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

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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 technology which maps parental investments into future child outcomes. We document that parents perceive late investments as more productive than early investments, and that they perceive investments in different time periods as substitutes. These beliefs contrast with findings in the empirical literature which suggest that early investments are more productive and are complementary to late investments. 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 parental investments are positively related to household income, thereby potentially contributing to intergenerational earnings persistence.

Keywords: Parental Investments, Skill Accumulation, Human Capital, 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 within the population, 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 wages (Guryan, Hurst and Kearney 2008, Ramey and Ramey 2010). This raises the important question of why we observe such a large and systematic variation in parental investments. While differences in 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.

Parental beliefs about the technology which maps investments into future outcomes might not only be important for the total level of investments parents choose to make, but also for how parents choose to allocate resources across different time periods. An increasing amount of empirical evidence suggests that early investments are more productive than late investments because skills become less malleable as children age (e.g. Carneiro and Heckman 2003, Cunha, Heckman and Schennach 2010, Del Boca, Flinn and Wiswall 2014, Heckman and Kautz 2014).[1] Also, skills acquired at earlier ages have been shown to increase the productivity of later investments because of important dynamic complementarities in the skill accumulation process (*'skills beget skills'*) (Cunha, Heckman and Schennach 2010, Caucutt and Lochner 2012, Attanasio et al. 2015).[2] A range of quantitative studies find that it would be more efficient to target interventions at early rather than later childhood (Restuccia and Urrutia 2004, Caucutt and Lochner 2012, Lee and Seshadri 2014, Herrington 2015). If indeed resources directed to younger children are more likely to produce long lasting effects, this raises the important question whether parents, who make investment decisions on a daily basis, are aware of the relative importance of early investments. Since parental beliefs about returns to investments in different time periods are likely to determine both the level and timing of parental investments, a better understanding of

[1] There is an increasing number of studies which document that early childhood interventions can at least partially remedy the adverse effects of poverty. Examples of such successful interventions include the Jamaican Study (Grantham-McGregor et al. 1991, Gertler et al. 2014), Head Start (Deming 2009), the Perry Preschool Programme (Heckman et al. 2010, Heckman, Pinto and Savelyev 2013) and the Carolina Abecedarian Project (Campbell et al. 2014).

[2] Heckman and Mosso (2014) provide an extensive survey on the dynamic complementarity of early and late investments.

parental beliefs seems crucial for understanding what drives parental investment decisions.

The aims of this paper are threefold. First, we document parental beliefs about the technology which maps parental investments into future outcomes. More specifically, we investigate (a) whether parents perceive early or late investments as more productive, and (b) whether they believe that the skill-production technology exhibits dynamic complementarities. Second, we document individual heterogeneity in beliefs about the productivity of investments. In particular, we investigate (a) whether this heterogeneity in perceived returns can predict actual investment decisions, and (b) whether perceived returns are systematically related to the socio-economic background of the respondent. Third, we examine whether parental beliefs about the returns to parental investments are positively correlated with parental beliefs about the malleability of children's skills/the capability of children to acquire skills. Intuitively, if parents believe that children's skills are not malleable through home inputs or that children do not have the capability to acquire skills, even if they are provided with professional support, then we would expect parents to be less likely to believe that parental investments pay off.

To address these questions, we survey 538 parents of 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 parental beliefs about the technology which maps investments into future outcomes, we present parents with hypothetical investment scenarios which vary along three dimensions: (i) the level of early investments, (ii) the level of late 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.[3] In the scenarios, early investments refer to investments made during school years 3-6, while late investments refer to investments made during school years 7-10. We focus on a particular type of parental investment which is relevant to all school-age children: the number of hours parents spend per week helping their child with school work.

The results reveal that parents do perceive the returns to early and late investments to be different. However, in contrast to the findings in the empirical literature, we find that parents perceive *late* investments to be more productive than early investments. Moreover, we find that parents perceive early and late investments as substitutes rather than complements. While a greater efficiency of early investments combined with dynamic complementarities would suggest that missed investments are difficult to make up for, parents seem to believe that postponing investments into later periods of

[3]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. Moreover, by presenting parents with hypothetical investment decisions of hypothetical families, we can hold a series of factors constant, such as household, child and neighbourhood characteristics.

childhood is the more efficient allocation. This wedge between research evidence and parental beliefs could drive a misallocation of investments in the home environment, which might prevent children from accumulating skills optimally.

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. Moreover, we document that the heterogeneity in perceived returns is systematic: Compared to parents with high income, parents with low income perceive the returns to parental investments to be lower.

Finally, we show that parental beliefs about the returns to parental investments are positively correlated with (i) parental beliefs about the malleability of children's skills through home inputs and (ii) parental beliefs about the capability of children to acquire skills given they are provided with professional support. Moreover, when we examine the heterogeneity of responses in these two supplementary belief measures, we find that low income parents are less likely to believe that children's skills are malleable and that children have the capability of acquiring skills.

The results presented in this paper have important policy implications. While traditional policies have focused on improving child outcomes by alleviating credit constraints, our results suggest that policies which target parental beliefs about the productivity of parental investments are also likely to be effective in raising child outcomes. For example, such policies could inform parents about the benefits of parental investments, and raise parental awareness about the fact that early investments are particularly important and difficult to make up for at later stages. Also, policies which target parental beliefs about the malleability of children's skills or the capability of children to acquire skills might be effective in raising parental investments. A similar intervention which targets children's beliefs about the malleability of skills, has been shown to increase children's propensity to engage in skill accumulating activities and to increase skill levels (Alan, Boneva and Ertac 2015). Our findings also suggest that policies which target parental beliefs are most likely to benefit children from low socio-economic backgrounds. Therefore, such policies have the potential to reduce the socio-economic gap in achievement and improve equality of opportunity.

There is a growing literature which documents the importance of *students'* beliefs about the returns to education for students' educational investment decisions.[4] Attanasio and Kaufmann (2009) and Kaufmann et al. (2014) analyze the link between students' beliefs about the returns to formal education

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

and students' decisions to spend more time in formal education. Delavande and Zafar (2014) and Wiswall and Zafar (2015) investigate how students' beliefs about earnings and other non-pecuniary benefits affect students' college choices. 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.

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 also drawn attention to the importance of parental beliefs in the skill accumulation process.[5] Caucutt, Lochner and Park (2015) provide a theoretical framework in which they explore how information-based frictions can lead to 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. Our study relates to recent work by Cunha, Elo and Culhane (2013) which documents differences in parental beliefs about the productivity of parental investments during periods of very early childhood, and to work by Cunha (2014) which investigates the relative role of parental beliefs for explaining differences in parental investments.

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. Section 4 presents details about the data collection and the characteristics of the sample. Section 5 presents the main results, while Section 6 presents additional analyses using the two supplementary measures of parental beliefs. Section 7 discusses the results and concludes.

2 Theoretical Framework

In the following, we present a theoretical framework that describes the technology which maps parental investments into future child outcomes. We use this theoretical framework to highlight which parental beliefs are likely to be critical for parents' investment decisions and to motivate our survey design.

[5] 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.

The model is based on the general framework developed in Cunha, Heckman and Schennach (2010).[6]

Consider a model with two periods of childhood $t\epsilon\{1,2\}$, followed by one period of working life. Each child enters period t with a set of skills or initial conditions, denoted as θ_t. Parental ability is denoted by P_t and is assumed to be constant over time. In every period of childhood, parents choose how much to invest in their child (I_t). The technology of skill production depends on the stock of skills θ_t, parental ability P_t, parental investments I_t, and the production function f in period t:

$$\theta_{t+1} = f_t(\theta_t, P_t, I_t). \tag{1}$$

Assume that f is monotone increasing in its arguments, twice continuously differentiable and concave in I_t. Adult outcome y is produced by the set of skills with which the child enters working life, θ_3, via the following function: $y = g(\theta_3)$. We assume that g is monotone increasing in its argument. Taken together, adult outcome y depends on the child's initial conditions θ_1, parental ability P_1, early investments I_1, late investments I_2, and the function h which maps these inputs into adult outcome y.

$$y = h(\theta_1, P_1, I_1, I_2). \tag{2}$$

Given the complex nature of the process, it seems unlikely that parents have complete information about how their investments map into future child outcomes. Instead, when deciding how much to invest, parent i's decision will be based on the *perceived* production technology:[7]

$$y = h_i(\theta_1, P_1, I_1, I_2). \tag{3}$$

Parental beliefs about different partial and cross derivatives of this production technology are likely to be critical for parents' investment decisions. First, investment choices are likely to be driven by the perceived marginal returns to investments in the different time periods:

$$\frac{\partial h_i(\cdot)}{\partial I_1}, \frac{\partial h_i(\cdot)}{\partial I_2}. \tag{4}$$

Not only are these quantities of interest in themselves, but what also seems particularly important

[6]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.

[7]Note that there are different reasons why parents might differ in their beliefs about how investments map into future outcomes. 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).

for the timing of investments is whether parents perceive investments to be more productive in any of the two time periods:

$$\frac{\partial h_i(\cdot)}{\partial I_1} \lessgtr \frac{\partial h_i(\cdot)}{\partial I_2}. \tag{5}$$

Second, the literature emphasizes the importance of different cross derivatives in determining the optimal level of investments. 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:

$$\frac{\partial h_i(\cdot)}{\partial I_2 \partial I_1} \lessgtr 0. \tag{6}$$

Also, the perceived degree of complementarity between investments and the initial level of human capital is likely to play an important role. In particular, 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.

$$\frac{\partial h_i(\cdot)}{\partial I_t \partial \theta_1} \lessgtr 0 \; \forall t \epsilon \{1, 2\}. \tag{7}$$

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 important characteristics of the production function, we elicit parental beliefs using a novel survey design.

3 Eliciting Parental Beliefs

As motivated in the theory section, parental beliefs about specific characteristics of the production technology are likely to be critical for parental investment decisions. In particular, parental beliefs about several partial and cross derivatives are likely to determine the level, timing and allocation of parental investments. To gain a better understanding of how parents perceive the production technology, we elicit parental beliefs by presenting parents with different hypothetical investment scenarios that vary along three key dimensions: (i) the level of early investments, (ii) the level of late investments, and (iii) the initial human capital level of the child. A comparison of the parents' responses across the different scenarios allows us to infer how parents perceive the returns to early

and late investments (equations (4) and (5)), and how parents perceive the complementarity between different inputs (equations (6) and (7)).

The parents' responses to the hypothetical scenarios do not only allow us to gain a better understanding of how parents perceive the characteristics of the production function, but they also allow us to investigate whether individual differences in beliefs are predictive of actual parental investment decisions. Moreover, we can investigate whether parental beliefs systematically differ with the characteristics of the respondent, such as the parents' socio-economic status.

In addition to using hypothetical scenarios to elicit parental beliefs about the production technology, we also administer two supplementary surveys which allow us to shed further light on why parents might differ in their beliefs about the productivity of parental investments. In the following, we first present details on the hypothetical investment scenarios and the empirical specification we use to estimate parental beliefs about the characteristics of the production technology. We then proceed by explaining the two supplementary measures of parental beliefs.

Hypothetical Scenarios: To elicit parental beliefs about important characteristics of the production technology, we present parents with several different hypothetical investment scenarios.[8] More specifically, we present all parents with *two* hypothetical families (the "Jones" and the "Smiths"). In both hypothetical families there is one child ("John Jones" and "Simon Smith") who is in Year 3 of primary school. Parents are told that while the Jones and the Smiths live in the same neighbourhood and are similar in many different respects (e.g. in terms of income and education), their children differ in their prior achievement in the national curriculum test which children in the UK have to take at the end of Year 2.[9] More specifically, they are told that John managed to achieve the level which is expected of this age group, while Simon did not.[10]

For each of these two hypothetical families, parents are then presented with *four* different investment scenarios. In particular, those investment scenarios differ in terms of how much time the Jones and the Smiths spend every week helping their child with school work (i) in school years 3-6 (henceforth referred to as *early* investment) and (ii) in school years 7-10 (henceforth referred to as *late* investment). 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

[8] For the precise wording of the questions, see Appendix.

[9] We chose to make it explicit that the two hypothetical families are otherwise very similar (e.g. two-parent households with one son, parents have similar income and education, families live in the same neighbourhood) because this allows us to abstract from other potential differences between the families.

[10] The expected level in the Year 2 national curriculum test (Key Stage 1, age 7) is level 2. More than 80% of all students are successful in achieving the expected level (Source: National Pupil Database, 2014). We chose this stark difference in achievement to make the difference in initial ability levels salient to the respondents.

investments/high late investments. In total, parents are hence 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 when he is 30 years old (y_j).[11] 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. In addition to asking about the likely future earnings, we also ask parents to state how likely they think it is that the child will graduate from university, an outcome which is also of interest in itself.[12]

Table 1: Overview of Different Scenarios

A: The Jones
High Initial Human Capital

	Low Late Investment	High Late Investment
Low Early Investment	y_1 Low early/ Low late	y_2 Low early/ High late
High Early Investment	y_3 High early/ Low late	y_4 High early/ High late

B: The Smiths
Low Initial Human Capital

	Low Late Investment	High Late Investment
Low Early Investment	y_5 Low early/ Low late	y_6 Low early/ High late
High Early Investment	y_7 High early/ Low late	y_8 High early/ High late

While we present all respondents with eight different scenarios (see Table 1), we vary the amount of time which is associated with *low* and *high* levels of investments. In particular, for half the respondents "high" investments refer to spending 4h every week helping the child with his school work, while "low" investments refer to spending 1h every week on these activities. For the other half of the respondents "high" investments refer to 3h while "low" investments refer to 0h. This design allows us to additionally investigate whether parents perceive returns to be diminishing as investment levels rise.

The parents' responses to the eight different scenarios allow us to infer parental beliefs about the characteristics of the production technology. First, the design allows us to investigate parental beliefs about the partial derivatives of the production function with respect to early and late investments (equations (4) and (5)). Intuitively, by comparing parents' responses in the scenarios in which early investments are high to the corresponding scenarios in which early investments are low, we can obtain

[11] Parents are instructed to assume there is no inflation, and are asked to report their response in £.

[12] To limit the length of the questionnaire, we administer the university question to a random subset of all respondents (N=266). To facilitate comprehension, parents can select the probability in a range between 0 and 100 using a moveable ruler. We also give the additional information that 0% means "definitely not", that 100% means "definitely yes", and that higher numbers indicate a higher probability of graduating from university.

an estimate of parental beliefs about the returns to early investments. Similarly, by comparing parents' responses in the scenarios in which late investments are high to the corresponding scenarios in which late investments are low, we can obtain an estimate of parental beliefs about the returns to late investments.[13]

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 (equations (6) and (7)). Intuitively, 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 $(\log y_4 - \log y_3) > (\log y_2 - \log y_1)$ and $(\log y_8 - \log y_7) > (\log y_6 - \log y_5)$. If instead investments in the different time periods are perceived as substitutes, we expected perceived returns to late investments to be *lower* when early investments are high. Moreover, 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. For example, if early investments and initial human capital levels are perceived as complements, we expect perceived returns to early investments to be higher when the initial human capital level of the child is high, i.e. we expect $(\log y_3 - \log y_1) > (\log y_7 - \log y_5)$ and $(\log y_4 - \log y_2) > (\log y_8 - \log y_6)$.

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. In particular, we estimate the β coefficients in the following specification:

$$\log y_j = \alpha + \beta_1 I_{1j} + \beta_2 I_{2j} + \beta_3 \theta_j + \beta_4 I_{1j} \times I_{2j} + \beta_5 I_{1j} \times \theta_j + \beta_6 I_{2j} \times \theta_j + \gamma_i + \epsilon_j, \tag{8}$$

where j indicates the scenario, α is the intercept, I_{1j} and I_{2j} denote the levels of early and late investments, respectively, θ_j refers to the initial level of human capital, and γ_i are parent fixed effects. A comparison between β_1 and β_2 reveals whether parents perceive early or late investments as more productive. Moreover, if parents perceive early and late investments as complements (substitutes),

[13]For the perceived returns to early investments, the differences of interest are $(\log y_3 - \log y_1)$, $(\log y_4 - \log y_2)$, $(\log y_7 - \log y_5)$, and $(\log y_8 - \log y_6)$. For the perceived returns to late investments, the differences of interest are $(\log y_2 - \log y_1)$, $(\log y_4 - \log y_3)$, $(\log y_6 - \log y_5)$, and $(\log y_8 - \log y_7)$.

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.[14]

Supplementary Measures: In addition to presenting parents with hypothetical investment scenarios, which allow us to examine parents' beliefs about the returns to investments, we administer two supplementary questionnaires, which allow us to gain a deeper understanding of *why* parents might differ in their beliefs about the productivity of 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*").[15] 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.[16] We use this information to investigate 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.

4 The Data

The data we collect contain detailed information on parental beliefs as well as information on current parental investment decisions. This allows us to investigate whether parental beliefs about the returns to investments are predictive of current parental investments. In addition, we collect information on background characteristics, which allows us to examine whether parents with different characteristics

[14] 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.

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

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

hold systematically different beliefs about the returns to parental investments.

We collect the information on parental beliefs, parental investments and parent and child characteristics using an online survey. The survey was distributed in June 2015 via the parental mailing lists of 5 primary schools and 5 secondary schools in the UK that agreed to participate (see map in Appendix).[17] We incentivize parental participation through a prize draw of a voucher worth £100.

The Sample: Our sample consists of 538 completed parental surveys.[18] The data contain a range of different parent, child and household characteristics (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 in our sample is £55,771. Only 14% of the sample are single parent households.

The parents in our sample on average have 1.96 children. The children for whom the parents completed the survey are on average 13 years old, 56% of them are female and 8% receive free school meals. 26% of the children attend primary school, while the remaining 74% are in secondary school.[19]

Table 2: Descriptive Statistics

	Mean	[SD]
Female respondent	.85	[.36]
Employed	.85	[.35]
Part-time	.4	[.49]
Full-time	.6	[.49]
University graduate	.45	[.5]
Single parent	.14	[.34]
Language other than English	.06	[.23]
Number of children	1.96	[.88]
Age of child	13.39	[3.58]
Female child	.56	[.50]
Primary school	.26	[.44]
Free School Meal	.08	[.27]
Household income	55771.12	[27019.46]
Observations	538	

Note: Household income refers to the gross annual income of all household members.

Compared to a representative sample of parents in England with at least one child aged 5-19,

[17] We set up the survey with the survey software Qualtrics. The invitation to participate asks the primary caregiver (referred to as 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.

[18] In total, the invitation was sent to approx. 7,500 parents, so the response rate is about 7%. About 9.8% of the contacted parents have a child enrolled in the school who is eligible for free school meals (Source: Department for Education). In our sample, the percentage of parents with children eligible for free school meals is 8%.

[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 the oldest child enrolled in this school.

the parents in our sample have somewhat higher levels of education, they are less likely to be single parents, more likely to be employed and they report higher annual household incomes.[20] Figure C.2 in the Appendix shows the distribution of annual household incomes for parents in our sample and parents in the Family Resources Survey (FRS).

Parental Investments: To investigate whether parental beliefs about the productivity of investments are predictive of current parental investment activities, we ask every parent to provide detailed information on the time and financial resources that he/she allocates towards his/her child. In particular, parents are asked 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").[21]

Tables A.1-A.3 in the Appendix present the summary statistics of the responses to these three questionnaires, respectively. The median number of hours that parents talk to their children about their experiences at school and help them with their homework is 3.8h/week for children in primary school and 3.9h/week for children in secondary school. The median number of hours parents spend on reading/telling stories and playing board/card games is 3.5h/week for children in primary school. For children in secondary school this number decreases to 0.3h/week, which reflects the fact that these types of activities are more relevant for younger children (Table A.1). Concerning the frequency at which parents engage in different types of activities, we can see that there is a significant amount of heterogeneity in responses (Table A.2). Moreover, there are differences between primary and secondary school children. For example, parents of secondary school children spend less time with their children on joint outdoor activities. Turning to monthly expenditures (Table A.3), parents of primary (secondary) school children on average spend about £11/month (£10/month) on books (other than school books), £18/month (£10/month) on toys, games, DVDs etc., £53/month (£46/month) on sport clubs/music lessons/other societies, and £7/month (£13/month) on private tuition.

[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 of which 7% receive free school meals. The average annual household income in this sample is £44,520. We randomly draw 1,000 subsamples comprised of 85% females (to make the sample comparable with our sample) and find that on average 32% have a university degree, 30% are single parents, and 69% are employed. Out of those employed, 58% work full-time.

[21] See Appendix for more details on the specific questions, which were included in the questionnaire.

5 Results

In this section, we use parents' responses to the hypothetical investment scenarios to address several important questions. In Section 5.1 we examine parental beliefs about the technology which maps investments into future outcomes. More specifically, we are interested in establishing whether parents perceive early or late investments as more productive (equations (4) and (5)), and whether they perceive the different inputs into the production technology as complements or substitutes (equations (6) and (7)). In Section 5.2 we document the heterogeneity in individual perceived returns to investments, and investigate to what extent individual perceived returns differ with the socio-economic background of the respondent. In Section 5.3 we show that individual beliefs about the returns to investments are predictive of current parental investment decisions.

5.1 Parental Beliefs about the Production Technology

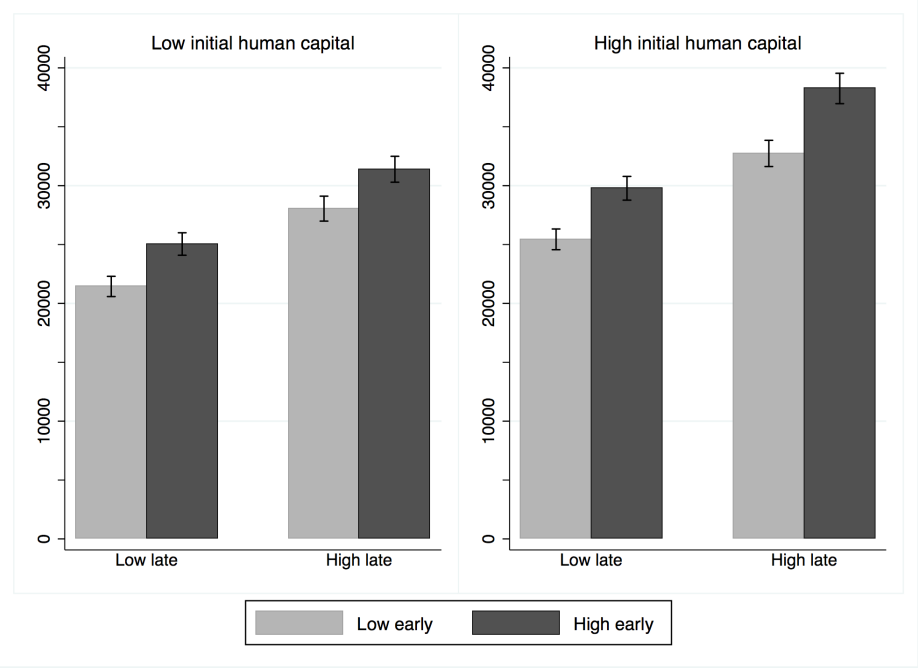
As explained in Section 3, parents are presented with eight hypothetical investment scenarios and they are asked to state the expected earnings of the child at age 30 in each of these eight scenarios. Figure 1 depicts the child's expected earnings (y_j) in the eight scenarios (see Table 1), averaged across all respondents. While the left panel depicts the average expected earnings for the child with low initial human capital ("Simon Smith"), the right panel depicts the average expected earnings for the child with high initial human capital ("John Jones"). 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).

As can be seen from the first bar in the first panel, parents expect children with low initial human capital who are exposed to low levels of investments in both periods to earn approximately £21,400 per annum when they are 30 years old. This number increases as we move to scenarios with either high early investments (bar 2, £25,000 per annum) or high late investments (bar 3, £28,000 per annum), or high early and high late investments (bar 4, £31,400 per annum). Note that parents expect earnings to be significantly *higher* when children are exposed to low early/high late investments compared to when they are exposed to high early/low late investments;[22] a finding which is inconsistent with the evidence in the empirical literature suggesting that early investments are more productive than late investments (Cunha, Heckman and Schennach 2010, Del Boca, Flinn and Wiswall 2014). The right panel depicts the expected earnings for a child with high levels of initial human capital. As we would expect, the

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

average expected earnings are higher in all four investment scenarios, with average expected earnings being approx. £25,400 per annum for low early/low late investments, £29,8000 per annum for high early/low late investments, £32,700 per annum for low early/high late investments and £38,300 per annum for high early/high late investments.

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), averaged across all respondents (with 95% confidence intervals).

Using the Family Resource Survey of 2013-2014, we find the average annual earnings of 25-34 year old men in England to be £29,950. 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 £26,450. Given that about 80% of all students in the UK achieve the expected level, the weighted average of parental estimates is about £30,500, which is remarkably close to the actual average earnings of men in the specified age group.

To investigate the perceived returns to investments in more detail, we pool all parents' responses to the eight hypothetical investment scenarios and regress the expected log earnings of the child at age 30 ($\log y_j$) on (i) the number of weekly hours of early investments in the scenario (I_{1j}), (ii) the number of weekly hours of late investments in the scenario (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_j).[23]

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

Dependent variable: log earnings at age 30				
Early Investment	0.058***	0.058***	0.057***	0.051***
	(0.004)	(0.004)	(0.004)	(0.003)
Late Investment	0.092***	0.091***	0.090***	0.085***
	(0.004)	(0.004)	(0.004)	(0.003)
High Human Capital	0.185***	0.185***	0.190***	0.185***
	(0.013)	(0.013)	(0.013)	(0.010)
Log(HH income)			0.186***	
			(0.014)	
Employed			0.052**	
			(0.021)	
University graduate			-0.045***	
			(0.014)	
Number of children			0.014*	
			(0.008)	
Female respondent			-0.077***	
			(0.019)	
Single parent			0.109***	
			(0.022)	
Constant	9.786***	9.446***	7.500***	9.749***
	(0.015)	(0.046)	(0.156)	(0.010)
School fixed effects	No	Yes	Yes	No
Parent fixed effects	No	No	No	Yes
Observations	4069	4069	3771	4069
R^2	0.181	0.226	0.275	0.827

Notes: 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 expected earnings of the child in the hypothetical scenario at age 30 (in logs). Early Investment refers to the number of weekly hours the parents in the scenario help their child with his school work in years 3-6, while Late Investment refers to the number of weekly hours the parents help the child with his school work in years 7-10. High Human Capital is a dummy variable which equals 1 if the child in the scenario has high initial human capital. 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, and whether the responding parent is a single parent.

Column 1 of Table 3 presents the results we obtain when we do not include any fixed effects or additional controls in the regression. According to these estimates, an additional weekly hour of early investments (i.e. during school years 3-6) translates into an increase in expected earnings by 5.8%, while an additional weekly hour of late investments (i.e. during school years 7-10) translates into an increase in expected earnings by 9.2% (see equation (4)). High initial human capital is associated

[23] As explained in Section 3, half the respondents are presented with investments of 1h/week (low) and 4h/week (high), while the other half of the respondents is presented with investments of 0h/week (low) and 3h/week (high). Hence, investments can take the values 0, 1, 3 and 4.

with an earnings increase of 18.5%. These effects are all significant at the 1% level. The results are remarkably robust to the inclusion of school fixed effects (column 2) and the inclusion of parent and household characteristics (column 3). Column 4 presents the results we obtain when we use parent fixed effects, which allows us to estimate the coefficients using within-parent variation only. Again the estimates we obtain are very similar in magnitude and significant at the 1% level. A result worth noting is that in all four specifications the coefficient on late investments is significantly larger than the coefficient on early investments (at the 1% level), indicating that parents perceive an additional weekly hour of late investments as more productive than an additional weekly hour of early investments (see equation (5)).

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 equation (6)). When we allow for an interaction between early and late investments, we find that the coefficient on the interaction term is significantly negative (at the 1% level), indicating that parents perceive early and late investments as substitutes (column 1). Again this finding contrasts with findings in the empirical literature, which has documented that late investments are *more* productive if they are preceded by high early investments (e.g. Cunha, Heckman and Schennach 2010, Caucutt and Lochner 2012, Attanasio et al. 2015). Next we investigate whether parents perceive investments as more productive if the initial human capital of the child is high (see equation (7)). 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). Finally, since we have different levels of hourly investments, we can also investigate whether parents believe that there is a concave relationship between investments and expected earnings. When we allow for a quadratic relationship between the level of investments and log earnings, we find that investments are perceived to have a lower productivity at higher levels (column 3). When we simultaneously control for all interaction terms and the squared terms we obtain similar results (column 4).

We also examine the parents' beliefs about how likely it is that the child will graduate from university in each of the eight scenarios. These questions were asked to a random subset of respondents (N=266). Table A.4 in the Appendix shows that the estimated relationships are similar to the ones we obtain when we use expected earnings as a dependent variable. Parents perceive the productivity of late investments to be higher than the productivity of early investments (column 1). More specifically, an additional hour of early investments translates into an increase in the probability of graduating

from university by 3.7 percentage points, while an additional hour of late investments translates into an increase by 4.8 percentage points. The difference between these two coefficients is statistically significant at the 1% level. When we examine the perceived substitutability/complementarity of investments in the different time periods (column 2), we also find that the coefficient on the interaction term is negative (p-value=0.102).

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

Dependent variable: log earnings at age 30				
Early Investment	0.061***	0.050***	0.083***	0.082***
	(0.003)	(0.003)	(0.011)	(0.012)
Late Investment	0.094***	0.086***	0.102***	0.104***
	(0.004)	(0.004)	(0.014)	(0.014)
High Human Capital	0.185***	0.187***	0.185***	0.187***
	(0.010)	(0.016)	(0.010)	(0.016)
Early x Late	-0.005***			-0.003**
	(0.001)			(0.001)
Early x High HC		0.002		0.002
		(0.003)		(0.003)
Late x High HC		-0.003		-0.003
		(0.004)		(0.004)
Early^2			-0.008***	-0.006**
			(0.003)	(0.003)
Late^2			-0.004	-0.003
			(0.003)	(0.003)
Constant	9.731***	9.748***	9.731***	9.723***
	(0.011)	(0.012)	(0.013)	(0.015)
Parent fixed effects	Yes	Yes	Yes	Yes
Observations	4069	4069	4069	4069
R^2	0.827	0.827	0.828	0.828

Notes: 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 expected earnings of the child in the hypothetical scenario at age 30 (in logs). Early Investment refers to the number of weekly hours the parents in the scenario help their child with his school work in years 3-6, while Late Investment refers to the number of weekly hours the parents help the child with his school work in years 7-10. 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 late investments have a greater payoff than early investments and that foregone early investments can be made up for due to their perceived substitutability with 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, these potentially biased beliefs could lead to a misallocation of investments across time. If parents are not sufficiently aware of the relative importance of early investments, this could lead to an underinvestment in early periods. This could be especially problematic since there are also other reasons which might prevent parents

from optimally investing in their young children. For example, parents are more likely to be credit constrained when their children are young (e.g. Caucutt and Lochner 2012) and parents might choose to invest less into younger children because the payoffs to early investments lie in the more distant future.

5.2 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 early investments and the perceived returns to late investments 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.[24] We average across these differences and divide the resulting value by 3 to obtain the average return to 1h of parental time investment:[25]

$$r_i^{early} = \frac{1}{3}\frac{(\log y_3 - \log y_1) + (\log y_4 - \log y_2) + (\log y_7 - \log y_5) + (\log y_8 - \log y_6)}{4}$$

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

$$r_i^{late} = \frac{1}{3}\frac{(\log y_2 - \log y_1) + (\log y_4 - \log y_3) + (\log y_6 - \log y_5) + (\log y_8 - \log y_7)}{4}$$

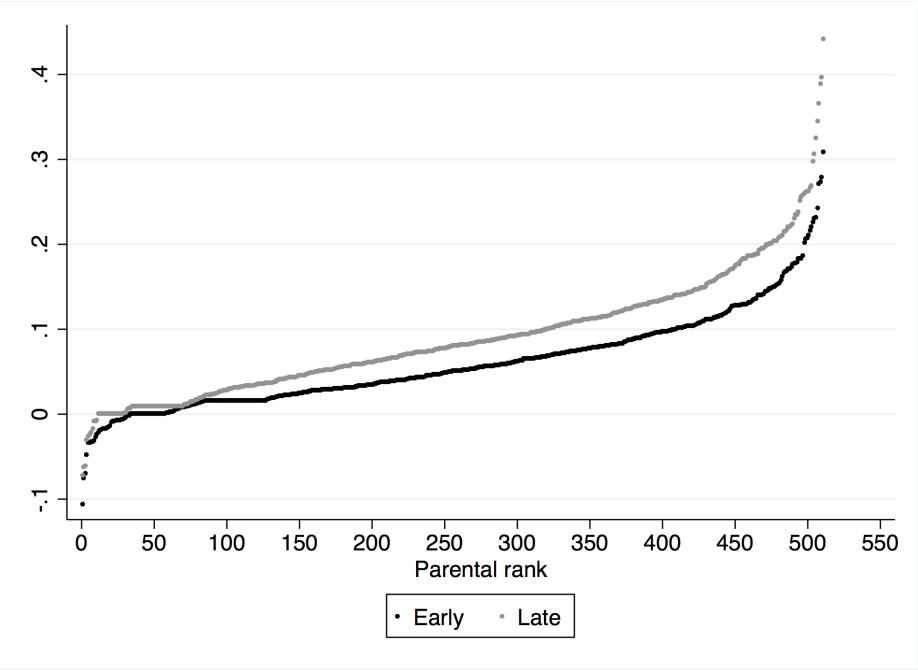
Figure 2 plots the ranked perceived returns to early investments and the ranked perceived returns to late investments. As can be seen in this figure, there is a high degree of heterogeneity in perceived returns. What is also visible from this graph is that the distribution of perceived returns to early investments contains lower values than the distribution of perceived returns to late investments, indicating that parents perceive early investments to be less productive than late investments. 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

[24] To make individual averages comparable, we account for the fact that the samples are randomized into a group for whom low investments are 0h while high investments are 3h, and a group for whom low investments are 1h while high investments are 4h. 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.

[25] Note that high levels of investments always exceed low levels of investments by 3 hours.

early and late investments. While there are some parents who perceive early investments to be more productive than late investments, most parents perceive late investments to be more productive.

Figure 2: Distribution of Individual Perceived Returns (ranked)



Note: This figure shows the ranked perceived returns to early investments and the ranked perceived returns to late investments that we calculate for each respondent. 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 investments vary with the characteristics of the respondent. Specifically, we are interested in whether parents with different socio-economic backgrounds hold different beliefs about the returns to investments. We revisit the main estimates in Table 3 (column 4) and examine whether the estimated effects differ by the household income of the respondent. Columns 1 and 2 of Table 5 present the results for below and above median income respondents, respectively. The results reveal that there are substantial differences in perceived returns across households with different levels of income. Respondents with below median household income perceive the returns to an additional hour of weekly early investments to be 4.9% and the returns to an additional hour of weekly late investments to be 8.3%. In contrast, respondents with above median household income perceive the returns to early and late investments to be 6.3% and 9.5%, respectively. The perceived return to having high initial human capital also differs by the income of the respondent. In particular, while below median respondents believe that high initial human capital

is associated with 15.7% higher earnings, above median respondents perceive the returns to high initial human capital to be 19.5%.

Table 5: Determinants of Log Earnings at Age 30 (3)

Dependent variable: log earnings at age 30				
	Median income		Interactions	
	(Below)	(Above)	(Median)	(Income)
Early Investment	0.049***	0.063***	0.049***	0.052***
	(0.004)	(0.005)	(0.004)	(0.003)
Late Investment	0.083***	0.095***	0.083***	0.085***
	(0.005)	(0.007)	(0.005)	(0.003)
High Human Capital	0.157***	0.195***	0.157***	0.184***
	(0.012)	(0.023)	(0.012)	(0.010)
Above median income x Early			0.014**	
			(0.006)	
Above median income x Late			0.012	
			(0.009)	
Above median income x HC			0.038	
			(0.026)	
Standardized income x Early				0.006**
				(0.003)
Standardized income x Late				0.002
				(0.004)
Standardized income x HC				0.023**
				(0.010)
Constant	10.003***	9.712***	9.712***	9.724***
	(0.014)	(0.022)	(0.022)	(0.017)
Parent fixed effects	Yes	Yes	Yes	Yes
Observations	1803	1160	2963	3907
R^2	0.860	0.793	0.840	0.828

Notes: 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 expected earnings of the child in the hypothetical scenario at age 30 (in logs). Early Investment refers to the number of weekly hours the parents in the scenario help their child with his school work in years 3-6, while Late Investment refers to the number of weekly hours the parents help the child with his school work in years 7-10. High Human Capital is a dummy variable which equals 1 if the child in the scenario has high initial human capital. The variable Above Median Income is a dummy which equals 1 if the respondent's household income is above the median, and 0 if the respondent's household income is below the median. Standardized Income refers to the standardized household income of the respondent (mean 0, standard deviation 1).

In column 3, we estimate the regression for all respondents with below and above median income, and we interact the variables of interest with a dummy which equals 1 if the respondent's income is above the median. The coefficients on the three interaction terms are positive and significant, indicating that parents with above median income perceive the returns to investments and to initial human capital to be higher. We also interact the three variables of interest with a continuous measure of household income (column 4).[26] Here, the coefficients on all three interaction terms are also positive,

[26]To facilitate the interpretation of the coefficients, the household income variable used in this regression is standardized

but only the coefficients on the interactions with perceived returns to early investments and perceived returns to high initial human capital are significant (at the 5% level).[27]

We can also use the individual perceived returns to early and late investments, r_i^{early} and r_i^{late}, to visualize differences in perceived returns between respondents with different levels of income. In Panels A and B of Figure 3, we depict the kernel densities of the individual perceived returns to early and late investments for bottom and top income quartile respondents, i.e. for respondents in those two income quartiles for whom the differences are most pronounced. For early investments (Panel A), the distribution of perceived returns for top income parents is shifted to the right (Kolmogorov-Smirnov test for equality of distributions: p-value=0.03). For late investments (Panel B), the distribution of perceived returns for top income quartile respondents is also shifted to the right, although here the Kolmogorov-Smirnov test does not reject the null of equal distributions (p-value=0.27).

We use a similar strategy to calculate the individual perceived returns to high human capital and depict the kernel densities for bottom and top income quartile respondents in Panel C. Top income quartile respondents perceive the returns to high initial human capital to be significantly higher (p-value=0.04). Finally, Panel D depicts the individual perceived log earnings in the baseline scenario, i.e. in the scenario in which human capital, early investments and late investments are low. Again the distribution for top income respondents is shifted to the right, indicating that parents in the top income quartile expect earnings to be higher even when the initial human capital of the child is low and investments in both periods are low (p-value=0.04).

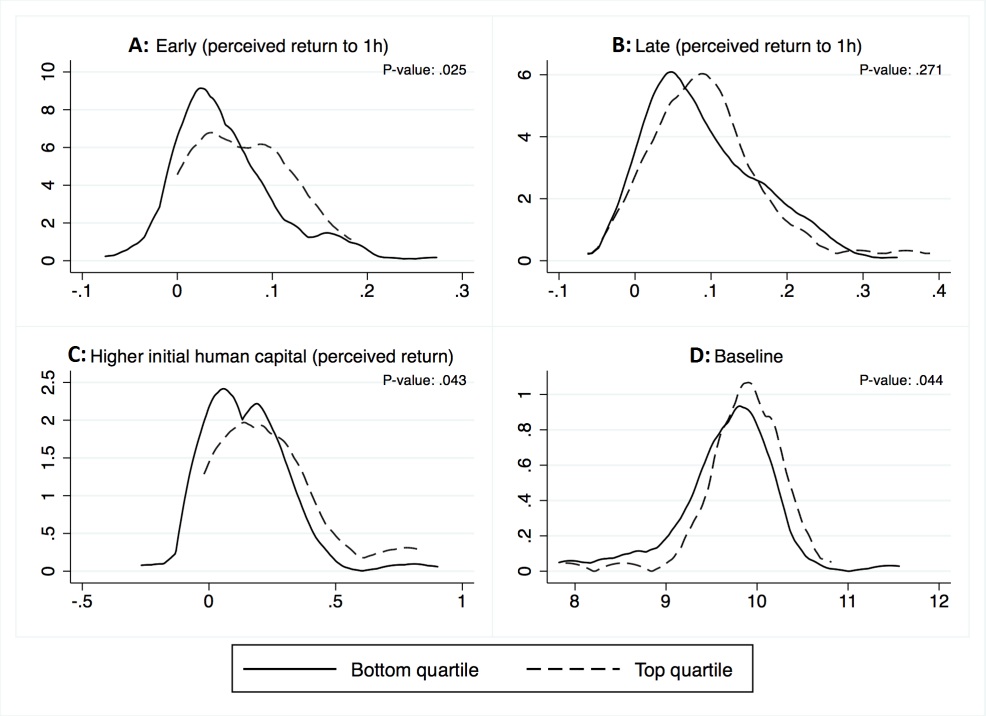
5.3 Do Perceived Returns Predict Current Parental Investments?

In the survey, we also ask parents to provide information on their current investment decisions. We can use this information to investigate whether parental beliefs about the returns to current time investments are predictive of the parents' current investment choices while controlling for a range of parental and child characteristics. More specifically, we regress different measures of current parental time and financial investments on the parents' individual beliefs about the productivity of time investments in the given time period, r_i^t. For parents with children in primary school, we set $r_i^t = r_i^{early}$, whereas for parents with children in secondary school, we set $r_i^t = r_i^{late}$. To facilitate the interpretation of the coefficients, we standardize r_i^t so that the variable has a mean of 0 and a standard deviation of 1.

(mean 0, standard deviation 1).

[27] When we examine the differences in perceived returns in the regression where we use the probability of going to university as a dependent variable, we also find that parents with higher income levels perceive the returns to early investments to be significantly higher (see column 3 of Table A.4).

Figure 3: Distribution of Individual Coefficients by Income Quartile of the Respondent



Note: Panels A and B depict the kernel densities of the perceived returns to 1h of additional weekly early and late investments, respectively. Panel C depicts the kernel density of the perceived return to high human capital while Panel D depicts expected log earnings in the baseline scenario, i.e. when human capital, early investments and late investments are low. All densities are depicted separately for bottom and top income quartile respondents. The reported p-values are from Kolmogorov-Smirnov tests for equality of distributions.

The results are presented in Table 6. A one-standard-deviation increase in the perceived returns to weekly time investments, r_i^t, is associated with parents spending significantly more time (i) helping their children with their homework (column 3), (ii) reading/telling stories to their children (column 4) and (iii) playing games with their children (column 5). Overall, a one-standard-deviation increase in perceived returns predicts a significant increase in the total time parents spend on the specified weekly activities by 68 minutes (column 1). We also extract the first principal component from the questionnaire which asks 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).[28] The estimated coefficient is positive but insignificant. Finally, we regress the total monthly expenditures of the parents on the parents' perceived returns to weekly time investments and we find that a one-standard-deviation increase in perceived returns is associated with parents spending £5.60 more every month (column 7).

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

Overall, the parents' perceived returns to weekly time investments, which we elicit with the help of the hypothetical investment scenarios, are predictive of the parents' actual time investments, especially for how much parents help their children with their homework. These results are consistent with a theoretical model in which parents' investment choices are at least partly determined by parental beliefs about the productivity of investments.

In Section 5.2 we documented that parental beliefs about the returns to investments are positively correlated with the household income of the respondent. 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).

Table 6: Determinants of Current Parental Investments

Dependent variable: Current parental investment							
	Weekly Time Investments					Activities	Expenditure
	Total	School	Homework	Stories	Play		
Perceived Returns$_t$	68.095***	15.719	22.724***	13.005**	14.720*	0.041	5.594*
	(20.869)	(9.652)	(7.667)	(6.092)	(7.725)	(0.045)	(3.317)
Age of child	-1.380	10.415**	-4.168	-8.168**	-5.829	-0.030	-0.753
	(11.285)	(5.161)	(4.061)	(3.236)	(4.133)	(0.024)	(1.805)
Female child	-24.828	-6.794	0.581	-6.021	-8.379	0.205**	11.536
	(45.955)	(20.826)	(16.224)	(13.028)	(16.820)	(0.097)	(7.226)
Log(HH income)	-55.693	-2.239	-10.349	-12.907	-32.564**	0.112	18.575***
	(42.456)	(19.624)	(15.414)	(12.161)	(15.603)	(0.092)	(6.730)
University degree	37.841	24.813	6.916	16.286	-4.997	0.246***	23.523***
	(43.716)	(19.789)	(15.621)	(12.535)	(16.073)	(0.093)	(6.916)
Employment	129.429**	21.953	39.785*	14.522	56.978**	-0.040	8.725
	(65.348)	(29.744)	(23.259)	(18.540)	(24.011)	(0.138)	(10.252)
Number of children	2.081	7.634	-1.414	-4.941	2.006	0.031	-3.806
	(23.949)	(11.045)	(8.635)	(6.839)	(8.728)	(0.052)	(3.826)
Female respondent	118.524**	36.562	46.811**	25.995	31.569	0.018	8.377
	(59.701)	(27.313)	(21.726)	(17.393)	(22.013)	(0.129)	(9.606)
Single parent	-17.574	-0.223	-20.135	-9.093	43.476*	-0.066	-17.661
	(71.871)	(33.321)	(25.337)	(20.680)	(26.055)	(0.149)	(11.192)
Foreign lang. at home	-142.242	-22.163	-47.556	-65.358**	-37.135	-0.329	-12.394
	(101.750)	(45.334)	(35.047)	(28.001)	(36.938)	(0.207)	(15.346)
School fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	377	421	421	404	394	471	441
R^2	0.143	0.052	0.089	0.325	0.114	0.103	0.153

Notes: Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Standard errors are clustered at the parent level. 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 early investments for parents with primary school children, and to the perceived return to late investments for parents with secondary school children. The variable is standardized so that it has a mean of 0 and a standard deviation of 1.

6 Supplementary Measures of Parental Beliefs

In this section, we examine the information from the two supplementary questionnaires which pertain to parents' beliefs about (i) the malleability of their children's skills through the home environment and (ii) the capability of their children to acquire skills given they are provided with maximum support. Intuitively, if parents believe that their children's skills are not malleable through the home environment, or if they believe that their children do not have the capability to acquire skills even if they are provided with maximum support, then parents should be less likely to perceive the returns to parental investments to be high. In the following, we first investigate how the two additional measures correlate with the parents' perceived returns to early and late investments. We then proceed by documenting that the responses to these two additional questionnaires are also systematically related to the socio-economic background of the respondent.

6.1 Correlations Between Different Measures

To construct a composite measure from the questions pertaining to the malleability of skills through the home environment, we use factor analysis to extract the first principal component from the different questionnaire items. Similarly, we extract the first principal component from the items in the capabilities questionnaire to construct a measure of the parents' beliefs about the capability of their child to acquire new skills.[29] Table 7 shows the Spearman rank correlations between these two measures and the parents' perceived returns to early and late investments (see Section 5.2).

Table 7: 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: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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

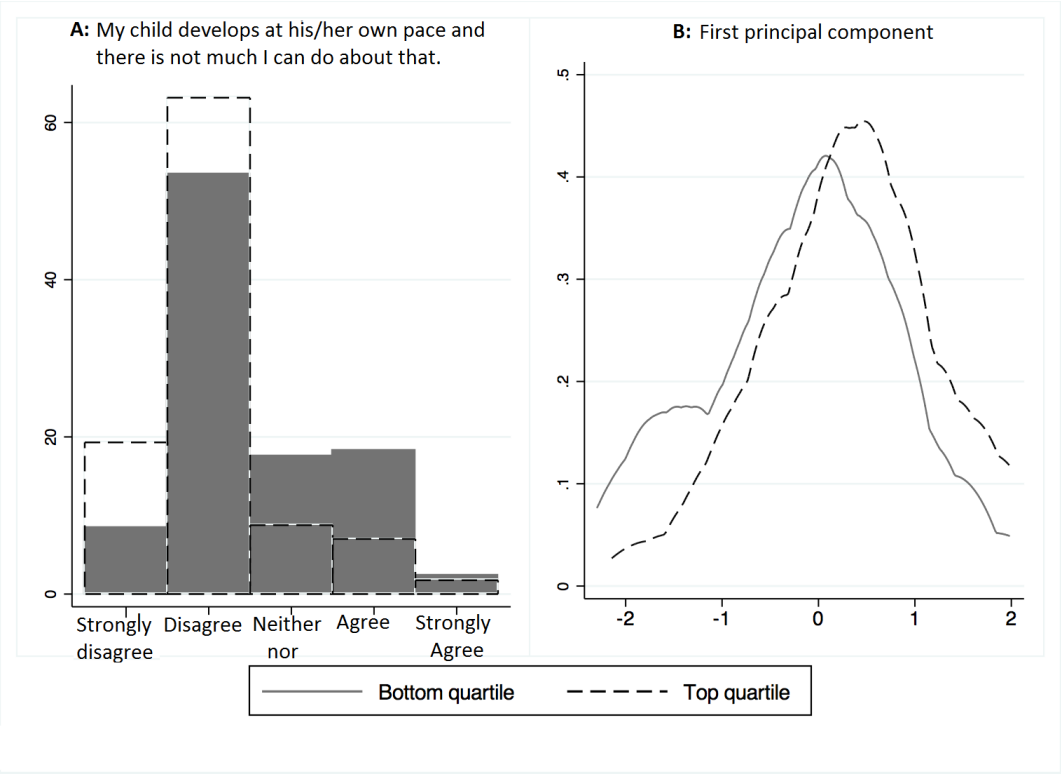
[29] The extracted factors from the malleability of skills and capabilities questionnaire explain 47% and 61% of the variation in item responses, respectively.

with maximum support are also more likely to believe that parental investments pay off, though the correlations are less strong.

6.2 Heterogeneity in Responses

In Section 5.2 we document that parents differ substantially in their beliefs about the returns to parental investments, and that this heterogeneity is systematically related to the socio-economic characteristics of the respondent. When we investigate the parents' responses to the two supplementary questionnaires, we find similar patterns.

Figure 4: Perceived Malleability of Skills by Income Quartile of Respondent



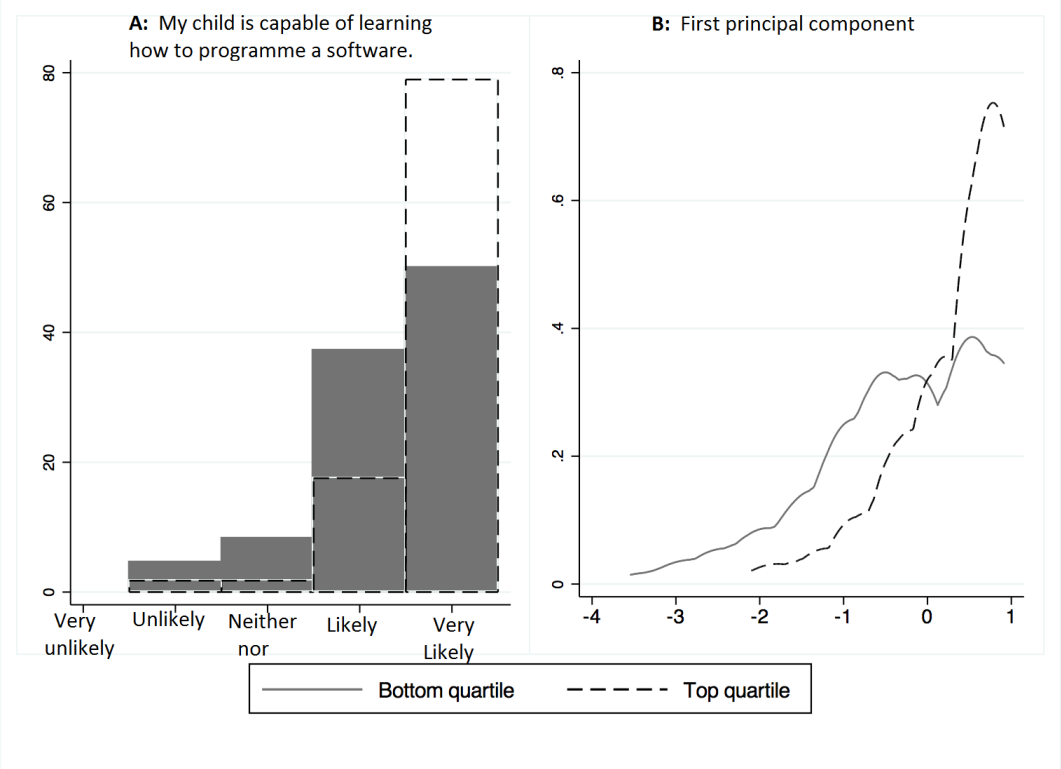
Note: Bottom quartile refers to the parent being in the bottom quartile of the household income distribution, while top quartile refers to the parent being in the top income quartile. Panel A shows the distribution of responses to one specific question in the malleability questionnaire, while Panel B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

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.[30] The

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

differences are even more pronounced when we compare parents in the bottom and the top income quartile. We illustrate these differences graphically in Figure 4. Panel A shows the parents' responses to the question "*My child develops at his/her own pace and there is not much I can do about that*", separately for parents in the bottom and the top income quartile. We can see that parents in the top income quartile disagree with this statement more often than parents in the bottom income quartile. Panel B depicts the distribution of the extracted factor, with higher values indicating that parents believe that skills are malleable and can be affected through the home environment. The kernel density depicting the distribution of the factor for respondents in the top income quartile is shifted to the right of the kernel density for respondents in the bottom income quartile, indicating that richer parents are more likely to believe that they can influence the development of their children.[31]

Figure 5: Capabilities of Own Children by Income Quartile of Respondent



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 responses to one specific question in the capabilities questionnaire, while Panel B shows the distribution of the extracted factor from all items in this questionnaire (see Appendix for a list of all questions).

[31]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).

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.[32] Again we illustrate the relationship graphically by comparing bottom and top income quartile respondents, for whom the differences are even more extreme (Figure 5). Panel A depicts the parents' responses to the question whether their children would be capable of learning how to programme a software given they were provided with maximum support. Compared to parents in the bottom income quartile, parents in the top income quartile are more likely to believe that their child has the capability of acquiring this skill. Moreover, when we examine the kernel densities of the extracted factors for bottom and top income quartile respondents, we find that the distribution for top income respondents is shifted to the right, indicating that richer parents are more likely to believe that their children have the capability of acquiring the three different skills (Panel B).[33]

7 Conclusion

In this paper, we document parental beliefs about the technology which maps early and late parental investments into future child outcomes. Our first main findings are that parents perceive late investments as *more* productive than early investments, and that parents perceive investments in different time periods as substitutes rather than complements. These findings contrast with results in the empirical literature that investigates the characteristics of the technology of skill formation. In particular, the recent literature provides evidence that early investments are more productive than late investments, and that there are important dynamic complementarities in the skill accumulation process ('*skills beget skills*')(e.g. Cunha, Heckman and Schennach 2010, Caucutt and Lochner 2012, Attanasio et al. 2015). If parents are not sufficiently aware of the importance of early investments, they are likely to allocate resources inefficiently over time. Given the dynamic nature of the skill accumulation process, missed early investments are difficult to make up for in later time periods. Therefore, an inter-temporal misallocation of parental investments away from early periods into later periods could prevent children from optimally accumulating skills. The results suggest that an informational intervention which makes parents aware of the importance of early investments could result in parents

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

[33] 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).

shifting the inter-temporal allocation of resources into earlier time periods, which could promote the accumulation of skills.

We further document a substantial degree of heterogeneity in parents' beliefs about the technology which maps parental investments into future outcomes. This heterogeneity is systematic in a sense that parents with higher income perceive the returns to parental investments to be higher. While 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, Lee and Seshadri 2014), our findings point towards an additional mechanism, namely that parents with different socio-economic backgrounds differ in their beliefs about the productivity of parental inputs. Given that perceived returns to investments are predictive of actual investment decisions, these differences in parental beliefs are likely to manifest themselves in different investment choices. Understanding which bottlenecks need to be overcome to promote parental investments in poor families can help us design effective policy interventions which have the potential of enhancing equality of opportunity and reducing socio-economic inequality.

Finally, we document that parental beliefs about the productivity of investments are systematically related to parental beliefs about (i) the malleability of their children's skills through home inputs and (ii) the capability of their children to acquire new skills given they are provided with professional support. While the evidence we provide is descriptive, it is pointing to a potential channel through which parental investments can be affected. If parents believe that their home inputs do not play a major role in their children's development, or if parents believe that their children do not have the capability to acquire skills even if they are provided with professional support, then it is likely that they will perceive the returns to investments to be lower and invest less as a result. In the school context, there is evidence from a large-scale randomized control trial demonstrating that an educational intervention, which conveys the idea that skills are malleable, increases children's propensity to engage in skill accumulating activities and leads to increased skill levels (Alan, Boneva and Ertac 2015). Whether a similar intervention could be helpful in the context of the home environment is an open question which needs to be explored.

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Appendix A: Supplementary Analysis

Table A.1: Parental Time Spent with Children (in min)

	Weekday	Weekend day	Week total	SD	Min	Max	Median
Total sample							
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
Primary school							
Talk about school	21.61	24	160.09	237.99	25	1980	100
Help with homework	24.61	35.09	177.81	148.61	0	870	135
Reading-telling stories	20.72	25.94	156.16	157.86	0	1320	140
Play board-card games	10.96	34.73	114.65	129.06	0	790	70
Total time	77.79	113.4	579.28	484.86	69	3630	480
Secondary school							
Talk about school	27.24	23.11	180.39	169.63	0	1020	135
Help with homework	17.3	22.04	132.29	146.2	0	1060	95
Reading-telling stories	6.13	7.9	46.89	115.82	0	810	0
Play board-card games	5.48	29.7	81.11	159.6	0	1400	20
Total time	52.37	79.08	423.27	371.95	0	3170	325

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

	Never	Once a year	Every 6 months	Every 3 months	Once a month	Every 2 weeks	Every week
Total sample							
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
Primary school							
Watch theatre or circus	6.4	32.9	27.1	20.7	9.3	3.6	0
Visit museum or art gallery	12.1	35.7	32.1	17.1	2.1	0	.7
Outdoor activities	.7	0	0	.7	6.4	9.9	82.3
Meet with teachers	.7	4.3	39	37.6	11.3	2.1	5
Secondary school							
Watch theatre or circus	7.6	37.5	30.1	19.5	3.8	.5	1
Visit museum or art gallery	13.2	34.5	31	18	2.5	.5	.3
Outdoor activities	2.3	1.5	4.3	6.3	20.3	13.5	51.8
Meet with teachers	1	23.8	47.1	24.8	2.5	.5	.3

Table A.3: Monthly Expenditures of Parents

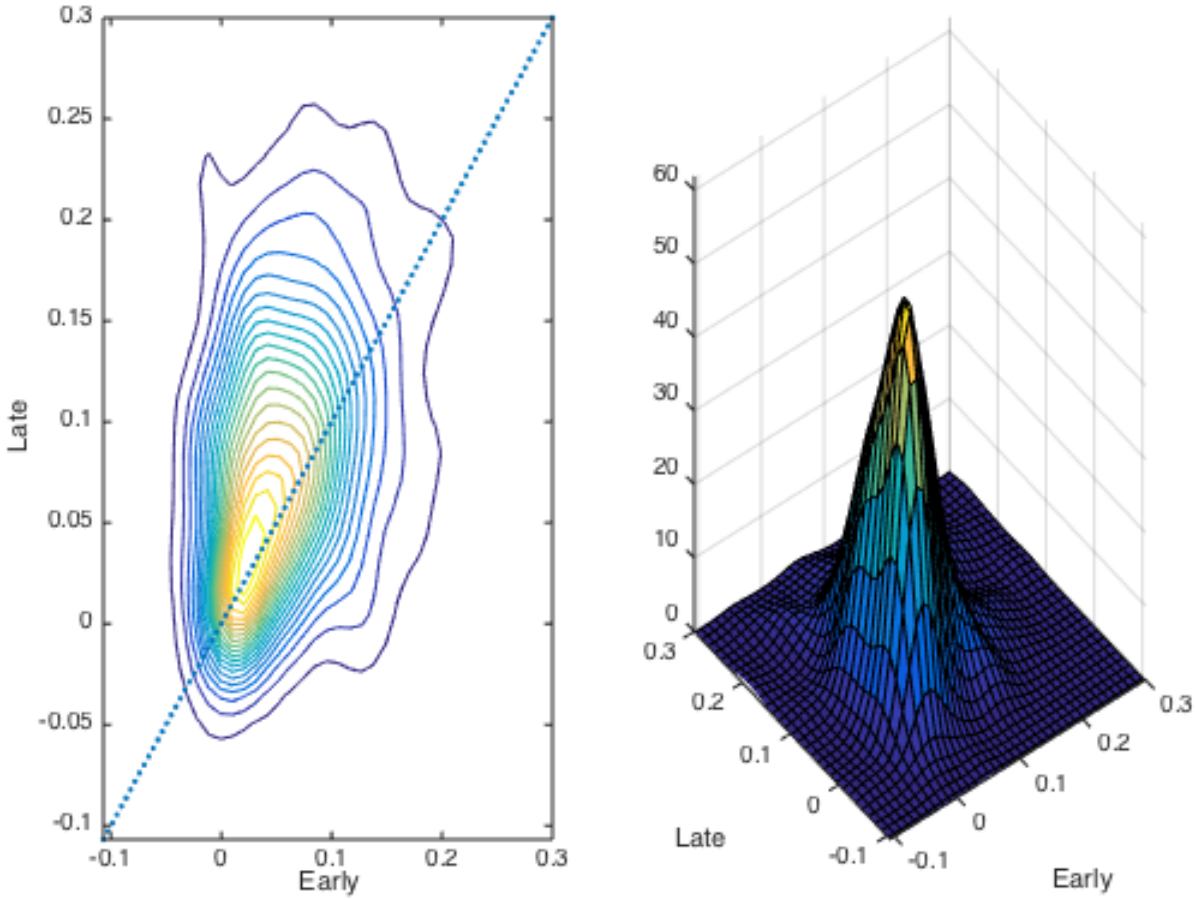
	Mean	SD	Min	Max	Median
Total sample					
Books (non-school)	10.27	9.56	0	60	10
Toys, games, DVDs etc.	11.93	17.67	0	300	10
Sports, music lessons	47.56	54.17	0	500	30
Private tuition	11.54	44.78	0	700	0
Total money	79.3	86.82	0	1201.5	60
Primary school					
Books (non-school)	10.59	9.31	0	60	10
Toys, games, DVDs etc.	17.67	27.03	0	300	10
Sports, music lessons	52.49	56.67	0	400	35
Private tuition	6.53	22.95	0	120	0
Total money	84.97	78.5	10	710	60
Secondary school					
Books (non-school)	10.16	9.66	0	60	10
Toys, games, DVDs etc.	9.84	12.04	0	100	10
Sports, music lessons	45.76	53.19	0	500	30
Private tuition	13.36	50.31	0	700	0
Total money	77.25	89.63	0	1201.5	55

Table A.4: Determinants of Probability of Going to University

Dependent variable: Expected probability of graduating from university			
Early Investment	3.673***	3.990***	3.719***
	(0.239)	(0.246)	(0.245)
Late Investment	4.756***	5.073***	4.836***
	(0.261)	(0.337)	(0.270)
High Human Capital	13.925***	13.927***	14.149***
	(0.817)	(0.817)	(0.833)
Early x Late		-0.161	
		(0.102)	
Standardized income x Early			0.516**
			(0.257)
Standardized income x Late			0.299
			(0.305)
Standardized income x HC			1.183
			(0.871)
Constant	10.144***	9.554***	7.866***
	(0.723)	(0.739)	(1.102)
School fixed effects	No	No	No
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 (0-100). Early Investment refers to the number of weekly hours the parents in the scenario help their child with his school work in years 3-6, while Late Investment refers to the number of weekly hours the parents help the child with his school work in years 7-10. High Human Capital is a dummy variable which equals 1 if the child in the scenario has high initial human capital. Standardized Income refers to the standardized household income of the respondent (mean 0, standard deviation 1).

Figure A.1: Distribution of Individual Perceived Returns



Note: This figure shows the joint distribution of individual perceived returns to early and late investments.

Appendix B: Questionnaires

B.1 Hypothetical Investment Scenarios

Parents are presented with *two* hypothetical families, the Jones and the Smiths, and *four* different hypothetical investment scenarios for each family. For each of the resulting *eight* hypothetical scenarios, parents are asked (i) to state how likely they think it is that the child will obtain a university degree and (ii) to provide their estimate of the gross yearly earnings of the hypothetical child at age 30.[34] More specifically, the parents are asked the following questions and are presented with the following scenarios:

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.

Q1: *What do you think is the probability (in %) that John will obtain a university degree ... [see four scenarios below]*

Q2: *Assuming there is no inflation, what do you expect John's gross yearly earnings to be when he is 30 years old... [see four scenarios below]*

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.

Q3: *What do you think is the probability (in %) that Simon will obtain a university degree... [see four scenarios below]*

Q4: *Assuming there is no inflation, what do you expect Simon's gross yearly earnings to be when he is 30 years old... [see four scenarios below]*

[34] All parents need to provide their estimate of the gross yearly earnings in the eight different scenarios. The question about the likelihood of obtaining a university degree is only asked to 50% of all respondents.

Four Scenarios:[35]

1. ... if they help John [Simon] *0 hours every week* in school years 3-6, and *0 hours every week* in school years 7-10?
2. ... if they help John [Simon] *0 hours every week* in school years 3-6, and *3 hours every week* in school years 7-10?
3. ... if they help John [Simon] *3 hours every week* in school years 3-6, and *0 hours every week* in school years 7-10?
4. ... if they help John [Simon] *3 hours every week* in school years 3-6, and *3 hours every week* in school years 7-10?

OR

1. ... if they help John [Simon] *1 hour every week* in school years 3-6, and *1 hour every week* in school years 7-10?
2. ... if they help John [Simon] *1 hour every week* in school years 3-6, and *4 hours every week* in school years 7-10?
3. ... if they help John [Simon] *4 hours every week* in school years 3-6, and *1 hour every week* in school years 7-10?
4. ... if they help John [Simon] *4 hours every week* in school years 3-6, and *4 hours every week* in school years 7-10?

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

B.2 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.3 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.4 Actual Parental Investments

Q1: *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*

Q2: *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*

Q3: *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*

Appendix C: Sample

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

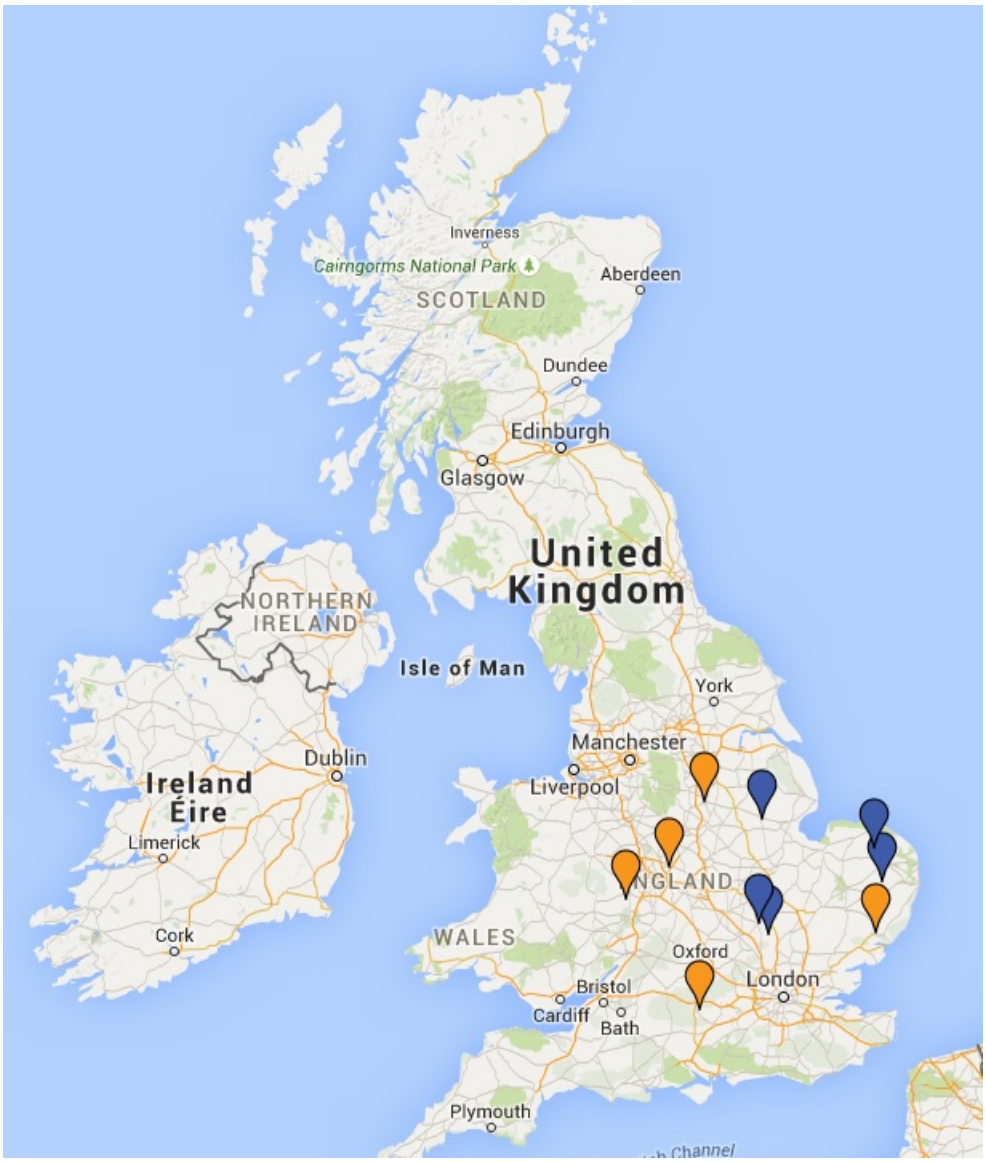
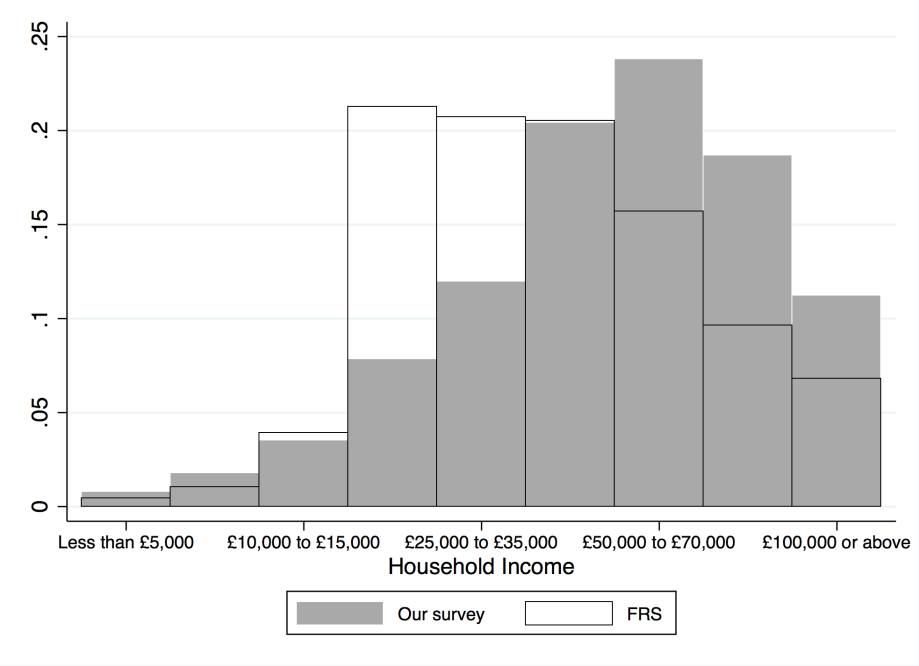


Figure C.2: Distribution of Annual Household Income



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).

Appendix D: Harmonization of Differences Between the Two Randomized Samples

To account for the fact that the samples are randomized into a group for whom low investments are 0h and high investments are 3h, and a group for whom low investments are 1h and high investments are 4h, we run the following regression:

$$\log y_j = \alpha + \beta_{1,1} I_{f,1j} + \beta_{1,2} I_{n,1j} + \beta_{2,1} I_{f,2j} + \beta_{2,2} I_{n,2j} + \beta_3 \theta_j + \gamma_i + \epsilon_j, \tag{9}$$

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 1h instead of 4h will be smaller than the difference between investing 0h instead of 3h. 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 1h and 4h 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 0h and 3h of time investment.