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Belief in a Just World and Children's Test Scores

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Belief in a Just World and Children's Test Scores[1]

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Abstract

Parental beliefs, recognised by child psychologists as a causal influence on early development, are incorporated into a two-period model of human capital accumulation. In the first period parents transfer their beliefs, distinct from genes, to their child by signalling their 'belief in a just world' or the perceived return to effort. The child responds by choosing effort, irrespective of the real world returns, which combines with their genes to create early their ability. This ability determines the rate of return to second period investment and final attainment. This is an ontological model, in the sense that children's beliefs influence the attainment they achieve. The identifying assumption is that parent beliefs are slow-moving and they not conditioned on the child. If parents are credit constrained, then both beliefs and income determine attainment. Empirical analysis using the NCDS shows that beliefs are a strong predictor of early attainment and reduces the importance of parental income or wealth. This justifies effective mentoring programmes for children with problem parents.

[1] This paper is based on a chapter of my Doctoral thesis entitled "How Parent Transfers Affect children's Incentives, with Incomplete Capital Markets" submitted in September, 2010. The views and findings expressed herein do not in any way reflect the views of HM Treasury and are a personal assessment of the author.

1. INTRODUCTION

A positive association between family income and children's success in education has long been recognised in countries with different education systems and income distributions. In Becker and Tomes (1986) economic model of the family they show that parents who are 'rich enough and altruistic enough', or who can borrow on behalf of their children, will invest in their education up until the altruism discounted rate of return on their education falls to the riskless interest rate.[2] But human capital is a poor asset to use as collateral and markets do not exist for borrowing against children's future earnings. This market incompleteness is usually described as a credit constraint. It means that parents who are not 'rich enough and altruistic enough' and cannot borrow on behalf of their child and they are therefore limited to sub-optimal investment in their children's education. This is the traditional explanation of credit constraints causing a correlation between parent income and child attainment.

This causal interpretation has had a strong influence on policy despite differences in attainment persisting after many policy initiatives and across many different funding regimes. An important issue for policy is to establish if and when in a child's life-cycle the credit constraint actually binds. The traditional view is at the point of deciding whether to continue in further education. In an important paper, Carneiro and Heckman (2002) challenge this view by comparing US college attainment of children from families across income quartiles and after taking account of test scores at 11 years of age and family background. They find that there is at most an 8% difference in enrolment rates between children from the highest and lowest family incomes. They propose an alternative hypothesis, that family background (e.g. parent education, etc) influence children's early test scores and eventual attainment levels and is also correlated with parental income when the later attainment is measured. The conclusion is that the scarce resource is good parenting rather than income or resources.

However, this alternative hypothesis merely begs the question of why differences in attainment emerge at early ages between children from families in different income brackets in the first place. This is especially puzzling since education services at this age are free. Put another way, which part of early test score performance does parent income actually buy? And if there is no buying involved, why then do poor families appear to under-invest in their children when they offer above average returns and there is no cost involved in a repeated

[2] The term 'rich enough and altruistic enough' is used by Behrman (1997) to indicate where full risk sharing occurs between parents and children or where the intergenerational Euler equation holds with equality.

inter-generational game?[3] Part of the solution is to recognise the special importance of early child development (ECD) and the role of non-cognitive as well as cognitive skills. Yet even with the particular importance of ECD, there is no consensus on which inputs are necessary at young ages and why they seem to be linked to family incomes.

This paper is in the spirit of the ECD literature. It is an assessment of the importance of family culture, in particular the role of parental beliefs, as a causal influence on differences in levels of early childhood attainment. In a major cross-discipline review of EDC by the US National Research Council and Institute of Medicine, they report that the "influence of culture on the rearing of children is fundamental and encompasses values, aspirations, expectations and practices" and yet "the empirical literature in this area is underdeveloped [and the] imperative for extensive research is clear."[4] This provides a motivation for this analysis. It is intended to incorporate some of the long established insights of psychologists into an economic framework. Families are interpreted as 'institutions' which set informal rules and codes of conduct.[5] These rules and codes include the beliefs of parents, based on their own life experiences, which have a special influence on their children. These parental beliefs shape the beliefs of their children which influence their actions at school and the outcomes as a result. The model can be interpreted as 'ontological' in the sense that the child's actions re-enforce their belief system and perpetuate the family culture.

This paper considers a specific aspect of family culture, parents' belief in a just world (BJW), as a causal influence on children's early attainment levels. Parents' BJW is used in the psychological economics literature as short-hand for the extent to which people get what they deserve in life or the degree to which they perceive that effort is rewarded. The idea is that parenting involves more than simply investment in stuff, such as books and even time spent reading with a child, which are choice variables with costs. Parenting also involves the transmission of family culture which includes beliefs and attitudes, shaped in childhood and early adulthood, but which become slow-moving as there are costs to changing beliefs if they then become inconsistent with experience.[6] Children then observe the behaviour and attitudes of their parents and apply these codes to their own life with consequences for early test

[3] Ermisch (2003) points out that the suggestion that this is solely due to inherited genes cannot explain why on average inherited ability increases over time.

[4] Shonkoff and Phillips (2000), p.27.

[5] For an economic interpretation of institutions see D. North (2005).

[6] Psychologists refer to the cost of having beliefs inconsistent with experience as cognitive dissonance.

scores. Note, that while the family is taken as the most obvious way that elders influence the beliefs of children, the findings are applicable to guardians and mentors where again the purpose is shaping children's beliefs and attitudes rather than simply investing time.

While concepts such as culture and beliefs are ubiquitous, they are generally outside of mainstream economics. Yet excluding them from analyses can lead to important biases, especially if they are correlated with explanatory variables. For example, endogeniety may overstate the role of parent income if family beliefs are excluded (assuming they are positively correlated with income) and create false inferences about credit constraints. However, using culture or beliefs to explain economic outcomes not only requires identifying a causal mechanism but also formulating refutable hypotheses to test against the data. Roland et al. (2004) considers "what is called culture, including values, beliefs, and social norms, can be classified as a slow-moving institution" which Becker (1996) concurs with "because of the difficulty in changing culture and its low depreciation rate, culture is largely 'given' to individuals throughout their lifetime."[7] This view of family culture, in particular beliefs, as slow-moving and not conditioned on the performance of the child is the identifying assumption in this paper. It is consistent with psychologists' interpretation where choosing beliefs which are inconsistent with experience would create cognitive dissonance and an incentive to re-evaluate beliefs to avoid the cost of the dissonance.

This paper considers one aspect of family culture, parents' belief in a just world (BJW), as a causal influence on children's early attainment levels. Section 2 includes a review of the evidence since Carneiro and Heckman on differences in early child attainment, including parental income and family culture. The Carneiro and Heckman model is re-estimated using UK data in Annex 2. Section 3 presents a modified version of Becker and Tomes which includes a two-period childhood where early learning benefits later investments through complementarity. The early learning is by the transmission of a belief system which shapes a child's own expectations of the return to effort. This is an early form of non-cognitive development and creates differences in the return to later investment and the child's eventual attainment. The hypothesis that parental beliefs are a causal factor is tested using the National Child Development Survey (NCDS) in section 4. The evidence suggests that after taking including parental beliefs in a just world then income has little explanatory power on children's early test scores. Some conclusions are drawn in section 5.

[7] Roland (2004) p.4 and Becker (1996) p.19.

2. LITERATURE REVIEW

In the last decade economists have re-focussed their attention on the association between parent income and children's attainment levels at early stages of development. Almond and Currie (2009) note that in 2000 there were no articles on early child development in three leading journals and since 2005 there have been five or six per year.[8] Carneiro and Heckman (2002) show that differences in children's college attainment are, in large part, a reflection of differences in earlier attainment levels which in turn are correlated with later parent income. This hypothesis is tested using the UK NCDS dataset in Annex 2 and the results show an upper limit of only 4% of statistically difference in attainment levels can be explained by parent income after taking account of early test scores.[9] This is consistent with Carneiro and Heckman but a larger effect than reported in Dearden, McGranahan and Sianesi (2004).

The significance of early development is succinctly shown in figure 1 which presents NCDS cohort members' attainment levels at 7 and 11 and participation in full time education at 16 years of age. The results are shown by parents' income quartile measured by total family income when the child is 16 and the attainment levels are standardised for comparison. Differences in attainment are well established at 7, and even widen slightly due to the falling relative performance of children from the lowest family income quartile. This corroborates with Cunha and Heckman (2007) of differences in attainment at 5, Ermisch (2008) of differences in cognitive and behavioural assessments at 3 and Feinstein (2003) of differences as early as 22 months old.

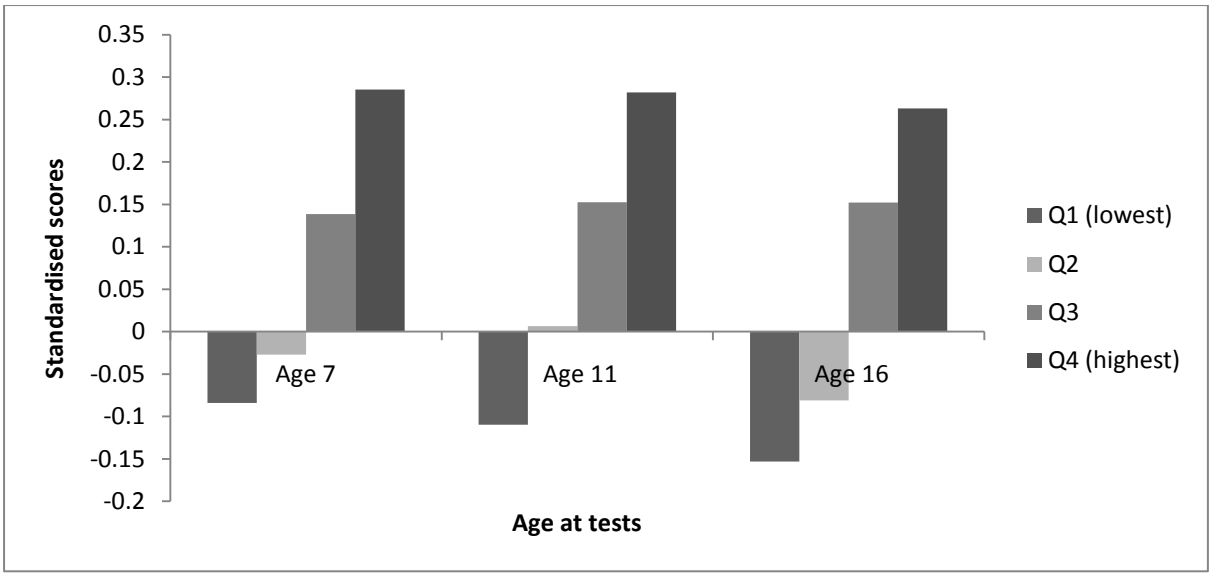
This review is in three sections covering the key arguments to emerge since Carneiro and Heckman (2002) on why these early childhood differences in attainment occur. First, the idea of generating early abilities and their interaction with later investment is expanded to contrast with Becker and Tomes' single period production process. This is closer in spirit to child psychologists and neurologists and now economists' understanding of a dynamic learning process. Second, some recent research is presented showing that differences in parental income in early childhood are particularly important, even controlling for the same total life-cycle income. This is a re-interpretation of Becker and Tomes' credit constraints. Third, the

[8] Almond and Currie's (2009) sample of journals include the American Economic Review, Journal of Political Economy and Quarterly Journal of Economics.

[9] The tests in Annex A differ from Dearden, McGranahan and Sianesi (2004) in that a measure of permanent income rather than current income is used to reduce measurement error and test scores at age 7 rather than 11 to minimise the possible cost of secondary education playing a role on exam performance.

importance of family culture in the early phase of child development and the few economic papers which include culture as an explanatory variable are reviewed.

Figure 1: Child Attainment by Age and Parent Income Quartile at 16 Years Old



Note: The sample is the NCDS cohort members where income quartiles are based on family income at age 16. The test scores are the first principal component of maths and reading test scores at age 7, a general ability test score at 11 and a participation rates at school at 16.

2.1 The Importance of Early Childhood Development

In a series of recent papers, James Heckman and co-authors proposed a framework for children's learning process building on extensive research by neurologists, child psychologists and non-mainstream economists. In this cross-discipline vein, Knudsen, Heckman, Cameron and Shonkoff (2006) report that "virtually every aspect of early human development, from the brain's evolving circuitry to the child's capacity for empathy, is affected by the environments and experiences that are encountered in a cumulative fashion, beginning in the prenatal period and extending throughout the early childhood years."[10] The authors suggest that a cross-disciplinary framework for ECD must include the following elements:

(a) skills are formed by an inextricable interaction between genetics and experiences,

[10] Knudsen et al. (2006) quote from Shonkoff and Phillips (2000) p.6. For an introduction to the recent research of neurologists and child psychologists see http://www.charlierose.com/view/interview/10877?sponsor_id=1.

(b) skills necessary for economic success are created in hierarchical sequence such that later attainments are built on early foundations,

(c) cognitive and non-cognitive skills contribute to attainment levels and success in the work place,

(d) human abilities are formed in predictable sequence of sensitive periods, although they can be adapted in other stages.

(1) $$A_t^k = f_t(I_t^p, A_{t-1}^k) \ \ where \ \ t = 1,2$$

(2) $$\frac{\partial A_2^k}{\partial A_1^k} = \frac{\partial f_2}{\partial A_1^k} > 0$$

(3) $$\frac{\partial^2 f_2}{\partial A_1^k \partial I_2^p} > 0$$

In an attempt to capture some of these cross-discipline features in a familiar economics framework, Cunha, Heckman, Lochner and Masterov (2005) posit a two period recursive ability function (1)where the subscripts denote time periods. Ability is a vector of abilities, including cognitive and non-cognitive abilities (or skills).[11] The function is increasing in both arguments and concave in investment and initial ability A_0 is inherited through in utero experiences and genetics. Two further assumptions in (2) and (3) describe self-productivity and complementarity. Self-productivity captures how ability in one period creates the capacity for greater ability in the next period which Heckman and Lochner (2005) describe as 'learning begets learning'.[12] With vectors of ability this may also describe synergies between different types of abilities: for example, early learning creates a cognitive capacity which, if complemented with later non-cognitive abilities, such as motivation, this creates further learning and cognitive capacity. Complementarity shows how higher ability in the previous period increases the return on investment in the current period.

An important distinction between this recursive framework and Becker and Tomes is that inputs into the production of skills at different stages are assumed to be complements (rather

[11] This model has similarities to Todd and Wolpin (2003) and id a generalisation of Ben-Porath (1967).

[12] Heckman and Lochner (2005).

than an implicit assumption of perfect substitutes).[13] This is distinction is key for three reasons. First, complementarity implies that for some abilities early development is more important than late development or, more generally, there are 'critical periods' for nurturing some abilities and skills. Second, complementarity increases the cost of remediating or correcting a lack of early investment. Third, this creates an 'equity versus efficiency' trade-off for policy. It is efficient to encourage higher second period investment in children with highest first period ability but this will also widen the inequality in total skills between children. In Becker and Tomes there is no equity versus efficiency trade-off as those with below optimal investment have a high marginal return to investment.

The idea of a hierarchical learning process with critical periods for nurturing some abilities is well established in psychology (since Jean Piaget) and neurology and also observed in experiments with higher primates (see Knudsen et al. (2006)). This has a physical dimension as a lack of sensory input during early child development results in abnormal development of the brain, for example in terms of perception, interpretation and processing.[14] Two tangible examples of 'critical period' are for learning languages (accent and syntax) which is reported to decline from 7 onwards and IQ scores are generally stable after 10 years of age. Similarly, non-cognitive abilities e.g. persistence, emotional control and optimism, are important in achieving higher attainment both directly and by enhancing cognitive ability.

The benefits of early remediation and the 'efficiency versus equity' trade-off are shown in the assessments of previous or current programmes.[15] The Perry Pre-school and Abecedarian Programs in the US are randomised experiments with disadvantaged children which introduce treatment at 3-4 years and 4.5 months old respectively. The treatments were daily classroom sessions and weekly home visits by teachers and the progress of the children were followed up to 40 and 21 years of age to observe the long-term effects. While the interventions had no impact on IQ scores, they had significant long-term benefits on education attainment, employment outcomes and anti-social behaviour. Rolnick and Grunewald (2003) report the real internal rate of return on the Perry Preschool programme is 4% to the participant and 12% to society for a total return of 16%. UK programmes are more

[13] In Becker and Tomes genetic an cultural influences are discussed interchangeably and combined into a single inherited endowment which parents cannot influence. They simply choose the optimal level of investment for a given endowment.

[14] See Heckman (2008).

[15] See Almond and Currie (2009) and Chuna, Heckman, Lochner and Masterov (2005) for full accounts of how these programmes operate.

recent and so the assessments are less robust. Sure Start, which combines childcare, health and family support and part-time education for 3-4 year olds has had cautiously positive assessments although programmes targeted at high risk areas appears have more impact.[16] The Incredible Years Programmes, which targets families with pre-school children showing anti-social behaviour with a six month series of weekly clinics, are also reported to show positive results.[17]

Interventions in adolescent years are also successful. Studies of mentoring programmes in the US using random selection show schemes have delivered improved attainment and behavioural outcomes. Participants in Big Brothers/Big Sisters (a mentoring scheme for over 90 years) after eighteen months delivered improved outcomes in truancy, school grades and better relationships with parents.[18] The channels by which mentors influence mentees depends on the type of programme, but for youth mentoring it is reported to be through motivation and attitude as much as instruction. There is no comparable UK mentoring results using randomised selection. Aim Higher is similar in that it aims to raise awareness and aspirations of school children underrepresented in tertiary education. Goodman and Gregg (2010) report a positive impact on GCSEs and enrolment rates. The evidence on returns to late adolescent and adult intervention (such as prisoner rehabilitation, adult education) is less favourable. In the UK the Train-to-Gain job training programme subsidises training for the low skilled is found to show low returns and a high degree of deadweight loss. While cost-benefit assessments are not consistent across interventions, there appears to be an efficiency trade-off in favour of early interventions for disadvantaged children.[19]

2.2 Early Child Development and Credit Constraints

While cross-discipline research has created a framework which emphasises the particular importance of early development, this does not explain why richer families, on average, achieve higher levels of ECD. One explanation is that poorer families with young children face credit constraints at that stage which prevent them from delivering the necessary inputs. This is a re-interpretation of Becker and Tomes rationale for credit constraints: rather than

[16] See NESS (2008) for a discussion of the results.

[17] See Goodman and Gregg (2010).

[18] Tierney and Grossman findings are reported in Heckman (2008).

[19] See Carneiro, Dearden and Vignoles (forthcoming).

parents being unable to borrow against their child's future income (an inter-generational constraint) parents may not be able to borrow against their own future income (an intra-generational constraint).[20] The root cause of the constraint is not be the limitation of the child's future earnings as a form of collateral but the quality of the parents' future earnings as collateral. This would imply different ethical and policy implications.

Caucutt and Lochner (2004) measure the importance of differences in the timing of parent income by compiling annual family income histories for parents of the US National Longitudinal Survey of Youth members since their children's birth after 1979. This enables them to test whether differences in children's test scores at 5-14 years are correlated with parental income at that age. They find that differences in income at early ages have a larger impact than differences at later ages on later attainment levels. If $10,000 of parent income could be shifted from when the child is 10 years old to when they are one year old this would lead to a 0.01 to 0.02 standard deviation increase in test scores. They also show that the slope of the family income profile over twenty years, but controlling for the same present value of life-cycle income, is negatively correlated with early attainment levels. This implies young children of parents who have low initial income (but the same life-time incomes) have lower levels of development. This is consistent with intra-generational credit constraints.

If indeed early family income is a causal influence on early attainment which, in turn, is important for later attainment levels, an intriguing question is what the additional income buys to enable this improved performance. Expressed another way, which inputs into child's early ability production function are (temporarily) low income parents unable to finance? There are differences in infant or junior schools across catchment areas but this is likely to reflect differences in permanent income between families and even in aggregate books and other inputs would not involve a high level of borrowing. When children are young all levels of family spending is mediated by parents, so it is unclear whether it is the resources or the quality of parents which is the scarce resource.

Goodman and Gregg (2010) present a detailed study of differences in home environments between affluent and poor families which correlate with differences in attainment levels. They observe that differences in health (breast fed, birth weight), interactions, regularity of routines, learning environment (reading, teaching, taking to library etc) are all important in

[20] Caucutt and Lochner (2005).

explaining differences in attainment. Yet it is not clear that income is such an important factor in delivering this environment as few of the factors cost significant sums of money. They also add intriguingly that a larger proportion of the gap between affluent and poor children scores is left unexplained by these factors.

2.3 Family Culture as a Causal Variable

The importance of family culture on child development is widely recognised. Becker and Tomes (1986) acknowledge that "both biology and culture are transmitted from parents to children, one encoded in DNA and the other in a family's culture."[21] Having made this distinction, they combined genetics and culture into a single endowment transmitted across from parent to child. Parents cannot influence a child's fixed endowment, so the influence of family culture on outcomes or in shaping the expression of genes is excluded from the analysis. This negates the importance of the family in shaping non-cognitive skills essential for success at school. Bowles and Gintis (1976) recognise that "perseverance, dependability and consistency are the most important predictors of grades in school,"[22]

The importance of family culture in ECD is also recognised across a wide range of related child development disciplines. Psychologists refer to informal rules and codes of behaviour in families as culture which is similar to an economist's interpretation of the family as an institution where rules and codes condition behaviour of its members through beliefs and preferences. Shweder et al. (1998) recognise the importance of integrating both beliefs and behaviours into family culture as "beliefs and doctrines make it possible for a people to rationalise and make sense of the life they lead" and "patterns of behaviour that are learned and passes on from generation to generation".[23] Shonkoff and Phillips's (2000) review of early child development recognise family culture as encompassing "values, aspirations, expectations and practices" providing a "virtual how-to manual for rearing children".[24]

Several recent theory papers have considered how culture can be transmitted within a family. Laibson (1996) suggests that parents can influence the time preferences of their children to encourage longer term choices. This idea is explored further in Burton, Phipps and Curtis

[21] Becker and Tomes (1986) p.S4.
[22] Quoted in Cunha, Heckman, Lochner and Masterov (2005) p.21.
[23] Quoted in Shonkoff and Phillips (2000) p.59.
[24] Shonkoff and Phillips (2000) p.25.

(2002) strict parents engage in strategies and the child is rewarded for delayed gratification. Bisin and Verdier (2000) show selective marriage of partners with similar cultural traits can lower the cost of diffusing religious culture into the preferences of children. Similarly, Tabellini (2008) show how parents inculcate their own attitudes and values of good conduct into their children which creates the possibility of cooperative outcomes. Benabou and Tirole (2006) present a signalling model where 'belief in a just world' promotes goal oriented behaviour. Children form beliefs about the reward to effort from signals transmitted by parents, which parents manipulate to create a game between parent and child.

There are many dimensions of family culture which influence the behaviour of children. In the transmission on inequality literature Osborne-Groves (2005) estimated that around one-quarter of the correlation in income between fathers and sons is explained by the transmission of personality traits.[25] Yet traits cover a vast range of possible behaviours from perseverance and motivation to mental disorder. One particularly influential dimension of culture is the 'belief in a just world' (BJW) idea proposed by Lerner in 1965. The essence is that "individuals have a need to believe that they live in a world where people generally get what they deserve. Without such a belief it would be difficult for the individual to commit himself to the pursuit of long range goals or to the socially regulated behaviour of day to day life".[26]

This concept of 'belief in a just world' is closely related to an interpretation of fairness of the reward from effort. This captures an important aspect of family culture as it enables a child to commit to the pursuit of long-term goals which is essential for attainment (see earlier quotes from Bowls and Gintis (1978)). As will be shown in Section 4, the questions which make up the BJW measure are specifically not related or conditioned on children or the value of education but are about the workplace. This is important to prevent reverse causality where parents believe education is important based on the ability or perceived success of their child. The idea that efforts are rewarded is integral to family culture and can be seen as an input by which non-cognitive skills are transmitted from parents to children which becomes an important cause of later attainment.[27]

[25] Osborne-Grove is contained in Bowles, Gintis and Groves Eds. (2005).

[26] Lerner and Miller (2008) p.1030.

[27] The aim of Goodman and Gregg (2010) is to investigate the importance of parent and child attitudes, but they are clear to point out that the analysis cannot have a causal interpretation because of reverse causality. The attitude questions ask whether the mother hopes the child will go to university or leave school after getting good

3. TRANSMISSION OF BELIEFS AND EDUCATION ATTAINMENT

This section presents a model in which the beliefs of parents or other influential adults have an identifiable effect on children's early levels of attainment. The purpose is to formulate testable hypothesis for the empirical analysis in section 4. This presentation has three stages. First, the mechanisms by which beliefs are transmitted from parent (assumed to be the influential adult) to child and how human capital is accumulated are set out. Second, the child and parent optimisation problems are set out with optimal conditions and the relevant comparative statics presented. Third, the implications of incomplete capital markets for identification issues and some stylised regression functions are presented.

This model has the same parent and child preferences as Becker and Tomes (1986). Parent decision making is by consensus with one-sided altruism (children are not altruistic towards their parents) to rule out strategic games. The resource allocation problem is also unchanged so parents who are 'rich enough and altruistic enough' and so have no need to borrow decide how much to invest in their child's education and how much to leave as a financial transfer. The structure of childhood is in the spirit of a dynamic ECD model similar to Cuhna et al. (2005). Becker and Tomes assumption of a single inherited aggregate endowment of genetic and cultural attributes is discarded to allow these attributes to be transmitted separately. Consistent with the findings of neurologists the attributes interact.[28] This different assumption creates two distinctions to the Becker and Tomes model. First, there are two periods of childhood in the life cycle and two parent transmissions in the form of a beliefs signal and later investment in their education. Second, because the transmission of beliefs requires a learning process, the child also makes a decision in response to the belief signal received.

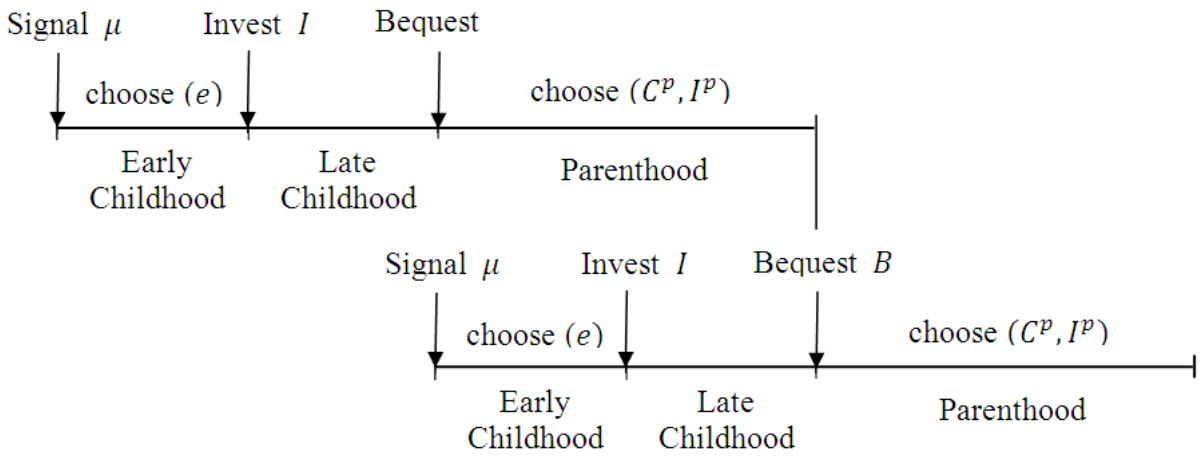
The overlapping generations model in figure 2 shows the two parts of childhood in the life cycle and the timing of the transfers. At the start of the first period the child is born and inherits some natural ability from parents α (assumed to be genetic). They then receive a signal of family beliefs μ which is described as parents' 'belief in a just world'. The child then forms an expectation of the return to effort on the basis of this signal and chooses how much effort e to apply at school given their learning capability $\iota(\alpha)$ which is an increasing

GCSEs, and the child's own assessment of their ability and the importance of school. These questions make clear that causation cannot be interpreted to run solely from attitudes to attainment.

[28] See Shonkoff and Phillips (2000) on how the nature versus nurture debate is obsolete as nature and nurture interact to create genetic expression.

function of inherited ability. In the second period of childhood parents observe this effort and invest in their child's education, similar to Becker and Tomes. When education is complete the child becomes an adult and possibly receives a bequest and sells their human capital to generate income for consumption and investment in their own children.

Figure 2: Overalpping Generations: Two Period Childhood



This two-step childhood goes some way to meeting the criteria of Cunha et al. (2005) for a model of human capital to be consistent with evidence from child psychologists (see section 2). With two stages in the development of human capital (signal/response and investment) this is more of an accumulation rather than a production process. It is also ontological, in that parents create a reality for the child which they fulfil irrespective of its consistency with true or 'real world' circumstances.

3.1 Family Beliefs and a Model of Human Capital Production

In this paper the key dimension of family culture is parents' beliefs of how effort is rewarded, summarised by their `belief in a just world'. The transmission of beliefs shapes their child's own early beliefs and expectations and influences their behaviour, such as how much effort to apply at school. If parents believe effort is fairly rewarded, this is transmitted by their attitude and behaviour to their child who is likely to respond by trying harder at school. The identifying assumption is that these beliefs are 'slow-moving' in parenthood; parents cannot simply change their core beliefs to manipulate their child's behaviour over a number of years.

(4) $$A^k = b\alpha + \varphi e(\mu, \alpha)$$

(5) $$\hat{\varphi} \equiv \mathrm{E}[\varphi \mid \mu], \quad where\ \mathrm{E}[\varphi \mid \mu_H] = \hat{\varphi}_H > \hat{\varphi}_L = \mathrm{E}[\varphi \mid \mu_L]$$

(6) $$c(e) = e^2 (2\iota(\alpha))^{-1}$$

A child's ability is summarised by an affine function (4) of natural ability α (where b is a parameter) and a choice of effort e times the true, but unknown, payoff to effort φ. A young child has little or no experience of how closely effort and rewards are matched in the 'real world' beyond the influence from their family. Therefore, they form an expectation conditional on family culture based on their parents' beliefs of the return to effort. Parents' beliefs are transmitted by a signal μ which may be transmitted verbally, or through their attitude at home or even by a child observing parents' responses to incentives. Using signalling technology from Benabou and Tirole (2005) and others, a child's expectation of the return to effort is conditional on parents' beliefs transmitted through the family belief system. The signal of a parent who believes the return to effort is either high or low is described in equation (5). Children with parents who believe the return to effort is high will themselves tend to form high expectations.

Children do not always follow parent's guidance and there is a cost to applying effort. The cost function shown in equation (6) can be interpreted as the energy spent concentrating or the opportunity cost of studying and not playing games. The function is convex, so the cost of an extra hour of effort increases. The cost is scaled by a measure of a child's learning capability $\iota(\alpha)$, which is an increasing function of natural ability. A child with a favourable endowment of natural ability is likely to have a greater learning capability and so a lower cost to effort. This is another distinction from Becker and Tomes by allowing genetic and cultural endowments to interact, consistent with the findings of neurologists.

(7) $$H^k = Ph(I, A^{k*}), \quad where\ \ P\frac{\partial^2 h(I, A^{k*})}{\partial A^{k*} \partial I} > 0$$

(8) $$Y^p = WH^k + \omega, \quad \omega \sim (o, \sigma^2)$$

The human capital accumulation function (7) has two differences to Becker and Tomes' formulation. First, a parameter P is included to reflect parent's ability to develop human capital at home. This performs a similar function to Hicks neutral technological progress as it does not affect the balance of inputs but accounts for differences in capacity to create human

capital across families. Second, the ability of the child is an optimal response to the child's optimisation problem (indicated by the asterisk) and is created before any investment. This generates a two stage process where the transmission of family beliefs at an early stage and investment at a later stage. The cross partial shows that investment is a complement to ability. This means that the return to a given level of investment will be higher for a higher level of ability or early development in response to affirmative beliefs in a just world. Because the Inada conditions apply to the function, there is always a positive level of investment and it is assumed that parents only leave net bequests.[29] The wage function is the same as Becker and Tomes where the labour income is the product of the stock of human capital and the return on a unit of human capital W or the real wage plus risk ω.

3.2 Child and Parent Optimisation Problems

The child and parent optimisation problems are set out below. In each case the optimality conditions are presented which are then used in comparative statics to highlight the development from Becker and Tomes. As an initial reference point, capital markets are assumed to be complete so parents can borrow on behalf of their child to fund an optimal level of investment in their human capital which the child then repays in adulthood.

(9) $$\underset{e}{Max}\ v = v(b\alpha + \hat{\varphi}e - e^2(2\iota)^{-1})$$

(10) $$e^* = \hat{\varphi}\iota$$

(11) $$A^{k*} = b\alpha + \varphi e^*$$

A child's response to their cultural environment means that they are active in developing their own ability, a point emphasised in Shonkoff and Phillips (2000). This is characterised by their choice of effort e described in equation (9). The objective function is a standard value or utility function increasing in ability, which can be interpreted as the utility or value of better test scores or even recognising that greater ability will lead to more consumption in adulthood. That additional effort comes at ever greater cost ensures an internal solution. The equilibrium conditions reflect a child's optimal level of effort in (10) and their optimal ability

[29] A net bequest means that a gross bequest is made only if parents can afford to optimally invest in their child's education without borrowing on their behalf.

in (11). Note that the choice of effort is on the basis of the expected return while ability is a function of the actual return to effort (so socially sub-optimal outcomes are possible).

(12) $$\frac{\partial A^{k*}}{\partial \mu} = \varphi \iota \frac{\partial \hat{\varphi}}{\partial \mu} > 0$$

(13) $$\frac{\partial A^{k*}}{\partial \alpha} = b + \varphi \frac{\partial \iota}{\partial \alpha} \hat{\varphi} > 0$$

(14) $$\frac{\partial^2 A^{k*}}{\partial \alpha \, \partial \mu} = \varphi \frac{\partial \iota}{\partial \alpha} \frac{\partial \hat{\varphi}}{\partial \mu} > 0$$

The comparative statics in equations (12)-(14) show that a child's ability is an increasing function of family beliefs, their natural characteristics and the interaction between them. The cross partial in (14) is a reflection of recent physiological evidence discussed in section 2 that genes have a degree of malleability and interact with the environment. This captures Knudsen et al. (2006) point (a) in section 2.1 above.

The parent's optimisation problem is very similar to Becker and Tomes except that investment occurs after the child has chosen their optimal level of effort. Parents are altruistic and take account of future generations described in (15) where $0<\beta<1$ measures the degree of parent altruism. The objective function (15) shows that parents' welfare depends on their own utility and the altruism discounted utility of their child. The choice variable is the size of financial transfer T which may be through investment I^p or bequest B as shown in equation (16). The inequality shows one-sided altruism so children do not make net transfers to parents. The total investment I in a child's human capital or education can be financed by parent resources or debt if they are not 'rich enough or altruistic enough and capital markets allow such borrowing. The pooled family budget constraint (18) indicates that capital markets are complete and there is full resource and risk sharing.

(15) $$V^p(T) = \underset{T}{Max} : U(C^p) + \beta U(C^k)$$

(16) $$T = B + I^p, \quad and \;\; T > 0$$

(17) $$I = I^p + D$$

(18) $$C^p + C^k(1+r)^{-1} = Y^p + Y^k(1+r)^{-1} - I - D(1+r)^{-1}$$

Parents' optimisation leads to the usual two optimality conditions of the Euler equation (19) and optimal investment condition (20). Even though transfers must be positive and there are complete capital markets, the Euler condition need not hold with equality if parents are not 'rich enough and altruistic enough' and so full risk sharing may not occur. However, complete capital markets ensure that the optimal investment rule (20) applies and investment in their child's development is independent of parents' income and preferences. The implicit function of optimal investment is presented in equation (21) in which parent income is not an argument.

(19) $$\frac{\partial U(C^p)}{\partial T} \geq \beta(1+r)\frac{\partial U(C^k)}{\partial T}$$

(20) $$\frac{\partial Y^p}{\partial I} = W\frac{\partial H^k}{\partial I} = WP\frac{\partial h(I, A^{k*})}{\partial I} = (1+r)$$

(21) $$I^* = g(A^{k*}(\overset{+}{\alpha}, \overset{+}{\mu}, \overset{+}{\iota}), \overset{-}{r})$$

There are four comparative statics with respect to a child's educational attainment. The first two enter the parent's optimisation problem and are identical to the Becker and Tomes model. It is useful to repeat these results in advance of the empirical analysis in section 4.

(22) $$\frac{dH}{dY^p} = P\left\{\frac{\partial h(\overset{+}{I}, A^{k*})}{\partial I^p}\frac{d\overset{+}{I}^p}{dY^p} + \frac{\partial h(\overset{+}{I}, A^{k*})}{\partial D}\frac{d\overset{-}{D}^*}{dY^p}\right\} = 0$$

First, if a parent receives an increase in income, what is the effect on the child's education? Assuming that the income is a shock ω, and since parent income does not enter (21) then there is no impact on the optimal level of education. Parents will share the greater income to maintain the Euler condition. If parents borrow to invest in their child's human capital they may transfer resources by increasing the amount of they invest and reduce the debt. This is illustrated in equation (22). But since the rate of return is the same in complete capital markets, this has no effect on the level of human capital. Parents who are 'rich enough and altruistic enough' to not rely on debt will transfer resources to their children through larger bequests to restore equality of the Euler equation.

(23) $$\frac{dH}{dr} = P\left\{\frac{\partial h(\overset{+}{I}, A^{k*})}{\partial I}\frac{\overset{-}{dI}}{dr}, \frac{\partial h(\overset{+}{I}, A^{k*})}{\partial A^{k*}}\frac{\overset{0}{dA^{k*}}}{dr}\right\} < 0$$

Second, what is the effect of an increase in interest rates on educational attainment? As with any standard inter-temporal models an increase in interest rate creates an income, substitution and a human capital effect and the net balance of these to forces cannot be established without more information on preferences.[30] However, the impact on education shown by the total derivative in (23) is negative. This is because there is an alternative investment opportunity (bequest) where the return on financial investments has increased resulting in a substitution from investing in education and towards leaving a bequest. The lower level of investment raises the marginal return to investing in education until the optimal condition (20) is restored.

(24) $$\frac{dH}{d\mu} = p\left[\frac{\partial h(I, A^{k*})}{\partial I}\frac{\partial I}{\partial A^{k*}} + \frac{\partial h(I, A^{k*})}{\partial A^{k*}}\right]\varphi\iota\frac{\partial\hat{\varphi}}{\partial\mu} > 0$$

(25) $$\frac{dH}{d\alpha} = p\left[\frac{\partial h(I, A^{k*})}{\partial I}\frac{\partial I}{\partial A^{k*}} + \frac{\partial h(I, A^{k*})}{\partial A^{k*}}\right]\left(b + \varphi\frac{\partial\iota}{\partial\alpha}\hat{\varphi}\right)$$

The third and fourth comparative statics relate to variables which lead to an initial change in a child's behaviour followed by a response by their parent. As they have similar arguments they are presented together. An increase in the family beliefs signal in equation (24) leads to higher human capital both directly through a higher level of ability (as per equation (12) and also indirectly through the increase in later complementary investment. However, the size of the impact depends on the change in expected return to effort from the increase in cultural signal. There is no need for this to be linear (and may in fact be concave). It also depends on learning capability and the true return which is a common factor. Similarly an increase in natural ability leads to direct and indirect effects and higher human capital. The size of this effect depends on how learning capability improves with natural or inherited ability and also family culture.

[30] See Deaton (1992) for a discussion of these three effects.

The comparative static (24) can also be seen as the return to mentoring. If a mentor succeeds in raising a child's beliefs, then the improvement in human capital will depend on the extent to which this occurs and the child's learning ability. The more the child updates their own expectation then the more effective will be the mentoring in terms of higher levels of human capital.

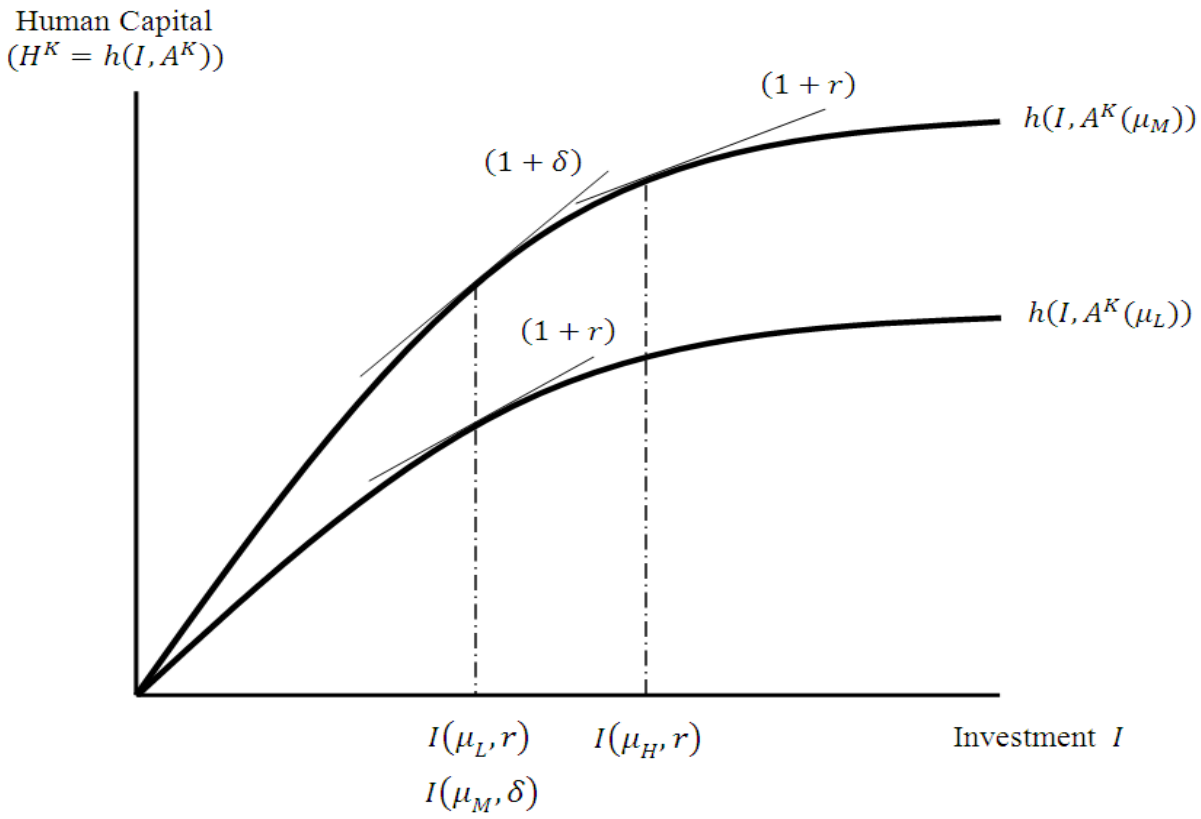
In this model low levels of family beliefs transmitted to children also create a self-fulfilling outcome of lower levels of human capital. This is the static cost in terms of one generation. If the low levels of human capital and low income as adults are interpreted as justifying the family culture then there is a dynamic effect through following generations. The persistence of culture across generations may explain why poorly educated parents who believe they mean the best for their children accept sub-optimal investment (from a social perspective) in their children even though there is no cost in their early years in repeated family games.[31]

3.3 Incomplete Capital Markets and Identification

The key comparative static of interest to this section is (24) which is derived assuming that capital markets are complete. The issue of how this result would change if markets are incomplete comes down to the responsiveness of investment for an increase in optimal ability $(\partial I/\partial A^{K*})$. If credit constraints are binding and all investment is funded by parents with no borrowing then the responsiveness of investment to a change in beliefs will be less than in complete markets. As ability raises the marginal return to investment, parents re-allocate resources towards investment to meet the Euler condition. This raises the marginal rate of substitution or shadow price of investment resulting in both a lower level and a smaller change (smaller derivative) in human capital. This can be thought of as crowding-out. Those effected are parents who face hard constraints or soft constraints but fund the investment themselves. In this circumstance, attainment in a function of income. Where parents cannot afford to invest their own resources and rely on borrowing on the child's behalf, there is no change in the cost of credit and so for homothetic functions the change in human capital is the same as families who are unconstrained.

[31] The transmission of attitudes across generations is shown in Goodman and Gregg (2010).

Figure 3: Family beleifs, credit constraints and Indetification



Unpacking Becker and Tomes' single endowment into natural ability and family beliefs means that differences in early attainment may not be simply due to credit constraints or inherited ability but also family culture as emphasised in the child development literature.

Applying this model to data raises two significant identification problems. The first is to distinguish between low levels of investment in human capital which may be either optimal from a parent's perspective due to low child ability from poor family beliefs or due to the existence of credit constraints. The identification problem is illustrated in figure 3 above where the reason for the low level of investment is ambiguous. In figure 3 this is indicated by $(I^*(\mu_L, r)) = (I^{CC}(\mu_H, \delta))$ where the superscripts indicate optimal and credit constrained investment respectively. Poor family culture together with complete markets may create the same level of investment as good family culture but with credit constraints (where $r < \delta$). A corollary is that previous studies which exclude family culture are likely to have omitted variable bias and overstate the importance of credit constraints.

The implicit functions (26) and (27) show differences in human capital, which in this instance is measured by early test scores. In addition to a proxy for family culture, other relevant variables are a measure of natural ability (inherited with error from parents), parenting ability and a measure of a child's learning capability. All of these variables follow from the model. The function (27) includes parent income as the parents are assumed to be credited constrained and fund the investment themselves. Since (26) is nested within (27) the significance of the income terms can be estimated. If the income coefficient is not statistically significant with the inclusion of the beliefs variable, this suggests that differences in income contain no further explanatory power of differences in early test scores and therefore no evidence of credit constraints.

(26) $$\Delta H^k = h(g(\overset{+}{\alpha}, \overset{+}{\mu}, \overset{+}{\iota}) \overset{+}{p}) \;\; if \;\; I = I^*$$

(27) $$\Delta H^k = h(g(\overset{+}{\alpha}, \overset{+}{\mu}, \overset{+}{\iota}) \overset{+}{p}, \overset{+}{Y^P}) \;\; if \;\; I^{cc} < I^*$$

A deeper identification problem is if family culture or beliefs reflects an expectation of future credit constraints. If, for example, parents rely on debt for any investment in their child's education then the child may be discouraged from responding to a positive belief system as they do not intend to encourage parents to take-on more debt on their behalf to be repaid in adulthood. Similarly, if parents are not 'rich enough and altruistic enough' to invest optimally then they may opt for a weak belief signal knowing that in adolescence they will under invest because of credit constraints. For example, if parents believed that tertiary education is simply too expensive then they may transmit a weak cultural signal. It is the expectation of being credit constrained which leads to a weaker belief signal. Since these issues cannot be fully disentangled, the identifying assumption is that family culture is slow-moving and hence does not simply reflect expectations of credit constraints. This would create parents with different beliefs in a just world depending on the issue and hence create the potential for cognitive dissonance.

4. EMPIRICAL ANALYSIS

This section presents empirical evidence on family culture as a causal influence on children's early test scores. This is carried out in three stages. First, a summary of two special studies in the 1991 National Child Development Survey (NCDS) follow-up survey is provided and the estimation strategy outlined. The follow-up studies enable a panel to be constructed linking the early economic and social circumstances of cohort members and their later beliefs (family culture) to the cognitive test scores of their children. Second, the hypothesis that parent beliefs are a causal factor in early attainment scores is tested with the data. Of particular relevance is the impact on income as an explanatory variable and the inferences about incomplete capital markets. Finally, the robustness of parent beliefs is assessed, whether they are a conduit for other directly observable measures of parent behaviour and what might explain the causal mechanism. All the data used in the chapter are presented in annex 1.

4.1 Two special studies from the NCDS dataset

The fifth NCDS follow-up in 1991 (when the cohort member was aged 33) includes two special studies particularly useful for this application. The first includes information on cognitive and non-cognitive skills of children randomly selected from one-third of cohort members. This creates a sample of 4,227 children, an equal numbers of boys and girls, from 2,587 separate families. The child ages range from 216 new-born children to 341 teenagers, with 60% between four and eleven. One drawback of this study is that at the 33 years old many cohort members have not have completed their families. This may introduce some sample bias as economically successful adults often have children later. These NCDS cohort members' children are the sample for this study. Note that because all of the regressions contain child test scores and parent beliefs (the variables of interest) and the same set of child and parent controls, the sample is reduced from 4,227 to a maximum of 2,050 observations.

(28) $$H_i^k = \pi_0 + \pi_1 \mu_i + \pi_2 A_i^p + \pi_3 P_i - \pi_4 \iota_i + \Delta X_i' \pi_5 + u_i$$

(29) $$H_i^k = \pi_0 + \pi_1 \mu_i + \pi_2 A_i^p + \pi_3 P_i - \pi_4 \iota_i + + \pi_5 Y_i^p + \Delta X_i' \pi_5 + u_i$$

Functions (3.26) and (3.27) are approximated by linear in parameters sample regression functions (28) and (29) where the subscripts indicate that variables corresponds to family i.

The absence of subscripts on the coefficients implies that children respond homogeneously to explanatory variables. The OLS estimator can therefore be interpreted as an average causal effect. The estimation strategy is a similar reduced form procedure to Tomes (1984). The key is the selection of explanatory variables. No explanatory variable is chosen by the child, the parent explanatory variables are not conditioned on the ability of the child and, most importantly, the key beliefs variable of interest is specifically not with reference to the child.

The main cognitive test used in this analysis is the Peabody Picture Vocabulary Survey (PVSS) which measures verbal intelligence. This is list of 175 words of increasing difficulty and the child selects one of four pictures which bests describes the word's meaning. While the test is designed for children over three, in the NCDS it is only completed by children over four years old. The Piat Individual Achievement Tests (PIAT) are also used in the analysis. These cover three separate fields: reading recognition, comprehension and mathematics and were completed by children 6 years and older. All scores are normed on age so the mean test score is 100 and standard deviation 15. As the median age of child who sat the PVSS test is 8.25 years old, the results are an early measure of education attainment.

The second special study contains information on cohort members' beliefs and attitudes on various social and economic issues. Responses are used to create a measure of family culture. The dimension of family culture relevant to this study is the extent to which cohort members believe that people "get what they deserve". This is measured by adding the responses to three statements in table 1 into a "belief in a just world" (BJW) measure. Responses are from 1 (strongly agree) to 5 (strongly disagree), so positive readings are consistent with a belief that effort is fairly rewarded, or people generally get what they deserve. Parents' responses to the survey are given before the child's test score is known and relate to returns to work. While it is conceivable that the progress of their child influences their parents' beliefs, whether this would lead a parent to respond differently to these statements is doubtful. The measure is normalised (mean zero and unit standard deviation) to assist interpretation.

Table 1 Questions used to Construct BJW Beliefs Metric

1.	Big business benefits owners at the expense of workers
2.	Management will always try to get the better of employees if it gets the chance
3.	Ordinary working people do not get a fair share of the nation's wealth

Source: NCDS sweep 5, "What Do You Think?"

The identifying assumption in this paper is that family culture is a slow-moving institution. While this does not preclude belief formation being a gradual learning process over time, it requires that beliefs at least not updated lock-step with changes in economic and family circumstances. A measure of the extent to which beliefs are slow-moving can be seen from the transition probabilities between the 1991 and 2000 surveys in Table 2 below. The cell entries show the transition probabilities between sextile rankings between 1991 and 2000. For example, the probability of being in the lowest sextile in 1991 and then the lowest sextile in 2000 is 37.6% and the probability of moving from the lowest ranking to the highest in nine years is only 2.8%.

Table 2: Transition Probabilities of BJW between 1991 and 2000 NCDS Surveys

2000\1991	1	2	3	4	5	6	Total
1	37.6	21.4	16.7	12.1	10.4	1.8	100.0
2	20.9	18.4	21.2	18.3	17.2	4.0	100.0
3	15.4	16.8	18.7	21.1	23.6	4.4	100.0
4	9.4	12.1	17.9	13.8	29.7	7.1	100.0
5	6.0	7.9	13.0	20.4	37.6	15.2	100.0
6	2.8	4.4	6.9	11.4	38.1	36.5	100.0
Total	19.4	15.0	15.9	20.0	23.4	9.32	100.0

Source: NCDS sweeps 5 and 6

As well as attainment and parental beliefs the regression functions show other variables to be included in the estimation in accordance to the model presented in section 3. Two measures of parents' natural ability are considered. The first comprises of three tests at 7 years of age covering maths, reading and drawing. Principal component analysis shows that the maths and reading tests have similar patterns and the first component explains 77% of the total variation in both series. The second measure is a General Ability test taken at 11 years of age and similar to an IQ test. The earlier test scores are taken as a better measure of inheritable ability on the basis that any tests taken around 11 years of age are likely to be influenced by preparation for the key 11-plus exams.

Parenting ability in the context of child attainment is usually proxied for by including parent qualifications. A thirteen point categorical variable showing the level of education of the cohort member is included in all of the regressions. More qualified parents will be in a better position to teach their child to be successful in attainment tests and possibly have more interest in doing so. The cost to a child of learning may be shaped by the cultural messages they receive in the family. In order to make this distinction, the cost is considered to be due to physical reasons and an indicator variable is included to show if the child has significant health problems affecting school attendance or requiring ongoing medical attention.

The measurement of income and resources is central to this study. Long term consumption and investment decisions are likely to be taken on the basis of expected life time resources rather than income at a single point in time. Current income can have measurement error which bias estimates toward zero. Several measures of family income and assets were considered and over different time periods. This is especially the case since both the 1981 and 1991 surveys took place during recessions when unemployment is likely to be temporarily high. Net family income is the most relevant measure. The top and bottom percentiles are dropped to avoid any bias as a result of leveraged observations. Family income reported at the same time as the attainment tests and beliefs were reported is used as a benchmark, although an earlier family income is also reported to reflect on the findings of Caucutt and Lochner (2005). Asset values were also considered in both surveys. While they are often significant there are concerns around measurement. Following Michael (2002) a categorical wealth variable is constructed based on the number of utilities at the parent or cohort member's home. This is similar to the wealth variable described in Annex 1.

Family income is not necessarily a good indicator of parents' investment in children. To capture parents' preferences for investment for a given amount of resources two categorical data series showing how many books the child owns and how often the parent reads to their child are considered. These are direct measures of parent investment in their children. A measure of parent involvement in school activities was also considered but with little impact on results. There is a high degree of co-linearity between books and reading, but including one measure is likely to be positively correlated with higher test scores. A final measure used is an index of home cognitive conditions which is based on the interviewers' observation of the conditions at home. Authors have noted that this variable is closely correlated with

income. These variables are included in specific regressions, but as they lead to a loss in sample size by around one-third they are not included in the initial specifications.

Three sets of controls variables contained in all the regressions. The first set takes account of child characteristics which may influence attainment levels but which are exogenous to the child. These include age (in months), sex, birth weight and whether they are a first child. The second set of controls describes the cohort member parent and their circumstances which are largely unrelated to their child but may influence attainment levels. These include sex, whether their parents were white, the mother was in their teens when the child was born and whether there are marital problems defined as some form of separation. The final set of controls is the size of household to take into account the resources per head in each household and the region of residence to take account of differences in beliefs across regions.

4.2 The Influence of Family Beliefs and Credit Constraints

A reasonable initial requirement for family culture to be a causal influence on test scores is a significant bi-variate correlation. Results show that a one standard deviation increase in family culture at the mean (or a 0.8 increase on a 1 to 5 point scale) leads to a 2.7% increase in test score and explains 3.3% of variation. To put this into context, a one standard deviation increase in annual family net income in 1981 (an increase of £2,513) leads to an increase of 1.8% and a similar increase in family net income in 1991 (an increase of £5,418) leads to a 1% increase in test scores. An alternative interpretation is that a one point increase in the BJW measure has the same impact on test scores as a 3 category improvement on a 13 point scale in the parent's level of education. Family culture passes this initial requirement.

Table 3 assess the impact of the culture variable on the current family income coefficient. Column (1) is a human capital production function with early test scores as the dependent variable and family income as a significant explanatory variable. This suggests that parent income is a statistically significant predictor of test scores and that credit constraints may prevent optimal investment in the child. Column (2) includes the parent ability measured by the first principal component of math and reading tests at 7 years of age. This is economically and statistically significant while the significance of the income coefficient falls below conventional thresholds. Since ability measured at age 7 is before any earnings, this cannot be a proxy through which income operates.

The family culture BJW variable is included in column (3) and is also economically and statistically significant and the coefficient on income falls. Both results cast doubts on current parent income being a statistically significant variable. The final column includes both culture and parental ability. The inclusion of income shows that the regression function (28) is assumed the correct specification whereas the results suggest that (29) may be more appropriate. An interpretation of the results in column (4) is that a one point increase in beliefs leads to a 1.6% increase in BJW test scores and is statistically significant at 1%.

Table 3: Regression Results of Early Test Scores on Beliefs controlling for Family Income
(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS	(4) PVSS
BJW			1.321***	1.367***
			(3.6)	(3.57)
Child health	-2.222**	-1.800*	-2.391**	-1.936***
	(2.41)	(1.92)	(2.53)	(2.02)
Parent ability 1		1.746***		1.639***
		(5.51)		(4.95)
Parent quals 5	1.126***	0.917***	1.035***	0.825***
	(11.15)	(8.14)	(9.69)	(6.96)
Family Income5	0.156*	0.109	0.134	0.083
	(1.76)	(1.17)	(1.46)	(0.86)
Constant	74.885***	76.629***	76.859***	78.618***
Observations	1764	1562	1682	1493
R-squared	0.14	0.16	0.15	0.16

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother and region of residence. BJW is a standardised variable describing 'belief in a just world'. Family income5 is family net income measured in 1991 at the time of the tests.

Further evidence on the role of income is presented in table 4. Column (1) includes the general aptitude test measure of parental ability. This has the dual effect of making the income variable statistically significant at the margin, and markedly reduces the size of the beliefs coefficient. The impact of a 1 point increase in beliefs is a 0.9% increase in test scores. This change in variable leads to the biggest fall in size of the coefficient of interest in all the results analysed. This issue is revisited in the robustness tests below. Column (2) includes family income in 1981 instead of 1991 which is economically and statistically more powerful. This is consistent with Caucutt and Lochner's (2005) that income even at the start of life has a higher significance on ECD outcomes than income received later in childhood. For 75% of the children in this survey income in 1981 was before they were born.

The derived family wealth variable in 1991 is included in columns (3) and (4) and is found to be statistically significant at 1%. The difference between the two results is the inclusion of the BJW culture variable in (4) column. While the wealth coefficient is still significant, it is reduced by around one quarter by the inclusion of BJW although both variables are significant at 1%. It is difficult to interpret a stock variable such as wealth as indicative of a credit constraint as this reflects the longer term resourcefulness of parents. This is more consistent with the long run characteristics of the family rather than an inability to borrow or an incomplete capital market issue. That the family wealth proxy did not reduce the coefficient on the culture variable suggests that it is not simply a proxy for unmeasured income or resources

Table 4: Regression Results of Early Test Scores on Beliefs with an Alternative Parent Ability Measure and Controlling for Family Income and Wealth

(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS	(4) PVSS
BJW	0.754*	1.617***		1.554***
	(1.93)	(4.64)		(4.79)
Child health	-2.750***	-2.688***	-2.453***	-2.577***
	(2.81)	(3.07)	(3.10)	(3.18)
Parent ability 1		1.886***	1.880***	1.727***
		(6.04)	(6.76)	(5.96)
Parent ability 2	0.198***			
	(6.93)			
Parent quals 5	0.609***	0.733***	0.769***	0.699***
	(5.09)	(6.87)	(7.82)	(6.85)
Family Income5	0.157*			
	(1.65)			
Family Income4		0.278**		
		(2.32)		
Family Wealth5			1.043***	0.760***
			(3.88)	(2.71)
Constant	69.561***	80.338***	76.840***	79.377***
Observations	1473	1848	2173	2075
R-squared	0.17	0.16	0.17	0.17

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother and region of residence. BJW is a standardised variable describing 'belief in a just world'. Family income5 is family net income measured in 1991 and family income4 is family net income measured in 1981. In column (1) parent ability (2) is measured by a general aptitude test at 11. Wealth5 is a derived categorical variable described in Annex 1.

To investigate the importance of family income in the presence of family culture further, a similar exercise to the Carneiro and Heckman (2002) application in Annex 2 is reported in table 5 below. Families are divided into quartiles based on income and tertiles based on family culture. Each quartile is assigned a dummy variable where the highest income quartile is the base (dropped) dummy. Equation (30) describes the procedure where the coefficients of interest are on the income quartile dummies. The dependent variable is the PVSS test score and the controls are the same as in the regression tables. This equation is effectively estimated for each tertile of family culture. F-tests where the null hypothesis is that the income dummy coefficients are jointly equal to zero are carried-out. If this null can be rejected then this indicates that income is a statistically significant predictor of test scores, after taking account of differences in family culture.

(30) $$H^k = X'\pi_b + \pi_{b,1}Y_1^p + \pi_{b,2}Y_2^p + \pi_{b,3}Y_3^p + u$$

Panel A divides the sample based on family income in 1991 and panel B is based on family income in 1981. Families in the highest income quartile are denoted as in Q4. The first column in both panels shows the results without control variables and without differentiating across family culture. Three lower income quartiles are compared to the highest income families and so lower test scores are indicated by negative signs. In both cases the F-tests indicate that the null hypothesis can be rejected at 1% significance level. This corresponds to the simple correlation between attainment levels and parent income noted at the start of the chapter. The second column in both panels marked 'conditional' includes the same controls used in the regression tables. Again the F-test indicates that the null hypothesis is rejected at 5% and 1% respectively. These results indicate that parent income is statistically significant predictor of test scores if family culture is not taken into account.

Columns (3)-(5) carry out the same regression, but for each tertile of family culture on the basis of BJW responses (columns 3 and 5 are families with the lowest and highest responses respectively). Because the dependent variable is continuous the analysis does not allow a probabilistic comparison of the number who may be credit constrained. However, the results show that income in 1991 only matters for families with middle family culture. Put another way, those families with distinctive family cultures are unlikely to have differences in children's attainment scores which are due to family income. The F-test shows that only for those families in the second culture tertile can the null hypothesis be rejected. The results

using family income in 1981 shows that the only statistical differences are between the first and second highest income groups. The F-test shows that the null hypothesis that the dummy coefficients are jointly equal to zero cannot be rejected. Taking the results of panel A and B together, after controlling for family culture only one group (1991 income and BJW tertile 2) shows that differences in family income remain an important influence on test scores. For the other five groups of family culture by family income the results suggest that income is not statistically significant.

Table 5: NCDS cohort members' children's test scores PVSS by parental income and family culture (BJW)

	Unconditional		Conditional		Culture tertile 1 (low)		Culture tertile 2 (mid)		Culture tertile 3 (high)	
	Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Panel A: PVSS scores by family net income quartiles at time of exam (1991) and parent belief in a just world (1991)										
Q4-Q1	-0.0961	0.0649	-0.1314	0.0915	0.1369	0.1693	-0.3626***	0.1534	-0.0035	0.1919
Q4-Q2	-0.3004***	0.0701	-0.2360***	0.0835	-0.0449	0.1425	-0.4497***	0.1457	-0.0710	0.1997
Q4-Q3	-0.0997	0.0766	-0.0799	0.0769	0.0459	0.1361	-0.1253	0.1326	-0.1275	0.1671
H0: all gaps = 0	F(3,1159)=6.8***		F(3,1536)=3.2**		F(3,495)=0.85		F(3,582)=3.7***		F(3,338)=0.33	
Panel B: PVSS scores by family net income quartiles at time of exam (1981) and parent belief in a just world (1981)										
Q4-Q1	-0.2833***	0.0569	-0.1509***	0.0603	-0.1488	0.1170	-0.0339	0.0960	-0.1914	0.1199
Q4-Q2	-0.1753***	0.0558	-0.0753	0.0578	-0.0873	0.1170	-0.0410	0.0891	0.0037	0.1153
Q4-Q3	-0.2979***	0.0515	-0.2134***	0.0542	-0.2075**	0.1039	-0.1986**	0.0848	-0.1185	0.1176
H0: all gaps = 0	F(3,2448)=13.77***		F(3,1886)=5.67***		F(3,607)=1.45		F(3,711)=1.97		F(3,441)=1.13	

Note: ***statistically significant at 1%, **statistically significant at 5%, * statistically significant at 10%. BJW is the family culture measure. Controls include:
region of school and child controls for age, sex, birth weight and whether first child and cohort member controls for sex,
non-white, marital problems and whether a teenage mother.

4.3 Robustness of Family Culture a Predictor of Test Scores

If parents are credit constrained then the amount of investment in their child's development will depend on their preferences expressed through the marginal rate of substitution. Since this may not be the same for all parents, a proxy for parent investment in their child is needed. A second justification for including a measure of investment is that beliefs might simply reflect an observable behaviour. For example, those who respond that they believe the world is just and that people are rewarded for effort may read to their children more often without any wider cultural influence. Table 6 includes three alternative measures of parent investment in their child. Column (1) is the same as column (4) in table 3 for reference. Column (2) includes a six point categorical variable of the number of books the child owns. As expected this reduces the significance of the income.

Table 6: Regression Results of Early Test Scores on Beliefs with Measures of Parent Investment

(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS	(4) PVSS
BJW	1.367***	1.493***	1.365***	1.708***
	(3.57)	(3.39)	(3.57)	(3.82)
Child books		2.664***		
		(4.98)		
Parent Interest			0.076	
			(0.35)	
Child read				0.840**
				(2.48)
Child health	-1.936***	-2.055*	-1.932***	-1.933***
	(2.02)	(1.72)	(2.02)	(1.58)
Parent ability 1	1.639***	1.473***	1.632***	1.741**
	(4.95)	(3.32)	(4.92)	(3.94)
Parent quals5	0.825***	0.598***	0.821***	0.674***
	(6.96)	(4.20)	(6.89)	(4.69)
Family income5	0.083	-0.049	0.083	-0.079
	(0.86)	(0.44)	(0.86)	(0.70)
Constant	78.618***	73.265***	78.511***	80.892***
Observations	1493	991	1493	987
R-squared	0.16	0.18	0.16	0.17

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother and region of residence. BJW is a standardised variable describing 'belief in a just world'. Family income5 is family net income measured in 1991. In column (2) child books is a categorical variable for how many books the child owns, in column (3) parent interest is a categorical variable describing parental involvement with the school, and columns (4) child read is a categorical variable describing how often a parent reads to their child.

Column (3) includes a 7 point measure of the interest the parent takes in school activities, ranging from whether they attend parent evenings to becoming a school governor. Surprisingly this has no significance. Column (4) includes a six point measure of the frequency which parents read to their child. This also reduces the significance of income. If the books and reading variables are both included then the reading variable becomes redundant due to the high degree of co-linearity. Including the books or reading variables also leads to a large reduction in sample size.

By including the measure of parent investment the size of the coefficients on family culture tend to become slightly larger suggesting that there is more to family culture than directly observable parenting behaviours. This is consistent with the interpretations of child psychologists discussed in section 2 who refer to culture as setting family values, aspirations and expectations. Buying books or reading to the child, while beneficial in terms of test scores, is not a substitute for family culture. Including the investment measures comes at a cost in terms of sample size and brings the risk of bias due to endogeniety as parents may be buying more books for children who work hard. The coefficients in column (2) indicate that a one point increase in BJW family culture at the mean is equivalent to a 1.8% increase in PVSS score.

Robustness checks are presented in table A2 in Annex 1. Column (1) is a weighted least squares regression of column (2) in table 6 where outlier observations measured by a Cook's D test more than one are excluded from the sample. The remaining observations are weighted using Huber-White errors. The coefficient on the family culture variable is higher after adjusting for outliers. All the variables are listed in the table and the coefficient signs are as the model in section 3 predicts. In column (2) the preferred measure of parent ability is replace for the general ability test score at 11 years old and introduced in table 4. While the size of the coefficient declines, an adjustment is required to take account of the units of the other variables. The BJW culture variable is significant at 5% and a one point increase at the mean leads to 1.3% increase in test score. Column (3) re-introduces the family wealth variable which is just significant at the usual thresholds and again leads to a larger rather than smaller culture coefficient.

Two further robustness tests are conducted. First, each of the three statements used to construct the BJW measure is included in the model as an explanatory variable to replace the

culture measure. Each of response is statistically significant, although smaller than the aggregate measure (see Annex 1). This indicates that there is not one statement is driving the results. Second, three alternative test scores are considered as dependent variables. A single factor from a principle component analysis of the three tests is used as the dependent variable. This explains 76% of the variation in the three scores. The coefficient on the culture variable is marginally below the usual threshold with a p-value of 0.11. The culture variable is significant for reading but not in the comprehension or mathematics tests. Including family income in 1981 raises the statistical significance of the culture variable above the usual thresholds in all but the comprehension test.

Table 7: Regression Results of Early Test Scores on Beliefs and Measures of Cognitive Support and Self Worth

(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS
BJW	1.367***	1.282***	0.47
	(3.57)	(3.24)	(0.92)
Home cognitive		0.071***	
		(5.18)	
Self Worth			1.176**
			(2.57)
Child health	-1.936**	-2.287***	-1.082
	(2.02)	(2.38)	(0.88)
Parent ability	1.639***	1.698***	1.660***
	(4.95)	(5.08)	(3.89)
Parent quals 5	0.825***	0.714***	0.941***
	(6.96)	(5.75)	(5.72)
Family Income5	0.083	-0.006	0.385***
	(0.86)	(0.06)	(2.82)
Constant	78.618***	79.521***	76.840***
Observations	1493	1408	772
R-squared	0.16	0.19	0.20

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother and region of residence. BJW is a standardised variable describing 'belief in a just world'. Family income5 is family net income measured in 1991 a the time of the tests.

All of the regressions so far are reduced form, meaning that parental beliefs enter into the regressions rather than through variations in children's beliefs or efforts. Yet the model in section 3 shows that the transmission of culture requires a response from the child where they update their beliefs. Two variables are used to examine this idea in table 7. The first is a

measure of home cognitive stimulus based on the interviewer's assessment of home conditions. Researchers have suggested that this is another proxy for family resources. If this reduces the significance of the family culture variable then it would suggest that observing the change in child behaviour can be replaced by looking at the 'inputs' in the home. Column (1) is the same as reported in column (4) of table 3 for comparison. The cognitive score test is included in column (2) and is significant and appears correlated with family income but has minimal impact on the family culture coefficient. This suggests the effect of family culture may be through more channels than home inputs.

As a proxy for the child's response to the culture signal a standardised variable measuring the child's perception of their self-worth is included in column (3). This is an imperfect way to get at the child's response to the family culture. If the culture is one where parents believe people are generally not rewarded for their efforts this may lead the child to have low self worth if there is a perception of little merit to effort. If this is a reasonable interpretation then the self worth measure would make the culture variable redundant. This is indeed found to be the case. There appears to be a link between family culture and children's self-worth which has a high degree of predictive value in early test scores.

3.5 SUMMARY

The importance of family culture in shaping the values, aspirations and expectations of children has long been recognised by child psychologists. Perhaps because 'culture' is ubiquitous and difficult to measure it has been omitted from econometric models of child development. Yet omitting key variables from the analysis is likely to introduce biases and, in this instance, may lead to false inferences about the role of credit constraints. This chapter presents a model to show how family culture is transmitted from parent to child and how a child optimally responds to cultural signals. This is described as an ontological model where the child's action (based on family culture) creates their outcome, irrespective of reality, reflected in test scores and ultimately differences in educational and economic success.

The empirical analysis exploits two follow-up surveys from the NCDS to enable cohort members' attitudes to be matched to a sample of their children's test scores. The dimension of family culture of interest, is cohort members' 'belief in a just world', that is the extent to which they believe people generally get what they deserved in life. A measure was created from cohort members' responses to attitude statements. While all attitudes are ultimately endogenous, the rate of transition suggests that this belief is slow-moving and therefore can be used as an explanatory variable. It is noteworthy that the response variable is determined by the child and the attitude by the parent. While there may be some reverse causation, this is unlikely since the statements relate to the work place and not their child. The Peabody Vocabulary Test Score is used as a benchmark of attainment.

Without including the beliefs variable, family income is correlated with the test scores. Early family income appears a particularly powerful influence. This is consistent with Caucutt and Lochner's (2005) idea of early credit constraints. When the culture variable is included in the regression, the coefficients on income decline. In a detailed test of the role of income after taking account of family culture, there is evidence that income is an explanatory variable in only a limited sub-set of the sample. Early family income was not found to be statistically significant after taking account of family culture. It follows that excluding family culture from child attainment models is likely to lead to omitted variable bias and may lead to false inferences about credit constraints.

Perhaps most surprising about this exercise is the size and robustness of the family culture coefficients. In the specification including parent investment in books a one point increase in

beliefs (on a 1 to 5 scale) causes a 1.3% increase in test scores. This is larger than the gain in test scores for a standard deviation increase in income without any control variables. The use of different income and wealth measures and proxies for family investment suggest the culture variable is not a conduit for family resources. This is consistent with what child psychologists suggest about beliefs and aspirations. One issue remain outstanding. While there is no conclusive way to show how parents' behaviour affects their child, more knowledge of the child's behavioural response would build a stronger case. The self-worth measure is an interesting start to this problem.

ANNEX 1

The National Child Development Study (NCDS) is a longitudinal study of more than 17,400 babies born in Great Britain in the week beginning 3rd March 1958 (98% of all children born that week). After the initial perinatal mortality survey at birth, there has been eight follow-up survey sweeps collecting data on many aspects of cohort members' lives including education, family experiences and financial and economic circumstances.[32] The fourth and fifth sweeps in 1981 and 1991, when cohort members were 23 and 33, include supplementary surveys on attitudes and cognitive and non-cognitive tests on children from a random selection of one-third of cohort members with children. These children of the cohort members are the sample used in the regressions in this paper.

The data used in the analysis are summarised in table A1 below with the exception of the regional controls. Because the regressions require test scores for cohort members (a parent) as well as their children (the sample) and attitudinal responses, the sample is limited to at most 2,050. The 'belief in a just world' measure is standardised in the regressions to assist in interpretation. The large skew in net family income in 1991 is problematic and has removed by dropping the first and last percentile observations in both income in 1981 and 1991. While this has a cost in terms of sample size, the resultant descriptive statistics are more representative. A family wealth variable is derived from the sum of indicator variables of whether the cohort member family has a phone, separate bathroom, own their home, have not claimed welfare and have savings or investments. The idea is to create a measure of accumulated wealth which may be more indicative of permanent income. This follows the methodology of Michael (2002) although applied to a different NCDS generation.

Table A2 includes robustness checks and the full results with the exception of regional dummies for the model specified in table 6 in section 4. Column (1) is the same regression as column (2) in table 6 except that any influential variables with a Cook's D score above 1 are dropped and weighted least squares are used to account for observations with large residuals. Column (2) uses an alternative measure of parent ability (a general aptitude test taken at 11) which reduces the size of the beliefs variable while column (3) uses the derived wealth variable discussed above in place of family net income. All statistically significant variables have the signs indicated by the model presented in section 3.

[32] See NCDS4 and NCDS5 cohort member interview questionnaires on http://www.cls.ioe.ac.uk/

Table A1: Summary of NCDS Data Used in Section 4

	Obsv.	Max	Min	Mean	Median	SD	Skew
Attitudinal responses							
Belief in just world	2050	5.00	1.00	2.58	2.67	0.81	0.22
Support for work ethic	2028	5.00	1.00	2.80	2.67	0.80	0.11
Left- right beliefs	2036	5.00	1.00	2.65	2.67	0.64	0.04
CM's child test scores							
Peabody vocabulary	2050	187	1.00	100.6	100.0	14.40	-0.13
Peabody reading)	1785	174	47.0	100.6	101.0	14.94	0.08
Peabody comprehension	1680	170	46.0	100.2	100.0	14.89	0.17
Peabody mathematics	1774	187	36.0	100.6	100.0	14.98	0.14
CM parent test scores							
Arithmetic (math) (age 7)	2050	10.0	0.00	5.07	5.00	2.40	0.11
Reading (read) (age 7)	2050	30.0	0.00	23.6	26.0	6.62	-1.07
General aptitude (cmiq) (age 11)	1847	79.0	5.00	43.5	45.0	15.5	-0.13
CM parenting ability							
Books child owns	1349	6.00	1.00	5.16	5.00	0.88	-1.00
Read to child	1346	6.00	1.00	4.52	5.00	1.43	-0.79
CM qualifications 5	2050	13.0	0.00	4.65	4.00	3.45	0.64
CM interest in school	2050	7.00	0.00	2.59	3.00	1.70	0.19
Child learning ability							
CH Health problem	2050	1.00	0.00	0.19	0.00	0.39	1.61
CM Income/wealth £'000							
Family net income 4	1805	16.6	0.00	5.05	4.78	2.76	0.38
Family net income 5	1503	686	0.94	10.1	7.68	25.7	24.3
Family net income 5	1465	36.8	1.87	8.98	7.76	5.40	1.24
Family assets 4	1805	80.0	-2.75	2.43	1.00	4.90	6.25
Family assets 5	2037	341	-36.0	28.8	22.7	32.8	2.59
Family wealth	2042	6.00	1.00	4.25	5.00	1.30	-0.60
Child controls							
Age of child (months) (chage)	2050	224	47.00	104	99.00	36.61	0.46
Sex of child (1=boy) (chsex)	2050	1.00	0.00	0.49	0.00	0.50	0.03
Weight at birth (chweight)	2050	213	30.00	117	118.0	19.04	-0.35
First child (chfirst)	2050	1.00	0.00	0.68	1.00	0.46	-0.80
Child's self worth (standardised)	1083	1.59	-3.66	-0.00	0.14	1.01	-0.06
CM controls							
Sex (cmsex)	2050	2.00	1.00	1.64	2.00	0.48	-0.58
Marital problems 5 (cmmaritpr)	2050	2.00	0.00	0.42	0.00	0.80	1.42
Non-white (cmethnic)	2050	1.00	0.00	0.01	0.00	0.08	12.96
Teenage mother (cmteenmum)	2050	1.00	0.00	0.14	0.00	0.35	2.06
Household size (hhsize)	2050	6.00	0.00	4.29	4.00	0.96	-0.78
Home cognitive score	1936	98.0	0.00	50.1	51.0	28.1	-0.06

Table A2: Regression Results of Early Test Scores on Beliefs with Robustness Checks

(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS
BJW	1.587***	1.042**	1.600***
	(3.50)	(2.41)	(4.31)
Child health	-0.926	-2.891**	-2.266**
	(0.87)	(2.50)	(2.26)
Child books	2.778***	2.505***	2.987***
	(5.33)	(4.85)	(6.33)
Parent ability 1	1.722***		1.299***
	(4.20)		(3.29)
Parent ability 2		0.161***	
		(4.76)	
Parent quals5	0.524***	0.391***	0.496***
	(3.81)	(2.74)	(4.04)
Family Income5	-0.053	0.039	
	(0.48)	(0.36)	
Family wealth5			0.581*
			(1.66)
Child age	0.054***	0.047**	0.067***
	(2.71)	(2.44)	(3.93)
Child sex	2.336***	1.647**	1.637**
	(2.86)	(1.97)	(2.25)
Child birth weight	0.058***	0.063***	0.039**
	(2.81)	(3.05)	(2.06)
First child	1.526*	1.966**	2.516***
	(1.66)	(2.13)	(3.12)
Parent sex	-0.218	0.635	0.167
	(0.17)	(0.48)	(0.22)
Parent marital probs	0.080	-0.856	-0.294
	(0.13)	(1.31)	(0.50)
Parent non-white	-6.663	-0.955	-10.007
	(1.28)	(0.22)	(1.53)
Parent teen mum	-3.810*	-3.189	-2.529
	(1.78)	(1.40)	(1.45)
Household size	0.234	0.135	0.258
	(0.50)	(0.27)	(0.59)
Constant	72.279***	66.166***	68.057***
Observations	991	970	1369
R-squared	0.19	0.19	0.20

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother and region of residence. BJW is a standardised variable describing 'belief in a just world'. Family income5 is family net income measured in 1991. Column (1) is a weighted least squares regression with absolute t statistics in parenthesis. Parent ability2 is a general aptitude test at 11 years old and family wealth5 is a derived variable described above in Annex 1.

ANNEX 2

Blossfeld and Shavit (1993) report a persistent correlation between parental income and children's educational attainment across time and countries with very different education systems. The key issue is whether income itself leads to higher attainment or whether there are other factors related to higher attainment which also explain higher income. An enormous amount of intellectual endeavour has been devoted to this important issue. Economists have generally interpreted this question as whether there are credit constraints which prevent low income parents from optimally investing in their children. This interpretation is consistent with Becker and Tomes (1986) which has been the economic paradigm in which much of the policy debate has been conducted.[33]

In an important paper, Carneiro and Heckman (2002) show that after taking account of early childhood attainment and family characteristics there is little significant difference in across later attainment between families with different income levels. Family characteristics such as parents' education, marital status, number of siblings and regional location all correlate with long run family income and are reflected in early child ability. They argue that as differences in attainment can largely be explained by early childhood ability and indicators of long run family income there is little remaining to be explained by short term credit constraints at school leaving age.[34] This has shifted the debate from differences in education attainment at school leaving age or in college to explaining differences in early attainment levels.

(A1) $$H^k = X'\pi_a + \pi_{a,1}Y_1^p + \pi_{a,2}Y_2^p + \pi_{a,3}Y_3^p + u \qquad a = 1,2,3$$

The key regression in Carneiro and Heckman is (A1) where the Y's represent indicator variables for quartiles of parent income rather than a continuous variable and the subscripts indicate the child's tertile of ability based on early test scores. In effect the regression is estimated three times for each ability tertile and the highest income quartile is the base (dropped) dummy variable. The π parameter measures the marginal change in attainment level for children in each income quartile relative to the highest quartile after controlling for differences in ability and long term family characteristics. The difference between parameter values is the unexplained or upper bound which might be the result of credit constraints.

[33] Behrman (1997) points out that most analytical and policy work has been derived within this framework.

[34] Carneiro and Heckman (2002) also point out that if the objective of policy is to maximise human capital then measures to compensate for differences in attainment later in life are likely to be inefficient.

There are criticisms of this procedure. First, the measure of family income used at the time of college entry is at a specific point in time and includes transitory elements and a high degree of measurement error. A stronger case would exist if a proxy for permanent income were used. Second, early test scores are a function of parent income and so their inclusion creates a downward bias on the income coefficient. This rests on whether there is enough variation in the income data after including test scores and family characteristics for significance tests to have power. Third, some of the controls such as family structure are at least in part a function of income. How long run family income influences early test scores remains unanswered.

The correlation between parent income and status and children's education attainment has long been documented in the UK.[35] Most research into the causes has been multi-disciplinary and consistent with the life cycle approach to human capital. For example, Hutchison, Prosser and Wedge (1979) use children's test scores at the age of 7 to show they are strong predictors of scores at the age of 16. Currie and Thomas (2002) show that early test scores are a significant predictor of employment and wage rates at 33 years of age. Relatively few papers using UK data have examined credit constraints, perhaps because tertiary education has traditionally not involved fees.

Dearden, McGranahan and Sianesi (2004) directly apply Carneiro and Heckman (2002) methodology to the National Child Development Survey (NCDS) (1958) and BCS. As measures of education attainment they look at the likelihood of staying in continuous full time education past the 16 minimum leaving age and completing a higher education qualification. They find that less than the 7% upper bound estimated in the US are possibly credit constrained in the UK. The NCDS data show almost no significant evidence of possible credit constraints while the BCS show up to 7% of statistically significant differences which may be due to credit constraints.[36]

However, Dearden et al do not address the criticisms of Carneiro and Heckman and perhaps compounded them by their choice of controls. For example, the tests at 11 years old are in the same year as the all important 11 plus exam which largely determined the type of secondary education for the child. Preparation is likely to be heavily influenced by what parents expect

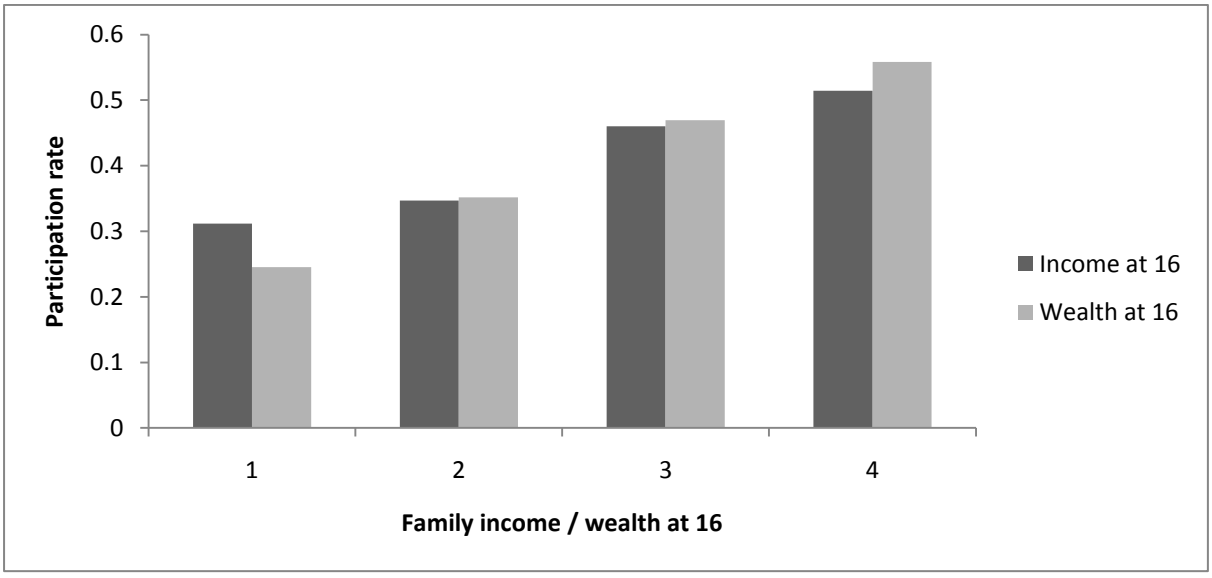
[35] See, for example, Rowntree's famous study of the causes of poverty (1901).

[36] Dearden et al. (2004) find that using the NCDS data only 2% of men and 5% of women, and using the BCS data 3% of men and up to 6% of women are possibly credit constrained in completing a higher education qualification.

to afford.[37] Similarly, family income is reported on a three day week due to industrial action and may be more susceptible to measurement error. Finally, including control variables will capture much of the between family variation in income at that date. All of these judgements reduce the chance of finding credit constraint effects and are addressed below.

The Carneiro and Heckman model is re-estimated with three alternative sets of early attainment and income measures to address these shortcomings. First, test scores at age 7 are used instead of age 11. Figure 1 in section 2 shows that test scores by income group at this age are similar to test scores by income group at age 11. Second, a wealth variable is constructed to reflect permanent income and remove transitory elements perhaps which would bias the results towards zero. [38] This is a categorical variable based on an approach by Michael (2002) adding together a list of six amenities describing parent's home: an indoor WC and bathroom, central heating, fridge, freezer, telephone, black and white TV, colour TV, one car, two cars. As well as perhaps being a better reflection of permanent income there is much smaller loss of sample size of 27% and it is reasonably symmetrically distributed. Figure A1 shows that the wealth index has a similar correlation with test scores as income but the difference in participation rates at 16 between children from the highest and lowest quartiles is 20 percentage points using income and 35 percentage points using wealth.

Figure A1: Child Participation at School at 16 by Parent Income and Wealth



Source: NCDS sweep 3. Income refers to parents' total income and wealth refers to wealth constructed by the number of amenities in the home.

[37] Places in grammar schools were financially assisted. But given that the high proportion of grammar school children to enter university they imply a large indirect cost.

[38] The method is similar to Michael (2002). The strike disruptions are likely to add to measurement error.

Table A.3 recreates table 3 in Carneiro and Heckman (2002) using the results from the NCDS to compare participation rates in continuous full time education after 16. Panel A is the preferred specification using test scores at 7 and the constructed measure of wealth to address the concerns discussed above. Panels B uses family income and test scores at 7 and panel C uses family income and test scores at 11 as a comparator. Note that the sample in this exercise is the cohort members themselves, while the empirical analysis in this paper is with regard to a random sample of cohort members children.

Column A contains the estimates of (A1) without separating into ability tertiles therefore restricting $\pi = 0$. The beta coefficients measure estimated attainment gaps by income quartile relative to the highest quartile with the standard errors adjacent. For example, children from the lowest income quartile have a 0.35 lower probability of staying in full time education at 16. The F test rejects the null that that all betas are zero. Column B repeats the exercise but includes the control variables. It is clear that controlling for longer term factors associated with differences in income greatly reduce the importance of current wealth or income in determining the education attainment. The statistical and economic significance of the results in panel A are much higher than in panels B and C which supports the use of the wealth variable and test scores at age 7.

Columns C-E report repeated estimation of B for each of the three ability tertiles. This is the Carneiro and Heckman model. Taking account of early age ability reduces the attainment gaps further, less in panel A than in B and C. By weighting each statistically significant beta by the number of children in each cell relative to the sample creates an estimate of the proportion of children possibly from credit constrained families. The results show that between 3.9% (panel A) and 1.7% (panel C) are were possibly credit constrained in the traditional sense.[39] Counting only the coefficients which are statistically significant, the range reduces to 3.8% to 1.7% respectively. It is interesting to note that there is more evidence consistent with credit constraints in the lower ability tertile, a finding consistent with Carneiro and Heckman. In their words, there is evidence that more "dumb rich" kids stay on than "dumb poor" kids.

Despite the ongoing debate some consensus of the importance of credit constraints is emerging. For example, Krueger (2003) acknowledges that credit constraints (or a convex

[39] Including non-statistically significant betas raise the proportions of the sample who may be credit constrained to 4.8% and 2.5% for panels A and C respectively.

cost of funds function) "could be interpreted as reflecting an increasing marginal distaste for school that varies with family income."[40] This seems to be close to the life cycle assessment where skills beget skills and motivation begets motivation. A crude summary to date is that: (a) differences in family income and child attainment are persistent and consistent with credit constraints; (b) after taking account of long run influences, the size of constraints are likely to be much smaller than earlier reported, perhaps up to 4% based on UK survey evidence; and, (c) differences in parent resources influence the early test scores which correlate with later levels of education attainment. How different family resources influence early test scores remains unanswered.

[40] Krueger (2003) in Krueger and Heckman (2003) p.57.

Table A.3 NCDS Cohort Members Education Attainment by Parental Income and Wealth

	Unconditional		Conditional		Ability tertile 1 (low)		Ability tertile 2 (mid)		Ability tertile 3 (high)	
	Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Panel A: stay on at school after 16 by total family income quartiles and ability at 7 years old										
Q4-Q1	0.2025***	0.0168	0.0832***	0.0173	0.0700***	0.0292	0.0789***	0.0297	0.0387	0.0305
Q4-Q2	0.1674***	0.0165	0.0535***	0.0166	0.0621***	0.0286	0.0379	0.0285	0.0136	0.0288
Q4-Q3	0.0540***	0.0180	0.0186	0.0177	0.0121	0.0312	0.0291	0.0304	-0.0239	0.0301
H0: all gaps = 0	F(3,7039)=64.69***		F(3,5957)=9.13***		F(3,1636)=3.08**		F(3,2099)=2.6*		F(3,1959)=1.4	
Panel B: stay on at school after 16 by family wealth proxy quartiles plus controls and ability at 7 years old										
Q4-Q1	0.3129***	0.0134	0.1101***	0.0155	0.0768***	0.0255	0.1176***	0.0266	0.0639***	0.0281
Q4-Q2	0.2067***	0.0156	0.0709***	0.0164	0.0903***	0.0282	0.0595***	0.0275	0.017	0.0210
Q4-Q3	0.0891***	0.0153	0.0319***	0.0154	0.0232	0.0285	0.0191	0.0263	0.029	0.2557
H0: all gaps = 0	F(3,8263)=200.26***		F(3,6882)=16.06***		F(3,1911)=4.77**		F(3,2410)=7.37***		F(3,2253)=1.84	
Panel C: stay on at school after 18 by family wealth quartiles plus controls and ability at 7 years old										
Q4-Q1	0.3129***	0.015	0.0878***	0.0172	0.0162	0.0256	0.1107***	0.0291	0.0381	0.0328
Q4-Q2	0.2270***	0.0169	0.0529***	0.018	0.0102	0.0275	0.0561*	0.03	0.0113	0.0339
Q4-Q3	0.1183***	0.0151	0.0317**	0.0154	-0.017	0.0253	0.0593**	0.026	0.0071	0.0207
H0: all gaps = 0	F(3,8263)=176.6***		F(3,6882)=9.9***		F(3,1911)=4.8**		F(3,2410)=5.1**		F(3,2253)=1.0	

Note: OLS estimates with robust t statistics in parenthesis where *** shows statistical significnace at 1%, **shows statistical significance at 5% and * shows statistical significance at 10%. Fourth quartiles (richest) in the base dummy (dropped). Controls include: region of school, school leaving age of both parents, father's social class, a missing parent dummy and number of children in family all recorded at age 7.

ANNEX 3

The 'belief in a just world' measure is checked to see whether the responses to one statement are dominant. This is important because the interpretation of the statement may have a time specific content. Each of the responses is measured on a five point scale and is standardized. In column (4) the first principal component of the three sets of responses is used rather than adding the responses. The results show that the responses to each statement and the principal component measure are all statistically significant.

Table A4: Regression Results of Early Test Scores on Beliefs with Robustness Checks

(Dependent variable: Peabody Vocabulary Test Score)

	(1) PVSS	(2) PVSS	(3) PVSS	(4) PVSS
Business	0.961***			
	(2.60)			
Management		1.486***		
		(4.01)		
Wealth			0.613*	
			(1.73)	
PC_BJW				0.971***
				(3.50)
Child health	-1.989**	-2.081**	-1.952**	-1.931**
	(2.08)	(2.21)	(2.07)	(2.02)
Parent ability	1.707***	1.579***	1.728***	1.645***
	(5.24)	(4.91)	(5.33)	(4.96)
Parent quals5	0.869***	0.829***	0.899***	0.827***
	(7.47)	(7.08)	(7.80)	(6.99)
Family income5	0.086	0.080	0.095	0.084
	(0.90)	(0.85)	(0.99)	(0.87)
Household size	0.237	0.231	0.172	0.283
	(0.45)	(0.45)	(0.33)	(0.54)
Constant	78.542***	78.437***	77.535***	78.578***
Observations	1512	1524	1524	1493
R-squared	0.16	0.17	0.16	0.16

OLS estimates with robust t statistics in parentheses: *** shows statistical significance at 1%, ** shows statistical significance at 5% and * shows statistical significance at 10%. Each regression includes child controls for age, sex, birth weight and whether a first child and cohort member controls for sex, non-white, marital problems if teenage mother. ZBJW is a standardised measure of the 'belief in a just world' index. Family income 5 refers to net income measured in 1991. Business refers to statement 1, management refers to statement 2 and wealth refers to statement 3 in table 1 in section 4. In column (4), PC-BJW is the first principal component of responses to the three statements.

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