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ABSTRACT

The Bilingual Gap in Children's Language and Emotional Development*

In this paper we examine whether – conditional on other family inputs – bilingual children achieve different outcomes in language and emotional development. Our data come from the UK Millennium Cohort Study (MCS) which allows us to analyze children's language and emotional development in depth. We relax the usual assumption that the production function underpinning child development is not itself a function of the age of the child and estimate the bilingual gap in children's language and emotional development as a cumulative process that depends on current and past endowments of cognitive and non-cognitive capacity. We find that the language development of bilingual children is not significantly different to that of their monolingual peers; however, there is evidence of a positive effect of bilingualism on emotional development.

JEL Classification: I20, J24, D10

Keywords: cognitive and non-cognitive skills, production function, value-added model, cohort studies

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1. Introduction

The number of international migrants worldwide reached 258 million in 2017, an increase of 17 percent from 2010. Two thirds of all international migrants worldwide live in just twenty countries (United Nations, 2017). In the United States, more than 4.9 million English learners were enrolled in public elementary and secondary schools during the 2013/14 school year, representing just over 10 percent of the total student population (Snyder et al., 2015), while in the Canadian province of Ontario over 25 percent of students are identified as English language learners (Ontario Education Department, 2007). Similarly, the United Kingdom's Department of Education estimates that there were more than a million children, aged between five and 18 and enrolled in U.K. schools, who collectively speak more than 360 different languages (Department for Education, 2013).

This dramatic rise in global migration has left some countries grappling with the policy challenges of educating bilingual children. For instance, the cost of providing English language support to 50 pupils has been estimated by Edinburgh City Council at roughly £33,000 a year, largely driven by the cost of employing an English language support teacher (Rolfe and Metcalf, 2009). At the same time, there is a debate largely centered around the economic merits of speaking a second language in the context of globalization - directly addressing the danger of a country relying on the primacy of, say, English (see Nuffield Foundation (2002) for one example of the debate for the U.K.).[1] The wider question is whether bilingual children perform better than English-only students (Bialystok et al., 2012; Hoff, 2013). For example, recent studies in the U.S. find that bilingual education programs (which use some native language

[1] A compulsory foreign languages element in the national primary school curriculum is a relatively new Government initiative; in September 2014 languages became part of the National Curriculum in England from ages seven to 14, with the requirements that at Key Stage 3 (age 11-14) a modern language is taught (see Long and Boulton, 2016).

instruction) and English-only programs are not significantly different in their impact on standardized test performance (Guo and Koretz, 2013; Chin et al., 2013).

In this paper we examine whether – conditional on other family inputs – bilingual children achieve different developmental outcomes. We use data from the U.K. Millennium Cohort Study (MCS) which allows us to analyze children's language and emotional development in depth. Measures of children's English language development are constructed from widely validated, age-appropriate tests from the British Ability Scales (BAS). While the children's emotional development is assessed using parental responses to the Strength and Difficulties Questionnaire (SDQ), which screens for children's antisocial behavior, hyperactivity (inattention), emotional symptoms, and peer relationship problems (see Goodman, 2001).

Our study makes several important contributions. Whilst research has focused on a wide variety of determinants of skills (such as childhood family income, family structure, parental education, maternal time investments, child care and school quality) (see Ermisch and Francesconi, 2001; Almond and Currie, 2011; Del Bono et al., 2016), it has not examined the potential importance of the language spoken at home on language or emotional development. Building on the theoretical analyses of Todd and Wolpin (2003), Cunha et al. (2006) and Cunha and Heckman (2008), we estimate a skills production function for children born in the U.K. to at least one migrant parent. This focus on the early development of native-born children of migrant parents allows us to avoid any potential confounding factors associated with time since arrival. An important distinction is that we relax the usual assumption that the production function underpinning child development is not itself a function of the age of the child. We estimate the bilingual gap in children's language and emotional development as a cumulative process that depends on current and past endowments of cognitive and non-cognitive capacity as well as a history of family investments. Our examination of the bilingual gap in the acquisition of both language and emotional skills between the ages of three and 14 complements existing studies that focus solely on the link between bilingualism and developmental skills measured at specific ages.

We find that, based on age-specific analysis, younger bilinguals have lower levels of language development but by age seven they now have an advantage, and by age 11 bilinguals are back to having lower language development than their monolingual peers. Controlling for lagged outcome test scores in an attempt to reduce the bias caused by omitted past inputs, along with a rich set of time-varying controls, we find that on average there is no bilingual gap in language development. In terms of emotional development, our analysis suggests that past bilingual status is associated with fewer difficulties. We find some variation in the impact with the benefit to emotional development larger for boys and children of lower educated parents. There is a stronger persistence in emotional development than language development, but overall persistence in outcomes is quite low (<0.5).

The rest of the paper is organized as follows. Section 2 discusses the previous literature and Section 3 presents the data, sample selection, and variable construction. Section 4 outlines our conceptual framework and empirical specification. Section 5 discusses the results and Section 6 concludes.

2. The literature

There is an extensive literature focused on the impact that exposure to multiple languages has on the development of children. Some experts believe that bilingualism confuses children (Genesee, 1989), while others have argued that bilingual children are slower to develop language skills because their language learning capacity is divided across acquiring multiple languages (Macnamara, 1967; Hoff, 2013). Studies of bilingual children focusing on verbal tests of intelligence appear to lend support to these concerns by concluding that on average bilingual children exhibit slower cognitive development (see Darcy, 1953; Hakuta, 1986; Bhatia and Ritchie, 2008) and initially possess a smaller vocabulary in each of their languages (Oller and Eilers, 2002; Clifton-Sprigg, 2016). While, among first- and second-generation children, a lack of English proficiency is cited as a primary reason for a poor performance in elementary school (Rosenthal et al., 1983).

There is emerging evidence, however, on the importance of bilingualism for some forms of cognitive functioning. Bilingualism is associated with higher executive functioning and attention in children (Bialystok, 2001; Yang et al., 2011) and young adults (Costa et al., 2008), and protects against cognitive decline in old age (Bialystok et al., 2012). Further, learning a foreign language is said improve people's development of analytical and communicative skills (Saiz and Zoido, 2005; Kamhöfer, 2014), while exposure to bilingualism at an early age has a positive impact on reading, phonological awareness, and language competence in both languages (Kovelman et al., 2009).

Researchers are increasingly utilizing experimental or quasi-experimental designs to study the effects of bilingual education on children's educational outcomes. Across six schools, Slavin et al. (2011) randomly assigned kindergarteners with limited proficiency in English to either bilingual education or structured English 'immersion'. They find no statistically significant difference in standardized test scores in English by fourth grade (i.e., by age nine or 10). Although students in bilingual education initially had weaker English skills than students in the immersion programs, their later skills did not differ significantly. Chin et al. (2013) exploit policy changes governing the provision of bilingual education programs in Texas, where school districts were required to offer bilingual education when the enrolment of students of limited English proficiency in a particular elementary grade level reaches a threshold. Using this discontinuity as an instrument for district bilingual education provision, they find that bilingual education programs do not significantly impact the standardized test scores of students with Spanish as their home language. Clifton-Sprigg (2016) examines the early age performance gap of bilingual children using data for Scotland. They find children perform comparably on an array of measures, including cognitive (picture similarities), non-cognitive (Strengths and Difficulties Questionnaire) and motor development. Where differences do emerge (vocabulary naming, speech assessment), the outcomes are likely to be related to speech and linguistic skills. The author highlights that bilingual families are a heterogeneous group and children with two foreign-born parents are at a particular disadvantage at this early age.

A number of studies use MCS data (as we do here) to examine the importance of home environment and time investment in shaping early child outcomes. Ermisch (2008) finds that much of the difference in child development at the age three can be explained by parenting style and educational activities. Similarly, Dickerson and Popli (2016) find that the cognitive development test scores at age seven are lower for children who live persistently below the poverty line throughout their early years compared to children who have never experienced poverty. However, the studies utilizing U.K. data do not typically account for unobservable child heterogeneity or for the persistence in language and emotional development over time. An exception is Del Bono et al. (2016), who estimate the relationship between maternal time inputs and early child development using a specification in which lagged inputs and past test scores are controlled for. Our work complements the Del Bono et al. (2016) research but considers a longer time horizon and examines the effect of being bilingual on children's language and emotional development at various stages between the ages of three and 15 years.

3. Data: The UK Millennium Cohort Study

The data used in this analysis comes from the U.K. Millennium Cohort Study (MCS) of approximately 19,000 children born between 2000 and 2001 (Plewis et al., 2007). Earlier U.K. birth cohort studies sampled babies born within a given week, while the MCS has the advantage of capturing a birth cohort who were born across a whole year. To date six surveys have been conducted, at nine months and three, five, seven, 11 and 14 years old resulting in a uniquely detailed portrait of children's development.

The MCS collects information about many diverse aspects of children's lives including: children's behavior, cognitive development, health, schooling, and living arrangements; as well as parental employment and education; family income and poverty status; housing, neighborhood and residential mobility; and social capital and ethnicity. The main unit of observation is the cohort member (the child), and information is collected from cohort members and main respondents (typically the child's biological mother).[2] For example, children's verbal reasoning test scores, a measure of language development, are collected directly from children by trained interviewers, whilst questions about the children's socio-emotional behavior are asked of parents.

3.1 Bilingualism in our Estimation Sample

Bilingualism is a multifaceted phenomenon with no commonly accepted definition. We adopt the perspective proposed by Kohnert (2010) who views bilinguals as "individuals who receive regular input in two or more languages during the most dynamic period of communication development - somewhere between birth and adolescence" (p. 457). We use information on the language spoken at home to construct a measure of bilingual status. The main respondent is asked: "*Is English the language spoken at home?*". Children of respondents reporting "*Yes-English only*" or "*Yes-mostly English and sometimes other languages"* are classified as monolingual, while the children of respondents reporting "*Yes- about half English and half other language*" or "*No - mostly other, sometime English*" and "*No-other languages only"* are

[2] The "main respondent" is defined as person who answered the main interview questions regarding the cohort child. In the majority of cases, this was the biological mother.

classified as being bilingual. Information about the language status of the children in our sample is depicted in Figure 1. At age three, 56 percent of the children are exposed to foreign language at home; by age 14, less than 30 percent of children continue to be bilingual.

[INSERT FIGURE 1 HERE]

Given our research interests we focus on a sub-sample of U.K.-born children for which at least one parent is foreign-born; these are the children most likely to be exposed to multiple languages at home.[3] A total of 3,528 children (at age three) meet these selection requirements. We also restrict the sample to cases with complete information on our language and emotional development measures and other control variables. These restrictions yield a sample of 1,994 children at age three; with subsequent attrition reducing the sample to 1,682 at age five; 1,693 at age seven; 1,497 at age 11; and 1,359 at age 14.[4]

We begin with a cross-sectional analysis that exploits information for these children at every age that they are observed. We then estimate pooled models that rely on an unbalanced panel of 9,532 child-wave observations for those children aged three to 14 for whom we have complete information on the key development measures and additional controls of interest.

3.2 Language and Emotional Development

The MCS provides a range of cognitive ability measures administered directly to the children. We use age appropriate tests that come from the British Ability Scales (BAS). Our measure of

[3] As all of the MCS sample are born in the U.K., all children in our sample are exposed to broadly the same institutional and cultural environment outside of the home. Moreover, restricting the sample to children with at least one foreign-born parent is helpful in reducing any heterogeneity associated with the fact that foreign-born parents may differ from native-born parents in ways that are non-random.

[4] The longitudinal pattern of response in the MCS is complex, with attrition, re-entry and a small number of late entrants who were eligible at wave 1 but were not included as they were not recorded on the register for Child Benefit. The Child Benefit, a universal provision payable from the child's date of birth, was used as the sampling frame for the MCS.

language development comes from a series of tests of verbal reasoning and knowledge and is constructed using the following assessments: the BAS Naming Vocabulary test taken at ages three and five; the BAS Word Reading test taken at age seven; the Verbal Similarity test taken at age 11; and the Word Activities test taken at age 14.[5] The Naming Vocabulary score reflects expressive language skills, vocabulary (knowledge of nouns), ability to attach verbal labels to pictures, retrieval of names from long-term memory, and general level of language development (Hansen, 2010). The Word Reading test assesses English reading ability, while the Verbal Similarity test assesses verbal reasoning and verbal knowledge. Finally, the Word Activities assessment measures the ability of children to understand the meaning of words. For each of these verbal reasoning tests, we use the age-standardized scores. To facilitate interpretation of the results, we transformed the outcomes into *z*-scores.

The emotional development of children is assessed using the Strength and Difficulties Questionnaire (SDQ – see Goodman, 2001) which is completed by both main respondent and their partner. It comprises 25 questions about five domains of behavior, namely: i) *emotional issues:* child complains of headaches, stomach aches/sickness, often seems worried, unhappy, nervous, or clingy in new situations; ii) *conduct problems*: often has temper tantrums, fights with or bullies other children, is often argumentative with adults; iii) *hyperactivity:* child is restless, over-active, cannot stay still for long, constantly fidgeting, easily distracted; iv) *peer problems*: child tends to play alone, does not have at least one good friend, is not generally liked by other children, picked on or bullied by other children, gets on better with adults; and v) *pro-social behavior*: considerate of others' feelings, shares readily with others, helpful if someone is hurt, upset, or ill, kind to younger children. Respondents indicate whether each item is 'not true', 'somewhat true', or 'certainly true'. Scores from the conduct problems,

[5] We do not consider child outcomes on mathematical reasoning tests as no consistent measures were available at ages 11 and 14.

hyperactivity, emotional symptoms and peer problems sub-scales are summed to construct a total SDQ score which varies between 0 and 40, with higher scores indicative of more behavioral and emotional difficulties. The SDQ score is expressed as a normalized *z*-score.

3.3 Control Variables

A major advantage of the MCS data is that they include detailed information about socio-economic characteristics, migration background, and parental inputs. Our socio-economic controls include the child's age, gender, ethnicity, birth weight, number of siblings and whether their biological mother lives in the household; the mother's age and marital status; parental education levels; region of residence; and the family's poverty status (i.e., income below 60 percent of median income).[6] Parental education at birth captures the additional time that educated parents, especially mothers, tend to spend with their child and also the fact that better educated parents are more likely to be fluent in English (Locay et al., 2013).

There is evidence that the language proficiency of one family member is positively associated with that of other family members, and that children's language proficiency is more highly correlated with maternal, rather than paternal, proficiency (Chiswick et al., 2005). Unfortunately, the MCS does not include measures of parental fluency in English. It does, however, provide information about migrant status, age at (U.K.) arrival and country of origin, which may all be correlated with parental language proficiency and, consequently, with their propensity to speak English at home. In particular, we control for whether mothers and fathers come from a non-English-speaking country.[7] We also control for whether migrant parents

[6] This is the official measure of poverty that is reported in the official Households Below Average Income report (Department for Work and Pensions, 2010), and is defined as living in a household with net equivalent income less than 60 percent of the U.K. median household income.
[7] We used The World Almanac and Book of Facts (Park, 2005) to determine whether English was an official or predominant language in each country of origin. We classify the following as English-speaking countries: Australia, Canada, Barbados, Bermuda, Dominica, Ethiopia, Ghana, Guyana, Hong Kong, India, Ireland, U.S.,

arrived in the U.K. before the age of 11 (as they are likely to have a higher degree of English proficiency).[8]

Parents' investments in their children's development are captured in responses to detailed questions regarding the interactions that parents have with their children. Specifically, when children were nine months old, the main respondent was asked how important: i) talking; ii) cuddling; iii) stimulating; and iv) establishing regular sleeping and eating times were for the development of their child. This gives us an insight into parents' approach to child rearing in infancy and we control for this in our cross-sectional analysis at age three. We measure parental investments at older ages using information about how often parents read to their children or take them to the library.[9]

3.4 The Bilingual Gap in Children's Language and Emotional Development

Table 1 reports the summary statistics of our unstandardized measures of language and emotional outcomes along with other characteristics.[10] There are pronounced differences in socio-economic and demographic characteristics between the two groups of children. Within their age cohort, bilingual children score much lower than their monolingual counterparts in the verbal reasoning exercise at both age three and five; but by age seven the gap in language development between the two groups is insignificant. Bilingual children also score higher on

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Jamaica, Kenya, New Zealand, Nigeria, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Singapore, Trinidad and Tobago, and Zambia.

[8] The parents in our sample arrived between 1954 and 1995. Parents from non-English-speaking countries who arrive at an early age typically have English language skills comparable to migrant parents from English-speaking countries (Bleakley and Chin, 2008). Age at arrival may also have an impact on cultural assimilation. Those parents who arrived at older ages may differ in their values, views about parenting etc., all of which may have an impact on the language and emotional development of their children.

[9] The level and quality of parental investments are usually proxied by the Home Observation Measurement of the Environment (HOME) scores that have been shown to be significantly correlated with later cognitive, health and non-cognitive development (Todd and Wolpin, 2007; Cuhna and Heckman, 2008). Similar constructs are available in our data but they are inconsistently measured over waves and so are not used in our analysis.

[10] Corresponding information for native-born children is reported in Appendix Table 1. Note that the scaling of the unstandardized verbal measure changes across waves making it not directly comparable across time.

the SDQ total difficulties scale, but the difference tends to decline with age. Children whose parents speak a foreign language at home come mainly from non-white, ethnic and lower educated households.

[INSERT TABLE 1 HERE]

Parental investment at nine months, as measured by mother's attitudes toward child rearing, is significantly different between bilingual and monolingual mothers. Mothers of bilingual infants are more likely to believe that talking to, cuddling, stimulating their babies and having regular sleeping and feeding habits are important. When bilingual children are aged three to five, mothers score lower on our parental activity measures, while in contrast when bilingual children are aged seven, parents tend to spend more time reading to their child and visiting the library. These results suggest that parenting practices are not consistent over time.

4. Methods

Our primary objective is to understand whether – relative to their monolingual peers – there is a gap in the language and emotional development of children exposed to a foreign language at home. We address this issue by estimating child development production functions using the approach developed by Todd and Wolpin (2003, 2007) and applied in Fiorini and Keane (2014), Del Boca et al. (2017) and Del Bono et al. (2016). In particular, children’s development is taken to be a cumulative process that depends on both contemporaneous and historical family investments as well as children’s skill endowments. We are particularly interested in the developmental consequences of families’ decisions to raise their children in a bilingual home environment.

There are well-known econometric challenges in generating unbiased estimates of production function parameters with observational data. The first hurdle arises because investments in children are not exogenous, but instead result from the active choices that parents make when trying to maximize their children's human development given the constraints they face. This would not necessarily be a problem if comprehensive data on all relevant inputs (e.g., parental, school, and community investments; child endowments; etc.) into child development were observed (see Todd and Wolpin, 2003); however, this is rarely ever the case. These unobserved inputs (e.g., children's innate ability) are almost certainly correlated with the inputs researchers do observe (e.g., reading to children) resulting in the usual omitted variable bias problem. The second problem stems from the threat that both structural (e.g., simultaneity, mutual causality) and statistical endogeneity (e.g., unobserved heterogeneity, measurement error) pose for causal estimation of the effect of parental investments on children's development. Finally, parental and school inputs are likely to have different effects at different developmental stages (Cunha et al., 2010); this complicates the estimation strategy and limits our understanding of the dynamics of child development.

A range of empirical strategies have been used to deal with these issues. The most common approaches include: i) value-added models; ii) child fixed-effects estimation; iii) instrumental variable estimation; and iv) inclusion of proxy variables (see Todd and Wolpin 2003; 2007 for reviews). In isolation, no one approach provides a complete solution. The inadvertent inclusion of invalid proxies, i.e., those that are related to both included and omitted variables, say through parental decision rules, confounds the interpretation of the estimates and can result in greater bias (see, for example, Keane and Wolpin, 1997; Wooldridge, 2016). Similarly, Fiorini and Keane (2014) point to the econometric challenges in estimating IV models with multiple endogenous regressors; they argue that instead value-added and fixed-effects models – in combination with a rich set of controls and sensitivity testing – are a more practical way to deal with the endogeneity caused by missing inputs.[11]

As is often the case, instrumental variable estimation is not a feasible option for us given a paucity of potentially valid instruments for parental, time-varying, investments in their children.[12] Instead, we rely on the richness of the MCS data to control for an extensive set of family and child background characteristics as well as parental inputs in our models of child development; these controls are important in reducing the potential for omitted variables to bias our results. As we clearly cannot control for all relevant inputs in the production of children's language and emotional development – most notably school inputs – we account for the cumulative nature of child development using value-added specifications (see Hanushek et al., 2009; Harris, 2010, for details). We relax the usual assumption that the production function underpinning child development is invariant with respect to child age.

We illustrate our identification strategy using a baseline specification in which children's language achievement and emotional development depends only on parental inputs, family background characteristics, and an individual-specific effect that is assumed time invariant. Specifically:

$$C_{ija} = \beta_1 B_{ija} + \boldsymbol{X}'_{ija}\gamma + \mu_i + \varepsilon_{ija} \tag{1}$$

where C_{ija} denotes language and emotional development at age *a* for child *i* in family *j*; B_{ija} is the bilingual status indicator; and $\boldsymbol{X}_{ija}$ is a complete set of child- and family-specific covariates (child's age, gender, ethnicity, number of siblings and birth weight, maternal age, parental education measured at nine months, the presence of the biological mother in the household,

[11] See also Todd and Wolpin (2003, 2007) who model test scores as a function of home and school inputs along with unobserved initial ability. They address the model specification problem by applying cross-validation criteria in addition to conventional specification tests and focus on inferences from the preferred model.

[12] Fiorini and Keane (2014) note that even if instrumental variables estimation were feasible, it is not necessarily preferred. Rather it is simply an alternative approach – with alternative maintained assumptions – to deal with endogeneity.

parents' non-English background, young migrant indicator, reading and library visitation frequency, poverty and regional indicators). The term μ_i denotes unobserved child-specific and time-invariant effects (i.e., ability) that may drive the capacity for language achievement and emotional development, and ε_{ija} is a idiosyncratic error term that includes the effect of any omitted inputs, including investments made in previous periods, child endowments and measurement error.[13] This equation is identified only under very strong assumptions that are unlikely to hold in most contexts. Specifically, we can consistently estimate β_1 using OLS only if all omitted factors are orthogonal to the included covariates; that is so long as $E(\mu_i + \varepsilon_{ija} | X_{ija}) = 0$.

One obvious difficulty is the potential for parents' decisions to expose their children to a language other than English at home to depend on children's unobserved ability (μ_i). Fixed-effects estimation would provide one possible solution to this problem; however, it is reliant on a strict exogeneity assumption which may fail if, for example, parental investments are partially driven by historical or contemporaneous shocks to child development (Rothstein, 2010). We tested and rejected the strict exogeneity hypothesis.[14] Consequently, we follow the literature in turning to a value-added approach in which lagged dependent variables are incorporated into the model as a means of resolving the practical difficulties we face in measuring all relevant inputs into children's development. The lagged development measure acts as a sufficient statistic for all time-varying inputs, eliminating the need for historical data on parental investments and school-based inputs so long as the marginal impacts of all previous inputs

[13] See Fiorini and Keane (2014) who discuss measurement error as a form of endogeneity. As our indicator of bilingual status is arguably less subject to measurement error than other parental investments investigated in the literature, e.g., time use collected through retrospective surveys or time diaries (Del Bono et al., 2016; Fiorini and Keane, 2014), we view measurement error as a secondary concern.

[14] Specifically, we performed a test for strict exogeneity by adding leads of the main explanatory variable and testing their joint significance in the fixed-effects regression (see Wooldridge, 2002, chap. 10). The significance of the future bilingual indicators suggests that we strongly reject the null and thus the key assumption that is needed for asymptotically unbiased fixed-effects estimation. The F-statistics for testing the joint significance of bilingual and leads in bilingual indicator is F = 14.90, p-value=0.00. Results of the test are available on request.

decay at a geometric rate over time (Sass et al., 2014).[15] This allows us to relax the strict exogeneity assumption and account for model dynamics in the form of lagged values of the dependent variable instead (see Ashley, 2012).

Specifically, we estimate a cumulative value-added specification that includes both lagged development and lagged input measures along with measures of contemporaneous inputs:

$$C_{ija} = \beta_1 B_{ija} + \beta_2 B_{ija-1} + \boldsymbol{X}'_{ija}\gamma + \boldsymbol{X}'_{ija-1}\delta + \lambda C_{ija-1} + \epsilon_{ija} \tag{2}$$

where λ is a persistence parameter that links development across periods $|\lambda| < 1$. The model in equation (2) takes an important step forward in accounting for the effects of heterogeneity associated with family background, endowments, etc. on children's development. Importantly, C_{ija-1} effectively accounts for any time-constant, child-specific unobserved heterogeneity affecting development levels (see Todd and Wolpin, 2003; Sass et al., 2014). There may, however, also be unobserved differences in the rate at which children acquire language skills or develop emotionally. In this case, the error term is best modelled as $\epsilon_{ija} \equiv \eta_{ia} + \mu_i$ where η_{ia} captures child-specific differences in the rate of development. Equation (2) would still be consistently estimated by OLS so long as lagged language and emotional development, C_{ija-1}, is uncorrelated with both η_{ia} and μ_i; and, conditional on C_{ija-1}, the observed covariates are uncorrelated with η_{ia} and μ_i (see Del Boca et al., 2017).

As Todd and Wolpin (2003, 2007) and Fiorini and Keane (2014) point out, this analysis aims to overcome the difficulty of measuring all the relevant inputs to child development, and the problem of distinguishing a simple correlation between unobserved inputs and outcomes from a true causal impact. We address the first issue by estimating child language and emotional development functions heavily reliant on a rich set of control variables, although we clearly

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[15] The value-added model requires a number of other assumptions not all of which are innocuous (see Harris, 2010).

cannot claim to include all the inputs relevant to child development. The second issue is harder to tackle – drawing policy implications requires that we account for the possibility that changing the level of a single input has an impact on decisions surrounding other inputs. While we cannot interpret these results as causal, the inclusion of past language and emotional outcomes should largely reduce the bias due to unobserved heterogeneity.

5. Results

5.1 The Bilingual Gap in Children's Development

We take advantage of the longitudinal structure of the data to investigate how the bilingual gap evolves from early childhood to adolescence. Hence, we estimate equation (2) separately by age group. Table 2 reports the estimated coefficients, by age group, for both the language and emotional development production functions respectively.

[INSERT TABLE 2 HERE]

Panel (a) presents the results for language development as measured by the standardized verbal reasoning test scores. We find that three-year-old children whose parents speak a foreign language at home have significantly lower verbal reasoning test scores than their monolingual peers. Other things being equal, speaking a foreign language at home when the child was nine months old reduces their language development measured at age three by 0.16 standard deviations. In comparison, having a father with a non-English language background is associated with a 0.08 standard deviation reduction – less than half the impact of bilingualism. In fact, the negative impact of bilingualism is about the same as that of low socio-economic background – a nine-month-old child who is living in poverty can be expected to be have a verbal reasoning score that is 0.21 standard deviations below that of a non-poor child at age three.[16]

The penalty of not exclusively speaking English at home is reduced at age five once we fully control for the observable characteristics, though bilingual children continue to score lower on average in comparison to their monolingual counterparts. The gap is statistically significant at the 10 percent level. Other things being equal, the results suggest that, on average, bilingual children's verbal reasoning scores are 0.11 standard deviations below that of monolingual children. This is suggestive evidence that five-year-old bilingual children continue to fall behind in their expressive language and knowledge of names. Consistent with Cuhna and Heckman (2008) and Dickenson and Popli (2016), past language endowment has a positive and significant effect on language development measured at a later age. For example, a one standard deviation increase in the verbal reasoning test score at age three is associated with greater language development (0.38 of a standard deviation) at age five.

The language development for bilingual children, at the age of seven, is significantly higher than for children who had previously only used English language at home (at the age of five) – 0.19 standard deviations above the score of monolingual children.[17] To get a sense of how important these estimates are, we can compare them to the effect of parental education. At the age of seven, having a mother and father with a higher education degree is associated with

[16] The full set of estimated coefficients are reported in Tables 2 to 6 of the Online Appendix. These estimates additionally reveal that the education of the mother and father, measured at the time of the child's birth, has a significant and positive association with language development at age three. Having a mother with a higher degree is associated with a 0.23 standard deviation increase in the verbal reasoning score as opposed to having a mother with a lower qualification. Children with gross, fine motor development and communication delays measured at nine months have not caught up developmentally by age three. The effect of having parents who arrived in the U.K. at younger ages results in a significant positive increase in the verbal development at age three by around 0.13 standard deviations. Parental inputs, as measured by the frequency with which the mother or father reads to the child and or visits the library, significantly impacts the verbal outcomes of five-year-old children. Overall, adding a comprehensive set of controls reduces the estimated coefficient on current bilingual status, and in some specifications the effect is rendered statistically insignificant at the conventional levels.

[17] Recall that in the verbal reasoning test taken at age seven (the BAS-Word reading test), the child must correctly pronounce words within locally accepted standards, with emphasis on the correct syllable or syllables.

a 0.09 and 0.11 standard deviation increase in language development respectively, as opposed to having parents with lower qualifications. The bilingual status effect (measured via the one-period lag of bilingualism) is nearly twice as large. The corresponding effect of the current bilingual status is insignificant. The persistence in language outcomes, as measured by the past verbal reasoning skills, is statistically significant, however, the persistence diminishes as the children age.

These results are consistent with Mumtaz and Humphreys (2001), who show that bilingual children are better at reading compared to their monolingual counterparts. This suggests a possible 'transfer' of first language literacy skills to the development of reading in a second language. It also supports the view that bilingual reading development may aid the acquisition of certain literacy skills such as phonological awareness and memory, and regular-word reading.[18]

At age 11, the advantage in the verbal reasoning tests for children who were bilingual at the age of seven (measured via the one-period lag of bilingualism), is not statistically significant once we fully control for child and parental characteristics. Current bilingualism, however, now decreases verbal reasoning scores by 0.11 of a standard deviation. The corresponding effect of persistence in language is still significant at age 11. These results are mirrored for bilingual children at age 14 with a decrease in verbal reasoning scores of 0.17 of a standard deviation.

The results for emotional development, as measured by the standardized SDQ, are presented in Panel (b) of Table 2. We find that the discrepancies in SDQ scores between bilingual and monolingual children, originally found in Table 1, are insignificant once we

[18] Mumtaz and Humphreys (2001) investigate the impact of Urdu as a first language on learning to read in English as second language. All students were tested individually over a period of eight weeks. Bilingual children were also found to have an advantage in phonological awareness at the earliest stages of reading as compared to monolingual children.

control for observable characteristics. That is, being bilingual has no significant impact on the emotional development of children, regardless of their age. There is a strong persistence in emotional development outcomes, with lagged SDQ scores being highly predictive of current SDQ scores. For example, a one standard deviation increase in emotional difficulties at age five is associated with a 0.59 standard deviation increase in emotional difficulties at age seven.

We summarize our age-specific findings by estimating equations (1) using individual fixed-effects models and equation (2) using cumulative value-added models with our unbalanced panel of 9,532 child-wave observations.[19] Results for these models are presented in the last two columns of Table 2. We will not discuss our fixed-effects results in detail because, given that we fail the test for strict exogeneity, we believe them to be inconsistent. Nonetheless, we present these them for completeness.[20] The individual fixed-effects model reveals that bilingual children have poorer language skills. Specifically, holding other factors constant, switching bilingual status is associated with a reduction in verbal reasoning skills by 0.14 standard deviations. However, consistent with our age-specific results, we find no effect of bilingualism on the emotional development of children using the fixed-effects model.

The cumulative value-added model, reported in the last column of Table 2, can be considered as an average of the age-specific coefficients presented in columns 1 to 5. Only a one-period lag of bilingual status is included because the additional lags were not precisely estimated.[21] The coefficients associated with both the current and past bilingual status are not statistically different from zero. Past language outcomes do play a statistically significant role; a one standard deviation increase in the lagged verbal reasoning scores increases the current

[19] We also estimated equation (1) via OLS and the results, available upon request, are similar to the reported results for individual fixed-effects models.
[20] The model also does not allow us to identify whether the effects of observed inputs change over child's life cycle and whether past idiosyncratic individual shocks affect current input decisions.
[21] We included a two-period lag of bilingual status for both language and emotional development models but coefficient was insignificant.

score by 0.27 standard deviations. In general, as in our age-specific analysis, the coefficient on past language skills is well below one indicating that persistence in language achievement is far from perfect in our context. Lower persistence in the language measure indicates a greater rate at which learning is lost over time.

The evidence is slightly different for emotional development, where we find a long-term effect of bilingualism on our measure of emotional development. Specifically, other things equal, being bilingual over time reduces the total strength and difficulties index by 0.066 (= 0.012 + (-0.078)) of a standard deviation. Consistent with previous results, the CVA specification also illustrates a strong persistence in the SDQ outcome, especially when compared to the weaker intertemporal relationship in verbal reasoning skills. In particular, about 50% of emotional development persists over time - a one standard deviation increase in the lagged SDQ score increases the current emotional difficulties by 0.50 of a standard deviation - while a quarter of verbal reasoning skills persist across ages. This finding, which is also emphasised by Del Bono et al., (2016) and Fiorini and Keane (2014),is consistent with the idea that production functions for cognitive and non-cognitive skills are very different (Cuhna et al., 2006).[22]

5.2 Heterogeneity

Next, we explore whether there is any heterogeneity in the effects found in Table 2. Specifically, we consider whether the effects of bilingualism on language and emotional development differs by the child's gender and their mother's and father's education levels. We denote 'high' education levels to those parents with A-level or higher qualifications (higher,

[22] We assess the sensitivity of our results by re-estimating our models using the balanced panel of children with no missing information in the main family background variables over the five observed time periods; that leaves us with 914 children, 4,570 child-year observations. We do not observe any significant change in our bilingual coefficients. The results are available on request.

first degree or diploma), while ‘low’ education refers to GCSE/O-level or below. Table 3 presents the results for pooled cumulative value-added models estimated separately for each subgroup. The comparable CVA estimates for the full sample are found in the last column of Table 2.

[INSERT TABLE 3 HERE]

We find that the gap in language development is larger for girls than for boys. Specifically, being bilingual over time decreases verbal reasoning scores by 0.054 (= -0.116 + 0.062) of a standard deviation for girls, and by 0.038 (= -0.102 + 0.064) standard deviations for boys. In the case of emotional development, it is mainly boys that are found to benefit from their bilingual background. Furthermore, we do not find evidence of heterogeneous production functions for the language development across children of parents with different educational qualifications; however, there is a premium associated with bilingualism in emotional development for children of low educated mothers and fathers.

6. Conclusions

Relatively few studies evaluate the key issues surrounding the development of bilingual children, despite a burgeoning literature on child cognitive and non-cognitive development more generally. In this paper, we model the language and emotional development production functions for bilingual children using cumulative value-added specifications which account for parental investments and children’s own ability.

We emphasize several aspects of our findings. Analysis by child age confirms that bilingual children initially have worse language skills than their monolingual peers. There are several possible channels for this initial result. For example, Feng et al. (2014) show that the bilingual gap in early reading scores is explained by family differences in socio-economic disadvantage as well as in parental home and school investment. Both may be particularly important if we consider the improvement at age seven, and the declining influence of the lag of bilingual status, as being a result of the increasing exposure of bilingual children to English as they age through participation in different social activities, childcare, and starting school. Moreover, the basic descriptive statistics point to the change in behavior of bilingual parents on educational investment. Parents of bilingual children start investing more heavily in home activities to enhance the learning environment of their children (and possibly trying to compensate the early bilingual cognitive disadvantage).

We find evidence of long-term positive effects of bilingualism on emotional development, and it is mainly boys who are found to benefit from their bilingual background. The outcome persistence parameters are generally low but slightly higher in the emotional development production function, which suggests that the production functions for language and emotional development are different. Finally, the cumulative bilingual effect on the emotional development is more evident for low-educated mothers and fathers, which may be driven by selection (i.e., less educated and less proficient in English language mothers are more likely to speak a foreign language). We cannot disentangle this explanation since our data do not allow us to pin down the language proficiency level.

Ultimately, the most important finding is that overall bilingual children are not significantly different when compared with their monolingual peers in language development, taken together with the positive effect of bilingualism on emotional development. With the arguments promoting language acquisition in school from a relatively young age as a means to promote economic competitiveness and growth, the lack of any gap in language and emotional development for bilingual children is key.

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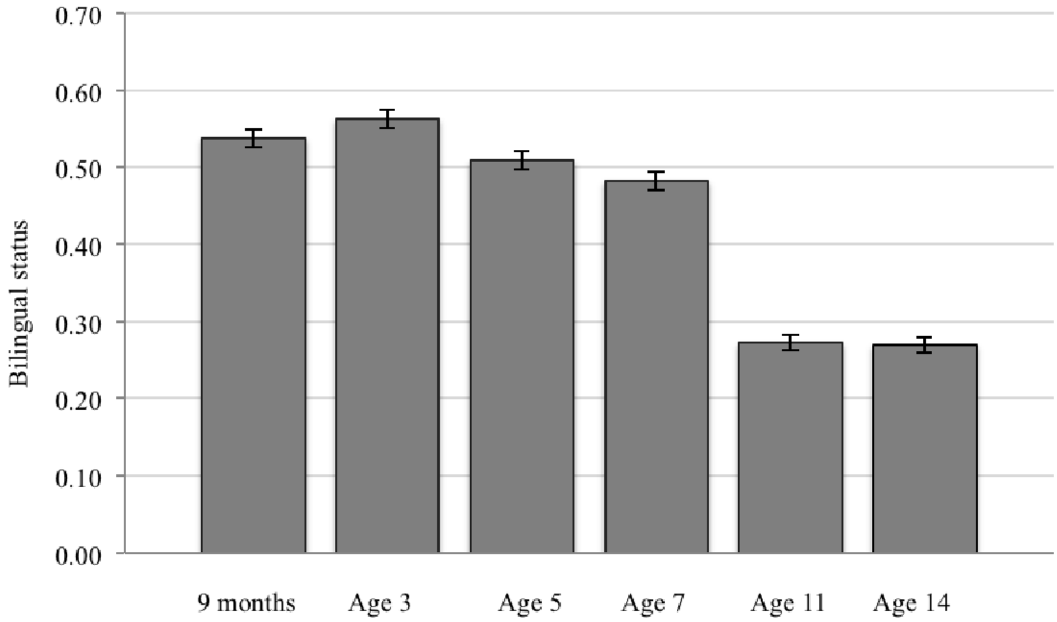
FIGURE 1— Children's bilingual status over time



Source: UK Millennium Cohort study. Author's calculations based on bilingual sample.

TABLE 1— Summary Statistics of Selected Variables

Outcomes	Monolingual		Bilingual		Difference
	Language development (Verbal reasoning skills)				
Age 3	50.42	[10.68]	38.87	[11.30]	-11.55***
Age 5	55.10	[10.69]	43.95	[11.65]	-11.15***
Age 7	115.47	[18.07]	114.88	[17.35]	-0.59
Age 11	60.15	[9.70]	56.98	[10.60]	-3.17***
Age 14	6.98	[3.38]	6.10	[2.80]	-0.88***
	Emotional development (Strengths and Difficulties score)				
Age 3	9.11	[5.00]	11.18	[5.88]	2.07***
Age 5	6.89	[4.60]	8.49	[5.29]	1.61***
Age 7	6.87	[5.02]	8.26	[5.20]	1.39***
Age 11	7.07	[5.37]	7.71	[5.25]	0.64**
Age 14	13.3	[3.89]	14.35	[4.33]	1.05***
	Time-varying controls				
	Child's age in months				
Age 3	37.62	[2.34]	38.24	[3.21]	0.62***
Age 5	62.67	[2.84]	62.63	[2.83]	-0.04
Age 7	86.96	[2.84]	87.12	[2.85]	0.16
Age 11	128.06	[5.68]	127.97	[5.74]	-0.09
Age 14	165.06	[5.42]	165.11	[5.45]	0.05
	Mother’s age				
At child's age of 3	30.16	[5.69]	28.02	[5.52]	-2.13***
At child's age of 5	35.68	[5.62]	33.74	[5.79]	-1.95***
At child's age of 7	37.8	[5.60]	35.78	[5.86]	-2.02***
At child's age of 11	41.98	[5.44]	39.84	[5.69]	-2.14***
At child's age of 14	44.95	[5.43]	42.79	[5.59]	-2.17***
	Below 60% of the median UK income				
Age 3	0.29	[0.45]	0.54	[0.50]	0.25***
Age 5	0.27	[0.45]	0.57	[0.50]	0.30***
Age 7	0.26	[0.44]	0.55	[0.50]	0.29***
Age 11	0.28	[0.45]	0.56	[0.50]	0.28***
9 months: Gross motor delay	0.11	[0.32]	0.14	[0.35]	0.03*
9 months: Fine motor delay	0.120	[0.33]	0.14	[0.35]	0.02
9 months: Communication gesture delay	0.410	[0.49]	0.43	[0.50]	0.03

TABLE 1 (cont.) — Summary Statistics of Selected Variables

Parental inputs					
9 months: Importance of stimulating the baby	0.36	[0.57]	0.58	[0.67]	0.22***
9 months: Importance of talking to the baby	0.15	[0.38]	0.31	[0.53]	0.16***
9 months: Importance of cuddling the baby	0.12	[0.34]	0.24	[0.51]	0.13***
9 months: Importance of regular sleep/feeding time	0.59	[0.75]	0.75	[0.82]	0.16***
Age 3: Frequency taken to the library	0.56	[0.78]	0.41	[0.73]	-0.15***
Age 3: Frequency reading to the child	3.31	[0.98]	2.67	[1.34]	-0.63***
Age 5: Frequency taken to the library	0.73	[0.67]	0.68	[0.72]	-0.05*
Age 5: Frequency reading to the child	2.45	[0.63]	2.31	[0.75]	-0.14***
Age 7: Frequency taken to the library	0.75	[0.66]	0.8	[0.72]	0.05
Age 7: Frequency reading to the child	2.11	[1.59]	2.36	[1.45]	0.26***
Time invariant controls					
Male	0.52	[0.50]	0.5	[0.50]	-0.02
Birth weight	1.23	[0.75]	1.71	[1.05]	0.48***
Yong migrant	0.77	[0.42]	0.52	[0.50]	-0.24***
Mother born non-English country	0.26	[0.44]	0.88	[0.33]	0.62***
Father born non-English country	0.27	[0.44]	0.88	[0.33]	0.61***
Child is white	0.72	[0.45]	0.12	[0.33]	-0.60***
Mother with higher qualification	0.43	[0.50]	0.32	[0.47]	-0.11***
Father with higher qualification	0.59	[0.49]	0.57	[0.50]	-0.01

TABLE 2— The Effects of Bilingualism on Language and Emotional Development, selected coefficients.

	Value-added models at:					Individual FE	Cumulative value-added
	Age 3	Age 5	Age 7	Age 11	Age 14		
Panel (a): Outcome: z-Verbal Reasoning skills							
Bilingual_a	-0.280***	-0.112*	0.000	-0.114*	-0.173**	-0.142***	-0.013
	(0.064)	(0.058)	(0.073)	(0.068)	(0.068)	(0.039)	(0.034)
Bilingual_{a-1}	-0.161**	-0.106*	0.194***	0.031	0.033	.	-0.035
	(0.063)	(0.062)	(0.073)	(0.072)	(0.066)	.	(0.036)
z-verbal skills $_{a-1}$	.	0.383***	0.326***	0.230***	0.221***	.	0.269***
	.	(0.023)	(0.028)	(0.028)	(0.028)	.	(0.014)
$z\text{-SDQ}_{a-1}$	.	-0.039**	-0.193***	-0.033	-0.033	.	-0.096***
	.	(0.019)	(0.025)	(0.025)	(0.026)	.	(0.014)
Child's age (months)	0.004	-0.014**	-0.011	-0.012***	0.008**	-0.018**	-0.016
	(0.006)	(0.006)	(0.007)	(0.004)	(0.004)	(0.009)	(0.010)
Male	-0.169***	-0.002	-0.062	0.093**	-0.123**	.	-0.026
	(0.034)	(0.034)	(0.043)	(0.043)	(0.048)	.	(0.023)
White	0.273***	0.061	-0.129**	-0.020	0.046	.	0.058*
	(0.049)	(0.049)	(0.061)	(0.057)	(0.072)	.	(0.035)
R^2	0.400	0.416	0.219	0.240	0.140		0.214
Panel (b): Outcome: z-SDQ index							
Bilingual_a	-0.029	-0.048	0.033	-0.063	0.079	0.043	0.012
	(0.077)	(0.067)	(0.061)	(0.068)	(0.076)	(0.035)	(0.029)
Bilingual_{a-1}	0.105	-0.076	-0.064	-0.083	-0.076	.	-0.078**
	(0.073)	(0.070)	(0.058)	(0.072)	(0.073)	.	(0.031)
z-verbal skills $_{a-1}$	.	-0.029	-0.047*	-0.117***	-0.016	.	-0.056***
	.	(0.025)	(0.025)	(0.026)	(0.032)	.	(0.010)
$z\text{-SDQ}_{a-1}$	.	0.519***	0.590***	0.570***	0.442***	.	0.501***
	.	(0.026)	(0.023)	(0.026)	(0.027)	.	(0.013)
Child's age (months)	-0.013	-0.028***	0.001	0.001	-0.007	-0.016**	-0.021**
	(0.008)	(0.007)	(0.007)	(0.004)	(0.004)	(0.008)	(0.009)
Male	0.176***	0.130***	0.099***	0.047	-0.124***	.	0.061***
	(0.042)	(0.039)	(0.036)	(0.042)	(0.047)	.	(0.018)
White	-0.084	-0.103**	0.080	0.071	0.040	.	0.011
	(0.058)	(0.051)	(0.051)	(0.060)	(0.064)	.	(0.027)
R^2	0.180	0.358	0.433	0.389	0.279		0.485
N	1994	1682	1693	1497	1359		
Observations						9532	6292

Notes: Standard errors, clustered at family-level, are in parentheses. The specifications at each age are slightly different and tend to include one period lagged language and emotional development indicators, the child's age, gender, ethnicity and birth weight, the mother's age and marital status, the mother's and father's highest qualification, indicator for young migrant, mother and father coming from non-English speaking background, biological mother present in the household, number of siblings, frequency of reading to the child or library visits, poverty indicator and regional controls. The individual FE model is estimated with the unbalanced panel. The pooled CVA also includes time dummies. The full specifications are reported in Online Appendix.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE 3— Heterogeneous Effects of Bilingualism

	Child's gender		Mother's education		Father's education	
	Boys	Girls	High	Low	High	Low
Panel (a): Outcome: z-Verbal Reasoning skills						
Bilingual$_a$	-0.102**	0.062	-0.099	0.025	-0.012	-0.002
	(0.050)	(0.046)	(0.060)	(0.041)	(0.046)	(0.050)
Bilingual$_{a-1}$	0.064	-0.116**	-0.016	-0.037	-0.087*	0.048
	(0.053)	(0.050)	(0.061)	(0.045)	(0.047)	(0.057)
z-verbal skills $_{a-1}$	0.270***	0.265***	0.258***	0.271***	0.282***	0.245***
	(0.021)	(0.020)	(0.024)	(0.018)	(0.019)	(0.022)
z-SDQ$_{a-1}$	-0.110***	-0.089***	-0.090***	-0.099***	-0.108***	-0.080***
	(0.020)	(0.019)	(0.024)	(0.017)	(0.018)	(0.021)
Child's age (months)	-0.015	-0.017	-0.027*	-0.010	-0.025*	-0.000
	(0.015)	(0.013)	(0.016)	(0.013)	(0.013)	(0.016)
Male	.	.	-0.001	-0.039	-0.040	-0.018
	.	.	(0.038)	(0.028)	(0.030)	(0.034)
White	0.053	0.059	0.090	0.030	0.064	0.036
	(0.048)	(0.050)	(0.058)	(0.044)	(0.045)	(0.057)
R^2	0.220	0.227	0.156	0.192	0.234	0.184
Panel (b): Outcome: z-SDQ index						
Bilingual $_a$	-0.007	0.032	0.020	0.015	-0.010	0.034
	(0.044)	(0.039)	(0.048)	(0.037)	(0.039)	(0.045)
Bilingual $_{a-1}$	-0.132***	-0.012	-0.015	-0.098**	-0.040	-0.135***
	(0.045)	(0.043)	(0.050)	(0.040)	(0.040)	(0.050)
z-verbal skills $_{a-1}$	-0.056***	-0.054***	-0.035**	-0.066***	-0.066***	-0.043***
	(0.014)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)
z-SDQ$_{a-1}$	0.520***	0.472***	0.525***	0.484***	0.504***	0.490***
	(0.020)	(0.018)	(0.021)	(0.017)	(0.018)	(0.021)
Child's age (months)	-0.018	-0.026**	-0.027**	-0.017	-0.032***	-0.006
	(0.012)	(0.012)	(0.013)	(0.011)	(0.011)	(0.014)
Male	.	.	0.058**	0.059**	0.092***	0.020
	.	.	(0.026)	(0.024)	(0.024)	(0.028)
White	0.011	0.023	-0.010	0.024	0.041	-0.045
	(0.039)	(0.036)	(0.042)	(0.035)	(0.034)	(0.045)
R^2	0.479	0.504	0.517	0.460	0.510	0.463
Observations	3080	3212	2345	3947	3518	2774

Notes: Unbalanced panel. Standard errors, clustered at family-level, are in parentheses. The specifications include the same controls as in Table 2. 'High' corresponds to A-level or higher qualification (higher or first degree, diploma), while 'low' parental education corresponds to GCSE/O-level and below.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.