(0.1042)
Information and Technology	-0.1058	-0.0996	-0.1087	-0.2644^{***}	-0.2648^{***}	-0.2628^{**}
	(0.0925)	(0.1595)	(0.1021)	(0.1017)	(0.1012)	(0.1024)
Creativity	-0.0553	-0.0200	-0.0574	-0.1540^{+}	-0.1362	-0.1546
	(0.0898)	(0.1007)	(0.0817)	(0.0934)	(0.1041)	(0.0976)
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Household	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Maternal	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Father	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: Each row corresponds to a child's ability dimension. Values in the table are the parameter estimates of the DV effect. See tables A1-A6 in the Appendix for a detailed breakdown. The estimates from columns (1), (2) and (3) correspond to the econometric estimation at age 7 and columns (4), (5) and (6) correspond to the econometric estimation at age 11. Child variables: race, sex, whether the child born with low weight, born between September-December, whether obese or overweight. Mother variables: age, whether she has ever been diagnosed with depression, whether she suffers from chronic conditions, whether at work, highest educational level attained (academic or vocational): GCSE grades (D-G) or equivalent, O level or equivalent, A-level or equivalent, First degree or equivalent, Higher degree or equivalent. Father variables: age, whether ever been diagnosed with depression, whether he suffers from chronic conditions, whether at work, highest educational level attained (as defined for the mother).Household variables: whether family lives in a council house (or in a housing association), natural logarithm of the household income. Columns (2) and (5) do not control for the variable income, because the Maximum likelihood function does not converge [7].
Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table 3.10 presents the same set of specifications using the *Ever* definition of DV. Overall, results shown are similar in terms of sign and statistical significance to those obtained using the Contemporaneous-DV. Mainly, we notice that the effects in Table 3.10 are slightly smaller than in Table 3.9. This could be partially explained by the fact that the Ever-DV definition may include isolated DV occurrences in the past that might not repeat again. Thus, the influence of this cases may mitigate the estimate of the effect of DV.

Interestingly, the differences between the effects of *Ever-DV* and *Contemporaneous-DV* are heterogenous across the different academic dimensions. The decrease in Science and Maths (from -0.32SD in Table 3.9 to -0.20SD and from -0.24SD in Table 3.10 to -0.21SD) is higher than the one in the English dimension (from -0.17 to -0.13SD). These results are in line with what we observe for age 7, where, although insignificant, the effect was already negative for both DV definitions. Consequently, this suggest that the cumulative impact of DV seems higher for technical and scientific knowledge than for Creativity, Physical Education and Language, even not statistically different from one to another. Contemporaneous-DV has a higher impact on the concentration mechanisms required to acquire more technical and/or scientific knowledge. A plausible explanation is that in DV households the child faces difficulties in learning at early stages, complicating the learning process at a later age when the child grows up and making it difficult to keep up with their peers afterwards. Therefore, early detection of DV would help to lessen the negative impact on the learning process of children from families with DV. In general a control function strategy is more precise than a 2SLS path, since the latter does not require the assumption $E(\varepsilon|X) = \rho v_i$.[8] Nevertheless, if equation 3.7. is not correctly specified parameters estimates would be inconsistent. See Wooldridge (2010).

[8]The linear projection of the error term of equation 3.7 is $\varepsilon_i = \rho v_i + e_1$

Table 3.10: Estimated DV gap - Ever DV

	Age 7			Age 11		
	OLS	Sample selection	Control function	OLS	Sample selection	Control function
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking and listening (English)	-0.03067	-0.0302	-0.0305	X	X	X
	(0.0676)	(0.0673)	(0.0762)			
Read (English)	-0.0802	-0.0936	-0.0803	X	X	X
	(0.0677)	(0.0702)	(0.0663)			
Writing (English)	-0.0952	-0.0943	-0.0952	X	X	X
	(0.064)	(0.0638)	(0.065)			
English	X	X	X	-0.1333^{**}	-0.1331^{**}	-0.1331^{+}
				(0.067)	(0.0666)	(0.0747)
Science	-0.0352	-0.0231	-0.0355	-0.2033^{***}	-0.2032^{***}	-0.2032^{**}
	(0.0655)	(0.0719)	(0.0622)	(0.0697)	(0.0693)	(0.0841)
Maths	0.0046	0.0053	0.0043	-0.2176^{**}	-0.2173^{***}	-0.2178^{***}
	(0.0651)	(0.0649)	(0.067)	(0.0701)	(0.0697)	(0.076)
Physical education	-0.0664	-0.0523	-0.0666	0.0164	0.03268	0.0175
	(0.0665)	(0.0774)	(0.0673)	(0.0651)	(0.0712)	(0.0661)
Information and Technology	-0.0636	-0.0535	-0.0639	-0.0932	-0.09343	-0.0931
	(0.068)	(0.0785)	(0.0814)	(0.0697)	(0.0694)	(0.0671)
Creativity	-0.0361	-0.0202	-0.0364	-0.0823	-0.06605	-0.0824
	(0.0649)	(0.0735)	(0.0643)	(0.0632)	(0.0696)	(0.0625)
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Household	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Maternal	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Father	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: See notes in Table 3.9. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

As a final note, we observe that the effects for all specifications in Tables 3.9 and 3.10 are almost identical. Therefore, we believe that the relevance of the unobserved factors are not likely to add bias to our OLS estimates. Neither the selection by the availability of teachers' questionnaires nor the self-selection into a violent relationship seem to be affecting the main results. It is reasonable to suggest that given the extensive number of covariates included in our OLS specification, the DV estimates are robust to selection biases. Other studies, like Aizer (2011) rely mainly on administrative data, making it difficult to control for a more comprehensive set of covariates and the value added from our study is the depth and comprehensiveness of the covariates we can control for.

Table 11 presents the average treatment effects. In Table 3.11 we provide the Average effect of Treatment over the Treated (ATT) obtained from

the propensity score matching model in Section 3.3.2 by using the Ever-DV definition.[9] The sign and statistical significance are in line with the one presented in Tables 3.9 and 3.10. However, once we match our sample of children from DV families with the counterfactual sample (i.e. children with the same set of characteristics except for being in a family without DV), the Creativity dimensions also become statistically significant at age 11. The only non-significant impact is on Physical Education. Interestingly, the effect with respect of the comparison group in English is -0.20SD, which is in line with previous results. Nevertheless, for Science and Maths children in families with DV lose around 0.30SD when compared to their counterfactual group.

[9]With the Contemporaneous definition we were not able to match for a comprehensive set of characteristics, making our results unreliable

Table 3.11: Average effect of Treatment on the Treated

	Age 7	Age 11
Speaking and listening (English)	-0.024	X
	(0.069)	
Read (English)	-0.067	X
	(0.068)	
Writing (English)	-0.067	X
	(0.075)	
English	X	-0.196^{***}
		(0.081)
Science	-0.026	-0.295^{***}
	(0.087)	(0.084)
Maths	-0.006	-0.281^{***}
	(0.083)	(0.083)
Physical education	-0.104	-0.02
	(0.083)	(0.07)
Information and Technology	-0.082	-0.157^{***}
	(0.078)	(0.064)
Creativity	-0.057	-0.164^{***}
	(0.064)	0.075
N. treated	237	223

Notes: To define matched variables (control and treatment=DV) we use the nearest neighbor matching process with replacement. We estimate our parameters by using the Stata® build-in ado file developed by Becker et al. (2002). Standard errors in parentheses. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$.

Our results suggest that there might be a cumulative effect of DV which happens to be heterogenous across academic subjects. In those areas for which previous knowledge was relevant (technical-oriented disciplines), the effect is worse than in those for which this is not the case (if a child does not learn how to divide when he has to, it is tougher to learn how to calculate a square root later on). Thus, there is a clear mechanism by which DV affects learning that becomes significant in later stages at age 11 even if not captured in the scores at age 7. Most importantly, even when applying matching techniques using children with the same set of characteristics (see section 3.2 for a breakdown), the impact of DV is large and significant. The ATT estimates shows that there is a negative impact of living in a household with DV that goes beyond the effect of only having the socio-economic characteristics of such a family.

3.5 Conclusion

The relationship between children's education and their later job market performance has been widely established. Our paper aims to tackle a complementary question, that of the spillover effect of DV on children's educational outcomes, which therefore may affect their adulthood's labour market outcomes.

Our paper establishes that living in a household affected by DV has a negative impact on children's learning process. Exploiting the MCS, a national survey that tracks the lives of nearly of 19,000 children born in the UK over the period 2000-2001, our results indicate that there is a negative impact of living with DV on educational attainment although the impact is heterogenous across academic subject areas. While at 7 years of age most of the negative effects are not statistically significant, by the age of 11 a substantial gap in educational outomes emerges. There is a clear difference in magnitude in the effect of DV for all academic subjects studied. Although we are able to establish difference in educational outcomes across these two ages, the analysis is bounded to four year lapses between waves and we do not observe what happens between 7 and 11 years of age. Thus, a richer and

more informative dataset would enable us to monitor and to refine the causal impact of DV on educational attainment over time.

Our parameter estimates rely on two definitions of DV. The first definition, *Contemporaneous-DV*, captures if DV is reported in the current survey. The second one, *Ever-DV*, reflects if DV has been reported in the current wave or at any of the previous waves. We use the two DV definitions to minimise the underreporting problem of DV. We acknowledge the limitation introduced by not observing the true DV distribution among households and how this might created downward-bias in our results. Also, due to data constraints, we cannot correct for the frequency and intensity of DV. Finally, our parameter estimates rely on physical abuse as we do not have data on verbal abuse.

A difference between the coefficients associated to the Ever and the Contemporaneous DV definitions would indicate the existence of an accumulative effect of DV on chidren's educational outcomes, in particular for those subjects for which the Contemporaneous coefficient is lower than that of Ever. Interestingly, our data indicates that this is the case for Maths and Science but not for English. Thus, our analysis helps to shed light on the learning process. The estimates highlight the importance of ensuring that children are able to learn the foundations of these subjects undisrupted to be able to build up knowledge later. There is a clear higher marginal cost of acquiring new information for those children who were not able to acquire the basic concepts at the expected age due to the distortions introduced by living in a household with DV.

In both analyses we include various strategies to control for the potential problems created by unobserved factors, which might bias our OLS specification. First, we address the selection introduced by having or not having the questionnaire available. We opt for the simplest specification in which we control for whether we do or do not have the questionnaire adjusting for the observed covariates. We also explore the impact on the coefficient of interest of the parents' self-selection into a violent relationship. To do so, we exploit the regional difference between male and female unemployment rates. In areas where the gap is lower, females have a higher bargaining power and viceversa. We do not find any big differences in terms of magnitude

and significance in the estimates of our results across the different empirical strategies. We interpret this as evidence that the OLS specifications control for such a comprehensive set of estimates such that, indirectly, the effect of the unobserved factors has been minimised and is not biasing our estimates.

The analysis is also extended by incorporating the Average Treatment Effects over the Treated. Even when matching children living under a roof with DV with their closest counterfactual (non-DV) group in terms of background and socio-economic characteristics, the effect of DV is negative for both age groups, although only statistically significant at age 11. This result highlights that tackling DV at the family level maybe even more important for the learning process than addressing other environmental influences such at the neighborhood.

The contribution of this study is twofold. First we give a clear account of the effect on children's educational outcomes of living in a household with DV and, also, we show that there might be a cumulative impact of DV that differs by subject area. Areas for which previous knowledge is important are more affected by DV in the latter stages of the learning process. There is a clear message for policy making arising from the results, indicating that early interventions to remove DV from children's lives will translate into improved present and future educational attainment.

3.6 Appendix

Table A1: OLS Estimates of DV gap on educational outcomes - Contemporaneous DV definition

	Age 7				Age 11		
	(1)	(2)	(3)		(4)	(5)	(6)
Speaking and listening (English)	-0.2341^{**}	-0.1458	-0.1374		X	X	X
	(0.0953)	(0.0917)	(0.0913)				
N	3763	3763	3763				
ll	-5264.404	-5161.577	-5143.314				
Read (English)	-0.1908^{+}	-0.1433	-0.1393		X	X	X
	(0.0999)	(0.0946)	(0.0937)				
N	3763	3763	3763				
ll	-5230.172	-5156.133	-5132.804				
Writing (English)	-0.2297^{**}	-0.09886	-0.1291		X	X	X
	(0.0943)	(0.1387)	(0.0901)				
N	3763	2185	3763				
ll	-5211.363	-2915.418	-5086.084				
English	X	X	X		-0.3035^{***}	-0.1869^{**}	-0.1738^{**}
					(0.0927)	(0.0885)	(0.0887)
N					2766	2766	2766
ll					-3835.566	-3734.397	-3720.663
Science	-0.1471	-0.04203	-0.02886		-0.4382^{***}	-0.3258^{***}	-0.3158^{***}
	(0.0911)	(0.0859)	(0.0861)		(0.1058)	(0.1007)	(0.0996)
N	3763	3763	3763	2766	2766	2766	
ll	-5293.561	-5174.266	-5154.813	-3875.428	-3762.280	-3745.312	
Maths	-0.1912^{***}	-0.1024	-0.1001		-0.3601^{***}	-0.2530^{***}	-0.2445^{**}
	(0.0973)	(0.0914)	(0.0910)		(0.1090)	(0.1051)	(0.1045)
N	3763	3763	3763		2766	2766	2766
ll	-5275.025	-5188.849	-5176.784		-3871.401	-3788.979	-3771.708
Physical education	-0.1495^{+}	-0.0868	-0.0723		-0.1494	-0.0720	-0.0588
	(0.0906)	(0.0891)	(0.0890)		(0.0980)	(0.0987)	(0.0980)
N	3763	3763	3763		2766	2766	2766
ll	-5267.659	-5230.938	-5224.484		-3828.520	-3787.339	-3780.393
Information and Technology	-0.1896^{**}	-0.1045	-0.1058		-0.3621^{***}	-0.2649^{**}	-0.2644^{***}
	(0.0960)	(0.0929)	(0.0925)		(0.1056)	(0.1028)	(0.1017)
N	3763	3763	3763		2766	2766	2766
ll	-5290.172	-5219.596	-5213.559		-3885.977	-3808.550	-3798.467
Creativity	-0.1398	-0.0688	-0.0553		-0.2379^{**}	-0.1637^{+}	-0.1540^{+}
	(0.0918)	(0.0908)	(0.0898)		(0.0940)	(0.0935)	(0.0934)
N	3763	3763	3763		2766	2766	2766
ll	-5165.736	-5110.642	-5104.498		-3781.844	-3725.234	-3717.711
Controls							
Child	*Yes*	*Yes*	*Yes*		*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*		*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*		*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*		*No*	*Yes*	*Yes*

Notes: Each row corresponds to a child's ability dimension. Values in the table are the parameter estimates of the DV effect. Robust standard errors in parentheses and clustered at child level. The estimates from columns (1), (2) and (3) correspond to the econometric estimation at age 7 and columns (4), (5) and (6) correspond to the econometric estimation at age 11. Child variables: race, sex, whether the child born with low weight, born between September-December, whether obese or overweight. Mother variables: age, whether she has ever been diagnosed with depression, whether she suffers from chronic conditions, whether at work, highest educational level attained (academic or vocational): GCSE grades (D-G) or equivalent, O level or equivalent, A-level or equivalent, First degree or equivalent, Higher degree or equivalent. Father variables: age, whether ever been diagnosed depression, whether suffers from chronic conditions, whether at work, highest educational level attained (as defined for the mother).Household variables: whether family lives in a council house (or in a housing association), natural logarithm of the household income. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table A2: OLS Estimates of DV gap on educational outcomes - Ever DV definition

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking and listening (English)	−0.1056	-0.05714	-0.03067	X	X	X
	(0.0703)	(0.0696)	(0.0676)			
N	3763	3512	3763			
ll	-5266.770	-4803.358	-5144.504			
Read (English)	-0.1320^{+}	-0.0830	-0.0802	X	X	X
	(0.0706)	(0.0684)	(0.0677)			
N	3763	3763	3763			
ll	-5230.598	-5156.730	-5133.377			
Writing (English)	-0.1763^{**}	-0.0396	-0.0952	X	X	X
	(0.0664)	(0.0946)	(0.0640)			
N	3763	2185	3763			
ll	-5211.306	-2915.711	-5086.154			
English	X	X	X	-0.2198^{***}	-0.1416^{**}	-0.1333^{**}
				(0.0700)	(0.0671)	(0.0670)
N				2766	2766	2766
ll				-3835.229	-3734.075	-3720.327
Science	-0.1297^{+}	-0.0464	-0.0352	-0.2950^{***}	-0.2117^{***}	-0.2033^{***}
	(0.0679)	(0.0653)	(0.0655)	(0.0737)	(0.0700)	(0.0697)
N	3763	3763	3763	2766	2766	2766
ll	-5293.079	-5174.131	-5154.722	-3876.190	-3763.122	-3746.180
Maths	-0.0721	-0.0007	0.0046	-0.2976^{***}	-0.2256^{***}	-0.2176^{**}
	(0.0685)	(0.0651)	(0.0651)	(0.0726)	(0.0704)	(0.0701)
N	3763	3763	3763	2766	2766	2766
ll	-5276.849	-5189.561	-5177.461	-3868.766	-3786.857	-3769.716
Physical education	-0.1283^{+}	-0.0794	-0.0664	-0.0442	0.0057	0.0164
	(0.0673)	(0.0667)	(0.0665)	(0.0649)	(0.0654)	(0.0651)
N	3763	3763	3763	2766	2766	2766
ll	-5267.259	-5230.714	-5224.325	-3829.500	-3787.617	-3780.550
Information and Technology	-0.1322^{+}	-0.0667	-0.0636	-0.1649^{**}	-0.0967	-0.0932
	(0.0701)	(0.0680)	(0.0680)	(0.0712)	(0.0700)	(0.0697)
N	3763	3763	3763	2766	2766	2766
ll	-5290.553	-5219.812	-5213.838	-3889.858	-3811.286	-3801.250
Creativity	−0.0972	-0.0454	-0.0361	-0.1406^{**}	−0.0892	-0.0823
	(0.0661)	(0.0654)	(0.0649)	(0.0645)	(0.0634)	(0.0632)
N	3763	3763	3763	2766	2766	2766
ll	-5165.964	-5110.725	-5104.555	-3782.745	-3725.838	-3718.272
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Notes: See notes in Table A1. Robust standard errors in parentheses and clustered at child level. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table A3: Estimated sample selection model-Contemporaneous DV definition

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking	-0.2338**	-0.1699+	-0.1363	X	X	X
	(0.0952)	(0.0958)	(0.0909)			
N	5599	5599	5599			
ll	-8793.758	-8671.681	-8649.74			
Reading	-0.2356**	-0.1419	-0.1379	X	X	X
	(0.1004)	(0.0943)	(0.0933)			
N	5599	5599	5599			
ll	-8791.691	-8667.02	-8639.223			
Writing	-0.2289**	-0.1522	-0.1268	X	X	X
	(0.0942)	(0.0964)	(0.0898)			
N	5599	5599	5599			
ll	-8740.717	-8616.635	-8592.503			
English	X	X	X	-0.3035***	-0.2188**	-0.1736**
				(0.0926)	(0.1048)	(0.0882)
N				3573	3573	3573
ll				-5736.311	-5591.861	-5600.631
Science	-0.1226	0.001508	0.001508	-0.4355***	-0.3400***	-0.3157***
	(0.1)	(0.0942)	(0.0942)	(0.1158)	(0.1081)	(0.0991)
N	5599	5599	5599	3573	3573	3573
ll	-8816.69	-8655.569	-8655.569	-5767.78	-5643.031	-5625.28
Maths	-0.1907**	-0.1006	-0.09841	n.a.	n.a.	-0.2440**
	(0.0972)	(0.0912)	(0.0906)			(0.1039)
N	5599	5599	5599			3573
ll	-8804.379	-8699.734	-8683.202			-5654.976
Physical Education	-0.1173	-0.04245	-0.03133	-0.1461	-0.05392	-0.03999
	(0.1047)	(0.1029)	(0.1028)	(0.1066)	(0.107)	(0.1064)
N	5599	5599	5599	3573	3573	3573
ll	-8751.573	-8691.622	-8681.342	-5722.991	-5667.432	-5653.787
Information and Technology	-0.1704	-0.07215	-0.0759	-0.3621***	-0.2659***	-0.2648***
	(0.1087)	(0.1057)	(0.1056)	(0.1054)	(0.1026)	(0.1012)
N	5599	5599	5599	3573	3573	3573
ll	-8793.6	-8699.014	-8688.899	-5786.758	-5695.382	-5678.436
Creativity	-0.1142	-0.03188	-0.01999	-0.2378**	-0.144	-0.1362
	(0.103)	(0.1018)	(0.1007)	(0.0946)	(0.1043)	(0.1041)
N	5599	5599	5599	3573	3573	3573
ll	-8673.213	-8597.326	-8586.37	-5678.726	-5600.912	-5586.891
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Notes: Each row corresponds a child's ability dimension. Values in the table are the parameter estimates of the DV effect from a Maximum Likelihood Heckman Sample selection model. Standard errors are clustered at child level. The estimates from columns (1), (2) and (3) correspond to the econometric estimation at age 7 and columns (4), (5) and (6) correspond to the econometric estimation at age 11. Child variables: race, sex, whether the child born with low weight, born between September-December, whether obese or overweight. Mother variables: age, whether she has ever been diagnosed with depression, whether suffers from chronic conditions, whether at work, highest educational level attained (academic or vocational): GCSE grades (D-G) or equivalent, O level or equivalent, A-level or equivalent, First degree or equivalent, Higher degree or equivalent. Father variables: age, whether ever been diagnosed with depression, whether suffers from chronic conditions, whether at work, highest educational level attained (as defined for the mother).Household variables: whether family lives in a council house (or in a housing association).n.a stands for those function where the Maximum likelihood function does not converge. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table A4: Estimated sample selection model-Ever DV definition

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking	-0.1055	-0.03493	-0.03025	X	X	X
	(0.0703)	(0.0676)	(0.0673)			
N	5599	5599	5599			
ll	-8796.311	-8674.04	-8651.161			
Reading	-0.1574**	-0.0825	-0.07968	X	X	X
	(0.071)	(0.0683)	(0.0674)			
N	5599	5599	5599			
ll	-8792.741	-8667.878	-8640.028			
Writing	-0.1761***	-0.09614	-0.09435	X	X	X
	(0.0663)	(0.0646)	(0.0638)			
N	5599	5599	5599			
ll	-8740.846	-8618.338	-8592.806			
English	X	X	X	-0.2198***	-0.1514+	-0.1331**
				(0.0699)	(0.0781)	(0.0666)
N				3573	3573	3573
ll				-5736.015	-5592.524	-5600.287
Science	-0.1221	-0.03378	-0.02313	-0.2880***	-0.2206***	-0.2032***
	(0.0751)	(0.0719)	(0.0719)	(0.0804)	(0.0753)	(0.0693)
N	5599	5599	5599	3573	3573	3573
ll	-8816.485	-8679.364	-8655.713	-5768.813	-5643.943	-5626.14
Maths	-0.0797	-0.01671	0.005274	n.a.	n.a.	-0.2173***
	(0.0763)	(0.072)	(0.0649)			(0.0697)
N	5599	5599	5599			3573
ll	-8791.25	-8691.338	-8684.111			-5652.972
Physical Education	-0.1203	-0.06482	-0.05215	-0.04428	0.02149	0.03268
	(0.0787)	(0.0778)	(0.0774)	(0.0648)	(0.0715)	(0.0712)
N	5599	5599	5599	3573	3573	3573
ll	-8751.303	-8691.538	-8681.317	-5730.286	-5667.778	-5653.915
Information and Technology	-0.1298	-0.05638	-0.05346	-0.1649**	-0.09735	-0.09343
	(0.0803)	(0.0783)	(0.0785)	(0.0711)	(0.0699)	(0.0694)
N	5599	5599	5599	3573	3573	3573
ll	-8794.665	-8699.877	-8689.795	-5790.644	-5698.116	-5681.21
Creativity	-0.08895	-0.02958	-0.02024	-0.1368+	-0.07219	-0.06605
	(0.075)	(0.0741)	(0.0735)	(0.0717)	(0.07)	(0.0696)
N	5599	5599	5599	3573	3573	3573
ll	-8673.992	-8597.912	-8586.848	-5671.821	-5601.738	-5587.645
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Notes: See notes in Table A3.

Table A5: Control function-Contemporaneous DV definition

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking	-0.2307**	-0.1421	-0.1350	X	X	X
	(0.0944)	(0.0922)	(0.0938)			
N	3763	3763	3763			
ll	-5262.246	-5159.466	-5141.674			
Reading	-0.2366***	-0.1438+	-0.1399+	X	X	X
	(0.0914)	(0.0860)	(0.0849)			
N	3763	3763	3763			
Ll	-5262.307	-5156.102	-5132.690			
Writing	-0.2288***	-0.1267	-0.1288	X	X	X
	(0.0851)	(0.0802)	(0.0792)			
N	3763	3763	3763			
ll	-5211.214	-5107.073	-5086.060			
English	X	X	X	-0.3034***	-0.1865**	-0.1734+
				(0.0988)	(0.0919)	(0.0906)
N				2766	2766	2766
ll				-3835.565	-3734.367	-3720.627
Science	-0.1496**	-0.04509	-0.03153	-0.4381***	-0.3251***	-0.3153***
	(0.0748)	(0.0706)	(0.0718)	(0.1108)	(0.1036)	(0.1025)
N	3763	3763	3763	2766	2766	2766
ll	-5292.426	-5172.820	-5152.822	-3875.427	-3762.224	-3745.261
Math	-0.1947**	-0.1064	-0.1034	-0.3622***	-0.2549**	-0.2463**
	(0.0915)	(0.0852)	(0.0840)	(0.1093)	(0.1036)	(0.1011)
N	3763	3763	3763	2766	2766	2766
ll	-5272.845	-5186.388	-5173.800	-3870.829	-3788.496	-3771.162
Physical education	-0.1512+	-0.07652	-0.07393	-0.1482	-0.07051	-0.05768
	(0.0831)	(0.0853)	(0.0828)	(0.1069)	(0.1039)	(0.1042)
N	3763	3512	3763	2766	2766	2766
ll	-5267.132	-4887.741	-5223.747	-3828.320	-3787.032	-3780.177
Inf tech	-0.1928+	-0.1082	-0.1087	-0.3608***	-0.2632**	-0.2628**
	(0.1013)	(0.1013)	(0.1021)	(0.1063)	(0.1028)	(0.1024)
N	3763	3763	3763	2766	2766	2766
ll	-5288.288	-5217.604	-5211.158	-3885.747	-3808.122	-3798.027
Creativity	-0.1414+	-0.1591	-0.05740	-0.2390**	-0.1645+	-0.1546
	(0.0816)	(0.1379)	(0.0817)	(0.0957)	(0.0971)	(0.0976)
N	3763	2185	3763	2766	2766	2766
ll	-5165.245	-2957.665	-5103.342	-3781.677	-3725.141	-3717.639
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Notes: Each row corresponds a child's ability dimension. Values in the table are the parameter estimates of the DV effect from a Control function. Robust standard errors in parentheses. The estimates from columns (1), (2) and (3) correspond to the econometric estimation at age 7 and columns (4), (5) and (6) correspond to the econometric estimation at age 11. Child variables: race, sex, whether the child born with low weight, born between September-December, whether obese or overweight. Mother variables: age, whether she has ever been diagnosed with depression, whether suffers from chronic conditions, whether at work, highest educational level attained (academic or vocational): GCSE grades (D-G) or equivalent, O level or equivalent, A-level or equivalent, First degree or equivalent, Higher degree or equivalent. Father variables: age, whether ever been diagnosed with depression, whether suffers from chronic conditions, whether at work, highest educational level attained (as defined for the mother).Household variables: whether family lives in a council house (or in a housing association), natural logarithm of the household income. Significance levels: $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

Table A6: Control function-Ever DV definition

	Age 7			Age 11		
	(1)	(2)	(3)	(4)	(5)	(6)
Speaking	-0.1050	-0.03467	-0.03046	X	X	X
	(0.0787)	(0.0752)	(0.0762)			
N	3763	3763	3763			
ll	-5264.472	-5160.768	-5142.984			
Reading	-0.1577**	-0.08313	-0.08030	X	X	X
	(0.0715)	(0.0675)	(0.0663)			
N	3763	3763	3763			
ll	-5263.184	-5156.702	-5133.234			
Writing	-0.1761**	-0.09675	-0.09519	X	X	X
	(0.0708)	(0.0646)	(0.0650)			
N	3763	3763	3763			
ll	-5211.124	-5107.092	-5086.147			
English	X	X	X	-0.2197***	-0.1416+	-0.1333+
				(0.0785)	(0.0770)	(0.0747)
N				2766	2766	2766
ll				-3835.221	-3734.039	-3720.313
Science	-0.1301**	-0.04719	-0.03554	-0.2949***	-0.2117**	-0.2032**
	(0.0646)	(0.0615)	(0.0622)	(0.0851)	(0.0854)	(0.0841)
N	3763	3763	3763	2766	2766	2766
ll	-5292.037	5172.674	-5152.628	-3876.177	-3763.072	-3746.153
Math	-0.07272	-0.001644	0.004292	-0.2978***	-0.2258***	-0.2178***
	(0.0742)	(0.0675)	(0.0670)	(0.0784)	(0.0779)	(0.0760)
N	3763	3763	3763	2766	2766	2766
ll	-5274.813	-5187.161	-5174.430	-3868.279	-3786.332	-3769.045
Physical education	-0.1286+	-0.07341	-0.06660	-0.04416	0.005955	0.01655
	(0.0684)	(0.0610)	(0.0673)	(0.0641)	(0.0662)	(0.0661)
N	3763	3512	3763	2766	2766	2766
ll	-5266.775	-4887.575	-5223.589	-3829.268	-3787.212	-3780.257
Inf tech	-0.1327	-0.06759	-0.06386	-0.1648**	-0.09653	-0.09313
	(0.0829)	(0.0812)	(0.0814)	(0.0657)	(0.0674)	(0.0671)
N	3763	3763	3763	2766	2766	2766
ll	-5288.786	-5217.848	-5211.366	-3889.567	-3810.950	-3800.969
Creativity	-0.09747	-0.04603	-0.03637	-0.1407**	-0.08939	-0.08240
	(0.0642)	(0.0637)	(0.0643)	(0.0602)	(0.0620)	(0.0625)
N	3763	3763	3763	2766	2766	2766
ll	-5165.506	-5109.755	-5103.103	-3782.610	-3725.753	-3718.175
Controls						
Child	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Mather	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*
Father	*No*	*No*	*Yes*	*No*	*No*	*Yes*
Household	*No*	*Yes*	*Yes*	*No*	*Yes*	*Yes*

Notes: See notes in Table A5.

Table A7: OLS without endogenous variables

	Wave 4		wave 5	
	Contemp	Ever	Contemp	Ever
	(1)	(2)	(3)	(4)
Speaking	-0.1531+	-0.04246		
	(0.0917)	(0.0677)		
Reading	-0.1560+	-0.09247		
	(0.0948)	(0.0685)		
Writing	-0.1460	-0.1077+		
	(0.0914)	(0.0648)		
English			-0.1694+	-0.1368**
			(0.0886)	(0.0673)
Science	-0.03982	-0.04330	-0.3120***	-0.2042***
	(0.0864)	(0.0656)	(0.0992)	(0.0697)
Maths	-0.1166	-0.007829	-0.2397**	-0.2208***
	(0.0922)	(0.0658)	(0.1036)	(0.0703)
Phyed	-0.1116	-0.09741	-0.03456	0.01144
	(0.0930)	(0.0692)	(0.1005)	(0.0676)
Inftech	-0.1219	-0.07548	-0.2650***	-0.09908
	(0.0936)	(0.0685)	(0.1023)	(0.0701)
Expcreat	-0.06993	-0.04793	-0.1459	-0.08340
	(0.0907)	(0.0653)	(0.0932)	(0.0631)
N	3763	3763	2766	2766

Note: The entries are parameters estimates of pupil-level data for those students in the MCS who do not have missing values for gender, race, birth weight , month born, parental long standing illness, parental smoking, parental education, parental age and parental working status and whether the family lives in a Council house or in a housing association. Columns (1) and (3) use the Contemporaneous DV definition and columns (2) and (4) use the Ever DV deinition. Significance levels : $^{+}p < 0.10, ^{**}p < 0.05, ^{***}p < 0.01$

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Chapter 4

Children's Well-being and Maternal Labour Supply

4.1 Introduction

There has been an increase in participation of women aged 16 to 64 in the labour force over the last four decades. In the period from April to June 2013, about 67% of women were in work,[1] an increase from 53% in 1971. Over 80% of females aged 25-35 without children were in employment, whilst for those with children the employment rate was around 60%. For females aged 35-49, the employment rate of both groups, with and without children, was similar and around 80%. Only about 39% of single mothers whose youngest child was aged up to three were in work, compared to 65% for young mothers living with a partner. The employment rate for mothers whose youngest child was in primary school age (between four and ten years) was higher (74%) if they were in a couple than if they were single parents (61%).

Although the relationship between maternal job status and work intensity and children's cognitive and physical outcomes has been widely discussed in

[1] http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetyp
articles/womeninthelabourmarket/2013-09-25#women-in-the-labour-market

the literature, the results are mixed (Mendolia 2016). Nevertheless, there are few studies that focus on the spillover effects of maternal work on children's well-being measures, which are key for the acquisition of soft or non-cognitive skills (Miyamoto et al. 2015). Over the last few years, there has been mounting evidence on the role that noncognitive skills formation play later on in life in job market success (Cunha et al. 2010, Heckman et al. 2006). Heckman et al. (2006) find that noncognitive skills influence positively school performance, and so affect future wage and employment opportunities. Maternal work intensity might impact childhood well-being through various paths and might affect a variety of child's well-being dimensions. For example, working long hours could have a detrimental impact by reducing time spent with the child, providing emotional support and being able to be involved in school and after-school activities (Mendolia 2016).

Our study exploits the Millenium Cohort Study (MCS) to understand the correlation between maternal work intensity and childhood well-being. We use children's subjective measures of well-being, including a composite measure of *happiness*, and also the child's Body Mass Index (BMI), which has been associated with a child's well-being. As robustness checks we explore the relationship between maternal working status and well-being for the 25% and 75% income quartiles; the potential impact of maternal commuting time; and whether the results hold for the sub-sample of children living with both natural parents. Our results are not uniform across all subjective measures of well-being but overall suggest that children's well-being is positively related to maternal working hours. We also find a clear positive association between maternal working time and the likelihood of being obese or overweight. Further, our estimates suggest that children in the bottom quartile of the income distribution are better-off if their mothers work but those at the top quartile are negatively affected by maternal working hours, although these effects are mostly only significant at the age of 7. Finally, we find that in households where both natural parents cohabitate, paternal employment reduces the well-being of the child.

This paper has several contributions to the economics of well-being literature. First and foremost, to the best of our knowledge, this research is

the first to focus on the relation between *experience* [2] and *evaluative* [3] dimensions of child well-being with maternal work intensity. Our empirical approach also differs from the existing literature because we use a latent factor analysis measure of *happiness* that takes into account responses of the child, parents and teachers regarding the child's happiness. This strategy allows us to lessen the cognitive bias that may arise by relying only on the child's reporting. Finally, a further innovation of our work is that we add commuting time to the working time of the mother in order to account for the total time away from home of the mother.

The structure of the paper is as follows: section 2 discusses some of the related literature; section 3 presents the theoretical framework and the empirical strategy; section 4 describes the data and the outcome variables of interest; section 5 shows the results alongside a number of extensions and robustness checks and section 6 concludes.

4.2 Background literature

The existing literature points toward mixed results on how maternal work intensity is associated with children's well-being. One strand of the literature finds a negative relation between maternal working hours and child's well-being outcomes. For instance, Buehler & O'Brien (2011) show that mothers working part-time are more likely to get involved in children's school activities. Aizer (2004) finds that adult supervision of school-age children is associated with a reduction in risky or antisocial behaviours such as skipping school, alcohol and/or drugs use, stealing or hurting others. However, other authors have found a positive association between maternal work intensity and children's well-being. Menaghan et al. (2000) finds that children from non-working mothers are more prone to oppositional behavioural problems; Lopoo (2004) looks at the effect of maternal employment on her

[2] A prototypical *experience* well-being question is: Overall, how worried did you feel yesterday? (Dolan et al. 2012)

[3] A prototypical *evaluative* well-being question is: How satisfied are you with your personal relationships? (Dolan et al. 2012)

teenage daughter's probability of becoming pregnant. His findings suggests that adolescent daughters of working mothers are 11.7% less likely to become pregnant compared to teenage daughters of non-working mothers. However, the effect is different across socioeconomic ladders. Teenage girls of working mothers studying in wealthier schools exhibit a higher probability of teenage pregnancy compared to those of non-working mothers but this effect is the opposite for teenage girls in poorer schools. In a later work, Lopoo (2007) argues that children of working mothers are more likely to engage in after-school sports activities. In contrast, there is some research that finds no statistically significant relationship between maternal job and children's self-esteem (Harvey 1999) and risky behaviours (Aughinbaugh & Gittleman 2004). Ruhm (2008) suggests that moderate maternal working hours is positively associated to children's cognitive development as long as it contributes substantially to the household's total income. Overall, the research on the impact of maternal working hours and children's well-being is mixed but it is worth noting that this area is at an early stage of development.

We include obesity as a measure of well-being as there is some consensus in the literature about the link between children's well-being and obesity. Ge et al. (2001) suggest that a child's self-perception of being overweight is related to depressive moods and a lower self-esteem. Those associations are not homogeneous across gender and ethnicity. For instance, the relation between perceiving oneself as overweight and a depressive mood is more likely if the respondent is White or Hispanic in the case of girls. For boys, the depressive mood is only negatively related if the child is White, and positive for African-American. Strauss & Pollack (2003) analyse the marginalization of overweight children in a social network. Not only were overweight children less likely to be nominated as a closer friend by their friends than normal-weight children, but also friends of overweight children were also more likely to be marginalized. In another study, Chang & Nayga Jr (2010) highlight the existence of a trade-off between "enjoying" fast-food, making children feel *happier*, and probability of becoming obese. These studies highlight an issue of circular endogeneity between child´s obesity and well-being. Difficult to disentangle whether a child is marginalized because she/he is obese or due to the fact of being marginalized, the child has eating disorders and he/she

is prone to become obese.

There is a strand of literature suggesting that maternal work intensity is positively related to an increase in offspring's Body Mass Index (BMI) (Anderson et al. 2003, Ruhm 2008, Morrissey et al. 2011) while paternal job status plays is irrelevant (Cawley & Liu 2012). This is a particularly important issue given the trends in the last twenty years of children's obesity. The proportion of obese boys aged 2-10 years old was around 10% in 1995 and about 15% in 2014 and for boys aged 11-15 years, the proportion was around 15% in 1995 and almost 20% in 2014. A similar pattern holds for girls, 10% in 1995 and 15% in 2014 for those aged 2-10 years old and around 16% in 1995 and almost 20% in 2014 for those aged 11-15 years old.[4] Anderson et al. (2003) show that maternal labour supply increases the likelihood of children's obesity, especially in high-income families. In another study, von Hinke Kessler Scholder (2008) looks at maternal employment and children's obesity over different ages. The relationship between the amount of work of the mother and obesity is positive, again, the effect being stronger for children living in higher income households. A precise account of the opportunity costs of the number of hours that the mother works is provided by Cawley & Liu (2012). The authors explore the amount of minutes that a working mother spends doing specific household tasks (shopping, cooking, eating with children, caring for children, etc.) compared to a non-working mother. Their results indicate that maternal work and child's BMI are positively correlated if mother's working hours are not compensated by greater paternal involvement, in contrast with von Hinke Kessler Scholder (2008). However, Costa-Font et al. (2015) finds that the effect disappears if one controls for parental obesity. Further, Greve (2011) shows that children's obesity patterns are also explained by the quality of the regional childcare institutions, rather than just by the maternal job schedule.

One of our robustness analysis includes maternal commuting time. The literature on maternal working time and the child's well-being typically limits the analysis to the time that the mother is out of the home accounting only for the working time. This approach excludes mother's commuting time,

[4]See http://content.digital.nhs.uk/catalogue/PUB19295

which adds to the total time she is away from home. Nevertheless, in the economics of well-being, commuting has been pointed out as a time-consuming activity with detrimental effects on individual well-being. Thus, the effect of maternal commuting time on children's well-being might not only be direct (less time to be spend together) but, also indirect if maternal mental health is negatively affected and this changes the quality of the parenting provided. Stutzer & Frey (2008) coin the negative effect of commuting on well-being as the *commuting paradox*. They argue that those who commute more heavily rate their well-being lower, on average, even though standard economic theory points out that the disutility derived from their commuting should be compensated through higher wages and/or housing market opportunities. Stutzer & Frey (2008) propose two behavioural explanations for this paradox: first, individuals might not be capable of properly assessing the costs of commuting in terms of well-being when they take their home location decision, which is in line with Frederick & Loewenstein (1999) and Loewenstein & Schkade (1999) on the difficulty of predicting future utility. Second, those who commute more than what they consider optimal have weaker willpower and are not able to change their location.

Roberts et al. (2011) also look at the commuting effect on well-being, by focusing on gender differences that would reinforce the detrimental negative indirect effect of maternal commuting time on children's well-being. They show that while women spend less time both in commuting and at work in comparison to men, their psychological health is more adversely affected by commuting than men, even after accounting for the potential compensation through housing and/or wages. Women are more likely to end up working in low skilled jobs close to home, which are available in more geographically dispersed areas. As a result, females' average wages tend to be lower and so are their relative costs of commuting. But, as women are likely to be responsible for the domestic work and children's supervision, they might have higher time constraints with a costlier valuation of commuting time than men (Madden & White 1980). In addition to that, females tend to be the secondary wage earner in a family (Blau et al. 1992) and the location is likely to be chosen to suit the labour market preferences of the primary earner (Hanson & Pratt 1991, Kain 1962).

4.3 Framework & empirical strategy

The extant economic literature characterizes households as production entities and are widely analyzed through the lens of collective labour supply models. To motivate our discussion, we adapt a stylised version of Blundell et al. (2005) and Browning et al. (2011). The household is composed of a mother(m), a father(f) and a child(c). Parents not only derive utility from private consumption, but also from their child's welfare. Therefore, the child's well-being acts as a public good which is modeled like a domestic good (Becker 1965) and is produced by expenditure and time-allocation. The income of the household is pooled and invested in the Hicksian composite good. In this setting, the composite good is used for adult consumption (ac) and child consumption (cc), with price equals to one. Each partner has one unit of time, that can be allocated to work or to the household, and thus the child. Let h_i and t_i be the time allocated to work and to the household/child, respectively, such that $h_i = 1 - t_i$, for $i = f, m$.

We specify the child well-being function (cw) as:

$$cw = W(t, cc, z) \tag{4.1}$$

where cw is a function of the time (t) allocated to the child by parents; cc the amount of composite good invested in the child; and z the child's characteristics, including anthropomorphic measures that influence his/her well-being and also proxy the household's lifestyle and parenting type.

The household's utility function can be written as a weighted average of the father's and mother's utility functions:

$$\lambda u_f(ac, cw) + (1 - \lambda)u_m(ac, cw), \tag{4.2}$$

where λ and $1 - \lambda$ capture the relative bargaining power of the father and the mother, respectively. The budget constraint for the household given a non-wage endowment of Y is:

$$ac + cc = w_m h_m + w_f h_f + Y \tag{4.3}$$

Thus, the household's utility maximisation problem becomes:

$$max_{ac,cc,t_m,t_f}\ \lambda u_f(ac, W(t, cc, z)) + (1 - \lambda)u_m(ac, W(t, cc, z))) \tag{4.4}$$

s.t.

$$(1 - t_m)w_m + (1 - t_f)w_f + ac + cc = Y \tag{4.5}$$

In this paper, we are interested in the impact of maternal labor supply on the child's well-being function. From the simple model presented above, maternal labour time and child's well-being are simultaneously determined. Cherchye et al. (2012) estimates a similar model with a rich Dutch dataset containing information on couples with children. Interestingly, the results suggest that parents' preferences depend on the Hicksian composite good, which determines a child's welfare too, and that there is an inverse relationship between the value of λ (the gender bargaining power intra-household) and the household's non-labor income Y.

We are unable to estimate the full model outlined above (the function 4.4 and its restriction 4.5) given the limitation of our data set since we do not have time use data to evaluate the full model. This study aims to shed light of the parental contribution on equation 4.1, and the maternal aspect in particular. Thus, we rely on a hybrid function approach as in Rosenzweig & Schultz (1983) to evaluate the maternal labour supply effect on children's well-being, in line with Ruhm (2004, 2008). Parameter estimates from a hybrid production function generally embody both the technological properties of the child well-being production process and covariate variables that affects this process (both quality and quantity of parental time inputs (Ruhm 2008)). Thus, the maternal working intensity represents the association given to average difference in control variables (Ruhm 2008). Therefore, our interest lies in estimating the following reduced form equation of the child's well-being production function:

$$cw_{it} = \psi + \alpha h_{mit} + Z_i\beta + \epsilon_{it} \tag{4.6}$$

where cw_i is the well-being of child i in *t=1,2*; ψ is a constant; h_{mi} is the number of maternal m weekly working hours; Z_i is a vector of child and family characteristics; and ϵ_{it} is a disturbance defined as $\epsilon_{it} = \upsilon_{it} + d_i$, in which d_i represents household specific unobserved factors impacting child well-being and υ_{it} an *i.i.d.* error term.

Our strategy is to disentangle *preferences* for the mother participating in

the labour market from the household technology producing children's well-being. If there are unobservable factors in d_i that are correlated to maternal time allocation decision, i.e. $cov(\ h_{mi},\ d_i) \neq 0$, the coefficient associated to maternal work, α, and the intercept, ψ, will be biased. To minimise the bias caused by the unobservables, Ruhm (2004) includes as many covariates unrelated to the labor supply decision as possible. We follow this approach and include an exhaustive range of controls not related to the household's decision that the mother participates in the labour market. Additionally, we include whether the mother was in work in previous waves because job status might be positively correlated over time and that could bias α_t in the direction of α_{t-j}. We estimate equation (6) using Weighted Ordinary Least Squares, in which the attrition correcting weights are provided by the MCS. In the following section, we present the dataset we exploit, including the set of children's well-being measures, mother's labour market participation indicators, and controls.

4.4 Data

We examine the subjective well-being of children aged 7 and 11 years old in the United Kingdom using data from the Millennium Cohort Study (MCS). This survey follows nearly 19,000 children born in the UK in 2000-2001. The first wave was collected when children were 9 months old and consecutive waves were collected when they were 3, 5, 7 and 11 years old. The MCS is designed to track a cohort of children across their early childhood years and follow them into adulthood. It contains information on a wide range of areas such as childcare, school choice, child behaviour and cognitive development, child and parental health, parents' employment and education, income and poverty, housing, neighborhood and residential mobility, and social capital and ethnicity.

4.4.1 *Outcome variables*

Well-being information

Our main outcome variables are subjective responses to queries over a range of well-being dimensions. The literature uses interchangeably the terms well-being, happiness and life-satisfaction. There exists several well-being definitions and so it is left to individuals researchers to decide which one to use. As a general rule, if the researcher wants to use the responses to well-being queries as a proxy to utility measurements, two main assumptions should be made: (1) Responses should be able to be interpreted as a positive monotonic transformation of the theoretical underlying utility function; (2) Responses should be comparable either at the ordinal or at the cardinal level (Ferrer-i Carbonell & Ramos 2014).

Subjective well-being measures have been extensively classified into three categories: *Experience*, *Evaluation*,[5] and *Eudemonic*. *Evaluation* measures rely on a range of questions (Freeman 1978, Bradford & Dolan 2010) and are widely used in the economic literature, mainly because of its prevalence in national and international surveys (Dolan et al. 2012) and their appeal to policy makers (Donovan & Halpern 2002). The *Evaluation* type of questions aim at eliciting the subjective perception of one own's well-being, for example in questions like *"How satisfied are you with your personal relationships?"* (Dolan et al. 2012).

Experience measures capture emotional states felt by the individual during a stated period of time (Dolan et al. 2012). It represents the *Benthamian* view of well-being (Bentham 1789), by which pleasure is the only thing that is good for us, and pain is the only thing that is bad (Dolan et al. 2012). Consequently, subjective well-being is regarded as the average balance between enjoyment and pain. *Experience*-like questions are *"Overall, how worried did you feel yesterday?"* (Dolan et al. 2012).

Eudemonic measurements are based on the Aristotelian concept of *Eudaimonea*, which is the state that a rational subject would seek (Dolan et al.

[5]Evaluation is sometimes referred as *Hedonic* in the literature, see for instance Deaton & Stone (2013).

2012) rather than would feel (Dolan et al. 2006). In that regard, the literature using the *Eudemonic* concept of well-being considers that individuals have underlying psychological needs, such as meaning, autonomy, control and connectedness (Ryff 1989). The satisfaction of these needs contribute to a well-being state independently of any pleasure they might convey (Hurka 1993). A prototypical *Eudemionic* question is: *"Overall, to what extent do you feel that the things you do in your life are worthwhile?"*(Dolan et al. 2012)

The type of well-being questions available in the MCS that we exploit focus on five different dimensions: (1) overall *Happiness*, (2) being *Worried*, (3) having problems with *Temper*, (4) being *Bullied* and (5) being *Horrible* to others. Thus, while (1) belongs to the *Eudemonic* type, the rest are within the *Evaluative* (i.e.*"How often do you lose your temper?"*) and Experience (i.e.*"How often do other children bully you?"*) realm.

Our well-being measure for overall *Happiness* is a composite measure that takes into account the child's, the parents' and the teacher's appreciation of how frequently the child *feels happy*. Costa JR & McCrae (1994) find that personality might not become stable until the age of 30, when adults are likely to have accomplished enough major life transitions such as starting a family, complete education or to be settled into their careers (Coffey et al. 2014). In our case, children answer questions about their well-being at 7 and 11 years of age, when their personalities are thought to still be developing (Holder & Klassen 2010). Thus, their answers to questions on *Happiness* such as *'How often do you feel happy?'* might change depending on their phrasing and on children's perception and ability to understand. With this in mind, to elicit the latent happiness of a child, we exploit all the range of information on happiness available in waves 4 and 5.

In wave 4, when the child is 7, the question posed directly to the child is: *'How often do you feel happy?'*. The parents and the teacher are asked: *'[Cohort child name] is often unhappy, downhearted or tearful?'*. As the question to the child is about happiness and the ones to the parents and teacher about unhappiness, we invert the ordering of the parental and teacher's answers, that is, when parents and teachers answer that the child is never unhappy, downhearted or tearful, we assume the answer is equivalent to the child

being *always* happy, and viceversa. Table 4.1 presents the answers to the

happiness-related questions available in wave 4.[6]

[6]The LCA is a probability model based on cluster analysis. LCA identifies homogenous clusters of data from three different perspectives of child's happiness. In order to maximize the resemblance within the cluster and to minimize the likeness among different clusters. LCA assumes that the data is from a mixture model of different probability distributions (Lanza et al. 2013). It assumes that there is a latent variable that divides the data into mutually exclusive homogenous subdivisions. To identify the latent classes based on questions responses and following a similar notation as in (Lanza et al. 2013). Let γ_c represents latent class membership for latent class cluster c (c=1,2,...,c number of clusters). Suppose that each relationship between the answers to the three questionnaires (child, parents and teachers) can be characterized with S attributes (in our case the three questions), Z_i represents relation's i's attribute of characteristic s and Z_i ia a categorical variable from 1,..., r_s. ρ indicates the probability that "happiness" i has the attribute in terms of all the S characteristics conditional on latent class membership. So

$$\rho_{s,r_s|c}^{I(z_s=r_s)}$$

represents the probability that a relationship has attribute r_s of characteristic S, conditional on membership in latent class c.The indicator function, I($z_s = r_s$), equals 1 when the attribute of the characteristic S equals r_s, and equals zero, otherwise. The probability of observing a particular vector of responses

$$P(Z = z) = \sum_{c=1}^{c} \gamma_c \coprod_{s=1}^{S} \coprod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)}$$

The most suitable number of clusters "c" –or type of relation- is unknown beforehand. Instead, the user should examine multiple models by using different numbers of clusters and choose the appropriate number on the basis of the AIC and BIC.To estimate the posterior probability for a specific relationship the methodology developed by (Lanza et al. 2013) uses the Bayes' rule. So

$$P(L = c|Z = z) = \frac{(\coprod_{s=1}^{S} \coprod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)})\gamma_c}{\sum_{c=1}^{c} \gamma_c \coprod_{s=1}^{S} \coprod_{r_s=1}^{R_s} \rho_{s,r_s|c}^{I(y_s=r_s)}}$$

Table 4.1: Response Categories (1) happiness - Age 7

		(1) Never	(2) Sometimes	(3) Always
(a)Child	N	265	7,847	4,938
	(%)	(2.03)	(60.13)	(37.84)
(b)Parent	N	321	1,415	11,812
	(%)	(2.37)	(10.44)	(87.19)
(c)Teacher	N	333	1,295	7,210
	(%)	(3.77)	(14.65)	(81.58)

Notes: N refers to the number of observations.*(%) refers to the percentage. In (a)* a child responds to the question *How often do you feel happy?*. Parent *(b)* and teacher *(c)* respond to the question *[Cohort child name] is often unhappy, downhearted or tearful?*.

In wave 5, when the child is 11, these questions are slightly modified. The child is asked: *'On a scale of 1 to 7, how do you feel about the following parts of your life? (a) Your life whole (...)'*, where *1* is *Very Unhappy* and *7 Very Happy*. Parents and teacher are asked the same question as in wave 4 and thus we again reverse the ordering of the parental and teacher's answers. Table 4.2 shows the responses to these questions by the child, parents and the teacher.

Table 4.2: Response Categories (1) happiness - Age 11

		(1) *Very Unhappy*	(2)	(3)	(4)	(5)	(6)	(7) *Very happy*
(a)Child	N	319	226	285	670	1,258	3,259	6,976
	(%)	(2.46)	(1.74)	(2.19)	(5.16)	(9.68)	(25.08)	(53.69)
		(1) *Never*	(2) *Sometimes*	(3) *Always*				
(b)Parent	N	313	1,701	9,952	N/A	N/A	N/A	N/A
	(%)	(2.62)	(14.22)	(83.17)	N/A	N/A	N/A	N/A
(c)Teacher	N	214	1,211	5,936	N/A	N/A	N/A	N/A
	(%)	(2.91)	(16.45)	(80.64)	N/A	N/A	N/A	N/A

N refers to the number of observations.*(%) refers to the percentage. N/A*: categories not available for the parent and teacher question. The child *(a)* responds to the question *'On a scale of 1 to 7 where '1' means completely happy and '7' means not at all happy, how do you feel about the following parts of your life? (a) Your life as a whole (...)'*, note that ladders from (2) to (6) are not phrased, instead they are presented as an evaluative scale. Parent *(b)* and teacher *(c)* answer the question *[Cohort child name] is often unhappy, downhearted or tearful?*. Recoding of the parent and teacher answers is applied to be consistent with the child's answers.

In order to elicit the *latent happiness* of the child, we use all answers to the happiness questions, that is, the answers given by the child, by the parents and by the teacher. With those, we estimate two mixture models, one for wave 4 and one for wave 5. Mixture models assume that there is an underlying unobserved categorical variable reflecting the *true* happiness of the child and split the sample into mutually exclusive and exhaustive groups of children according to their latent level of happiness. We use the methodology PROC LCA (Lanza et al. 2011). The happiness measures used for the mixture model in wave 4 are summarised in Table 1 and those used for wave 5 in Table 2. Table 4.3 displays the goodness of fit statistics of using 2 versus 3 happiness latent classes. The goodness of fit is measured by the information criteria embedded in the Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC).

Table 4.3: Happiness

n. latent class	G^2	df	AIC	BIC	Adjusted BIC	Entropy R^2
Wave IV						
2	17.10	13	43.10	134.07	92.76	0.32
3	8.29	6	48.29	188.24	124.68	0.30
Wave V						
2	42.01	41	84.01	226.14	159.41	0.50
3	35.22	30	99.22	315.81	214.12	0.46

Notes: The term *n.latent class* stands for the number of possible analysed latent classes. G^2 is the likelihood ratio statistic reflecting the deviation between the likelihood from the reduced model and the saturated one. *df* are the degrees of freedom. *AIC* is the Akaike Information Criteria. *BIC* is the Schwarz-Bayesian Information Criteria. *Adjusted BIC* is the adjusted Schwarz-Bayesian Information Criteria. *Entropy* R^2 is an overall measure of fuzziness reflecting the distinguishability of the types, ranging from 0 (fuzzy and suggesting no difference among latent classes) to 1 (types clearly different).

According to the measures of goodness of fit in Table 4.3, the optimal number of groups is two for both waves, since for more than two types both AIC and BIC decrease.This is also in line with the G^2 index which suggests the lower type the better. Thus, we create a binary variable that takes value one for children that are happier, according to the mixture model, and zero otherwise. Tables A1 and A2 in the Appendix tabulate the answers of the children, parents and teachers against the latent binary variable according to the mixture model classification.

In addition to the composite measure of happiness, we also explore four additional measures of well-being. Tables 4.4 and 4.5 summarise the frequencies of the answers to the well-being measures related to questions (2) to (5) in waves 4 and 5, respectively. Because of the increased psychological maturity and understanding of children at age 11, and somewhat unfortunately for the researcher, the phrasing of the well-being questions changed from wave 5 onwards, making it impossible to pursue a longitudinal analysis.

Table 4.4: Child well-being - Age 7

		(1) Never	(2) Sometimes	(3) Always
(2) Worried				
	N	4,111	7,998	682
	(%)	(32.14%)	(62.53%)	(5.33%)
(3) Temper				
	N	3,864	7,678	1,262
	(%)	(30.18)	(59.97)	(9.86)
(4) Bullied				
	N	6,602	5,091	1,167
	(%)	(51.34)	(39.59)	(9.07)
(5) Horrible				
	N	10,965	1,586	312
	(%)	(85.24)	(12.33)	(2.43)

N refers to the number of observations. (%) refers to the percentage. Hereafter, we rephrase *How often do you get worried? as (2) Worried*; *How often do you lose your temper? as (3) Temper*; *How often do other children bully you? as (4) Bullied* and *How often are you horrible to other children at school? as (5) Horrible*

Table 4.5: Child well-being - Age 11

	(1) *Never*	(2) *Almost never*	(3) *Sometimes*	(4) *Often*	(5) *Almost always*	(6) *N/A*
(2) Worried						
N	5,474	3,416	2,423	890	337	N/A
(%)	(43.65)	(27.24)	(19.32)	(7.10)	(2.69)	
(3) Temper						
N	3,134	4,711	3,382	986	288	N/A
(%)	(25.07)	(37.68)	(27.05)	(7.89)	(2.30)	
	(1) *Never*	(2) *Less often*	(3) *Every few months*	(4) *Once a month*	(5) *Once a week*	(6) *Most days*
(4) Bullied						
N	5,540	3,437	896	896	1,071	807
(%)	(43.80)	(27.18)	(7.08)	(7.08)	(8.47)	(6.38)
(5) Horrible						
N	9,118	2,426	380	334	264	137
(%)	(72.03)	(19.16)	(3.00)	(2.64)	(2.09)	(1.08)

N refers to the number of observations. (%) refers to the percentage. *N/A* stands for not applicable as for those questions there were only five categories. Worried stands for answers to *In the last four weeks, how often did you get worried about what would happen to you?*; Temper to *In the last four weeks,how often did you you get angry?*; Bullied to *How often do other children hurt you or pick on you on purpose?*; and Horrible to *How often do you hurt or pick on other children on purpose?*. Responses range from (1) *Never or Unlikely to happen* to 5 and 6 *Likely or Almost Always*.

Obesity and overweight

To provide additional evidence on the association of maternal work intensity and childhood well-being, we use the child being overweight or obese as a dependent variable. Being obese is known to carry social stigma and the psychological literature has established a link between being an obese child and suffering from low self-esteem, depression, anxiety, rejection from peers (Ge et al. 2001, Strauss & Pollack 2003), in addition to other pernicious effects experienced later (Cawley & Liu 2012).

We create two dichotomous indicators of being obese and being overweight using the methodology developed in Saxena et al. (2004), which adjusts obesity and overweight BMI thresholds by age and gender. Table 4.6 presents partial correlations and statistical significance of BMI and the well-being measures in section 3.1.1. At age 7 being overweight is negatively related to *happiness* whereas obese children are less worried but suffer bullying. At age 11, being overweight is related to losing temper and being obese is negatively correlated with *Happiness* and being *Horrible*.

Table 4.6: Partial correlation between obesity and overweight and well-being measures

	Age 7		Age 11	
	Overweight	Obesity	Overweight	Obesity
(1) Happiness	-0.0246^{***}	-0.0040	-0.0076	-0.0458^{***}
(2) Worried	-0.0039	-0.0260^{**}	0.0027	0.0144
(3) Temper	0.0100	0.0158	0.0219^{+}	0.0229^{+}
(4) Bullied	0.0090	0.0225^{**}	0.0062	0.0029
(5) Horrible	-0.0018	0.0061	0.0178	-0.0215^{+}
N	7,852	7,852	6,191	6,191

N refers to the number of observations. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.4.2 *Control variables*

Maternal employment

We explore a wide range of maternal employment measures in our specifications. First, we consider a binary variable that indicates if the mother is employed or not. Second, a dichotomous variable that takes value 1 if the mother has been in long term unemployment for more than a year and 0 if she has been unemployed for less than a year.[7] The motivation for looking at long-term unemployment is that it lowers individual's future wages and employability (Jacobson et al. 1993, Arulampalam 2001) with a pervasive, long lasting effect on well-being, even after being reemployed (Clark et al. 2001, Powdthavee 2012). In addition to this scarring effect (Powdthavee & Vernoit 2013), long-term unemployment becomes a bad signal in the job market as well as indicative of the willingness to work for a relative lower wage. Unemployment has been highlighted as one of the largest depressors on an individual's mental health, self-esteem, and overall subjective well-being (Clark & Oswald 1994). Evidence suggests that previous unemployment spells experienced by the father have a negative effect on children's confidence and self-esteem, whereas this same negative effect prevails for maternal unemployment but only for current spells of joblessness (Powdthavee & Vernoit 2013).

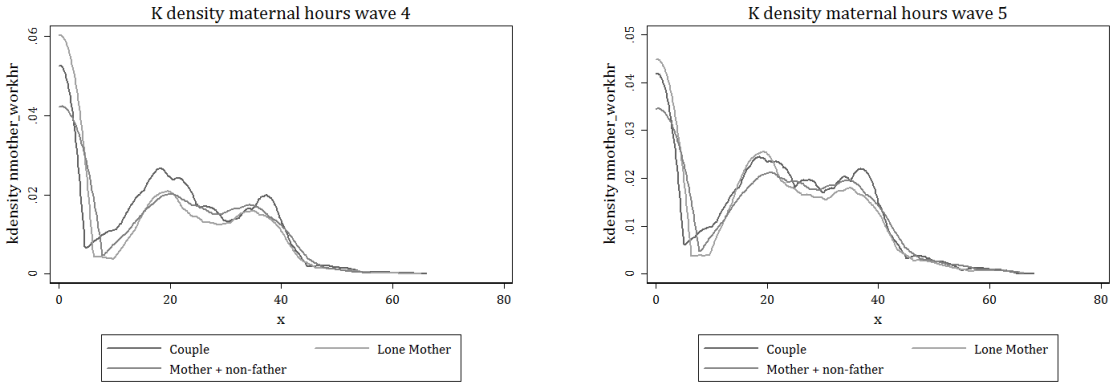
We also define alternative binary job market variables depending on the maternal labour intensity. First, we look at the association of a child's well-being and part-time employment by using a binary variable that takes value

[7]We have the response to the query from the parental questionnaire regarding the main reason of the current-non working status when applicable. Available answers are: Looking after the family; Found a job, waiting to start it; Out of work and looking for a job; Out of work, for reasons of poor health; Taking part in the New Deal (training, task force or voluntary work); On another Government training scheme; On a modern apprenticeship scheme; Full-time student; Retired from paid work; Not in paid work for some other reason. We only consider as unemployed those mothers that are looking after the family or are looking for jobs, which sets to zero hours of work.

1 if the mother works between 1 and 16 hours and 0 if she works more than 16 hours. Second, we use a categorical variable that captures whether the mother's working hours per week (h/w) are: (1) less than 16; (2) between 16 and 29; (3) between 29 and 40; (4) more than 40. Similarly, we look at two additional specifications, one that includes the number of weekly hours as a continuous variable and a second one that allows to specify a concave function among a child's well-being measures and maternal labour intensity by including both the number of working hours and its value squared.

Figure I displays the Kernel densities of the continuous variable of hours[8] across waves by family type: families where the child lives with both natural parents; those in which the mother's partner is not the natural father; and those in which the mother is single. Except for the zero hours' area, the shape of the density is quite similar for all families in both waves. The bulk of observations concentrates mainly in three peaks: 0 h/w; 20 h/w; and, 40 h/w. In a marriage setting, mothers are more likely to be working in comparison to the other two family types examined. The majority of observations of the typical family in our sample are concentrated next to the peaks of $20h/w$ and 40 h/w. A similar pattern is observed for families formed by the natural mother and her couple. Single mothers are more likely to be either non-working or working less than 20 h/w. Tables A3 and A4 in the Appendix show the summary statistics of these employment variables and all other controls included.

[8]Those who are unemployed or not in work have zero hours.



(I) (II)

Figure 4.1: Maternal work intensity by family type

Job Category

We also include as a control covariate the current maternal job category. To do so, we define a categorical variable that has 6 levels: *(1) Unemployed; (2) Routine or Semi Routine; (3) Lower supervisor or lower technical; (4) Small employer or self-employed; (5) Intermediate; and, (6) Managerial or professional.*[9] Parasuraman & Simmers (2001) looks at the effect of work and family life for self-employed and employed persons. Their results show that self-employed persons have greater flexibility and autonomy at work, resulting in a higher job involvement and satisfaction. However, they experience higher levels of work-family conflict as well as lower family satisfaction than employees.

Child, mother and other family controls

We control for the child's gender (=1 if female), ethnicity and a dummy on whether the child was born with a low birthweight (2.5kg or below). Among the variables that relate to the mother controls we consider maternal educa-

[9]In those specifications in the Results section in which we look at the maternal job intensity once the mother works, the base category is the second ladder; *(2) Routine or Semi Routine*, so to avoid multicollinearity

tion (Powdthavee & Vernoit 2013, Ruhm 2008).[10] Davis-Kean (2005) finds that parents' education indirectly relates to children's academic accomplishment partially because the former affects parents' beliefs and behaviours. Nevertheless, the process differs by racial group. Even so, the inclusion might not be orthogonal to the decision on how many hours to work and thus may cause a downward bias of the estimates.

We also control for the mother's own perception of the time she has spent with the child in all waves prior to wave 4 and 5. We name this variable as *amount of time*$_{it}$ and it is built based on the question *'A lot of people nowadays feel they don't have enough time to spend with their children. How do you feel about the amount of time you have to spend with* ***Cohort child's name****. Would you say you have...'*. This variable has 5 available options: (1) Plenty of time; (2) Just enough; (3) Not quite enough; (4) Nowhere near enough; and, (5) Not sure. As explained above, following Ruhm (2008), we use contemporaneous maternal labour supply but all other variables related to labour supply that could be affected by maternal working time are included with lags. If we were to estimate the relation of work on child's well-being dimensions including $hours_{it}$ but not *amount of time*$_{it-j}$, the coefficient of $hours_{it}$ will be biased in the direction of the previous maternal relation with her child at time $t-j$. Parental child time-life working status to control for the heterogeneity is widely used in the literature (Ruhm 2004, 2008, Powdthavee & Vernoit 2013).

Our specifications also include a dichotomous variable on whether the natural mother smokes as an indicator of lifestyle and information on religious views.[11] Prior studies have established that religious individuals have higher life satisfaction. Idler & Kasl (1997) discuss various functions of religion (interpretative, regulative and integrative). In that regard, religion can

[10]Parents' education is a categorical variable of 5 levels each including academic and vocational qualifications: GCSE grade below C or equivalent, GCSE grade A-C or equivalent, A-levels or equivalent, First degree or equivalent, higher degree or equivalent

[11]The variable religion includes: (1) no religion; (2) Christian; (3) Muslim; (4) Less common religions: Hindu, Sikh, Jewish, Buddhist & others

provide some individuals with a significance to life, regulates conduct and extrinsically promotes behaviours that can be beneficial in terms of health and well-being. Religious bodies may provide health care and education, in particular where the state provision is limited. Another by-product of church-going is the creation of social capital, that is, friends from church have been said to provide a more effective support to individual well-being than friends in general (Lim & Putnam 2010). Nevertheless, Deaton & Stone (2013) emphasize that there are no systematic differences in the well-being levels between religious societies and secular ones.

We also consider additional controls related to the family characteristics that might affect the upbringing of the child. We control for family structure type by creating a categorical variable classifying households into three groups: both natural parents cohabitate; natural mother has a partner that is not the natural father of the child; and, natural mother does not have a partner. As a measure of literacy we include the number of books in the household[12] and two additional controls on the number of rooms and the housing tenure status.[13]

Part of the analysis focuses on the sample in which both parents cohabitate. For this sub-sample, we estimate a model that includes father characteristics such as job status, level of education and age. In a related study, Powdthavee & Vernoit (2013) look at how paternal unemployment affects adolescents' happiness. They find that parental job loss and children's happiness are not statistically significantly correlated. They find that early exposure to parental unemployment has a positive effect, but the impact becomes negative or zero as the child grows up.

We also explore how the estimates change along the income distribution.

[12]This question is only asked during the fifth wave but we use this information for wave 4

[13]We define housing tenure as a categorical variable of three ladders: (1) Own outright; Own - mortgage/loan; Part rent/part mortgage (shared equity); (2) Rent privately; Rent from local authority; Rent from Housing Association; (3) households that are either living with their parents or living rent free.

Blau (1999) looks at the effect of the income on children's cognitive, social and emotional development. The author distinguishes between "permanent" income (as income averaged over all periods) and "current" income. The study reveals that permanent family income has a small effect on child development in comparison to that of family background and other characteristics.[14] Because income may confound the effect of the labour supply decision, i.e. the household income level effects the working intensity decision, we do not include it in the benchmark specifications. However, we investigate the robustness of the benchmark results for the bottom and top quartiles of the income distribution.

Geographically linked data

Our specification also controls for the geographical location of the household. We use the *ONS Rural Combined Code* for England and Wales, which is a categorical variable that takes into account the population-density and quantity of inhabitants; the *Scottish Executive Urban Rural Classification* for Scotland, and the *Urban/Rural Status* for Northern Ireland. In line with the general strategy of not including variables directly related to the decision to work, we include these urban/rural indicators lagged.

4.5 Results

4.5.1 Maternal work and subjective well-being

Table 4.7 reports the association between the type of maternal labour participation at the age of 7 and 11 and the different child well-being dimensions

[14]In the MCS, income is defined as the combined annual income in a household from all sources after deductions and is given in thresholds levels. We take the midpoint of each reported interval and use the annual average Consumer Price Index provided by the Office of National Statistics to convert it into real income, taking 2005 as the base year, see the first chapter for a discussion

we explore: (1) *Happiness*;[15] (2) *Worried*; (3) *Temper*; (4) *Bullied*; and, (5) *Horrible*. Each panel in these tables provides the estimates for the specification obtained using each measure of the mother's work intensity: whether the mother is in work (*Employment*); whether she has been unemployed for more than a year (*Long Term (LT) Unemp.*); whether the mother works part time *(Part-time)* (working between 1 hour and less than 16 hours per week (h/w)); work intensity as captured by the categorical variable that takes 4 levels; [16] the number of working hours *(Hours)* and, finally, including both the number of hours per week *(Hours)* and also its square *($Hours^2$)*, to allow for non-linearities in the effect of working hours on the well-being of the child.[17]

Results at age 7 in Table 4.7 Column (1) reveal that the mother working part-time has a negative and statistically significant association on the child's *Happiness*. In line with those results, the fourth panel shows that overall children of mothers working above 16 h/w are more likely to be happier. This effect is even larger when mothers work more than 40 hours. The continuous variable *Hours* is positively associated with the child's *Happiness* but once we incorporate the quadratic term it becomes insignificant.[18]

The estimates of the associations of the mother's working intensity measures and the well-being indicator on *Worried* in Column (2) show a very similar pattern from results in Column (1), though of opposite sign. Working part-time is positively associated to the child being *Worried*. When the mother works more than 16 h/w, there is a negative association with the child being *Worried* and this effect is again larger for mothers at the upper end of the working hours distribution. When looking at the impact of the number

[15] *Happiness* is the latent binary indicator variable as defined in section 4.

[16] Reference category is working less than 16 hours per week.

[17] Specifications in panels (3) to (6) only consider working mothers.

[18] Note that when calculating the local maximum between hours and happiness by solving $\frac{\partial happiness}{\partial hours} = \beta_h - 2 * \beta_{h^2} * h = 0$, this yields $37.70 h/w$ (a maximum as β_{h^2} is negative). Even though this result is non statistically significant, it points out that child's *Happiness* and maternal job intensity are positively correlated up to a threshold of about 37.7 h/w, above which each additional maternal hour of work decreases the child's *Happiness*.

of hours as in panel (5) and (6), the same results as in Column (1) emerge. For all other dimensions of well-being, the only statistically significant effect shows that mothers working more than 40 h/w is negatively associated to the child being *Horrible* to other children (Column (5)). All other parameter estimates in Table 4.7 are not statistically relevant and thus suggests that the maternal labour participation does not particularly relate to dimensions (3) to (5) at the age of 7 years.

Columns (6) to (10) in Table 4.7 present the estimates of the coefficients for the maternal working variables at the age of 11. The estimates for *Happiness* show that the mother being in employment is positively associated with the child being happy. In line with results at age 7, the mother working part-time has a negative association with *Happiness* and the estimated coefficients for the categorical variable on working intensity suggest that only working between 16 and 29 hours is positively associated with happiness. At age 11 the coefficient for *Hours* is not statistically significant.[19] Long-term unemployment of the mother seems to have a negative association with the likelihood of the child having a bad *Temper*. We find a negative but statistically significant association between the mother working longer hours and the child being *Bullied* at school. However, working between 16 and 29 h/w has a positive association with being *Horrible* to others. In sum, at the age of 11 there is some evidence of an association between a child's well-being and the mother's job status, but it is only significant for a few of the selected well-being measures.

Due to the change in the phrasing of the questions and the change in the child's maturity from age 7 to 11, we are not able to establish causal links. Nevertheless, our estimates consistently indicate a positive relation with the maternal employment status. There is another effect that we do not contemplate in this study, though it could be relevant. In 2008, there was a financial crisis across the European Union and this impact might also affect the association of the parameter estimates. Although we cannot account for the impact of the Great Recession in our specification, it worth highlighting

[19]In this case, the local maximum is $43h/w$ (see footnote 18). This is in line with the non-significant results for panel (4) in Table 4.7.

that before the recession (age 7) what seems to affect well-being is the maternal time spent at work whereas during the recession (age 11) it is to have a job. Since happiness is a latent variable defined from the perspective of three subjects (child, parent-mainly the mother- and the teacher), we cannot rule out the possibility that parents' evaluation of children's happiness might not reflect some of their own gloomier outlooks.

Table 4.7: Basecase results

	Age 7					Age 11				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Specification	Happy	Worried	Temper	Bullied	Horrible	Happy	Worried	Temper	Bullied	Horrible
(1) Employment	-0.01503	-0.02987	0.02797	0.002738	0.007054	0.06909**	0.05336	0.04048	-0.1000	0.05902
	(0.0459)	(0.0275)	(0.0540)	(0.0350)	(0.0208)	(0.0309)	(0.0577)	(0.0832)	(0.0847)	(0.0854)
N	5377	7994	8002	7973	7964	4402	8068	8032	8086	8097
LL	-3212.908	-6173.654	-7021.439	-7596.880	-4147.663	-2353.787	-1.18e+04	-1.10e+04	-1.49e+04	-1.07e+04
(2) LT Unemp.	0.03269	0.09011	0.02827	0.08559	0.01694	0.08756	-0.2228	-0.2079+	-0.2937	-0.03279
	(0.0633)	(0.0615)	(0.0668)	(0.0736)	(0.0525)	(0.0827)	(0.1366)	(0.1146)	(0.2187)	(0.1187)
N	355	562	558	563	562	433	746	746	741	745
LL	-208.355	-438.763	-461.825	-552.055	-305.985	-266.785	-1068.910	-1067.161	-1388.360	-969.687
(3) *Part-time*	-0.04891**	0.04093**	-0.01020	-0.01469	0.005990	-0.03831+	0.05718	0.02799	0.05637	-0.05150
	(0.0200)	(0.0184)	(0.0214)	(0.0229)	(0.0147)	(0.0215)	(0.0413)	(0.0370)	(0.0607)	(0.0338)
N	4016	5879	5883	5864	5854	3450	6332	6293	6339	6344
LL	-2353.673	-4442.677	-5105.847	-5513.965	-2843.841	-1763.927	-9197.676	-8533.571	-1.16e+04	-8325.505
(4) $16 \leq h \leq 29$	0.04979**	-0.03823**	0.01199	0.01185	-0.004364	0.03808+	-0.06157	-0.02186	-0.04236	0.06170+
	(0.0209)	(0.0194)	(0.0224)	(0.0238)	(0.0155)	(0.0226)	(0.0433)	(0.0389)	(0.0636)	(0.0363)
$29 < h \leq 40$	0.04435+	-0.04007+	0.01005	0.02248	-0.005270	0.03566	-0.05665	-0.03757	-0.07605	0.02900
	(0.0236)	(0.0223)	(0.0256)	(0.0280)	(0.0174)	(0.0244)	(0.0468)	(0.0424)	(0.0690)	(0.0386)

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Table 4.7: Basecase results – Continued

	Age 7					Age 11				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Specification	Happy	Worried	Temper	Bullied	Horrible	Happy	Worried	Temper	Bullied	Horrible
$40 < h$	0.07192+	-0.1011**	-0.02349	0.004607	-0.04463+	0.05826	-0.01013	-0.04145	-0.1007	0.06770
	(0.0436)	(0.0414)	(0.0477)	(0.0526)	(0.0269)	(0.0368)	(0.0703)	(0.0598)	(0.1018)	(0.0567)
N	4016	5879	5883	5864	5854	3450	6332	6293	6339	6344
LL	-2353.401	-4441.206	-5105.476	-5513.782	-2842.811	-1763.655	-9197.273	-8533.397	-1.16e+04	-8324.660
(5) *Hours*	0.001337+	-0.001571**	-0.0005231	0.0007966	-0.0005156	0.0009969	-0.0004161	-0.001239	-0.003745+	0.0007215
	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0006)	(0.0008)	(0.0014)	(0.0013)	(0.0021)	(0.0012)
N	4016	5879	5883	5864	5854	3450	6332	6293	6339	6344
LL	-2355.573	-4442.855	-5105.758	-5513.759	-2843.480	-1764.900	-9198.789	-8533.363	-1.16e+04	-8326.552
(6) *Hours*	0.004250	-0.001775	-0.001028	0.001051	0.0006215	0.002741	-0.007641	-0.002637	-0.004410	0.002227
	(0.0028)	(0.0027)	(0.0030)	(0.0032)	(0.0021)	(0.0027)	(0.0050)	(0.0044)	(0.0072)	(0.0043)
$Hours^2$	-0.00005636	0.000003912	0.000009711	-0.000004900	-0.00002195	-0.00003173	0.0001296	0.00002502	0.00001193	-0.00002701
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
N	4016	5879	5883	5864	5854	3450	6332	6293	6339	6344
LL	-2354.813	-4442.851	-5105.740	-5513.755	-2843.279	-1764.609	-9197.44	-8533.302	-11600	-8326.474

Notes: Table 4.7 presents the weighted OLS regressions on *Happiness*, being *Worried*, losing *Temper*, being *Bullied* and being *Horrible* to other children on different measures of mother's labour force participation. All panels include the following control covariates: housing tenure, mother religion, maternal age, maternal smoking, number of siblings living in the household, number of rooms, low birth weight, number of books in the house, cohort sex, mother race, rural urban index, maternal type of work, maternal level of education, maternal perception of time with child in previous waves, family structure, consistency on happiness response. Panel (2) excludes maternal type of work as the sample only includes those in short and long-term unemployment. N refers to the number of observations. LL refers to the log likelihood of each regression. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.5.2 Maternal labour supply and child's weight

In this section, we examine the impact of maternal work on two objective measures that have been linked to well-being: obesity and overweight. The dependent variables of interest are dichotomous variables indicating if a child is obese or overweight by relying on the methodology developed in Saxena et al. (2004) which uses age and gender adjusted BMI thresholds.

Table 4.8 presents the Average Partial Effects (APEs) from a probit specification across the fourth and fifth sampling wave. Our results suggest that maternal work intensity is positively correlated with both overweight and obesity at the age of 7. Interestingly, the statistically relevant maternal working range is between 29 and 40 h/w. Thus, if the mother works between 29 to 40 hours, it is related to the child being 3.43% more likely of being overweight and 2.44% of being obese. When the mother works more than 40 hours the likelihood of being overweight goes up to 10%. At age 11 the maternal work intensity is also positively correlated with both childhood obesity and overweight, however the statistical relevance does not follow the same pattern as in the fourth sampling wave. For instance, only when we incorporate a non-linearity in the variable *Hours* in our specification, the effects of *Hours* become statistically significant with respect to being an overweight child, whereas the likelihood of being obese is positively correlated to hours, but not when we include the squared number of hours term.

Table 4.8: Maternal working status and child's weight

	Age 7		*Age 11*	
	(1)	(2)	(3)	(4)
Specification	Overweight	Obese	Overweight	Obese
(1) Employment	-0.0036	-0.0042	0.0158	0.0163
	(0.0136)	(0.0085)	(0.0161)	(0.0103)
N	8061	8061	8142	8142
(2) LT Unem.	0.0596	0.0040	0.0707	-0.0198
	(0.0375)	(0.0265)	(0.0477)	(0.0316)
N	560	440	754	668
(3) *Part-time*	-0.0186	-0.0101	-0.0288^{+}	0.0021
	(0.0130)	(0.0085)	(0.0160)	(0.0109)
N	5925	5925	6376	6376
(4) $16 \leq h \leq 29$	0.0063	0.0038	0.0289^{+}	-0.0079
	(0.0136)	(0.0089)	(0.0166)	(0.0114)
$29 < h \leq 40$	0.03432^{**}	0.0244^{**}	0.0355^{+}	0.0044
	(0.0149)	(0.0097)	(0.0182)	(0.0121)
$40 < h$	0.1006^{***}	-0.0146	-0.0160	0.0221
	(0.0256)	(0.0191)	(0.0275)	(0.0170)
N	5925	5925	6376	6376
(5) *Hours*	0.0019^{***}	0.0007^{**}	0.0006	0.0007^{**}
	(0.0005)	(0.0003)	(0.0005)	(0.0004)
N	5925	5925	6376	6376
(6) *Hours*	-0.0019	0.0021^{+}	0.0050^{**}	-0.0007
	(0.0017)	(0.0011)	(0.0020)	(0.0012)
$Hours^2$	0.0001^{**}	-0.0000	-0.0001^{**}	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	5925	5925	6376	6376

Notes: Results show the weighted Average Partial Effects on childhood Overweight (Column(1) at age 7 and Column(3) at age 11) and Obese (Column(2) at age 7 and Column(4) at age 11) on different measures of mother's labour force participation. Panels (1), (3)-(6) control covariates: housing tenure, mother's religion, maternal age, maternal smoking, number of siblings living in the household, number of rooms, low birth weight, number of books in the house, cohort sex, mother's race, rural urban index, maternal type of work, maternal level of education, maternal perception of time with child in previous waves, family structure, consistency on happiness response. Panel (2) control covariates: housing tenure, mother's religion, maternal age, maternal smoking, number of siblings living in the household, number of rooms, low birth weight, number of books in the house, cohort sex, mother's race, rural urban index, maternal level of education, maternal perception of time with child in previous waves, family structure, consistency on happiness response. N refers to the number of observations. The weights used to correct for attrition are available in the MCS data set. LL refers to the log likelihood of each regression. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.5.3 Extensions and robustness checks

Differences on well-being at the lower and upper end of the income distribution

We investigate the correlation with maternal employment by constraining our analysis to the lower 25% and upper 75% of income distribution in the sample.[20] This extension allows us to examine the association across the income distribution since we cannot control for the income in our specification in Tables 4.7 because this will bias the decision on the work intensity (Rosenzweig & Schultz 1983, Ruhm 2008). Tables 4.9 and 4.10 display the results of regressing our child well-being measures against the same set of maternal working covariates for children in the upper and lower quartile subsamples at the age of 7 and 11, respectively. We follow the same strategy as in section 4.1. Thus, parameters estimates come from an OLS specification and those from column (1) should be interpreted as in a linear probability model because *happiness* is a dichotomous variable.

For children aged 7 in the lower quartile of the income distribution, the higher the working hours the less *Worried* and losing *Temper*, as indicated by the coefficients in panels (4) and (5). For these two well-being measures the part-time employment status of the mother has a detrimental effect on the child's well-being. Children in the upper 75% of the income distribution experience bullying when mothers work long hours. These effects are no longer significant at the age of 11 as seen in Table 4.10. The estimations at this later age show that, except for two of the coefficients, all other estimates are not statistically relevant. The only effects we find is that longer working hours is positively associated to being *Happy* and being in long term (LT)

[20]In the MCS, the household income is given in threshold levels and is defined as the combined annual income from all sources after deductions. We take the midpoint of the reported range and then convert it into real prices using the annual average Consumer Price Index provided by the Office of National Statistics with 2005 as a base. As commonly done, we take the natural logarithm of the income in order to avoid problems caused by its skewed distribution.

unemployment is negatively related to being *Horrible* to others. These effects are significant for children at the lower end of the income distribution only.

These results are in line with previous studies (see for instance Mendolia (2016)), which finds that the mother's participation in the labour market has a positive effect partly via her contribution to the household's income. In this paper, although we cannot establish causation, we try to minimise the biases caused by endogeneity as

Table 4.9: Age 7 - Lower ($q <= .25$) and upper ($q >= .75$) quartile income distribution

	Happy		Worried		Temper		Bullied		Horrible	
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$
(1) *Employment*	0.04944	0.02975	-0.1726	0.009447	-0.05396	-0.01073	0.1548	-0.01937	0.05982	0.08400
	(0.1247)	(0.0451)	(0.1353)	(0.0756)	(0.0909)	(0.0524)	(0.0998)	(0.0557)	(0.0632)	(0.0741)
N	755	1905	1233	2740	1231	2743	1228	2732	1223	2727
ll	-461.239	-1078.757	-1023.586	-1947.401	-1156.925	-2315.082	-1272.479	-2420.154	-830.156	-1239.560
(2) *LT Unemp.*	0.02614	0.01534	0.1148	0.01949	0.08074	0.1341	0.1076	0.03484	-0.1044	0.1929+
alone	(0.1394)	(0.1780)	(0.1147)	(0.1224)	(0.1094)	(0.1277)	(0.1177)	(0.1827)	(0.1120)	(0.1052)
N	105	94	185	143	182	144	184	144	183	144
LL	-42.960	-43.706	-134.530	-64.231	-135.338	-88.301	-152.778	-127.020	-109.082	-63.733
(3) *Part-time*	-0.02712	-0.03195	0.1198+	0.02476	0.1551+	0.02365	-0.1045	-0.04550	0.08241	-0.01231
	(0.0735)	(0.0309)	(0.0676)	(0.0293)	(0.0812)	(0.0339)	(0.0858)	(0.0355)	(0.0692)	(0.0210)
N	352	1485	544	2134	542	2133	541	2123	538	2119
LL	-187.771	-813.960	-412.945	-1514.583	-481.352	-1808.224	-539.365	-1870.744	-346.376	-956.853
(4) $16 <= h <= 29$	0.03445	0.03117	-0.09359	-0.02641	-0.1432+	-0.01311	0.1069	0.02619	-0.07632	0.02108
	(0.0757)	(0.0326)	(0.0695)	(0.0310)	(0.0834)	(0.0360)	(0.0876)	(0.0371)	(0.0704)	(0.0230)
$29 < h <= 40$	0.02428	0.02739	-0.2010**	-0.01393	-0.1863+	-0.04209	0.09976	0.07997+	-0.09046	0.001513
	(0.0918)	(0.0371)	(0.0897)	(0.0356)	(0.1045)	(0.0405)	(0.1137)	(0.0427)	(0.0806)	(0.0246)
$40 < h$	-0.2007	0.08857	-0.3041**	-0.08648	-0.2973	-0.05283	0.05862	0.09304	-0.2386**	-0.04983
	(0.1720)	(0.0547)	(0.1546)	(0.0582)	(0.1843)	(0.0714)	(0.2823)	(0.0736)	(0.0993)	(0.0364)
N	352	1485	544	2134	542	2133	541	2123	538	2119
LL	-186.535	-813.289	-410.917	-1513.557	-480.866	-1807.725	-539.333	-1869.219	-345.689	-955.273
(5) *Hours*	0.0004394	0.001400	-0.007395***	-0.0006886	-0.008604***	-0.001728	0.0004707	0.003049**	-0.004183	-0.0004808
	(0.0029)	(0.0012)	(0.0028)	(0.0012)	(0.0032)	(0.0014)	(0.0040)	(0.0014)	(0.0027)	(0.0008)
N	352	1485	544	2134	542	2133	541	2123	538	2119
LL	-187.853	-813.818	-410.728	-1514.782	-479.530	-1807.581	-540.284	-1869.041	-345.862	-956.860
(6) *Hours*	0.01449	0.003149	-0.0006338	0.0008950	-0.01751+	-0.002824	0.007429	0.002747	-0.003741	0.001362
	(0.0093)	(0.0039)	(0.0088)	(0.0043)	(0.0105)	(0.0046)	(0.0120)	(0.0046)	(0.0097)	(0.0031)
$Hours^2$	-0.0002943	-0.00003295	-0.0001442	-0.00002949	0.0001900	0.00002041	-0.0001489	0.000005650	-0.000009449	-0.00003441

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Table 4.9: Age 7 - Lower ($q <= .25$) and upper ($q >= .75$) quartile income distribution – Continued

	Happy		Worried		Temper		Bullied		Horrible	
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$
	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0001)
N	352	1485	544	2134	542	2133	541	2123	538	2119
LL	-186.227	-813.698	-410.355	-1514.684	-479.029	-1807.545	-540.037	-1869.039	-345.860	-956.642

Notes: See notes in Table 4.7.N refers to the number of observations. LL refers to the log likelihood of each regression. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4.10: Age 11 - Lower ($q <= .25$) and upper ($q >= .75$) quartile regressions

	A:Happy		B:Worried		C:Temper		D:Bullied		E:Horrible	
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$
(1)*Employment*	-0.1559	0.08030	0.03092	0.06115	-0.02556	0.03622	0.4141	0.06956	-0.07460	0.1234
alone	(0.1979)	(0.0819)	(0.1529)	(0.1417)	(0.1322)	(0.1376)	(0.4126)	(0.1403)	(0.1130)	(0.0825)
N	527	1819	1014	3236	1012	3210	1019	3236	1018	3238
ll	-301.958	-838.831	-1526.7	-4548.336	-1461.935	-4106.881	-1927.696	-5787.293	-1440.685	-4155.38
(2)*Lt unemp.*	-0.2421	0.2788	0.09424	-0.2398	-0.1775	-0.3242	-0.3349	-0.1905	-0.7648**	0.1938
alone	(0.1565)	(0.1720)	(0.2225)	(0.2432)	(0.2333)	(0.2214)	(0.3623)	(0.4945)	(0.3470)	(0.2383)
N	116	104	222	178	220	179	220	176	219	178
LL	-58.454	-33.759	-289.67	-214.654	-291.912	-206.595	-373.809	-300.626	-262.19	-210.196
(3)$h < 16$	-0.04413	-0.04329	0.04658	0.05196	-0.08724	0.04801	0.1473	0.001055	0.03294	-0.03087
	(0.0799)	(0.0297)	(0.1476)	(0.0593)	(0.1314)	(0.0517)	(0.2111)	(0.0880)	(0.1258)	(0.0539)
N	313	1517	578	2731	576	2709	579	2732	578	2733
LL	-169.257	-651.813	-862.716	-3831.706	-811.694	-3441.294	-1081.811	-4854.876	-802.498	-3522.358
(4)$16 < h <= 29$	0.02463	0.04936	-0.06673	-0.05054	0.04516	- 0.03945	-0.1703	0.01162	-0.09095	0.05919
	(0.0829)	(0.0311)	(0.1550)	(0.0623)	(0.1372)	(0.0547)	(0.2216)	(0.0924)	(0.1277)	(0.0589)
$29 < h <= 40$	0.07934	0.03003	0.08591	-0.06900	0.2054	-0.06749	0.007852	-0.02336	0.1076	-0.01753
	(0.0976)	(0.0345)	(0.1805)	(0.0673)	(0.1610)	(0.0594)	(0.2681)	(0.1005)	(0.1773)	(0.0585)
$40 < h$	0.2365	0.05807	-0.2112	0.04083	0.2597	-0.01553	-0.3381	0.009421	0.2954	0.04461
	(0.1462)	(0.0490)	(0.2681)	(0.0979)	(0.2727)	(0.0758)	(0.4775)	(0.1399)	(0.2744)	(0.0796)
N	313	1517	578	2731	576	2709	579	2732	578	2733
LL	-168.202	-651.341	-861.789	-3830.556	-810.655	-3440.836	-1081.227	-4854.726	-800.301	-3520.528
(5) *Hours*	0.004941+	0.001093	-0.0003081	-0.001021	0.006350	-0.001759	-0.005479	-0.003439	0.006663	-0.0005689
	(0.0028)	(0.0011)	(0.0053)	(0.0021)	(0.0049)	(0.0017)	(0.0083)	(0.0030)	(0.0050)	(0.0018)
N	313	1517	578	2731	576	2709	579	2732	578	2733
LL	-167.859	-652.498	-862.78	-3832.013	-811.032	-3441.221	-1081.836	-4854.068	-801.464	-3522.502
(6) *Hours*	-0.0008554	0.003222	-0.001762	-0.009633	0.008879	-0.006092	0.009217	0.001986	-0.001536	0.002058
	(0.0088)	(0.0037)	(0.0175)	(0.0068)	(0.0157)	(0.0060)	(0.0238)	(0.0101)	(0.0137)	(0.0060)
$Hours^2$	0.0001135	-0.00003781	0.00002795	0.0001494	-0.00004829	0.00007507	-0.0002806	-0.00009413	0.0001565	-0.00004556

Continued on Next Page...

Table 4.10: Age 11 - Lower ($q <= .25$) and upper ($q >= .75$) quartile regressions – Continued

	Happy		Worried		Temper		Bullied		Horrible	
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$	$q \leq .25$	$q \geq .75$
	(0.0002)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0001)	(0.0004)	(0.0002)	(0.0002)	(0.0001)
N	313	1517	578	2731	576	2709	579	2732	578	2733
LL	-167.609	-652.262	-862.77	-3831.039	-811.016	-3440.901	-1081.618	-4853.885	-801.286	-3522.389

Notes: See notes in Table 4.7.N refers to the number of observations. LL refers to the log likelihood of each regression. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

much as possible by first, controlling for a very complete full-set of covariates, which reduce the impact of the unobserved factors; and second, by including regressors that are not related to the decision to work, which mitigates the bias caused by the circularity of *Happiness* and income (Ruhm 2004, 2008).

Maternal commuting time and children's well-being

We now proceed to investigate whether commuting time to work affects children's well-being. A potential mechanism for that would be that commuting affects a mother's well-being and this is therefore indirectly projected onto the child's well-being. We proxy the distance of the mother's work place to home by exploiting the answers to the following question: *'On a typical day, how long does it take you to get from home to work, one way?'* which has 8 different choices ranging from *Working from Home* to *2 or more hours.*[21] We construct a variable interacting the number of hours the mother works with the commuting time to work. Thus, we are able to estimate the following equation for each wave:

$$cw_{it} = \psi + \alpha h_{it} + \alpha_2(h_{it} * comtime_{it}) + comtime_{it}\eta + Z_{it}\beta + \epsilon_{it} \qquad (4.7)$$

where h_i are the job maternal working *Hours*, $comtime_i$ is the commuting time, Z is the set of control variables, i is the child identifier, t is the sampling wave, ϵ_i is an i.i.d normally distributed error.

Table 4.11 and 4.12 display the results of estimating equation 4.7 in an OLS fashion. As in previous specifications, we adjust for survey probabilities to account for attrition. The reference category is working from home. At the age of 7, the association between *Happiness* and *Hours* term is mainly positive, but not significant except beyond two hours which is marginally significant of a small size. Nevertheless, the dummy variable of more than

[21]The choices are: (1) Under 5 minutes, (2) 5, under 15 minutes, (3) 15, under 30 minutes, (4) 30, under 45 minutes, (5) 45, under 1 hour, (6) 1 under 2 hours, (7) 2 or more hours, (8) Works at home. We re-scaled (8) to be the first level.

120 min of commuting is bigger than the interaction term of commuting with hours. Traveling between 15 -45 min. is negatively and significantly related of being worried, also commuting beyond two hours is significantly related on losing temper. In both cases the dummy variables for this thresholds are of contrary sign.Thus, it means that the effect of commuting needs a certain amount of maternal working place to be of the sign of the interaction term. The same idea holds at the age of 11, commuting between 60-120 min. is associated on being worried and losing temper. As well as of being less likely being both horrible and and a bully. These relation at the age of 11 are only of the sign of the interaction term hours and commuting beyond certain threshold of maternal work.

The major threat to the validity of these estimates is that they are related to the work intensity decision, thus the *Hours* covariates might have a downward bias, both in terms of statistical relevance and magnitude. In previous specifications, we seized our regression with contemporaneously non-related covariates to the maternal work intensity decision and for those suspected to be related to such decisions we evaluated with values from previous waves and as a result the size and statistical relevance of maternal working hours were higher and relevant. This section allows us to investigate the size of the bias if we incorporate a known variable that affects the job decision, in this case measured in time-distance. This is important since the literature on maternal employment points towards a maternal job more likely to be next to home. Thus, bigger distances in our specification might also mask the relevance of the effect due to the lack of enough numbers of observations in our specification. Specifically, Table A6 in the Appendix shows that the bulk of the observations are between 15 to 45 minutes commuting time.

Table 4.11: Mother's commuting time and child's well-being at Age 7

Specification	(1) Happiness	(2) Worried	(3) Temper	(4) Bullied	(5) Horrible
Age 7					
h	-0.001418	0.002763	-0.003161	0.002088	-0.0001934
	(0.0020)	(0.0021)	(0.0022)	(0.0025)	(0.0015)
$h * (5 \leq t < 15)$	0.002477	-0.003289	0.004400	-0.002251	-0.00009724
	(0.0028)	(0.0028)	(0.0032)	(0.0035)	(0.0022)
$h * (15 \leq t < 30)$	0.003356	-0.006491^{***}	0.002746	-0.0006774	0.0001531
	(0.0024)	(0.0024)	(0.0026)	(0.0029)	(0.0017)
$h * (30 \leq t < 45)$	0.003971	-0.005248^{**}	0.001560	-0.001192	-0.001470
	(0.0024)	(0.0024)	(0.0027)	(0.0030)	(0.0018)
$h * (45 \leq t < 60)$	-0.0001771	-0.001736	0.005067	-0.001365	0.0009521
	(0.0030)	(0.0029)	(0.0031)	(0.0034)	(0.0021)
$h * (60 \leq t < 120)$	0.003924	-0.001382	-0.002744	-0.005825	-0.002030
	(0.0036)	(0.0041)	(0.0045)	(0.0048)	(0.0028)
$h * (\geq 120)$	0.007519^{+}	-0.003593	0.01036^{**}	0.006112	0.001815
	(0.0042)	(0.0043)	(0.0051)	(0.0055)	(0.0039)
$(5 \leq t < 15)$	-0.005551	0.1037	-0.08531	0.06654	0.02002
	(0.0733)	(0.0762)	(0.0823)	(0.0894)	(0.0574)
$(15 \leq t < 30)$	-0.08443	0.1528^{**}	-0.09351	0.05244	0.009729
	(0.0641)	(0.0673)	(0.0683)	(0.0766)	(0.0464)
$(30 \leq t < 45)$	-0.06845	0.1312^{+}	-0.04052	0.08929	0.04452
	(0.0668)	(0.0684)	(0.0710)	(0.0794)	(0.0498)
$(45 \leq t < 60)$	0.02258	0.01408	-0.1786^{**}	0.01497	-0.02630
	(0.0831)	(0.0827)	(0.0871)	(0.0965)	(0.0576)
$(60 \leq t < 120)$	-0.05718	0.1040	0.06444	0.2009	0.09551
	(0.1070)	(0.1214)	(0.1302)	(0.1457)	(0.0859)
(≥ 120)	-0.2024	0.1453	-0.2385	-0.1006	0.04223
	(0.1327)	(0.1231)	(0.1507)	(0.1548)	(0.1128)
N	3901	5705	5707	5688	5679
LL	-2272.014	-4291.731	-4946.581	-5346.865	-2728.282

Notes: Table 4.11 presents the weighted OLS on happiness (column(1)), Being worried (column(2)), Losing Temper (column(3)), Bullied (column(4)) and being horrible to other children (column (5)) on different measures of mother's labour force participation for both sampling waves Age 7 and Age 11. See notes in Table 4.7. N refers to the number of observations. weights used to correct for attrition are available in the MCS data set. LL refers to the log likelihood of each regression. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4.12: Mother's commuting time and child's well-being at Age 11

	(1)	(2)	(3)	(4)	(5)
Specification	Happiness	Worried	Temper	Bullied	Horrible
Age 11					
h	-0.00003981	-0.00003833	-0.003038	0.002709	0.004729
	(0.0020)	(0.0034)	(0.0035)	(0.0056)	(0.0032)
$h * (5 \leq t < 15)$	-0.002668	-0.0006487	0.005616	-0.01078	-0.004121
	(0.0027)	(0.0048)	(0.0045)	(0.0075)	(0.0043)
$h * (15 \leq t < 30)$	0.003074	0.002233	0.007300^{+}	-0.009595	-0.005550
	(0.0024)	(0.0041)	(0.0041)	(0.0065)	(0.0038)
$h * (30 \leq t < 45)$	0.001404	-0.003723	0.002774	-0.003226	-0.003980
	(0.0024)	(0.0044)	(0.0042)	(0.0068)	(0.0039)
$h * (45 \leq t < 60)$	0.002048	0.007912	0.003581	-0.008339	-0.003034
	(0.0032)	(0.0056)	(0.0052)	(0.0084)	(0.0053)
$h * (60 \leq t < 120)$	0.004349	0.01572^{**}	0.01518^{**}	-0.02620^{**}	-0.01766^{***}
	(0.0040)	(0.0067)	(0.0063)	(0.0109)	(0.0061)
$h * (\geq 120)$	-0.004810	-0.008831	-0.0004080	-0.0001346	0.002469
	(0.0053)	(0.0076)	(0.0077)	(0.0115)	(0.0060)
$(5 \leq t < 15)$	0.08470	0.02224	-0.07011	0.2157	0.04069
	(0.0739)	(0.1421)	(0.1333)	(0.2290)	(0.1234)
$(15 \leq t < 30)$	-0.1156^{+}	-0.01214	-0.1354	0.2880	0.1009
	(0.0697)	(0.1273)	(0.1201)	(0.2029)	(0.1106)
$(30 \leq t < 45)$	-0.04908	0.07676	-0.07947	0.07077	0.08081
	(0.0714)	(0.1344)	(0.1257)	(0.2103)	(0.1148)
$(45 \leq t < 60)$	-0.07473	-0.2296	-0.05917	0.1506	0.03589
	(0.0951)	(0.1729)	(0.1611)	(0.2679)	(0.1654)
$(60 \leq t < 120)$	-0.1747	-0.3934^{+}	-0.3446^{+}	0.9162^{**}	0.5173^{**}
	(0.1317)	(0.2180)	(0.2069)	(0.3725)	(0.2084)
(≥ 120)	0.04825	0.3006	0.08371	0.1028	-0.08966
	(0.1628)	(0.2496)	(0.2508)	(0.3709)	(0.1942)
N	3315	6091	6056	6098	6103
LL	-1663.206	-8831.381	-8222.193	-1.11e+04	-8008.912

Notes: see references 4.11.

Children living with both parents

We now turn attention to the subsample of families in which the child lives with both natural parents. The objective is to analyse the association of the maternal work intensity with the child's well-being measures, taking into account characteristics of the father. Table 4.13 displays the results at the age of 7 and 11 for the sub-sample (Columns (1) and (4)); and also for the lower and upper income quartile from this sub-sample (Columns (2) and (5); and (3) and (6), respectively).[22] The specification in Table 4.13 includes the maternal working hours (*Hours*), the father's employment status defined as a dichotomous variable (*Fatherempl*=1 if he works, 0 otherwise), his age and education, as well as all other control variables included in previous set of estimations.

When controlling for the father's employment, the number of maternal working hours are only significant for the lower quartile of income. There is a negative association at age 7 with having bad *Temper* and being *Worried*; however, the latter effect becomes positive when the child grows older at age 11. At this age, children of mothers working long hours are less happy. This suggests that maternal working hours have a positive impact on the child's well-being at a younger age but as the child grows older the opposite holds. The estimates of the mother's working hours lose some significance with respect to previous estimates, especially in comparison to the full sample.

The impact of the father being in work is negative for *Happiness* and positive for being *Horrible* to others across the highest income quartile at the age of 7 but at age 11 the impact is positive for being *Bullied* and *Horrible* to others. At both ages there is a detrimental effect of the father being at work and, as opposed to the mother working, the effects only prevail at the higher income distribution. One of the main interesting results found in Table 4.13 is the opposite direction of the effect that maternal and paternal working status has on the child being *Happy*. Whereas there is a positive association with the mother there is a negative effect for the father being at work. Overall, maternal working hours are positive for the well-being of the

[22]The lower and upper percentiles are drawn from the income distribution for this specific subsample of children living with both natural parents.

child at the age of 7 but not at a later age and the father's working status seems to have an adverse effect on well-being.

The major drawback of this estimates is that the decision on the intensity to work is also shaped by the current father employment situation. Thus, the maternal labour supply is a consequence in the regression rather than a mere correlation with the child's well-being. As a result, the parameter estimate might be downward biased. In related work, Ruhm (2008) does not control for the paternal employment status, just whether he is present. Another interpretation for the lack of relevance of the maternal work intensity comes from the literature on Family Economics. In that regard, the relevant work pioneered by Becker (1985) highlights that child care (and housework) is mainly carried by women in a classical marriage setting. Thus, it might limit the maternal ability to access higher paid jobs that requires traveling or longer working hours. Those activities are energy and time consuming and as a result affects the maternal time allocation to the job market, both in terms of work intensity and better paid opportunities.

Table 4.13: Sub-sample families where both parents cohabitate

	Age 7			*Age 11*		
	(1)	(2)	(3)	(4)	(5)	(6)
	Total	$q \leq .25$	$q \geq .75$	Total	$q \leq .25$	$q \geq .75$
(1) happiness						
Hours	0.001035	0.001456	0.001389	0.0006287	-0.01104**	-0.0004904
	(0.0009)	(0.0034)	(0.0015)	(0.0009)	(0.0053)	(0.0015)
Fatherempl	-0.1765***	-0.002247	-0.2379***	0.04181	0.2956+	0.04247
	(0.0515)	(0.1370)	(0.0387)	(0.0648)	(0.1523)	(0.1653)
N	2662	232	929	2195	119	747
LL	-1523.060	-119.907	-488.350	-1004.057	-28.937	-272.952
(2) Worried						
Hours	-0.001730+	-0.007727**	-0.0001053	-0.0003765	0.01956+	-0.0008122
	(0.0009)	(0.0032)	(0.0015)	(0.0017)	(0.0108)	(0.0028)
Fatherempl	-0.01156	0.1010	-0.1234	-0.2926**	-0.3245	0.2437
	(0.0629)	(0.1255)	(0.0994)	(0.1479)	(0.2879)	(0.2884)
N	3855	394	1317	3912	226	1274
LL	-2808.260	-296.416	-908.553	-5533.920	-319.212	-1743.823
(3) Temper						
Hours	0.0004268	-0.006484+	-0.0002657	-0.001610	0.0006761	0.0004083
	(0.0010)	(0.0033)	(0.0017)	(0.0015)	(0.0087)	(0.0024)
Fatherempl	0.01542	0.08125	0.1953	0.03957	0.2578	0.1494
	(0.0823)	(0.1406)	(0.1659)	(0.1029)	(0.2033)	(0.2600)
N	3854	392	1315	3884	225	1257
LL	-3234.774	-322.987	-1089.503	-4996.597	-270.760	-1507.550
(4) Bullied						
Hours	-0.0005548	0.001903	0.0003546	-0.004702+	0.01572	-0.001172
	(0.0011)	(0.0041)	(0.0018)	(0.0025)	(0.0144)	(0.0039)
Fatherempl	-0.07757	-0.1364	-0.02931	0.1067	0.3850	0.9387***
	(0.0924)	(0.1697)	(0.1748)	(0.2065)	(0.3642)	(0.2914)
N	3842	393	1308	3910	227	1271
LL	-3478.436	-357.025	-1117.166	-6966.057	-392.207	-2206.044
(5) Horrible						
Hours	-0.0001820	0.0007416	-0.0005539	0.0004900	0.007291	-0.001283
	(0.0006)	(0.0023)	(0.0010)	(0.0014)	(0.0098)	(0.0020)
Fatherempl	0.01432	-0.01326	0.1311***	-0.01359	-0.1981	0.2929**
	(0.0546)	(0.0997)	(0.0361)	(0.0991)	(0.2055)	(0.1173)
N	3835	393	1307	3912	226	1270
LL	-1595.686	-141.301	-507.793	-4848.903	-260.372	-1532.385

Notes: Results shows the weighted OLS specification. Row (3) & Row (6) other controls: housing tenure, mother religion, maternal age, maternal smoking , number of siblings living in the household, number of rooms, low birth weight, number of books in the house, cohort sex, mother race, rural urban index, maternal type of work, maternal level of education, maternal perception of time with child in previous waves, family situation, consistency on happiness response, father education, father age. Significance levels : $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Robustness checks on children's weight

So far, we have discussed and identified the association of five child's well-being dimensions: *Happiness*, *Worried*, *Temper*, *Bullied* and *Horrible* with the mother's working hours and also adjusting for commuting time, the father's employment status and inspecting across the poorest and the wealthiest quartiles of the income distribution. In this section, we aim to repeat this exercise with childhood obesity and overweight as outcome variables.

Table 4.14 summarizes the findings of the average partial effects from a probit specification estimated for population subgroups. Columns (1) and (2) present the estimates at the lower ($q < .25$) and upper($q > .75$) quartile of the income distribution. Column (3) present the parameters of the group in which both natural parents cohabitate across the full sample and Columns (4) and (5) further split the sample of cohabiting parents according to income distribution. We also estimated the coefficients when including the interaction with the commuting time but only the coefficient for commuting more than two hours was significant for the likelihood of being overweight at the age of 7. All other coefficients were not significant and therefore we do not show the results here for paucity.

Regarding the association at age 7, maternal work intensity is positively correlated to almost all specifications. Nevertheless, the association is not always relevant. It is interesting to note that the sign of the effect corroborates findings in the literature. For instance, the effect at the upper quartile is in line with results found in Anderson et al. (2003). Our specification controls for a comprehensive set of parameter estimates that tackles a variety of possible cofounders, nevertheless given the data we are not able to discern the transmission mechanism along the upper quartile which is statistically significant in terms of overweight (the pattern does not hold for the obesity outcome). Specifically, in the sub-sample of households with both parents cohabiting, the fact that the father is in work across the upper quartile has a negative relation on the probability of the child being overweight but the effect is positive for obesity in the lower quartile. If we look at the relation with the maternal work intensity in the lower quartile it is negatively related to obesity, nevertheless once we include the paternal work situation

this association is no longer statistically relevant.

By inspecting the maternal work intensity at age 11, we find some parallels to the results observed at age 7. We find that the association at the upper quartile is positive and significant for the probability of being overweight, but not with respect to childhood obesity. Another statistically relevant association is also with respect to obesity once we examine the subgroup of families in which both parents cohabitate, where the paternal work status is significant and negative, being the size of the effect higher. It is also important to note that the association of the father is positive and significant with respect to being overweight.

These findings are in line with what we observed previously in Table 4.8 and maternal work intensity is positively related to obesity and overweight outcome variables. Our results are also in line with what has been documented in the literature by pointing to a positive association between the maternal labour supply and a child's BMI.

Table 4.14: Robustness checks Overweight-Obese

	Full-sample		*Father*		
	(1)	(2)	(3)	(4)	(5)
Age 7	$q \leq .25$	$q \geq 75$	All	$q \leq .25$	$q \geq 75$
Overweight					
Hours	0.0006	0.0017**	0.0019***	-0.0006	0.0019+
	(0.0015)	(0.0008)	(0.0006)	(0.0017)	(0.0010)
Father employed			-0.02938	-0.07976	−0.1299+
			(0.0471)	(0.0659)	(0.0780)
N	531	2146	3880	393	1317
Obese					
Hours	−0.0027+	0.0001	0.0009***	-0.0007	-0.0004
	(0.0016)	(0.0005)	(0.0003)	(0.0014)	(0.0006)
Father employed			0.0141	0.1973***	-0.0064
			(0.0242)	(0.0674)	(0.0397)
N	465	2071	3880	335	1184
Age 11					
Overweight					
Hours	0.0006	0.0012+	0.0009	0.0007	0.0018+
	(0.0017)	(0.0007)	(0.0006)	(0.0029)	(0.0009)
Father employed			0.0843+	0.0384	0.0509
			(0.0506)	(0.0811)	(0.1159)
N	579	2748	3935	219	1279
Obese					
Hours	0.001278	0.0002053	0.0009**	0.0002	-0.0004
	(0.0016)	(0.0005)	(0.0004)	(0.0025)	(0.0007)
Father employed			−0.0550**	-0.0560	0.0422
			(0.0235)	(0.0411)	(0.0667)
N	540	2674	3931	123	1078

Notes: Table 4.14 presents the Average Partial Effects from a weighted Probit specification. Columns (1) and (2) includes all family types. Columns (3), (4) and (5) focus on the sub-sample of families where both natural parents cohabitate. Control covariates: housing tenure, mother religion, maternal age, maternal smoking , number of siblings living in the household, number of rooms, low birth weight, number of books in the house, cohort sex, mother race, rural urban index, maternal type of work, maternal level of education, maternal perception problem with child in previous waves, family situation, consistency on happiness response. Additional controls for columns (3)-(5): father education and age. Significance levels: $^{+}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

4.6 Conclusions

This paper examines the relation of maternal working hours on children's well-being, relying on a sample of seven and eleven year-old children from the MCS in the UK. First, we define as an outcome variable a composite measure of parental, teacher and children perceptions of the child's happiness in order to lessen the effect of the cognitive ability of the child. We also include as outcome variables several well-being aspects such as being *worried*, losing *temper*, being *bullied* and being *horrible* to other children. Because obesity and overweight have been linked to well-being, we further investigate the maternal labour supply relation on the likelihood of the child being overweight and obese.

Our benchmark set of estimates present the OLS estimates over the child's well-being dimensions throughout an array of maternal labour measures. The decision of the mother to work part-time at the child's age of 7 has a negative and significant association on *Happiness* and this is corroborated by the positive effect that working longer hours has on the child's well-being. The child is also less *Worried* the longer the mother works. At age 11, these results mainly only hold for the *Happiness* dimension of well-being. We re-ran the analysis for the lowest 25% and upper 75% income quartiles. Interestingly, there is no significant maternal working effect on the children's *Happiness*. Nevertheless, the effect of working full time, even though not always significant, has a negative impact on losing *temper* or being *worried* along the lowest quartile and mostly at age 7.

We also investigate the maternal labour spillover effect on the child's well-being by including the interaction between maternal labour supply and commuting time, with ambiguous results on the child's well-being for longer commuting times and shorter commuting time affecting *Happiness* positively at age 7 and longer commuting times reducing *Happiness* at age 11. We further look at the child's well-being analysis and restrain our sample to those houses where the mother cohabitates with the natural father. Our specification includes a set of paternal control variables. Remarkably, the father being employed is negatively correlated with happiness at age 7 at the highest income quartile. This effect becomes positive at age 11 at the

lowest income quartile in contrast to the negative relation of maternal work intensity on the child's *Happiness*.

Overall, the effect of working full-time is positively correlated with happiness and negatively with well-being states like *losing temper* or *feeling worried*. However, maternal labour intensity also has a positive effect on the probability of being obese or overweight. This result prevails across a number of robustness checks.

The contribution of this research has different layers. First and foremost, to the best of our knowledge we are the first to expand the literature on maternal job intensity impact on child well-being. The literature purely concentrates on two fronts, on one hand a number of seminal works look at the relation of the maternal job status with respect to children's academic development and on the other hand there is an extensive literature looking at the relation with the likelihood of the child being obese or overweight. Our research opens a new frontier, thanks to the comprehensiveness of the MCS in terms of quality and availability of covariates, to properly assess correlations between maternal working intensity and an array of subjective and objective child's well-being dimensions. In this research we focus on the *evaluative* and *experience* ladders of the child's well-being. Our findings show that in households in which mothers work full-time, children are, on average, happier, less worried, as well as less likely to lose their temper. Another key contribution of the paper comes from the definition of a new "evaluative" measure taking into account three different points of view on happiness (the child's, parents and teacher), potentially overcoming the limitation of the cognitive bias of relying exclusively on the child's response.

Our parameter estimates are subject to various limitations. The data, even though comprehensive in a lot of areas, does not allow for control for the quality time with the child. We tried to proxy for a subjective measurement of the mother of the amount of time with the child, but this might not properly reflect the quality time. We are unable to identify the mechanism on how working more than a threshold benefits the child's well-being. However, a natural channel would be the linkage of the family production function such as quality time with the child as well as a positive role model. Another aspect we are not able to control for, but that to some extent can be proxied

by maternal education, is the communication between parents and child, which might show the assimilation of the family context, in terms on how the child rationalizes and understand his environment. We are not able to imply causation of our estimates, just correlation, even though we give a clear account of the positive effect of the maternal work intensity. Though, we acknowledge that the strategy of not including cofounding factors (following Ruhm (2004, 2008) papers) in the hybrid function might itself capture other association that are not counted for. A further limitation is the time elapsed between sampling waves, as a four-years time gap between 7 and 11 may be crucial to understand child cognitive development. In future studies, we propose to extend the results in this paper on two fronts, one to look at the production function of a child's well-being dimension and second to examine whether the historical role of the mother changes across a wider period.

4.7 Appendix

Table A1: Relation Latent variables & dimensions wave IV

Dimensions	Child		Parents		Teacher	
	(1)	(2)	(3)	(4)	(5)	(6)
Latent value	0	1	0	1	0	1
Levels						
1	82	55	104	70	208	92
2	1,437	3,482	598	207	694	452
3	705	2,322	1,522	5,582	1,322	5,315
N	2,224	5,859	2,224	5,859	2,224	5,859

Note: Note: The entries of this tables are the summary responses to the child's (in column (1) and (2)), parent's (in column (3) and (4)) and teacher's (in column (5) and (6)) questionnaire on child's happiness question and the relation with the composite measurement created using the PROC LCA (Lanza et al. (2011)).

Table A2: Relation Latent variables & dimensions wave V

Dimensions	Child		Parents		Teacher	
	(1)	(2)	(3)	(4)	(5)	(6)
Latent value	0	1	0	1	0	1
Levels						
1	53	82	137	29	138	43
2	74	52	671	257	613	413
3	80	63	761	4,573	818	4,403
4	201	143	-	-	-	-
5	218	432	-	-	-	-
6	400	1,314	-	-	-	-
7	543	2,773	-	-	-	-
			-	-	-	-
N	1,569	4,859	1,569	4,859	1,569	4,859

Note: Note: The entries of this tables are the summary responses to the child's (in column (1) and (2)), parent's (in column (3) and (4)) and teacher's (in column (5) and (6)) questionnaire on child's happiness question and the relation with the composite measurement created using the PROC LCA (Lanza et al. (2011)).

Table A3: Summary statistics - Age 7

Variable	N	mean	sd	p25	p50	p75	max	min
Employment	13155	.6412011	.4796663	0	1	1	1	0
LT Unemp	4954	.1794509	.3837682	0	0	0	1	0
$1 \leq h < 16$ (*Part-time*)	8435	.2013041	.4009985	0	0	0	1	0
$16 \leq h \leq 29$	8435	.4336692	.4956101	0	0	1	1	0
$29 < h \leq 40$	8435	.3251926	.4684746	0	0	1	1	0
$40 < h$	8435	.039834	.1955807	0	0	0	1	0
Hours	8435	24.50836	10.98943	16	23	35	66	1
Overweight	13838	.1386038	.3455451	0	0	0	1	0
Obese	13838	.0763116	.2655056	0	0	0	1	0
Housing tenure								
Own/rent privately	13700	.7541606	.4305995	1	1	1	1	0
Rent housing association/council	13700	.2264234	.4185315	0	0	0	1	0
Other	13700	.0194161	.1379872	0	0	0	1	0
Non-religion	13692	.4911627	.4999402	0	0	1	1	0
Christian	13692	.396655	.4892211	0	0	1	1	0
Muslim	13692	.0821648	.2746256	0	0	0	1	0
Other	13692	.0300175	.1706417	0	0	0	1	0
Mother age	13729	36.01085	5.871421	32	36	40	60	21
Mother Smoker	13709	.2651543	.4414314	0	0	1	1	0
N. siblings	13838	1.541697	1.11276	1	1	2	13	0
N. rooms	13744	6.098006	1.755543	5	6	7	25	1
Time with child Wave I	13342	1.499101	.8538106	1	1	2	4	1
Time with child Wave II	12506	1.573964	.8909372	1	1	2	4	1
Time with child Wave III	13103	2.094101	.8498554	1	2	3	4	1
Female	13838	.4942911	.4999855	0	0	1	1	0
Low birth weight	13372	.0758301	.264736	0	0	0	1	0
N.books	11837	3.248036	1.383097	2	3	4	6	1
White	13832	.8514315	.3556755	1	1	1	1	0
Ban/Ind/Pak	13832	.0889965	.284749	0	0	0	1	0
Black	13832	.0347744	.1832146	0	0	0	1	0
Other	13832	.0247976	.1555133	0	0	0	1	0
Unemployed	13142	.3591539	.4797707	0	0	1	1	0
Routine or semi-routine	13142	.2454725	.4303834	0	0	0	1	0
Lower supervisor or lower technical	13142	.1361284	.342938	0	0	0	1	0
Smaller employer or self-employed	13142	.0539492	.225926	0	0	0	1	0
Intermediate	13142	.0246538	.1550735	0	0	0	1	0
Managerial or professional	13142	.1806422	.3847361	0	0	0	1	0
Mother education Level I	11767	.0791196	.2699368	0	0	0	1	0
Mother education Level II	11767	.3072151	.4613589	0	0	1	1	0
Mother education Level III	11767	.1768505	.3815584	0	0	0	1	0
Mother education Level IV	11767	.3581202	.4794681	0	0	1	1	0
Mother education Level V	11767	.0786947	.269273	0	0	0	1	0
Both parents	13838	.7323313	.4427599	0	1	1	1	0
Natural mother	13838	.2046539	.403463	0	0	0	1	0
Natural mother + couple	13838	.0630149	.2429985	0	0	0	1	0

N refers to the number of observations in each group where the family situation is: Both natural parents cohabiting, only mother , mother + couple (non-natural father). *sd* refers to the standard deviation, *p25,p50 and p75* stand for the percentiles 25, 50 and 75; *Max and min* stand for the maximum and minimum value, respectively.

Table A4: Summary statistics - Age11

variable	N	mean	sd	p25	p50	p75	max	min
Employment	12282	.697362	.4594186	0	1	1	1	0
LT Unemp	4066	.2961141	.4565981	0	0	1	1	0
$1 \leq h < 16$ (*Part-time*)	8565	.1544658	.3614158	0	0	0	1	0
$16 \leq h \leq 29$	8565	.4242849	.4942628	0	0	1	1	0
$29 < h \leq 40$	8565	.3527145	.4778427	0	0	1	1	0
$40 < h$	8565	.0685347	.252676	0	0	0	1	0
Hours	8565	26.24332	11.41963	18	25	35	68	1
Overweight	13114	.1986427	.3989936	0	0	0	1	0
Obese	13114	.0933354	.2909129	0	0	0	1	0
Housing tenure								
Own/rent privately	12835	.7680561	.4220898	1	1	1	1	0
rent from housing association/council	12835	.2164394	.4118332	0	0	0	1	0
Other	12835	.0155045	.1235527	0	0	0	1	0
Non-religion	12990	.4714396	.4992029	0	0	1	1	0
Christian	12990	.4072363	.4913385	0	0	1	1	0
Muslim	12990	.0893764	.2852973	0	0	0	1	0
Other ethnic	12990	.0319477	.1758675	0	0	0	1	0
Age	12990	39.96898	5.825486	36	40	44	64	25
Mother Smoker	12956	.2342544	.4235483	0	0	0	1	0
N.siblings	13114	1.597758	1.137104	1	1	2	10	0
N. rooms	12885	6.221032	1.875687	5	6	7	30	1
Time with child wave I	12647	1.499565	.8528333	1	1	2	4	1
Time with child wave II	11841	1.571996	.8907783	1	1	2	4	1
Time with child wave III	12204	2.093658	.8503509	1	2	3	4	1
Time with child wave IV	11832	2.10666	.8663252	1	2	3	4	1
Female	13114	.4959585	.5000027	0	0	1	1	0
Low birth weight	12677	.0776998	.2677091	0	0	0	1	0
N.books	12872	3.206262	1.387071	2	3	4	6	1
White	13088	.8421455	.3646185	1	1	1	1	0
Ban/Ind/Pak	13088	.0974939	.2966404	0	0	0	1	0
Black	13088	.0333894	.179658	0	0	0	1	0
Other	13088	.0269713	.1620056	0	0	0	1	0
Type of work								
Unemployed	12120	.3066832	.4611357	0	0	1	1	0
Routine or semi-routine	12120	.2744224	.4462412	0	0	1	1	0
Lower supervisor or lower technical	12120	.1671617	.3731356	0	0	0	1	0
Smaller employer or self-employed	12120	.0601485	.2377716	0	0	0	1	0
Intermediate	12120	.019967	.1398926	0	0	0	1	0
Managerial or professional	12120	.1716172	.3770629	0	0	0	1	0
Mother education Level I	11284	.07134	.2574033	0	0	0	1	0
Mother education Level II	11284	.2751684	.4466189	0	0	1	1	0
Mother education Level III	11284	.1714817	.3769461	0	0	0	1	0
Mother education Level IV	11284	.3735378	.4837644	0	0	1	1	0
Mother education Level V	11284	.1084722	.3109896	0	0	0	1	0
Both parents	13114	.6775965	.4674143	0	1	1	1	0
Natural mother	13114	.2265518	.4186161	0	0	0	1	0
Natural mother + couple	13114	.0958518	.2943991	0	0	0	1	0

N refers to the number of observations in each group where the family situation is: Both natural parents cohabiting, only mother , mother + couple (non-natural father). *sd* refers to the standard deviation, *p25,p50 and p75* stand for the percentiles 25, 50 and 75; *Max and min* stand for the maximum and minimum categorical value respectively

Table A5: Summary statics Obese & Overweight

Variable	N	mean	sd	p25	p50	p75	max	min
wave 4								
Obese	13838	0.08	0.27	0	0	0	1	0
Overweight	13838	0.14	0.35	0	0	0	1	0
wave 5								
Obese	13114	0.09	0.29	0	0	0	1	0
Overweight	13114	0.20	0.40	0	0	0	1	0

N refers to the number of observations in each group where the family situation is: Both natural parents cohabiting, only mother , mother + couple (non-natural father).
sd refers to the standard deviation, *p25,p50 and p75* stand for the percentiles 25, 50 and 75; *Max and min* stand for the maximum and minimum categorical value respectively

Table A6: Maternal commuting time across waves

Sampling wave	4	5
Home	500	467
(t<5)	878	868
(5≤t<15)	2,801	2,926
(15≤t<30)	2,309	2,444
(30≤t<45)	970	898
(45≤t<60)	459	394
(60≤t<120)	288	249
(≥120)	22	25
N	8,227	8,271

Note: The entries of this tables are the summary responses to the maternal commuting time in minutes, t is time.The first row *Home* stands for working from home.

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Chapter 5

Thesis conclusion

This thesis presents a collection of three autonomous chapters in applied microeconometrics over children's dimension of health, academic performance and well-being outcomes. The research presented in this thesis inspects and relies on the data set Millennium Cohort Study, a national survey that tracks the lives of nearly 19,000 children born in the UK over the period 2000-2001. The first wave was collected when children were 9 months old and consecutive interviews were gathered at different intervals (3, 5, 7 and 11 years old). Trained interviewers carried out a set of multipurpose questionnaires which are intended to capture not only the cognitive and physical attributes as such, but also the socioeconomic and demographic environment of the child.

In the first chapter we examine the association between parental assessed child health and Domestic Violence (DV), which is survey reported.Our sample follows a set of children across the age of 5, 7 and 11. Our first set of results provides solid support for an association between child health and DV. Nevertheless, we acknowledge the existence of different sources of unobserved factors that might bias our results. In particular, attrition and simultaneity among outcomes variables. Thus, to lessen the effect of attrition we weight our specifications for the probability of losing observations along the period of study. So to avoid the downward bias of the DV parameter estimate due to the fact of losing families in which we observe DV. The second source of bias is the likelihood of unobserved characteristics affecting simultaneously

both subjective outcomes of interest, child health and DV. We address this potential endogeneity problem by estimating a set of simultaneous models in which we include two exclusion restrictions or instruments associated with DV but not with child health. Our restrictions variables are the relation with the affective relation of the father with the paternal grandparents and the regional gender unemployment gap. Findings in this study point out that children living in a house in which there is DV are between 55% and 61% less likely to have their health rated as Excellent in comparison to other children.

In relation to the first chapter we further investigate the spillover effect of DV on the child's upbringing. In particular, we examine whether there is a negative impact over the child's academic performance. We restrict the sample to a set of children across the age of 7 and 11. In this case our parameter estimates rely on two definitions of DV. The first definition, *Contemporaneous-DV*, captures if DV is reported in the current survey. The second one, *Ever-DV*, reflects if DV has been reported in the current wave or at any of the previous waves. We use the two DV definitions to minimise the under-reporting problem that affects DV and to get a clear idea about the accumulated effect in the case that DV has been observed in previous waves. Our results show that there is a negative impact of living with DV on educational attainment although the impact is heterogenous across academic subject areas. While at 7 years of age most of the negative effects are not statistically significant, by the age of 11 a substantial gap in educational outomes emerges. There is a clear difference in magnitude in the effect of DV for academic subjects. Although we are able to establish difference in educational outcomes across these two ages, the analysis is bounded to four year lapses between waves and we do not observe what happens in between 7 and 11 years of age. The difference among Ever and Contemporaneous DV definitions indicates the existence of a cumulative effect from previous waves. In those subjects where both DV definitions are similar, it implies no cumulative effect; though, in those areas where the Contemporaneous is lower than the Ever parameter estimates, it suggests a mounting effect from previous waves. Interestingly, our data points to a stable difference across waves in English, whereas the gap between Ever and Contemporaneous in Mathematics and Science increases. In this sense, our analysis helps to shed

light on the learning process. The estimates highlight the importance of ensuring that children can learn the foundations undisrupted in order to be able to build up knowledge later. There is a clear higher marginal cost of acquiring new information for those children who were not able to acquire the basic concepts at the expected age due to the distortions introduced by living in a household with DV.

In both analyses we include various strategies to control for the potential problems created by unobserved factors, which might bias our OLS specification. First, we address the selection introduced by having or not having the academic information available. We opt for the simplest specification in which we control for whether or not we have the questionnaire adjusting for the observed covariates. We also explore the impact on the coefficient of interest of the parents' self-selection into a violent relationship. To do so, we exploit the regional difference between male and female unemployment rates during the first wave. In areas where the gap is lower, females have a higher bargaining power and viceversa. We do not find any big differences in terms of magnitude and significance across estimates of our results across the different empirical strategies. We interpret this as evidence that the OLS specifications control for such a comprehensive set of estimates such that, indirectly, the effect of the unobserved factors has been minimised and is not biasing our estimates.

The last chapter examined the relation of maternal working hours on children's well-being measures, relying on a sample of seven and eleven year-old children. We define as an outcome variable a composite measure of parental, teacher and children perceptions of a child's happiness in order to lessen the effect of the cognitive ability of the child. We also include as outcome variables several well-being aspects such as being *worried*, losing *temper*, being *bullied* and being *horrible* to other children. Because obesity and overweight have been linked to well-being, we further inspect the maternal labour supply relation on the likelihood of the child being overweight and obese.

The contribution of the last chapter has different layers. First and foremost, to the best of our knowledge we are the first to expand the literature on maternal job intensity impact on child well-being. The literature purely concentrates on two fronts, on one hand a number of seminal works look at

the relation of the maternal job status with respect to children's academic development and on the other hand there is an extensive literature looking at the relation with the likelihood of the child being obese or overweight. Our research opens a new frontier, thanks to the comprehensiveness of the MCS in terms of quality and availability of covariates, to properly assess correlations between maternal working intensity and an array of subjective and objective child's well-being dimensions. In this research we focus on *evaluative* and *experience* concepts of child's well-being. We find that in households in which mothers work full-time, children are, on average, happier, less worried, as well as less likely to lose their temper. Another key contribution of the paper comes from the creation of an "evaluative" measure that takes into account the points of view on happiness of the child, the parents and the teacher. This overcomes the limitation imposed by relying exclusively on the child's response. However, maternal labour intensity also has a positive effect on the probability of being obese or overweight. This result prevails across a number of robustness checks.