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# Exploring the role of parental engagement in non-cognitive skill development over the lifecourse*

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**Abstract**

We examine the role that parental engagement with child's education plays in the lifecourse dynamics of locus of control (LOC), one of the most widely studied non-cognitive skills related to economic decision-making. We focus on parental engagement as previous studies have shown that it is malleable, easy to measure, and often available for fathers, whose inputs are notably understudied in the received literature. We estimate a standard skill production function using rich British cohort data. Parental engagement is measured with information provided at age 10 by the teacher on whether the father or the mother is very interested in the child's education. We deal with the potential endogeneity in parental engagement by employing an added-value model, using lagged measures of LOC as a proxy for innate endowments and unmeasured inputs. We find that fathers', but not mothers', engagement leads to internality, a belief associated with positive lifetime outcomes, in both young adulthood and middle age for female and socioeconomically disadvantaged cohort members. Fathers' engagement also increases the probability of lifelong internality and fully protects against lifelong externality. Our findings highlight that fathers play a pivotal role in the skill production process over the lifecourse.

**JEL classification:** I12, J24.

**Keywords:** Non-cognitive skills, locus of control, father school involvement, lifecourse dynamics, British Cohort Study 1970.

## 1 Introduction

The increasing representation of non-cognitive, or socioemotional, abilities in economic models of human capital production has garnered renewed interest in the dynamic processes that determine their formation and the potential for their enhancement through targeted interventions, particularly in childhood (Kautz et al., 2014) and adolescence (Schurer, 2017b). One specific non-cognitive skill – internal locus of control (also commonly referred to as self-efficacy) – has notably been singled out as a powerful predictor of economic decision-making.[1] Locus of control (from here onward referred to as *LOC*) describes a person's belief about the control she possesses over her life's outcomes. Internally-oriented individuals have strong expectations about the causal link between the efforts they invest and the outcomes they experience. Externally-oriented individuals, on the other hand, tend to attribute life's outcomes to factors beyond their control, such as luck, fate, or other people (Rotter, 1966). Although a significant body of research exists on the dynamics and determinants of locus of control for adolescents and adults (Elkins et al., 2017; Cobb-Clark and Schurer, 2013; Specht et al., 2013; Lachman, 2006; Lewis et al., 1999; Lachman and Leff, 1989; Doherty and Baldwin, 1985), there is no insight about LOC trajectories from childhood into adulthood.

We are the first to examine the lifecourse dynamics of locus of control, following the lives of children from birth into their advanced adulthood. We examine the role that parents play in these dynamics. We focus our analysis on parental engagement with the education of the child, as previous studies have shown that it is malleable, and thus a promising target for public policy. It is also a parental input which can be objectively measured, for instance through teacher assessments. We use longitudinal data sourced from the 1970 British Cohort Study (BCS) to follow

[1] A landmark study by Heckman et al. (2006) showed that a summary non-cognitive skill measure derived from self-efficacy and self-esteem personality questionnaires was at least as important as cognitive skills in determining a range of life outcomes including educational and labor market outcomes. A series of studies that followed and the role of non-cognitive skills in shaping lifetime opportunities were elegantly summarised in Almlund et al. (2011) and in Cobb-Clark (2015).

the control beliefs of 6,566 cohort members across three life stages spanning 32 years: childhood (*age 10*), young adulthood (*age 30*), and middle age (*age 42*). Currently, this is the only cohort study that allows a follow-up of LOC tendencies from childhood into middle age.[2] Focusing on a single birth cohort enables separation of the aging effect from likely cohort and period effects to study the dynamics in LOC (see Schurer, 2015; Dohmen et al., 2017, for a discussion of these issues in the context of risk preferences).

We apply the human capability production framework to model the determinants of middle age control beliefs as a function of past control beliefs, parental behaviors, and socioeconomic opportunities that shape a child's life (Todd and Wolpin, 2003; Cunha and Heckman, 2008; Cunha et al., 2010; Fiorini and Keane, 2014). Importantly, we utilize a teacher-reported measure of parental interest in education to avoid some of the bias associated with parent self-reported measures (e.g., Reynolds, 1992). To deal with the likely endogeneity in teacher-assessed parental engagement, we use the so-called value-added model, which proxies for all unobserved parental inputs that may correlate with parental involvement by including one or two lagged measures of locus of control. Under the assumptions of this value-added model (Todd and Wolpin, 2003; Fiorini and Keane, 2014), we are able to identify the causal impact of parental educational engagement on LOC development by middle age. To complement this analysis, we also identify the most common LOC maturation-pathways from childhood into middle age, and study how parental engagement affects these pathways. This is particularly important when interest lies not only in understanding the 'average' pathway, but the diversity of pathways. For instance, some individuals may be internal throughout their lives, which is a positive outcome, while others may

[2]We have explored rigorously the possibility of alternative data to study this question. To date, the BCS1970 is the only available data set that provides LOC data in both childhood and at least some consistent LOC measurements in young adulthood and middle age. The National Child Development Study (NCDS) has data available on four adulthood LOC measures, but has no measures in childhood. The Avon cohort – the so-called ALSPAC study – provides LOC data in childhood, but the participants are only young adults in the follow-up. Our own previous research has exploited available LOC data to study the malleability of LOC in adolescence (over eight years) and in adulthood (over four years) using the Household Income and Labour Dynamics in Australia survey (Cobb-Clark and Schurer, 2013; Elkins et al., 2017).

always be external, which may be considered a problematic outcome. To identify and describe the most common LOC maturation pathways, we use a machine learning algorithm commonly employed in decision tree analysis to identify clusters (Kass, 1980; Biggs et al., 1991; Ratner, 2003; Van Diepen and Franses, 2006; Ritschard, 2010). Such an algorithm has the advantage that we allow the algorithm to choose the cut-off values to categorize the locus of control measures rather than using arbitrary thresholds.

Following its early conceptualization by Rotter (1966) in the context of social learning theory, an extensive literature has amassed demonstrating the diverse individual and societal benefits associated with internality. Internally-oriented individuals tend to invest more heavily in various aspects of their human capital, and thus perform better in the labor market (see Cobb-Clark, 2015, for an overview). They achieve higher levels of education (Coleman and Deleire, 2003; Hadsell, 2010), invest more heavily in their children's cognitive development through active play (Lekfuangfu et al., 2017), and earn significantly higher wages (Schnitzlein and Stephani, 2016; Heineck and Anger, 2010; Duncan and Morgan, 1981; Andrisani, 1981, 1977). Internally-oriented individuals are also more likely to pursue healthy lifestyles (Cobb-Clark et al., 2014; Chiteji, 2010) and save money for a rainy day (Cobb-Clark et al., 2016). Moreover, internal control beliefs seem to provide a form of "psychological insurance," helping individuals cope more effectively in the face of certain negative life events (Buddelmeyer and Powdthavee, 2016); this effect has been observed among workers who seek to find re-employment after job loss (Caliendo et al., 2015; McGee, 2015) and employed workers who experience episodes of ill health (Schurer, 2017a). LOC could be a good proxy for what the field of positive psychology would term resilience.

Despite the diverse positive outcomes associated with internality, the determinants underlying its formation and lifelong maturation processes remain poorly understood. Such research is pertinent for identifying the childhood factors that compromise optimal skill development (and thus later life outcomes) and informing the development of better intervention strategies to boost

the skills of children in disadvantaged environments. Non-cognitive abilities are generally understood as the product of a complex combination of social learning processes and parental investments in child development, as well as genetic factors, education, and other aspects of the environment in which a child is raised. Early stocks of non-cognitive (and cognitive) skills feed into the production of later ones, such that compromised skill formation early on can hinder skill development processes down the track (e.g., Cunha et al., 2010).

Evidence, which we will review in detail in Section 2, consistently demonstrates a positive association between socioeconomic privilege and internality; yet this is of little practical or theoretical use without a clear understanding of the mechanisms driving this relationship—socioeconomic status manifests in many aspects of child development, including educational opportunities, health, neighborhood context, exposure to stress, and parental socioemotional investments (see Duncan et al. (2017) for a review of channels). It is widely known that economically disadvantaged children are confronted with more environmental inequalities during their childhood (Evans, 2004; Evans and English, 2002; Evans and Kim, 2010), experiencing harsher and less attentive parenting (Cobb-Clark et al., 2019; Gershoff et al., 2007; Magnusson and Duncan, 2002; Hart and Risley, 1995; Conger and Elder Jr., 1994; McLoyd, 1994). Inequalities in parenting behaviors have been shown to partially explain the link between economic inequalities and child behavioral problems (Kaiser, 2017) or school achievement (Kiernan and Mensah, 2011).

It is for these reasons that parenting behaviors and styles have received attention for their role as a transmission mechanism of socioeconomic disadvantage (Cobb-Clark et al., 2019). Parenting behaviors and styles could be a target for intervention to break cycles of intergenerational disadvantage. Such interventions fundamentally assume that although better socioeconomic conditions are conducive to better parenting, effective parenting can occur despite conditions of disadvantage, fostering resilience to overcome socioeconomic barriers to successful life outcomes (Heckman, 2008, 2011). To date, research on the parental and broader socio-experiential determi-

nants of LOC has often been limited by significant methodological issues, frequently neglected to examine the role of fathers alongside that of mothers, and rarely gone beyond the short-term dynamics of how parenting factors influence LOC maturation well beyond childhood.

We focus our analysis on parental engagement with the education of the child, which may represent a multitude of behaviors related to supporting a child's learning (Mattingly et al., 2002; Grolnick et al., 1997; Fishel and Ramirez, 2005). Strong involvement in a child's education is an important time investment that parents can make to foster their children's non-cognitive skill development that need not depend on their own education level and other socioeconomic characteristics (Reynolds, 1992), and which can help to "close demographic gaps in achievement" (Hill and Tyson, 2009). Teacher assessment of such behavior is particularly useful, because it is a more objective assessment than what is usually provided by the prim caretaker. Parental interest in the child's education is a strong predictor of educational attainment above and beyond parents' education and occupational class (Bratti, 2007; Feinstein et al., 1999; Feinstein and Symons, 1999), buffers against poor adolescent mental health (Westerlund et al., 2015), and reduces the likelihood of "a chain of risk involving low academic achievement, low socioeconomic position and physiological dysregulation" (Westerlund et al., 2013, p. 512). Some interpret lack of parental educational engagement as a proxy for neglect (Power et al., 2015; Thomas et al., 2008).

Our interest in this specific parenting behavior is also motivated by its strong policy relevance. Parental involvement can be strengthened through initiatives within the schooling system, and getting parents more engaged with their children's schooling has been an integral component of many school reform policies, particularly in the US and UK (see, for example, Mattingly et al., 2002; Wilder, 2014; Huat See and Gorard, 2015; Jeynes, 2012, and references contained within). Yet, the impacts of these policies on children's non-cognitive skill development over the lifecourse have rarely been examined.

The remainder of this paper is as follows. In Section 2 we comprehensively review the litera-

ture on the socioeconomic gradient in and the dynamic properties of locus of control. In Section 3 we describe the 1970 British Cohort data used for the analysis. In Section 4 we describe the empirical framework used to estimate the relationships of interest. In Section 5 we present the estimation results. Section 6 discusses the findings and concludes. An appendix provides supplementary material.

## 2 Literature Review

The past 40 years have witnessed an extraordinary academic interest in the determinants and maturation processes of locus of control tendencies. This section will review the key insights and unanswered questions from this literature, and outline where and what we contribute to this literature.

### 2.1 Dynamics in locus of control perceptions

Early work focused on the likely maturation pathways from childhood into young adulthood from a theoretical perspective. Some hypothesized that children score unrealistically high on internality, and then readjust their perceptions as they grow older, while others hypothesized that children start out with externality, but become more internal over time (see Weisz and Stipek, 1982, for an overview). Although an empirical question, in the absence of long-term follow-up data, research could only answer this question by exploring age-gradients in LOC, relying on cross-sectional data. Numerous studies found an inverse-U-shaped age profile in LOC, whereby internality is lowest for the young, highest in middle-age, and low again for the older age groups (see Mirowsky and Ross, 2007; Ross and Mirowsky, 2002; Mirowski, 1995, for US data). The problem with age gradients estimated from cross-sectional data is that such analysis does not allow to separate out aging from cohort effects (see Dohmen et al., 2017; Schurer, 2015, for recent applications to risk preferences). It is possible, for example, that older cohorts born before

various emancipation movements in the 1960s—i.e., the civil rights and women's movements, both of which influenced the culture of individual empowerment—may have already been more externally-oriented during their youth relative to cohorts born later (Doherty and Baldwin, 1985).

To overcome these issues, more recent studies have employed representative, longitudinal data to follow the control beliefs of adolescents (but not children) and adults over time periods of four to 12 years (Elkins et al., 2017; Cobb-Clark and Schurer, 2013; Specht et al., 2013; Lachman, 2006; Lewis et al., 1999; Lachman and Leff, 1989; Doherty and Baldwin, 1985). While these studies convey different messages about the stability of control perceptions, there seems to be agreement that adolescents tend to increase in internality over time. For instance, in a representative Australian youth sample (ages 15-24), Elkins et al. (2017) report a marginal reduction in external control tendencies over an eight-year window, with more pronounced changes observed for adolescents (< age 18) relative to young adults. Similarly, in a sample of 14-22 year olds from the NLSY, Lewis et al. (1999) found that internal control tendencies increase in adolescence, but decrease in young adulthood over a 12-year time window.[3]

Studies focusing on the LOC maturation process of adults arrive at very different conclusions. Lachman (2006) and Lachman and Leff (1989) find that control perceptions are stable in older age over a five-year window. Cobb-Clark and Schurer (2013), using a representative sample of Australians, find that the very old age groups (over 70) increase in externality, while working-age groups (ages 25-60) do not change their LOC scores over a four-year window. In contrast, Specht et al. (2013), who exploited a six-year window for a comparable German sample, demonstrate increasing internality for age groups up to age 40, decreases for age groups up to age 60, and increases for older age groups.[4] No empirical evidence exists on the LOC maturation process

[3]They argue that a reversed trend occurs because the youngest sample members (age 14) were lowest in internality in the first measurement period and therefore able to experience the largest increase.

[4]The findings in Specht et al. (2013) may be driven by the utilization of LOC measures that were differently coded in the two measurement periods. Thus, changes in LOC may be the result of coding differences and not of differences in personality change.

from childhood into middle age.

### 2.2 Determinants of locus of control perceptions

A rich body of empirical evidence exists on the likely predictors of LOC. An important insight from this literature is that children from higher-education backgrounds – that are not necessarily of higher income – are more likely to express internality (e.g. Wickline et al., 2011, for *age 10*).[5] Lewis et al. (1999) explain that well-educated parents value "self-reliance, personal responsibility, and personal development" in their children and reward independence, while parents from disadvantaged backgrounds teach their children obedience and conformity (see also Gerris et al., 1997; Kohn, 1969; Mirowsky and Ross, 1998; Whitbeck et al., 1997).

Lekfuangfu et al. (2017) recently suggested that the link between parental education and children's LOC tendencies may operate through a transmission of parental internality tendencies by investing in their child. The study first derives a theoretical model that describes how LOC shapes parental expectations about how likely it is that their investments will improve their child's development. The model is tested using high-quality cohort data from Britain (ALSPAC); the authors find that mothers with high levels of internality – measured while the baby was in utero – believe that stimulating the child is important for their development (among others); they also spend more time on active, stimulating play with their babies (ages 0-1) and infants (ages 4-5) and are married to fathers who also spend more time on active play. These findings suggest that maternal LOC beliefs affect time investment, over and above the influence of parental education.[6]

[5]Early work in the 1970s found that a socioeconomic gradient in internal control beliefs already existed among young school children (see Stephens and Delys, 1973, for a review of this literature). Stephens and Delys (1973) found that pre-Kindergarteners from disadvantaged backgrounds attending Head Start schools were more likely to report external control tendencies than middle class children from Montessori and cooperative nursery schools. In contrast, Bartel (1971) found that control perceptions did not differ between socioeconomic groups before entering first grade, but reported that substantial differences emerged by the sixth grade, an effect they suggest is driven by differences in the social control exerted by schools.

[6]These findings are in line with previous studies suggesting that highly-educated parents do not only spend more time with their children but spend their time on activities believed to be more productive or "developmentally effective" (Kalil et al., 2012).

What we also know is that parenting styles – the manner in which a parent expresses expectations, rules, and emotional responses to her child – are likely to play a fundamental role in children's LOC development (Carton and Nowicki, 1994). A series of studies have demonstrated a strong link between internality and non-authoritarian parenting styles, which are characterized by greater warmth, consistent contingent reinforcement, encouragement of achievement and autonomy, and supportiveness. In contrast, authoritarian and inconsistent parenting styles, characterised by harsh discipline, excessive control, over-protectiveness, and inconsistent reinforcement, have been linked to external control beliefs (see McClun and Merrell, 1998; Gordon et al., 1981; Carton and Carton, 1998; Carton and Nowicki, 1996, 1994; Katkovsky et al., 1967; Moilanen and Shen, 2014; Lynch et al., 2002; Spokas and Heimberg, 2008; Wickline et al., 2011).

Studies on the parental determinants of LOC have often examined short-term LOC dynamics or are cross-sectional in design, making it difficult to ascertain the direction of influence (e.g. Wickline et al., 2011). Most also suffer from limitations driven by reliance on parentsal self-report of their own behaviors (leading to concerns about social desirability bias) or retrospective 'perception of parent' data collected from adult subjects, although some notable exceptions employ observational methods—e.g., Carton and Carton (1998); Crandall and Crandall (1983); Gordon et al. (1981); Carton et al. (1996). A common methodological strategy is to ask young adults (typically high school or undergraduate college students) to contemporaneously complete a LOC measure and report their perceptions of their parents' attitudes or behaviors (e.g., Macdonald, 1971), an indirect method that has led to concerns about poor correspondence between actual childhood experience and how these experiences are perceived in adulthood (see Carton and Nowicki, 1994, for a review of these issues).

Many studies have focused on maternal parenting factors only, despite the important, and sometimes qualitatively distinct, role fathers may play in children's behavioral, social, and psychological development outcomes (see Sarkadi et al., 2008; Flouri and Buchanan, 2003; Cabrera

et al., 2000). There is evidence that children from father-absent homes tend to be more externally-oriented compared to those from intact families (Lancaster and Richmond, 1983; Duke and Jr., 1976; Bain et al., 1983).[7] Yet, few studies have explained why fathers' presence plays an important role in a child's development, which could be occurring either through a socialization or an income channel. An exception is Kalil et al. (2016), who exploit parental death as exogenous variation in the years of presence of fathers. The authors find that father presence strongly affects the intergenerational correlation of educational attainment and conclude that the mechanism is likely to operate through a better nurturing environment in the home, and not through the income channel. This conclusion is in line with evidence provided in Flouri and Buchanan (2004), who find that early father involvement in the education of the child predicts educational attainment over and above the influence of parental socioeconomic status and maternal investments.

Finally, whilst several studies have explored how parents' activities relate to LOC orientation (see examples above as well as, e.g., Taris and Bok, 1997; Williams and Radin, 1999; Ahlin and Lobo Antunes, 2015), few have explicitly examined whether LOC is predicted by parental involvement in the specific domain of child's education, despite its strong relationship to academic achievement (Hill and Taylor, 2004; Flouri, 2006). The few exceptions focus on the role of parental involvement, usually assessed by the child, on young children's motivations including LOC, and how these motivations mediate the impact of parental involvement on school achievement (e.g. Grolnick and Slowiaczek, 1994; Taris and Bok, 1997; Ross and Broh, 2000). In a review of the literature, Gonzalez-DeHass et al. (2005) suggest that parental involvement may proxy effective school interaction of parents with teacher, enhancing children's sense of control over their own school outcomes. None have explored how parental involvement shapes LOC maturation patterns over the lifecourse.

In what follows, we address some of the gaps identified in the previous literature by inves-

[7] Hofferth (2006) discusses the evidence on the positive association of non-traditional family structures – families that are not composed of married-biological-parents – and children's behavior problems.

tigating the maturation process of control perceptions and its associated parental determinants over a window of 32 years. We contribute to the literature by describing the most common LOC maturation pathways and by quantifying the likely influence of both mother's *and father's* involvement in their child's education, as reported by the teacher when the child was ten years of age. We focus on parental involvement because it can be understood as a parental time investment that has proven to be malleable in interventions and thus can be the focus of policy measures. The high quality of our longitudinal cohort data allow us to carefully condition the analysis on early-life socioeconomic opportunities and other parental behaviors.

## 3 Data: The 1970 British Cohort Study

The 1970 British Cohort Study (BCS) began with an at-birth survey of around 17,000 individuals born between the 5th and 11th of April 1970 in England, Scotland, Wales and Northern Ireland. The overall catchment area was estimated to cover 95-98% of all births. Originally designed to study perinatal mortality and the provision of ante- and post-natal services (Chamberlain, 1975), the BCS was subsequently expanded and now includes eight major follow-up surveys: 1975, 1980, 1986, 1996, 2000, 2004, 2008 and 2012. In addition to the original birth cohort, the three major childhood surveys (age 5, 10 and 16) include any children who were born outside of the country during the reference week but who were identified from school registers at later ages. These childhood surveys collected detailed information from parents (typically cohort members' mothers) and teachers on the cohort member's health and behavior, as well as family demographics and SES. Cognitive ability was also assessed in these surveys via a range of tests administered by the survey interviewers. The four major adult surveys collected information from cohort members on employment, income, education, health, relationships and attitudes.

Our analysis is based on data from the 1970 (birth), 1975 (age 5), 1980 (*age 10*), 2000 (*age 30*), and 2012 (*age 42*) surveys. Although LOC tendencies were recorded in six sweeps at ages 10,

16, 26, 30, 34, and 42, we focus our analysis on *age 10* (childhood), *age 30* (young adulthood), and *age 42* (middle age) LOC outcomes. This is because some young adulthood measures of LOC were limited to one question only, and a teacher strike that interfered with data collection in 1986 heavily compromised the quality of the age 16 data (Mostafa and Wiggins, 2015).

Restricting the sample to cohort members with non-missing information on LOC measures at ages 10, 30, and 42, we are left with a sample of 6,566 cohort members. To retain the maximum number of observations, missing control variables were recoded as 0, and these observations were flagged with dummy variables. A full list of variables and their summary statistics is reported in the supplement (Table A.1). Using data over the full lifecycle of the study will lead to some attrition bias. Over 42 years, from birth in 1970 until the ninth sweep in 2012, 7,930 cohort members have dropped out: some have died, others have left the country, while others have refused to participate or disappeared from the study to reappear again (Mostafa and Wiggins, 2015). As described in our previous work (Johnston et al., 2013, 2014) and comprehensively discussed in Mostafa and Wiggins (2015), this dropout is systematic. Cohort members from less educated families, single-mother households, or born to teenage mothers, are much less likely to re-appear in Sweep 9, when the cohort members are aged 42 (see Mostafa and Wiggins, 2015, Table 3). This implies that our estimates as presented in Section 5 may not be representative for families at the bottom end of the socioeconomic spectrum.

### 3.1 Locus of control measures

Childhood (*age 10*) LOC is measured by the CARALOC questionnaire, which was initially piloted on 800 children to test and confirm its reliability, uniqueness and discrimination (Gammage, 1975). The measure is a modified version of the children's LOC scale developed by Nowicki and Strickland (1973), which has demonstrated validity (Furnham and Steele, 1993) and has been employed in well over a thousand research studies to date (Wickline et al., 2011). The children were asked

to respond to the following 16 questions with either a "yes", "don't know", or "no":[8]

1. Do you feel that most of the time it's not worth trying hard because things never turn out right anyway?
2. Do you think that wishing can make good things happen?
3. Are people good to you no matter how you act towards them?
4. Do you usually feel that it's almost useless to try in school because most children are cleverer than you?
5. Is a high mark just a matter of luck for you?
6. Are tests just a lot of guesswork for you?
7. Are you often blamed for things which just aren't your fault?
8. Are you the kind of person who believes that planning ahead makes things turn out better?
9. When bad things happen to you, is it usually someone else's fault?
10. When someone is very angry with you, is it impossible to make him your friend again?
11. When nice things happen to you, is it only good luck?
12. Do you feel sad when it's time to leave school each day?
13. When you get into an argument is it usually the other person's fault?
14. Are you surprised when your teacher says you've done well?
15. Do you usually get low marks, even when you study hard?
16. Do you think studying for tests is a waste of time?

A child with an internal LOC would tend to answer "no" to all questions except item 10. Each answer corresponding to an internal control perception was coded to equal 1, uncertainty to equal 0, and external control perception to equal -1. We then summed the items across all 16 questions. Figure 1 describes the distribution of the continuous index, which is empirically bounded between -12 (strict externality) and 16 (strict internality). Figure 1 indicates that less than 13% of the cohort members scored higher than 10 on this index.

[8]Note: The full CARALOC questionnaire contains 20 items, with five "distractors". We have retained distractor item 12 based on a factor analysis because it improves the scale's Cronbach's alpha (see Ogollah, 2010).

**[Insert Figure 1 here]**

The adulthood measure of internal LOC at *age 30* and *age 42* is constructed from a three-item scale based on Rotter (1966)'s original LOC scale. The same items are included in a number of comparable longitudinal studies, including the Millennium Cohort Study and the National Child Development Study, and have been used to measure LOC (or self-efficacy) in numerous studies to date (e.g., Hertzman et al., 2001; Cutler and Lleras-Muney, 2010; Hatch et al., 2010; Hammond and Feinstein, 2005; Peruzzi, 2014). Cohort members were asked to choose between two options for each of the following items:

1. "I never really seem to get what I want out of life" *vs* "I usually get what I want out of life"
2. "I usually have a free choice and control over my life" *vs* "Whatever I do has no real effect on what happens to me"
3. "Usually I can run my life more or less as I want to" *vs* "I usually find life's problems just too much for me"

Answers indicating an internal control perception were coded to equal 1, and the alternative choices – which correspond to an external control perception – equal to 0. An index bound between 0 (strict externality) and 3 (strict internality) was constructed by summing the choice scenario answers. Figure 2 displays the distribution of this index at both ages 30 and 42. On this scale, almost 78% of the cohort members were classified as "strictly internal" in adulthood. The distributions of *age 30* and *age 42* locus of control are almost identical, suggesting that locus of control is a stable concept in adulthood life.

**[Insert Figure 2 here]**

### 3.2 Using decision trees to classifying LOC maturation types

Both the ordinal adult and continuous childhood measures of LOC are employed in a detailed analysis of LOC determinants in Section 5.1. However, to better understand long-term patterns of

LOC maturation, we also study the determinants of the most common LOC maturation pathways across the lifespan. To classify cohort members into a specific pathway, for instance external in childhood, and internal in both adulthood follow ups, we need a method to categorize cohort members into external or internal in every life stage. One commonly used approach is to set a threshold on the LOC scale; however, no firmly established thresholds of classification exist. While some researchers have used cut-off values based on a specific percentile of the distribution,[9] this approach is not useful in our case because the proportion of individuals classified as internal would be arbitrarily influenced by the percentile cut-off value choice.

Instead, we use Chi-squared Automatic Interaction Detection (CHAID), a machine learning algorithm commonly employed in decision tree analysis to identify clusters (Kass, 1980; Biggs et al., 1991; Ratner, 2003; Van Diepen and Franses, 2006; Ritschard, 2010). Classification trees are sometimes referred to as recursive partitioning, segmentation trees or decision trees. They are used as prediction and exploratory tools. CHAID uses a recursive partitioning algorithm that searches for an optimal decision tree structure based on the correspondence between the dependent variable and a set of independent variables (Kass, 1980; Biggs et al., 1991). It seeks to increase the model's predictive power, simultaneously partitioning the dataset into clusters of observations based on predefined "splitting" variables.

There are many other decision tree methods such as classification and regression tree (CART), quick unbiased and efficient statistical tree (QUEST), and C4.5 (Quinlan, 1993), but CHAID is among the most flexible (Ture et al., 2009). CHAID is an alternative modelling approach to multiple linear or logistic regression models. It is useful when the data set is not well-suited to regression analysis if for instance the data is not normally distributed, if there are many missing observations, or if there is a highly non-linear relationship between predictors and outcomes (Van

[9]For examples: Lekfuangfu et al. (2017) distinguish between internal, external and neutral control tendencies using the upper and lower 25th percentile for cut-offs; Caliendo et al. (2015) use the median as a cut-off; Schurer (2017b) uses the upper 25th percentile as cut-off.

Diepen and Franses, 2006). Another important advantage over alternative decision-tree methods is its ability to build non-binary trees. In short, CHAID accommodates a great variety of data types including continuous, categorical, and binary data. In data-settings with a large amount of missings, it can handle missings by including these data points as a group of their own. They are also useful, when two or many predictors have interaction terms, which are hard to model and interpret (Ratner, 2003). CHAID (and other decision tree) algorithms have been used in marketing research to classify consumers into types (see Ratner (2003) for applications), and more recently in health services research to identify high-risk or high-need groups of health services (Murphy and Comiskey, 2013; MIMH Multisite HIV Prevention Trial Group, 2012; Garner et al., 2008; Ture et al., 2009; Doherty et al., 2000) and civil engineering to classify building demolition waste (Cha et al., 2017).

In our setting CHAID is particularly useful, because a priori it is not clear how the two predictors (*age 10* and *age 30* locus of control) are related to *age 42* locus of control. We consider *age 42* locus of control as the outcome variable, and *age 30* and *age 10* locus of control as predictor variables which are likely to have interaction effects. For instance, the impact of *age 30* locus of control may be more extreme on *age 42* locus of control for children who were at very low levels of locus of control at *age 10*. Depending on the relationship between these two independent and the dependent variables, CHAID splits the data into statistically significant homogeneous sub-groups using step-wise chi-square analysis. These sub-groups describe the terminal nodes of the decision tree, which can then be depicted in a diagram, which is easy to understand and interpret.

The CHAID algorithm proceeds as follows. For ease of illustration, we consider only *age 10* locus of control as predictor and *age 42* locus of control as dependent variable. This dependent variable has four levels (a=0, 1, 2, 3) and the predictor variable has 29 levels (b=-12(1)16). Imagine a table with four columns representing the levels of the dependent variable, and 29 rows repre-

senting the levels of the independent variables.[10] Each cell a/b will include a certain number of observations. Some cells may be empty. Without any reduction in the dimensionality, we would obtain 116 groups, which is to be to use for understanding the factors that are associated with group attainment.

The objective of the CHAID algorithm is to get rid of groups for which the predictor variable is not significantly different for the given level of outcome. It can do this by constructing a decision tree. The algorithm splits subsets of the data into two or more nodes repeatedly, beginning with the entire data set. To determine the best split at any node, any allowable pair of categories of the predictor variable is merged until there is no statistically significant difference within the pair with respect to the outcome variable (Ture et al., 2009). The process is repeated until no insignificant pair is found.[11]

In our setting the algorithm therefore identifies clusters of observations, or pathway 'types', over the three LOC measurement periods (*age 42*, *age 30*, and *age 10*). These are interpreted as different combinations of average LOC scores over the life course. Each pathway type thus reflects a certain pattern of maturation. For example, some types will be characterized by relatively low internality in childhood and high internality in adulthood, others may be characterized by stability in their relative position throughout the life course. We will compare our findings using the CHAID algorithm with findings obtained from a standard 'k-mean' clustering algorithm.[12]

[10]Practically, such a large dimension is not possible, especially if a third predictor variable is added. To aid the data reduction process, the algorithm needs to categorise the continuous variables such as *age 10* LOC. We ex ante specify to categorise *age 10* LOC into three terciles. As we will demonstrate in the empirical section, the key conclusions of the analysis are not sensitive to this split.

[11]Practically, the algorithm does this by including only levels of the predictor variable that are significantly different from each other. To reduce the b × a table to the most significant k × a with $k = 2(1)b$. Then choose the k × a table that has the most significant chi-square statistic. The null hypothesis of the independence of the predictor variable *age 10* LOC and the dependent variable *age 42* is tested using the Pearson's chi-square statistic. We use the – chaid – program for STATA written by Joseph N. Luchman at Behavioral Statistics Lead. The algorithm considers three steps: Preparing predictors, merging categories, and selecting the split variable.

[12]Cluster analysis is another data reduction technique which is designed to group similar observations in a dataset, such that observations in the same group are as similar to each other as possible, and similarly, observations in different groups are as different to each other as possible. The 'K-means' cluster analysis method groups observations by minimizing Euclidean distances between them. Euclidean distances are similar to measuring the hypotenuse of a triangle, where the differences between two observations on two variables, let's say *age 42* LOC and *age 10* LOC,

In our data application, we obtain eight LOC of pathways using the CHAID algorithm as described above. Fig. 3 describes the maturation types by plotting the average LOC scores measured at each stage of the lifecourse (horizontal axis), for each identified pathway type (vertical axis). Depicted are the standardized (mean=0, SD=1) averages for internality scores, where a blue bullet point represents *age 10* LOC, a red diamond *age 30* LOC, and a green square *age 42* LOC.

**[Insert Figure 3 here]**

Pathway types 1 (1%), 2 (4%), and 3 (7%) are characterized by internality scores consistently below the mean across the whole life course. This indicates that 12% of the sample tend to be external throughout their lives. Types 5 (1%) and 6 (8%), collectively representing 9% of the sample, tend to have above-average internality scores in childhood—yet below average scores in both adulthood periods. In contrast, type 4 individuals (27%) tend to exhibit below-average internality scores in childhood and above-average scores in adulthood. Thus, about one third of the sample (36%) reverse their control tendencies from childhood into adulthood. Finally, type 7 (26%) and type 8 (25%) are characterized by very high internality scores in adulthood (almost maximum possible values), and above average childhood internality scores. Thus more than half of the sample tend to be always internal. The only difference between type 7 and type 8 is their values on childhood locus of control, where type 8 cohort members exhibited very strong internality in childhood, while type 7 cohort members exhibited scores closer to the mean. Only 6%, and thus a very small fraction of the sample (types 1, 2, and 5) produced LOC scores that differed markedly between the two adulthood measures. The magnitude of these shifts is between 2 and

are plugged into the Pythagorean equation to solve for the shortest distance between the two points. This approach requires that all variables used to determine clustering using k-means must be continuous, which we will assume in our data setting. In order to perform k-means clustering, the algorithm randomly assigns k initial centers, a number which needs to be chosen by the user ex ante. We use the standard algorithm, the Hartigan-Wong algorithm, which aims to minimize the Euclidean distances of all points with their nearest cluster centers, by minimizing within-cluster sum of squared errors (SSE). K-means clustering also requires a priori specification of the number of clusters *k*, a choice that can be facilitated empirically with the data. We use a screeplot to graph within-group SSE against each cluster solution (Aldenderfer and Blashfield, 1984).

3 SD relative to the mean, always in the direction of increasing internality between *age 30* and *age 42*. This finding is consistent with our conclusions drawn from Figure 2 that locus of control is a relative stable construct in adulthood.[13]

Note, when using a more restrictive 'k-mean' clustering approach, the data tentatively suggests the presence of five clusters (see Fig. B.3, Supplement). These five types cover the major types obtained by the CHAID algorithm, but do not reveal the more subtle types, which reverse control tendencies. For instance, 28% of the sample tend to be always external over the lifecycle (types 2 and 3), while 40% tend to be always internal (types 1 and 5). Almost one quarter of the sample (23%) tend to exhibit average locus of control at each life stage (Fig. 4B.1, Supplement). k-mean clustering does not uncover individuals who reverse their control tendencies. This suggests that five clusters may be too few to characterize sufficiently the heterogeneity in maturation pathways. When allowing for eight types ex ante, we obtain a similar type description as when using the CHAID algorithm (Fig. 5B.1, Supplement).

We will revisit these classifications in Section 5.2, where we discuss the association of parental involvement with the probability of each LOC maturation pathway.

### 3.3 Parental engagement with child's education

To proxy parental engagement with the child's education, we use a measure collected from teachers during the *age 10* survey. Parents in the context of this questionnaire include parent figures or other adults responsible for the child's upbringing. Teachers assessed the involvement separately for fathers and mothers. Teachers were asked the following question: "With regard to the child's education: how concerned or interested do the parents appear to be". The possible answers are:

1. Very interested
2. Moderately interested

[13]When categorizing *age 10* LOC ex ante into four quartiles or five quintiles, we obtain nine maturation pathway types. These are almost identical to the eight types described above, but we are able to identify a slightly more nuanced maturation profile (Fig. B.2, Supplement).

3. Very little interested
4. Uninterested
5. Cannot say
6. No parents/parent figures

We transform the category of this measure into a binary indicator to identify parents considered to be "very interested" relative to all others. We choose a binary format instead of using the full available scale to simplify the analysis and comparisons between the treatment effects for fathers and mothers. We are able to demonstrate in our empirical section that the use of finer categories neither changes our conclusions nor adds to additional insights. About 41% of both fathers or mothers fall into this category.

We observe a strong socioeconomic gradient in parental engagement. Fig. 4 depicts the proportion of children whose fathers and mothers are very interested in their education, separately by occupational class.[14] Teachers were much more likely to report that parents of higher occupational classes were very interested in their child's education. For example, 70% of fathers and 86% of mothers of professional occupations were interested in their child's education compared to 18% of fathers and 36% of mothers in unskilled occupations. Despite the strong SES-gradient in parental involvement, these numbers mean that there is still one in five socioeconomically disadvantaged children whose fathers are interested in the education of the child. Children of semi-skilled fathers still have a 30% probability of having a father interested in their education. In contrast, among the very advantaged children, 30% have fathers who are not very interested in their education. This means that we have quite substantial variation within each occupational class that can be exploited in our empirical analyses.

Furthermore, across every category of occupational class, a considerably higher proportion of mothers were reported to be interested in their child's education than fathers–though moth-

[14]A supplement, Table A.2 reports the underlying sample numbers

ers were much less likely to be in professional occupations. This disparity between mother's and father's involvement may be partially attributable to a pattern where mothers take greater responsibility for school-based contact (e.g., attending parent-teacher meetings), and thus are more likely to be recognized as being involved compared to the father. For most cohort members, however, either both parents were reported as very interested (40%), or both parents were reported as not very interested (43%). Only a small proportion (2%) had an very interested father only, while 16% had a very interested mother only.

These results align with those of previous studies (Kohl et al., 2000; Reynolds et al., 1992; Grolnick et al., 1997). It is possible that parents with higher-status jobs (and who typically have a greater level of education) are more involved in their child's education because they place a higher value upon their children's educational attainment and recognize the importance of encouraging, motivating, and supporting their child in this domain. Parents from lower SES backgrounds may be confronted with more barriers to active school involvement (Hill and Taylor, 2004), including employment conditions that do not support flexibility, different expectations about the value in engagement with their child's school and their capacity to effectively involve themselves.

**[Insert Figure 4 here]**

Similar teacher-reported parental interest information has been used in numerous studies to indicate the degree of a parent's support and involvement in their child's education (e.g., Reynolds et al., 1992; Izzo et al., 1999; Flouri, 2006; Schoon et al., 2004; Osborn, 1990). The variable is predictive of educational attainment above and beyond parents' education and occupational class (Feinstein and Symons, 1999; Feinstein et al., 1999; Bratti, 2007). It is also associated with lower likelihood of premature death among children and attenuates the association between low childhood IQ and early adult mortality (Jokela et al., 2009). Studies of the Northern Swedish Cohort, where a very similar question was asked of teachers, have found that parental interest in education buffers against poor adolescent mental health (Westerlund et al., 2015) and reduces the

likelihood of "a chain of risk involving low academic achievement, low socioeconomic position and physiological dysregulation" (Westerlund et al., 2013, p. 512). Some studies used the variable to proxy parental neglect for instance in the context of obesity development. Power et al. (2015) and Thomas et al. (2008) measure parental neglect broadly from information collected during a home-based interview with the child's primary guardian (usually the mother) and from a structured questionnaire completed by the child's teacher. Neglect includes information about parental interest in the child's education and whether the father was home during the evenings. Thus, what the teacher observes about the behaviour of the father may be a predictive proxy of educational or intellectual neglect.

One advantage of such a teacher-reported measure is avoidance of social desirability bias associated with parent self-report; another is that teachers may provide a more reliable rating because they have experience with varying degrees of parental interest and involvement. Yet, teachers can only report based on their knowledge of, and experience with, a parent's school involvement behavior. This measure can only provide a broad indicator of parental school involvement as not all forms of parental educational interest and involvement are evident to teachers. This may be particularly problematic when carers change or are not the biological parents. In these cases, teachers may not have enough information to reliably rate a parental figure. For instance, in 11% of the cases in our sample, there is no biological father in the household. In 5.9% of the cases, assessment refers to a step father. In 0.9% of the cases the mother states that there is no father figure in the household at *age 10*, but the teacher makes an assessment about the level of interest by a male carer. Teacher ratings of parental engagement differ indeed by who is the male carer in the household. While teacher-assessments are the same for biological, adoptee and foster fathers – 41%-50% of them are rated to be very interested in the education of the child – mother's cohabitees and step fathers are rated to have much less involvement (11%-23%). Thus, variations in teacher assessments may reflect unstable family environments rather than the ac-

tual involvement of the father. In a robustness check, we will therefore consider a sample with only biological or adoptee fathers (N=5,465 instead of N=6,566), as both receive the same average rating of involvement by the teacher, and reflect more stable family environments.

### 3.4 Parental background variables

As highlighted in Section 2, socioeconomic status and many other parental behaviors predict LOC. We therefore control for these factors in our estimation models as much as we can. To capture socioeconomic status, we use occupational class and education of each parent. The former is measured through a series of binary variables, ranging from "Unskilled" to "Professional." Mother's level of education was proxied by the age at which she completed her education and father's education was measured by three binary variables indicating whether the father has a degree, other qualifications, or no qualifications.

We derive a measure of parenting style from mother's responses to a 16-item questionnaire about attitudes to authoritative parenting, which was collected when the cohort member was age 5.[15] The index was constructed by averaging answers (some reverse coded) and standardizing the score such that the index was bound between 0 and 1, with larger values indicating more liberal parenting views (see Flouri and Hawkes, 2008, for an application). Overly authoritarian parenting styles, including physical abuse, have been linked to personality development and behavioral problems in children (see Fletcher and Schurer, 2017; McClun and Merrell, 1998, and references therein).

Maternal mental health was measured at age 5 by a nine-item subset of the 24-item Malaise Inventory developed by Rutter et al. (1970), a short version of the 196-item Cornell Medical Index of Health Questionnaire. The Malaise Inventory has been widely validated for identifying symp-

[15]Examples of items include "children should not be allowed to talk at the meal table", "unquestioning obedience is not a good thing in a young child", and "a well-brought up child is one who does not have to be told twice to do something."

toms of anxiety and depression (see Johnston et al., 2013, for a discussion). A standardized index was created, with larger values signifying poorer mental health.

Additional father information was collected via maternal report at *age 10*: how often away on Saturdays, smoking behavior, hostility, and ethnic background. Furthermore, we control for the presence of the father in the household at birth and age 5 and the father (figure)'s relationship to the child (biological, adoptive, step, cohabitee, etc); various studies have demonstrated that father family structure is related to child development outcomes (Hofferth, 2006) or educational attainment (Kalil et al., 2016).[16]

### 3.5 Individual childhood factors

We also control for a battery of standard, early-childhood factors that may impact upon LOC development. These include sex, low birth weight (<2500 grams), having been breastfed for first seven days of life, and having been diagnosed with abnormalities at birth. We also control for battery of early childhood cognitive (Peabody vocabulary test, copy test, and drawing test) and non-cognitive (Rutter Behavioral Problem Index) endowments that were collected at age 5. Each skill measure is standardized to mean 0 and standard deviation 1.

## 4 Empirical framework

Our empirical analysis departs from the perspective that LOC observed at any age $a$ is the result of a cumulative dynamic process that depends on past inputs, some fixed mental capacity, shocks and education opportunities (Todd and Wolpin, 2003; Cunha and Heckman, 2008; Cunha et al., 2010; Fiorini and Keane, 2014). The LOC production function of individual $i$ at age $a$ is:

[16] Optimally, we would like to use the same control variables for fathers and mothers. However, we rely on information about the father as reported by the mother in the interview. Father and mother roles in the family were very different in the 1970s and 1980s, therefore, work- and occupation-related information for mothers is less predictive in our models than for fathers. We have experimented with different specifications, among others specifications where we perfectly align the available control variables for fathers and mothers. Our estimation results and conclusions are not sensitive to the concern that paternal and maternal control variables are not perfectly symmetric.

$$LOC_{ia} = LOC_a[E_i(a), X_i(a), \theta_{i0}, \varepsilon_{ia}], \tag{1}$$

where $E_i(a)$ captures all education opportunities, $X_i(a)$ are all relevant family inputs including father's and mother's interest in the education of the child, $\theta_{i0}$ is the initial skill endowment and $\varepsilon_{ia}$ is measurement error in skills or age-specific shocks, which are assumed to be independent of E, X, and $\theta$. In this flexible specification, the impact of all inputs are allowed to vary by age. However, estimating this specification is not feasible, because information on all relevant, historical inputs and initial endowments in skills is usually not available, and this is so in our case.

To control for all historical inputs into the LOC production function and initial skill endowment, we condition the analysis on past values of LOC, an approach widely used in the literature to model noncognitive skill development for children and adolescents (see Fiorini and Keane, 2014; Bono et al., 2016; Elkins et al., 2017; Black and Kassenboehmer, 2017; Kassenboehmer et al., 2018). The key assumption of this approach is that the impact of each input – including parental engagement – is independent of the age at which the input occurs (see Fiorini and Keane, 2014; Todd and Wolpin, 2003, for a discussion):

$$LOC_{i,t+1} = \alpha_1 LOC_{i,t} + \beta_1 F_{i,t-1} + \beta_2 M_{i,t-1} + X'_{i,t-1}\gamma + Z'_{i,t-2}\delta + W'_{i,t0}\mu + \varepsilon_{i,t+1}. \tag{2}$$

The dependent variable is $LOC_{i,t+1}$ for individual $i$ measured in time period $t+1$ (*age 42*). It is an ordered, categorical variable, with four values $k \in \{0, \ldots, 3\}$ and increasing in internal LOC.

Our independent variables include observations from the past, including $t$ (age 30), $t-1$ (*age 10*), $t-2$ (age 5), and $t0$ (Birth). Of main interest are the coefficients on father's ($F_{i,t-1}$) and mother's ($M_{i,t-1}$) interest in the education of the child, a time input invested when the child

was 10 years of age. $\beta_1$ and $\beta_2$ measure the association of paternal and maternal interest with adulthood LOC, *ceteris paribus*.

*age 30* LOC ($LOC_{i,t}$) is used as proxy for all unobservable parental and educational inputs into the child's locus of control until *age 30* and baseline endowments in skills ($\theta_{i0}$). The vectors $X_{i,t-1}, Z_{i,t-2}, W_{i,t0}$ include baseline control variables that are likely to affect LOC but that may also be associated with parental engagement. These include parental socioeconomic status, parenting behaviors, and maternal mental health measured at age 5 or *age 10*; and individual-specific characteristics measured at birth (e.g. health) or at age 5 (e.g. cognitive and non-cognitive skills).

The error term $\varepsilon_{i,t+1}$ is assumed to be the sum of remaining individual-specific heterogeneity ($\mu_i$) and period-specific shocks ($\varphi_{i,t+1}$). Given that we condition on past LOC and early life ability measures, we hope these controls proxy most of the unobservable variation in $\mu_i$ that may be correlated with parental engagement. $\varphi_{i,t+1}$ remains a period-specific shock or measurement error in adulthood locus of control. Under the assumption of zero remaining covariance between both components in $\varepsilon_{i,t+1}$ and parental engagement, estimating $\beta_1$ and $\beta_2$ with ordinary least squares (OLS) would yield an unbiased estimate of the influence of parental engagement. This assumption would not hold, for instance, if the effect of parental engagement on LOC development was heterogeneous at different stages of the child's development. This is not an unreasonable concern. Since we have information on the child's LOC measured at *age 10*, we estimate an additional model in which control for both *age 10* and *age 30* LOC as follows:

$$LOC_{i,t+1} = \alpha_1 LOC_{i,t} + \alpha_2 LOC_{i,t-1} + \beta_1 F_{i,t-1} + \beta_2 M_{i,t-1} + X'_{i,t-1}\gamma + Z'_{i,t-2}\delta + W'_{i,t0}\mu + \varepsilon_{i,t+1}. \tag{3}$$

In this setting, $LOC_{i,t-1}$ captures all LOC-specific investments in the child that were made until the age of 10, while $LOC_{i,t}$ captures all LOC-specific investments that were made over

and above *age 10*, possibly with differential impact. Under the assumptions that these past LOC measures sufficiently capture unobserved investments, we can interpret $\beta_1$ and $\beta_2$ as causal.[17] To estimate the parameters of the model, we use an ordered probit specification, which takes account of the ordinal nature of the dependent variable, and calculate the marginal probability effects of scoring the highest internality score.[18]

## 5 Estimation results

### 5.1 Impact of parental engagement on locus of control in middle age

We quantify the long shadow cast by parental engagement with the education of the child on the maturation of internal control beliefs by middle age. Table 1 reports the marginal probability effects (from here onward referred to as *MPE*) of being strictly internal in middle age (about 77% of the sample reported strict internality at *age 42*) across a series of models. Model (1) includes a full set of control variables, but no past control beliefs. Model (2) adds *age 30* control beliefs and is a direct representation of Eq. (2). Model (3) additionally adds *age 10* control beliefs (Eq. 3), allowing for the possibility that unobserved investments before *age 10* have a differential impact on locus of control than unobserved investments made by parents after the age of 10. For ease of illustration, we present only the effects for variables of interest. Full estimation results are provided in the Supplement (Table A.3).

Model (1) demonstrates that father's educational engagement significantly increases the probability of strict internality at *age 42* by over 6%-points (statistically significant, 1% level), over and above the impact of maternal interest and maternal, paternal, and individual childhood factors. In contrast, mother's engagement has no significant impact on *age 42* locus of control beliefs

[17] In a further robustness check, we add also age 10 cognitive skills for children to further control for the possibility that parental engagement at age 10 reflects only unobserved skills.

[18] For an overview of these standard models and how to calculate marginal probability effects, see Cameron and Trivedi (2005).

(1.4%-points, not significant). A model with no control variables yields *MPEs* of 8.5%-points for fathers, and 3.1%-points for mothers (both statistically significant, 1% level). This suggests that the role of maternal interest is fully explained by other early-life factors such as socioeconomic status, while it is not explained by such factors for fathers. It should be noted that mother's interest in the education of the child is significantly associated with childhood locus of control measured at age 10, with approximately the same magnitude as father's interest, especially for female cohort members. Thus, maternal interest has importance early in life, its influence on middle-age locus of control operates through locus of control in childhood. See Supplement, Table C.1. Once adding lagged measures of locus of control to the model, the *MPEs* for father's interest are reduced but stabilize at around 4%-points (Models (2), (3), and (4)), and remain statistically significant (1% level).[19] Allowing for interaction effects between mother's and father's parental interest in education does not alter these conclusions.[20]

For comparison, we have estimated Model (1) and (2) using *age 30* control beliefs as outcome measure (Models (5) and (6)). We obtain almost identical *MPEs* as those reported in Models (1), (2) and (3). This is furthermore evidence that adulthood locus of control is relative stable. This claim is also evidenced by a strong intertemporal correlation coefficient between *age 42* and *age 30* control beliefs. The intertemporal correlation coefficients on *age 30* LOC is almost 11%-points (Model (3)). Relative to the base-probability of 78%, this means that a 1 SD increase in *age 30* internality leads to a 14% increase in the probability of being strictly internal at *age 42*, *ceteris paribus*. Given that a 1 SD in *age 30* internality is 0.6 units, and that the measure is scaled from 0

[19]Our conclusions are robust to adding additional control variables for unobserved abilities at age 10. Parental engagement with the education of the child at age 10 could be the result of cognition difficulties that were not present at age 5, which caused especially fathers to engage with the child's schooling. We added cognitive ability tests scores from age 10 into Model (4) such as the BAS Word Definitions test BAS Recall of Digits test, BAS Similarities test, BAS Matrices test. The MPE for father's interest in the child changes from 0.036 to 0.035 and remains statistically significant at the 5% level. These results are provided upon request.

[20]For children where both parents were interested in their education, the MPEs for both father's and mother's interest are, respectively, .056 with a standard error of .016 (significant at the 1% level) and .019 with a standard error of .036 (not significant).

(external) to 3 (internal), this implies a probability increase of 70% when moving a cohort member from fully external (0) to fully internal (3) at *age 30*. In simpler terms, this means that 2 out of 3 cohort members would be fully internal at *age 42* for all who 'were moved' into full internality at *age 30*.

**[Insert Table 1 here]**

In Table 2 (Panel A) we describe the heterogeneity in the impact of father's interest in the education of the child on locus of control development by sex and socioeconomic status (SES). *High SES* is defined as professional or manager occupations, while *Low SES* is defined as low- or no-skilled or service occupational class. We report the *MPEs* obtained from our benchmark Model (3) as reported in Table 1, because it is the most flexible specification. We find that the impact of father's interest in education on middle-age internality is exclusive to female cohort members and members from more disadvantaged socioeconomic backgrounds. For example, female cohort members whose fathers were very interested in their education, are 6%-points more likely to be strictly internal by mid-age (statistically significant, 1% level). This estimate is slightly larger for families with biological or adoptee fathers (Panel B). The same conclusion can be drawn for cohort members of *low SES*, for whom we estimate a MPE of roughly 6%-points.

**[Insert Table 2 here]**

We can only speculate why we find this beneficial effect for females and the less privileged. One explanation could be that fathers tend to invest less in their daughter's education and generally less in their children, if they have less means available (which we proxy with occupational class). Hence, we have more variation in the data for these two groups. Our estimation strategy controlled for the possibility that father's interest is just a proxy of many of the unobserved parental investments that families make or of other unobserved family characteristics that affect

the maturation pathways. Thus, we may interpret our estimates as causal, if the assumptions of the statistical model are correct (see Section 4 for a discussion).

### 5.2 Shaping locus of control maturation pathways

So far, we have shown that father's engagement with the child's education casts a long shadow over the maturation of locus of control tendencies. We now focus in more detail on the predictive power of parental engagement in explaining the different maturation-pathway types which we have described in Fig. 3. We ask, for instance, whether father's interest predicts lifelong internality – which is associated with positive outcomes, or lifelong externality, which is associated with negative outcomes. To study the predictive power of these types, we employ a multinomial logistic regression model, in which we regress type membership on parental educational interest and the full set of control variables used in Model (1) (Table 1). The dependent variable – type membership – includes eight different values, corresponding to each of our observed pathways. We assume no ordinal ranking across pathways.

Fig. 5 illustrates the *MPEs* for each type for our two variables of interest, mother's and father's interest. Grey horizontal bars represent 95% confidence intervals. The *MPEs* are interpreted as the percent probability of being classified within a specific maturation pathway given that the father or the mother was very interested in the cohort member's education. These *MPEs* are of predictive nature only, and thus cannot be interpreted as causal. We understand it as a useful descriptive tool to complement our causal analysis from Section 5.1.

**[Insert Figure 5 here]**

Fig. 5 yields three important findings. First, lifelong externality – types 1, 2, and 3 – is negatively associated with father's interest. For instance, cohort members whose father's were very interested in their education are almost 100% less likely to be of type 2, which is characterized

by extremely low levels of control beliefs in all three age groups.[21] A similar story can be told for types 1 and 3, although the estimated magnitudes are less extreme and standard errors are slightly larger. Second, lifelong internality – types 7 and 8 – is positively associated with father's interest. For instance, cohort members whose father was very interested, are 25% more likely to be classified as type 8.[22] This type is characterized by the highest possible internality scores in each age group. A similar picture emerges for type 7, although the MPE is more inefficiently estimated. Third, fathers interest does not generally determine whether cohort members reverse their control beliefs between childhood and adulthood, pathways which are described in types 4, 5, and 6. The influence of father's interest depends on the control beliefs expressed in childhood. For instance, type 4 is characterized by below average internality in childhood, an above-average internality score in young adulthood, and an average internality score in middle age. Cohort members whose father's were very interested are 5%-points or 20% less likely to belong to this type (statistically significant, 1% level). In contrast, father's interest is positively associated with type 6 membership, which is described by very high levels of internality in childhood, but below average internality in both adulthood follow ups.

Our general findings are robust to a series of re-specifications and heterogeneity analysis such as:

1. Excluding all families with no stable parental figure in the household (Supplement, Fig. B.1).

2. Alternative pre-categorisation of the continuous *age 10* locus of control measure, for instance allowing five quintiles or four quartiles instead of three terciles (Supplement, Fig. B.2).

[21]This calculation is based on a MPE of 4%-points and a base probability of 4%, which yields a percent decrease of 100.

[22]This calculation is based on a MPE of 5%-points and a base probability of 25%, which yields a percent increase of 25.

3. Alternative decision-tree method, such as 'k-mean' clustering with five (Supplement, Fig. 4B.1) and eight (Supplement, 5B.1) ex ante clusters.

4. Re-estimate the model on female cohort members (Supplement, Figure B.6), although the models did not converge for male members.

5. Re-estimate the model separately by high and low SES cohort members (Supplement, Fig. B.7). Similar to our findings presented in Section 5.1, the estimated associations are larger and more significant for cohort members who grew up in disadvantaged households.

Taken together, these findings suggest that individuals raised by fathers who were involved in their education are more likely to follow, what the psychology literature refers to as, adaptive patterns of control-belief maturations. In particular, they are considerably more likely to follow a pathway of lifelong internality, and considerably less likely to follow a pathway of externality. These associations exist independent of the influence of socioeconomic status and other family-factors widely understood to influence the LOC construct. These findings complement our evidence on our more rigorous evidence from the previous section that established that father's interest may play a causal role in locus of control maturation into middle age.

## 6 Discussion and conclusion

An internal locus of control (LOC) is the generalized belief that one has control over the outcomes of one's own life; it is associated with important benefits across the domains of health, education, labor market, and social outcomes (see Cobb-Clark, 2015, for a recent review). Our study extended existing research on the lifelong patterns of development and early-life determinants of internal LOC—areas of research that have been relatively neglected despite their importance for the development of interventions to boost non-cognitive skills. We focused on the causal impact of parental interest in education (as reported by teachers) because of its policy relevance; get-

ting parents engaged with their children's schooling has been the focus of many school reform programs, and considerable evidence points toward the positive relationship between parental involvement and school achievement outcomes.

Our results first suggest that individuals' can follow a number of different LOC maturation pathways between childhood and middle age. Eight maturation pathways were distinguished based on combinations of LOC scores over the life course. The observed pathways range from those characterized by lifelong internality – which could be considered a highly adaptive maturation pattern – to those characterized by lifelong externality – a pattern probably less conducive to positive life outcomes. Control beliefs were found to be highly stable between young adulthood (*age 30*) and middle age (*age 42*) for the majority of the sample, while a small minority (6%) exhibited large relative increases in internality between these two periods.

We found, perhaps surprisingly, that it is only father's educational engagement which affects internality in middle age. This effect is found for female and socioeconomically disadvantaged cohort members. The magnitude of these effects is comparable to that of important socioeconomic factors such as parental education and occupational status, and is considerably larger than the impact of parental variables such as maternal mental health and parenting beliefs. Furthermore, father's educational involvement considerably increases the probability that an individual will follow a maturation process characterized by high lifelong internality, and "protects" individuals from lifelong externality.

Though we cannot attribute causality to all of our findings, they are of considerable relevance to policy design. The well-founded relationship between parental school involvement and children's educational success may be at least partially explained by its impact on children's non-cognitive skill development (see, e.g., Gonzalez-DeHass et al., 2005). Both schooling and parenting inputs play an important and interactive role in children's non-cognitive skill development. When parents are strongly engaged in their children's education, children may have

more effective school interactions, greater consistency between home and school, and higher quality support to get the most out of their education, learning that they have a greater capacity to control their educational, and broader life, outcomes. Through such processes, parental school involvement may boost the role that education plays in non-cognitive skill development. As suggested by Hill and Taylor (2004), parental school involvement enhances both "social capital" and "social control," improving the capacity of parents to effectively support their children's learning and building consensus about behavioral expectations and their enforcement. These conditions likely produce an environment conducive to the development of internal control perceptions.

Like internality itself, both mothers' and fathers' school engagement is strongly associated with socioeconomic status; and thus, the children who stand to benefit the most from parental involvement are the least likely to experience it. We show, for example, that 70% of fathers and 86% of mothers in professional occupations were reported by teachers as very involved, compared to just 18% of fathers and 36% of mothers in unskilled occupations. Yet, parental involvement is a malleable factor that need not depend on parents' background, and which may be a productive investment that parents across the socioeconomic spectrum can make in their children's non-cognitive skill development (Reynolds, 1992; Hill and Tyson, 2009). Parental involvement has been successfully enhanced through school- and community-based programs, which can assist parents to understand the value of greater engagement with their child's education. Such programs should increasingly focus on helping to overcome socioeconomic barriers to involvement (Hornby and Lafaele, 2011), such as inflexible working conditions and expectations about the value of getting more involved. Moreover, our results suggest that fathers' school involvement may be a particularly productive target for intervention, especially for girls and socioeconomically disadvantaged children.

This study has important limitations. First, while teacher-reported measures of parental interest have considerable benefits over parental self-report or adult children's perception-of-parent

measures, it cannot be a perfect gauge of parent behavior. Parent involvement in education takes many forms (e.g., homework support and supervision, talking to the child about school, encouraging achievement, working with the teacher to support learning, etc), some of which may not be evident to teachers. In addition, part of the disparity between mothers and fathers on this measure may arise from mothers (at any occupational level) taking on more of the school involvement activities that are visible to teachers. Ideally, we would use multiple sources of information to best understand this behavior.

Yet, what fathers do or do not do in the eye of the teacher, is strongly predictive and much more so than what mothers do. In our data, there is a higher proportion of mothers that are very interested in the formal education of their child according to the school teacher across all occupations. Maternal engagement with the school seems to have been the norm during the late 1970s. Hence, variation in the data is obtained from father's engagement behaviors. Fathers who were very interested in the education of the child were obviously special, but we do not know in what ways. Father's educational involvement may be a reflection of underlying factors such as family cohesion or other variables, though we have done our utmost to control for a wide range of relevant variables. Others argue that the lack of parental engagement with the school is a proxy for parental neglect (Power et al., 2015; Thomas et al., 2008). Although over-represented in more privileged families, we show that those special fathers exist both in privileged (70 percent) and less privileged families (20 percent). More research is clearly needed on the specific role of fathers in shaping the control beliefs and skills of children. Unfortunately, the absence of detailed father information is a typical shortcoming afflicting analyses with many major international cohort studies such as AddHealth, the Longitudinal Study of Australian Children, and the Millennium Cohort Study.

Another limitation of the data is that we do not have locus of control information available in adolescence. Although some information is available at the 1986 (Age 16) follow-up, the response

rate was especially low in 1986 when a teacher-led industrial dispute disrupted the dissemination of the BCS questionnaire. The questionnaire was then disseminated by telephone which resulted in a self-selection of the sample (see e.g. Mostafa and Wiggins, 2015; Johnston et al., 2013, for a discussion).

Despite these limitations, our study is the first to describe LOC maturation pathways from childhood into middle age and thus is able to describe permanent control tendencies. We are also the first to demonstrate the important role that fathers' involvement can play in shaping a highly-beneficial non-cognitive skill over the lifecourse. Our study highlights the individual and family determinants of LOC with an eye on their potential relevance to intervention strategies that focus on shaping "what parents do" (i.e., their parenting behaviors and investments) rather than (or regardless of) "who parents are" (i.e., a product of their socioeconomic background and other socio-experiential factors). Yet, in doing so, we do not wish to discount the pervasive structural conditions and barriers that drive socioeconomic inequalities underlying these disparities. Socioeconomic disadvantage produces a context whereby available opportunities and resources (material or otherwise) are reduced, and effective parenting becomes a more challenging and taxing exercise. Alongside interventions that boost the non-cognitive skills of children to enhance life outcomes, these structural barriers need to be addressed in the long term to treat the underlying sources of socioeconomic disparities in non-cognitive skills.

**Compliance with Ethical Standards:**

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**Conflict of Interest:**

The authors declare that they have no conflict of interest.

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## Figures

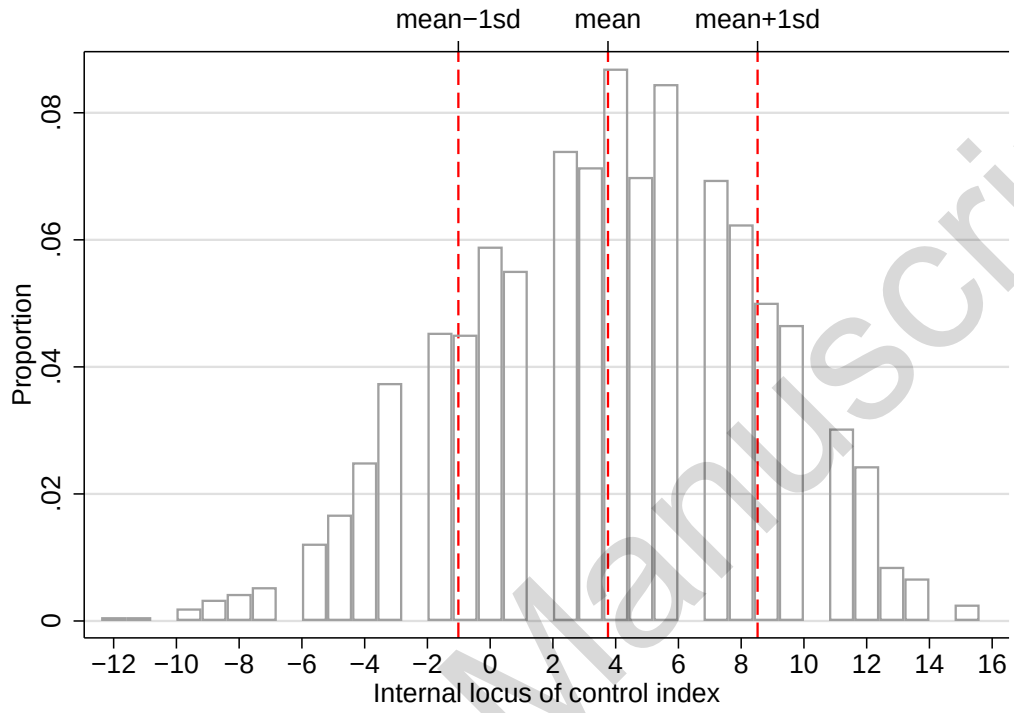



Figure 1: Distribution of internal locus of control at *age 10*

*Note:* The Index is generated from summing the three possible answers to 16 questions on the CARALOC instrument. Indication of external locus of control tendencies is coded as -1, of internal tendencies as 1, and of uncertainty as 0.

*Source:* BCS 1970, Sweep *age 10* (N=6,566)

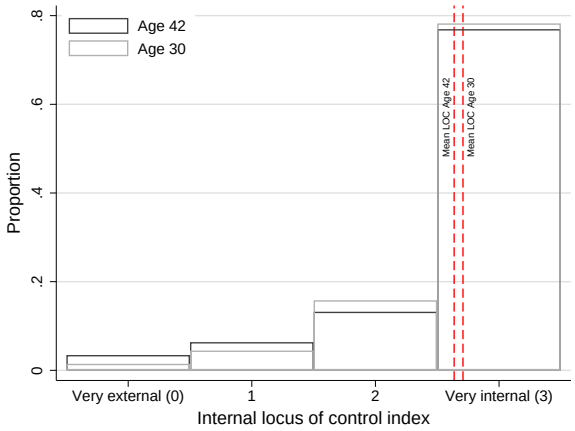



Figure 2: Distribution of internal locus of control at *age 30* and *age 42*

*Source:* BCS Sweep *age 30* and *age 42* (N=6,566)

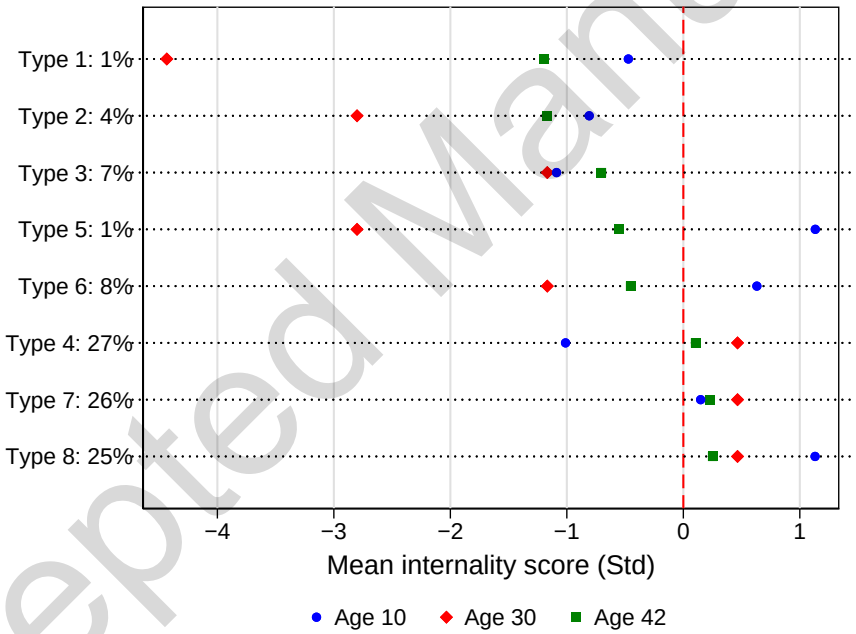



Figure 3: Reported are the standardised mean values of each locus of control measure across the life course, for different maturation pathway types in the sample. Blue circles represent the mean value of LOC for children measured at *age 10*; red diamonds represent the mean value of LOC for young adults measured at *age 30*; and green squares represent the mean value of LOC for middle aged adults measured at *age 42*. We estimated eight types of individuals using the Chi-square automated interaction detection (CHAID) method, a recursive partitioning algorithm that searches for an optimal decision tree structure based on the correspondence between the dependent variable and a set of independent variables. Details of the method are described in Section 3.2.

*Source:* BCS Sweep Ages 10, 30 and 42 (N=6,566).

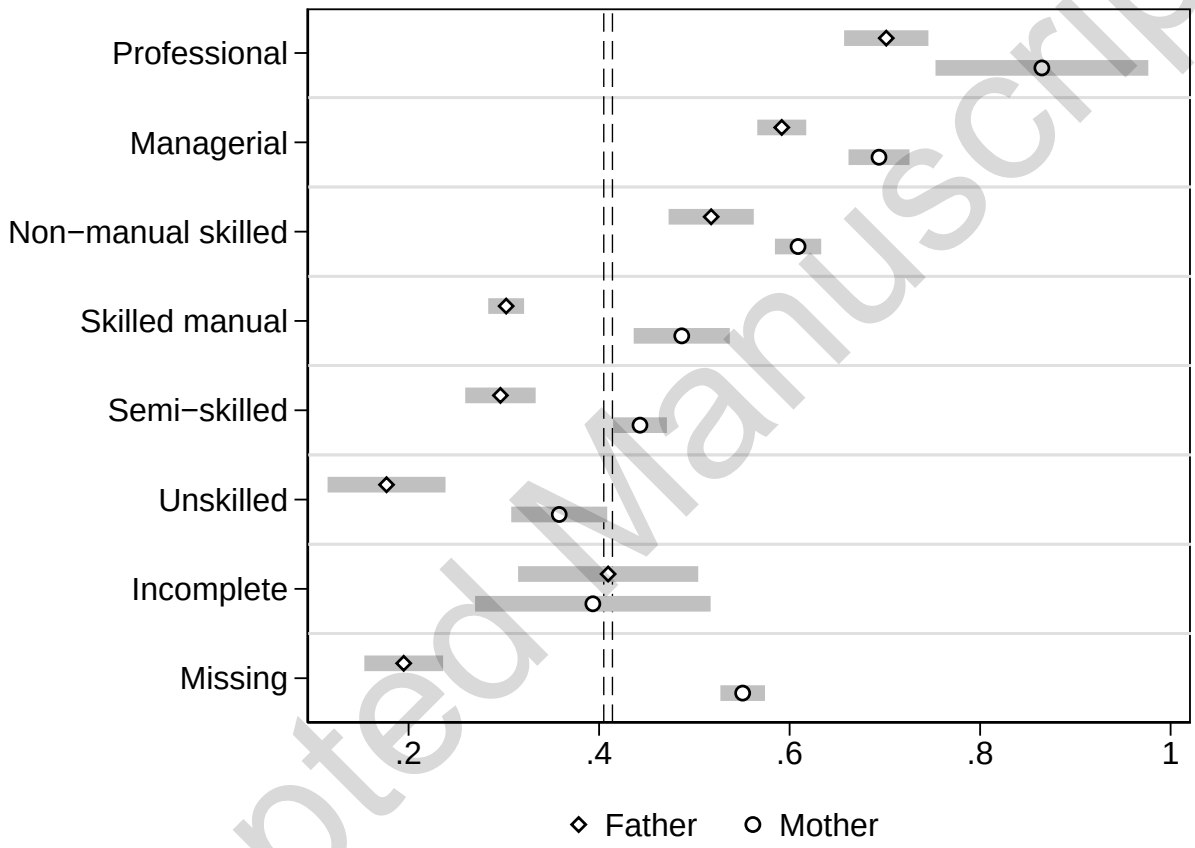



Figure 4: Proportion of parents who are very interested in the education of their child(ren) by occupational class measured by teacher report when the child was 10 years of age. Grey horizontal bars represent 95% confidence intervals

*Source:* BCS Sweep *age 10*.

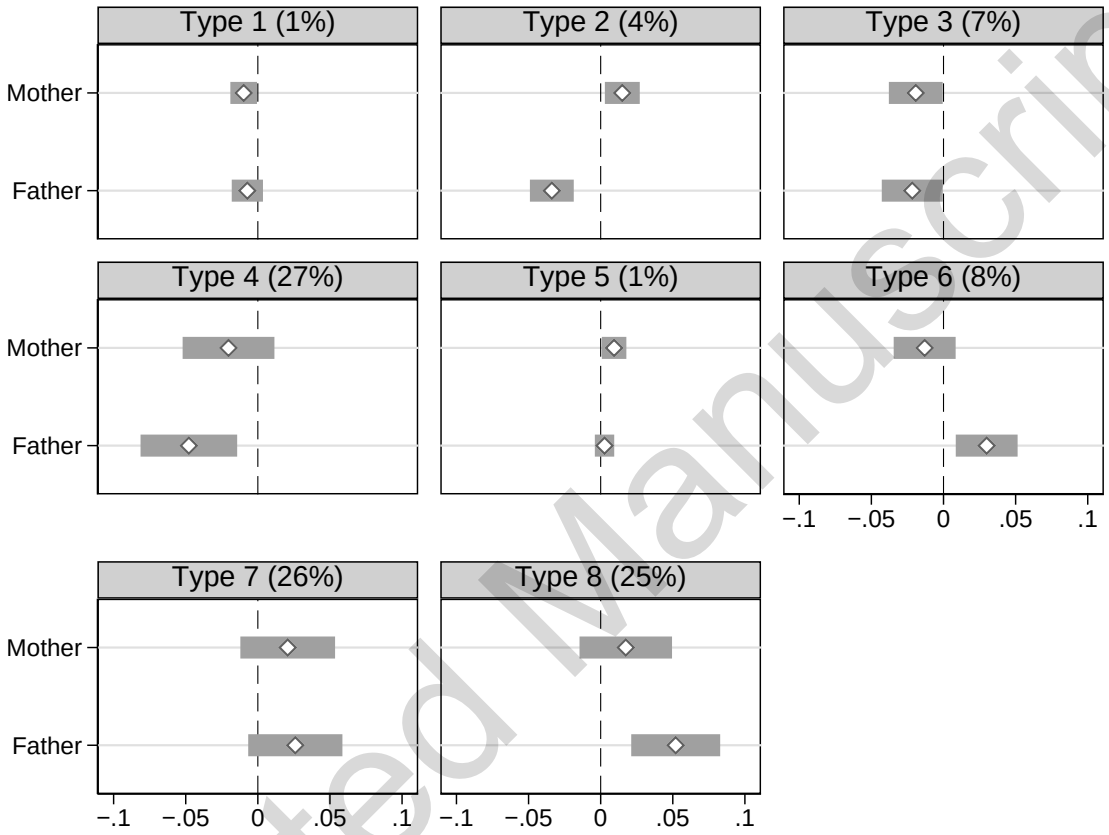



Figure 5: Relationship between parental interest in child's education (mother, father) and the probability of a specific permanent control belief type (Childhood-Age30-Age42). Reported are marginal probability effects obtained from a multinomial logit model estimated on 6,566 observations with a full set of control variables. Types 1, 2 and 3 exhibit lifelong externality; Types 7 and 8 exhibit lifelong internality; Types 5 and 6 demonstrate a relative reversal whereby they are above-average in childhood but below-average in adulthood; Type 4 individuals exhibit the opposite pattern indicating low childhood internality and high adulthood internality. Types 4, 7, and 8 constitute 78% of the sample. Grey horizontal bars represent 95% confidence intervals.

*Source:* BCS Sweep Ages 10, 30 and 42.

## Tables

Table 1: Relationship between parental interest in the education of the child and locus of control beliefs at *age 42* and *age 30*

| | (1) LOC Age 42 | (2) LOC Age 42 | (3) LOC Age 42 | (4) LOC Age 42 | (5) LOC Age 30 | (6) LOC Age 30 |
|---|---|---|---|---|---|---|
| Mother is very interested | 0.014 | 0.007 | 0.010 | 0.005 | 0.018 | 0.012 |
| | (0.013) | (0.013) | (0.012) | (0.012) | (0.013) | (0.013) |
| Father is very interested | 0.064*** | 0.055*** | 0.044*** | 0.036*** | 0.042*** | 0.036** |
| | (0.015) | (0.015) | (0.013) | (0.013) | (0.014) | (0.014) |
| LOC Age 10 (Std) | | 0.051*** | | 0.035*** | | 0.039*** |
| | | (0.005) | | (0.005) | | (0.005) |
| LOC Age 30 (Std) | | | 0.106*** | 0.102*** | | |
| | | | (0.004) | (0.004) | | |
| Observations | 6566 | 6566 | 6566 | 6566 | 6566 | 6566 |

*Note:* Table reports the marginal effects of the probability of being strictly internal at *age 42* (columns (1), (2), (3)) and at *age 30* (columns (4) and (5)), which are calculated on the basis of ordered logit coefficients at the mean values of all other control variables. Each column is a separate model where LOC is measured either at age 42 or age 30. All models include a full set of control variables. Full estimation results are reported in Supplement, Table A.3. In a model with no control variables, the marginal probability effects on *age 42* LOC for father's and mother's interest in the education of the child are .085 (standard error 0.014) and .031 (standard error .012), respectively. For *age 30* LOC they are: .065 for fathers (standard error .014) and .034 for mothers (standard error .013). Robust standard errors in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

*Source:* BCS70, Sweeps Birth, age 5, *age 10, age 30*, and *age 42*

Table 2: Relationship between parental interest in the education of the child and locus of control beliefs at *age 42*, by sex and socioeconomic status

| | Pooled (1) | Female (2) | Male (3) | High SES (4) | Low SES (5) |
|---|---|---|---|---|---|
| Panel A: All family types | | | | | |
| Mother is very interested in education child | 0.005 | −0.001 | 0.016 | 0.020 | 0.020 |
| | (0.012) | (0.016) | (0.018) | (0.029) | (0.016) |
| Father is very interested in education child | 0.036*** | 0.056*** | 0.013 | −0.004 | 0.050*** |
| | (0.013) | (0.018) | (0.020) | (0.029) | (0.019) |
| LOC Age 30 (Std) | 0.102*** | 0.092*** | 0.111*** | 0.103*** | 0.103*** |
| | (0.004) | (0.005) | (0.005) | (0.008) | (0.004) |
| LOC Age 10 (Std) | 0.035*** | 0.030*** | 0.042*** | 0.059*** | 0.027*** |
| | (0.005) | (0.007) | (0.007) | (0.011) | (0.007) |
| Observations | 6566 | 3369 | 3197 | 1204 | 3951 |
| Panel B: Families with biological or adoption father | | | | | |
| Mother is very interested in education child | −0.009 | −0.014 | 0.001 | −0.002 | 0.011 |
| | (0.013) | (0.018) | (0.019) | (0.033) | (0.017) |
| Father is very interested in education child | 0.049*** | 0.062*** | 0.030 | 0.000 | 0.059*** |
| | (0.014) | (0.019) | (0.020) | (0.031) | (0.020) |
| Locus of control Age 30 (Std) | 0.098*** | 0.086*** | 0.111*** | 0.101*** | 0.097*** |
| | (0.004) | (0.005) | (0.006) | (0.009) | (0.005) |
| Locus of control Age 10 (Std) | 0.032*** | 0.027*** | 0.038*** | 0.064*** | 0.031*** |
| | (0.005) | (0.008) | (0.008) | (0.012) | (0.007) |
| Observations | 5465 | 2805 | 2660 | 1052 | 3320 |

*Note:* The results reported in this table are based on the benchmark specification, column (4) reported in Table 1. The benchmark model is re-estimated for female and male cohort members (columns (2) and (3)) and by high and low socioeconomic status of the father measured at age 5 (columns (4) and (5)). Low SES refers to father's social class, defined as unskilled/skilled manual labour or service industry; High SESf refers to father social class defined as high-skilled non-manual professions. Marginal effects of the probability of being strictly internal at *age 42* are calculated on the basis of ordered logit coefficients. Robust standard errors in parentheses. Full estimation results are reported in Supplement, Table A.4.

* p < 0.1, ** p < 0.05, *** p < 0.01.

*Source:* BCS70, Sweeps Birth, age 5, *age 10*, *age 30*, and *age 42*

# A APPENDIX-A

Table A.1: Summary statistics

| Variable | Mean | Std. Dev. | Min. | Max. | N |
|---|---|---|---|---|---|
| LOC *age 42* | 2.637 | 0.752 | 0 | 3 | 6566 |
| LOC *age 30* | 2.708 | 0.62 | 0 | 3 | 6566 |
| LOC *age 10* - Summary of responses 1 versus 0 | 8.117 | 2.947 | 0 | 16 | 6566 |
| LOC *age 10* - Summary of responses -1, 0, 1 | 3.755 | 4.768 | -12 | 16 | 6566 |
| **Cohort member controls (Default: age 5 unless otherwise indicated)** | | | | | |
| Female cohort member *Birth* | 0.513 | 0.5 | 0 | 1 | 6566 |
| Birth weight $<$ 2500 grams *Birth* | 0.053 | 0.224 | 0 | 1 | 6311 |
| Exclusively breastfed first 7 days *Birth* | 0.119 | 0.324 | 0 | 1 | 6137 |
| Diagnosed abnormalities *Birth* | 0.074 | 0.262 | 0 | 1 | 6545 |
| Rutter score based on simple summing | 9.15 | 5.24 | 0 | 33.231 | 5553 |
| Copy test (Std) | 0 | 1 | -2.576 | 1.536 | 5560 |
| Drawing objects test (Std) | 0 | 1 | -3.34 | 3.524 | 5520 |
| Picture Vocabulary test (Std) | 0 | 1 | -3.102 | 2.407 | 5521 |
| **Maternal controls (Default: age 5 unless otherwise indicated)** | | | | | |
| Mother age at completion of education | 15.81 | 1.709 | 7 | 31 | 6089 |
| Mother authoritarian parenting views | 0.07 | 0.998 | -3 | 2.807 | 5581 |
| Mother Malaise score (age 5) | 4.071 | 3.435 | 0 | 23 | 5517 |
| Mother is very interested in education child *age 10* | 0.414 | 0.493 | 0 | 1 | 15669 |
| **Paternal controls (Default: age 5 unless otherwise indicated)** | | | | | |
| No father in HH (Birth) | 0.031 | 0.174 | 0 | 1 | 6163 |
| No father in HH | 0.053 | 0.224 | 0 | 1 | 5581 |
| Father: Professional | 0.059 | 0.236 | 0 | 1 | 6140 |
| Father: Managerial | 0.129 | 0.335 | 0 | 1 | 6140 |
| Father: Non-manual skilled | 0.137 | 0.344 | 0 | 1 | 6140 |
| Father: Skilled manual | 0.438 | 0.496 | 0 | 1 | 6140 |
| Father: Semi-skilled | 0.129 | 0.335 | 0 | 1 | 6140 |
| Father: Unskilled | 0.045 | 0.208 | 0 | 1 | 6140 |
| Father: Other | 0.032 | 0.176 | 0 | 1 | 6140 |
| Father is often away Saturdays | 0.095 | 0.293 | 0 | 1 | 6123 |
| Father is sometimes away Saturdays | 0.153 | 0.36 | 0 | 1 | 6123 |
| Father is never away Saturdays | 0.591 | 0.492 | 0 | 1 | 6123 |
| Cigarettes smoked:father | 7.431 | 10.989 | 0 | 66 | 5440 |
| Father: biological *age 10* | 0.814 | 0.389 | 0 | 1 | 6566 |
| Father: none *age 10* | 0.115 | 0.319 | 0 | 1 | 6566 |
| Father: adopted/foster *age 10* | 0.019 | 0.137 | 0 | 1 | 6566 |
| Father: step/cohabitee *age 10* | 0.046 | 0.208 | 0 | 1 | 6566 |
| Father: grandfather/other *age 10* | 0.007 | 0.083 | 0 | 1 | 6566 |
| Father has no qualifications | 0.315 | 0.465 | 0 | 1 | 6566 |
| Father has other qualifications | 0.555 | 0.497 | 0 | 1 | 6566 |
| Father has a degree | 0.13 | 0.336 | 0 | 1 | 6566 |
| Father is very interested in education child (age 10) | 0.405 | 0.491 | 0 | 1 | 6088 |
| Father is hostile | 0.002 | 0.039 | 0 | 1 | 6566 |
| Father English/Irish | 0.843 | 0.364 | 0 | 1 | 6566 |
| Father of European origin | 0.012 | 0.108 | 0 | 1 | 6566 |
| Father Indian Bangl Pakistani West Ind | 0.023 | 0.151 | 0 | 1 | 6566 |
| Father other ethnicity | 0.003 | 0.056 | 0 | 1 | 6566 |

Table A.2: Distribution of parental interest in education of the child by parental social class

| | Not very interested | Very interested | Total |
|---|---|---|---|
| Panel A: Father | | | |
| Professional | 123 | 289 | 412 |
| Managerial | 574 | 832 | 1406 |
| Non-manual-skilled | 232 | 249 | 481 |
| Skilled manual | 1596 | 692 | 2288 |
| Semi-skilled | 413 | 174 | 587 |
| Unskilled | 121 | 26 | 147 |
| Incomplete Information | 62 | 43 | 105 |
| Missing data | 285 | 69 | 354 |
| Total | 3406 | 2374 | 5780 |
| Panel B: Mother | | | |
| Professional | 5 | 32 | 37 |
| Managerial | 244 | 553 | 797 |
| Non-manual-skilled | 607 | 945 | 1552 |
| Skilled manual | 194 | 184 | 378 |
| Semi-skilled | 664 | 528 | 1192 |
| Unskilled | 224 | 125 | 349 |
| Incomplete Information | 37 | 24 | 61 |
| Missing data | 779 | 955 | 1734 |
| Total | 2754 | 3346 | 6100 |

*Note:* This table describes the number of observations in each parental social class bracket, separately for parents that are very interested in the education of the child according to the teacher's assessment, and parents that are not. Teacher assessments and the Father and Mother social class brackets are collected in 1980, when the cohort member was 10 years old.

*Source:* BCS70, Sweeps Birth, *age 10*

Table A.3: Full estimation results

| | Age 42 (1) | Age 42 (2) | Age 42 (3) | Age 30 (4) | Age 30 (5) |
|---|---|---|---|---|---|
| Mother is very interested in education child | 0.014 | 0.010 | 0.005 | 0.018 | 0.012 |
| | (0.013) | (0.012) | (0.012) | (0.013) | (0.013) |
| Father is very interested in education child | 0.064*** | 0.044*** | 0.036*** | 0.042*** | 0.036** |
| | (0.015) | (0.013) | (0.013) | (0.014) | (0.014) |
| LOC Age 30 (Std) | | 0.106*** | 0.102*** | | |
| | | (0.003) | (0.004) | | |
| LOC Age 10 (Std) | | | 0.035*** | | 0.039*** |
| | | | (0.005) | | (0.005) |
| Female cohort member | 0.036*** | 0.034*** | 0.040*** | 0.029*** | 0.035*** |
| | (0.011) | (0.010) | (0.010) | (0.010) | (0.010) |
| Birth weight < 2500 grams | −0.004 | −0.010 | −0.007 | 0.011 | 0.017 |
| | (0.023) | (0.021) | (0.021) | (0.022) | (0.022) |
| Exclusively breastfed first 7 days | 0.007 | −0.002 | −0.005 | 0.007 | 0.006 |
| | (0.017) | (0.016) | (0.016) | (0.017) | (0.017) |
| Diagnosed abnormalities at birth | −0.014 | −0.031 | −0.031 | 0.010 | 0.015 |
| | (0.044) | (0.041) | (0.041) | (0.045) | (0.045) |
| Behav. problems Age 5 (Std) | −0.014** | −0.008 | −0.006 | −0.020*** | −0.018*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Copy test Age 5 (Std) | 0.020*** | 0.011* | 0.006 | 0.024*** | 0.018*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Drawing objects test Age 5 (Std) | −0.001 | −0.002 | −0.005 | 0.002 | −0.001 |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Picture Vocabulary test Age 5 (Std) | 0.004 | −0.002 | −0.004 | 0.018*** | 0.016*** |
| | (0.006) | (0.005) | (0.005) | (0.006) | (0.006) |
| Maternal age left education (Std) | 0.007 | 0.005 | 0.002 | 0.010 | 0.006 |
| | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) |
| Maternal views liberal parenting (Std) | 0.007 | 0.007 | 0.004 | 0.002 | −0.001 |
| | (0.006) | (0.005) | (0.005) | (0.006) | (0.006) |
| Maternal mental health (Std) | −0.013** | −0.006 | −0.006 | −0.012** | −0.012** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| No father in HH (Birth) | 0.037 | 0.049* | 0.045 | −0.004 | −0.006 |
| | (0.031) | (0.028) | (0.028) | (0.030) | (0.030) |
| Father: none Age 10 | −0.024 | −0.019 | −0.020 | −0.023 | −0.022 |
| | (0.017) | (0.016) | (0.016) | (0.017) | (0.017) |
| Father: adopted/foster Age 10 | −0.118*** | −0.102*** | −0.095*** | −0.051 | −0.044 |
| | (0.036) | (0.033) | (0.033) | (0.038) | (0.037) |
| Father: step/cohabitee Age 10 | −0.067*** | −0.068*** | −0.065*** | −0.027 | −0.022 |
| | (0.022) | (0.021) | (0.020) | (0.023) | (0.023) |
| Father: grandfather/other Age 10 | −0.066 | −0.100* | −0.098* | 0.064 | 0.069 |
| | (0.059) | (0.053) | (0.053) | (0.069) | (0.068) |
| Father has no qualifications | −0.026** | −0.015 | −0.014 | −0.038*** | −0.035*** |
| | (0.012) | (0.011) | (0.011) | (0.011) | (0.011) |
| Father has a degree | 0.041** | 0.045** | 0.037** | −0.003 | −0.010 |
| | (0.019) | (0.018) | (0.018) | (0.018) | (0.018) |
| Father is hostile | −0.166* | −0.126 | −0.127 | −0.010 | −0.010 |
| | (0.100) | (0.101) | (0.100) | (0.116) | (0.116) |
| Father of European origin | −0.101** | −0.080** | −0.084** | −0.068 | −0.068 |
| | (0.042) | (0.038) | (0.038) | (0.042) | (0.042) |
| Father Indian Bangl Pakistani West Ind | 0.019 | 0.048 | 0.060* | −0.064** | −0.052* |
| | (0.036) | (0.034) | (0.034) | (0.031) | (0.031) |
| Father other ethnicity | −0.004 | −0.046 | −0.037 | 0.133 | 0.143 |
| | (0.097) | (0.085) | (0.086) | (0.123) | (0.122) |
| Observations | 6566 | 6566 | 6566 | 6566 | 6566 |

*Note:* Outcome variable is *age 42* and *age 30* locus of control. Marginal probability effects of being strictly internal at *age 42* or *age 30* are calculated on the basis of coefficients obtained from an ordered logit specification. Both lagged locus of control measures and all continuous measures (cognitive test scores, Rutter behavioural index, mother's age when left education) are standardized to mean 0 and standard deviation 1. Robust standard errors in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

*Source:* BCS70, Sweeps Birth, age 5, *age 10*, *age 30*, and *age 42*

Table A.4: Full estimation results, by sex and socioeconomic status

| | Pooled (1) | Female (2) | Male (3) | High SES (4) | Low SES (5) |
|---|---|---|---|---|---|
| Mother is very interested in education child | 0.005 | −0.001 | 0.016 | 0.020 | 0.020 |
| | (0.012) | (0.016) | (0.018) | (0.029) | (0.016) |
| Father is very interested in education child | 0.036*** | 0.056*** | 0.013 | −0.004 | 0.050*** |
| | (0.013) | (0.018) | (0.020) | (0.029) | (0.019) |
| LOC Age 30 (Std) | 0.102*** | 0.092*** | 0.111*** | 0.103*** | 0.103*** |
| | (0.004) | (0.005) | (0.005) | (0.008) | (0.004) |
| LOC Age 10 (Std) | 0.035*** | 0.030*** | 0.042*** | 0.059*** | 0.027*** |
| | (0.005) | (0.007) | (0.007) | (0.011) | (0.007) |
| Female cohort member | 0.040*** | 0.000 | 0.000 | 0.101*** | 0.029** |
| | (0.010) | (.) | (.) | (0.020) | (0.012) |
| Birth weight < 2500 grams | −0.007 | 0.002 | 0.004 | −0.048 | 0.017 |
| | (0.021) | (0.027) | (0.033) | (0.045) | (0.027) |
| Exclusively breastfed first 7 days | −0.005 | −0.028 | 0.032 | −0.033 | 0.029 |
| | (0.016) | (0.019) | (0.026) | (0.027) | (0.022) |
| Diagnosed abnormalities at birth | −0.031 | 0.009 | −0.091 | 1.839 | −0.052 |
| | (0.041) | (0.058) | (0.058) | (121.561) | (0.053) |
| Behav. problems Age 5 (Std) | −0.006 | −0.002 | −0.014* | −0.009 | −0.011 |
| | (0.006) | (0.007) | (0.008) | (0.013) | (0.007) |
| Copy test Age 5 (Std) | 0.006 | −0.003 | 0.017* | 0.011 | 0.003 |
| | (0.006) | (0.008) | (0.009) | (0.012) | (0.008) |
| Drawing objects test Age 5 (Std) | −0.005 | −0.008 | −0.005 | −0.030*** | 0.004 |
| | (0.006) | (0.008) | (0.008) | (0.012) | (0.007) |
| Picture Vocabulary test Age 5 (Std) | −0.004 | −0.002 | −0.004 | −0.031** | 0.002 |
| | (0.005) | (0.008) | (0.008) | (0.013) | (0.007) |
| Maternal age left education (Std) | 0.002 | −0.007 | 0.006 | 0.009 | 0.007 |
| | (0.006) | (0.008) | (0.009) | (0.010) | (0.011) |
| Maternal views liberal parenting (Std) | 0.004 | 0.011 | −0.004 | −0.016 | 0.004 |
| | (0.005) | (0.007) | (0.008) | (0.012) | (0.007) |
| Maternal mental health (Std) | −0.006 | −0.013* | 0.002 | 0.007 | −0.005 |
| | (0.006) | (0.008) | (0.008) | (0.013) | (0.007) |
| No father in HH (Birth) | 0.045 | 0.031 | 0.072 | 0.000 | 0.000 |
| | (0.028) | (0.035) | (0.046) | (.) | (.) |
| Father: none Age 10 | −0.020 | 0.023 | −0.059*** | −0.013 | 0.004 |
| | (0.016) | (0.022) | (0.022) | (0.035) | (0.021) |
| Father: adopted/foster Age 10 | −0.095*** | −0.092* | −0.104** | 1.821 | −0.122** |
| | (0.033) | (0.047) | (0.047) | (264.388) | (0.060) |
| Father: step/cohabitee Age 10 | −0.065*** | −0.087*** | −0.042 | −0.051 | −0.073*** |
| | (0.020) | (0.027) | (0.030) | (0.057) | (0.027) |
| Father: grandfather/other Age 10 | −0.098* | −0.103* | −0.083 | −0.041 | −0.133** |
| | (0.053) | (0.057) | (0.116) | (0.151) | (0.060) |
| Father has no qualifications | −0.014 | −0.008 | −0.020 | −0.035 | −0.013 |
| | (0.011) | (0.015) | (0.016) | (0.026) | (0.013) |
| Father has a degree | 0.037** | 0.085*** | −0.001 | 0.046* | 0.082** |
| | (0.018) | (0.026) | (0.025) | (0.027) | (0.040) |
| Father is hostile | −0.127 | −0.295** | 0.117 | 1.850 | −0.198 |
| | (0.100) | (0.119) | (0.158) | (382.727) | (0.159) |
| Father of European origin | −0.084** | −0.081* | −0.055 | 1.799 | −0.080* |
| | (0.038) | (0.047) | (0.063) | (222.207) | (0.044) |
| Father Indian Bangl Pakistani West Ind | 0.060* | 0.073 | 0.050 | 0.133 | 0.040 |
| | (0.034) | (0.048) | (0.049) | (0.151) | (0.045) |
| Father other ethnicity | −0.037 | −0.140 | 0.109 | 1.825 | −0.053 |
| | (0.086) | (0.099) | (0.166) | (306.305) | (0.124) |
| Observations | 6566 | 3369 | 3197 | 1204 | 3951 |

*Note:* The results reported in this table are based on the benchmark specification, column (4) reported in Table 1. The benchmark model is re-estimated for female and male cohort members (columns (2) and (3)) and by high and low socioeconomic status of the father measured at age 5 (columns (4) and (5)). Low SES refers to father's social class, defined as unskilled/skilled manual labour or service industry; High SES refers to father social class defined as high-skilled non-manual professions. Marginal effects of the probability of being strictly internal at *age 42* are calculated on the basis of ordered logit coefficients. Robust standard errors in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

*Source:* BCS70, Sweeps Birth, age 5, *age 10*, *age 30*, and *age 42*

# B APPENDIX B-Robustness checks

## B.1 Sample of cohort members who lived with their biological fathers

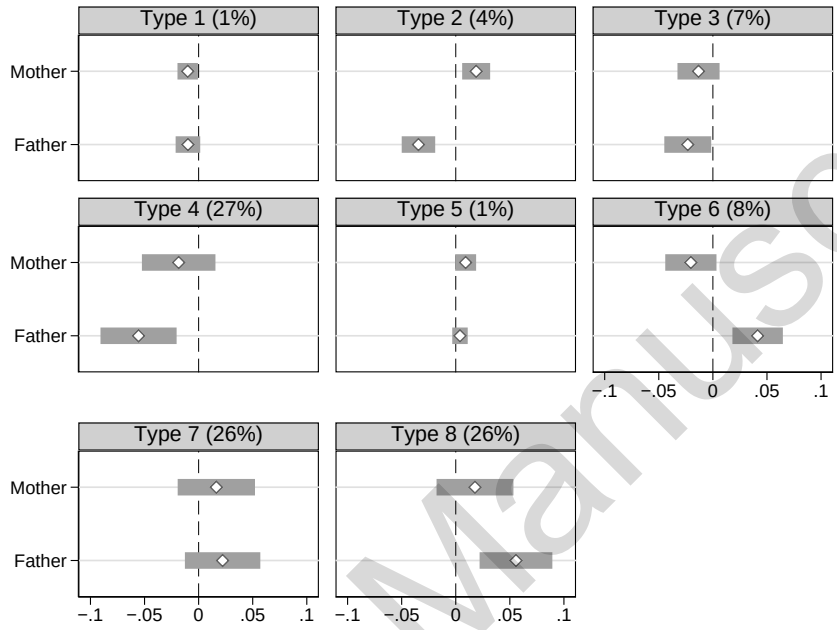
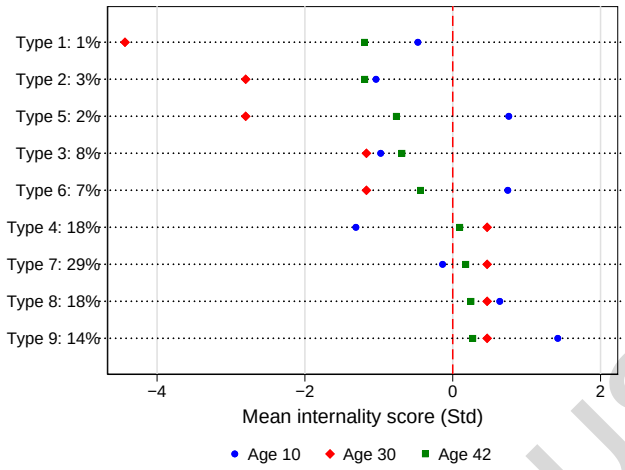
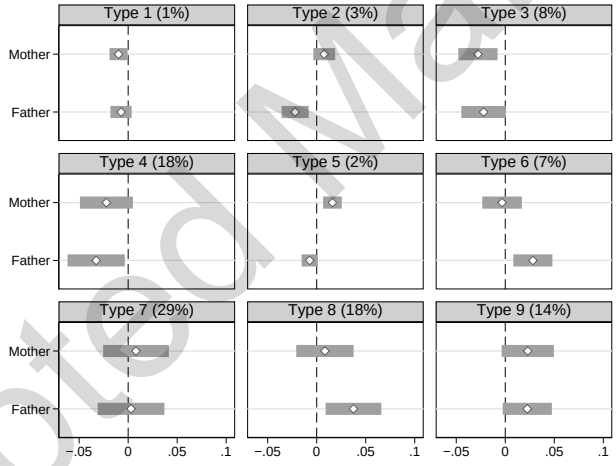



Figure B.1: Relationship between parental interest in child's education (mother, father) and the probability of a specific permanent control belief type (Childhood-Age30-Age42). Reported are marginal probability effects obtained from a multinomial logit model estimated on 5,465 observations with a full set of control variables. Types 7 and 8 have high lifelong internality; types 1 to 3 have lifelong externality; types 5 and 6 demonstrate a relative reversal whereby they are above-average in childhood but below-average in adulthood; and type 4 individuals exhibit the opposite pattern indicating low childhood internality and high adulthood internality. Types 4, 7, and 8 constitute 78% of the sample. Horizontal grey bars are 95% confidence intervals.

## B.2 Relaxing the number of percentiles in *age 10* LOC to split the groups




B.1 Type characteristics




B.2 Association between parental involvement and maturation-pathway type–Grey bars are 95% confidence intervals

Figure B.2: CHAID: 9 clusters (allowing for four or five quintiles to dichotomize childhood LOC)

## B.3 Choice of number of clusters with k-mean clustering

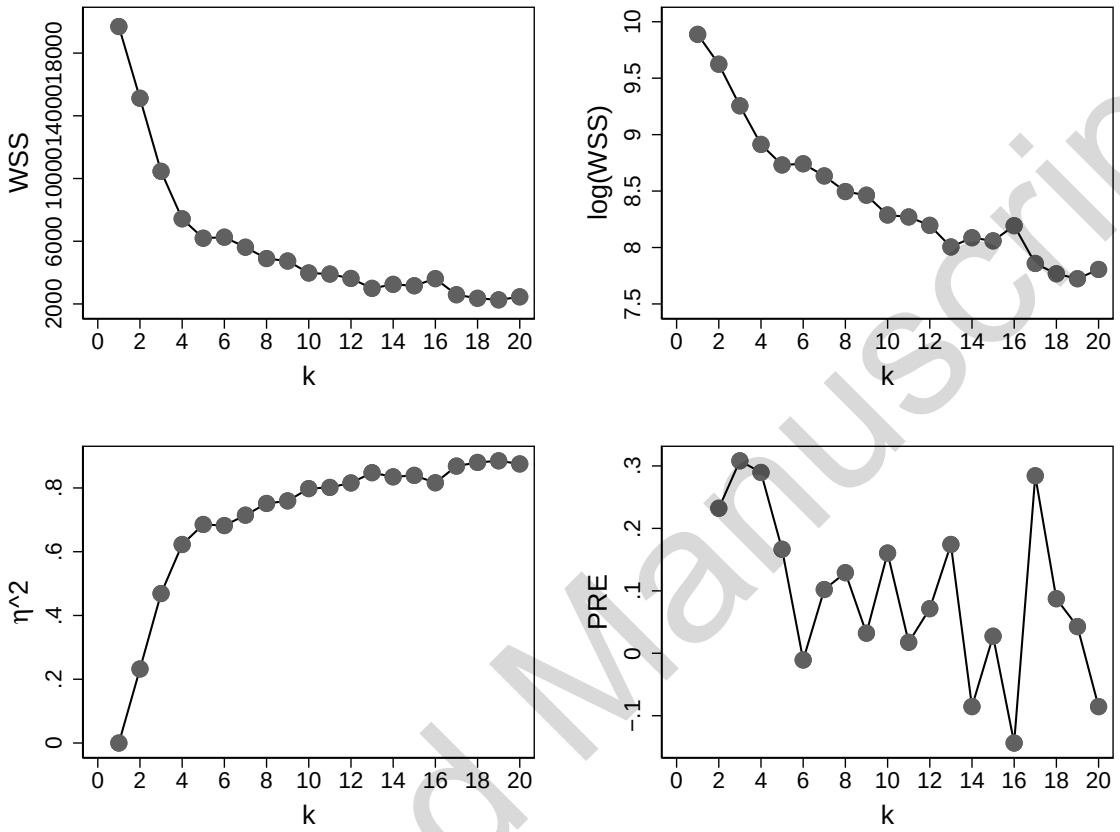
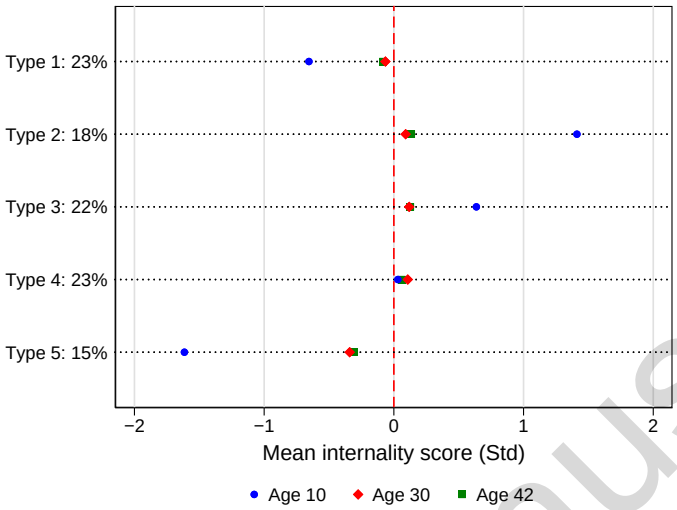
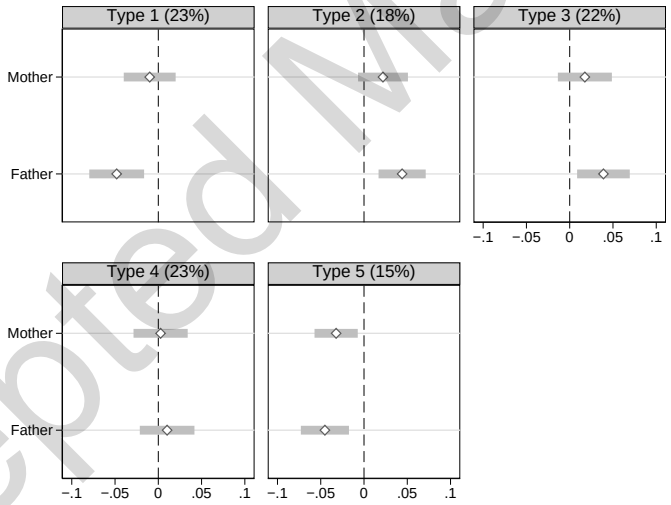



Figure B.3: Optimal number of clusters: standard clustering method

## B.4 k-mean clustering: ex ante five clusters



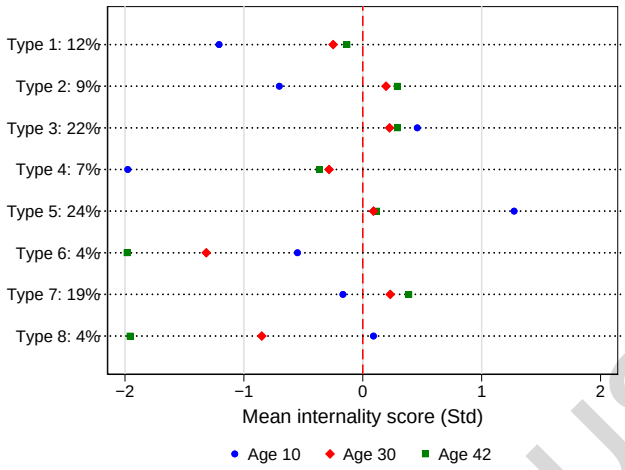

B.1 Type characteristics



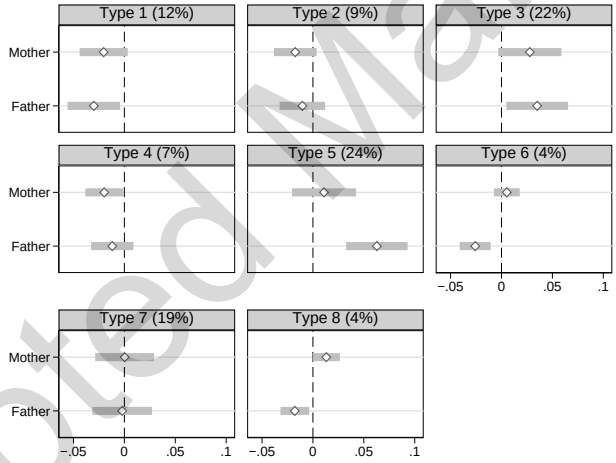

B.2 Association between parental involvement and maturation-pathway type–Grey bars are 95% confidence intervals

Figure B.4: k-mean clustering: 5 clusters

## B.5 k-mean clustering: ex ante eight clusters




B.1 Type characteristics




B.2 Association between parental involvement and maturation-pathway type-Grey bars are 95% confidence intervals

Figure B.5: k-mean clustering: 8 clusters

## B.6 Heterogeneity: by sex

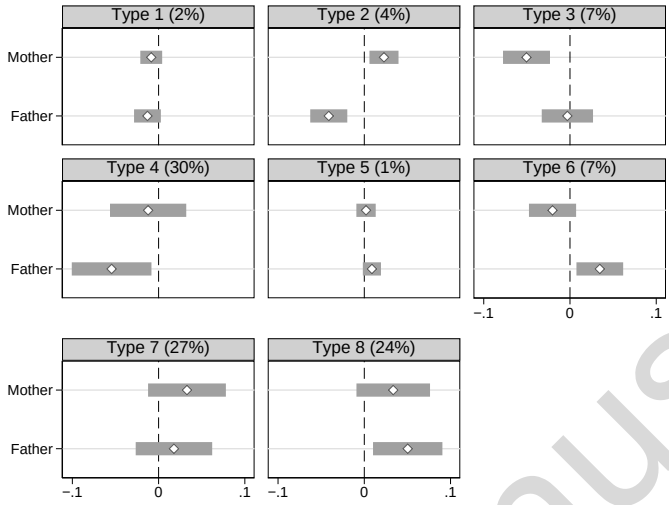
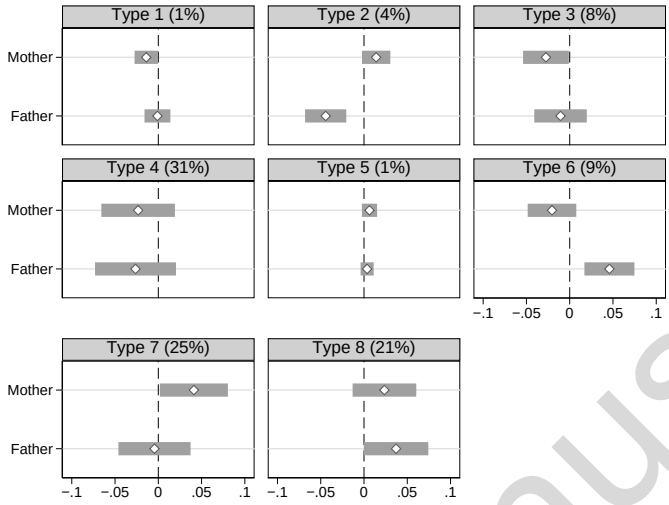
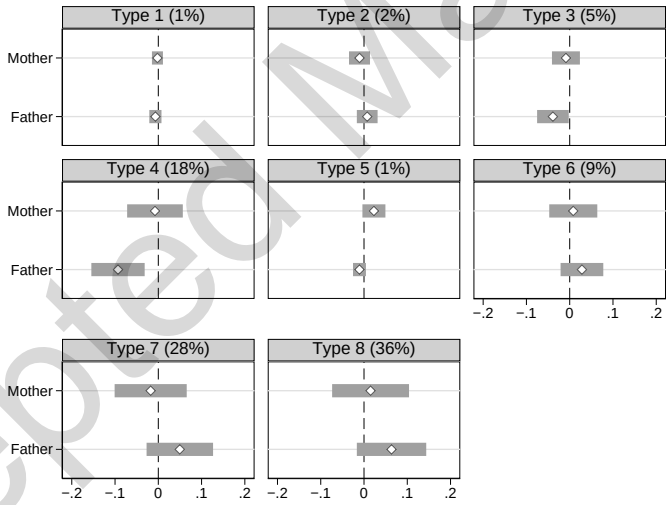



Figure B.6: Type estimation based on CHAID with eight clusters-heterogeneity for female (estimation did not converge for male)

## B.7 Heterogeneity: by socioeconomic status




B.1 Low SES




B.2 High SES

Figure B.7: Type estimation based on CHAID with eight clusters-heterogeneity by SES

## C APPENDIX C-Determinants of *age 10* Locus of Control beliefs

To understand the initial conditions of locus of control, we present in Table C.1 estimation results from a regression model in which we regress a measure of age 10 internality on a set of standard early-life factors, including parental involvement in the education of the child. The dependent variable is a standardized version of our continuous childhood control belief measure, and parameter estimates are obtained using ordinary least squares (OLS). We allow for heteroskedastic standard errors (Huber-White). Results are presented by sex and socioeconomic status (according to father's occupational class). High SES is defined as professional or manager occupations, while low SES is defined as low- or no-skilled or service occupational class. To reduce the high-dimensionality of estimation results, we present and limit our discussion to the estimated coefficients of interest. Full estimation results are provided upon request.

Parental interest in the education of the child predicts childhood internality independent of the influence of family structure; maternal, paternal, and individual childhood factors; and important socioeconomic indicators including parental occupational status and education. Overall, we find that children of parents very interested in their education are more internally oriented relative to children of parents who are not very interested. The magnitude of this association varies by sex and SES for mother's involvement (standardized coefficients range between 0.07 and 0.15 SD and drop from significance among high SES cohort members), although the differences across groups are not statistically significant. In contrast, father's involvement is a significant and stable predictor of internality across every group (standardized coefficients range between 0.17 and 0.22 SD), and the magnitude of this association with LOC is stronger than for mother's involvement, especially for boys and children from privileged backgrounds. The estimates on father's involvement are stronger in magnitude when focusing on families with biological or adoptee fathers (Panel B).

Table C.1: Predictors of internal locus of control beliefs at *age 10*, by sex and socioeconomic status (OLS): Selected parameters

| | Pooled (1) | Female (2) | Male (3) | High SES (4) | Low SES (5) |
|---|---|---|---|---|---|
| Panel A: All family types | | | | | |
| Mother is very interested in education child | 0.123*** | 0.152*** | 0.093** | 0.073 | 0.148*** |
| | (0.031) | (0.042) | (0.045) | (0.079) | (0.039) |
| Father is very interested in education child | 0.182*** | 0.188*** | 0.176*** | 0.219*** | 0.167*** |
| | (0.032) | (0.045) | (0.047) | (0.076) | (0.043) |
| Maternal age left education (Std) | 0.077*** | 0.087*** | 0.063*** | 0.043** | 0.094*** |
| | (0.013) | (0.018) | (0.020) | (0.022) | (0.023) |
| Maternal views liberal parenting (Std) | 0.087*** | 0.070*** | 0.110*** | 0.094*** | 0.084*** |
| | (0.013) | (0.018) | (0.020) | (0.027) | (0.017) |
| Maternal mental health (Std) | 0.007 | 0.017 | −0.009 | 0.016 | −0.003 |
| | (0.014) | (0.019) | (0.021) | (0.033) | (0.018) |
| Father has no qualifications | −0.065** | −0.031 | −0.094** | −0.179** | −0.043 |
| | (0.028) | (0.038) | (0.041) | (0.075) | (0.033) |
| Father has a degree | 0.174*** | 0.229*** | 0.116** | 0.013 | 0.373*** |
| | (0.040) | (0.055) | (0.058) | (0.071) | (0.078) |
| Observations | 6566 | 3369 | 3197 | 1204 | 3951 |
| Panel B: Families with biological or adoption father | | | | | |
| Mother is very interested in education child | 0.098*** | 0.137*** | 0.057 | 0.130 | 0.105** |
| | (0.034) | (0.048) | (0.050) | (0.085) | (0.043) |
| Father is very interested in education child | 0.212*** | 0.222*** | 0.199*** | 0.202** | 0.198*** |
| | (0.035) | (0.049) | (0.051) | (0.080) | (0.046) |
| Maternal age left education (Std) | 0.072*** | 0.088*** | 0.050** | 0.050** | 0.079*** |
| | (0.014) | (0.019) | (0.021) | (0.023) | (0.025) |
| Maternal views liberal parenting (Std) | 0.092*** | 0.076*** | 0.111*** | 0.099*** | 0.088*** |
| | (0.014) | (0.019) | (0.021) | (0.028) | (0.019) |
| Maternal mental health (Std) | 0.027* | 0.061*** | −0.016 | 0.030 | 0.005 |
| | (0.016) | (0.022) | (0.024) | (0.035) | (0.020) |
| Father has no qualifications | −0.062** | −0.045 | −0.072* | −0.203*** | −0.038 |
| | (0.029) | (0.040) | (0.043) | (0.078) | (0.035) |
| Father has a degree | 0.172*** | 0.219*** | 0.126** | 0.052 | 0.375*** |
| | (0.041) | (0.056) | (0.061) | (0.073) | (0.082) |
| Observations | 5465 | 2805 | 2660 | 1052 | 3320 |

*Note:* The dependent variable *age 10* internal locus of control index is standardized to mean 0 and standard deviation of 1. Average locus of control score in sample is 8, and 1 standard deviation is 3 units on an index that ranges between 0 and 16. Estimates are obtained from Ordinary Least Squares. The model includes a full set of control variables derived from birth, age 5 and *age 10*. Low SES refers to father's social class, defined as unskilled/skilled manual labour or service industry; High SES refers to father social class defined as high-skilled non-manual professions. Hubert-White (heteroskedasticity-adjusted) standard errors in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

*Source:* BCS70, Sweeps Birth, age 5, *age 10*