Parental Beliefs about Returns to Educational Investments - The Later the Better?

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Abstract

In this paper, we study parental beliefs about the returns to parental investments made during different periods of childhood. Using two independent samples, we document that parents perceive the returns to different late investments to be higher than the returns to early investments, and that they perceive investments in different time periods as substitutes rather than complements. We show that parental beliefs about the returns to investments vary substantially across the population and that individual beliefs are predictive of actual investment decisions. Moreover, we document that parental beliefs about the productivity of investments differ significantly across socio-economic groups. Perceived returns to early parental investments are positively associated with household income, thereby potentially contributing to the intergenerational persistence in earnings.

Keywords: Parental Investments, Human Capital, Beliefs, Inequality

JEL classifications: I24, I26, J13, J24, J62

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1 Introduction

It has been well documented that the amount of time and financial resources parents allocate towards their children varies considerably across families, and that differences in parental investments are highly predictive of test scores and important life outcomes such as educational attainment, earnings and health (e.g., Todd and Wolpin 2007, Lareau 2011, Carneiro, Meghir and Parey 2013, Attanasio et al. 2013, Gayle, Golan and Soytas 2015, Putnam 2015). Moreover, more educated and wealthier parents do not only spend more financial resources on their children, but they also spend more time with their children despite facing a higher opportunity cost in terms of foregone earnings (Guryan, Hurst and Kearney 2008, Ramey and Ramey 2010, Deckers et al. 2015). This raises the question of why we observe such a large and systematic variation in parental investments. While differences in preferences or available resources might explain part of this variation (e.g., Caucutt and Lochner 2012, Lee and Seshadri 2014), parental beliefs about the productivity of investments are likely to play a crucial role in parental investment decisions.

To investigate the role of beliefs in human capital investment decisions it is not possible to rely on choice data alone. The reason is that observed choices may be consistent with many different alternative specifications of preferences and beliefs (Manski 2004). To overcome this identification problem, we need direct measures of individual beliefs about the returns to human capital investments. One useful way to measure perceived returns, which was pioneered by Dominitz and Manski (1996), is to construct hypothetical educational investment scenarios and ask respondents about the likely outcomes of these scenarios. By constructing hypothetical scenarios it is possible to vary one input at a time while keeping other factors constant, which allows the researcher to elicit individual perceived returns to a specific educational input.[1] In recent work, Cunha, Elo and Culhane (2013) make an important contribution to the literature by developing a method that relies on the use of hypothetical investment scenarios to elicit parental beliefs about the returns to parental investments. In a sample of parents with low socio-economic status, they document beliefs about the returns to parental investments made in children aged 0-2. In this paper, we build on the seminal work by Cunha, Elo and Culhane (2013) and make two contributions to the literature. Motivated by the empirical work which investigates the optimal timing of investments and the dynamic properties of the skill production function (e.g., Cunha, Heckman and

[1] This approach has been successfully used in a growing number of studies (e.g., Jensen 2010, Attanasio and Kaufmann 2014, Kaufmann 2014). In comparison, vaguely worded qualitative questions have been shown to provide little useful information about respondents' expectations (see for example Manski (1990) and Juster (1966)). See Manski (2004) for a review and discussion of different survey elicitation approaches.

Schennach 2010, Del Boca, Flinn and Wiswall 2014, Heckman and Kautz 2014, Attanasio, Meghir and Nix 2015, Attanasio et al. 2015, Attanasio et al. 2017), we document parental beliefs about the returns to parental investments made during different periods of childhood. More specifically, we document parental beliefs about the returns to parental investments made during early stages of a child's school life (henceforth referred to as early investments) and later stages of a child's school life (henceforth referred to as late investments). We also investigate how parents perceive the dynamic properties of the skill production function, i.e. whether parents perceive investments in different time periods as complements or substitutes. Recent empirical evidence suggests that skills acquired at earlier ages increase the productivity of later investments because of dynamic complementarities in the skill accumulation process ('skills beget skills') (e.g., Cunha, Heckman and Schennach 2010, Caucutt and Lochner 2012, Heckman and Mosso 2014, Attanasio et al. 2015, Attanasio et al. 2017). In addition, we document individual heterogeneity in perceived returns and investigate whether this heterogeneity is systematic. In particular, we are interested in whether parents from different socio-economic groups hold different beliefs about the returns to parental investments. To our knowledge, this is the first paper to document how parents perceive the dynamic properties of the skill production function and how parental beliefs about the returns to parental investments in different time periods differ across socio-economic groups.

To investigate these questions, we conduct two separate surveys with 538 and 1909 parents of both primary and secondary school children in the UK. We collect detailed information on parental beliefs, parental investment activities, and parent and child characteristics. To elicit beliefs about the productivity of investments, we build on and extend the approach developed in Cunha, Elo and Culhane (2013). In particular, we present parents with hypothetical investment scenarios which vary along three dimensions: (i) the level of early parental investments, (ii) the level of late parental investments, and (iii) the initial human capital level of the child. For each scenario, parents are asked to state what the future earnings of the child will be at age 30.[2]

In the scenarios of the first survey, early investments refer to investments made during school years 3-6, while late investments refer to investments made during school years 7-10. Here we focus on a particular type of parental investment which is relevant to all school-age children: the number of hours parents spend every week helping their child with school work. The chosen metric, i.e. the number of

[2]Asking parents directly about the likely outcomes of these scenarios, and not about interim test scores, has the advantage that we can directly calculate expected returns without having to make assumptions about the returns of arbitrarily scaled test scores.

hours spent on a specific activity, has the advantage that it is comparable across time periods. In the second survey, we construct the scenarios by replicating the types of parental investments included in the British Cohort Study (BCS). Information on parental investments is collected as part of the BCS when children are 5 and 10 years old and the investments are age-specific (e.g., reading to child at age 5, talking to child about school at age 10). In the hypothetical scenarios we construct, we use the same age-specific investments as in the BCS and vary the levels of investments made at age 5 and at age 10.

The results are remarkably consistent across the two surveys and reveal that parents perceive the returns to early and late investments to be different. In particular, we find that parents perceive late investments in the scenarios to be significantly more productive than early investments. Moreover, we find that parents perceive the early and late investments as substitutes rather than complements. We further document that parents differ substantially in their beliefs about the returns to parental investments. We show that individual beliefs about the productivity of parental investments are predictive of parents' current investment decisions and document that the heterogeneity in perceived returns is systematic. Compared to parents with high socio-economic status, parents with low socio-economic status perceive the returns to early investments to be significantly lower. We do not detect significant socio-economic differences in the perceived returns to late investments.

We also provide evidence from a supplementary questionnaire in which we elicit parental beliefs about the malleability of children's skills and the capability of children to acquire skills given they are provided with professional support. We find that beliefs about returns to parental investments, which we elicit using the hypothetical investment scenarios, are positively correlated with these two supplementary measures of parental beliefs. Moreover, when we examine the heterogeneity of responses in these two supplementary belief measures, we also find that parents with low socio-economic status are less likely to believe that children's skills are malleable and that children have the capability of acquiring skills.

An important question which emerges is whether parents' perceptions of the returns to early and late investments are correct. In Boneva and Rauh (2017), we estimate a dynamic latent factor model using the BCS data and the estimation technique developed by Agostinelli and Wiswall (2016). Using the estimated model, we simulate how increases in investments in the two different time periods translate into increased earnings at age 30. For early investments, we find that the estimated returns are very close to what parents perceive them to be. For late investments, we find that parents overestimate

the returns by a factor of two, which suggests that parents overestimate the relative importance of late relative to early investments. The second interesting question which emerges is whether parents with low socio-economic status only *perceive* the returns to early investments to be lower or whether the returns to investments are actually lower in families of low socio-economic status. In Boneva and Rauh (2017) we investigate whether the production function parameters differ across families with different characteristics to shed some light on this question. Interestingly, we cannot reject the null that the returns to parental time investments are the same across households with different parent or child characteristics. These results suggest that interventions which target parental beliefs about returns to investments may be effective at raising child outcomes and narrowing the socio-economic gap in achievement.

Our study relates to the growing literature which documents the importance of individual beliefs about the returns to education for *students'* educational investment decisions.[3] Attanasio and Kaufmann (2014) analyze the link between students' beliefs and parents' beliefs about the returns to formal education and students' decisions to spend more time in formal education. Kaufmann (2014) documents differences in student beliefs by socio-economic groups and shows that poor students require higher expected returns to be induced to attend college than students from rich families. Jensen (2010) shows that the perceived returns to schooling can differ from actual measured returns and that an intervention which informs students about actual returns increases school attendance. Our work also relates to the literature which investigates the role of individual beliefs in explaining students' choice of major and students' choice of which university to attend (Montmarquette, Cannings and Mahseredjian 2002, Arcidiacono 2004, Arcidiacono, Hotz and Kang 2012, Beffy, Fougere and Maurel 2012, Stinebrickner and Stinebrickner 2012, Zafar 2013, Stinebrickner and Stinebrickner 2014, Delavande and Zafar 2014, Wiswall and Zafar 2015, Giustinelli 2016).

The literature on parental investments in children, pioneered by Becker and Tomes (1979, 1986), traditionally assumes that parents are endowed with perfect information concerning the human capital production function. Recent studies have relaxed this assumption and have drawn attention to the importance of parental beliefs in the skill accumulation process.[4] Caucutt, Lochner and Park (2017) provide a theoretical framework in which they explore how information-based frictions can lead to

[3] By analyzing patterns of belief-updating, Zafar (2011) provides evidence that subjective expectations can inform educational choice models.

[4] In his recent EEA presidential address, Attanasio (2015) discusses the recent developments in the skill accumulation literature and stresses the importance of investigating the role of parental beliefs in understanding parental investment decisions and child outcomes.

inefficiently low investments. Dizon-Ross (2014) finds that parents tailor financial educational investments according to their (inaccurate) beliefs about their children's academic achievements, and that in response to an educational intervention, parents reallocate their financial investments. As mentioned above, our study most closely relates to Cunha, Elo and Culhane (2013) who use hypothetical scenarios to elicit maternal beliefs about the productivity of investments made in children aged 0-2. Using the same data, Cunha (2014) investigates the relative role of heterogeneity in budget sets, preferences, beliefs about the technology of skill formation, and human capital at birth to explain the black-white gap in early parental investments, and concludes that the racial gaps in early investments are primarily produced by differences in beliefs and differences in preferences. While Cunha, Elo and Culhane (2013) and Cunha (2014) elicit parental beliefs about how parental investments in very early childhood (age 0-2) map into increased skill levels at age 2, we elicit parental beliefs about how parental investments in *different* periods of childhood map into later-life outcomes, which allows us to investigate how parents perceive the dynamic nature of the skill production function. Our rich data set also allows us to gain further insights into differences in beliefs across socio-economic groups.

This paper proceeds as follows: Section 2 presents a stylized model of the production technology that incorporates parental beliefs and that highlights which (perceived) characteristics of the production technology are likely to be critical for parents' investment decisions. Section 3 presents the survey design we use to elicit parental beliefs about the characteristics of the production technology as well as details about the data collection and the characteristics of the sample. Section 4 presents the main results, while Section 5 presents additional analyses using the two supplementary measures of parental beliefs. Section 6 compares perceived returns to estimated returns, while Section 7 concludes.

2 Theoretical Framework

In the following, we present a theoretical framework that describes the technology which maps parental investments into future child outcomes as well as the parents' decision problem. We use this theoretical framework to highlight which parental beliefs are likely to be critical for their investment decisions and to motivate our survey design. The model is based on the general framework developed in Cunha, Heckman and Schennach (2010).[5]

Consider a model with two periods of childhood $t \in \{1, 2\}$, followed by one period of working life

[5]For our purposes, we simplify the framework by Cunha, Heckman and Schennach (2010) in several ways, e.g., we only consider two periods of childhood and we do not distinguish between cognitive and non-cognitive skills.

($t = 3$). Each child i enters period t with a set of skills or initial conditions, denoted as θ_{ti}. In every period of childhood, parents choose how much to invest in their child (I_{ti}). The technology of skill production depends on the stock of skills θ_{ti}, parental investments I_{ti}, and the production function f in period t:

$$\theta_{t+1,i} = f_t(\theta_{ti}, I_{ti}).$$

Assume that f is monotone increasing in its arguments, twice continuously differentiable and concave in I_{ti}. Adult outcome y_i is produced by the set of skills with which the child enters working life, θ_{3i}, via the following function: $y_i = g(\theta_{3i})$. Taken together, adult outcome y_i depends on the child's initial conditions θ_{1i}, early investments I_{1i}, late investments I_{2i}, and the function h which maps these inputs into adult outcome y_i.

$$y_i = h(\theta_{1i}, I_{1i}, I_{2i}).$$

In any given time period, parent i can allocate her total available leisure time, L_{ti}, to activities that help child i accumulate skills (I_{ti}) and activities that do not directly promote the child's human capital, which we henceforth refer to as 'own' leisure time (l_{ti}). Suppose that parental preferences are a function of own leisure time in period 1, l_{1i}, own leisure time in period 2, l_{2i}, as well as child outcome y_i:

$$u_i(l_{1i}, l_{2i}, y_i) = \ln l_{1i} + \alpha_i \ln l_{2i} + \beta_i \ln y_i,$$

where α_i captures how much parent i values own leisure time in period 2 relative to own leisure time in period 1, and β_i captures how much parent i values child outcome y_i relative to own leisure time in period 1. Parent i chooses I_{1i} and I_{2i} so as to maximize utility $u_i(l_{1i}, l_{2i}, y_i)$ subject to the following within period time budget constraints,

$$l_{ti} + I_{ti} = L_{ti} \;\; \forall t \in \{1, 2\},$$

as well as the *perceived* technological constraint,

$$\tilde{y_i} = h_i(\theta_{1i}, I_{1i}, I_{2i}).$$

Note that parents base their decisions on the *perceived* technological constraint $h_i(.)$, which may or may not coincide with the 'true' technological constraint $h(.)$. Given the complex nature of the

human capital accumulation process, it seems unlikely that parents have complete information about how inputs map into future child outcomes.[6] As a result, the investment levels chosen by parent i may or may not actually be optimal, i.e. the investment levels chosen might differ from the investment levels that would be chosen by parent i if the parent was fully informed about the 'true' function $h(.)$.

From the first order conditions to this problem it becomes apparent that parental beliefs about the partial derivatives of this production technology are critical for parental investment decisions:

$$\frac{\partial h_i(\cdot)}{\partial I_{1i}}, \frac{\partial h_i(\cdot)}{\partial I_{2i}}. \tag{1}$$

Notice that these (perceived) marginal returns may depend on the levels of the other inputs. It is therefore equally important to investigate parental beliefs about the cross derivatives of the production function. For example, a question which has been much debated in the literature is whether late investments are more productive if they are preceded by high early investments. We are therefore interested in how parents perceive the degree of complementarity between investments in the two different time periods:

$$\frac{\partial^2 h_i(\cdot)}{\partial I_{2i} \partial I_{1i}} \lessgtr 0. \tag{2}$$

Moreover, the (perceived) marginal returns to investments may depend on the initial level of human capital of the child, which is why it is interesting to investigate how parents perceive the degree of complementarity between investments and the child's initial skill level.[7]

$$\frac{\partial^2 h_i(\cdot)}{\partial I_{ti} \partial \theta_{1i}} \lessgtr 0 \; \forall t \epsilon \{1, 2\}. \tag{3}$$

While the literature has been emphasizing the importance of these partial and cross derivatives for parental investment decisions, little is known about parents' beliefs about these derivatives. To gain a better understanding of how parents perceive these characteristics of the production function, we elicit parental beliefs using a novel survey design.

[6] Note that there are different reasons why parents might differ in their beliefs about how investments map into the expected future outcome $\tilde{y}$. First, parents can differ in their beliefs about how investments translate into higher skill levels (f). Second, parents can differ in their beliefs about how an increase in the skill level translates into adult outcomes (g). Here we abstract from these two different channels and directly investigate how parents differ in their beliefs about how their investments map into adult outcomes (h).

[7] The extent to which parents perceive investments to be complementary to initial skill levels can be especially important for the parents' decisions of how to allocate limited resources across siblings with different initial ability levels. See for example Aizer and Cunha (2012) who find that parents invest more into children with higher human capital, consistent with strong complementarities in the production of human capital.

3 Eliciting Parental Beliefs

To collect information on parental beliefs as well as current parental investment decisions, we administer two different surveys to two independent samples (referred to as Sample A and Sample B). This allows us to document parental beliefs about the production technology and to investigate whether parental beliefs about the returns to investments are predictive of current parental investment decisions. In addition, we collect information on background characteristics, which allows us to examine whether parents with different characteristics hold systematically different beliefs about the returns to parental investments.

We collect all survey data online. Both surveys are distributed via the parental mailing lists of schools in England that agreed to participate (see maps in Appendix C).[8] Survey A was distributed to parents via the mailing lists of 5 primary and 5 secondary schools in May-June 2015 (Sample A), while Survey B was distributed via the mailing lists of 11 primary and 24 secondary schools in May-June 2016 (Sample B).[9] In each sample, we incentivize parental participation through a prize draw of a voucher worth £100.

As motivated in Section 2, parental beliefs about several partial and cross derivatives of the production function are likely to be critical for the level, timing and allocation of parental investments. We build on Cunha, Elo and Culhane (2013) and use hypothetical investment scenarios to elicit parental beliefs about the characteristics of the production function.[10]

Hypothetical Scenarios: We present parents with different hypothetical scenarios and ask them to state what they expect the earnings of the child in the scenario to be at age 30. The scenarios vary along three key dimensions: (i) the initial human capital level of the child, (ii) the level of early investments, and (iii) the level of late investments. A comparison of the parents' responses across the different scenarios allows us to infer how parents perceive the importance of the initial human capital level of the child, the returns to early and late investments (derivative (1)), and the complementarity

[8] We used the same sampling procedure for Sample A as well as for Sample B. We did not use any specific selection criteria to select the schools we contacted. The Department for Education provides lists of all primary and secondary schools in England. We used these lists of potential schools and contacted the head teachers of a random subset of these schools in no specific order.

[9] We set up the survey with the survey software Qualtrics. The invitation to participate asks the primary caregiver (referred to as the parent throughout this document) to complete the survey. The survey was advertised to take 15-20 minutes. The actual mean (median) time of completion was 14 (13) minutes in Sample A and 20 (13) minutes in Sample B.

[10] Note that Cunha, Elo and Culhane (2013) do not elicit parental beliefs about returns to investments in different periods of childhood, which is why they cannot document how parents perceive the dynamic nature of the skill production function. Another important difference between the two studies is that while we elicit parental beliefs about how parental investments in different periods of the child's school life map into later-life outcomes, Cunha, Elo and Culhane (2013) elicit parental beliefs about how parental investments in very early childhood (age 0-2) map into increased skill levels at age 2.

or substitutability between the different inputs (cross derivatives (2) and (3)). More specifically, all parents are presented with *two* hypothetical families (the "Jones" and the "Smiths"). In both hypothetical families there is one child of primary school age. Parents are told that while the Jones and the Smiths live in the same neighbourhood and are very similar in many different respects (e.g., in terms of income and education), there is *one* difference between the two families. In particular, they are told that the children of the two families differ in their initial level of human capital.[11] For each of these two hypothetical families, parents are then presented with *four* different investment scenarios that vary in the levels of investments the Smiths and the Jones could make during the following time periods. The four different investment scenarios are (1) low early investments/low late investments, (2) low early investments/high late investments, (3) high early investments/low late investments and (4) high early investments/high late investments.[12] Therefore, each parent is in total presented with *eight* different scenarios, which are illustrated in Table 1. For each of these eight scenarios j, parents are asked to state the expected gross annual earnings of the child at age 30 ($\tilde{y}_j$).[13]

Table 1: Overview of Different Scenarios

The Jones
High Initial Human Capital

	Low Late Investment	High Late Investment
	$\tilde{y}_1$	$\tilde{y}_2$
Low Early Investment	Low early/ Low late	Low early/ High late
	$\tilde{y}_3$	$\tilde{y}_4$
High Early Investment	High early/ Low late	High early/ High late

The Smiths
Low Initial Human Capital

	Low Late Investment	High Late Investment
	$\tilde{y}_5$	$\tilde{y}_6$
Low Early Investment	Low early/ Low late	Low early/ High late
	$\tilde{y}_7$	$\tilde{y}_8$
High Early Investment	High early/ Low late	High early/ High late

The parents' responses to the eight different scenarios allow us to infer parental beliefs about the characteristics of the production technology. First, we can infer the parents' beliefs about the importance of the initial human capital level of the child by comparing the parents' responses to the

[11] See Appendix B for the exact formulation. While we cannot perfectly rule out that parents inferred other differences between the families from our description, we explicitly described the two hypothetical families as being very similar to each other (e.g., in terms of income, education and the neighbourhood they live in) and stressed that there was *one* difference between the two families, while at the same time avoiding the use of explicit economic jargon (e.g., 'ceteris paribus' or 'all else equal').

[12] Note that parents saw all four scenarios for each hypothetical family simultaneously on one screen, i.e. they could compare across the four scenarios while responding to the questions. We chose this design to mitigate potential concerns that could arise from the order in which the scenarios are presented.

[13] We chose to directly ask parents about the likely future earnings of the child, instead of asking about some interim test result, because this allows us to calculate expected returns without having to rely on assumptions about the returns of arbitrarily scaled test scores.

scenarios in which the level of human capital is high to the corresponding scenarios in which the level of human capital is low. Second, the design allows us to investigate parental beliefs about the partial derivatives of the production function with respect to early and late investments (derivative (1)). Intuitively, by comparing parents' responses in the scenarios in which early (late) investments are high to the corresponding scenarios in which early (late) investments are low, we can obtain an estimate of parental beliefs about the returns to early (late) investments.[14]

The design also allows us to obtain insights into parental beliefs about the complementarity or substitutability of different inputs or, put differently, parental beliefs about the cross derivatives of the production technology (cross derivatives (2) and (3)). By comparing perceived returns to late investments when early investments are low to perceived returns to late investments when early investments are high, we can learn something about the perceived complementarity/substitutability between early and late investments. More specifically, if investments in different time periods are perceived as complements, we expect perceived returns to late investments to be *higher* when early investments are high, i.e. we expect $(\log \tilde{y}_4 - \log \tilde{y}_3) > (\log \tilde{y}_2 - \log \tilde{y}_1)$ and $(\log \tilde{y}_8 - \log \tilde{y}_7) > (\log \tilde{y}_6 - \log \tilde{y}_5)$. If instead investments in the different time periods are perceived as substitutes, we expect perceived returns to late investments to be *lower* when early investments are high. Similarly, a comparison between perceived returns to investments when human capital is low to perceived returns to investments when human capital is high informs us about the perceived complementarity/substitutability between parental investments and the initial human capital level of the child.

Empirical Specification: To estimate the partial and cross derivatives of interest, we estimate an ordinary least squares regression in which we allow for interactions between the different inputs. Given that we have eight responses for each parent, this gives us a pseudo-panel for each parent, which allows us to include parental fixed effects. In particular, we estimate the β coefficients in the following specification:

$$\log \tilde{y}_{ji} = \alpha + \beta_1 I_{1j} + \beta_2 I_{2j} + \beta_3 \theta_{1j} + \beta_4 I_{1j} \times I_{2j} + \beta_5 I_{1j} \times \theta_{1j} + \beta_6 I_{2j} \times \theta_{1j} + \gamma_i + \epsilon_{ji}, \qquad (4)$$

where j indicates the scenario, $\tilde{y}_{ji}$ are the earnings parent i expects in scenario j, α is the intercept, I_{1j} and I_{2j} are dummy variables indicating whether early and late investments are high, respectively,

[14] For the perceived returns to initial human capital, the differences of interest are $(\log \tilde{y}_5 - \log \tilde{y}_1)$, $(\log \tilde{y}_6 - \log \tilde{y}_2)$, $(\log \tilde{y}_7 - \log \tilde{y}_3)$, and $(\log \tilde{y}_8 - \log \tilde{y}_4)$. Similarly, for the perceived returns to early investments, the differences of interest are $(\log \tilde{y}_3 - \log \tilde{y}_1)$, $(\log \tilde{y}_4 - \log \tilde{y}_2)$, $(\log \tilde{y}_7 - \log \tilde{y}_5)$, and $(\log \tilde{y}_8 - \log \tilde{y}_6)$, while for the perceived returns to late investments, the differences of interest are $(\log \tilde{y}_2 - \log \tilde{y}_1)$, $(\log \tilde{y}_4 - \log \tilde{y}_3)$, $(\log \tilde{y}_6 - \log \tilde{y}_5)$, and $(\log \tilde{y}_8 - \log \tilde{y}_7)$.

θ_{1j} is a dummy variable indicating whether the initial level of human capital is high, and γ_i are parent fixed effects. β_1 and β_2 reveal how parents perceive the returns to early and late investments in the scenarios, while β_3 reveals how parents perceive the returns to the child's initial human capital level. If parents perceive the early and late investments as complements (substitutes), we expect $\beta_4 > 0$ ($\beta_4 < 0$). If parents perceive early/late investments and initial human capital as complements (substitutes), we expect $\beta_5 > 0$ ($\beta_5 < 0$) and $\beta_6 > 0$ ($\beta_6 < 0$), respectively.[15]

Types and Levels of Investments: The structure of the hypothetical scenarios is the same across the two surveys, i.e. in both surveys we present all parents with eight different scenarios, which vary in the level of initial human capital, as well as in the level of early and late investments (see Table 1). The main difference between the two surveys is that we use different types and levels of investments.

In Survey A, the children of the two families are in Year 3 of primary school (7-8 years old), and they differ in their prior achievement in the national curriculum test which children in the UK have to take at the end of Year 2. In particular, while the child of the Jones managed to achieve the level which is expected of children in this age group, the child of the Smiths did not.[16] We then vary the level of investments the two families make in school years 3-6 (i.e. the level of *early* investments) and the level of investments the two families make in school years 7-10 (i.e. the level of *late* investments). In this survey, we hold the *type* of investments fixed across time periods. More specifically, in both time periods we vary the amount of time the Jones and the Smiths spend helping their child with his school work. To additionally investigate whether parents perceive the returns to investments as diminishing as investment levels rise, we randomize respondents into two different conditions. In particular, for half the respondents "high" and "low" investments refer to spending 4 hours and 1 hour every week helping the child with his school work, respectively. For the other half of the respondents "high" investments refer to 3 hours while "low" investments refer to 0 hours.

While there are advantages to keeping the type of investment fixed across the different time periods, a potential concern with this design is that in different time periods different types of investments might be relevant for the production of human capital. We provide evidence that our results are not merely driven by the specific type of investment we choose by conducting a second survey (Survey B) in

[15]Essentially, the empirical specification is similar to a difference-in-difference approach. The coefficients on the interaction terms indicate whether the perceived returns to investments I_{tj} are higher if the variable the investments I_{tj} are interacted with are also higher.

[16]The expected level in the Year 2 national curriculum test (Key Stage 1, age 6-7) is level 2. More than 80% of all students are successful in achieving the expected level (Source: National Pupil Database, 2014).

which we use the British Cohort Study (BCS) to replicate questions about investments relevant for children of different ages.[17] We choose the descriptions of the scenarios in Survey B so that the types of investments described in the scenarios match those collected as part of the BCS.

The children of the two families in Sample B are 5 years old, and they differ in how intelligent they are. In particular, on an intelligence test the child of the Jones scored better than 70% of all children in the same age group, while the child of the Smiths scored worse than 70%. We then vary the level of age-specific investments parents make at age 5 and the level of age-specific investments parents make at age 10.[18] When choosing the levels of *low* and *high* investments, we choose values which are ± 0.5 standard deviations from the mean response of parents who are part of the BCS. More specifically, we use the data on the actual investments parents in the BCS make and first extract a factor from the three age-specific investments (separately for each time period). We then compute the average level of each investment for parents whose predicted factor is -0.5 standard deviations below the mean, and +0.5 standard deviations above the mean, and use these values to construct our scenarios. The resulting scenarios are as follows. In scenarios in which age 5 investments are *low*, the parents in the hypothetical scenario read to their child every second day, they rarely take their child to the playground, and they let their child watch TV for 2 hours every day. In contrast, in scenarios in which the level of age 5 investments is *high*, parents read to their child every day, they take their child to the playground once every fortnight, and they let their child watch TV for 1 hour every day. In scenarios in which age 10 investments are *low*, parents show moderate interest in their child's education, they don't talk to their child very much, and they sometimes engage in activities together (e.g., go out for walks, have breakfast or tea together). In contrast, in scenarios in which age 10 investments are *high*, parents show a lot of interest in their child's education, they talk to their child quite a lot, and they often engage in activities together.

Gender of Child in Scenario: While in Sample A all parents are presented with hypothetical scenarios in which the child is a boy ('John' or 'Simon'), we present a subset of the respondents in Sample B with hypothetical scenarios in which the child is a girl ('Jessica' or 'Sarah'). More specifically, all parents in Sample B who received the invitation to participate via their daughter's school were presented with scenarios which featured girls, while all parents who received the invitation to participate via their son's school were presented with scenarios which featured boys. This allows

[17]The BCS (1970) follows all children born in a specific week in 1970. More details on the BCS can be found on the following website http://www.cls.ioe.ac.uk as well as in Section 6.

[18]Note that the BCS collects information on parental investments at age 5 and age 10, which is why we also chose these ages to make our survey consistent with the BCS.

us to compare how parents with daughters perceive the returns to investments in girls to how parents with sons perceive the returns to investments in boys.

Additional Outcome: In addition to asking about the likely future earnings of the child at age 30, we also ask a random subset of parents in Sample A (N=266) to state how likely they think it is that the child will graduate from university in each of the eight scenarios. We ask parents to report their response on a 0-100% scale. While our main analysis focuses on using the likely future earnings as the outcome variable, we use the respondents' answers to these additional questions to investigate whether we find similar results if we use a different outcome measure.

3.1 Summary Statistics

Sample A consists of 538 parents who completed the survey. The characteristics of the sample are reported in Panel A of Table 2. 85% of the respondents in our sample are female. Out of the 85% who are employed, 60% work full-time while 40% work part-time. A university degree is held by 45% of the respondents and the average annual household income of the families is £55,771. 14% of the respondents in Sample A are single parent households. The parents in Sample A on average have 1.96 children. The children for whom the parents completed the survey are on average 13 years old.[19]

In Sample B, we have information on 1909 parents who completed the survey (see Panel B of Table 2). 68% are female and 82% are employed either full-time or part-time. 60% of the responding parents have a university degree and the average annual household income is £78,996. 14% of the respondents are single parent households, and on average the parents in this sample have 2.28 children. The children for whom the parent completed this survey are also on average 13 years old.

Compared to a representative sample of parents in England with at least one child aged 5-19, the parents in our sample have higher levels of education, they are less likely to be single parents, are more likely to be employed and report higher annual household incomes.[20] Figure C.3 in the Appendix shows the distribution of annual household incomes for parents in our two samples and parents in the Family Resources Survey (FRS). We note that while parents in our samples have higher levels of income compared to the parents in the representative sample, there is still a substantial amount of

[19] Parents are asked to provide detailed information only about the child who is enrolled in the school through which the survey is distributed. If parents have several children enrolled in the school, they are instructed to provide information on only one of the children enrolled in this school.

[20] We use the Family Resources Survey 2013-2014 to obtain the statistics for a representative sample of parents in England. We restrict the sample to parents who have at least one child aged 5-19. On average the respective households have 1.84 children. The average annual household income in this sample is £45,679. To make the sample comparable to our samples, we randomly draw 1,000 subsamples comprised of 72% females (the average from our samples) and find that on average 32% have a university degree, 30% are single parents, and 70% are employed.

variation in parental income, which allows us to estimate differences in parental beliefs across different socio-economic groups.

Table 2: Descriptive Statistics

	A: Sample A		B: Sample B		FRS	
	Mean	[SD]	Mean	[SD]	Mean	[SD]
Female respondent	.85	[.36]	.68	[.47]	.72	[.45]
Employed	.85	[.35]	.82	[.39]	.70	[.46]
Part-time	.40	[.49]	.31	[.46]	.37	[.49]
Full-time	.60	[.49]	.69	[.46]	.63	[.49]
University graduate	.45	[.50]	.60	[.49]	.32	[.47]
Single parent	.14	[.34]	.14	[.34]	.30	[.46]
Number of children	1.96	[.88]	2.28	[.94]	1.84	[.88]
Age of child	13.39	[3.58]	12.99	[3.33]	10.44	[4.16]
Female child	.56	[.50]	.32	[.47]	.50	[.50]
Household income	55771	[27019]	78996	[37546]	45679	[28031]
Observations	538		1909		3381	

Note: Household income refers to the gross annual income of all household members. For the FRS we present the averages of 1000 randomly drawn samples resembling a convex combination of Sample A and B in terms of share of female respondents that had at least one child aged 5-19 in the household.

There are two different reasons why the characteristics of parents who participated in our survey are different from the characteristics of a representative sample of parents in England (see Table 2). First, it was the decision of the head teacher whether or not to distribute our survey among parents, so the schools included in our sample are not representative of the population of English schools (see Table C.1 in the Appendix for a comparison). For example, the schools in our sample have a lower share of students eligible for Free School Meals (FSM) compared to the national average. Second, participation in the survey was voluntary and the response rate to our survey was 7% so the characteristics of participating parents may differ from the characteristics of the full sample of parents that was contacted via the participating schools.[21] While the administrative school data does not contain information on parental income or education, which would allow us to assess whether parents in our surveys self-select on these characteristics within the participating schools, we note that 8% of the parents who participated in Survey A report that their children are eligible for Free School Meals, which corresponds to the actual percentage of students on FSM in these schools (8.2%).[22] While we

[21]Table C.1 in the Appendix also contains information on the response rates by school type (primary/secondary) and sample. The response rates were 6.1% (primary schools) and 8.1% (secondary schools) in Sample A, and 3.9% (primary schools) and 7.5% (secondary schools) in Sample B. We note that despite the similar response rates we have significantly more respondents whose children attend secondary schools because more head teachers of secondary schools agreed to participate and because secondary schools are, on average, much larger than primary schools.

[22]Note that this information was not collected in Sample B which is why we cannot make this comparison for the parents in this sample.

can only speculate whether or not we would find similar results if we surveyed a representative sample of parents in England, we note that we find the same results when we re-weigh our observations in order to resemble a representative population in terms of household income (see Table A.7 in the Appendix).

Parental Investments: To investigate whether parental beliefs about the productivity of investments are predictive of current parental investments, we ask parents to provide detailed information on the investments they currently make in their child. In Sample A, we ask all parents to provide information on (i) the time they spend every week on certain activities (e.g., "help child with homework, check workbooks"), (ii) the frequency at which they engage in certain activities with their child during the year (e.g., "visit museum/art gallery"), and (iii) the financial resources they spend every month on different categories related to their child's education (e.g., "Sport clubs/music lessons/other societies").[23] Tables A.1-A.3 in the Appendix present the summary statistics of the responses to these three questionnaires, respectively.

In Sample B, we replicate the questions from the British Cohort Study, and ask about the same age-specific investments which we vary in the hypothetical investment scenarios. In particular, we ask parents of children aged 3-9 to provide information on (i) how many days their child has been read to at home in the past 7 days, (ii) how many hours per day the child usually watches TV, and (iii) whether the child has been taken to a park or playground during the past 7 days. Parents of children aged 10 or above are asked about (i) the frequency of different activities they do together with their child (e.g., have breakfast or tea together), (ii) how interested they are in their child's education, and (iii) how much time they usually spend talking to their child every day. Tables A.4-A.5 in the Appendix present the summary statistics of the responses to these different questions. To investigate whether the results are susceptible to the order in which the survey modules are presented, we randomize the order in which perceptions and investments are elicited in Sample B.[24]

4 Results

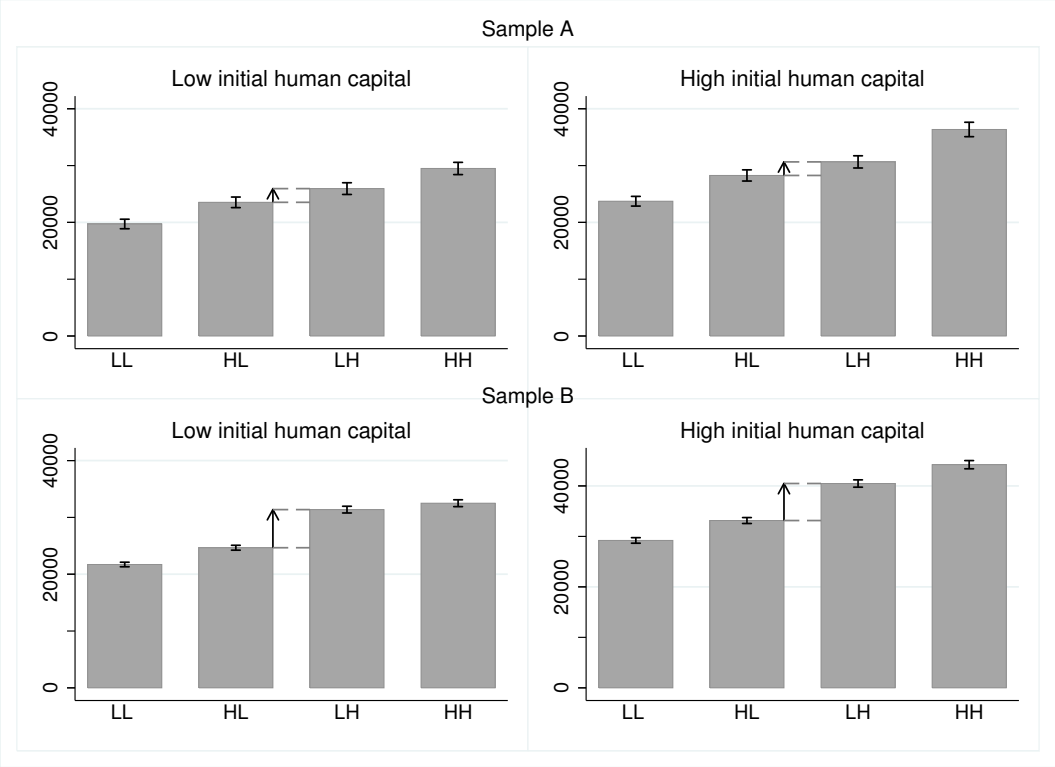
4.1 Parental Beliefs about the Production Technology

In both surveys, all parents are presented with eight hypothetical investment scenarios and are asked to state the expected earnings of the child at age 30 in each scenarios (see Table 1). Figure 1 depicts

[23] See Appendix B for more details on the specific questions, which were included in the questionnaire.
[24] Note that in Sample A the order of the survey modules was not randomized.

the child's expected earnings ($\tilde{y}_j$) in the eight scenarios for Sample A and Sample B, respectively, averaged across respondents. While the left panels depict the average expected earnings for the child with low initial human capital, the right panels depict the average expected earnings for the child with high initial human capital. For each level of human capital, we show the average expected earnings by the level of early investments (low vs. high) and by the level of late investments (low vs. high).

Figure 1: Expected Earnings at Age 30



Note: This figure depicts the expected earnings of the child at age 30 in each of the eight hypothetical investment scenarios (see Table 1) for Sample A and Sample B, respectively, averaged across all respondents in a given sample (with 95% confidence intervals). *LL*: low early, low late investments; *HL*: high early, low late investments; *LH*: low early, high late investments; *HH*: high early, high late investments.

There are several patterns which are worth noting. First, parents give meaningful responses to the questions in the sense that higher levels of initial human capital or higher levels of investments are also associated with higher expected earnings of the child in the scenario. Moreover, parents are on average remarkably close in their estimates to the true average.[25] Using the Family Resources Survey of 2013-2014, we find the average annual earnings of 25-34 year-old men in England to be £30,977 and

[25]Note that we did not give parents any information on actual average earnings, i.e. we did not anchor responses in any way.

the average annual earnings of 25-34 year-old women to be £25,630 (conditional on working full-time, i.e. at least 30 hours per week). In Sample A, in which we present all parents with scenarios in which the children are male, the average estimates across the four scenarios in which the child achieved the expected level in the national curriculum test ('high initial human capital') is £31,550, while the average estimates across the four scenarios in which the child did not achieve the expected level ('low initial human capital') is about £26,480. Given that about 80% of all students in the UK achieve the expected level, the weighted average of parental estimates in Sample A is about £30,540, which is remarkably close to the actual average earnings of men in the specified age group. In Sample B, in which we present some parents with girls and other parents with boys, parents believe that a child who is more intelligent than 70% of the children in their age group ('high initial human capital') will earn about £36,750, while a child who is less intelligent than 70% of the children in their age group ('low initial human capital') will earn about £27,560. Averaging across these two numbers gives us an estimate of £32,155, which is again very close to the true average, albeit slightly higher than the average across the two genders in the FRS (£28,303).

Another pattern which emerges in both samples is that parents believe, irrespective of the initial human capital level of the child, that the earnings of a child will be *higher* when early investments are low and late investments are high (bar 3) compared to when early investments are high and late investments are low (bar 2). This indicates that parents perceive returns to the late investments in the scenarios to be higher than returns to the early investments.[26]

To investigate the perceived returns to the different inputs in more detail, we pool the parents' responses to the eight hypothetical investment scenarios and estimate variants of the empirical specification presented in Section 3 (equation 4). We first regress the log expected earnings of the child at age 30 as reported by parent i ($\log \tilde{y}_{ij}$) on (i) a dummy variable which takes a value of 1 if early investments in the scenario are high (I_{1j}), (ii) a dummy variable which equals 1 if late investments in the scenario are high (I_{2j}) and (iii) a dummy variable which takes a value of 1 if the child in the scenario has high initial human capital (θ_{1j}). In Sample A, the difference between scenarios in which investments are high and scenarios in which investments are low is that the parents spend an additional 3 hours every week helping their child with school work.[27] In sample B, low levels of investments are described as

[26]The differences in means are significantly different from zero at the 1% level in all four cases.

[27]As explained in Section 3, half the respondents in Sample A are presented with investments of 1 hour/week (low) and 4 hours/week (high), while the other half of the respondents is presented with investments of 0 hours/week (low) and 3 hours/week (high). In the regressions which do not include parental fixed effects we additionally control for the dummy variable *high baseline* which equals 1 if the responding parent saw 1 hour/4 hours (rather than 0 hours/3 hours) for low/high levels of investments.

being 0.5 standard deviations below the actual mean investments made by panel members of the BCS, while high levels of investments are described as being 0.5 standard deviations above the mean (see Section 3). The difference between low and high levels of investments for Sample B is therefore one standard deviation in age-specific investments. The regression results are presented in Table 3.

Table 3: Determinants of Perceived Log Earnings at Age 30 (1)

Dependent variable: Perceived log earnings at age 30						
	Sample A			Sample B		
	(1)	(2)	(3)	(4)	(5)	(6)
Early investments	0.154***	0.155***	0.154***	0.100***	0.100***	0.100***
	(0.008)	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)
Late investments	0.255***	0.255***	0.254***	0.316***	0.315***	0.315***
	(0.010)	(0.010)	(0.010)	(0.006)	(0.006)	(0.006)
High human capital	0.185***	0.190***	0.185***	0.277***	0.290***	0.288***
	(0.009)	(0.009)	(0.010)	(0.007)	(0.006)	(0.006)
Log(HH income)		0.184***			0.111***	
		(0.042)			(0.016)	
Employed		0.055			-0.033	
		(0.055)			(0.021)	
University graduate		-0.045			0.010	
		(0.033)			(0.017)	
Number of children		0.015			0.009	
		(0.021)			(0.009)	
Female respondent		-0.078			-0.059***	
		(0.051)			(0.017)	
Single parent		0.107			0.040	
		(0.072)			(0.025)	
Female child					-0.083***	
					(0.018)	
High baseline	0.210***	0.192***				
	(0.034)	(0.032)				
Constant	9.777***	7.514***	9.749***	9.924***	8.445***	9.485***
	(0.028)	(0.493)	(0.010)	(0.009)	(0.173)	(0.005)
School fixed effects	No	Yes	No	No	Yes	No
Parent fixed effects	No	No	Yes	No	No	Yes
Observations	4069	3771	4069	16251	13551	16251
R^2	0.181	0.275	0.827	0.204	0.332	0.782

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors are clustered at the parent level. Columns 1-3 show the results for Sample A, while columns 4-6 show the results for Sample B. For each sample, the regressions are performed using the parents' responses to all eight hypothetical investment scenarios. The dependent variable is the log of expected earnings of the child in the hypothetical scenario at age 30. *Early investments* is a dummy variable indicating that parental time investments in the early period are high, while *Late investments* is a dummy variable that indicates that parental time investments in the late time period are high. *High human capital* is a dummy variable which equals 1 if the child in the scenario has high initial human capital. *High baseline* is a dummy variable indicating that the responding parent was randomized into the group that saw 1 hour/4 hours (rather than 0 hours/3 hours) for low/high levels of investments. The additional control variables include the log household income of the respondent, whether the respondent is employed (0 if not employed, 0.5 if part-time employed, 1 if full-time employed), whether the respondent holds a university degree, the number of children, whether the respondent is female, whether the responding parent is a single parent, and the age of the respondent. *Female child* refers to whether the child in the scenario is female (for Sample B only).

In Sample A, three additional weekly hours of investments made in school years 3-6 translate into

an increase in expected earnings by 15.4%, while three additional weekly hours of investments made in school years 7-10 translate into an increase in expected earnings by 25.5%. High initial human capital is associated with an earnings increase of 18.5% (column 1). In Sample B, a one standard deviation increase in the level of age-specific investment in the early period is associated with an earnings increase of 10.0%, while a one standard deviation increase in the level of age-specific investment in the later time period is associated with 31.6% higher earnings (column 4). The results are robust to the inclusion of household characteristics and school fixed effects (columns 2 and 5), as well as to the inclusion of parent fixed effects (columns 3 and 6). The inclusion of parent fixed effects allows us to estimate the coefficients using within-parent variation only. A result which is worth noting is that in all specifications the coefficient on late investments is significantly larger than the coefficient on early investments (at the 1% level), indicating that parents perceive the late investments in the scenarios as significantly more productive.

Table 4 explores additional features of the perceived function which maps investments into future outcomes. In particular, we first examine whether parents perceive early and late investments as substitutes or complements (see cross derivative (2)). When we allow for an interaction between early and late investments, we find that in both samples the coefficient on the interaction term is significantly negative (at the 1% level), indicating that parents perceive the returns to late investments as *less* productive if they are preceded by high early investments (columns 1 and 4). For Sample A every three additional hours invested early reduce the returns to three hours invested late by 10.4%, or -2.8 percentage points of earnings at age 30. In Sample B, high early investments reduce the returns to high late investments by 22%, or -7.7 percentage points of future earnings. Next we investigate whether parents perceive investments as more productive if the initial human capital of the child is high (see cross derivative (3)). In Sample A, we find that neither early nor late investments are perceived as more productive if the child in the hypothetical scenario has a high level of initial human capital (column 2). In Sample B, parents perceive early investments as more productive and late investments as less productive if the initial human capital level of the child is high (column 5). When we simultaneously control for all interaction terms we obtain similar results (columns 3 and 6).

Table 4: Determinants of Perceived Log Earnings at Age 30 (2)

Dependent variable: Perceived log earnings at age 30						
	Sample A			Sample B		
Early investments	0.168***	0.149***	0.163***	0.138***	0.090***	0.129***
	(0.009)	(0.009)	(0.010)	(0.004)	(0.004)	(0.005)
Late investments	0.268***	0.257***	0.271***	0.353***	0.325***	0.364***
	(0.012)	(0.011)	(0.013)	(0.007)	(0.007)	(0.009)
High human capital	0.185***	0.183***	0.183***	0.288***	0.288***	0.288***
	(0.010)	(0.012)	(0.012)	(0.006)	(0.008)	(0.008)
Early x Late	-0.028**		-0.027**	-0.077***		-0.077***
	(0.011)		(0.011)	(0.006)		(0.006)
Early x High HC		0.011	0.011		0.018***	0.018***
		(0.008)	(0.008)		(0.005)	(0.005)
Late x High HC		-0.006	-0.006		-0.019***	-0.019***
		(0.010)	(0.010)		(0.006)	(0.006)
Constant	9.742***	9.750***	9.743***	9.466***	9.485***	9.466***
	(0.010)	(0.011)	(0.011)	(0.006)	(0.006)	(0.006)
Parent fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4069	4069	4069	16251	16251	16251
R^2	0.827	0.827	0.827	0.784	0.782	0.784

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors are clustered at the parent level. Columns 1-3 show the results for Sample A, while columns 4-6 show the results for Sample B. For each sample, the regressions are performed using the parents' responses to all eight hypothetical investment scenarios. The dependent variable is the log of expected earnings of the child in the hypothetical scenario at age 30. *Early investments* is a dummy variable indicating that parental time investments in the early period are high, while *Late investments* is a dummy variable that indicates that parental time investments in the late time period are high. *High human capital* is a dummy variable which equals 1 if the child in the scenario has high initial human capital.

Overall, parents seem to believe that the late investments in the scenarios have a greater payoff compared to the early investments in the scenarios and that foregone early investments can at least partially be made up for during later time periods due to their perceived substitutability with late investments. We note that we find very similar patterns when we use the perceived probability of graduating from university as the main outcome variable (see Table A.6). Again parents perceive the returns to later investments to be significantly higher than the returns to earlier investments. We also find a negative but insignificant coefficient on the interaction term between early and late investments.

Since parental beliefs about the returns to investments in different time periods are likely to determine the inter-temporal allocation of parental investments, this raises the question of whether parents might misperceive the optimal timing of investments which could prevent parents from optimally investing in their children. We provide a discussion of this question in Section 6.

4.2 Heterogeneity in Perceived Returns

The estimated regression coefficients mask a substantial degree of heterogeneity across respondents. In the following, we separately calculate the perceived returns to the different inputs for each respondent i. To obtain a measure of individual perceived returns to early investments, r_i^{early}, we first calculate the perceived differences in log earnings by comparing a parent's responses in the four scenarios in which early investments are high to the parent's responses in the corresponding four scenarios in which early investments are low. We average across these differences to obtain the average perceived return to early investments:

$$r_i^{early} = \frac{(\log y_{3i} - \log y_{1i}) + (\log y_{4i} - \log y_{2i}) + (\log y_{7i} - \log y_{5i}) + (\log y_{8i} - \log y_{6i})}{4}$$

We apply the same procedure to calculate individual perceived returns to late investments, which we denote as r_i^{late}:[28]

$$r_i^{late} = \frac{(\log y_{2i} - \log y_{1i}) + (\log y_{4i} - \log y_{3i}) + (\log y_{6i} - \log y_{5i}) + (\log y_{8i} - \log y_{7i})}{4}.$$

Moreover, we also calculate the perceived return to high initial human capital by averaging across the following differences:

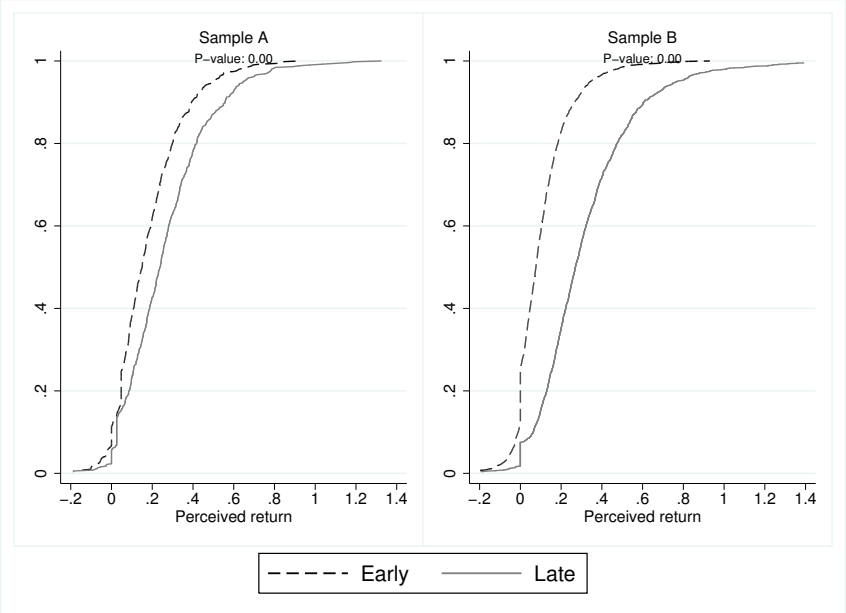
$$r_i^{HC} = \frac{(\log y_{5i} - \log y_{1i}) + (\log y_{6i} - \log y_{2i}) + (\log y_{7i} - \log y_{3i}) + (\log y_{8i} - \log y_{4i})}{4}.$$

Figure 2 plots the cumulative distribution of perceived returns to early and late investments separately for Sample A and Sample B respondents. The figure exhibits a high degree of heterogeneity in perceived returns in both samples. It is also visible that the distribution of perceived returns to early investments contains lower values than the distribution of perceived returns to late investments, indicating that parents perceive the early investments in the scenarios to be less productive than the late investments. In both samples, a Kolmogorov-Smirnov test for equality of distributions rejects the null of having equal distributions (p-value=0.00). Figure A.1 in the Appendix shows the joint distribution of perceived returns to both early and late investments separately for each sample. While

[28] To make individual averages comparable in Sample A, we account for the fact that the respondents are randomized into a group for whom low investments are 0 hours while high investments are 3 hours, and a group for whom low investments are 1 hour while high investments are 4 hours. For the latter group we remove the marginal effects of the first and last hour in the low and high scenario, respectively. The details can be found in the Appendix D. The results without this harmonization are qualitatively unchanged.

there are some parents who perceive the early investments in the scenarios to be more productive than the late investments, most parents perceive the late investments as more productive.

Figure 2: Cumulative Distribution of Individual Perceived Returns



Note: This figure shows the cumulative distribution of individual perceived returns to early and late investments separately for each sample. In both samples, a Kolmogorov-Smirnov test for equality of distributions rejects the null of having equal distributions (p-value=0.00).

Next we investigate whether the perceived returns to the different inputs vary with the characteristics of the respondent. The results of this analysis are presented in Table 5, separately for Sample A and Sample B. We are specifically interested in which characteristics predict the perceived returns to high initial human capital (columns 1 and 5), the perceived returns to early investments (columns 2 and 6), the perceived returns to late investments (columns 3 and 7), and the ratio of perceived returns to early vs. late investments (columns 4 and 8).[29]

[29]To make the analysis robust to outliers, which are salient in Figure 2, we set the bottom and top 1% of responses to missing. The results remain qualitatively unchanged if we do not perform this correction.

Table 5: Determinants of Perceived Returns

	Sample A				Sample B			
	HC	Early	Late	Ratio	HC	Early	Late	Ratio
2nd income quartile	0.034	0.019	0.007	0.131	0.024	-0.013	-0.013	-0.059*
	(0.024)	(0.022)	(0.028)	(0.211)	(0.018)	(0.009)	(0.017)	(0.034)
3rd income quartile	0.020	0.061**	0.060*	-0.025	0.049**	0.018*	0.013	0.038
	(0.029)	(0.026)	(0.033)	(0.249)	(0.020)	(0.010)	(0.019)	(0.036)
4th income quartile	0.073**	0.056*	0.056	0.346	0.072***	0.023**	0.001	0.037
	(0.034)	(0.031)	(0.039)	(0.295)	(0.019)	(0.010)	(0.018)	(0.035)
University graduate	0.007	0.016	-0.027	0.052	0.027**	0.005	-0.015	0.046*
	(0.018)	(0.016)	(0.021)	(0.156)	(0.014)	(0.007)	(0.013)	(0.026)
Number of children	-0.007	0.007	0.014	-0.125	-0.004	-0.006	-0.004	-0.010
	(0.010)	(0.009)	(0.012)	(0.088)	(0.007)	(0.004)	(0.007)	(0.014)
Female respondent	0.063***	0.010	0.019	-0.010	0.055***	-0.009	0.025*	-0.099***
	(0.024)	(0.022)	(0.028)	(0.212)	(0.015)	(0.008)	(0.014)	(0.028)
Single parent	-0.039	-0.007	0.031	-0.124	-0.010	0.001	-0.005	-0.011
	(0.028)	(0.025)	(0.032)	(0.240)	(0.019)	(0.010)	(0.019)	(0.036)
Age of child	0.004*	-0.000	-0.004	0.005				
	(0.002)	(0.002)	(0.003)	(0.020)				
Age of parent					0.002**	0.000	-0.001	0.000
					(0.001)	(0.001)	(0.001)	(0.002)
Age oldest child					-0.001	-0.001	-0.000	0.001
					(0.002)	(0.001)	(0.002)	(0.004)
Female child					0.006	-0.002	-0.016	-0.012
					(0.014)	(0.007)	(0.013)	(0.026)
Constant	0.075	0.132***	0.264***	1.133***	0.096*	0.118***	0.400***	0.413***
	(0.046)	(0.042)	(0.053)	(0.404)	(0.050)	(0.026)	(0.048)	(0.094)
Sample mean	.19	.18	.27	1.04	.29	.1	.32	.38
Observations	470	474	474	449	1683	1683	1683	1554
R^2	0.044	0.025	0.021	0.012	0.033	0.019	0.007	0.023

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-4 show the results for Sample A, while columns 5-8 show the results for Sample B. The dependent variables (in order) are the individual perceived returns to high initial human capital (HC), early and late investments, and the ratio of early/late, i.e. the relative importance of early investments. The additional control variables include household income quartile dummies, whether the respondent holds a university degree, the number of children, whether the respondent is female, and whether the responding parent is a single parent. Female child refers to whether the child in the scenario is female (for Sample B only). For Sample B, we also control for the order in which the survey modules were presented.

For both samples, the results reveal that parents with higher levels of income perceive the returns to high initial human capital and the returns to early investments to be significantly higher.[30] In Sample A, parents with higher levels of income also perceive the returns to late investments to be higher although the coefficients are less precisely estimated. In Sample B, we find no association between parental income and the perceived returns to late investments. When we investigate what predicts the ratio of perceived returns to early vs. late investments, we find no clear relationship between parental income and parental beliefs. We do note, however, that respondents with a university degree in Sample B perceive the ratio to be higher, i.e. they are more likely to believe that early investments matter relatively more compared to late investments. Figures A.2 and A.3 in the Appendix visualize

[30]We would also like to note that while there are significant differences in beliefs across socio-economic groups a large share of the variation cannot be explained by observables. More research will be needed into which other observed and unobserved factors play a role in determining beliefs.

the differences in perceived returns by income quartile as well as by parental education.[31]

Another interesting question is whether the age of the respondent's own child predicts perceived returns to early and/or late investments. In Sample A, we include the age of the target child (i.e. the child for whom the parent completed the survey) as a control variable, and we find no significant association between the age of the child and the perceived returns to early investments, the perceived returns to late investments or the ratio of perceived returns. In Sample B, we perform the same analysis this time controlling for the age of the respondent's *oldest* child. Again we find similar results, i.e. we find no significant association between the age of the oldest child and perceived returns to parental investments in any given time period.

We further investigate whether parents differ in their perceptions about the substitutability of the different inputs. For this purpose, we obtain individual measures of perceived substitutability/complementarity and regress them on parental characteristics (see details in Appendix E). In Sample B we find some evidence that more educated parents perceive investments across periods to be less substitutable indicated by the positive and significant coefficient of the university dummy (see Table E.1). We do not find any significant associations between household income and the perceived substitutability/complementarity of early and late investments. We also find no significant associations between the socio-economic background of the respondent and the perceived substitutability/complementarity between investments and the initial human capital of the child.

We also investigate heterogeneity in beliefs with regard to the gender of the child in the scenario. Recall that in Sample B all parents with daughters are asked about the likely earnings of girls, while all parents with sons are asked about the likely earnings of boys. Consistent with the literature which documents a gender gap in earnings (e.g., Altonji and Blank 1999, Bayard et al. 2003, Bertrand 2011), we find that parents who are asked about girls perceive the earnings of the child at age 30 to be lower compared to parents who are asked about boys (see Table 3). Interestingly, we find that parents underestimate the actual gender gap in earnings which we document using the representative sample of 25-34 year old men and women in the Family Resources Survey. While parents believe that girls will earn 8.3% less than boys at age 30, the true gender gap we find in the FRS data is 21%. One potential reason for this difference is that parents may misperceive the current gender gap in earnings.

[31] We would like to note that while all parents are presented with the same hypothetical scenarios, it may be that parents bring their own experiences to the survey and/or imagine families that have similar characteristics to their own. This can also be seen in Figure A.5 which depicts the parents' beliefs about the intercept, i.e. the earnings of a child with low initial human capital, early and late investments. In both samples, top income quartile respondents perceive the earnings of the child in the baseline scenario to be higher compared to parents in the bottom income quartile.

Alternatively, it may be that parents believe that the gender gap in earnings will diminish over time. The second interesting result which emerges from our data is that while we find differences in the perceived *levels* of earnings, we do not find that parents perceive the returns to initial human capital or the returns to investments to differ depending on the gender of the child in the scenario (see Table 5).

Finally, we can use the responses in Sample A to investigate whether parents differ in their beliefs about the returns to additional weekly time investments depending on whether the levels of low and high investments they are presented with are 0 hours and 3 hours or 1 hour and 4 hours.[32] As expected, we do find evidence for perceived diminishing returns as parents in the 0-3 group perceive the returns to be higher than parents in the 1-4 group (see Figure A.4 in the Appendix).

4.3 Do Perceived Returns Predict Current Parental Investments?

In both surveys, we also ask parents to provide information on their current investment decisions. We use this information to investigate whether parental beliefs about the returns to current investments are predictive of parents' current investment choices while controlling for a range of parent and child characteristics. In Sample A, we pool all respondents and regress different measures of current parental time and financial investments on the parents' perceived returns to one additional hour of weekly time investments in the given time period. We regress parental investments on the perceived returns to early investments if the child of the respondent is in primary school and on the parents' perceived returns to late investments if the child of the respondent is in secondary school.[33] The results are presented in Table 6.

Parental beliefs about the returns to investments are associated with the amount of time parents spend talking to their child about school, helping their child with their homework, reading/telling stories to their child, and playing games with the child. More specifically, an increase in the perceived return by 10 percentage points is associated with parents spending 147 minutes more every week on these activities.[34] We also extract the first principal component from the questionnaire which asks

[32] We randomized respondents in Sample A into two groups, the 0-3 group and the 1-4 group. Table C.2 in the Appendix shows that the two sub-samples are balanced in terms of observable characteristics.

[33] Given the apparent outliers in Figure 2, we exclude the top and bottom 1% of perceived returns. Including these outliers leads to qualitatively similar results but comes at the cost of a loss in precision.

[34] Note that the average perceived return to investment in any given time period is calculated using the differences in log earnings in the corresponding scenarios, i.e. $\log y_j - \log y_k$ (see Section 4.2). The perceived percentage point change in y, which is defined as $\frac{y_j - y_k}{y_k}$, is approximately equal to $\log y_j - \log y_k$ (log approximation rule), so r_i^{early} and r_i^{late} approximate the perceived percentage point difference in earnings between scenarios in which investments are high and scenarios in which investments are low. Because the difference between low and high investments is 3 hours, we additionally divide the perceived returns variables by three, so that the perceived return variable in Table 6 is measured

Table 6: Beliefs and Time Investments - Sample A

Dependent variable: Reported investment							
	Weekly Time Investments					Acti-	Expend-
	Total	School	Homework	Stories	Play	vities	iture
Perceived returns$_t$ (0-1)	1470.1***	321.2**	507.4***	227.3**	360.9***	1.8**	115.0**
	(346.6)	(160.7)	(127.2)	(101.3)	(128.5)	(0.7)	(55.4)
Age of child	2.0	11.1**	-3.7	-7.1**	-5.6	-0.0	-0.6
	(11.5)	(5.3)	(4.1)	(3.3)	(4.2)	(0.0)	(1.8)
Female child	-15.3	-5.8	3.9	-3.5	-7.4	0.2**	13.3*
	(46.6)	(21.3)	(16.4)	(13.2)	(17.1)	(0.1)	(7.3)
Log(HH income)	-83.0*	-8.0	-17.0	-17.6	-43.3***	0.1	19.7***
	(44.4)	(20.6)	(16.1)	(12.7)	(16.3)	(0.1)	(7.0)
University degree	38.8	25.0	7.8	16.9	-3.9	0.3***	24.1***
	(44.0)	(20.1)	(15.8)	(12.7)	(16.2)	(0.1)	(7.0)
Employment	145.2**	27.2	43.2*	13.5	65.1***	-0.0	8.3
	(66.4)	(30.5)	(23.7)	(18.9)	(24.4)	(0.1)	(10.5)
Number of children	1.0	7.8	-1.0	-5.8	1.7	0.0	-3.0
	(24.2)	(11.3)	(8.7)	(6.9)	(8.8)	(0.1)	(3.9)
Female respondent	120.2**	37.5	48.6**	24.8	33.1	0.0	9.3
	(59.7)	(27.6)	(21.8)	(17.4)	(22.0)	(0.1)	(9.7)
Single parent	-40.1	-1.6	-26.5	-15.7	39.1	-0.1	-17.7
	(72.6)	(34.0)	(25.6)	(20.9)	(26.3)	(0.1)	(11.3)
Foreign lang. at home	-146.9	-15.5	-47.7	-64.4**	-51.7	-0.2	-10.2
	(106.4)	(47.7)	(36.5)	(29.3)	(38.6)	(0.2)	(16.3)
School fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	368	412	412	395	385	461	432
R^2	0.159	0.056	0.105	0.326	0.130	0.112	0.156

Note: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. The weekly time investments are measured in minutes. *Activities* is an extracted factor from the activities questionnaire, and *Expenditure* refers to the total monthly expenditure parents devote to their children. *School* refers to the time parents spend talking to their child about their experiences at school, *Homework* refers to the time parents help their child with homework/check workbooks, *Stories* refers to the time parents spend reading/telling stories and *Play* refers to the time parents spend playing board/card games. *Perceived Return*$_t$ refers to the perceived return to 1 hour of weekly early investments for parents with primary school children, and to the perceived return to 1 hour of weekly late investments for parents with secondary school children. The top and bottom 1% of perceived returns were excluded from the sample.

parents to report how often they engage in certain less regular activities with their children and regress the extracted factor on perceived returns to weekly time investments (column 6).[35] Again we find a significant positive association between perceived returns and parental investment behavior. Finally, we regress the total monthly expenditures of the parents on the parents' perceived returns to weekly time investments and we find that an increase in perceived returns by 10 percentage points is associated with parents spending £11.50 more every month (column 7).[36]

in percentage points (0-1).

[35]The extracted factor from the activities questionnaire explains 47% of the variation in responses.

[36]The R^2 increases by 38% for total time when adding parental beliefs to a regression compared to only including household characteristics. On average it increases by 2 percentage points across the seven columns of Table 6. Similarly, the coefficients of perceived returns are robust to the inclusion of the two supplementary measures we introduce in Table 9 of Section 5. Also, perceived returns again on average add 1.9 percentage points to the R^2 above and beyond what is explained by household characteristics and the two supplementary measures, with an increase of 39% for time spent helping with homework.

Table 7: Beliefs and Time Investments at Age 5 - Sample B

	Read	TV	Park
Perceived returns$_t$	2.380*	-2.000***	-0.248
	(1.260)	(0.611)	(0.215)
Log(HH Income)	0.200	-0.196	0.011
	(0.324)	(0.157)	(0.055)
Employed	0.162	0.030	0.127**
	(0.377)	(0.183)	(0.064)
University graduate	0.167	0.199	-0.020
	(0.366)	(0.177)	(0.062)
Number of children	-0.522***	-0.056	0.021
	(0.163)	(0.079)	(0.028)
Female respondent	0.010	-0.045	-0.047
	(0.368)	(0.179)	(0.063)
Age of parent	0.014	0.008	-0.007
	(0.029)	(0.014)	(0.005)
Single parent	0.508	-0.478*	0.071
	(0.557)	(0.270)	(0.095)
Female child	-0.304	-0.063	0.038
	(0.288)	(0.139)	(0.049)
Order effect	-0.089	-0.279**	0.031
	(0.285)	(0.138)	(0.049)
Constant	2.878	3.208*	0.819
	(3.586)	(1.738)	(0.611)
School fixed effects	Yes	Yes	Yes
Observations	222	222	222
R^2	0.191	0.265	0.198

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. 'Read' refers to the number of days during the past week the parent has read to the child, 'TV' refers to the number of hours the child watches TV during a typical day, and 'Park' indicates whether the child has been taken to the park or playground during the past week. *Perceived Returns$_t$* refer to the perceived return to investments in children at age 5. The top and bottom 1% of perceived returns are excluded from the sample. *Order effect* is a dummy variable which takes the value 1 if respondents first saw the hypothetical scenarios before reporting own investments (and zero otherwise).

In Sample B, we ask parents to report investments which are specific to their child's age group (see Section 3.1). We separately regress the investments of parents with young children on the parents' beliefs about the returns to early investments (see Table 7), and the investments of parents with older children on the parents' beliefs about the returns to late investments (see Table 8). Again we document that parental beliefs are associated with parental investments. Parents who perceive the returns to early investments to be high are also more likely to spend more time reading to their child and let their child watch less TV. Moreover, parents who perceive the returns to late investments to be high are more likely to engage in different activities with their child (e.g., chat with their child, have meals

together), and they are more likely to be interested in their child's education.[37]

Table 8: Beliefs and Time Investments at Age 10 - Sample B

	Walks	Meals	Chat	Interest	Time
Perceived returns$_t$	0.136	0.325***	0.246***	0.469***	0.510***
	(0.115)	(0.099)	(0.071)	(0.079)	(0.100)
Log(HH Income)	-0.000	0.087**	0.105***	-0.021	-0.042
	(0.047)	(0.040)	(0.029)	(0.032)	(0.041)
Employed	0.063	0.018	-0.010	-0.099**	-0.085
	(0.069)	(0.059)	(0.042)	(0.047)	(0.059)
University graduate	-0.058	-0.032	-0.029	0.067*	-0.002
	(0.058)	(0.049)	(0.035)	(0.040)	(0.050)
Number of children	0.021	0.003	-0.030*	-0.037*	-0.076***
	(0.027)	(0.024)	(0.017)	(0.019)	(0.024)
Female respondent	0.129**	0.290***	0.220***	-0.042	0.206***
	(0.059)	(0.051)	(0.036)	(0.041)	(0.051)
Age of respondent	0.008**	0.007*	0.005*	0.007**	0.006*
	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)
Single parent	0.003	0.003	-0.053	-0.081	-0.128*
	(0.076)	(0.065)	(0.047)	(0.052)	(0.066)
Female child	-0.017	0.068	-0.002	0.032	-0.080
	(0.067)	(0.058)	(0.042)	(0.046)	(0.058)
Order effect	0.166***	0.112***	0.095***	-0.050	0.143***
	(0.050)	(0.043)	(0.031)	(0.034)	(0.043)
Constant	2.824***	2.689***	3.039***	4.342***	3.975***
	(0.573)	(0.491)	(0.354)	(0.394)	(0.497)
School fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1432	1433	1433	1433	1433
R^2	0.047	0.069	0.071	0.074	0.080

Note: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. The dependent variables are measured on a 5-point Likert scale. 'Walks' refers to going out for walks together, 'Meals' to having breakfast or tea together, 'Chat' to having a chat or talk with the child (for more than 5 min), 'Interest' to how interested or concerned the parent is interested in the child's education, and 'Time' to the time the parent spends talking to the child each day. *Perceived returns$_t$* refers to the perceived return to investments in children at age 10. The top and bottom 1% of perceived returns are excluded from the sample. *Order effect* is a dummy variable which takes the value 1 if respondents first saw the hypothetical scenarios before reporting own investments (and zero otherwise).

Overall, the parents' perceived returns to parental investments, which we elicit with the help of the hypothetical investment scenarios, are predictive of the investments parents report to make. While this evidence is of a correlational nature, the results are consistent with a model in which parents' investment choices are influenced by parental beliefs about the productivity of investments.[38]

[37]We also performed analyses in which we regress actual investments on the perceived returns to early and late investments, separately for parents whose children attend primary schools and parents whose children attend secondary schools. As one would expect, we find that perceived returns to late investments are predictive of late investments, while perceived returns to early investments are predictive of early investments, with the only exception that the positive coefficients on early investments in the sample of primary school parents in Sample A do not reach significance, possibly because the sample size in this cell is small (n $\approx$ 100). Results are available upon request.

[38]We note that while we cannot rule out that the correlations are driven by the respondents' desire to provide consistent responses across the different survey modules (Cialdini 1984), our results are not driven by order effects. We find a positive correlation between investments and beliefs irrespective of the order in which the survey modules

Combining the findings that parental beliefs about returns to investments are positively correlated with household income as well as with actual investments provides suggestive evidence that beliefs about returns to investments could be contributing to the intergenerational persistence in earnings, which is particularly high in the UK compared to other developed countries (Corak 2013).

5 Supplementary Measures of Parental Beliefs

In addition to using hypothetical scenarios to elicit parental beliefs about the production technology, we also administer two supplementary surveys in Sample A, which allow us to shed further light on why parents might differ in their beliefs about the productivity of parental investments. First, we present parents with a series of items which pertain to the malleability of children's skills through the home environment, and ask parents to rate these items on a Likert-type scale (e.g., "*My child develops at his/her own pace and there is not much I can do about that*").[39] We use this information to investigate whether parents who believe that the development of children's skills cannot be affected through the home environment are also more likely to perceive the returns to parental investments to be low.

Second, we elicit parents' beliefs about the capability of their child to acquire different skills. More specifically, we ask parents to state how likely it is that their child can learn how to (i) speak a new foreign language, (ii) programme a software and (iii) manage a company (over the course of their lives). Since we are interested in parental beliefs about the predisposition of their child to acquire a specific skill (rather than the availability of resources which might be necessary to acquire the skill), we make it explicit that parents should imagine a situation in which their child is provided with maximum support.[40] We use this information to explore whether parents who believe that their children do not have the capabilities to acquire different skills, even if they are provided with maximum support, are also less likely to believe that the returns to parental investments are high.

are presented. Within both subsamples we find that parents perceive returns to later investments to be higher than returns to earlier investments, that there are socio-economic differences in perceived returns, and that parental beliefs are predictive of current investment choices. We do, however, note that there is a level effect, i.e. parents on average report higher levels of investments when beliefs are elicited first, as indicated by the (for some cases) significant coefficient of *Order effect*.

[39] This questionnaire is inspired by the growth-mindset questionnaire developed in Dweck (2006). All questions can be found in Appendix B.

[40] We specify that this, for example, might involve that the child spends several hours every week with a professional teacher/coach. See Appendix B for exact wording.

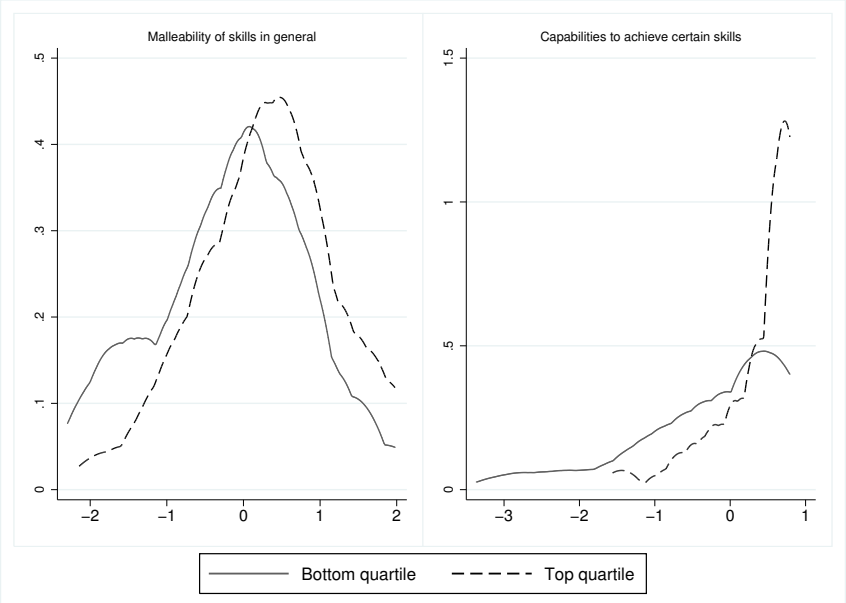
Table 9: Spearman Rank Correlations Between Different Measures

	Early	Late	Malleability	Capability
Perceived returns early	1			
Perceived returns late	0.372***	1		
Beliefs about malleability of skills	0.141***	0.127***	1	
Beliefs about capability	0.0982**	0.0125	0.0935**	1

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We extract factors from the parents' responses to each supplementary questionnaire.[41] Table 9 shows the Spearman rank correlations between these two measures and the parents' perceived returns to early and late investments (see Section 4.2). As we would expect, the parental belief measures are positively correlated. In particular, parents who believe that their own children's skills are malleable through the home environment are also more likely to perceive the returns to both early and late investments to be high (significant at the 1% level). Moreover, parents who believe their children are likely to acquire new skills given they are provided with maximum support are also more likely to believe that parental investments pay off, though the correlations are less strong.

Figure 3: Perceived Malleability of Skills and Capabilities of Children by Income Quartile



Note: Bottom quartile refers to the parent being in the bottom quartile of the household income distribution, while top quartile refers to the parent being in the top income quartile. Panel A shows the distribution of the extracted factor from the beliefs about malleability questionnaire, while Panel B shows the distribution of the extracted factor from the beliefs about capability questionnaire (see Appendix for a list of all questions).

[41] The extracted factors from the malleability of skills and capabilities questionnaire explain 47% and 61% of the variation in item responses, respectively.

There is also a substantial degree of heterogeneity in individual responses, and this heterogeneity seems to be systematically related to the socio-economic characteristics of the respondent. In particular, parents with lower levels of income are less likely to believe that their children's skills are malleable through the home environment. The extracted factor has a value of -.1 for parents with below median income, while it has a value of .25 for parents with above median income.[42] The differences are even more pronounced when we compare parents in the bottom and the top income quartile. We illustrate these differences graphically in Panel A of Figure 3.[43] These results are consistent with the findings in the literature which document that parents with lower socio-economic status have a lower locus of control (Becker et al. 2012). Similarly, parents with lower income are less likely to believe that their children can acquire skills given they are provided with maximum support. For parents with below median income the extracted factor from the capabilities questionnaire has a value of -.12, compared to a value of .29 for parents with above median income.[44] Again we illustrate the relationship graphically by comparing bottom and top income quartile respondents, for whom the differences are even more extreme (Panel B of Figure 3).[45] These results are consistent with the findings in Section 4 in which we document socio-economic differences in perceived returns to parental investments that we elicit with the help of the hypothetical investment scenarios.[46]

6 Comparison to Estimated Returns

Having documented how parents perceive the returns to early and late investments, a natural question which arises is whether parents are correct in their beliefs. Estimating the true returns to parental investments is an important yet challenging task. First, it requires a longitudinal data set that contains detailed information on investments made by parents during different stages of childhood as well as information on children's skills and later-life outcomes. Second, it is important to recognize that investments and skills are measured with error, which is why it is useful to have multiple measures

[42] This difference is statistically significant at the 1% level.

[43] The mean value of the factor for bottom income quartile respondents is -.15 while the mean value of the factor for top income quartile respondents is .31. The difference between these two values is significant at the 1% level. The Kolmogorov-Smirnov test rejects the null of having equal distributions (p-value=0.02).

[44] This difference is statistically significant at the 1% level.

[45] The mean value of the factor for bottom income quartile respondents is -.2 while the mean value of the factor for top income quartile respondents is .4. The difference between these two values is significant at the 1% level. The Kolmogorov-Smirnov test rejects the null of having equal distributions (p-value=0.00).

[46] Note that it may well be that parents from different socio-economic groups interpret the questions differently. It may for example be that parents from the top income quartile have a different understanding of what 'maximum support' means compared to parents from the bottom income quartile. The study design does not allow us to investigate the underlying reasons for why parents from different income quartiles perceive the malleability of their children's skills or the capability of their children to acquire new skills as different.

of investments and skills in the data. Third, one needs to account for the endogeneity of parental investments when parents make investment decisions in response to the characteristics of the child that may change over time (Cunha, Heckman and Schennach 2010).

The British Cohort Study data is a longitudinal data set which follows all individuals born in a specific week in 1970. It contains multiple measures of investments at age 5 and age 10, multiple measures of children's skills at ages 5, 10 and 16, as well as detailed information on later-life outcomes (including earnings at age 30). In Boneva and Rauh (2017) we use this rich data and estimate a dynamic latent factor model of human capital production using the estimation technique developed by Agostinelli and Wiswall (2016). The approach accounts for the fact that the data only contains imperfect proxies of investments and skills, and explicitly models the investments of parents as a function of different parent and child characteristics.[47]

To estimate the returns to parental investments, we use the estimated model to simulate earnings at age 30 for children exposed to low and high levels of investments. To make it comparable to the hypothetical scenarios we use to elicit beliefs, low and high levels of investment are 0.5 standard deviations below and above the mean. Using the simulated data we can then estimate a reduced form regression similar to our benchmark specification of which we present the results in Table 3. In Table 10 we compare the estimated "true" returns to the perceived returns of parents in our survey sample B.[48] We find that the estimated returns to early investments are very close to what parents perceive them to be (believed 10.0% vs 11.1% in the BCS). However, for the returns to late investments we find that parents overestimate these returns almost by a factor of two (believed 31.5% vs 17.3% in the BCS), suggesting that they overestimate the relative importance of late relative to early investments. Regarding the importance of initial human capital for earnings, we find that parental beliefs are fairly close to the data estimate.

We would also like to note that unlike some influential studies which have concluded that earlier investments are more productive than late investments (e.g. Cunha, Heckman and Schennach 2010, Del Boca, Flinn and Wiswall 2014), our estimates using the BCS suggest that the returns to an increase of one standard deviation in age-specific early investments are *lower* than the returns to an increase of one standard deviation in age-specific late investments (11.1% vs 17.3%). While previous studies have mainly focused on comparing the productivity of investments in children below age 5 to the

[47] Parental investments may also respond to unobserved shocks correlated with observables. While the estimation technique estimates the variance of a random shock, given that we do not have a valid instrument for parental investment in the data, we cannot account for endogenous shocks.

[48] For details on data, estimation, and simulation we refer to Boneva and Rauh (2017).

productivity of investments in children above age 5, we consider two later time periods in our study (age 5 vs age 10). Not much is known about whether the returns to investments are linearly decreasing in age, or which types of investments are most productive in any given time period. In fact, there are recent studies which suggest that shifting resources from middle periods of childhood to adolescence might indeed be optimal. For example, Carneiro et al. (2015) use registry data from Norway and find that shifting parental income from child ages 6-11 to ages 12-17 improves schooling outcomes, increases a child's earnings at age 30, and reduces the prevalence of teenage pregnancies. More research will be needed to fully understand which types of investments are most productive in any given time period, and how to optimally allocate resources over time.

Table 10: Data estimate versus survey beliefs about returns to time investment

Dependent variable: Log earnings at age 30		
	(BCS)	(Survey)
Early investments	0.111***	0.100***
	(0.001)	(0.003)
Late investments	0.173***	0.315***
	(0.001)	(0.006)
High human capital	0.250***	0.290***
	(0.001)	(0.006)
Controls	Yes	Yes
School FE	No	Yes
Datasource	BCS	Survey
Observations	800000	13551
R^2	0.165	0.332

Note: This table is adopted from Boneva and Rauh (2017). Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All regressions include a constant. The left column contains the estimated returns from simulated data based on a dynamic latent factor model using data from the BCS. This sample is composed of simulations from 100 drawn synthetic samples with 100000 individuals. For the simulated data initial human capital is considered low for a child at the 30th and high at the 70th percentile of the cognitive skill distribution. Controls include parental cognitive and non-cognitive skills. The right column is based on Sample B as presented in Table 3. Controls include log household income, number of children, and dummies for gender of the child and respondent, single parenthood, employment and whether the respondent has a university degree.

Another question which emerges from our study is whether parents with different socio-economic background only *perceive* the returns to parental investments to be different or whether the returns to parental investments really differ across families of different socio-economics status. In Boneva and Rauh (2017) we further investigate whether the production function parameters differ significantly with parent or child characteristics. Interestingly, we cannot reject the null that the returns to parental

time investments are the same across households with different socio-economic status, i.e. we find no evidence that high SES parents are more productive than low SES parents or that investments are more productive for children with high initial skill levels.

In the model we estimate, investments lead to increases in skill levels and increased skill levels lead to increases in earnings. An interesting related question is how parents of different socio-economic status perceive the mapping of investments into skills as well as the mapping of skills into earnings. Could it be that parents of different socio-economic status perceive the mapping of investments into skills as similar but that they differ in their beliefs about the returns to skills in the labor market? While our research design does not allow us to disentangle the two channels, we provide suggestive evidence in Table A.6 that the results are not merely driven by differences in beliefs about the returns to skills in the labor market. Compared to high SES parents, low SES parents also perceive the returns to early investments to be lower when we use the probability of graduating from university as an outcome variable. More research will be needed to shed some further light on this question.

7 Conclusion

In this paper, we use hypothetical investment scenarios to elicit parental beliefs about the technology which maps parental investments in different time periods into future child outcomes. Our first main result is that parents perceive the returns to parental investments in early periods of a child's school life as *less* productive compared to parental investments in later periods of childhood. Moreover, we find that parents perceive the investments in the different time periods as substitutes rather than complements, i.e. they perceive the returns to late investments to be *lower* if these investments are preceded by high early investments. Our second main finding is that parents differ in their beliefs about the productivity of investments and that this heterogeneity is systematic. In particular, parents with low socio-economic status perceive the returns to early investments to be lower. We also document that parental beliefs are predictive of current investment decisions made by parents.

These results are robust across two independently conducted surveys and raise important questions which need to be addressed to further our understanding of which policies might be most effective in raising child outcomes, especially among families of low socio-economic status. First, a question which emerges is whether parents are on average correct in their beliefs about the returns to investments in the different periods of childhood. A comparison to the estimated returns we obtain in Boneva and Rauh (2017) suggests that parents may in fact overestimate the relative importance of late investments,

which might lead to a misallocation of resources across time periods. While there is some recent work on the optimal timing of investments (e.g., Cunha, Heckman and Schennach 2010, Del Boca, Flinn and Wiswall 2014, Attanasio, Meghir and Nix 2015, Carneiro et al. 2015), more research will be needed on which parental investments are most effective in a given time period and how to optimally allocate resources over time.

Second, the results raise important questions concerning which bottlenecks need to be overcome to promote parental investments and child development in disadvantaged families. While traditional models of parental investments have pointed to the importance of credit constraints in explaining differences in investments across socio-economic groups (Restuccia and Urrutia 2004, Caucutt and Lochner 2012, Cunha 2013, Lee and Seshadri 2014), the findings in this paper suggest that socio-economic differences in parental investments might also be driven by socio-economic differences in parental beliefs about the returns to parental investments. If parents from low socio-economic groups underestimate the returns to parental investments and/or if they misperceive the malleability of their children's skills and the capability of their children to acquire new skills, then interventions which target parental beliefs may be effective in raising parental investments and child outcomes. In related work, Alan, Boneva and Ertac (2015) provide evidence from a randomized educational intervention which targets *students'* beliefs about the malleability of skills and find that treated students are significantly more likely to engage in skill accumulating activities and more likely to accumulate skills as a result. Whether a similar intervention targeted at parents has the potential to increase parental investments and child outcomes is an important policy-relevant question that future research should address.

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Appendix A: Supplementary Analysis

Table A.1: Parental Time Spent with Children every Week (in min) - Sample A

	Weekday	Weekend day	Week total	SD	Min	Max	Median
Talk about school	25.75	23.34	175.11	189.73	0	1980	120
Help with homework	19.19	25.58	144.39	148.06	0	1060	110
Reading-telling stories	10.14	12.66	76.01	137.01	0	1320	0
Play board-card games	6.86	31.06	89.76	152.88	0	1400	45
Total time	58.74	87.9	462.36	408.26	0	3630	360

Table A.2: Share of Parents Engaging in Activities with their Children (in %) - Sample A

	Never	Once a year	Every 6 months	Every 3 months	Once a month	Every 2 weeks	Every week
Watch theatre or circus	7.3	36.3	29.3	19.8	5.2	1.3	.7
Visit museum/art gallery	12.9	34.8	31.3	17.8	2.4	.4	.4
Outdoor activities	1.9	1.1	3.2	4.9	16.6	12.5	59.8
Meet with teachers	.9	18.7	45	28.2	4.9	.9	1.5

Table A.3: Monthly Expenditures of Parents - Sample A

	Mean	SD	Min	Max	Median
Books (non-school)	10.27	9.56	0	60	10
Toys, games, DVDs etc.	11.93	17.67	0	300	10
Sports, music lessons	47.56	54.17	0	500	30
Private tuition	11.54	44.78	0	700	0
Total money	79.3	86.82	0	1201.5	60

Table A.4: Time investments (age 5) - Sample B

	Mean	SD	Min	Max	Median
Visits park with child in a given week	.86	.35	0	1	1
Hours TV child watches per day	1.47	1.03	0	7	1
Days parent reads to child per week	5.17	2.04	0	7	6

Table A.5: Family activities (age 10) - Sample B

	1	2	3	4	5
Go for walks together	.02	.11	.4	.33	.14
Have breakfast/tea together	0	.03	.1	.25	.61
Have a chat with the child	0	.01	.04	.22	.73
Interested in child's education	0	.01	.06	.45	.47
Time spent talking to child	0	.03	.3	.41	.26

Parents were asked to give their responses on a 5-point Likert scale. For items 1-3, the Likert scale ranged from 'Never' (1) to 'Very often' (5). For item 4, the scale ranged from 'Not interested at all' (1) to 'Extremely interested' (5), while for item 5 the scale ranged from 'None at all' (1) to 'A great deal' (5). The numbers reported are the frequencies with which parents chose a specific answer.

Table A.6: Determinants of Probability of Graduating from University - Sample A

Dependent variable: Expected probability of graduating from university			
Early investments	11.020***	11.970***	11.156***
	(0.716)	(0.737)	(0.734)
Late investments	14.268***	15.219***	14.507***
	(0.783)	(1.010)	(0.810)
High human capital	13.925***	13.927***	14.149***
	(0.817)	(0.817)	(0.833)
Early x Late		-0.161	
		(0.102)	
Income x Early			1.547**
			(0.772)
Income x Late			0.898
			(0.915)
Income x HC			1.183
			(0.871)
Constant	10.144***	9.554***	7.866***
	(0.723)	(0.739)	(1.102)
Parent fixed effects	Yes	Yes	Yes
Observations	2132	2132	2030
R^2	0.735	0.736	0.734

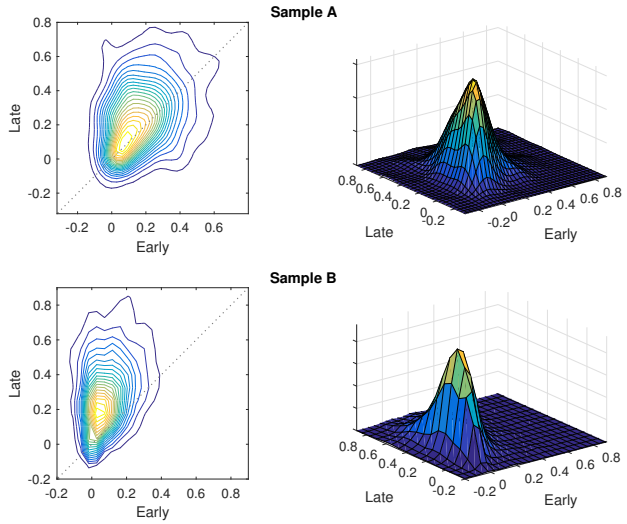
Note: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors are clustered at the parent level. The regressions are performed using the parents' responses to all eight hypothetical investment scenarios. The dependent variable is the probability with which the parents think the child in the hypothetical scenario will graduate from university (in percentage points, i.e. 0-100). *Early investments* is a dummy variable indicating that parental time investments in years 3-6 are high (i.e. parents spend 3 additional hours helping their child with his school work), while *Late investments* is a dummy variable that indicates that parental time investments in years 7-10 are high. *High human capital* is a dummy variable which equals 1 if the child in the scenario has high initial human capital. *Income* refers to the standardized household income of the respondent (mean 0, standard deviation 1).

Table A.7: Determinants of Perceived Log Earnings at Age 30 (weighted)

Dependent variable: Perceived log earnings at age 30				
	Sample A		Sample B	
Early investments	0.160***	0.179***	0.110***	0.139***
	(0.028)	(0.027)	(0.005)	(0.006)
Late investments	0.331***	0.350***	0.313***	0.343***
	(0.036)	(0.042)	(0.008)	(0.010)
High human capital	0.156***	0.156***	0.312***	0.312***
	(0.023)	(0.023)	(0.010)	(0.010)
Early x Late		-0.038		-0.059***
		(0.025)		(0.007)
Constant	9.723***	9.713***	9.469***	9.455***
	(0.017)	(0.019)	(0.008)	(0.008)
Parent fixed effects	Yes	Yes	Yes	Yes
Observations	3907	3907	13559	13559
R^2	0.812	0.812	0.768	0.770

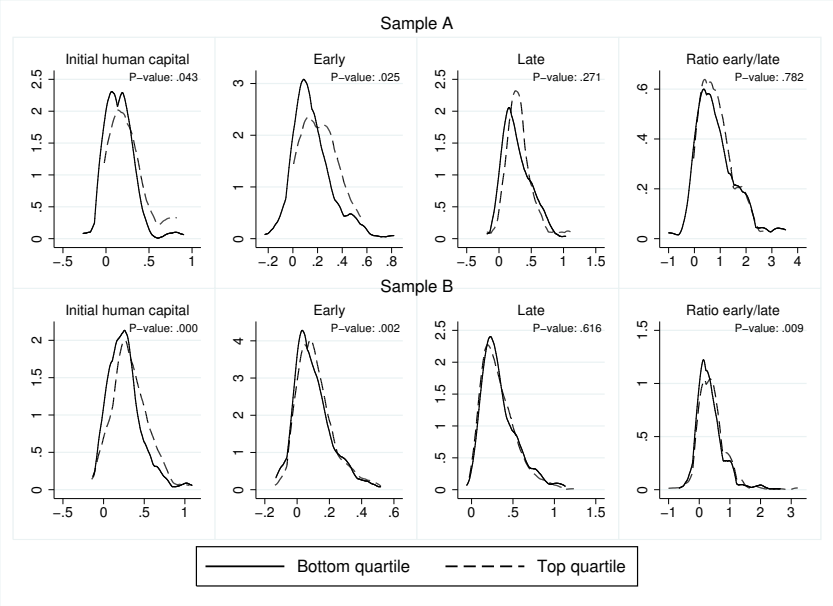
Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors are clustered at the parent level. Weights are computed in order to resemble a representative population in terms of household income. Columns 1-2 show the results for Sample A, while columns 3-4 show the results for Sample B. For each sample, the regressions are performed using the parents' responses to all eight hypothetical investment scenarios. The dependent variable is the log of expected earnings of the child in the hypothetical scenario at age 30. *Early investments* refers to the level of early investments parents make in the scenario, while *Late investment* refers to the level of late investments parents make in the scenario. *High human capital* is a dummy variable which equals 1 if the child in the scenario has high initial human capital.

Figure A.1: Distribution of Individual Perceived Returns



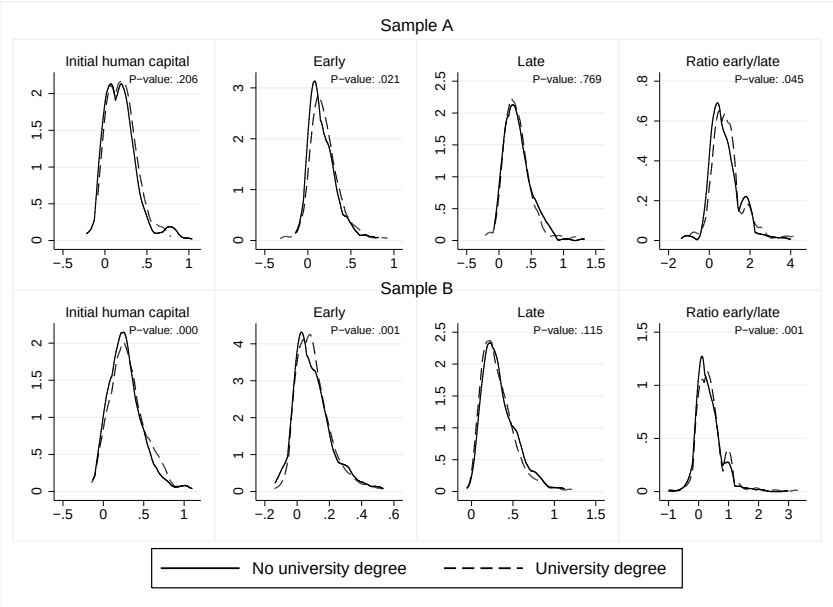
Note: This figure shows the joint distributions of individual perceived returns to early and late investments. The left panels show contour plots while the right panels show density distributions.

Figure A.2: Distribution of Perceived Returns by Income Quartile



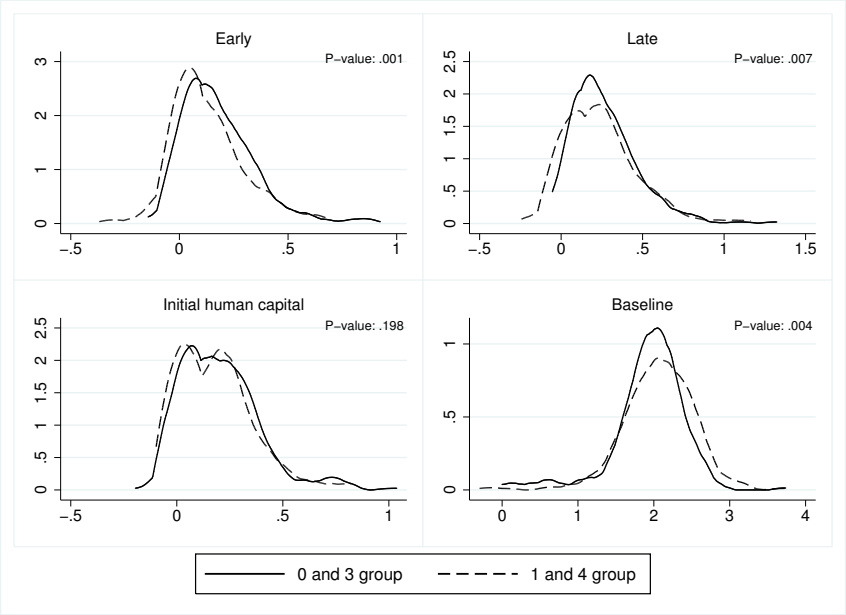
Note: Panels show kernel densities of perceived returns to high human capital, high early investments, high late investments, and perceived ratio of returns. Top panels show results for Sample A, bottom panels results for Sample B. All densities are depicted separately for bottom and top income quartile respondents. Reported p-values are from Kolmogorov-Smirnov tests for equality of distributions.

Figure A.3: Distribution of Perceived Returns by Parental Education



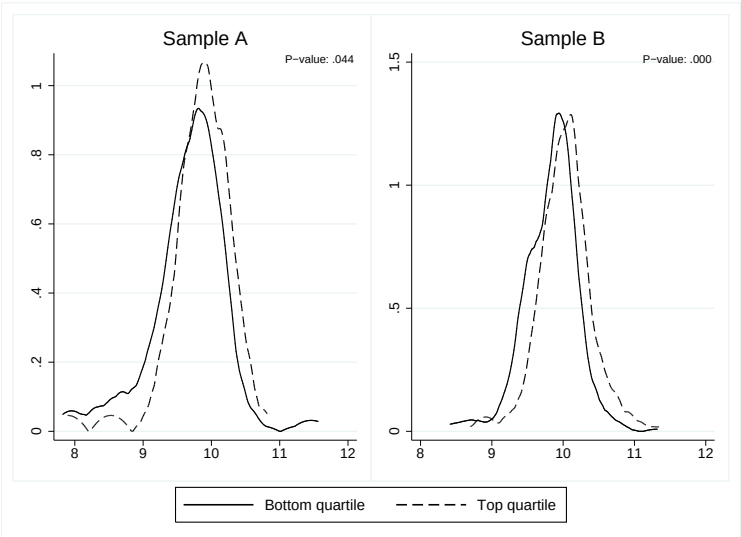
Note: Panels show kernel densities of perceived returns to high human capital, high early investments, high late investments, and perceived ratio of returns. Top panels show results for Sample A, bottom panels results for Sample B. All densities are depicted separately for respondents with and without university degree. Reported p-values are from Kolmogorov-Smirnov tests for equality of distributions.

Figure A.4: Beliefs in Sample A by Scenario Group



Note: Panels depict kernel densities of perceived return to early investments, late investments, and high human capital, as well as the perceived intercept, which captures the perceived earnings of a child with low human capital, and low early and late investments. The densities are depicted separately for respondents who saw 0 hours and 3 hours (0-3 group) and respondents who saw 1 hour and 4 hours (1-4 group). Reported p-values are from Kolmogorov-Smirnov tests for equality of distributions.

Figure A.5: Distribution of Perceived Baseline Level of Log Earnings at Age 30



Note: Panels depict the kernel densities of the perceived intercept, which captures the perceived earnings of a child with low human capital, and low early and late investments. The densities are depicted separately for top and bottom income quartile respondents. Reported p-values are from Kolmogorov-Smirnov tests for equality of distributions.

Appendix B: Questionnaires

B.1 Hypothetical Investment Scenarios (Sample A)

We are interested in your opinion about how important it is that parents help their children with their school work, and whether it is more important for parents to help their children during primary school or during secondary school. For this purpose, we will ask you to imagine two different families, the Jones and the Smiths, who make decisions about how much to help their child. We know these questions are difficult. Please try to consider each scenario carefully and tell us what you believe the likely outcome to be.

Mr and Mrs Jones have one child, John. John is in Year 3 of primary school, and in the KS1 SATs John achieved the expected level (i.e. Level 2). In the following school years, Mr and Mrs Jones can decide how much to help John with his school work. Assuming there is no inflation, what do you expect John's gross yearly earnings to be when he is 30 years old...[49]

A) if they help John 0 hours every week *in school years 3-6, and* 0 hours every week *in school years 7-10?*
B) if they help John 3 hours every week *in school years 3-6, and* 0 hours every week *in school years 7-10?*
C) if they help John 3 hours every week *in school years 3-6, and* 3 hours every week *in school years 7-10?*
D) if they help John 0 hours every week *in school years 3-6, and* 3 hours every week *in school years 7-10?*

Now imagine a different family, the Smiths. In many respects the Smiths are very similar to the Jones. For example, Mr and Mrs Smith also have one child, Simon, who is in Year 3 of primary school. They live in the same neighbourhood as Mr and Mrs Jones and they have similar levels of income and education. However, there is one *difference. Unlike John, Simon did not achieve the expected level in the KS1 SATs (he only achieved Level 1). Mr and Mrs Smith can decide how much to help Simon with his school work. Assuming there is no inflation, what do you expect Simon's gross yearly earnings to be when he is 30 years old...*

A) if they help Simon 0 hours every week *in school years 3-6, and* 0 hours every week *in school years 7-10?*
B) if they help Simon 3 hours every week *in school years 3-6, and* 0 hours every week *in school years 7-10?*
C) if they help Simon 3 hours every week *in school years 3-6, and* 3 hours every week *in school years 7-10?*
D) if they help Simon 0 hours every week *in school years 3-6, and* 3 hours every week *in school years 7-10?*

[49] Parents were either presented with low/high investments of 0 hours/3 hours or with low/high investments of 1 hour/4 hours. Half the group was randomly selected to see the 0 hours/3 hours scenarios, while the other half was presented with the 1 hour/4 hours scenarios.

B.2 Hypothetical Investment Scenarios (Sample B)

We are interested in your opinion about the importance of different parenting practices. For this purpose, we will ask you to imagine two different families, the Jones and the Smiths, who make decisions about how involved they should be in their child's upbringing. We know these questions are difficult. Please try to consider each scenario carefully and tell us what you believe the likely outcome to be.

Mr and Mrs Jones have one child, John. John is 5 years old, and he is more intelligent than the average kid. On an intelligence test, he scored better than 70% of the kids in his age group. Now let's think about the future earnings of John. Assuming that John is working full-time, what do you expect John's gross yearly earnings to be when he is 30 years old in each of the following scenarios:[50]

A) If at age 5 the parents read to John every second day, they rarely take John to the playground and John watches TV for 2 hours every day, and at age 10 the parents show moderate interest in John's education, they don't talk to John very much, and they sometimes engage in activities together (e.g., go out for walks, have breakfast or tea together).

B) If at age 5 the parents read to John every day, they take John to the playground once every fortnight, and John watches TV for 1 hour every day, and at age 10 the parents show moderate interest in John's education, they don't talk to John very much, and they sometimes engage in activities together (e.g., go out for walks, have breakfast or tea together).

C) If at age 5 the parents read to John every day, they take John to the playground once every fortnight, and John watches TV for 1 hour every day, and at age 10 the parents show a lot of interest in John's education, they talk to John quite a lot, and they often engage in activities together (e.g., go out for walks, have breakfast or tea together).

D) If at age 5 the parents read to John every second day, they rarely take John to the playground and John watches TV for 2 hours every day, and at age 10 the parents show a lot of interest in John's education, they talk to John quite a lot, and they often engage in activities together (e.g., go out for walks, have breakfast or tea together).

Now imagine a different family, the Smiths. In many respects the Smiths are very similar to the Jones. For example, Mr and Mrs Smith also have one child, Simon, who is also 5 years old. They live in the same neighbourhood as Mr and Mrs Jones and they have similar levels of income and education. However, there is one *difference. Unlike John, Simon is less intelligent than the average kid. On an intelligence test, Simon scored worse than 70% of the kids in his age group. Now let's think about the future earnings of Simon. Assuming that Simon is working full-time, what do you expect Simon's gross yearly earnings to be when he is 30 years old in each of the following scenarios:*

A) If at age 5 the parents read to Simon every second day, they rarely take Simon to the playground and Simon watches TV for 2 hours every day, and at age 10 the parents show moderate interest in Simon's education, they don't talk to Simon very much, and they sometimes engage in activities together (e.g., go out for walks, have breakfast or tea together).

B) If at age 5 the parents read to Simon every day, they take Simon to the playground once every fortnight, and Simon watches TV for 1 hour every day, and at age 10 the parents show moderate interest in Simon's education, they don't talk to Simon very much, and they sometimes engage in activities together (e.g., go out for walks, have breakfast or tea together).

[50] Note that respondents who received the invitation to participate in the survey via their son's school were presented with scenarios which featured John and Simon, while respondents who received the invitation to participate via their daughter's school were presented with scenarios which featured Jessica and Sarah.

C) If at age 5 the parents read to Simon every day, they take Simon to the playground once every fortnight, and Simon watches TV for 1 hour every day, and at age 10 the parents show a lot of interest in Simon's education, they talk to Simon quite a lot, and they often engage in activities together (e.g., go out for walks, have breakfast or tea together).

D) If at age 5 the parents read to Simon every second day, they rarely take Simon to the playground and Simon watches TV for 2 hours every day, and at age 10 the parents show a lot of interest in Simon's education, they talk to Simon quite a lot, and they often engage in activities together (e.g., go out for walks, have breakfast or tea together).

B.3 Beliefs about Malleability of Skills

Parents were asked to rate the following items on a 5-point Likert scale (1 "strongly disagree", 2 "disagree", 3 "neither agree nor disagree", 4 "agree", 5 "strongly agree").

1. *My child develops at his/her own pace and there is not much I can do about that.*
2. *If my child is not performing well in school, there is a lot I can do to help my child perform better.*
3. *My child is a certain kind of person, and there is not much that can be done to really change that.*
4. *Some children get more discouraged by setbacks than others – there is not much I as a parent can do to change that.*

B.4 Capabilities

Imagine your child was provided with maximum support, that is imagine that your child spent several hours every week with a professional teacher or coach. Do you think your child has the capability of achieving the following over the course of his/her life? [1 "very unlikely", 2 "unlikely", 3 "undecided", 4 "likely", 5 "very likely"]

1. *Learn a new foreign language*
2. *Programme a software*
3. *Manage a company*

B.5 Current Parental Investments (Sample A)

How much time do you usually spend on the following activities (with your child)? [provide time in minutes for a weekday, and time in minutes for a weekend day]

1. *Talk about child's experiences at school*
2. *Help the child with homework, check workbooks*
3. *Reading/telling stories*
4. *Play board or card games*

How often do you engage in the following activities (with your child)? [never, once a year, once every 6 months, once every 3 months, once a month, every 2 weeks, every week]

1. *Watch a show (e.g. theatre, circus)*
2. *Visit a museum/art gallery*
3. *Outdoor activities (e.g. take a walk, go to playground)*
4. *Meet with child's teachers*

How much money do you usually spend on the following categories every month (for your child)? [monthly expenditure in £]

1. *Books (other than school books)*
2. *Toys, games, DVDs etc.*
3. *Sport clubs/Music lessons/Other societies*
4. *Private tuition*

B.6 Current Parental Investments (Sample B - Ages 3-9)

1. *How many hours a day does your child usually watch TV?*
2. *On how many days has your child been read to at home in the past 7 days?*
3. *In the past 7 days, has your child been to a park, recreational ground or adventure playground?*

B.7 Current Parental Investments (Sample B - Ages 10 and above)

As a family, how often do you do any of the following activities with your child? [never, rarely, sometimes, often, very often]

1. *Go out for walks together*
2. *Have breakfast or tea together*
3. *Have a chat or talk with the child (for more than 5 minutes)*

With regard to your child's education, how concerned or interested are you compared to other parents? [Not interested at all, slightly interested, moderately interested, very interested, extremely interested]

About how much time do you spend talking to your child each day? [None at all, a little, a moderate amount, a lot, a great deal]

Appendix C: Sample

Figure C.1: Map of Schools Sample A (orange=primary, blue=secondary)

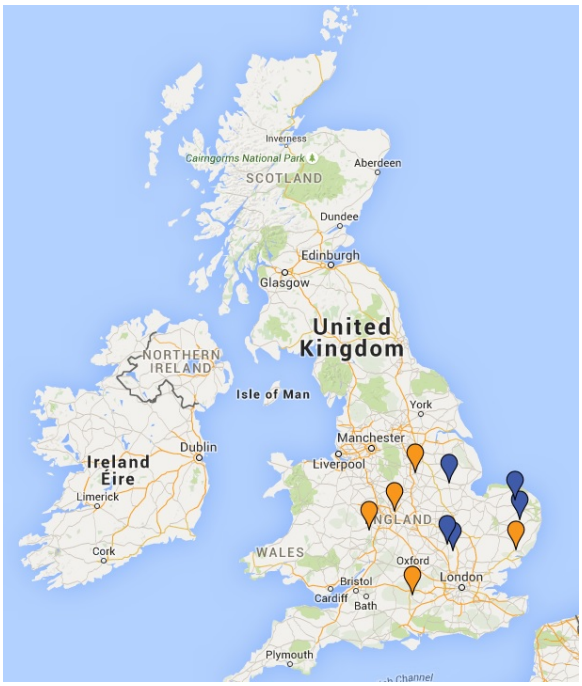


Figure C.2: Map of Schools Sample B (orange=primary, blue=secondary)

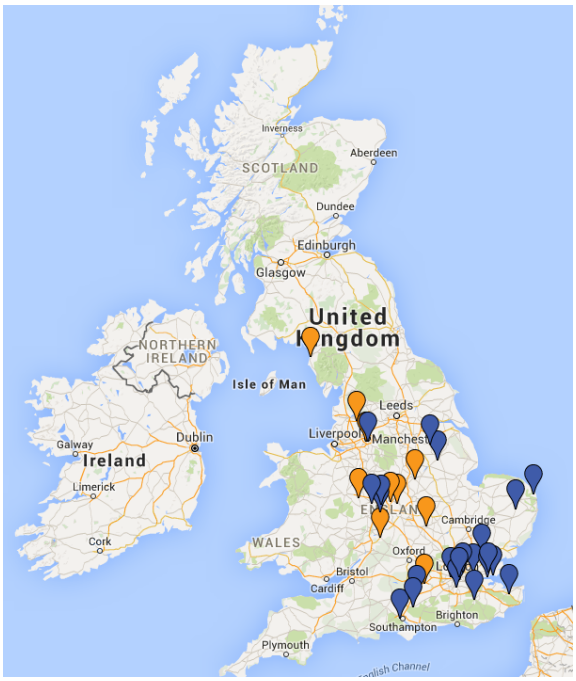
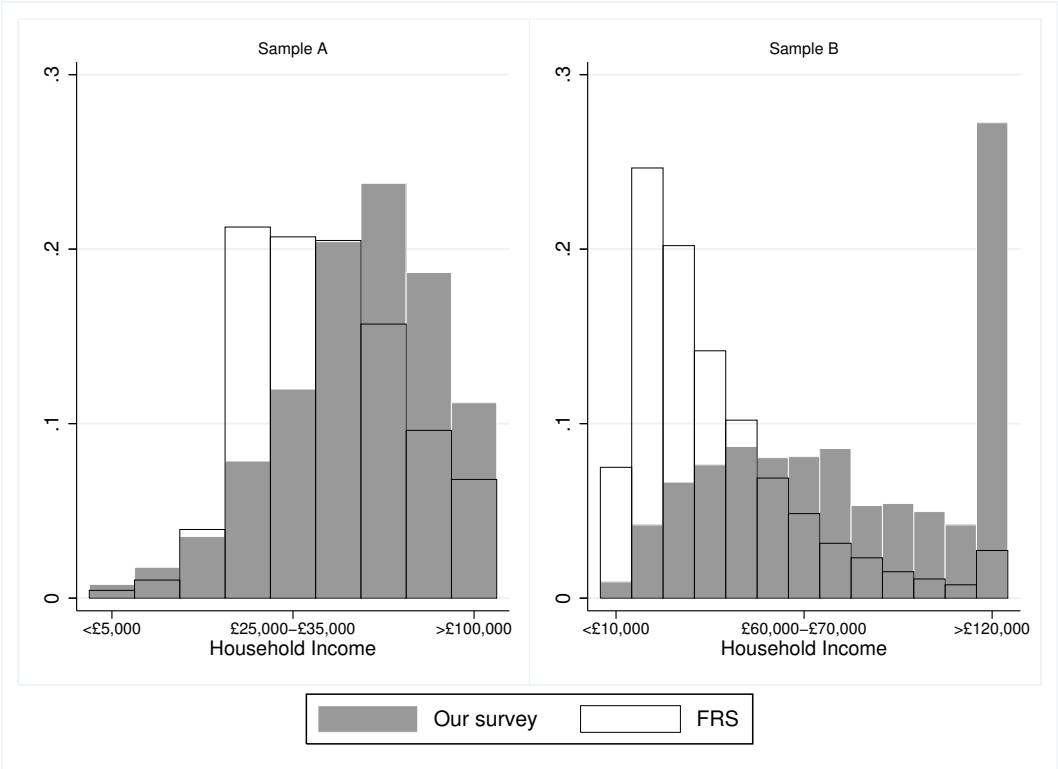


Table C.1: Characteristics of Schools in Sample

	Sample A		Sample B		National Average	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
% students on free school meals	10.6	7.4	10.3	11.7	25.4	29.3
% English not first language	3.6	11.0	24.0	15.0	20.0	15.7
% students meeting standard	49.4	-	49.6	-	53.0	-
Attainment 8 score	-	54.6	-	54.8	-	48.5
Number of schools	5	5	11	24		
Total number of students	2,304	4,901	5,534	22,502		
Number of parents in sample	140	398	214	1,695		
Response rate	6.1%	8.1%	3.9%	7.5%		

Notes: Averages shown for all schools within each sample (weighted by total number of students in each school). Data shown reflects the period in which schools were sampled (2015 for sample A and 2016 for sample B) with the exception of performance scores which are shown for 2016. For primary schools, the performance score is the percentage of students meeting the expected standards in reading, writing and Maths in the Key Stage 2 examinations, whereas for secondary schools it is the attainment 8 score, which measures students' average GCSE grade across eight subjects, including English and Maths. National averages shown for 2016.

Figure C.3: Distribution of Annual Household Income



Note: This figure shows the distribution of annual household income for parents in our sample and for a representative sample of parents in England who have at least one child aged 5-19 (Source: Family Resources Survey 2013-2014).

Table C.2: Balancing Tests

	0 and 3 group		1 and 4 group		Δ
	Mean	[SD]	Mean	[SD]	p-value
Female respondent	.83	[.37]	.85	[.35]	.53
Employed	.87	[.34]	.84	[.36]	.46
Part-time	.38	[.49]	.40	[.49]	.67
Full-time	.62	[.49]	.60	[.49]	.67
University graduate	.45	[.50]	.46	[.50]	.73
Single parent	.14	[.34]	.14	[.35]	.92
Number of children	1.98	[.99]	1.92	[.78]	.47
Age of child	13.47	[3.59]	13.16	[3.64]	.33
Female child	.57	[.50]	.54	[.50]	.61
Household income	55030	[269549]	56380	[26978]	.58
Observations		257		250	

Note: This table shows that the two sub-samples of Sample A are balanced in terms of observable characteristics. Parents in the 0-3 group where presented investment scenarios with 0 hours and 3 hours, while parents in the 1-4 group were presented with investment scenarios with 1 hour and 4 hours. Reported p-values from t-tests of differences in means.

Appendix D: Differences Between 0-3 Group and 1-4 Group

To account for the fact that Sample A respondents are randomized into a group for whom low investments are 0 hours and high investments are 3 hours, and a group for whom low investments are 1 hour and high investments are 4 hours, we run the following regression:

$$\log y_j = \alpha + \beta_{1,1} I_{f,1j} + \beta_{1,2} I_{n,1j} + \beta_{2,1} I_{f,2j} + \beta_{2,2} I_{n,2j} + \beta_3 \theta_{1j} + \gamma_i + \epsilon_j, \tag{5}$$

where the investment of the first hour for each period $k \in \{1, 2\}$ is represented by:
$I_{f,kj} = \begin{cases} 0 & \text{if } I_{kj} = 0 \\ 1 & \text{if } I_{kj} > 0 \end{cases}$ and the next hours by: $I_{n,kj} = \begin{cases} 0 & \text{if } I_{kj} < 3 \\ I_{kj} - 1 & \text{if } I_{kj} \geq 3 \end{cases}$.
The harmonization is carried out by replacing the income parents predict by:
$\log y_j = \begin{cases} \log y_j & \text{if } I_{kj} = 0 \\ \log y_j - \beta_{k,1} & \text{if } I_{kj} = 1 \end{cases}$ and $\log y_j = \begin{cases} \log y_j & \text{if } I_{kj} < 4 \\ \log y_j - \beta_{k,2} & \text{if } I_{kj} = 4 \end{cases}$.

The intuition behind this approach is that parents on average perceive decreasing returns to scale to hours invested. Therefore, the difference between investing 1 hour instead of 4 hours will be smaller than the difference between investing 0 hours instead of 3 hours. Given that we are interested in the perceived returns to the first three hours of investments for each individual parent, the estimates for parents in the scenarios with 1 hour and 4 hours are biased downwards if we do not conduct the before mentioned harmonization. With our approach we are computing each parent's perceived return as if all were facing the scenarios with 0 hours and 3 hours of time investment.

Appendix E: Heterogeneity in Perceived Substitutability

In order to investigate whether parents differ in their perceptions about the substitutability of the different inputs, we run a regression of the following form separately for each parent i:

$$\log \tilde{y}_{ij} = \alpha_i + \beta_{1i} I_{1j} + \beta_{2i} I_{2j} + \beta_{3i} \theta_j + \beta_{4i} I_{1j} \times I_{2j} + \beta_{5i} I_{1j} \theta_j + \beta_{6i} I_{2j} \times \theta_j + \epsilon_{ij}$$

We then regress the individual coefficients β_{4i}, β_{5i} and β_{6i}, which capture individual beliefs about the substitutability/complementarity of the different inputs, on parental characteristics and present the results in Table E.1. In Sample B we find some evidence that more educated parents perceive investments across periods to be less substitutable indicated by the positive and significant coefficient of the university dummy. We do not find any significant associations between household income and any of the perceived complementarity/substitutability coefficients.

Table E.1: Heterogeneity in Perceived Substitutability/Complementarity Between Different Inputs

Dependent variable: Perceived interaction coefficient early (E) and late (L) investments and initial human capital (HC)						
	Sample A			Sample B		
	(ExL)	(ExHC)	(LxHC)	(ExL)	(ExHC)	(LxHC)
2nd income quartile	-0.049	-0.008	0.001	-0.004	-0.006	-0.029*
	(0.031)	(0.022)	(0.023)	(0.017)	(0.012)	(0.016)
3rd income quartile	-0.046	-0.008	0.004	0.020	0.019	0.004
	(0.037)	(0.027)	(0.027)	(0.018)	(0.013)	(0.018)
4th income quartile	0.005	-0.039	-0.013	0.019	0.008	-0.016
	(0.044)	(0.031)	(0.032)	(0.017)	(0.012)	(0.017)
University graduate	0.011	0.001	0.018	0.027**	-0.007	-0.014
	(0.023)	(0.016)	(0.016)	(0.013)	(0.009)	(0.013)
Number of children	0.048***	-0.009	0.013	-0.011*	-0.008	-0.009
	(0.013)	(0.009)	(0.009)	(0.007)	(0.005)	(0.007)
Female respondent	-0.005	-0.008	-0.020	-0.010	0.023**	0.012
	(0.030)	(0.022)	(0.022)	(0.014)	(0.010)	(0.014)
Single parent	-0.013	-0.018	-0.016	-0.003	0.021	-0.013
	(0.036)	(0.026)	(0.026)	(0.018)	(0.013)	(0.018)
Age of child	0.007**	-0.004**	-0.003			
	(0.003)	(0.002)	(0.002)			
Age of parent				0.002**	0.001	0.000
				(0.001)	(0.001)	(0.001)
Age oldest child				-0.003*	0.002	0.001
				(0.002)	(0.001)	(0.002)
Female child				-0.006	0.001	-0.002
				(0.013)	(0.009)	(0.013)
Constant	-0.173***	0.106**	0.019	-0.106**	-0.048	-0.005
	(0.060)	(0.043)	(0.043)	(0.045)	(0.033)	(0.045)
Sample mean	-.03	.01	-.01	-.08	.02	-.02
Observations	468	468	468	1682	1682	1682
R^2	0.046	0.015	0.016	0.016	0.012	0.006

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Column 1-3 show results for Sample A, columns 4-6 show results for Sample B. Within each sample, the dependent variables is the individual perceived substitutability captured by the interaction term of early and late investments (first column), of early investments and initial human capital (second column), and of late investments and initial human capital (third column). Additional controls are household income quartile dummies, university education, number of children, gender, and single parent status. Female child refers to whether the child in the scenario is female (Sample B).