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LOCUS OF CONTROL AND ITS INTERGENERATIONAL IMPLICATIONS FOR EARLY CHILDHOOD SKILL FORMATION*

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Abstract

This article builds upon Cunha's (2015) subjective rationality model in which parents have a subjective belief about the impact of their investment on their children's early skill formation. We propose that this subjective belief is determined partly by locus of control (LOC), i.e. the extent to which individuals believe that their actions can influence future outcomes. Consistent with the theory, we show that maternal LOC measured at the 12th week of gestation strongly predicts maternal attitudes towards parenting style and actual time investments. We also utilise maternal LOC to improve the specification typically used to estimate skill production function parameters.

Standard economic theories assume that a significant part of an individual's decision to invest in human capital is driven not only by the expected returns to investment and their innate cognitive abilities but also by the current access to financial resources (Mincer, 1958, 1994; Becker, 1962, 1964; Ben-Porath, 1967; Grossman, 1972; Heckman, 1976). The idea that economic resources matter *per se* to human capital investment decisions has provided researchers with a useful framework for analysing inequalities regarding earnings, health, and social mobility among individuals from various socio-economic backgrounds (Flug *et al.*, 1998; Neal and Rosen, 2000; Deaton, 2001).

Yet, until recently, economists have made few attempts to understand why investment decisions can – and often do – vary significantly among individuals with similar levels of incomes and cognitive abilities (Phillips *et al.*, 1998; Feinstein, 2003; Cunha *et al.*, 2010). According to a study by Cobb-Clark (2014), one potential explanation for this is that individuals with comparable socio-economic backgrounds and cognitive abilities may nevertheless possess different subjective beliefs about the impact of their investments on the

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rate of return, which can in turn determine how much each individual is willing to invest in the human capital for him or herself.

These subjective beliefs depend in part on the individual's locus of control (LOC), which is a generalised expectancy regarding the nature of the causal relationship between the individual's behaviour and the consequences of the behaviour (Rotter, 1966). The formation of LOC as a trait happens early in life and remains relatively stable over time (Cobb-Clark and Schurer, 2013). Individuals with an external LOC believe that events in their life are outcomes of external factors (e.g. fate, luck and other people) and thus are beyond their control. In contrast, individuals with an internal LOC generally believe that much of what happens in their life stems from their own actions and thus tend to expect higher rates of return to their own behaviour than individuals with an external LOC.

This premise – that an individual's LOC drives each person's subjective expectation about the rate of return to investment – implies that, for efficiency reasons, people with an internal LOC will also naturally be driven to invest more of their current resources for enjoying future returns compared with people with an external LOC. With perhaps one exception,[1] the notion that an internal LOC person will invest more than an external LOC person on a range of individual self-improvement decisions is typically supported by the data. For example, Coleman and DeLeire (2003) were among the first economists to find that individuals with an internal LOC are *ceteris paribus* less likely to drop out from high school primarily because they tend to have higher expectations regarding the returns to human capital investments than do people with an external LOC. Cobb-Clark *et al.* (2014) find that individuals with an internal LOC are more likely to eat more healthily and exercise more regularly than people with an external LOC, when individuals' income, future orientation and the value they place on their health remain constant. People with an internal LOC also tend to search for a job more intensively when unemployed (Caliendo *et al.*, 2015; McGee, 2015), save more for 'rainier days' (Cobb-Clark *et al.*, forthcoming) and appear to possess higher levels of psychological resources from which they could draw upon to help them cope with negative life shocks compared to people with an external LOC (Schurer, 2014; Buddelmeyer and Powdthavee, 2016).

Our study advances from previous research in this area and focuses on the potential implications of the individual's LOC on investment decisions in children (rather than the implications of LOC on the individual's own human capital investments). The contribution of this study is twofold. First, recent research in the child development literature has concluded that parents do not have full knowledge of the technology of human capital formation and that there are uncertainties in achieving the desired outcomes (Cunha *et al.*, 2013; Cunha, 2015). This implies that parents' optimal investment decisions will depend not only on the resources that are available to them at the time but also on their subjective expectations about the rate of return to early childhood investment (Cunha *et al.*, 2013; Cunha, 2015).

[1]Using a different data set to Coleman and DeLeire (2003), Cebi (2007) does not find LOC to be a significant predictor of educational attainment when cognitive ability is controlled for; however, Cebi does find LOC to be an important predictor of future wages.

While empirical studies have found that parents' subjective expectations about the returns influence the actual investment levels and subsequent child outcomes (Attanasio and Kaufmann, 2009; Cunha *et al*., 2013), little is known about the sources of individual differences in subjective beliefs in the expected returns to early life investments. Thus, our first contribution is to fill this missing link in the early childhood investment model by proposing that a significant proportion of variation in parents' subjective expectations about the returns to investment may be explained by individual differences in LOC among mothers.[2] More specifically, using rich cohort data of British children born in the 1990s, we show that maternal LOC measured during pregnancy is an important predictor of beliefs in parental approaches to active child rearing (e.g. the beliefs that parents should be more active in rearing the child rather than leaving it to chance), which we believe to be a reasonably good proxy for parents' subjective expectations about the returns to their investments. Additionally, maternal LOC is strongly related to indicators of maternal time inputs and early cognitive outcomes – all measured during one to three years of age.

Our second and perhaps more novel contribution to the literature is in the methodology. In child development literature, researchers attempt to understand the role of parental characteristics and early home environments in the production of both cognitive skills and non-cognitive skills (Belsky and Eggebeen, 1991; Vandell and Ramanan, 1992; Parcel and Menaghan, 1994; Gregg *et al*., 2005; Bernal, 2008). However, according to Todd and Wolpin (2003), many empirical studies suffer from several data limitations that prevent many empirical exercises, which use observational data sets, from making causal interpretations of their findings. The main reason for this is that most – if not all – early childhood input decisions are subject to choices made by parents. This would not necessarily pose a problem for researchers who want to estimate a production function for child development if data on all relevant inputs as well as child endowments were observed. However, it does pose a problem when data on relevant inputs and endowments are omitted.

With longitudinal data, researchers can apply a first-difference (FD) model to correct for any permanent unobserved factors that normally bias the estimation of skill production function parameters, such as endowed mental capacity in children that does not change over time (Todd and Wolpin, 2003). However, the application of FD models is likely to result in estimates that are biased towards zero because of the attenuation bias normally associated with the differencing of data (McKinnish, 2008).

We aim to correct for part of this problem by proposing that a significant share of the within-child variation in the optimal investment level among mothers from the same socio-economic status (SES) is determined by individual differences in maternal LOC measured during pregnancy. At one extreme, the subjective belief that all maternal inputs are used efficiently to achieve the desired outcomes held by the absolutely internal LOC mothers implies that they will always invest fully in their children at each step of child development. At the other extreme, the subjective belief that active parenting is completely inefficient in

[2]Although Cunha *et al.* (2010) have shown parental cognitive skills, including parents' LOC, to be more important than parental cognitive skills as predictors of early investments in children, in their study they did not make the link between LOC and parents' subjective beliefs about the expected returns to investments.

achieving the desired outcomes held by the absolutely external LOC mothers implies that they are likely to invest less – if at all – in active parenting. Our empirical strategy will exploit this additional difference in the investment levels between mothers of internal LOC and those of external LOC who otherwise share similar backgrounds, to estimate the returns to early childhood investments. We advocate that our estimation technique, when applied to observational data, can correct for parts of the attenuation bias. Moreover, by pairing the comparable mothers, our method can account for some of the omitted time-varying variables, in particular the natural developmental trends of children. Therefore, the method helps to tackle some of the time-varying biases normally associated with the estimation of FD models.

The remainder of this article is organised as follows. Section 1 is a background to the literature and discusses in more detail the motivation of our study. Section 2 outlines the empirical framework for estimating the production function parameters. Section 3 describes the data and Section 4 discusses the econometric models. Section 5 presents and discusses the main results. Section 6 concludes.

1. Background

1.1. What Drives Human Capital Investments in Children?

Traditional economic models typically view the availability of financial resources as one of the key determinants of human capital investment in children (Becker, 1962; Ben-Porath, 1967; Becker and Tomes, 1986). According to these models, in which parents have full information regarding the production technology of skill formation in a child's early years, parents' decision to invest in the human capital of their children will depend almost exclusively on the objective net benefits of their investments. However, despite all parents wanting to invest optimally in their children, a presence of liquidity and borrowing constraints in the early years would imply that early childhood investments will be lower for low-income parents than for high-income parents (Lochner and Monge-Naranjo, 2011; Caucutt and Lochner, 2012), thus leading to the formation of a 'skill' gap early in a child's life and that may persist throughout adolescence and adulthood (Heckman and Carneiro, 2003).

Considerable empirical evidence shows that family income strongly predicts parents' human capital investment decisions in children and their cognitive outcomes at early stages. For example, Kaushal *et al.* (2011) use two nationally representative expenditure surveys to show that American families in the bottom family expenditure quintile spend 3% of their total expenditure on education enrichment items (e.g. preschool, drama lessons, music lessons), whereas families in the top income quintile spend 9%. Regarding early child outcomes, Duncan *et al.* (1994) find that differences in family income account for many of the observed differences between the early life IQs of children, even after controlling for differences in family structure and maternal schooling. Yeung *et al.* (2002) find family income to be an important predictor of preschool children's cognitive and behavioural developmental outcomes. They also find that much of the association between income and child outcomes is mediated by the family's ability to invest in a stimulating learning environment for children at the early stages. Using a range of data sets, other studies have also shown that family income at the early stages has a greater impact on later educational attainments than family income at late stages (Duncan and Brooks-Gunn, 1997; Duncan *et al.*, 1998; Caucutt and Lochner, 2012).

Despite numerous studies showing that early access to capital in a child's life does influence early childhood investments and developments, recent empirical evidence indicates that differences in income alone cannot explain the observed gap in school readiness between low and high-income children in the US (Phillips *et al.*, 1998; Cunha *et al.*, 2010) and in the UK (Feinstein, 2003). For example, Duncan *et al.* (2013) show that the widening income gap between families accounts for only three-quarters of the increasing schooling gap. Similarly, Reardon (2011), using data from 19 nationally representative studies, finds that only half of the rising income gap in test scores is attributed to rising income inequality.

One explanation is that other types of human capital inputs also matter. For example, growing evidence points towards radical differences in parenting behaviour between low and high-income families. Guryan *et al.* (2008) find that mothers with a college education spend approximately 4.5 hours per week more in childcare than mothers with a high-school degree or less. High-SES mothers are also found to be significantly more verbally engaging to their children; according to a qualitative study by Hart and Risley (1995), there are large differences in language stimulation environments measured by word count among mothers from different social classes.

Not only do high-SES parents invest more time in cognitively stimulating their children, they also do so more efficiently. Using data from the 2003–7 American Time Use Surveys, Kalil *et al.* (2012) show that high-SES mothers not only spend more time in childcare but they are also more likely to alter the composition of their time use to meet the age-specific developmental needs of their children. According to a qualitative study by Lareau (2003), high-SES parents tend to prefer the 'concerted cultivation' style of parenting (which actively develops children's skills) over the 'accomplishment of natural growth' style of parenting (which assumes a natural development of skills), which is more common among parents from lower SES backgrounds.

Evidence that parenting behaviour among parents from different SES backgrounds influences early childhood developments gives rise to two important questions. First, what drives the differences in parenting style between low and high-SES families? And second, for any given parenting style, do parents with similar endowments of wealth and educational backgrounds invest the same amount of time inputs in their children?

1.2. Uncertainty and the Subjective Rationality Model of Parental Investment

To understand better the source of heterogeneity in parenting behaviour between- and within-SES classes, some updating of the human capital theory is required. Recall that traditional economic models tend to assume that human capital investment decisions in children are driven purely by the objective costs and benefits of investments (Ben-Porath, 1967; Becker and Tomes, 1986). In fact, many uncertainties associated with the returns to investment in early childhood human capital will be realised by parents only years after the investments have taken place (Cunha *et al.*, 2013; Cunha, 2015). Because parents are unlikely to have the full information regarding the production technology of early life skills, their decision of whether to adopt an active parenting style will be driven in part by their subjective beliefs in future returns to their investments.

Psychology studies suggest that income level or family SES is associated with an active parenting style (Hess *et al.*, 1980; Ninio and Rinott, 1988; Mansbach and Greenbaum, 1999). However, recent studies show that some knowledge-based interventions can improve parental beliefs in the returns to active parenting behaviour among low-income families without necessarily changing their incomes (Fitzsimons *et al.*, 2012; Leffel and Suskind, 2013).

In other words, although subjective beliefs in the future returns to a concerted cultivating parenting style tend to be higher among high-income parents than among low-income parents, income itself is not a prerequisite for improving an individual's subjective beliefs in those returns. Moreover, Cunha *et al.* (2013) show that one of the main reasons why parents from socio-economically disadvantaged backgrounds tend to underinvest their time in cognitively stimulating their children at early stages is that they tend to underestimate the future returns from investing in such an active parenting style, regardless of potential liquidity constraints.

The importance of parents' subjective beliefs in future returns provides the central tenet to Flavio Cunha's (2015) seminal work on the subjective rationality model of parental investment. Under his framework, parents are assumed to have altruistic preferences for their children (Becker and Tomes, 1986) and to be rational agents who want to maximise their utility over the lifespan. However, parents lack information on the human capital process and therefore must rely on their own subjective assessment of the potential outcomes of the human capital production. Human capital accumulation is determined by the interaction between investments (e.g. number of books at home) and institutions (e.g. quality of school).

Similar to a classical framework of human capital investment, each parent faces budget constraints when attempting to optimise the desired outcomes. A point of departure is that Cunha's model allows each parent to make optimal decisions on children's human capital in two stages.[3] In the first stage, each parent chooses their optimal type of parenting style (Lareau's 2003 'concerted cultivation' versus 'natural growth'), which is essentially a production technology that governs how efficiently each type of input, i.e. own investment and institutional factor, is transformed. Each parent knows that if he or she chooses the 'concerted cultivation' style, the parent incurs a cost (in utility unit), whereas choosing the 'natural growth' style is costless. When an optimal parenting style is chosen, each parent then chooses the optimal level of own investment at each time period, subject to budget constraints.

Because income is less constrained and the utility cost of utilising the superior technology is lower for high-SES parents than for low-SES parents, the model predicts that high-SES parents are more likely than low-SES parents to adopt the concerted cultivation parenting

[3]For simplicity, we assume that each parent chooses their parenting style independently from one another, i.e. no learning from their partner.

style. More importantly, the model also implies that, for a given parenting style, the optimal level of investment will be higher when parents' subjective expectations about the input efficiency are higher (simply because having higher subjective expectations about the input efficiency increases the belief that each unit of investment will, with certainty, be converted into the desired output).

However, despite the theoretical importance of this subjective element in the human capital accumulation process, little is known about how parents acquire this subjective belief or its formation. Moreover, assuming that the differences in parents' subjective beliefs are not perfectly captured by differences in family SES, the main driver of input choices among parents from the same SES background is still poorly understood.

We propose that, conditional on their SES background, parents' subjective expectations regarding the input efficiency of a particular parenting style are mainly driven by LOC.

1.3. LOC and Human Capital Investment Decisions

Recall that

i. LOC is a generalised expectancy regarding the nature of the causal relationship between an individual's behaviour and the consequences of the behaviour (Rotter, 1966);

ii. LOC forms in childhood and remains relatively stable throughout life (Cobb-Clark and Schurer, 2013); and

iii. LOC has important implications across a variety of investment decisions, including human capital (Coleman and DeLeire, 2003), health (Cobb-Clark *et al.*, 2014), and job search (Caliendo *et al.*, 2015; McGee, 2015).

Although LOC can affect people's willingness to invest in human capital through several potential mechanisms, for example, productivity, preferences, self-efficacy, risk perception and self-control (Cobb-Clark, 2014), recent empirical studies in economics show that LOC is likely to affect human capital investment decisions mainly through its effect on the individual's subjective beliefs in returns to investments. For example, Coleman and DeLeire (2003) were the first to link the individual's LOC to expected wage outcomes by empirically showing that subjective beliefs in wage returns to education are higher for young people with internal LOC than for otherwise similar young people with external LOC. Both McGee (2015) and Caliendo *et al.* (2015) report that unemployed jobseekers with an internal LOC tend to have higher wage reservations and search for jobs more intensively. Both these studies attribute their observed effects to the impacts of LOC on the individual's beliefs in the returns to search rather than to productivity, because internal LOC jobseekers are no more successful at finding jobs than their external LOC counterparts. Finally, McGee and McGee (2011) provide experimental evidence showing that the link between LOC and search efforts disappears when it is made clear to people that there is no uncertainty associated with the returns to investment. In other words, they find virtually no difference in search efforts between high and low-LOC individuals in the laboratory when subjects know the true relationship between efforts and job offers.

Regarding the intergenerational implications of LOC on child outcomes, we hypothesise that parents' LOC can influence – independently of their SES background – the human capital development of their children through:

i. its impact on subjective expectations regarding returns to investments and, in turn, parenting style; and

ii. the genetic and behavioural heritability of LOC that affects the child's own human capital investment decisions (Anger, 2012).

However, by limiting ourselves to analysing the first few years of a child's life, it is possible to minimise the confounding influences that item (ii) has on the association between parents' LOC and the human capital accumulation in their children.

1.4. Estimation of the Returns to Parental Investments

Empirical evidence on the effects of parental time inputs on human capital accumulation in children at early stages is scarce.[4] Todd and Wolpin (2003, 2007) report that home inputs (e.g. parental involvement and the availability of learning materials) are strong predictors of cognitive development and that heterogeneity in these inputs explain approximately 10–20% of the racial attainment gaps. Fiorini and Keane (2014) use unique time-use diaries from the Longitudinal Study of Australian Children to establish the links between time allocation of children 1–9 years of age and human capital accumulation. They find that educational activities together with parents are the most productive time inputs for the development of cognitive skills, but not for non-cognitive skills. Similarly, Del Bono *et al.* (2014) find large effects of maternal time inputs, both educational and recreational, on cognitive and emotional skill development in children three to seven years of age.

According to Todd and Wolpin (2003), the main empirical challenge in the estimation of the effects of parental time inputs on child outcomes is that parenting style is endogenous and it is often unclear what type of variables could serve as a valid instrumental variable for parental time allocation. With longitudinal data, we can correct for part of this bias by eliminating unobserved individual fixed effects altogether from simultaneously affecting both parents' human capital investment decisions and child outcomes. However, by doing so we risk exacerbating the extent of attenuation bias that could result in a severe underestimation of the production parameters (McKinnish, 2008).

By assuming that LOC is primarily linked to human capital investment decisions in children through the individual's beliefs in investment returns, we can introduce a source of meaningful variation regarding parental time inputs in our early child outcomes regression equations that, in turn, helps to correct for some – if not all – of the attenuation bias caused by the application of the FD model. The following Section outlines the empirical framework in fuller detail.

[4]Much of the work in this area originates from randomised controlled trial studies on children from disadvantaged backgrounds (Heckman *et al.*, 2010; Gertler *et al.*, 2014; Attanasio *et al.*, 2015).

2. Empirical Framework

Let us assume the following early skills production function, which can be written in a non-parameterised format as:

$$Y_{ia} = Y(\boldsymbol{X}_{ia}, N_{ia}, \phi_{i0}, \varepsilon_{ia}), \quad (1)$$

where Y_{ia} is an early skill outcome of child i at age a; X_{ia} is vector of parental investments in the child's early skill at age a; N_{ia} represents all other inputs that influence the child's skill development that are independent from parents' investments at the child's age a; $\boldsymbol{\phi}_{i0}$ is a set of pre-birth family characteristics including parents' highest completed education levels (as a proxy for family SES) and the child's endowments at age zero; and is the error term.

A linear approximation of (1) is then given by:

$$\begin{aligned} Y_{ia} &= \phi_{i0}\gamma_a + \boldsymbol{X}_{ia}\beta_1 + \boldsymbol{X}_{ia-1}\beta_2 + \cdots + \boldsymbol{X}_{i1}\beta_a \\ &+ N_{ia}\alpha_1 + N_{ia-1}\alpha_2 + \cdots + N_{1i}\alpha_a + \varepsilon_{ia}. \end{aligned} \quad (2)$$

Todd and Wolpin (2003, 2007) discuss various ways for researchers to estimate (3) empirically, including:

i. cumulative specification in which data of contemporaneous and historical family and school inputs are used in the estimation;

ii. value-added specification in which missing data of historical inputs are replaced by the baseline achievement measure (or the lagged dependent variable); and

iii. within-child specification in which multiple observations on child outcomes and on inputs are used to difference out any unobserved time-invariant factors from the estimation process.[5]

Focusing on the within-child specification, we attempt to estimate the child's production function up to two years of age. For simplification, let us rewrite (2) for age 1 and age 2 as:

$$Y_{i1} = \phi_{i0}\gamma_1 + X_{i1}\beta_1 + N_{i1}\alpha_1 + \varepsilon_{i1}, \quad (2a)$$

and

$$Y_{i2} = \phi_{i0}\gamma_2 + X_{i2}\beta_1 + X_{i1}\beta_2 + N_{i2}\alpha_1 + N_{i1}\alpha_2 + \varepsilon_{i2}. \quad (2b)$$

Subtracting (2a) from (2b), we obtain the within-child FD specification:

[5]More specifications are developed and discussed in Del Bono *et al.* (2012), including using lagged outcome as an instrument in a modified value-added model.

$$Y_{i2}-Y_{i1}=\phi_{i0}(\gamma_2-\gamma_1)+(X_{i2}-X_{i1})\beta_1+X_{i1}\beta_2+(N_{i2}-N_{i1})\alpha_1+N_{i1}\alpha_2+(\varepsilon_{i2}-\varepsilon_{i1}). \quad (3)$$

Generally, neither ϕ_{i0} nor $N_{i2} - N_{i1}$ is observed. The parameters β_1 and β_2 can be consistently estimated under the following assumptions:

ASSUMPTION 1. The effect of endowment is age-invariant. Here, $\gamma_2 = \gamma_1 = \gamma_a$, in which case the differencing eliminates the endowment from (3), i.e. $\phi_{i0}(\gamma_2 - \gamma_1) = 0$.

ASSUMPTION 2. The omitted inputs are uncorrelated with observed inputs, i.e. $\mathrm{corr}(N_{i2} - N_{i1}; X_{i2} - X_{i1}) = 0$.

ASSUMPTION 3. There is no feedback effect of parental input choice from previous outcome, i.e. $\mathrm{corr}(X_{ia}, Y_{ia-t}) = 0$.

ASSUMPTION 4. The unobserved inputs are age-invariant: $N_{i2} = N_{i1} = N_{ia}$, *in which case the differencing eliminates the unobserved inputs from* (3), *i.e.* $(N_{i2} - N_{i1})\alpha_1 = 0$.

Given the above assumptions, the within-child FD regression can be written as:

$$Y_{i2}-Y_{i1}=(X_{i2}-X_{i1})\beta_1+X_{i1}\beta_2+e_i, \quad (4)$$

where $e_i = N_{i1}\,\alpha_2 + (\varepsilon_{i2} - \varepsilon_{i1})$. We now consider a way of relaxing the strong assumptions 3 and 4 that maintained that the omitted inputs are age-invariant and that later parental input choices are invariant to prior developmental child outcomes.

To account for the unobserved time-variant natural inputs and the endogeneity of parental inputs, we refer to our earlier conceptual framework and assume that, within the same SES background, input choices are mainly driven by parents' subjective expectations about the returns to investments and that the main source of these subjective beliefs is their predetermined LOC. More formally, we propose that parents can be further distinguished into two groups of individuals who possess different subjective beliefs about the returns to investments but who otherwise share, on average, statistically the same family characteristics and omitted inputs across the child's developmental path. It is this between-group difference in parents' subjective beliefs – which is partly predetermined by their LOC – that drives the between-group difference in optimal parental input choice. Given this assumption, we can extend the fixed effects equation, i.e. (4), for;

i. individuals who believe that their actions are efficient in producing the desired outcomes, i.e. the internal LOC individuals (*IN*); and

ii. individuals who believe that their actions are inefficient in producing the desired outcomes, i.e. the external LOC individuals (*EX*);

as:

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$$\begin{aligned} Y_{i2,\,IN} - Y_{i1,\,IN} = \phi_{i0,\,IN}\big(\gamma_{2,\,IN} - \gamma_{1,\,IN}\big) + \big(X_{i2,\,IN} - X_{i1,\,IN}\big)\beta_{1,\,IN} + X_{i1,\,IN}\beta_{2,\,IN} \\ +\big(N_{i2,\,IN} - N_{i1,\,IN}\big)\alpha_{1,\,IN} + N_{i1,\,IN}\alpha_{2,\,IN} + \big(\varepsilon_{i2,\,IN} - \varepsilon_{i1,\,IN}\big), \end{aligned} \quad (5)$$

and

$$\begin{aligned} Y_{i2,\,EX} - Y_{i1,\,EX} = \phi_{i0,\,EX}\big(\gamma_{2,\,EX} - \gamma_{1,\,EX}\big) + \big(X_{i2,\,EX} - X_{i1,\,EX}\big)\beta_{1,\,EX} + X_{i1,\,EX}\beta_{2,\,EX} \\ +\big(N_{i2,\,EX} - N_{i1,\,EX}\big)\alpha_{1,\,EX} + N_{i1,\,EX}\alpha_{2,\,EX} + \big(\varepsilon_{i2,\,EX} - \varepsilon_{i1,\,EX}\big). \end{aligned} \quad (6)$$

Because the subjective efficiency of parents' own investment is higher for the internal LOC type than for the external LOC type, we can derive that ceteris paribus $X_{ia,IN} > X_{ia,EX}$ for any given age a. Subtracting (6) from (5) gives a specification similar to a difference-in-differences (DD):

$$\begin{aligned} \Delta Y_{i,\,IN} - \Delta Y_{i,\,EX} &= \beta_1\big(\Delta X_{i,\,IN} - \Delta X_{i,\,EX}\big) \\ &+\beta_2\big(X_{i1,\,IN} - X_{i1,\,EX}\big) + \alpha_1\big(\Delta N_{i,\,IN} - \Delta N_{i,\,EX}\big) \\ &+\alpha_2\big(N_{i1,\,IN} - N_{i1,\,EX}\big) + \big(\Delta\varepsilon_{i,\,IN} - \Delta\varepsilon_{i,\,EX}\big), \end{aligned} \quad (7)$$

where Δ denotes a FD within-child and LOC group one to two years of age. For this DD specification to be appropriate, we need to account for the variables of the change of omitted inputs or what we refer to as the unobserved developmental trend, ΔN_i, which is the counterfactual developmental trend in the absence of parental inputs. To do this, we require in lieu of assumptions 3 and 4:

> ASSUMPTION 5. On average, the unobserved developmental trends are identical across LOC groups, i.e. $N_{i2,LOC}\ N_{i1,LOC} = N_{i2}-N_{i1}$.

Assumption 5 implies that the omitted variables of natural trend can be cancelled out by using the DD specification. However, it is possible that the quality of omitted inputs faced by parents of different LOC types, $N_{ia,LOC}$, will also be driven in part by the difference in their SES backgrounds, thus making Assumption 5 invalid. To account for the potential confounding influences on input choices from differences in parents' SES, a third difference – high-SES (H) and low-SES (L) – is introduced into the DD equation as follows:

$$\begin{aligned} &\big(\Delta Y_{i,\,IN,\,H} - \Delta Y_{i,\,EX,\,H}\big) - \big(\Delta Y_{i,\,IN,\,L} - \Delta Y_{i,\,EX,\,L}\big) = \\ &\beta_1\Big[\big(\Delta X_{i,\,IN,\,H} - \Delta X_{i,\,EX,\,H}\big) - \big(\Delta X_{i,\,IN,\,L} - \Delta X_{i,\,EX,\,L}\big)\Big] \\ &+\beta_2\Big[\big(X_{i1,\,IN,\,H} - X_{i1,\,EX,\,H}\big) - \big(\Delta X_{i1,\,IN,\,L} - X_{i1,\,EX,\,L}\big)\Big] \\ &+\Big[\big(\Delta\varepsilon_{i,\,IN,\,H} - \Delta\varepsilon_{i,\,EX,\,H}\big) - \big(\Delta\varepsilon_{i,\,IN,\,L} - \Delta\varepsilon_{i,\,EX,\,L}\big)\Big], \end{aligned} \quad (8)$$

where $(\Delta N_{i,IN,H} - \Delta N_{i,EX,H}) - (\Delta N_{i,IN,L} - \Delta N_{i,EX,L})$ and $(N_{i1,IN,H} - N_{1,EX,H}) - (N_{i1,IN,L} - N_{i1,EX,L})$ are assumed to be equal to zero. Given that our assumptions hold, the parameters β_1 and β_2 can be consistently estimated using this difference-in-difference-in-difference (DDD) approach.

3. Data

3.1. The Avon Longitudinal Study of Parents and Children

The Avon Longitudinal Study of Parents and Children (ALSPAC)[6] is a near-census English cohort survey designed to study the effect of environmental, genetic and socioeconomic influences on health and development outcomes of children. ALSPAC recruited pregnant women residing in the Avon area of England with expected delivery dates between 1 April 1991 and 31 December 1992. In total, 14,541 pregnancies (80– 90% of all pregnancies in the catchment area) resulted in a sample of 13,971 children at 12 months of age. The sample is representative of the national population of mothers with infants less than 12 months old (Boyd *et al.*, 2013) and contains multiple high-frequency reported measures on cognitive and socio-emotional skills in infancy as well as a rich set of parental investment measures and parental characteristics collected from the antenatal period onwards.

At seven, eight and nine years of age, the ALSPAC cohort underwent physical, psychometric and psychological tests administered in a clinical setting. Administrative data from the National Pupil Database has been matched to the ALSPAC children, containing school identifiers and results of national Key Stage test scores for all children attending public schools in the four local educational authorities[7] that cover the Avon area. As with any large cohort survey, the usual attrition due to loss in follow-up applies in the later waves. Moreover, the participating mothers did not always answer every question in every part of the questionnaires and, therefore, the sample size may vary across different regression equations and outcome variables. Our strategy is to conduct all our analyses by using complete cases.

We consider a number of subsamples for our analysis. The first subsample includes all mothers who were interviewed during pregnancy and responded to the selected baseline questions examined in our study, including self-reported questions on LOC and mental health. This initial subsample consists of 9,368 individuals. Depending on the outcome variable, this initial subsample fall to approximately 5,700 at two and three years of age and to approximately 3,100 at 16 years of age.

3.2. Measures of Early Childhood and Adolescent Outcomes

We based our main measures of early childhood outcomes on language skill development. Language development is a key part of early cognitive development and facilitates all other dimensions of early skill formation. Moreover, language skills at school-entry age predict

[6]The study website contains details of all the data that are available through a fully searchable data dictionary (www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/). Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

[7]These local educational authorities are Bristol, South Gloucestershire, North Somerset, and Bath and North East Somerset.

educational attainment at later ages (Duncan *et al.*, 2007). We measured both receptive and expressive language development by using the MacArthur Communicative Development Inventory, which is a mother-assessed questionnaire on early language development. Mothers were asked to report whether their child could understand (receptive) and use (expressive) listed vocabulary items (Law and Roy, 2008).

As part of our broader analysis, we also focus on adolescent outcomes based on the child's educational attainments at 16 years of age. We used the average total point score of the General Certificate of Secondary Education (GCSE) test, which is a national test generally taken in the UK in various subjects at 14–16 years of age as a measure of educational attainment.

3.3. Measures of Locus of Control

Parents' LOC were derived from the Adult Nowicki and Strickland Internal–External questionnaire (Nowicki and Duke, 1974*a*), which had been reported by parents at the 12th week of gestation of the ALSPAC children.[8] Responses to the 12 self-completed questions were then aggregated to create maternal LOC scores, with higher values representing more external LOC. We also constructed a measure of child's LOC at nine years of age based on a shortened version of the Nowicki and Strickland scale for preschool and primary children (Nowicki and Duke, 1974*b*).[9] Our focus in the current study is on the maternal LOC variable, which is asked during the antenatal stage. For our analysis, we grouped mothers by their relative percentile ranking of their LOC scores. Within each group, we classified those in the top quartile as *External LOC* and those in the bottom quartile as *Internal LOC*. The *Neutral LOC* then consists of those whose ranks were between 25th and 75th percentiles.[10]

3.4. Measures of Maternal Attitudes Towards Parenting and Parental Investments

Information on parental investment originates from:

i. self-reported attitudes towards parenting; and

ii. self-reported parental time-use data.

Both during the 32nd week of gestation and when the cohort child was eight months old, parents were asked questions about their attitudes towards parenting. To construct measures of time inputs, we relied on the self-reported parental activities with the child. The data contain information on the number of times in a given period that mothers and their partners individually engage in an activity with their child. First, we performed iterated exploratory factor analysis to determine the dimensionality of these parental time investment inputs. For parental time input – mother's and partner's – across all time periods, factor analysis produces three dimensions:

i. basic care;

ii. play time; and

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[8]For the list of questions, see online Appendix A.
[9]For the list of questions, see online Appendix B.
[10]See online Appendix C for summary statistics of early childhood characteristics by maternal LOC and education.

iii. structured activities.

For outdoor activities in which children engage with their either or both parents, factor analysis produces two dimensions:

i. structured outside activities; and

ii. outside activities.

After conducting the exploratory factor analysis, we obtained statistical guidelines for how each of these parental investment variables should be aggregated. Instead of extracting the factors, we decided to reduce the dimensionalities of our inputs while keeping our new index variables tractable by calculating an average index for each type of parental activity. For each input dimension, we aggregated all comprising variables by calculating an unweighted index. In total, we obtained the maximum of eight indices of parental time investment in each period:

i. maternal basic care activities;

ii. maternal play time activities;

iii. maternal structured activities;

iv. paternal basic care activities;

v. paternal play time activities;

vi. paternal structured activities;

vii. structured outside activities; and

viii. outside activities.[11]

Although both maternal and paternal time inputs are available, we focus on estimating the effects of maternal time inputs on child outcomes while holding paternal inputs constant.

3.5. Accounting for Sample Attrition

As suggested by the referees, we acknowledge that survey completion rates – and the likelihood that researchers can retain participants in a study – may depend on the participants' measures of non-cognitive skills (O'Leary *et al.*, 1979; Hitt *et al.*, 2014). One hypothesis is that external LOC mothers are more likely than internal LOC mothers to attrit in the next period[12] and that this could lead to an imprecise estimate of the production technology parameters simply because of a reduced variance in investments and child outcomes between internal and external LOC mothers.

As a check, in online Appendix D, we estimate a probit regression on the likelihood of dropping out of the sample when the child was three years old. This attrition equation (attrit = 1 *versus* non-attrit = 0) is estimated as a function of a set of characteristics that are measured for all individuals during the antenatal period, z_{i0}. This includes dummy variables

[11]For details of each variable contained in each index and the panel structure of the indices, see online Appendix D.

[12]For example, it is possible that mothers with the least developed child (in part because of underinvestment caused by their external LOC) may not want to be re-interviewed in the next period.

representing maternal LOC, whether the mother has completed at least one A-level,[13] gender of the child, whether partner lived with the mother at child's birth, whether mother was breastfed when she was a baby, whether mother had her father around when she was zero to five years old, whether mother left home before 18 years old, whether the pregnancy was intended and whether mother owned a house during the pregnancy, as well as age and age-squared of mother at child's birth, number of children, mother's physical health during pregnancy, maternal life event score during the antenatal period and duration of mother living in the Avon area by the first trimester. Under this specification, we found that mothers with an internal LOC have a statistically significantly lower probability of dropping out when the child was three years old when other antenatal characteristics are held constant. Conditioning on maternal LOC, we also found that mothers with at least an A-level are statistically significantly less likely to attrit in the future.

In an attempt to allow for selective attrition by maternal LOC and SES in ALSPAC, we computed the inverse probability weighting (IPW) based on online Appendix E's probit attrition specification. This method relies on 'selection on observables' and implies that attrition can be treated as ignorable non-response, conditional on z_{i0} (Fitzgerald *et al.*, 1998; Wooldridge, 2002). The probits of attrit/non-attrit are estimated at each ALSPAC wave in our sample, using the full sample of mothers whose characteristics, z_{i0}, are observed at the antenatal stage. The inverse of the residual probabilities from this model, $1/\left(1-\hat{p}_{it}\right)$, are then used to weight observations in all our regression equations. Thus, this process of re-weighting using IPW allows us to give more weights to individuals who have similar antenatal characteristics to those of individuals who are likely to subsequently attrit in the study.

4. Econometric Models

By adopting the empirical framework to the ALSPAC survey and focusing primarily on mothers and the impacts of their inputs on child development, we can write the econometric counterpart to the DD (7), which is estimated in this article as:

$$Y_{i,,a,l} = X_{i,a,l}\beta_{a,l} + \delta_1 L_{i,l} + \delta_2 A_{i,a} + Z_{i,a,l}\rho_{a,l} + \varepsilon_{i,a,l}, \quad (9)$$

where $Y_{i,a,l}$ is a level of early childhood skill, measured at age a, of a child i whose mother has L-type LOC; $\boldsymbol{X}_{i,a,l}$ is a vector of parental investments; $L_{i,l}$ is a set of dummies for each type of maternal LOC (*Neutral, Internal*); $A_{i,a}$ is the age dummy (0, 1); $\boldsymbol{Z}_{i,a,l}$ is a vector of the child's birth traits and the time-varying parental characteristics, including child's gender, maternal mental health (measured by Crown–Crisp experiential index), maternal smoking (number of cigarettes smoked), maternal physical health (self-assessed rating), maternal alcohol consumption, maternal employment status, hours of family member childcare and hours of non-family member childcare, and the log of family income during zero to five years of age; and $\varepsilon_{i,a,l}$ is the error term, where we assume that $E(\varepsilon_{i,a,l}|a,L) = 0$.[14]

[13] In UK education, A-level is one level beyond the compulsory qualification.

As mentioned above, one concern with (9) is that the unobserved developmental trends are, on average, not identical among children from different maternal LOC types. The estimates of β would be biased if the unobserved trends are correlated with within-child changes in parental inputs. In an attempt to mitigate this issue, we introduce a proxy of maternal SES (*High-School Graduates and High-School Dropouts*) as a third variation. The DDD specification, which is the empirical counterpart to (8), can be written as follows:

$$Y_{i,a,l,e} = X_{i,a,l,e}\beta_{a,l,e} + \tau_1\left(L_{i,l}A_{i,a}\right) + \tau_2\left(A_{i,a}E_{i,e}\right) + \tau_3\left(L_{i,l}E_{i,e}\right) + \pi_1 L_{i,l} + \pi_2 A_{i,a} + \pi_3 E_{i,e} + Z_{i,a,l,e}\rho_{a,l,e} + \vartheta_{i,a,l,e}, \quad (10)$$

where $\boldsymbol{X}_{i,a,l,e}$ is a vector of parental investments of child i of age a with maternal education e and LOC type l; $E_{i,e}$ is a dummy variable representing whether the mother has completed at least a high-school qualification (A-level). All of our regression models are estimated using ordinary least squares with robust standard errors and IPW. Recall that we based our FD, DD and DDD models only on early child outcomes. This is because the production of child development during these early ages is most likely to have been influenced entirely by the parents and less so by the school and peers. Additionally, it is less likely that the child's own LOC, which may be correlated with parents' LOC through heritability, will have a direct impact on the child's human capital accumulation at these early ages.

5. Results

5.1. Maternal LOC as Predictors of Maternal Inputs and Child Outcomes

Before we use LOC to estimate the production parameters of maternal inputs in child development, it is useful to begin our empirical analysis by asking: to what extent can we use maternal LOC measured at the 12th week of gestation to predict the mother's subjective beliefs about the rates of return to investments? Although we cannot find an outcome variable that perfectly captures the mother's subjective beliefs about the efficiency of her inputs, we can find a set of variables that closely approximate her preferences for the more active 'concerted cultivation' parenting style, which is assumed to be positively correlated with maternal subjective expectations about the returns to investments. This includes, for example, mother's preference towards cognitively stimulating her child and her attitude towards the 'natural growth' parenting style.

To make a first pass at the above question, Tables 1 and 2 respectively present the reduced-form ordinary least-squares estimates with maternal attitudes towards parenting variables as outcomes at 32nd week of gestation and when the child was eight months old. The responses to these maternal attitudes questions range from '1. Disagree with the statement' to '4. Agree with the statement', which we standardised to have a mean of 0 and a standard deviation of 1. Here, the explanatory variables of interest are maternal LOC dummies (*Neutral* and *Internal*) and, as a proxy for mother's SES, a dummy for whether the mother

[14]Because estimating the FD model is relatively straightforward – it is basically regressing (4) by using ALSPAC data – we have chosen not to describe it in detail here.

has completed at least A-level education. Each regression also controls for differences in antenatal characteristics (mother's age at birth, number of siblings, and child's gender), child's birth outcomes (birth weight, heel–crown length, gestation weeks, and head circumference), mother's personality traits (measures of interpersonal skills, self-esteem, religiosity, belief in divinity, maternal neuroticism (Crown–Crisp experiential index and Edinburgh postnatal depression scale) and log of household income at zero to five years of age.

Table 1 shows that the coefficients of the *Neutral* and *Internal* dummies of maternal LOC are *ceteris paribus* positive, monotonically increasing and statistically significant in the equation where the belief that 'babies need stimulation to develop' measured at 32nd week of gestation is the outcome. Additionally, the top 25% internal LOC mothers are significantly more likely to believe that 'parents should adapt life for baby' and significantly less likely to believe that 'babies development should be natural' at the antenatal stage than the baseline, i.e. the *External* LOC mothers. Moreover, high-SES mothers are more likely to believe in a more active ('concerted cultivation') parenting style: the coefficient on 'mother has at least A-level' is positive and statistically well-determined in the 'babies need stimulation to develop' and 'parents should adapt life for baby' regressions, but negative and statistically significant in the 'baby should fit into parents routine' regression.

Table 2 shows qualitatively similar results. When questioned when their child was eight months old, internal LOC mothers tend to be the most confident in their own child-rearing skills. They are also the most likely to believe that 'babies need stimulation to develop' and 'parents should adapt life to baby'.[15] In other words, our statistical results indicate that maternal internal LOC correlates well with variables that proxy for maternal preferences towards a 'concerted cultivation' parenting style measured during the antenatal period and the first year of a child's life.

Table 3 establishes whether internal LOC mothers are also more likely to act on those beliefs. Specifically, the Table tests whether internal LOC mothers are more likely than external LOC mothers to spend their time cognitively stimulating their child and how their estimates vary with the inclusion of various groups of controls. The dependent variable is the standardised index of maternal time spent on structured activities (e.g. read to the child, talk to the child) measured at 0.5, 1.5, and 3.5 years of age.

Without any controls, maternal internal LOC strongly predicts more maternal structured activities across all ages. This positive association observed at 0.5 years of age disappears when we control for mother's pre-birth characteristics – mother's age at child's birth, number of child's siblings and gender of child (column (2) of Table 3).[16] However, the positive and statistically significant relationship between internal LOC mothers and maternal structured activities at 1.5 and 3.5 years of age persist even when we control for mother having completed at least A-level, mother's pre-birth characteristics, child birth outcomes,

[15]The coefficients on *Neutral* and *Internal* LOC dummies also have the correct signs in other regressions, although we are unable to reject the null hypothesis of zero at the 5% level.
[16]One potential explanation for this is that the structured activities at 0.5 years of age are less time-consuming than those measured at later ages, thus resulting in internal and external LOC mothers investing similar levels of inputs at this early stage of development.

mother's personality traits and log household income at zero to five years of age. These results imply that, holding all other factors constant, all mothers – regardless of LOC type – tend to engage their child in structured activities during the first year of the child's life. However, it is internal LOC mothers who either continue to stimulate their child cognitively or increase their levels of engagement with their child as the child grows older.

Tables 4 and 5 report estimates of maternal LOC with other types of maternal and paternal time investments as outcomes. Internal LOC mothers tend to invest more in structured outside activities (e.g. take child to park, take child to friends/family, take child to places of interest) and in caring activities (e.g. bath child, put child to bed). We also find evidence of a significantly higher level of paternal time investments in cognitively stimulating activities at 3.5 years of age among internal LOC mothers.

As a further check, in Tables 6 and 7, respectively, we show whether the evidence that internal LOC mothers tend to invest more in structured activities is also reflected in early childhood cognitive outcomes, i.e. standardised MacArthur receptive scores and MacArthur expressive scores at two and three years of age and later educational attainments, i.e. standardised average total GCSE scores at 16 years of age.

Table 6 shows that maternal internal LOCs are good predictors of both MacArthur receptive scores and MacArthur expressive scores at two and three years of age. The results on early childhood language skills are robust to a specification that allows for a dummy variable representing mother with at least A-level.

Table 7 shows that children of internal LOC mothers also tend to perform better academically in their late teens. The positive association between internal LOC mothers and standardised average total GCSE scores does not disappear even when we control for mother with A-level; mother's self-esteem score (at 2.5 years of age); maternal depression during antenatal; a proxy for maternal time preference, i.e. a dummy for whether mother saves money (at 2.5 years of age); a proxy for mother's intrinsic preferences in child rearing, i.e. mother's enjoyment score (at 2.5 years of age); mother's prediction of the likelihood of her child obtaining the GCSE qualification (at 14 years of age); child's IQ (at nine years of age); and child's own LOC (at nine years of age). The estimated relationship is both quantitatively important and statistically significant. In the full specification, children with internal LOC mothers score approximately 12% higher in the standardised average GCSE score than children with external LOC mothers, and children with neutral LOC mothers score approximately 7% higher, on average.[17]

In summary, internal LOC mothers clearly tend to believe in a more active parenting style and, consequently, invest more of their time engaging their child in structured activities. Additionally, children with internal LOC mothers are more likely to have better cognitive outcomes in early childhood and perform better in their GCSEs at 16 years of age. These findings are robust to controlling for maternal education, early years household incomes and other observable differences in antenatal and early years characteristics.

[17]Although not shown here, we also find that children with internal LOC mothers are, on average, more likely to go on to take an A-level examination – which is a considered to be a reasonably good proxy for the likelihood of subsequently attending university.

5.2. Estimating the Production Parameters

To illustrate how input parameters in a child production function can be estimated, the first three columns of Tables 8 and 9 follow Todd and Wolpin's (2003) (2007) empirical strategy by estimating, for various development periods, FD regression equations in which changes in early language skills (MacArthur: Receptive and Expressive) are the outcome variables and changes in different parental time inputs are included on the right-hand side as parental investment variables.

The associations between within-child changes in the standardised maternal structured activities and changes in both measures of early language skills in the child's first three years, although positive, are mostly statistically insignificantly different from zero. The magnitudes of the estimated relationships are small: for example, an increase of 1 standard deviation in the maternal structured activities index predicts a standard deviation increase of approximately 0.01–0.02 in child language skills at one to two years of age.

We also find evidence that 'structured outside activities' are positively and statistically significantly correlated with early development of expressive language skills at one to two years of age. Nevertheless, the estimated magnitude of this statistically significant association is small: the estimated standardised coefficient on the structured outside activities index is 0.04 (or 4% of the standard deviation).

Other FD estimates also produce results that are more difficult to predict. For example, we find both maternal and paternal play time activities with the child to be mostly negatively, albeit statistically insignificantly, related to changes in early language skills in the first three years, when other factors are held constant.

The next three columns of Tables 8 and 9 report estimates obtained from running (9). The DD specification generally produces coefficients of the maternal structured activities index that are more positive and statistically robust than those obtained in the FD model. For example, the estimated DD coefficient of the maternal structured activities index in receptive language skill at one to two years of age is approximately six times larger than the FD estimates: an increase of 1 standard deviation in the maternal structured activities index is now associated with a 7% increase in the standardised receptive language skill. Moreover, we find that the estimated DD coefficients of maternal play time with the child, paternal structured activities and structured outside activities index are noticeably larger – and now mostly statistically insignificantly different from zero – than their FD counterparts in both sets of receptive and expressive language skills regression equations. This indicates that there may have been a significant attenuation bias in the FD regression model that biased most – if not all – FD estimates on the maternal (and paternal) cognitively stimulating activities index towards zero.[18]

Almost the same estimates as for the DD specification are obtained in the DDD regression equations, presented in the final three columns of Tables 8 and 9. This indicates that it makes

[18]One reason why there may be an important variation in paternal time investments by maternal LOC is assortative mating by personality traits, i.e. internal LOC women may be more likely to pair up with equally internal LOC men (Merikangas, 1982). This appears to be approximately true in the ALSPAC sample: The correlation coefficient between maternal and paternal LOC is 0.357.

virtually no difference whether or not we allow for the additional third between-group differences by maternal SES in the estimation process. The overall conclusion is the same: FD models appear to underestimate the effects of time spent on structured activities for development of the child, perhaps because of the severe attenuation bias that tends to be exacerbated following the FD process.

As a robustness check, in Table 10 we estimate the DDD specification by using only the firstborn sample as a way to control for the 'learning' effect among more experienced mothers. Maternal investment in structured activities continues to be associated positively and statistically significantly with receptive language skills throughout the early years. The estimated effects are also similar in magnitude to those observed in the final three columns of Table 8. Moreover, although statistical significance appears to have been lost for some of the estimated coefficients in the expressive language score regressions, their coefficients continue to be larger than the FD estimates obtained from using this smaller, firstborn, sample.

5.3. Discussion

One concern is that there may be more than one channel – other than the individual's subjective beliefs about the returns to investments – through which maternal LOC influences the mother's human capital investment decisions. According to Deborah Cobb-Clark and colleagues (Cobb-Clark, 2014; Cobb-Clark *et al.*, 2014), there are four channels through which an individual's LOC affects his or her investment decisions:

- **i.** Time preferences: internal LOC individuals may discount the future less than an average person, i.e. they are more forward-looking (Chiteji, 2010).
- **ii.** Procedural utility: internal LOC individuals may derive more utility (or satisfaction) from carrying out the act of investment than an average person.
- **iii.** Superior production function: internal LOC individuals may simply be better than an average person at converting each unit of investment into a desired outcome.
- **iv.** Subjective expectations about the returns: internal LOC individuals 'believe' in the efficiency of their inputs more than an average person, thus leading them to invest more.

We carried out robustness checks on these three other potential mechanisms and report our results in online Appendixes F–I. Our findings are summarised as follows:

- **i.** Conditioning on maternal LOC, we observe a statistically insignificant relationship between a proxy variable for being future-oriented (i.e. mother's propensity to save money reported when the child was almost three years old) and an index of maternal investments in structured activities at 1.5, 3.5, 4.5, and 5.5 years of age; see Appendix F. Thus, being future-oriented is unlikely to be one of the main drivers of maternal input choices.
- **ii.** By regressing the maternal enjoyment index (i.e. how much the mother enjoys looking after the baby) and the maternal postnatal depression scale on maternal

LOC and its interaction with investment, we find no evidence that internal LOC mothers enjoy spending time actively engaging with their child more than neutral or external LOC mothers do, i.e. the interaction coefficients between maternal LOC and time investments are largely statistically insignificantly different from zero; see Appendix G. Thus, it is unlikely that internal LOC mothers invest more in children simply because they derive more enjoyment from doing so.

iii. By regressing early language skill on its lagged, maternal LOC and its interaction with investment, we find no evidence that children with internal LOC mothers develop faster per given unit of input, i.e. the interaction coefficients between maternal LOC and time investments are largely statistically insignificantly different from zero; see Appendix H. Thus, it is unlikely that internal LOC mothers are simply better than an average person at converting each unit of investment into a desired outcome.

iv. By regressing the mother's predicted probability of her child achieving good grades at GCSE (asked at 11 years of age) on maternal LOC, we observe that internal LOC mothers are significantly more likely than others to expect that their child will receive at least five GCSEs at grades A*–C; see Appendix I. These results are robust to controlling for maternal education and early childhood incomes, among others. Thus, internal LOC mothers generally believe in higher returns to their human capital investments, even if this may not be the case in reality (as seen from Appendix H's estimates).

Another important caveat (as suggested by a referee) is that an individual's LOC is likely to be highly correlated with measures of non-cognitive skills other than subjective beliefs that may also affect parental investment decisions, such as conscientiousness and neuroticism (Judge *et al.*, 2003). It is possible, for example, that more conscientious parents may invest more in their children simply because they have a greater tendency to make and execute plans. Additionally, it is likely that less anxious parents will provide a stable home environment that is more conducive for child development. Although we are able to control for measures of postnatal anxiety and depression in our regression equations, there is probably no way to reject such concerns definitively, because we are not able to control for maternal conscientiousness. However, if it could be assumed that more conscientious individuals enjoy completing tasks more than an average person, then online Appendix G's results, i.e. that internal LOC mothers do not enjoy investing in their child more than neutral and external LOC mothers do, should go a long way to convincing readers that maternal LOC operates mostly through subjective beliefs about the returns.

Finally, children's rates of natural development in the early years may still vary significantly across different maternal LOC types even when we are able to condition for the differences in maternal inputs by maternal SES, as well as family and non-family care, in our DDD specification. Short of having randomly assigned maternal investments, there is probably little that can be definitely done to rule out the potential differences in children's rates of natural development by maternal LOC types. Given how our DDD model is specified, any remaining difference in the unobserved rates of children's natural development by maternal LOC and SES would probably bias our estimates upwards.[19] Thus, in interpreting our results, it may be sensible for readers to treat our FD results as lower-bound estimates and our DDD results as upper-bound estimates, with the true production function parameters likely to lie somewhere in-between.

6. Conclusion

This article empirically explores the intergenerational implications of maternal LOC on early child cognitive development. Using extremely rich cohort data, our study shows that the LOC of the mother measured at the 12th week of gestation significantly predicts her subjective expectations about the returns to the ‘concerted cultivation’ parenting style. Additionally, we present evidence that maternal LOC strongly predicts maternal investments in structured activities, as well as cognitive outcomes measured in early childhood and in late teens. The results are robust to controlling for a battery of maternal characteristics at the time of birth, as well as both maternal education and early childhood household income.

Although our reduced-form results are interesting in their own right, the main contribution of our study is in the introduction of maternal LOC as a potentially important tool for researchers to improve the quality of their estimates in their search to identify the production function parameters (Todd and Wolpin, 2003). By explicitly allowing for the within-child variations and the between-group differences regarding maternal LOC and maternal education in the estimation of early childhood cognitive skills, we are able to correct not only for the unobserved child fixed effects but also for a large part of the attenuation bias and the unobserved differences in the rate of development among children. In conclusion, based on our estimates of the effects of maternal cognitively stimulating activities on early child language development skills, Todd and Wolpin’s (2003) recommendation, i.e. the use of a FD model to account for the unobserved heterogeneity bias whenever data permit, may lead to estimates of the production function parameters that are potentially severely underestimated because of the attenuation bias.

More generally, our results advance our understanding of the role that an individual’s LOC plays in the parental decision-making process that impacts his or her children’s early skills formation. With better data on both parents’ LOC, future research should return to study the potential implications of an interaction effect between mother’s LOC and father’s LOC on childhood upbringing and long-term outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Maternal Locus of Control and Maternal Attitudes Towards Parenting Style Measured at 32nd Week of Gestation

Variables	Babies need stimulation to develop	Babies should not be disturbed much	Parents should adapt life for baby	Baby should fit into parents routine	Babies development should be natural	Important to talk to babies of all ages
Maternal LOC: neutral	0.137*** (0.048)	−0.051 (0.044)	0.065 (0.043)	0.012 (0.045)	−0.066 (0.044)	0.026 (0.041)
Maternal LOC: internal	0.248*** (0.048)	−0.026 (0.047)	0.196*** (0.047)	−0.047 (0.048)	−0.170*** (0.048)	0.041 (0.043)
Mother has at least A-level	0.114*** (0.024)	0.036 (0.030)	0.214*** (0.030)	−0.130*** (0.030)	0.044 (0.030)	0.028 (0.027)
Observations	5,614	5,586	5,596	5,581	5,475	5,662
R^2	0.052	0.012	0.037	0.021	0.030	0.007

Notes.

*** <1%. Robust standard errors are in parenthesis and IPW is used as sampling weight. The raw data of the outcome variables range from ‘1. Disagree’ to ‘4. Agree’. All outcomes are then standardised to have a mean of 0 and a standard deviation of 1. All regressions include antenatal characteristics (age of mother at birth, sib-ship size, gender), at birth outcomes of the child (birth weight, heel-crown length, gestation weeks, head circumference), maternal personalities (interpersonal skill, self-esteem, religiosity, belief in divinity, CCEI, Edinburgh post-depression) and log of household income between zero and five years old. Mother’s LOC is measured at week 12 of gestation. Neutral LOC consists of those with the measure falls within the middle quartiles. Internal LOC consists of those with the measure is at 1st quartile or under.

Table 2

Maternal Locus of Control and Maternal Attitudes Towards Parenting Style Measured When the Child was Eight Months Old

Variables	Mother confident with the CH	Babies need stimulation to develop	Babies should not be disturbed much	Parents should adapt life to baby	Babies should fit into parents routine	Babies development should be natural
Maternal LOC: neutral	0.077 * (0.046)	0.207 *** (0.058)	0.062 (0.045)	0.125 *** (0.045)	−0.019 (0.046)	−0.044 (0.047)
Maternal LOC: internal	0.107 ** (0.048)	0.285 *** (0.058)	0.087 * (0.048)	0.246 *** (0.048)	−0.096 * (0.049)	−0.056 (0.049)
Mother has at least A-level	0.055 ** (0.029)	0.046 * (0.026)	0.000 (0.030)	0.227 *** (0.030)	−0.110 *** (0.030)	0.038 (0.031)
Observations	5,503	5,478	5,451	5,449	5,416	5,367
R^2	0.073	0.026	0.007	0.053	0.016	0.012

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis and IPW is used as sampling weight. See Table 1 for notes.

Table 3

Maternal Locus of Control and Maternal Time Spend on Structured Activities at Different Ages

	Age 0.5 year			Age 1.5 years			Age 3.5 years		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Maternal LOC: neutral	0.083 ** (0.042)	0.032 (0.042)	0.029 (0.042)	0.152 *** (0.045)	0.113 ** (0.045)	0.078 * (0.045)	0.182 *** (0.046)	0.159 *** (0.046)	0.108 ** (0.047)
Maternal LOC: internal	0.152 *** (0.042)	0.063 (0.042)	0.053 (0.045)	0.261 *** (0.045)	0.189 *** (0.044)	0.097 ** (0.046)	0.262 *** (0.046)	0.227 *** (0.046)	0.124 ** (0.049)
Mother has at least A-level			0.143 *** (0.028)			0.197 *** (0.027)			0.119 *** (0.029)
Observations	5,730	5,730	5,730	5,755	5,755	5,755	5,582	5,582	5,582
R^2	0.003	0.025	0.047	0.008	0.023	0.035	0.007	0.016	0.039
Additional controls									
Mother’s pre-birth characteristics	N	Y	Y	N	Y	Y	N	Y	Y
Child birth outcomes	N	Y	Y	N	Y	Y	N	Y	Y
Mother’s personality traits + log household income	N	N	Y	N	N	Y	N	N	Y

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis and IPW is used as sampling weight. Index of maternal structured activities consists of activities such as talking to child, reading to child and singing to child (see online Appendix D), standardised to have a mean of 0 and a standard deviation of 1. Mother’s pre-birth characteristics include age of mother at birth, sib-ship size and gender. Child’s birth outcomes include birth weight, heel-crown length, gestation weeks and head circumference. Mother’s personality traits include measures of interpersonal skills, self-esteem, religiosity, belief in divinity, CCEI, Edinburgh post-depression, as well as log of household income between zero and five years old. Mother’s LOC is measured at week 12 of gestation. Neutral LOC consists of those with the measure falls within the middle quartiles. Internal LOC consists of those with the measure is at 1st quartile or under.

Table 4

Maternal Locus of Control and Maternal Time Spend on Other Activities with the Child

	(A) Mother's play time activities			**(B) Mother's basic care activities**	
Variables	**0.5 year**	**1.5 year**	**3.5 year**	**1.5 year**	**3.5 year**
Maternal LOC: neutral	−0.007 (0.045)	−0.038 (0.046)	−0.019 (0.046)	0.048 (0.047)	0.106** (0.047)
Maternal LOC: internal	−0.013 (0.048)	−0.047 (0.048)	−0.053 (0.049)	0.000 (0.050)	0.117** (0.049)
Mother has at least A-level	0.068** (0.029)	0.106*** (0.028)	0.096*** (0.030)	0.038 (0.029)	0.135*** (0.029)
Observations	5,578	5,580	5,437	5,582	5,437
R^2	0.046	0.035	0.033	0.009	0.041
	(C) Structured outside activities			(D) Outside activities	
Variables	0.5 year	1.5 year	3.5 year	1.5 year	3.5 year
Maternal LOC: neutral	0.075* (0.045)	0.153*** (0.043)	0.075* (0.045)	0.153*** (0.043)	0.075* (0.045)
Maternal LOC: internal	0.108** (0.048)	0.202*** (0.046)	0.108** (0.048)	0.202*** (0.046)	0.108** (0.048)
Mother has at least A-level	0.221*** (0.030)	0.348*** (0.030)	0.221*** (0.030)	0.348*** (0.030)	0.221*** (0.030)
Observations	5,581	5,595	5,581	5,595	5,581
R^2	0.03	0.05	0.03	0.05	0.03

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis, and IPW is used as sampling weight. See Table 3 for notes.

Table 5

Maternal Locus of Control and Paternal Time Spend on Different Activities with the Child

	Father's structured activities			Father's play time activities			Father's basic care activities		
Variables	**0.5 year**	**1.5 year**	**3.5 year**	**0.5 year**	**1.5 year**	**3.5 year**	**0.5 year**	**1.5 year**	**3.5 year**
Maternal LOC: neutral	−0.019 (0.044)	0.010 (0.046)	0.024 (0.049)	0.027 (0.047)	0.036 (0.048)	−0.02 (0.048)	−0.02 (0.045)	0.023 (0.046)	0.028 (0.046)
Maternal LOC: internal	−0.007 (0.047)	0.041 (0.048)	0.101 ** (0.051)	0.092 * (0.049)	0.048 (0.050)	0.01 (0.051)	−0.048 (0.048)	0.024 (0.048)	0.084 * (0.049)
Mother has at least A-level	0.206 *** (0.030)	0.247 *** (0.029)	0.187 *** (0.031)	0.109 *** (0.029)	0.059 ** (0.028)	0.044 (0.031)	0.137 *** (0.031)	0.268 *** (0.030)	0.244 *** (0.031)
Observations	5,469	5,422	5,164	5,491	5,423	5,164	5,460	5,431	5,164
R^2	0.071	0.092	0.058	0.071	0.084	0.069	0.058	0.063	0.078

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis, and IPW is used as sampling weight. See Table 3 for notes.

Table 6

Maternal Locus of Control and Early Childhood Language Skills

Variables	**(A) MacArthur: Receptive (2 year)**			**(B) MacArthur: Expressive (2 year)**		
Maternal LOC: neutral	0.145 *** (0.044)	0.085 * (0.044)	0.070 (0.044)	0.137 *** (0.041)	0.089 ** (0.041)	0.079 * (0.041)
Maternal LOC: internal	0.246 *** (0.044)	0.139 *** (0.044)	0.092 ** (0.045)	0.198 *** (0.041)	0.113 *** (0.043)	0.081 * (0.044)
Mother has at least A-level			0.169 *** (0.028)			0.114 *** (0.029)
Observations	5,739	5,739	5,739	5,739	5,739	5,739
R^2	0.007	0.052	0.058	0.004	0.076	0.079
Variables	(C) MacArthur: Receptive (3 year) (3 year)			(D) MacArthur: Expressive		
Maternal LOC: neutral	0.167 *** (0.045)	0.117 ** (0.045)	0.106 ** (0.045)	0.177 *** (0.047)	0.120 *** (0.046)	0.112 ** (0.046)
Maternal LOC: internal	0.223 *** (0.045)	0.130 *** (0.047)	0.096 ** (0.047)	0.221 *** (0.046)	0.118 ** (0.047)	0.094 ** (0.047)
Mother has at least A-level			0.125 *** (0.025)			0.086 *** (0.026)
Observations	5,839	5,839	5,839	5,839	5,839	5,839
R^2	0.006	0.032	0.036	0.006	0.041	0.043
Additional controls						
Mother's pre-birth characteristics	N	Y	Y	N	Y	Y
Child birth outcomes	N	Y	Y	N	Y	Y
Mother's personality traits + log household income	N	N	Y	N	N	Y

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis, and IPW is used as sampling weight. Both MacAuthur: Receptive (understanding) and Expressive (use) language skills scores are standardised to have a mean of zero and a standard deviation of 1. All regressions are controlled for at-birth characteristics. This includes child gender, birth weight, gestation weeks, head circumference at birth, crown-heel length at birth, number of siblings, age of mum at birth, average family income (during 0–5 years).

Table 7

Maternal Locus of Control and Education Attainment at 16

	Standardised average total GCSE score (16 years)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Maternal LOC: neutral	0.097 *** (0.035)	0.087 ** (0.034)	0.092 *** (0.035)	0.073 ** (0.035)
Maternal LOC: internal	0.178 *** (0.035)	0.153 *** (0.035)	0.162 *** (0.036)	0.115 *** (0.037)
Mother has at least A-level		0.090 *** (0.021)	0.092 *** (0.021)	0.087 *** (0.021)
Self-esteem (2.5 year)			−0.005 *** (0.002)	−0.005 *** (0.002)
CCEI (1st trimester)			0.002 (0.001)	0.001 (0.001)
Save money (2.5 year)			0.082 *** (0.019)	0.083 *** (0.018)
Enjoyment Score (2.5 year)			0.063 (0.067)	−0.003 (0.064)
Child GCSE, expected by mum (14 year)				0.935 *** (0.061)
Total IQ (9 year)	0.080 *** (0.014)	0.076 *** (0.014)	0.077 *** (0.014)	0.045 *** (0.014)
Child's LOC: neutral	0.014 (0.023)	0.014 (0.023)	0.016 (0.023)	0.015 (0.023)
Child's LOC: internal	0.044 (0.027)	0.039 (0.027)	0.043 (0.027)	0.045 * (0.026)
Observations	3,103	3,103	3,103	2,218
R^2	0.642	0.645	0.648	0.701

Notes.

* p < 0.1;

** p < 0.05;

*** p < 0.01.

Robust standard errors are in parenthesis. All regressions include inverse probability weighting (IPW) as probability weight. All regressions are controlled for at-birth characteristics. This includes child gender, birth weight, gestation weeks, head circumference at birth, crown-heel length at birth, number of siblings, age of mum at birth, average family income (between 0 and 5 years) and early academic test (11 years). Mother's LOC is measured at week 12 of gestation. The cohort member's LOC is measure at age 9. Neutral LOC consists of those with the measure falls within the middle quartiles. Internal LOC consists of those with the measure is at 1st quartile or under. All variables in the regressions are standardised to have a mean of 0 and a standard deviation of 1.

Table 8

Using Maternal LOC to Estimate the Returns to Different Parental Investment on Early Language Skills (MacArthur: Receptive scores)

	FD			DD			DDD		
Variables	**Age 1–2**	**Age 1–3**	**Age 2–3**	**Age 1–2**	**Age 1–3**	**Age 2–3**	**Age 1–2**	**Age 1–3**	**Age 2–3**
Maternal structured activities	0.0072 (0.0196)	−0.0282 (0.0178)	−0.0333* (0.0172)	0.0697*** (0.00999)	0.0676*** (0.00965)	0.0441*** (0.0108)	0.0670*** (0.0102)	0.0679*** (0.00975)	0.0404*** (0.0109)
Maternal play time activities	−0.005 (0.0177)	−0.0544*** (0.0206)	−0.0115 (0.0137)	0.0691*** (0.00991)	0.0450*** (0.0102)	0.0345*** (0.0115)	0.0682*** (0.0100)	0.0452*** (0.0103)	0.0341*** (0.0116)
Maternal basic care			−0.0265 (0.0166)			−0.00343 (0.00888)			−0.00574 (0.00888)
Paternal structured activities	0.0254 (0.0186)	0.014 (0.0185)	0.0057 (0.0162)	0.152*** (0.0117)	0.105*** (0.0108)	0.113*** (0.0122)	0.149*** (0.0119)	0.103*** (0.0110)	0.109*** (0.0124)
Paternal play time activities	0.00505 (0.0207)	−0.0479** (0.0209)	−0.0256 (0.0176)	0.0172 (0.0112)	−0.0113 (0.0107)	−0.0105 (0.0122)	0.0199* (0.0114)	−0.00785 (0.0108)	−0.00682 (0.0123)
Paternal basic care	0.0237 (0.0156)	0.0211 (0.0171)	0.00877 (0.0155)	−0.0386*** (0.0101)	−0.0253** (0.00987)	−0.0213** (0.0105)	−0.0422*** (0.0103)	−0.0271*** (0.00988)	−0.0238** (0.0106)
Outside activities	−0.0433*** (0.0149)	−0.0166 (0.0164)	0.0193 (0.0150)	0.00345 (0.00971)	0.0129 (0.00935)	0.0064 (0.00963)	0.00535 (0.00986)	0.0185* (0.00955)	0.0106 (0.00985)
Structured outside activities	0.0251 (0.0154)	0.0305* (0.0161)	0.00287 (0.0150)	0.0886*** (0.00987)	0.0654*** (0.00957)	0.0866*** (0.0104)	0.0840*** (0.0101)	0.0593*** (0.00963)	0.0780*** (0.0104)
FD observations	6,106	5,675	5,582	13,548	13,120	12,849	13,252	12,842	12,581
DD and DDD observations				4,516	4,373	4,283	4,418	4,280	4,193
R^2	0.031	0.042	0.029	0.09	0.057	0.066	0.093	0.061	0.068

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis. All regressions include inverse probability weighting (IPW) as probability weight. For all specification, we control for observed time-varying factors that may influence the child's outcomes. They are maternal emotional health (measured by CCEI); maternal smoking (number of cigarettes smoked); maternal physical health (self-assessed rating); maternal alcohol consumption; maternal employment status; hours of family-member childcare and hours of non-family member childcare. With ALSPAC, we do not have the income data in high frequency. Therefore, we include the log of family income during age 0–5. All regressions are also controlling for the child's gender.

Table 9

Using Maternal LOC to Estimate the Returns to Different Parental Investment on Early Language Skills (MacArthur: Expressive scores)

Variables	FD			DD			DDD		
	Age 1–2	Age 1–3	Age 2–3	Age 1–2	Age 1–3	Age 2–3	Age 1–2	Age 1–3	Age 2–3
Maternal structured activities	0.0199 (0.0165)	0.00167 (0.0176)	−0.0221 (0.0170)	0.0193** (0.00908)	0.0385*** (0.00906)	0.0239** (0.0102)	0.0176* (0.00918)	0.0385*** (0.00912)	0.0216** (0.0103)
Maternal play time activities	0.011 (0.0165)	−0.0338 (0.0206)	−0.00826 (0.0145)	0.0624*** (0.00854)	0.0324*** (0.00878)	0.0259** (0.0112)	0.0615*** (0.00865)	0.0313*** (0.00886)	0.0261** (0.0113)
Maternal basic care			−0.00518 (0.0169)			0.00998 (0.00920)			0.00862 (0.00936)
Paternal structured activities	0.0254 (0.0184)	0.0181 (0.0203)	−0.0102 (0.0175)	0.143*** (0.0120)	0.0903*** (0.0113)	0.126*** (0.0128)	0.143*** (0.0122)	0.0922*** (0.0115)	0.125*** (0.0130)
Paternal play time activities	0.0261 (0.0188)	−0.0308 (0.0230)	−0.0112 (0.0182)	0.0106 (0.0107)	−0.0104 (0.0105)	5.17E-05 (0.0126)	0.0121 (0.0109)	−0.00858 (0.0106)	0.00184 (0.0128)
Paternal basic care	0.0227 (0.0156)	0.0221 (0.0176)	0.00335 (0.0167)	−0.0194* (0.00996)	−0.00808 (0.00982)	−0.0155 (0.0110)	−0.0221** (0.0101)	−0.00917 (0.00986)	−0.0155 (0.0111)
Outside activities	−0.0313** (0.0145)	−0.000847 (0.0164)	0.0123 (0.0155)	0.0139 (0.00967)	0.0229** (0.00945)	0.00481 (0.00978)	0.0147 (0.00988)	0.0264*** (0.00969)	0.0066 (0.0100)
Structured outside activities	0.0357** (0.0160)	0.018 (0.0166)	0.000736 (0.0160)	0.0557*** (0.00957)	0.0456*** (0.00944)	0.0711*** (0.0107)	0.0502*** (0.00978)	0.0401*** (0.00954)	0.0656*** (0.0108)
FD observations	6,106	5,675	5,582	13,548	13,120	12,849	13,252	12,842	12,581
DD and DDD observations				4,516	4,373	4,283	4,418	4,280	4,193
R^2	0.03	0.024	0.027	0.076	0.044	0.071	0.079	0.047	0.072

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis. All regressions include inverse probability weighting (IPW) as probability weight. Same controls as in Table 8 are used here.

Table 10

Using Maternal LOC to Estimate the Returns to Different Parental Investment on Early Language Skills: First Born Sample Only

	Receptive (DDD)			Expressive (DDD)		
Variables	**Age 1–2**	**Age 1–3**	**Age 2–3**	**Age 1–2**	**Age 1–3**	**Age 2–3**
Maternal structured activities	0.0663*** (0.0158)	0.0762*** (0.0198)	0.0629*** (0.0240)	0.00691 (0.0156)	0.0113 (0.0204)	0.0165 (0.0218)
Maternal basic care			0.00435 (0.0184)			0.0111 (0.0194)
Maternal play time activities	0.0617*** (0.0190)	0.124*** (0.0289)	0.020 (0.0243)	0.0657*** (0.0174)	0.0946*** (0.0222)	0.0339 (0.0244)
Paternal structured activities	0.139*** (0.0174)	0.124*** (0.0216)	0.153*** (0.0249)	0.129*** (0.0192)	0.0977*** (0.0243)	0.163*** (0.0261)
Paternal basic care	−0.058*** (0.0153)	−0.059*** (0.0197)	−0.056*** (0.0195)	−0.0156 (0.0161)	−0.0332 (0.0205)	0.008 (0.0211)
Paternal play time activities	0.0421** (0.0186)	0.0365 (0.0243)	0.0431 (0.0270)	0.0102 (0.0202)	−0.00852 (0.0265)	0.0187 (0.0279)
Outside activities	0.0119 (0.0150)	0.0282 (0.0193)	0.00125 (0.0189)	0.0272* (0.0162)	0.0491** (0.0218)	0.00962 (0.0200)
Structured outside activities	0.0966*** (0.0145)	0.0822*** (0.0184)	0.118*** (0.0195)	0.0340** (0.0151)	0.00925 (0.0195)	0.0699*** (0.0202)
DDD observations	2,950	2,883	2,815	2,950	2,883	2,815
R^2	0.096	0.065	0.072	0.063	0.038	0.07

Notes.

* <10%;

** <5%;

*** <1%.

Robust standard errors are in parenthesis. All regressions include inverse probability weighting (IPW) as probability weight. Same controls as in Table 8 are used here.