Four Essays on the Formation of Human Capital

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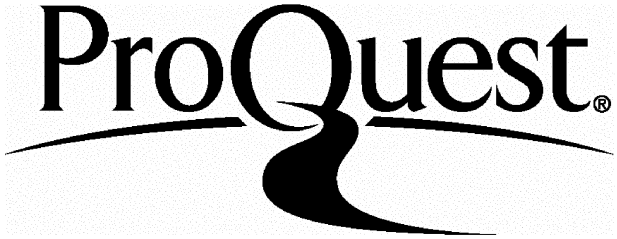

Abstract

The thesis is concerned with human capital formation. The effects of different aspects of families and other institutions in the formation of human capital are assessed but human capital is studied in a more broad sense than hitherto in the economics literature.

The first paper develops a time allocation model to see whether the attainments of children depend on pre-school participation. When analysis deals with the endogeneity resulting from the pre-school participation decision, one finds that any initial positive effects of early 1960s participation were lost by age eleven. Children, who were in pre-schools in the 1970s, performed worse in tests if they spent time in pre-school rather than with parents or other adults.

The second paper finds that infant development is a significant signal of final education qualifications. The strongest factor associated with early success is maternal education, particularly degrees, suggesting that interactions with the mother in early life have important implications for economic welfare. Differences in the educational quality of these interactions are, in part, responsible for later educational and hence economic inequality.

The third paper finds that the dominant factor in age 16 attainment is the interest taken by parents in the education of children. This dwarfs the effect of standard proxies for the domestic environment such as paternal occupational classifications and suggests that analyses such as those of OFSTED into the effects of schools must take account of this aspect of family background.

The final paper shows that hourly wages do not depend only on academic abilities developed in childhood but also on the psychological and behavioural capital built up by age ten, such as self-esteem and 'social behaviour'. The economic returns to investments in schooling, therefore, should not be conceived solely in terms of the production of academic ability.

Declaration

1. No part of this thesis has been presented to any University for any degree

2. Chapter 2 was written jointly with my supervisor James Symons and Donald Robertson. I contributed 50 % to this study. Chapter 4 was written in collaboration with James Symons. I also contributed 50% to this work. I would like to thank my co-authors for permission to include this joint work in my PhD thesis. A statement from them confirming the share of work undertaken by me is given below.

3. A version of Chapter 2 is forthcoming in Education Economics, Vol. 7, No. 3, 1999. A version of Chapter 3 has been published as Centre for Economic Performance Discussion Paper No. 404, 1998. A version of Chapter 4 has been published in Oxford Economic Papers, Vol. 51, Issue 2, 1999. A version of Chapter 5 is forthcoming as a Centre for Economic Performance Discussion Paper.

I confirm the above declaration, item 2, referring to joint work I carried out with Leon Feinstein.

James Symons

Donald Robertson

Table of Contents

List of Figures

List of Tables

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Chapter 1. Introduction

There is currently considerable concern about the success with which British children are educated and prepared for the labour market and life in general. Many people feel that education is both a source of general economic growth and a possible means of redressing social inequality. This political importance of education reflects the impact of the idea of human capital within economics. The origins of this notion can be seen in The Wealth of Nations in which Adam Smith observes that the work of an educated man "which he learns to perform, it must be expected, over and above the usual wages of common labour, will replace to him the whole expense of his education[1]."

The possibility of a return to education was present, therefore, from the birth of modern economics, suggesting that education might be thought of as an economic decision with associated costs. This possibility remained relatively undeveloped, however, and it isn't until the post-war period of the twentieth century that the implications of this wage premium have begun to be theoretically and empirically explored by economists. McCloskey (1990) describes the revelation of the idea of human capital for Schulz who:

"interviewed an old and poor farm couple and was struck by how contented they seemed. Why are you so contented, he asked, though very poor? They answer: You're wrong Professor. We're not poor, we've used up our farm to educate four children through college, remaking fertile land and well-stocked pens into knowledge of law and latin. We are rich."

It is to be hoped that this university education did indeed show satisfactory returns for the children of this particular couple but, importantly, Smith's observation of a general wage premium to repay educational expenditures had been extended to suggest the possibility of an explicit analogy between physical and human capital, an extension that has provided substantial research advantages. The intuition of the possibility of economic returns to human capital has since been established empirically in a number of frameworks, such as those of Mincer (1974) or Ben-Porath (1967). The importance of some measure of human capital in estimated earnings functions has been interpreted as a

[1] Smith, A., (1776). *The Wealth of Nations*. Bk 1, ch. 10, pt 1.

return to productivity or, alternatively, as a signalling effect but in either case, it is established that expenditure on education is a viable source of investment returns. This is despite the implications for human capital theory of the obvious distinctions between humans and machines, implications explored by, for example, Shaffer (1961), Schulz (1961a/b) and Blaug (1970).

The development of the theory of human capital has also been fruitful for growth economics. Countries or regions with high levels of human capital are expected to grow faster that others. In the models of Romer (1986) or Lucas (1988), for example, human capital enters the production function to make growth endogenous. These models, therefore, explicitly raise the question of how human capital is generated, or extending further the metaphor with physical capital as is commonly done, of the formation of human capital. This is the topic of the four papers of this thesis.

For labour economics, schooling and ability have become the standard measures of human capital. In the growth literature, on the other hand, human capital has been thought of in a number of other ways, the result, for example, of investment in physical capital (learning-by-doing, Arrow, 1962). Alternatively, in the model developed by Uzawa (1965) and extended by Lucas (1988), growth results from the technological outputs of the research community. These notions of productivity-enhancing knowledge gained from practice with sophisticated machinery or, in the Uzawa notion, growth-enhancing inventiveness are clearly distinct from an individual's academic ability or simple years of schooling as explored in labour economics and have explicitly different processes of formation.

The different foci of the two research strands, therefore, lead to different research questions for those concerned with human capital formation. In the growth literature, as has been said above, it has been important to model the way in which the formation of human capital is determined simultaneously with economic growth, providing endogenous growth. Alternatively, researchers have considered the question of which measures of human capital best predict growth rates in different models and with different estimation strategies (for example, as in Barro and Sala-I-Martin, 1995 or Benhabib and Spiegel, 1993). In this thesis attention is restricted to those issues explored in labour economics but it is worth bearing in mind that human capital formation is also important for growth.

For labour economics, research has focussed primarily on the problems of establishing precise estmates of the actual return to education. This has been investigated in terms of the direct returns for the individual (for example, Card, 1994, Neumark, 1994, or Blundell *et al.* 1997) or indirectly through returns to the public expenditure of resources in the education system. (See, for example, Angrist *et al.*, 1991, Betts, 1995, or Dearden *et al.*, 1997.) Individual heterogeneity of ability or of marginal costs of education expenditures lead to the possibility of externalities and inequalities that might be alleviated by state education expenditures but it has been a problem to show that investment in educational quality shows genuine economic returns.

Another problem has been the relationship between schooling and ability, both possible forms of human capital. For example, it is common to note that omission of ability measures causes a bias in estimation of returns to schooling. Schooling, moreover, is likely to be an endogenous choice variable but ability might be an argument in the choice equation. Furthermore, in terms of the development of the child, ability is not fundamentally separable from schooling. Even taken at seven years or earlier, observations of ability will be influenced by prior investments of schooling. Despite recent advances, therefore, it is still important to deepen understanding of the nature of human capital.

This thesis contributes to this research in a number of ways. The four papers consider the questions of how formal and informal institutions such as the family, peer groups and schools make a difference to the abilities of children, how much stability there is in the individual development of children over time and how diverse abilities influence labour market outcomes. The emphasis here is on differences between groups in society in the formation of human capital, leading to educational and hence economic inequality.

All four papers make use of the National Child Development Survey (NCDS) and British Cohort Study (BCS), the two main UK longitudinal data sets, also known more descriptively as the 1958 and 1970 cohorts, respectively. The earlier set of data is based on an initial survey of all children born in the UK between March 3-9, 1958. Further sweeps were carried out when the children were 7, 11, 16, 21 and 31, giving information on the academic attainment of those children who remain in the survey as well as substantial medical, sociological, psychological and institutional information. This is drawn from questionnaires and/or interviews with sample children, parents, teachers, doctors and health visitors. The later data set is a study of all British children born in the

week from the 5th to the 11th of April, 1970 and surveyed again when the children were 5, 10, 16, 21 and 26. Again, the cross-sectional information is substantial.

Economists have applied theoretical models to shed light on the complex set of factors that influence the attainment of children, as an indicator of human capital. The centre-piece of this theoretical apparatus is the education production function, a structural model of inputs and outputs. This is the method applied in Chapter 2 of this thesis, written with James Symons and Donald Robertson, which considers the contribution of pre-school care to the academic attainments of children. In a modern society with a large number of mothers in employment, it is important to consider the extent to which pre-school institutions can improve on or substitute for the learning that would otherwise be provided by mothers. This learning, of course, may be in the form of actual educational experiences that contribute directly to academic attainment or be a development from positive parent-child interactions that enable the child to learn subsequent academic skills.

In Chapter 2, a model of time allocation is applied so as to tackle the endogeneity that results from the simulteneity of mother's labour force and pre-school participation decisions. The empirical results are, therefore, an advance on previous research, described in Chapter 2, which has tended to consider only the association of pre-school participation and subsequent attainments without considering how parents who choose to send their children to pre-school might also be offering other kinds of advantages or dis-advantages.

The concern with early childhood as a vital period in the formation of human capital is also the motivation for Chapter 3 which considers the extent to which very early scores have forecasting power for later scores and for adult outcomes. Educational inequality appears to begin very early in Great Britain. Chapter 3 also includes an examination of the relative contribution of material, attitudinal and school-based inputs to the production of educational inequality at different ages. Given the part education is now expected to play it is important for economists to consider the role of economic and other factors in causing these early developmental inequalities and influencing later economic outcomes. If it is primarily material differences that dominate then there is clear support for policies that redistribute wealth to families, particularly families in persistent poverty. If, rather, it is parenting skills that have the greatest effects then there is an economic rationale for interventions that support and develop parenting, perhaps alongside measures to confront the material aspects of poverty. Given its importance within economics, it is, perhaps, also important for economists to be more conscious of the complexities of the process of human capital production at early ages.

Chapter 4, written jointly with James Symons, again applies an education production function, in this case to age 16 outcomes. In principle, the education production function should contain as an explanator the full history of parental involvement with the child as well measures of the efficacy of such time. In practice, such detailed information is not measured but crudely proxied by such variables as parental education and social class. Whereas these measures are usually found to be important, it is not clear what can be deduced from this. For example educated and otherwise successful parents could foster attainment because they have more financial resources to devote to their children, or because they have high marginal products in the relevant child-raising activities, or because they belong to a culture which values attainment. Chapter 4 finds that the attitudes of parents to education, as assessed by teachers, are the primary input to the educational attainments of children. Again, these may proxy a number of different underlying inputs, discussed in the text but, crucially, the variable provides a more accurate proxy than standard measures of social class such as father's ocupational category or parental education. This finding supports an emphasis on the role of parents in human capital formation.

In labour economics, ability as a measure of human capital is generally assessed by performance in tests of academic attainment. Brighter children are commonly predicted to earn more than others, presumably because of higher productivity. This can be thought of as a return to human capital in an investment sense to the extent that academic ability is generated by the economic inputs of parents, teachers and so on. However, parents and others also devote resources of care, time and effort into child development in order to foster other kinds of abilities and attributes that might also (either co-incidentally or instrumentally) receive reward in the labour market. This is the issue explored in Chapter 5 of the thesis. If other attributes such as good peer relations or sociability are also associated with wage premia then there is the possibility of extending the notion of human capital to encompass these and other features of personality. This would also suggest that economists might pay attention to the formation of such attributes and the possible returns to expenditures that support them, perhaps in competition with resources that would otherwise be devoted to academic ability. Having established that these other features of personality are important, Chapter 5 also examines the contribution of material, attitudinal and schooling variables to the formation of these aspects of non-academic ability and considers their correlation with academic ability.

Overall, this thesis considers the production of human capital at different stages of childhood, following two cohorts of children from birth and seeing how different aspects of upbringing influence their academic and other abilities and how these then lead on to further attainments or inequalities. The themes of each chapter are clearly linked but each is written to be self-contained. Thus, the first chapter considers early childhood and uses regression analysis to show the importance of different aspects of background in influencing the academic attainments of children. Similar methods are repeated in later chapters as subsequent chapters show the cumulative nature of dis-advantage, later problems compounding earlier ones as children develop a view of their abilities, of the world and of their place within it. This developmental process is shown to have economic implications as well as being influenced by pre-existing economic arrangements.

Chapter 2. Pre-school Education and Attainment in the NCDS and BCS

2.1 Introduction

For parents, issues of the quality and effects of pre-school education are especially pertinent since pre-school age children are particularly vulnerable. The issue is also receiving more attention from economists now that it is common for both parents to be working. The availability of child-care is an important aspect of mothers' labour force participation decisions. This chapter attempts to evaluate the effects of pre-school on children's subsequent attainment and social adjustment.

The belief in the value of pre-school education was supported in 1986 by the influential study of Schweinhart *et al.* (1986) who investigated pre-school systems for children in Ypsilanti, Michigan considered to be at risk of failing at school. They randomly selected a group of children to receive pre-school education, finding that the average Stanford-Binet IQ of the treatment sample rose by 27 points during the first year. The control group average IQ rose by only 4 points. By age seven the average IQ of the treatment sample had stabilised at between 90 and 100 compared to between 85 and 90 for the control group. (The low averages reflect the deliberate bias in the overall sample.) Similarly, Andersson (1992) considered a sample of 128 children attending day nurseries in Gothenburg, Sweden and found they had better results in school examinations than non-participants.

Osborn and Milbank (1987) use longitudinal data from the 1970 Cohort Study (BCS). In 1975 a matching study of all national pre-school institutions was carried out with sample sizes of over 6000 for all of the nine attainment tests. Osborn and Milbank, therefore, provide an important non-experimental consideration of the impact of pre-school provision. The authors find considerable diversity of types of provision. Playgroups tend to be informally organised by parent helpers and seem to be intended to meet the largely middle-class demand for social interaction between children. Local Authority day schools are intended for children whose families have come to the attention of Social Services Departments and provide all-day supervision of children who would otherwise be unsatisfactorily cared for. Local Authority and private nursery schools provide pre-school care, usually for about four hours per day. Attendance duration and the physical environment also differ between and within types of pre-school.

Osborn and Milbank control for social class, family size, neighborhood, gender, mother's age, mental state and employment, type of family, ethnic origin and the presence of handicaps. For improvements in attainment between five and ten years of age, changes in family size and structure were considered, as was interest in the child's education. They find large and significant benefits of pre-school experience on most of their attainment measures at five and ten years. An average deviation from mean attainment equivalent to one-third of a standard deviation was predicted if the child was in some form of pre-school care.

Although Osborn and Milbank control for social class and parental interest, it is possible that pre-school attendance was to some extent a measure of unobserved parental influences. Osborn and Milbank interpret the high playgroup parameter as a causal effect: playgroups were smaller on average than other forms of pre-school provision and had better peer groups. An alternative explanation is that the playgroup variable picked up effects of class or parental interest more accurately than the class and interest variables themselves. Osborn and Milbank reject such an explanation as implausible and conclude that the benefits of pre-school experience are not explained away by parental interest. They conclude also that the benefits are greatest when the child's own mother is involved in the pre-school institution. However, although they consider mother's labour force status as an independent variable, they do not allow for any interaction between mother's labour force status and pre-school participation. The advantages of pre-school surely differ between children of working and non-working women. Moreover, since mother's labour force status and pre-school participation are both choice variables, endogeneity bias might be expected. There are reasons, therefore, to look again at the BCS data. We shall also consider pre-school effects in the earlier National Child Development Study (NCDS: 1958 cohort).

One of the notable findings of the Schweinhart study was that different curricula in pre-school seem to have different effects. Some children were assigned to the High/Scope pedagogical model in which both child and teacher plan and initiate activities, in contrast to the Distar model where the teacher initiates activities and the child responds to them. The High/Scope group showed better family relations, higher expectations of educational attainment and better personal communication skills than those who were assigned to the Distar model. The Distar group engaged in five times as many acts of property violence as the High/Scope group. Interest in the High/Scope model of open learning follows from Berrueta-Clement (1984) who studied 126 children from

disadvantaged backgrounds in the US, of whom half were randomly assigned to the High/Scope program. By age nineteen, the control group were more likely to have been arrested and achieved lower results on attainment tests. The girls were more likely to experience teenage pregnancy. The group who participated in the pre-school were more likely to have jobs and to have completed school. More generally, Howe (1990) studied 80 children receiving different qualities of pre-school education in the US. Children attending high quality nurseries with low children-staff ratios and well-trained staff did significantly better in later attainment assessments than those in low quality nurseries. These findings suggest that quality and type of pre-school care may be important. Although these are interesting issues, they are beyond the scope of this study. Our sample, however, is much more representative of the average quality of pre-school care than the closely monitored experimental sample of the Schweinhart study.

We develop a model of pre-school choice, described in section 2.2, based on the allocation of maternal time that allows us to handle the endogeneity bias and consider the effects of participation at different types of pre-school. We focus on time with mothers because, for the vast majority of children, it is still mothers who take primary responsibility for day-time child-care. Section 2.3 discusses the results. The final section concludes.

2.2 A Model of Pre-school Education

Economic studies of attainment in schools are usually based on the theoretical concept of the education production function in which the output (attainment) is considered to be determined by a number of inputs, typically including the innate endowments of children and family background variables. The best-known early study of this kind is probably "Equality of Educational Opportunity" or "The Coleman Report" of James Coleman *et al.* (1966). Another important example is Hanushek (1992). We adopt this approach.

There are many different forms of pre-school provision. One approach to estimating their different effects would be to construct dummy variables for each kind of provision and to investigate the relationship between these and attainment. A complication arises because, as stated above, the marginal effect of an hour spent in a form of pre-school will vary according to the mother's labour force status. For example, nurseries may well foster attainment for children whose mothers are working but not,

relatively, for children whose mothers are at home. Therefore, the dummy variable approach needs to be augmented by interaction terms between pre-school type and mother's labour force status. Unfortunately, this leads to a massive inflation of variables, all of which are potentially endogenous. The BCS identifies 11 different types of pre-school provision, implying 23 endogenous variables to be estimated in the dummy variable approach. Clearly, therefore, some simplifying assumptions are required. One such is that all forms of pre-school provision have the same effects regardless of duration of exposure. This model is tested below. We shall assume, instead, that hours spent in any form of pre-school are equivalent, so that a child's attainment at seven depends upon:

h_m hours during the day spent with mother (time with mother)

h_p hours during the day spent in pre-school (time in pre-school)

h_o hours neither with mother nor in pre-school (other, informal care)

and is given by

$$(1) \qquad a = a_m h_m + a_p h_p + a_o h_o$$

where the a_i are fixed parameters (marginal products). There are three constraints:

$$(2) \qquad 1 = h_m + h_p + h_o \qquad \text{(child's time);}$$

$$(3) \qquad 1 = h_m + n + l \qquad \text{(mother's time),}$$

where n is mother's market labour supply and l is leisure; and

$$(4) \qquad y + nw_m = c + h_p p_p + h_o p_o$$

where y is father's income, w_m is the mother's wage, c is household consumption and p_p and p_o are the prices of pre-school and other, informal care respectively. The household's static optimisation problem is captured by a utility function,

$$(5) \qquad u = u(c, l, a)$$

which is maximised by choice of h_m, h_p, h_o, l and c. We obtain in particular,

(6) $h_m = h_m(y, w_m, p_p, p_o)$ and $h_p = h_p(y, w_m, p_p, p_o)$.

We are primarily interested in equation (1). Substitute from (2) to obtain

(7) $a = a_o + (a_m - a_o)h_m + (a_m - a_o)h_p$

Thus, if (7) is estimated, positive parameters on h_m and h_p indicate that mothers' time and pre-school time are more beneficial than other forms of child-minding, while the relative magnitude of the two parameters allows a comparison of the effects of time with mother and time at the pre-school.

We shall attempt to estimate a version of (7). Our coding of the hours variables is explained in the Data Appendix to this chapter. Leibowitz (1974) models a process in which parental abilities and education effect children's attainment via home production involving the input of goods and time, and also via heredity and family income. This builds on the Becker framework of home production of child quality developed in Becker and Tomes (1986, 1979) and Becker (1981). The econometric difficulty with this basic framework is the endogeneity of key components of home production, namely maternal employment, income, family size and family structure. Here, we treat family size, family structure and social class as exogenous and concentrate on the endogeneity of the hours variables. One usefulness of the formal model is that it allows assessment of the appropriateness of potential instruments. Thus the equations (6) suggest instruments for h_m and h_p: the right-hand side variables. We shall not use father's income y or mother's wage w_m as instruments because, problems of availability aside, these may be legitimate explanators of attainment in their own right. First it is possible that the parameter a_m depends on the same factors that determine the mother's wage: those women who are skilled in market work may tend to be skilled also in providing inputs to child attainment. Moreover, whereas equation (7) measures only the increment to attainment derived from activities during the day, the quality of both parents is presumably important in fostering attainment at other times. The prices of child care, p_p and p_o , are left as candidate instruments. These prices should reflect the true cost of child care including factors over and above the direct monetary cost, in particular, availability of child care. These costs are likely to vary between regions, suggesting that regional dummies may be used as instruments.

We prefer this hours model to the dummy variable model because it reduces the number of endogenous variables. The former is in fact a restriction of the latter since the hours variables can be constructed as linear combinations of the dummy variables and interaction terms. This will allow a test of the hours model against the more general dummy variable approach which tends to produce extremely imprecisely estimated parameters. Thus, although, a disadvantage of the hours model is that it implicitly assumes all forms of provision are the same, per hour, we are able to test this assumption.

2.2.1 Variables

The NCDS gives tests of children's ability in reading and mathematics at age seven, eleven and sixteen. It also provides measures of social adjustment. The BCS provides tests of ability at five and ten years. At age five, tests are given of picture copying, vocabulary and social development. The first two tests are considered to be good measures of cognitive development (Osborn *et al.*, 1984). At age ten, as with the NCDS, we have measures of mathematics, reading and social development. These variables are discussed in more detail in the Data Appendix. All test variables are transformed to range between 0 and 100, multiplying by 100 divided by the maximum possible score, to ease the interpretation of relative parameter estimates and to make models more comparable.

The information from which we derive the hours variables is different in the two data sets. In particular, the BCS data allow us to specify allocation of time in the pre-school years more precisely. We consider pre-school attendance for children between the ages of three and a half and four and a half, i.e. in the year prior to possible school entry in October 1975 when the children were four and a half years old. In the NCDS we simply consider reported pre-school attendance at any age. Another difference is that the BCS questionnaire considers eleven different types of pre-school whereas the NCDS identifies only five. Some children attended school before the autumn term of their fifth year. This time is included as pre-school hours but we include a dummy variable to control for the fact that this is early school entry rather than standard pre-school provision. Because the pre-school attendance information is more detailed in the BCS and more recent, we tend to regard BCS results as more reliable. Overall, 72% of BCS children attended some form of pre-school provision, excluding those who started school early. In the NCDS, only 20% of children attended one of the four forms of identified pre-school (which include playgroups). Limiting pre-school participation in the BCS to those categories identified in the NCDS, the participation rate was 60%. (These variables are described in

more detail in the Data Appendix to this chapter.) It is important to note that between 1961 when the NCDS children were three years old and 1973 when the BCS children were three years old, there had been a vast increase in the provision of pre-school care, particularly in the form of playgroups. About 4% of NCDS children attended playgroups compared to 46% of BCS children. If we exclude playgroups the participation rate in the BCS falls from 72% to 48%. Thus, even excluding playgroups, there has been a three-fold increase in the participation rate between the two surveys.

We also observe some change in the background of pre-school participants. See Table 2.1.

Table 2.1: *Family background of pre-school-participants in the NCDS and BCS*

	BCS			NCDS	
	Participants		*Population*	*Participants*	*Population*
	with playgroups	w/o playgroups			
Mother stayed on	0.41	0.37	0.35	0.35	0.25
Father stayed on	0.39	0.35	0.34	0.32	0.23
Top SES father	0.29	0.26	0.25	0.28	0.20
Middle SES father	0.51	0.50	0.53	0.51	0.55
Mother works	0.24	0.28	0.24	0.28	0.19

Note: Cells give the proportion of children with backgrounds as described.

In absolute terms, the proportion of children participating in pre-school (including playgroups) who had educated parents or parents from high occupational categories increased between the two surveys. However, the proportion of children in the population as a whole from these backgrounds grew more rapidly so that, in relative terms, the intake of pre-schools became broader. Excluding playgroups, the relative decline in pre-school peer groups is greater still. Table 2.1 also shows that the relative use of pre-schools as formal care for children of working mothers declined between the two data sets.

In Tables 2.2-2.5, below, we loosely group our explanators into five main classes (see Haveman and Wolfe, 1995, for a recent overview of the relative importance of these in other studies). Firstly we have "Child's time during day", our versions of h_m and h_p from (7). Second is "Parent quality": these variables are assumed to measure variation in the quality of time parents devote to children. The third category contains proxies for the available quantity of parental time. The fourth category consists of measures of school quality: in the NCDS the children had been in school for about two years at the time of these tests so it is important to control for this experience. In the BCS we exclude those children who were not in school by the time of the interview. A dummy variable is

included for Scottish children because their school system differs in a number of respects from the English. The final category contains measures of the child's development prior to pre-school age, as well as height at five or seven, to capture exogenous developmental factors and ethnic group to capture variations in language acquisition. We also control for the child's gender. Tables A2.3 and A2.4 in the Appendix to this chapter give summary statistics for all the independent variables used.

2.3 Results

We treat h_p and h_m as endogenous, instrumented by dummy variables for location, 188 Local Authority areas at birth in the NCDS; eleven regions of birth and 123 Local Education Authority areas at age ten in the BCS. Robertson and Symons (1996) and Chapter 4, below, contain extensive discussion of the endogeneity issue as well as the appropriateness of using geographical indicators as instruments. In the NCDS the Sargan tests of instrument orthogonality for mathematics at seven and mathematics and reading at eleven were significant at the 1% level so on this basis the full set of proposed instruments is invalid. However the adjusted R^2s for the regressions of residuals on instruments were very low: 0.01, 0.02 and 0.02 respectively. Thus residuals and instruments are approximately orthogonal, even if they are not so statistically in tests of conventional size. Nevertheless we have sought to rid our instrument set of those most strongly correlated with equation error by casting out all instruments with t-statistics greater than 2.0 (in absolute value) in the second-stage regression of the residuals on the instruments, and re-estimating with the smaller instrument set. The estimates presented in Tables 2.2-2.5 are computed on this basis. With the instrument set filtered in this way, Sargan tests are no longer significant at the 1% level for any of the six regressions in the NCDS data. None of the Sargan tests in the BCS were significant at the 1% level so we did not repeat the above exercise for the BCS.

Estimates of (7) for the NCDS sample are presented in Table 2.2 for the three measures of attainment at seven years: mathematics score, reading score and social adjustment.

Table 2.2: *IV estimates of effects on children's attainment at 7 in the NCDS*

		Maths score	Reading score	Social adjustment
Pre-school time during day	Hours at pre-school *	25.8 (2.7)	3.2 (0.5)	-1.6 (0.2)
	Hours with mother *	19.2 (2.6)	6.7 (1.4)	-0.8 (0.1)
Parent quality	Top SES father	0.8 (0.8)	2.5 (3.7)	1.4 (1.3)
	Middle SES father	-0.6 (0.1)	1.1 (2.3)	2.4 (3.2)
	Mother stayed on	3.3 (4.8)	3.3 (7.0)	-0.0 (0.0)
	Father stayed on	1.9 (2.6)	4.0 (7.7)	2.3 (2.9)
	Mother's age	-0.1 (1.7)	0.1 (1.7)	0.0 (0.5)
Parent time	Mother working currently *	1.4 (0.3)	4.7 (1.3)	-7.0 (1.2)
	Number of older children	0.3 (1.0)	-1.5 (8.2)	-0.7.(2.4)
	Number of younger children	-0.5 (1.0)	-0.4 (1.3)	-1.1.(2.3)
	Mother's interest in education	11.9 (9.3)	12.6 (14.5)	12.4 (9.1)
	Father's interest in education	5.3 (4.0)	8.1 (9.0)	10.5 (7.3)
	No mother present	28.5 (1.1)	12.3 (0.7)	15.3 (0.6)
	No father present	8.2 (1.8)	4.1 (1.3)	3.6 (0.7)
	Father plays a part in upbringing	1.5 (1.6)	2.1 (3.5)	2.8 (2.9)
School variables	Peer group at 7 years	2.6 (1.9)	3.3 (3.4)	-1.9 (1.3)
	Independent school	6.1 (3.3)	1.1 (0.9)	0.3 (0.1)
	Scottish	-3.0 (3.7)	4.7 (8.5)	0.7 (0.8)
Other controls	Incontinent at 3 years	-7.3 (5.2)	-6.6 (6.8)	-10.4 (6.8)
	Talks at 2 years	6.2 (5.4)	6.7 (8.5)	4.0 (3.2)
	Height at 7 years (inches)	0.6 (5.6)	0.5 (5.9)	-0.2 (1.4)
	Child started school early *	-6.2 (0.7)	2.5 (0.4)	3.7 (0.4)
	English not first language	-13.3 (4.4)	-14.6 (6.9)	-6.6 (2.0)
	Female	-2.5 (4.7)	4.8 (13.1)	7.1 (12.1)
	Constant	-9.7 (1.1)	-0.5 (0.1)	33.7 (3.6)
Standard error		23.7	16.2	25.7
R-squared		8.0	29.5	12.2
No. of obs.		8179	8143	8179

Notes. Absolute t-stats in brackets. Variables marked * are treated as endogenous and instrumented by dummy variables for 188 UK Local Authorities. Hours are measured in units of eight so that, for example, the parameter on 'hours with mother' measures the effect of a pre-school child being cared for entirely by its mother. All variables except family size, mother's age and child's height, range between zero and one (including the hours variables). The mother's current labour force status variable takes a value of 0.5 for part-time work and 1 for full-time work. (Experiments have supported this restriction). The peer group measure used here is the proportion of children in the class with fathers in professional or managerial occupations.

With regard to child's time during the day, the strongest results are for mathematics performance. Both time with mother and time at pre-school have large positive effects which are significant at the 1% level. For reading and social development there is no apparent strong effect of time distribution. To interpret these results, recall that the parameters measure effectiveness relative to the child being neither in pre-school school nor with mother: typically this means that the mother is working and the child is not placed in a pre-school, *i.e.* it is cared for by neighbours, other family members *etc.* Thus, there is strong evidence that time in pre-school is an effective substitute for time

with mother in the development of maths and little evidence that other attainments are changed for better or worse by the form of pre-school placement.

With regard to parent quality both higher social class and education are beneficial for reading but parental education is more important than the occupational social class variable. For maths only parental education is important. Social adjustment appears to depend on the education of the father but not of the mother.

Parent time is measured by the mother's current labour force status, the number of children in the family, by teachers' assessments of the interest taken by parents in the child's education, by whether or not the mother believes the father takes an active role in raising the child, and by the presence in the family of either parent. The presence of siblings reduces social adjustment but the effect of family size on reading and maths score is not as strong as in Robertson and Symons (1996). In fact, this is true for the 'parent quality' measures as well. The reason for this seems to be the inclusion of parental interest. The importance of parental interest is discussed in considerably more detail in Chapter 4. Mother's and father's interest are highly significant and, moreover, the associated parameters indicate qualitatively stronger effects than the other parental variables. For example, the net effect on reading of having parents in the highest SES group who both stayed on at school is 9.8 points which is of the same order as the effect of either parent showing maximum interest. Children of parents who are both very interested in their child's education do about 20% better than children whose parents show no interest. Attainment is particularly enhanced by fathers who are interested and involved in their child's development. The absence of either parent is never significantly negative: in fact the fitted parameters are always *positive*, though imprecisely measured. It seems likely that this is due to interaction with the parental interest variables. When parents are absent, that parental interest variable is set to zero. The positive parameters thus indicate that the effect of an absent parent is not as deleterious as the presence of a parent with zero interest.

Turning to the school variables, note that the quality of the peer group has a modest, positive effect on mathematics and reading measures. Robertson and Symons (1996) find that this variable is particularly important for increases in attainment between seven and eleven. Children in independent schools do better only at mathematics. Scots are somewhat better at reading, somewhat worse at maths at seven.

We include two measures of early development (talking and incontinence) as well as height at seven. Our aim here is to control for exogenous developmental factors. All

three are very strong. Note that girls, on average, are better adjusted socially, have better reading scores and are worse at maths. Given that the form of the human capital production function might differ between the sexes we also ran the regression of (7) for boys and girls separately but there were no important differences between them at seven in terms of the effect of the hours variables. We considered similarly a low human capital sub-group consisting of children neither of whose parents stayed on at school after the minimum school leaving age and a low socio-economic sub-group. There is some slight suggestion that these two sub-groups benefit less than average both for hours in pre-school and hours with mother.

Table 2.3 gives the results of similar regressions at five years in the BCS for copying, vocabulary and social adjustment[1]. Concentrating on the hours variables, we see that in the BCS the effects of pre-school participation are much more ambiguous than in the NCDS. For copying, the results are similar to the NCDS: both hours at pre-school and hours with mother are beneficial. However children attending pre-school seem to emerge with considerably reduced vocabulary and marginally worse social adjustment. This would appear to suggest that children's language abilities and social adjustment are improved by time spent with adults rather than with other children in a pre-school setting. That said, we also find that the copying score is a better predictor of later performance than vocabulary, both for maths and reading (see Table 2.5). Note that the NCDS and the BCS are at variance here. In the NCDS, pre-school children receive positive (though insignificant) benefits at seven in reading, whereas our results show they fare quite badly in vocabulary at five in the BCS.

Generally, the pattern of effects of the other variables in Table 2.3 is similar to that in Table 2.2 although the parental interest variables are weaker. It should be noted that these variables in the BCS at age five are not directly reported by teachers but constructed from the frequency of meetings between parents and teachers as reported by mothers. It is perhaps because this variable is less accurately measured that the other parent time variables become more significant here than in Table 2.2.[2]

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[1] We exclude mother's current labour force status from this model, unlike that of Table 2.2, because controlling for pre-school hours with mother, mothers working for the past few months could have had little effect on attainment that could be accurately ascribed to their labour force status. A current labour force status variable would, instead, pick up the purposeful behaviour of mothers who time their entry into the labour force and not reflect inputs to the attainment of the child, erroneous in a production function framework.

[2] In Chapter 4, it is shown that parental interest drives out the effects of other parental and family variables in attainment regressions.

Table 2.3: *IV estimates of effects on children's attainment at 5 in the BCS*

		Copying score	Vocabulary score	Social adjustment
Pre-school time during day	Hours at pre-school *	26.7 (2.2)	-42.3 (3.3)	-8.1 (1.3)
	Hours with mother *	14.2 (1.4)	-9.2 (0.9)	-0.8 (0.2)
Parent quality	Top SES father	8.3 (6.9)	7.7 (6.2)	1.7 (2.9)
	Middle SES father	4.6 (4.7)	3.3 (3.2)	0.3 (0.6)
	Father stayed on	4.1 (5.1)	2.4 (2.9)	1.0 (2.6)
	Mother stayed on	4.1 (5.2)	3.7 (4.5)	1.8 (4.6)
	Mother's age	0.1 (1.0)	0.4 (5.3)	0.3 (6.8)
Parent time	Number of older children	-1.6 (4.3)	-2.0 (5.2)	-0.3.(1.8)
	Number of younger children	-3.1 (4.0)	-3.0.(3.7)	-1.0.(2.7)
	Mother's interest in education	2.1 (1.7)	3.4 (2.7)	-0.1 (0.2)
	Father's interest in education	2.0 (1.8)	1.6 (1.4)	0.2 (0.4)
	No mother present	2.5 (0.2)	10.0 (0.7)	5.1 (0.8)
	No father present	3.5 (1.9)	0.3 (0.2)	-3.2 (3.4)
	Father plays a part in upbringing	3.2 (2.5)	1.0 (0.8)	-0.6 (0.9)
School variables	Peer group at 5 years	1.4 (1.7)	1.6 (1.9)	1.0 (2.4)
	Independent school	2.4 (1.2)	0.2 (0.1)	-1.5 (1.6)
	Scottish	-1.3 (0.4)	-0.3 (0.1)	1.1 (0.6)
Other controls	Problems at 6 months	-0.6 (0.5)	1.8 (1.4)	-5.5 (9.1)
	Height at 5 years (inches)	0.9 (5.6)	0.8 (4.9)	-0.1 (0.9)
	Child started school before 4 1/2*	-7.4 (2.0)	-5.0 (1.3)	0.6 (0.4)
	English not first language	-3.4 (2.2)	-11.2 (6.9)	-0.7 (0.9)
	Female	-0.0 (0.0)	-4.4 (6.4)	3.3 (10.2)
	Constant	-0.5 (0.1)	27.6 (2.5)	49.3 (9.4)
Standard error		23.1	24.0	11.4
R-squared		8.8	10.0	8.6
No. of obs.		5198	5198	5198

Notes. Absolute t-stats in brackets. Variables marked * are treated as endogenous and instrumented by dummy variables for 123 UK Local Education Authority areas and 11 regions. Other notes as for Table 2.2.

Finally, we note that boys score higher in vocabulary than girls. When we estimate the model separately for boys and girls we find that gains in copying from pre-school hours are less for boys (3.6 with a t-statistic of 0.2) than for girls (20.7; 1.5). We also find than pre-school hours significantly worsen social adjustment for boys (-19.9; 2.5) but have negligible effect for girls (-0.1; 0.0). Moreover, for boys we find that hours with mother also significantly worsen social adjustment (-13.6; 2.2), implying that the social adjustment of boys at 5 is better for time spent in informal care. This is, perhaps, evidence for a socialising effect of time spent with adults. Turning to the regressions for the other sub-groups, we found that the broad pattern remains the same as for the full sample except that for the low human capital group the negative effect of pre-school hours on vocabulary is considerably stronger (-64.4; 4.4) as is the negative effect on social adjustment (-23.4; 3.1). We also found the latter effect for the low SES sub-group (-17.6; 2.3).

Tables 2.4 and 2.5 show the effects of measured inputs at ages ten and eleven, conditioning on earlier attainment. In the NCDS initial attainment is the score in the corresponding subject at seven, whereas for maths and reading in the BCS it is represented by the copying and vocabulary scores at five, presented in Table 2.3. We observe again that the parental education variables are the important parent quality variables for reading and maths in both the BCS and NCDS, in addition to the effects coming through earlier attainment. Mother's labour force status is not important for either subject in either data set. Family size, particularly the number of older children, is important in the NCDS although it is not in the BCS. Parental interest is very important in both data sets.

In the NCDS, 32% of children were in streamed classes in primary school at age eleven (in 1969) as opposed to only 9% of the BCS sample at age ten (in 1980). However, 44% of the BCS were in streamed groups for maths and 40% for reading. This subject streaming is not reported in the NCDS. For the NCDS, we include a dummy variable for streamed classes together with dummies for high and low streams, the middle stream being the default group. In the BCS, these stream variables refer to subject-specific classes. To deal with the endogeneity of selection into a stream, these three school variables are instrumented by earlier parental interest and earlier teachers' assessments. We find that the disbenefit of being in a low stream is strongly apparent in both data sets but only in the NCDS is there a strong and significant gain from being in a high stream, particularly for mathematics.

Table 2.4: *IV estimates of effects on children's attainment at 11 in the NCDS*

		Maths score	Reading score	Social adjustment
Attainment at 7	Maths *	0.67 (19.7)		
	Reading *		0.48 (22.0)	
	Social adjustment *			0.41 (10.5)
Pre-school time during day	Hours at pre-school *	-3.3 (0.4)	7.4 (1.6)	1.2 (0.1)
	Hours with mother *	1.6 (0.2)	4.1 (1.1)	5.8 (0.7)
Parent quality	Top SES father	3.3 (3.5)	1.3 (2.2)	0.7 (0.5)
	Middle SES father	1.0 (1.6)	0.4 (1.0)	0.4 (0.5)
	Mother stayed on	2.5 (4.1)	1.5 (4.0)	0.3 (0.4)
	Father stayed on	3.2 (4.8)	1.7 (4.1)	-0.6 (0.7)
	Mother's age	0.1 (2.1)	0.3 (7.1)	0.1 (0.6)
Parent time	Mother working currently *	-2.3 (0.6)	1.4 (0.6)	1.4 (0.3)
	Mother working when child was 7 *	-3.8 (0.7)	1.4 (0.4)	0.1 (0.0)
	Number of older children	-1.1 (4.6)	-1.0 (6.9)	-0.6.(1.8)
	Number of younger children	-0.9 (2.2)	-0.3.(1.3)	-0.6.(1.1)
	Mother's interest in education	5.5 (3.1)	2.8 (2.6)	19.7 (8.9)
	Father's interest in education	6.0 (3.3)	4.8 (4.3)	10.3 (4.6)
	No mother present	2.7 (0.7)	-1.5 (0.6)	10.8 (2.2)
	No father present	3.6 (1.8)	3.8 (3.0)	6.3 (2.4)
	Father plays a part in upbringing	1.0 (1.2)	0.9 (1.8)	0.5 (0.5)
School variables	Streamed school *	0.1 (0.0)	1.0 (0.4)	-3.4 (0.6)
	High stream *	29.9 (4.9)	8.5 (2.2)	6.6 (0.9)
	Low stream *	-20.1 (3.0)	-9.3 (2.2)	-7.8 (0.9)
	Peer group	14.7 (8.1)	8.2 (7.4)	5.0 (2.2)
	Independent school	-4.8 (2.8)	-0.9 (0.9)	-0.9 (0.4)
	Scottish	6.1 (6.9)	-1.6 (3.1)	0.7 (0.6)
Other controls	Incontinent at 3 years	-0.2 (0.2)	-1.0 (1.2)	-1.3 (0.8)
	Talks at 2 years	-0.5 (0.5)	1.6 (2.6)	0.4 (0.3)
	Height at 7 years (inches)	0.2 (1.8)	0.3 (4.5)	0.1 (1.0)
	Child started school early *	-12.4 (1.7)	-10.1 (2.2)	-6.9 (0.8)
	English not first language	4.9 (1.8)	-0.3 (0.2)	-2.2 (0.6)
	Female	-1.1 (2.1)	-3.2 (10.5)	5.0 (7.7)
	Constant	-19.3 (2.2)	-15.3 (2.9)	6.6 (0.6)
Standard error		20.3	12.5	26.1
R-squared		36.8	49.4	18.7
No. of obs.		7516	7509	7496

Notes as Table 2.2. In addition to control for measurement error, the lagged dependent variable is instrumented by teachers assessments at 7.

Table 2.5: *IV estimates of effects on children's attainment at 10 in the BCS*

		Maths score	Reading score	Social adjustment
Attainment at 5	Copying *	0.17 (4.8)	0.27 (6.9)	
	Vocabulary *	0.13 (2.9)	0.16 (3.2)	
	Social adjustment *			0.21 (2.1)
Pre-school time during day	Hours at pre-school *	1.5 (0.2)	-16.9 (1.9)	-1.0 (0.1)
	Hours with mother *	11.1 (1.5)	-7.9 (0.9)	2.0 (0.3)
Parent quality	Top SES father	1.1 (1.4)	1.1 (1.2)	-0.7 (0.9)
	Middle SES father	-0.2 (0.3)	0.1 (0.1)	0.3 (0.4)
	Mother stayed on	2.7 (4.6)	2.4 (3.4)	-0.5 (0.7)
	Father stayed on	1.5 (2.5)	2.2 (3.2)	1.1 (1.8)
	Mother's age	0.1 (1.3)	0.1 (1.3)	0.1 (2.0)
Parent time	Mother working currently *	2.6 (0.7)	6.6 (1.6)	9.2 (2.4)
	Mother working when child was 5 *	4.9 (1.1)	-3.0 (0.6)	-5.2 (1.1)
	Number of older children	-0.3 (1.0)	-0.5 (1.4)	-0.3.(0.9)
	Number of younger children	0.6 (1.3)	0.5 (1.0)	0.2.(0.4)
	Mother's interest in education	7.2 (3.1)	10.5 (3.8)	0.0 (0.0)
	Father's interest in education	0.3 (0.1)	5.4 (2.0)	9.3 (3.9)
	No mother present	0.0 (0.0)	0.4 (0.1)	3.3 (0.9)
	No father present	1.3 (1.3)	1.7 (1.4)	-0.4 (0.4)
	Father plays a part in upbringing	-1.3 (1.3)	-2.5 (2.2)	1.1 (1.1)
School variables	Streamed school *	-0.4 (0.2)	1.6 (0.6)	1.5 (0.7)
	High stream *	2.7 (0.8)	4.9 (1.2)	-4.7 (1.3)
	Low stream *	-15.7 (4.5)	-16.2 (3.6)	-5.8 (1.6)
	High peer group	10.1 (3.6)	4.7 (1.4)	1.7 (0.6)
	Low peer group	-29.4 (7.7)	-31.9 (7.1)	-2.9 (0.8)
	Independent school	3.4 (2.1)	3.3 (1.7)	0.9 (0.5)
	Scottish	0.8 (0.3)	3.6 (1.3)	2.8 (1.1)
Other controls	Problems at 6 months	0.4 (0.4)	2.8 (2.6)	0.8 (0.7)
	Height at 5 years (inches)	0.1 (0.6)	0.3 (1.8)	0.2 (1.2)
	Child started school before 4 1/2 *	3.1 (1.2)	3.0 (1.0)	4.0 (1.5)
	English not first language	1.2 (1.0)	0.3 (0.2)	-1.3 (1.1)
	Female	-1.9 (3.9)	3.0 (4.6)	1.8 (3.0)
	Constant	25.1 (2.7)	16.9 (1.5)	32.9 (3.2)
Standard error		13.2	15.3	13.5
R-squared		36.0	39.4	1.3
No. of obs.		3568	3227	3245

Notes as Table 2.3. As in Table 2.4, the lagged dependent variable is instrumented by other picture copying scores at 5. We have used two peer group measures: The high peer group is the proportion of children in the class that the teacher rated as of high academic standard;. the low peer group is the proportion of low academic standard.

The direct peer group measure is important in both data sets. In the NCDS this variable is measured as the proportion of the class with fathers in professional or managerial occupations. There are very large and significant gains from being in a class with a high proportion of such parents. This accords with the findings in Robertson and Symons (1996) for the NCDS. For the BCS we include two peer group measures: teachers' assessments of the proportion of the class of low academic standard and the proportion of high academic standard. Interestingly, the dis-advantages of having non-

academic class-mates clearly outweigh the advantages of having bright class-mates. *Ceteris paribus*, moving from a class where all students are of average standard to one where all are of low academic standard will reduce a child's maths score by 29.4 points, even though we are conditioning for being in a low stream. The effect of moving from an average to a bright group is only 10.1 points. This effect is small relative to the low quality peer group effect but still larger, for example, than the gain from having parents who are interested in education. We notice that in the NCDS girls lose their advantage over boys in reading between seven and eleven but boys retain their advantage in maths. In the BCS, girls are now better at reading at ten, taking into account initial scores, but still worse at maths. Over the period of time between the NCDS and BCS, girls have substantially improved their academic position relative to boys.

Table 2.6 shows the overall effects of time distribution on mathematics and reading scores, factoring in the initial effects (Tables 2.2 and 2.3) through the lagged dependent variable.

Table 2.6: *Estimates of total effects of pre-school time allocation on children's attainment at 11 in the NCDS and at 10 in the BCS*

	Maths score	**Reading score**
NCDS (age 11)		
time in pre-school	14.0 (1.8)	8.9 (1.9)
time with mother	14.5 (2.2)	7.6 (1.9)
BCS (age 10)		
time in pre-school	-2.9 (0.4)	-16.9 (1.9)
time with mother	12.3 (1.7)	-5.5 (0.6)

Note: T-statistics computed using standard errors approximated by standard error of estimates of co-efficients on h_p and h_m in Tables 2.4 and 2.5.

In the NCDS by eleven, the time a child has spent in pre-school appears to be beneficial for both maths and reading and is roughly equivalent to time spent with mother. It is better for the child to spend time in either of these two ways than in the default group of informal care. However, in the BCS, children at ten are no better at maths as a result of time in pre-school and much worse at reading than they would have been if they had been in informal care. This appears to be a consequence of the bad effects on vocabulary at five of time in pre-school, discussed above. It is not, however, directly caused by the large increase in playgroup provision between the two periods. When we re-classify playgroup

time to the category of time with mother, the negative parameter on reading does move towards zero but remains large in magnitude. When we introduce dummy variables for participation at playgroup or local authority nursery school, they are never significant even at 10%. We do find that children who attended playgroups do slightly better in reading at ten than children who attended other forms of pre-school and that children who attended local authority nurseries do slightly worse. Although these effects are of low significance they do suggest that the overall decline in the value of time at nursery school between the two cohorts is unrelated to the change in composition of pre-school placements. The decline in value of pre-school hours for later attainment in reading may be due rather to the rapid expansion of the system and changing intake as highlighted in Table 2.1.

We noted above that the negative effect of pre-school hours on vocabulary and social adjustment in the BCS was considerably stronger for the low human capital sub-group as was the negative effect on social adjustment for the low SES sub-group. We find that although these effects continue through until ten, they are no longer significant at the 5% level by that age.

Good data are available in the NCDS for attainment at sixteen. When we extend the model in Table 2.4 using the variables described in Chapter 4 we find that there are no persistent effects of pre-school time by that age, i.e. the total effects for pre-school attendance, equivalent to those in Table 2.6, are all trivial in magnitude at sixteen and within one standard error of zero. We do find, however, that pre-school time with mother increases attainment in maths at sixteen by 6.3 points which is on the border of significance at the 5% level. Unfortunately, equivalent data for the third sweep of the BCS are not available because of the timing of industrial action by teachers in 1986.

2.4 Robustness

2.4.1 Endogeneity and the weak instrument problem

The results presented in Tables 2.2-2.5 are estimated by two stage least squares due to a concern about the endogeneity of a number of variables. Endogeneity of mother's input of time arises in Beckerian models of household production. For example, a negative shock that increases a mother's labour supply and so might increase pre-school hours, might also lower attainment. Alternatively, concern for a child's education might increase pre-school hours leading to a positive bias on the pre-school hours estimate by

OLS. These two examples suggest that the bias under OLS could go in either direction. Measurement error, likely to be considerable in the hours variable, will bias parameter estimates to zero. The fact that the parameters on pre-school hours in the copying and vocabulary regressions in the BCS are both significantly larger in absolute value by IV, even though the former is positive and the latter negative, suggests that measurement error is the dominant source of bias. Alternatively, this might imply that endogeneity bias is negative. As discussed above, the lagged dependent variables are also instrumented to deal with measurement error and the class stream variables are instrumented because of the endogeneity of selection into a stream conditioned by factors observed by schools but not by econometricians.

In Chapter 4, Hausman tests for similar variables in attainment regressions are performed (Hausman, 1978). These find significant endogeneity only for the lagged dependent variables and, marginally, for the parental interest variables[3]. Here, we concentrate on the time allocation. In Table 2.7 we present Hausman tests of endogeneity for the hours variables in the first sweep of the two surveys.

Table 2.7: *Comparison of OLS and IV estimates of hours variables in regressions of children's attainment at 7 in the NCDS and at 5 in the BCS*

		Variables treated as				**t-stat on**
		Exogenous		**Endogenous**		**difference**
		Estimate	Std.Error	Estimate	Std. Error	
Hours in pre-school	NCDS					
	Maths	1.8	1.4	25.8	9.5	2.5
	Reading	0.2	1.0	3.2	6.1	0.5
	Social adj.	-4.4	1.6	-1.6	9.4	0.3
	BCS					
	Copying	7.3	2.8	26.7	12.3	1.5
	Vocab.	-10.6	2.9	-42.3	12.8	2.4
	Social adj.	-1.8	1.4	-8.1	6.1	1.0
Hours with mother	NCDS					
	Maths	1.5	1.0	19.2	7.3	2.4
	Reading	1.0	0.7	6.7	1.4	3.6
	Social adj.	0.7	1.1	-0.8	7.7	0.2
	BCS					
	Copying	2.1	1.8	14.2	10.1	1.2
	Vocab.	0.3	1.9	-9.2	10.5	0.9
	Social adj.	1.1	0.9	-0.8	5.0	0.4

The important point to note is that the two sets of estimates tell the same story: the pattern of signs is the same by OLS as by IV. However, some of the IV estimates are much larger in magnitude. There is ample evidence of endogeneity in that differences in IV and OLS estimates are significant at the 5% level in four out of the twelve regressions.

However, weak instruments can give Hausman tests low power. Indeed, weak instruments also lead to biased estimators which are not well approximated by the asymptotic distribution in small samples. (See Staiger and Stock, 1997, and the large and growing literature cited therein.) As a rough guide, for a single endogenous regressor, the F-statistic for the exclusion of the over-identifying instruments in a regression of the endogenous variable on the full instrument set, is an inverse measure of the distortion of the asymptotic distribution of the IV estimator.[4] Table A2.5 in the Appendix presents F-statistics for all endogenous variables in the 12 models considered. Typically, they are around 2.0 for the hours variables and range from about 1.0 to 5.0 for most other endogenous variables. These lie in Staiger and Stock's region of unreliability and so raise doubts about inference based on the asymptotic distribution. To gauge the extent of this problem in the context of our models we have conducted an extensive Monte Carlo analysis of our estimators. Briefly, the strategy was to take a set of parameters (obtained either by 2SLS or OLS on the original data) and to compute the variance-covariance matrix of the implicit errors in the structural equation and the errors from each of the (first-stage) regressions of the endogenous variables on all the instruments. Residual vectors with this covariance structure were then used to create artificial data (holding the instruments fixed) from which artificial estimates of the parameter vector were obtained. Summary statistics on the basis of 100 replications are reported in Table 2.8.

Looking first at the 2SLS results, note that bias is almost always significant, at high levels.[5] On occasions the bias is high relative to the standard deviation of the estimates themselves. On the other hand, the average standard error tends to be within 10% of the standard deviation of the sample of estimates (Column V) which suggests that reported standard errors are reliable. Kolmogorov-Smirnov tests show little departure of

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[3] The other variables whose endogeneity in attainment regresions was tested in Chapter 4 were the peer group, stream, pupil-teacher ratio and the type of school (private, grammar or secondary modern). There was no evidence of endogeneity for any of these variables.

[4] It should be noted that it is not the p-value of the F-statistic that counts in this regression but its absolute magnitude: for a given number of instruments, two estimators over data with the same *population* F-statistic have identical distributions even if one has ten and the other has a million observations.

[5] Recall that the reported standard deviation in parentheses in Table 2.8 must be divided by 10 to give the standard error of the bias.

the sample of estimates from normality for any of the models.[6] Moreover, there appears to be roughly Gaussian weight in the tails of the empirical distribution.[7] The upshot is that the distribution of the estimates is approximately Gaussian, merely shifted from zero by the bias. Since bias and the parameters generating the data almost always have opposite signs, 2SLS appears biased towards zero. The same is true of OLS but with greater magnitude. The uniformity of this result gives support to the suggestion made above that either measurement error is the dominant form of bias or that selection bias is negative. It indicates also that the reported t-statistics understate parameter significance in the 2SLS regressions of Tables 2.2-2.5.

Bias by 2SLS tends to be between a quarter and a half of OLS bias. This accords with the orders of magnitude reported by Staiger and Stock for instruments as weak as these. The fact that 2SLS leaves a significant proportion of OLS bias is less important in studies such as this that seek to discover directions of effect or orders of magnitude at best. The weak instrument problem is more severe in studies such as Angrist and Krueger (1991) which seek to estimate rates of return wherein, for example, 0.12 is importantly different from 0.08. In terms of root mean square error sometimes 2SLS is better, sometimes OLS. As one might expect, OLS is worse when it is importantly biased.

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[6] To conduct these tests of the null of normality we used the computed variance-covariance matrix of the 100 vectors of estimates to convert the estimates into independent N(0,1) variates, roughly 3000 in each model.

[7] The N(0,1) variates from each of the 12 models were merged, 34500 in all, for which the following percentiles were calculated:

Percentile	**1%**	**5%**	**10%**	**50%**	**90%**	**95%**	**99%**
Empirical	-2.29	-1.64	-1.28	0.00	1.27	1.64	2.30
Gaussian	-2.33	-1.65	-1.28	0.00	1.28	1.65	2.33

Table 2.8: *Bias in estimate of hours variables based on 100 replications in Monte Carlo experiments with 2SLS estimates as truth.*

	Hours in pre-school					Hours with mother				
	Truth	OLS bias	2SLS bias (s.d.)	Rel. rmse OLS/ 2SLS	ivse/ ivsd	Truth	OLS bias	2SLS bias (s.d)	Rel. rmse OLS/ 2SLS	ivse/ ivsd
	I	II	III	IV	V	I	II	III	IV	V
NCDS										
Age 7										
maths	25.85	-23.85	-12.11 (7.70)	1.67	0.90	19.17	-17.62	-9.31 (5.52)	1.63	0.94
reading	3.19	-2.97	-1.67 (4.28)	0.69	1.07	6.72	-5.67	-2.57 (3.14)	1.41	1.10
soc. adj.	-1.62	-3.18	-2.14 (7.27)	0.53	0.98	-0.83	1.66	0.18 (5.06)	0.35	1.09
Age 11										
maths	-2.35	1.82	-0.05 (6.24)	0.35	0.95	1.61	-1.84	-0.74 (4.22)	0.47	1.07
reading	7.42	-6.56	-3.72 (3.26)	1.34	1.09	4.12	-3.90	-2.24 (2.43)	1.19	1.12
soc. adj.	1.20	-4.31	-1.88 (6.74)	0.64	1.08	5.79	-7.35	-3.11 (4.84)	1.29	1.14
BCS										
Age 5										
copying	26.73	-19.32	-4.68 (9.86)	1.79	1.04	14.24	-12.03	-3.22 (7.00)	1.58	1.11
Vocab.	-42.28	31.62	8.15 (9.76)	2.50	1.09	-9.20	9.53	3.63 (7.70)	1.14	1.06
soc. adj.	-8.08	6.39	2.85 (4.91)	1.16	1.03	-0.76	2.08	1.26 (3.78)	0.58	1.01
Age 10										
maths	1.47	-3.11	-1.66 (6.49)	0.54	1.01	11.10	-10.51	-4.90 (5.82)	1.40	0.97
reading	-16.93	12.48	3.79 (6.25)	1.74	1.18	-7.86	3.69	2.04 (6.37)	0.62	1.01
soc. adj.	-0.99	-2.29	-1.26 (5.92)	0.51	1.09	1.98	-0.78	-1.53 (5.56)	0.30	1.02

Notes: Column I gives the parameters used to generate the data (the 2SLS estimates of the model in the original data). Columns II and III give simulation estimates of bias for the hours parameters for the 12 measures of attainment. For the 2SLS estimates we also report the standard deviation of the 100 estimates. To obtain a standard error for significance of the bias, this standard deviation must be divided by $\sqrt{100}=10$. Column IV reports the root mean square error by OLS relative to the root mean square error by 2SLS. Column V gives the ratio of average standard error of the 100 estimates to the standard deviation of the sample of 100 estimates.

The Monte Carlo results in Table 2.8 are based on a model where the 2SLS parameter estimates are taken to be true, in the sense that we use these to generate the data. We have also conducted simulations where the OLS estimates generate the data. We found here that 2SLS is almost completely unbiased, standard errors agree with standard deviations of estimates and the empirical distribution is Gaussian. It follows that nominal critical values are approximately correct, in contrast to the case where the 2SLS estimates generate the data and, as stated above, tests are a little conservative.[8]

Therefore, on the one hand, in the first case where the 2SLS parameter estimate generates the data, we find that inference is distorted, but only mildly. On the other hand, if the OLS estimate generates the data, inference by 2SLS is correct. These experiments suggest that weak instruments do not invalidate the conclusions of this study.

2.4.2 *Testing the hours model as a restriction of the dummy variable approach*

As discussed above, we performed a chi-squared test of the hours model against the general dummy variable model and of the twelve possible regressions (three test scores at two ages in two data sets) only two failed at the 10% level (maths at seven in the NCDS, vocabulary at five in the BCS) and both of these passed at the 1% level. This suggests, at least, that the hours model does no particular violence to the data. In particular, it supports the assumption, implicit in the hours model, that all forms of pre-school care, per hour, are equivalent, independently of curriculum. Another way of testing this is to include dummy variables in the hours model for the different forms of pre-school care. As reported above, these are never significant for playgroup and local authority nursery school.

An alternative restriction on the general dummy variable model is that all forms of pre-school attendance are equivalent, regardless of hours spent per day. This model is a different restriction of the general dummy variable model and gives three terms to be estimated: a single pre-school attendance dummy, a dummy on mother's labour force status and one interaction term. A chi-squared test of this model finds that two of the

[8] The weak instrument problem is alleviated because bias is proportional to the covariance between the errors in the structural and first-stage equations, *ceteris paribus*. OLS estimates set to zero the covariance between the endogenous variables and the structural errors which tends to lower the covariance between the structural and first-stage errors.

regressions fail at the 1% level and a further two at the 5% level. It is not surprising that equating different quantities of pre-school participation is rejected by the data.

2.4.3 *Comparison with the findings of Osborn & Milbank*

Osborn and Milbank's study concludes that nurseries are generally good for attainment, private nurseries, including playgroups, being somewhat better than public nurseries. We sought to replicate their findings in our framework by replacing the hours section of our model with dummy variables for attendance at public or private nurseries (without an interaction term). In fact, Osborn and Milbank conducted a separate matching survey gathering data from pre-schools to set against the information received from mothers in the BCS questionnaire. They found a significant degree of measurement error in reported participation rates. Unfortunately these data have been lost so we cannot precisely replicate their findings. Instrumental variables estimation, however, may reduce the effects of this measurement error in the original BCS data. Table 2.9 gives the results of experiments to reconcile our results with those of Osborn and Milbank, using the same set of conditioning variables as we used in Tables 2.2-2.5.

In the first regression reported for each of the two test measures (columns (i) and (iii)), we do not control for early attendance at infant school as we did in the hours model. We see that, as for Osborn and Milbank, pre-school attendance appears to be beneficial for both copying and vocabulary.[9] Recall, however, that, in the hours model, time spent in infant school prior to age five was counted as time in pre-school but a separate dummy variable was introduced to control for the different nature of the experience. Osborn and Milbank themselves claim that early entrance to infant school can have detrimental effects.

When we include this extra dummy variable (columns (ii) and (iv)), we change the comparison group. Without the early attendance dummy variable, children who attended pre-school are compared with those who either did not attend any form of pre-school or who attended infant school before age five. Since many more children attended school early than did not attend any form of school, pre-school is effectively compared with early attendance at infant school.

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[9] When the model is fitted by OLS, closer to the method of Osborn and Milbank, results are similar, with lower standard errors.

Table 2.9: *IV estimates of the effects of pre-school attendance on attainment at five years in the BCS.*

	Copying		Vocabulary	
	(i)	(ii)	(iii)	(iv)
Pre-school	8.41 (2.4)	21.17 (2.2)	8.62 (2.4)	-7.65 (0.8)
Mother working	-9.07 (1.5)	-10.70 (1.7)	5.88 (0.9)	7.71 (1.2)
Early school		-7.3 (2.1)		-9.82 (2.4)

Notes: t-stats in parentheses. In columns (i) and (iii) pre-school is defined to exclude early participation at infant school. In columns (iii) and (iv) the pre-school dummy variable considers early school participation as pre-school but a separate dummy variable, "Early school," is included. The instruments are the same as those as for Tables 2.2-2.5, as are the other conditioning variables.

When we include the extra dummy variable and redefine pre-school to include early school attendance, we find that pre-schools remain effective for copying but are now detrimental for vocabulary: children who attend pre-school (including early infant school) are likely to have worse vocabulary scores than those who didn't attend any form of pre-school, although this negative effect is not significant at 10%. Children who attended infant school early will receive the effects of both school parameters in column (iv), a loss of 17.47 compared to those who stayed at home, significant at 1%. Thus controlling for early school attendance brings the results into line with those in Table 2.3.

We conclude that Osborn and Milbank's positive results for vocabulary in the BCS are due to their omission of the possible effects of early infant school. However, this evidence does support their view that children are better served by time in pre-schools than by time in infant school with older children: the point estimates on the early infant school variable in Table 2.3 are negative for both copying and vocabulary.

2.5 Conclusions to Chapter 2

In the BCS, time spent in nurseries effected no improvement in maths as compared to time in informal care. Moreover, it may well have led to a deterioration in reading. This worse performance was traceable to reduced vocabulary at five. In contrast to reading, pre-school children were more advanced in copying at five relative to children in informal care, but, while copying is a good predictor of scores in both maths and reading at ten, this advancement had been offset by then.

The more recent BCS data presumably give the more accurate picture of the current effects of pre-schools. The BCS also contains the more detailed description of

actual participation. The mixed results for the BCS are not reflected in the NCDS where pre-school children tended to be more advanced at eleven than those who had been in informal care in both maths and reading. Thus over about a decade (1962-1973), the pre-school experience appears to have ceased to improve test scores in children as they enter secondary school. Why this should be so is beyond the scope of this paper. We noted above that the intake of pre-schools tripled between the two data sets. Average pre-school hours have also more than doubled. This coincided with a reduction in the quality of the peer groups in pre-school care. The changed effect of pre-school time might be due to these factors. An alternative explanation might be changes in curricula which Schweinhart *et al.* have shown are important.

Finally, it might be noted that Schweinhart *et al.* considered pre-school effects for a group of children from dis-advantaged backgrounds and hence with high marginal benefits of time in pre-school. When we investigated the pre-school effects for children whose parents did not stay on at school after the minimum school leaving age or were from social class V, we found no such benefits. One reason might be the low quality of available pre-school care. Schweinhart *et al.* considered an experimental group in a highly controlled setting that is much harder to achieve for the population as a whole. It may be that the High/Scope curriculum model is more beneficial than the models applied in the majority of pre-schools in the UK. It may also be that quality generally is lower, regardless of curriculum. We find no evidence of lasting benefits from any of the forms of pre-school provision existing in 1973, including private pre-schools. It is an important conclusion of this study that an expansion of provision without a major improvement in the quality of provision will not further the educational attainment of UK children.

2.6 Data Appendix to Chapter 2

Data for this study come from the National Child Development Survey (NCDS) and British Cohort Study (BCS). The NCDS gathered medical and background data about every child born in Britain in the first full week in March 1958. Subsequent sweeps have gathered further educational, sociological, economic and psychological data in addition to continued medical and background information in 1965, 1969/70, 1973/4, 1981 and 1991. The BCS, initially, Child Health and Education Study, considers every child born in Britain in the first full week in April, 1970. Subsequent sweeps in 1975 and 1980 are used here.

The two variables of time with mother and time in pre-school school were constructed from data on pre-school attendance and mother's work status. For the NCDS sample children we know only whether or not they attended one of four forms of pre-school care, *at any time*. On the basis of responses to questions on mother's labour force status and pre-school attendance, the measures of h_m and h_p (hours with mother and at pre-school, respectively) were constructed as shown in Table A2.1.

Appendix Table A2.1: ***Hours with mother and in pre-school care***

Mother's market status	LA day school		Pre-school School (LA or private)		Other pre-school (playgroups)		No formal care	
	h_m	h_p	h_m	h_p	h_m	h_p	h_m	h_p
Full-time	0	8	0	4	0	2	0	0
Part-time	0	8	4	4	6	2	4	0
None	0	8	4	4	6	2	8	0

Cell-averages were used when more than one form of pre-school care was registered.

For the BCS sample, we know the age at which children started and left pre-school placements. Therefore, we can consider the effect of time allocations between the ages of three and a half and four and a half, i.e. in the year before normal school entry. Pre-school hours are also reported in the maternal questionnaire. We apply average hours for each pre-school type as in Table A2.1 but for each of nine different pre-school types. These are Local Authority and private pre-school schools, Local Authority and private classes, playgroups, Local Authority and private day schools and Local Authority and private

schools where children begin school early. In all regressions we include a dummy variable for this last pair of pre-school types.

The basic analysis of this chapter considers the impact of attendance at pre-school schools on three attainment variables. For the NCDS these are assessed in sweep II when the children were seven years old and in Sweep III when the children were 11. Two of the indicators, the maths and reading score, are described in detail in Symons and Robertson (1996). The third measure is an indicator of behavioral adjustment, the Bristol Social Adjustment Guide (BSAG). Teachers were asked to indicate whether sample children scored positively in a range of tests of social adjustment. These are coded by the BSAG into a set of 12 syndromes (Stott ,1965) such as hostility towards adults, restlessness and depression. For each syndrome a score is recorded based on the number of phrases underlined by the teacher. The sum of scores for each of the 12 syndromes gives a total BSAG score. However, the individual scores are coded with numbers that cannot, in our view, represent an index. For example, in the depression syndrome a positive response to the phrase "in asking teacher's help too apathetic to bother" receives a code of 1, whereas a positive response to "expression is miserable, depressed, seldom smiles" receives a code of 6. We do not believe this to be a valid cardinal index and preferred to code this variable on the basis of the number of positive responses, grouping children into five bands. A score of 0 is noted for a child who received no positive scores on any of the phrases constituting the 12 syndromes. Such a child is held to be a high achiever. A score of 1 is noted for a child who receives one positive mention in any of the syndromes; A child with between 1 and 9 in the total BSAG gets a score of 2; 10 to 19 scores 3; more than 19 scores 4. The BSAG score was then transformed (by appropriate subtraction and multiplication) to make it compatible with the maths and reading scores which are increasing in ability and range from 0 to 100.

Maths and reading scores are available in the BCS at age 10 but at age 5, the children were too young to be tested for these subjects. We use test scores in Copying and Vocabulary. Social adjustment scores are available at both ages.

Table A2.2 gives basic statistics for the test scores and hours variables.

Appendix Table A2.2: *Test score and hours statistics*

		Mean	s.d.
Test Scores			
NCDS at 7	maths	51.1	24.9
	reading	54.0	19.7
	social adj.	45.2	27.5
NCDS at 11	maths	41.6	25.9
	reading	45.7	18.0
	social adj.	47.5	28.9
BCS at 5	copying	58.6	25.2
	vocab	57.4	26.5
	social adj.	52.0	12.6
BCS at 10	maths	61.3	17.4
	reading	60.3	20.7
	social adj.	64.6	13.7
Hours Variables			
NCDS	Hours in pre-school	0.11	0.23
	Hours with mother	0.73	0.35
	Pre-school dummy	0.20	0.40
	Mother works pre-school	0.19	0.32
	Interaction term	0.05	0.20
BCS	Hours in pre-school	0.25	0.15
	Hours with mother	0.65	0.22
	Pre-school dummy	0.72	0.45
	Mother works pre-school	0.24	0.30
	Interaction term	0.17	0.27

Appendix Table A2.3: ***Summary statistics for variables used at 7 and 11 in the NCDS***

		Mean	s.d.
Age 7			
Parent quality	Top SES father	0.20	0.39
	Middle SES father	0.55	0.49
	Mother stayed on	0.25	0.43
	Father stayed on	0.23	0.42
	Mother's age	27.5	5.7
	Mother working currently	0.27	0.33
	Number of older children	1.3	1.6
	Number of younger children	1.0	1.1
Parent time	Mother's interest in education	0.56	0.39
	Father's interest in education	0.36	0.42
	No mother present	0.002	0.05
	No father present	0.029	0.17
	Father plays a part in upbringing	0.89	0.31
School variables	Peer group at 7 years	0.24	0.25
	Independent school	0.032	0.18
	Scottish	0.11	0.31
Other controls	Incontinent at 3 years	0.042	0.20
	Talks at 2 years	0.94	0.24
	Height at 7 years (inches)	48.2	2.4
	Child started school early	0.016	0.13
	English not first language	0.013	0.11
	Female	0.48	0.50
Age 11			
Parent time	Mother working currently	0.23	0.34
	Mother's interest in education	0.63	0.35
	Father's interest in education	0.49	0.40
	No mother present	0.007	0.09
	No father present	0.049	0.22
	Father plays a part in upbringing	0.89	0.31
School variables	Streamed class	0.32	0.47
	High stream	0.13	0.34
	Low stream	0.10	0.30
	Peer group	0.26	0.18
	Independent school	0.039	0.19

Appendix Table A2.4: ***Summary statistics for variables used at 5 and 10 in the BCS***

		Mean	s.d.
Age 5			
Parent quality	Top SES father	0.25	0.43
	Middle SES father	0.53	0.50
	Father stayed on	0.34	0.47
	Mother stayed on	0.34	0.48
	Mother's age	26.0	5.8
Parent time	Mother working currently	0.25	0.31
	Number of older children	1.06	1.16
	Number of younger children	0.52	0.64
	Mother's interest in education	0.70	0.36
	Father's interest in education	0.26	0.36
	No mother present	0.004	0.06
	No father present	0.050	0.02
	Father plays a part in upbringing	0.29	0.28
School variables	Peer group at 5 years	0.23	0.42
	Independent school	0.022	0.02
	Scottish	0.089	0.28
Other controls	Problems at 6 months	0.13	0.26
	Height at 5 years (inches)	42.4	2.1
	Child started school before 4 1/2	0.22	0.42
	English not first language	0.075	0.26
	Female	0.48	0.50
Age 10			
Parent time	Mother working currently	0.28	0.33
	No mother present	0.0053	0.07
	No father present	0.054	0.23
	Mother's interest in education	0.51	0.28
	Father's interest in education	0.34	0.33
School variables	Streamed maths	0.44	0.50
	High stream for maths	0.13	0.34
	Low stream for maths	0.11	0.31
	Streamed reading	0.40	0.49
	High stream for reading	0.13	0.34
	Low stream for reading	0.10	0.29
	High peer group	0.07	0.08
	Low peer group	0.07	0.08
	Independent school	0.02	0.15

Appendix Table A2.5: *F-statistics for endogenous variables in all hours model regressions*

	D.o.f.	F-stat
NCDS at age 7		
Maths	157,7998	
Hours in pre-school		3.55
Hours with mother		2.48
Mother working		2.34
Started school early		5.35
Reading	163,7956	
Hours in pre-school		3.06
Hours with mother		2.09
Mother working		2.16
Started school early		4.13
Social adjustment	160,7995	
Hours in pre-school		3.72
Hours with mother		2.43
Mother working		2.29
Started school early		5.23
NCDS at age 11		
Maths	163,7329	
Maths at 7		11.92
Hours in pre-school		3.22
Hours with mother		2.18
Mother working		1.96
Mother working, 11		1.55
Started school early		5.21
Streamed		4.07
High stream		3.29
Low stream		3.15
Reading	172,7313	
Reading at 7		36.34
Hours in pre-school		3.12
Hours with mother		2.21
Mother working		2.03
Mother working, 11		1.59
Started school early		4.65
Streamed		4.25
High stream		3.38
Low stream		2.97
Social adjustment	175,7271	
Soc adj at 7		10.60
Hours in pre-school		3.11
Hours with mother		2.15
Mother working		1.98
Mother working, 11		1.56
Started school early		4.97
Streamed		4.30
High stream		4.45
Low stream		3.91

	D.o.f.	F-stat
BCS at age 5	124,5063	
Hours in pre-school		3.59
Hours with mother		2.00
School before 4 1/2		3.29
BCS at age 10		
Maths	129,3416	
Copying at 5		5.02
Vocab. at 5		2.03
Hours in pre-school		2.81
Hours with mother		2.24
School before 4 1/2		2.19
Mother working, 5		1.99
Mother working		1.32
Streamed		1.86
High stream		1.18
Low stream		1.83
Reading	129,3075	
Copying at 5		4.54
Vocab. at 5		1.92
Hours in pre-school		2.78
Hours with mother		2.07
School before 4 1/2		2.15
Mother working, 5		1.79
Mother working		1.25
Streamed		1.90
High stream		1.14
Low stream		1.54
Social adjustment	129,3093	
Soc adj at 5		1.25
Hours in pre-school		2.82
Hours with mother		2.10
School before 4 1/2		2.14
Mother working, 5		1.82
Mother working		1.26
Streamed		1.89
High stream		1.15
Low stream		1.56

Degrees of freedom for F-stat = (J, n-K) where J=No. of restrictions, n=sample size and K=No. of independent variables in unrestricted equation.

Chapter 3. Pre-school Educational Inequality? British children in the 1970 Cohort.

The current Government's emphasis on education was briefly referred to in the introduction. As part of this emphasis, the Sure-Start initiative is an investment of £540 million in infant development projects between 1999 and 2002 that will "work with families to give children in disadvantaged areas the best start in life[1]." Given the findings of Chapter 2, that expenditures on pre-school care may actually be deleterious for the development of childhood ability, it is important to consider the nature of the process of human capital formation in the early years. This chapter puts the Sure-Start investment in context by considering which parents appear to be most in need of Sure-Start support. Is there evidence that this investment is likely to offer genuine returns? If so, which aspects of parenting appear to be the likeliest candidates? If not, is the programme simply a cover for failure to act more substantially elsewhere in the economy?

The motivation for the programme is the finding, well-established in the psychological literature, that social and family background factors influence the development of children before they have even entered school or, in fact, pre-school. Liaw *et al.* (1994), for example, show that "at risk factors" such as family mental health or problem behaviours related to poverty, influence the IQ of children as young as age three. Klebanov *et al.* (1998) show that these risk factors influenced the development of North American one-year olds and that, moreover, poverty significantly affected the same children by age two. By age three, even neighbourhood effects had played a significant role[2].

Of course, numerous studies have also shown that, once children are at school, family poverty continues to have a deleterious effect on education. Ability, therefore, is not fully determined prior to school entry and schools can make a difference. Thus, two empirical questions emerge. Firstly, to what extent are early measures of ability correlated with later ability and qualifications? In other words, how much information is contained

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[1] DfEE (1999).

[2] It is important to bear in mind, though, that, according to a recent review of psychiatric research on infant development (Zeanah *et al.*, 1997). "linear models of cause and effect are of little use in understanding the development of psychopathology." Similarly, with infant development, the emphasis is on risk factors rather than on proving that any particular benefit or problem has necessary links to subsequent outcomes. Psychiatrists, thus, reject deterministic, causal models of the impact of material factors on infant

in indices of pre-school development? Secondly, if early ability is important in this sense, what determines it and how amenable are these determinants to policy influence? Although these questions have been well examined in the psychological literature, this research tends to have been on North American data for which the relative significance of different aspects of upbringing will be different to that of British children with different implications for policy. Certainly, other than the data set used here, the 1970 Birth Cohort, there are no UK surveys with sufficient longitudinal information to show that pre-school development indices are important signals of post-school outcomes. Neither of the two earlier UK cohort studies gathered information about pre-school cognitive development. Moreover, even in the US, developmental studies have tended to show either that broad measures of SES are important or that early scores have predictive power for later scores. This chapter will discuss both issues using a data-set that enables a longitudinal study with unparalleled cross-sectional and longitudinal richness. We can, therefore, investigate the relative importance of different aspects of upbringing to the production of human capital. A further beneficial feature of the data is that, disregarding attrition, selection is random. This further differentiates results from those in the majority of early development studies such as those of the High/Scope programme in the U.S. discussed in Chapter 2 and which are based on selected samples (Berrueta-Clement *et al.* (1984), Schweinhart, *et al.*, (1986) among others). A final advantage of this data is that, as can be seen in Table 3.1 below, sample sizes are large.

Essential to the current study is the fact that BCS children were given tests of development at all sweep ages. Particularly useful are the tests of development given in two sub-samples, when the children were 22 and 42 months old. These tests show very clear divergence of development by the background of UK children. This begins very early in life and then continues month after month into school years and beyond.

Support for the forecasting power of early ability might come from psychological literature or from genetics, although with very different implications for social policy. For instance, it might be that very early parent-child interactions such as those described by Bowlby (1953) are crucial in the determination of variance of ability. Researchers have found clear social class differences in the way pre-school children are taught in the home. Bee(1969), for example, found that middle-class mothers provided more intellectual

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development but view these within the kind of stochastic framework in which material deprivations are 'risk factors'. This is akin to an econometrician's notion of causation.

stimulation than working-class mothers, were much more goal-oriented in the way in which they responded to children and much more likely to complement success rather than criticise failure. Similarly, Culp *et al.* (1988) found differences in mother-child interactions by age of the mother with younger mothers talking less and being more passive in face-to-face interactions, even conditioning on social class and race. Differences in housing, family size, nutrition and education of parents that have also been shown to be important influences could, in part, have profound early implications not just directly through the material environment but also via effects on the quality of such interactions[3].

Section 3.1 describes the data and the tests used to assess the development of the sample children. Section 3.2 considers the issue of the stability of scores. Section 3.3 establishes the existence of significant early social class effects in this data and maps them over time. Section 3.4 investigates the underlying components of this social class effect in terms of the wide-ranging observed aspects of family life and attempts to discriminate between cultural, educational and financial associations. Section 3.5 concludes.

3.1. The Data

Table 3.1, below, reports the ages at which the 1970 cohort have been sampled, together with sample numbers. Age sixteen BCS information is not used because of the low response to the Teacher's Questionnaire which unfortunately coincided with teachers' industrial action.

Due to medical concerns about the effect of fetal malnutrition on brain cell proliferation, a sub-sample of BCS children were studied at 22 and 42 months. A ten percent random sample of all births was included together with those children who were considered to be most at risk from fetal malnutrition, numbers from each of these sub-groups within the 22 and 42 month sub-samples are also given in Table 3.1.

[3] Alternatively, support for the thesis that early ability has strong explanatory power might be found from genetics although this offers even less obvious room for social policy intervention. Attempting to reduce income inequality by influencing the British schools system or other school-age measures would, in this latter scenario be, at the very least, considerably more problematic.

Table 3.1: *Observations in first four sweeps of BCS*

	Obs.		Test scores/ Qualifications
Birth	17196		
22 month sub-sample, of which:	2457		2329
Control	1125	(45.8%)	
Twins	228	(9.3%)	
Post-mature-sample	748	(30.4%)	
Small for dates	567	(23.1%)	
42 month sub-sample, of which:	2315		1394
Control	1093	(47.2%)	
Twins	211	(9.1%)	
Post-mature-sample	676	(29.2%)	
Small for dates	527	(22.8%)	
5 years	13135		12467
10 years	15049		12308
26 years	9003		8422

Notes: Figures in brackets represent percentages of 22 and 42 month sub-sample

Estimation of the mobility and explanation of test scores in the general population using data for these two sub-groups is likely to be biased if fetal malnutrition is linked to the development of brain activity, performance in developmental tests and also to other social and economic variables. Two strategies are, therefore, adopted. Firstly analysis was undertaken on each sub-group separately to test whether results varied from those for the control group. Generally it was found that there was no significant model estimation divergence between the sub-groups and the control group. Secondly, for regressions a weighted least squares procedure was used, unreported sub-group dummy variables controlling for membership of a particular sub-group[4]. These two strategies mean that results can be considered to be representative of the educational development of the wider population of children.

Another sampling issue is that only children from two-parent families were included in the sub-sample. This limits the representativeness of these results, particularly for those concerned with family breakdown. Nonetheless, bearing this exclusion in mind,

[4] Observations are re-weighted by the formula w2=w*w1 where w1 and w2 are the weights of randomly sampled and over-sampled observations and w is the ratio of observations in the sub-sample as a whole to the full BCS sample at birth, 0.142. (See notes to Table 3.9.)

analysis of these data should still shed light on the two questions of the importance and explanation of early ability differences between children of different backgrounds. Children in special schools at age ten were also excluded from the subsequent analysis on the assumption that they represent different educational problems.

3.1.1. Test scores

At each age BCS children were assessed by a wide range of tests of intellectual, emotional and personal development. The full list of tests is given in Appendix Table A3.1. At 22 months the children were asked by the Health Visitors administering the survey to complete a range of different tasks such as pointing to their eyes to illustrate understanding of language, putting on their shoes, indicative of personal development, stacking cubes and drawing lines as tests of locomotor ability. These tests, together with those at 42 months, were intend to indicate the general development of children based on the tests used for screening in child health clinics (Chamberlain *et al.*, 1976). A pilot study found high correlation between the BCS tests and similar tests of development such as the Bayley Scale of Infant Behaviour or the Newcastle Survey (Neligan *et al.*, 1969). At 42 months counting and speaking could be tested and further copying tests were administered such as drawing simple geometrical shapes. At age five copying was again assessed, together with tests of basic vocabulary. Harris (1963) and Koppitz (1968) show these scores to have good properties of discrimination and reliability.

Test scores at each age were combined by principal-components analysis. This has the virtue of maximising the information available at each age while reducing the number of dependent variables, combining scores into a single index of development. It is argued that the method is appropriate for these data because, as Appendix Table A3.1 shows, the test scores are sufficiently correlated to support the hypothesis that they are measuring manifestations of a similar process but sufficiently distinct that each contributes valuable information when they are combined. (See Gorsuch, 1983, for details of appropriate and inappropriate uses of factor analytic techniques.) It is hypothesised that the index is the best available measurement of the development of children at each age. In order to restrict components and to focus the index further, only those components that were significant in regressions of age ten maths or reading on earlier scores were included in the analysis.

This focusses the underlying hypothesised dimension of development as that part of development signalling future academic ability.

It should be emphasised, however, that the scores do not represent movement along a single axis of ability over time. This is an inherent problem in the field of educational and developmental measurement. Psychologists (for example, Dougherty *et al.*, 1997) have attempted recently to use the idea of Reaction Time, measured by eye movements, to proxy for infant intelligence and have found some degree of stability of the underlying process but this is a very specific measure and it is generally accepted that infant scales are poor measures of any hypothesised single process. Intelligence may change qualitatively over early maturation. There is also considerable instability in scores because very young children do not stay on-task for long. However, conducting analysis on rank position rather than actual scores should increase stability.

In order to explain why psychiatrists find early test scores meaningful and to put them in context, it may be helpful to review psychiatric notions of stability. Rutter (1987) offers an authoritative textbook statement of the psychiatric literature on stability of infant intelligence and personality. *Absolute invariance* or stability is considered an unusual notion in the field of development, concerned as it is with the process of change. More commonly observed is *regularity in the pattern of development,* a form of continuity in which the variations themselves, such as the timing of psychotic episodes, might follow regular patterns. To the extent that test scores reflect psychiatric characteristics, fluctuations in scores over time will be expected. *Ipsative stability* in personality allows considerable temporary fluctuations around predominant characteristics such as anxiety, akin to the problem measurement error in academic test scores but an observed characteristic of personality. Similarly, *continuity in structure, process or mechanism* allows for substantive divergences in surface manifestations of, for example, the *form* of relationships on the basis of underlying structural characteristics that, necessarily, can be little more than hypotheses. Fifth, continuity may be in the form of the *causal connections* such as between the lack of stable parent-child attachments in infancy and maladaptive patterns in later life. This does not assume correlations between attachments and any specific behavioural manifestations. These forms of continuity are less apparent and statistically weaker than those observed in consideration of normative stability, as here. Thus, Rutter argues, both IQ and height show considerable changes between the ages of five and fifteen years but inter-temporal rank correlations will be moderately high.

The single index used in this study, therefore, is intended as an indicator of outcomes in subsequent tests not as an observation of one-dimensional ability. I show, below, that early scores are important predictors of final educational outcomes at age 26. This is sufficient to show that these pre-school development test indices are important signals of developing ability and motivation. It does not suggest that any particular domain of early development such as cognitive, emotional, language or social development dominates.

In order to address the issue of how particular early scores prefigure later scores for particular aspects of ability, Table 3.2 reports the raw correlation of the individual components of each age's test score with test results at age 10.

Table 3.2: *Raw correlation of individual test scores with scores at 120 months*

	120 months	
	Reading	Maths
22 month scores		
Cube stacking	0.22	0.11
Language use	0.22	0.11
Personal dev.	0.22	0.13
Drawing	0.17	0.15
42 month scores		
Counting	0.30	0.11
Speaking	0.32	0.15
Copying designs I	0.30	0.13
Copying designs II	0.25	0.11
60 month scores		
Copying designs	0.41	0.19
Vocabulary	0.40	0.18
Human Figure Drawing	0.31	0.13

Table 3.2 highlights the general finding that reading scores are more easily predicted than maths scores (for example, Stevenson *et al.*, 1986) and also shows that at the earlier ages no single test dominates in terms of degree of association with subsequent scores, even, as with reading and vocabulary, in what one might expect to be related subjects. The copying score at age five is as highly correlated as the vocabulary score with both reading and maths at age ten, for example. Similarly, cube stacking and language scores at 22 months are equally associated with reading at age ten and the 42 month speaking test score is, in fact, more highly correlated than the counting score with maths at age ten. These correlations suggest that there is no particular connection between scores in tests of specific abilities at early ages and subsequent performance in more demanding

tests of the same abilities, at least in terms of these tests[5]. Rather, early test scores, particularly those at 42 months, appear to prefigure later ability, but in a more general manner. This supports the combination of the scores into weighted indices of development. The early test scores do appear from these raw correlations to show considerable association with later educational performance. However, as stated above, the development of attainment through childhood is also clearly not akin to a time-series of observations of, for example, Gross Domestic Product, because the variable itself changes as children mature.

Table 3.3 reports each component test in the score for each age and shows the weights given to each. It can be seen that no individual component dominates, all scores contributing to maximisation of the variance of test outcomes.

Table 3.3: *Scoring coefficients from principal components analysis for overall test scores, first and second factors*

	22 month		42 month		5 years		10 years	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Cube stacking	0.34	0.57						
Language use	0.37	-0.66						
Personal dev.	0.40	-0.37						
Drawing	0.33	0.59						
Counting			0.38	-0.37				
Speaking			0.34	-0.64				
Copying designs I			0.39	0.31				
Copying designs II			0.33	0.71				
Copying designs					0.50	-0.27		
Vocab					0.38	0.96		
Human Figure Drawing					0.48	-0.46		
Reading							0.34	-0.06
Maths							0.27	0.99
Picture language							0.29	-0.67
British Ability Scale							0.34	-0.14
Eigenvalue	1.92	0.80	1.92	0.88	1.59	0.83	2.58	0.68
Proportion of variance	0.48	0.20	0.48	0.22	0.53	0.28	0.64	0.17

Notes: Pricipal components analysis was undertaken using the principal components factor method based on analysis of the correlation matrix of test scores at each age. The proportion of variance is derived as the eigenvalue or latent root divided by the sum of the variances of the components, in this case all standardised to one.

[5] Some recent studies such as those of Jordan *et al.* (1992) have emphasised the extent to which early maths tests have picked up language ability because of the way questions are put. Correlations with SES can be much reduced for maths questions that are phrased in less story-based or verbal terms

Only the first factor is used in subsequent analysis. This is the variance-maximising index of development at each age and so maximises the signal provided by the scores and will be tested, below, as an indicator of future academic performance. The elements of the correlation matrices at each age are exclusively positive and reasonably similar so it is not surprising that each score contributes positively to the overall variance of development in the first factor. Second (and subsequent) factors explain additional variance of the underlying components but are not so readily interpretable as general indices of development since, under the assumption of zero covariance between first and subsequent factors implicit in principal components analysis, one or more of the components in subsequent factors must have a negative loading in these data. The (unrotated) second factors are described in Table 3.3 as further exploration of the variance in the data even though they are not used in the analysis[6]. It may be observed, for example, that twenty percent of additional variation in the 22 months scores is explained by a factor which effectively contrasts the motor and spatial skills of cube stacking and drawing on the one hand with the more intellectual/behavioural skills of language use and personal development on the other. However, this spatial factor score is not significant in regressions of the first principal component factor at age ten on age 22 factors. In fact, of the second factors at 22, 42 and 60 months, only the age five second factor, which emphasises vocabulary at the expense of human figure drawing tests, is a significant predictor of age ten development[7]. It could, therefore, be used later in the chapter where the age five scores are used as lagged dependent variables in the regression of the age ten development index on background explanators but adding it has no substantive influence on results. Although the second factors are interesting transformations of the underlying data they provide less powerful signals of development.

Given that our concern is with educational inequality the children are then ranked in normalised reverse order, a rank of one for the lowest scoring child and a rank of one hundred for the child scoring highest. This gives four outcome variables that reflect children's position in the distribution of hypothesised development at the ages of 22, 42 months, 60 and 120 months. Although the rank varies between one and one hundred there

[6] Even if the concern was to use the principal components as independent variables in subsequent multi-variate regressions no second factor has an eigenvalue above unity and so all would, in any case, be put aside by the Kaiser criterion (Kaiser, 1960) although not by the more strict Jolliffe rule (Jolliffe, 1972).

are potentially as many positions within this range as there are children in each sweep who completed the tests.

The final educational variable used is an ordinal measure of highest educational qualification as reported in the age 26 sweep of the BCS and coded as a stripped down version of the more detailed Schmitt schema (Schmitt, 1993) which gives an ordinal scale of educational/vocational attainment. This ordering is described in Table 3.4 and has been shown to be strongly linked with earnings in this data (see Chapter 5).

Table 3.4: *Age 26 educational and vocational qualifications, all sample members.*

	%	(s.e.)
None	4.45	0.22
Lower/Middle vocational	56.26	0.54
A'Level or above	39.29	0.53

3.2. The strength of the signal provided by the development indices

An immediate issue is the relation of the earlier test ranks to later outcomes. Perhaps the clearest picture of the relevance of the early position in the index of development is given by the results in Table 3.5 which show how the position in the distribution at each age predicts final qualification level at age 26[8].

It is striking that even measured at 22 months, children in the bottom quartile of this development index are significantly more likely not to get any qualifications than those in the top quartile. Moreover, more than twice as many of those in the top quartile at 42 months as those in the bottom quartile go on to get A'Level qualifications or above. Only two per cent of the top quartile don't get any qualifications. Given the young age of the children tested, these are strong findings, suggesting that the index picks up clear signals of educational development. These might be due to any number of underlying causes such as parental aspirations, ability and resources that are correlated both with early development and subsequent atainments. That issue will be addressed further below

[7] The coefficient on the first age five factor is 0.52, as opposed to 0.11 for the second age five factor as predictors of the age ten development index (age ten first factor). Both are significant at one per cent.

[8] A chi-squared test was used to check whether results were biased by over-sampling of low birth-weight and foetally under-nourished children. This was a goodness of fit test of the difference between proportions in Schmitt scale for the control group and full sub-sample including over-sampled groups at each age. The data do not reject the null hypothesis of uniformity between samples.

when we consider which aspects of parental background influence these developmental differences between children. At this point, however, it is worth emphasising that before children have even entered school, very substantial signals about educational progress are contained in standard tests of development.

Table 3.5: *Age 26 educational and vocational qualifications by quartile position in early development scores.*

	Bottom quartile		Top quartile		z-stat: H_0:p1=p2
	%	(s.e.)	%	(s.e.)	
22 month					
None	6.6	(1.6)	1.9	(0.8)	2.9
Lower/Middle vocational	61.8	(3.1)	54.6	(2.8)	1.7
A'Level or above	31.5	(3.0)	43.6	(2.8)	-2.9
42 month					
None	10.7	(2.6)	0.9	(0.7)	4.2
Lower/Middle vocational	65.7	(4.0)	48.4	(3.4)	3.2
A'Level or above	23.6	(3.6)	50.7	(3.4)	-5.1
5 year					
None	11.7	(0.9)	0.8	(0.2)	13.3
Lower/Middle vocational	70.3	(1.3)	40.5	(1.1)	15.9
A'Level or above	18.0	(1.1)	58.7	(1.1)	-21.9
10 year					
None	12.5	(1.0)	0.3	(0.1)	15.7
Lower/Middle vocational	75.8	(1.3)	32.7	(1.0)	23.1
A'Level or above	11.7	(1.0)	67.0	(1.0)	-29.7

The z-stat in column three is the test of the difference between the proportions of bottom and top quartile children for each age 26 educational group. It can be seen, for example, that the proportion of bottom quartile children with no age 26 qualifications is higher than that of top quartile children, witha z-statistic of 2.9, hence significantly at 1%.

A second approach to the initial question of the stability of the distribution of scores as the children develop is to consider transition matrices. These group children by their quartile position at each of two ages, giving a table of sixteen cells. Given the large degree of instability in scores at these ages, it is not obvious that movement to cells adjacent to the leading diagonal are informative of genuine mobility. Perhaps more interesting are movements from top to bottom and vice versa. Therefore, only these large movements are shown in Table 3.6 which reports mobility for children in the full 22 month sub-sample. The top panel of Table 3.6 shows movements from the quartile position at 22 months, the bottom panel shows movements from the 42 month position[9].

[9] Again, as with Table 3.5, it might have been expected that the degree of movement observed would be affected by the over-sampling of children at risk from fetal under-nourishment. If such children were hindered in early years but subsequently caught up, mobility would be over-stated in this sub-sample relative to that in the population. On the other hand, if such children were persistently affected, mobility might be under-stated. Chi-squared tests for contingency tables have been applied and presented in the

Table 3.6: *Selected cells from quartile transition matrices*

		Quartile at 42 months		Quartile at 10 years	
		1st	Top	1st	Top
Quartile at 22 months	1st	44.4	12.0	42.6	16.0
		(1.5)	(1.0)	(1.2)	(0.9)
	Top	10.4	43.3	11.6	37.1
		(0.9)	(1.4)	(0.8)	(1.2)
Chi-squared (dof=15):		3.3		10.6	
				1st	Top
Quartile at 42 months	1st			43.7	9.9
				(1.6)	(0.9)
	Top			7.9	43.5
				(0.8)	(1.6)
chi-squared (dof=15):				10.1	

Notes: Standard Errors are in brackets. Only extreme quartile cells are reported, i.e. top and bottom quartiles. The reported chi-squared test is a test of the difference between transition matrices of the control group and full sub-sample. The critical level at 5% for a chi-squared test with 15 degrees of freedom is 25.0

The first column shows that of the 25% of children scoring lowest at 22 months, 44% were still in the lowest quartile at 42 months. On the other hand, 12% had entered the top quartile. Clearly there is movement within the distribution over these twenty months but there is also evidence of some rigidity. By 120 months, even more children had made large movements across the distribution.

There is slightly more clear persistence of scores between 42 months and ten years, particularly in terms of the proportion of large movements. Thus, as one might expect, the position at 42 months seems to be more firmly fixed than that at 22 months. This would certainly be the expectation of infant development specialists. The review of psychiatric research mentioned earlier (Zeanah, *et al.*, 1997) summarises recent research finding three periods of major structural reorganisations in infancy. The last of these qualitative shifts involving the entry into verbal and symbolic representation, ends at around 20 months, after which changes can be more easily characterised quantitatively. At 22 months children will still be consolidating after the most recent shift but by 42 months

bottom section of Table 3.6. These suggest, as before, that there is no significant difference between the transition matrices for the full sub-sample and those for the control group. Other experiments were undertaken with mobility indices such as those of Bartholomew (1973) who weights cells by their distance from the leading diagonal, a high overall score indicating a large degree of mobility or Shorrocks (1978). These also showed that the mobility results described in the text are not substantially altered by over-sampling.

will "have available a sophisticated repertoire of skills for communicating and experiencing relationships[10]." More stability from 42 months might, therefore, be expected and development can be more readily assessed quantitatively. However 10% of the bottom group at 42 months had reached the top quartile by ten years. This emphasises the interpretation of the development indices as signals of development and not as stronger classifiying mechanisms. Plenty of scope still remains for children to catch-up and overtake other children who may be out-performing them early on. Nonetheless, the 22 and 42 month scores provide a meaningful guide to subsequent performance.

Taking the evidence of the mobility tables and the associations with age 26 outcomes, the development index at 42 months appears to be a more stable indicator of educational development than that at 22 months but the 22 month score cannot be discounted as random and without forecasting power. Other experiments have shown that for girls it is slightly more stable than for boys[11].

3.2.1. The association of early rank with age ten educational provision

Another aspect of the importance of early rank is that it influences subsequent educational provision. At age 10 (1980), 51% of BCS children were in set groups for maths, 47% in reading. Sets were classified into three groups by teachers and the probability of being in the top or bottom streams for reading and maths, conditional on being in a streamed school were regressed on ability rank at the three prior ages. Results from these probit regressions are shown in Table 3.7. The final column reports a regression of the peer group in which the child is taught at age ten on prior ability. The Peer Group Index used here is taken from Chapter 4 and measures the social class and ability of class members as reported by teachers.

The coefficients in Table 3.7 show the marginal effect of moving from the bottom to the top of the distribution at each age. Conditioning on age 5 rank, for example, the top scoring child at 42 months is 24% more likely to be in the top maths stream at age ten. Thus, children doing well at 42 months are likely to be placed in better classes. Evidently,

[10] Zeanah, op.cit.

[11] The main difference is that whereas only 40% of sub-sample boys maintained their 22 month position in the top quartile at 42 months, 47% of sub-sample girls did so. There were also more extreme movements between quartile at 22 months and that at five years. Overall, the chi-squared tests for gendered differences in the degree of mobility were not accepted for any transition matrix at 5%.

42 month development is strongly associated with the educational opportunities provided to children, even conditioning on 5 year scores[12].

Table 3.7: *Associations of early ability rank and educational provision at age 10.*

Age	High maths stream		Low maths stream		High reading stream		Low reading stream		Peer group quality	
22 month rank/100	-0.05	(0.62)	0.03	(0.39)	-0.03	(0.31)	-0.12	(1.56)	-0.08	(0.66)
42 month rank/100	0.24	(2.84)	-0.18	(2.32)	0.31	(3.15)	-0.23	(2.89)	0.26	(2.05)
5 year rank/100	0.36	(4.18)	-0.41	(5.26)	0.48	(5.00)	-0.27	(3.45)	0.33	(2.57)
Obs.	486		486		400		400		623	
(Pseudo-) R^2	0.07		0.10		0.11		0.11		0.03	

Notes: Coefficients reported in first four columns are marginal effects from probit regressions. The final regression is by OLS. The Peer Group Index is standardised to mean zero, standard deviation of one and is based on the social class and ability of class members as reported by teachers. t-statistics in brackets.

The first question to be addressed in this chapter was whether or not early measures of ability were correlated with later ability and qualifications. The mobility tables show that educational positions are far from being fixed before children enter school but we have also seen that pre-school development is strongly correlated both with ultimate educational success and with the schooling opportunities made available to children.

3.3. The raw association of test rank with social class

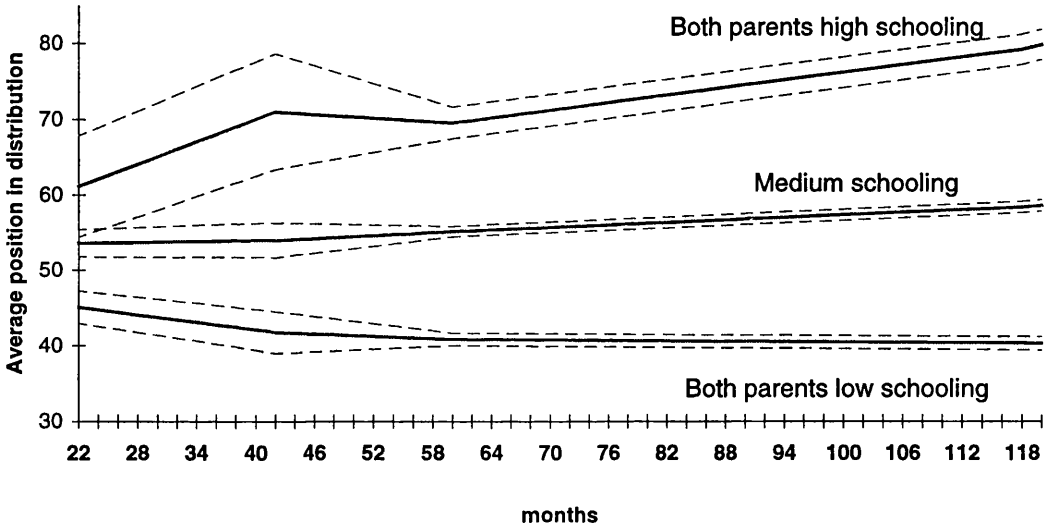
The second question to be addressed is the extent to which these positions are associated with aspects of social class. Figures 3.1-3.4 map the average position of children from different social backgrounds in the distribution at the four survey ages. The dotted lines show the two standard error interval. Whether children are grouped by the education of their parents or their parents' occupational classification (Socio-Economic Status, SES), there are already significant differences in test outcomes by 22 months. For example, Figure 3.1 shows that children of parents in the high schooling group, whose

[12] This remains the case even when parental education and ocupational classification are introduced. Results of two other experiments are also worth noting. Firstly, although the raw correlation of the 22 month rank with later outcomes is greater for girls than for boys, the 42 month and five year ranks are still sufficient for explanation of the dependent variables for boys and girls taken separately. Second, experiments with the second and third factors from the principal components analysis find that the third 22 month factor negatively predicts membership of the high reading set but that this is the only significant additional factor. This result supports use of the first factors as the development indices.

parents both have at least A'Levels, are already fourteen percentage points higher up the distribution than those in the bottom group, whose parents have no qualifications. They are also seven points higher than those in the middle educational group, at least one of whose parents have some qualifications but do not both have A'levels or higher.

Figures 3.1-3.4 - Average rank of test scores at 22, 42, 60 & 120 months

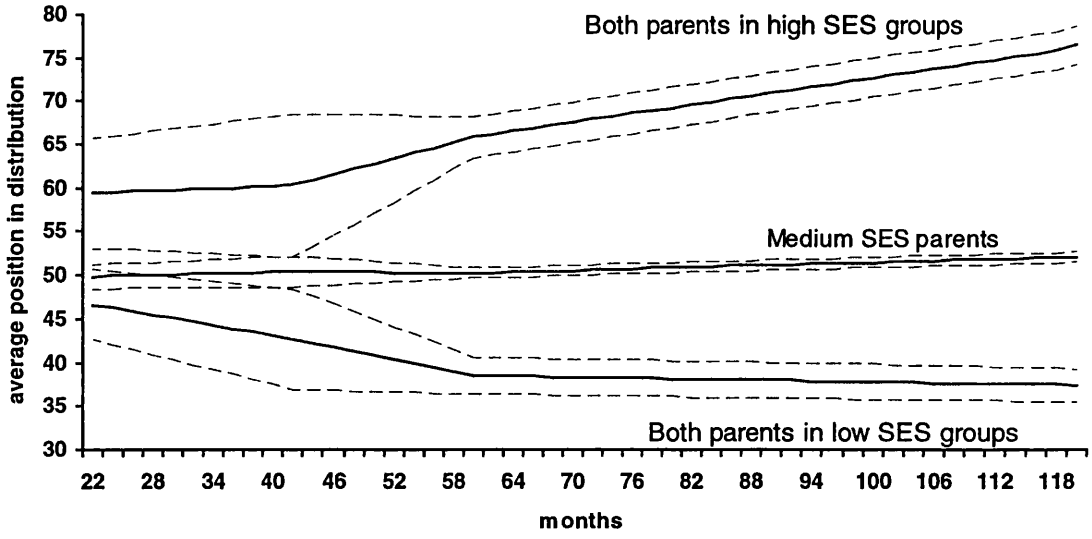
3.1. By schooling of parents



Notes: Dotted lines represent intervals of two standard errors. Top schooling parents both have at least an A'Level. Bottom schooling parents have no educational qualifications. Parents classified as medium schooling are those omitted from top and bottom categories.

Figure 3.2 shows that this pattern of results is broadly similar when children are stratified by parental SES, although in this case the top group are performing significantly better than the medium group by 22 months.

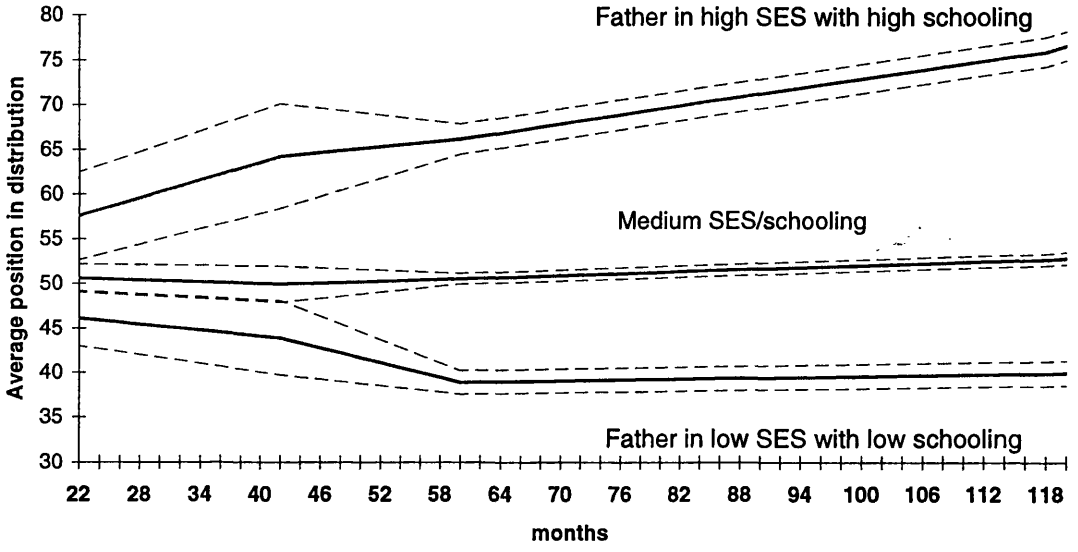
3.2. By SES of parents



Notes: Dotted lines represent intervals of two standard errors. Top SES parents are those in professional and/or managerial occupations. Bottom SES parents are those in unskilled or semi-skilled occupations. Parents classified as medium SES are those omitted from top and bottom categories.

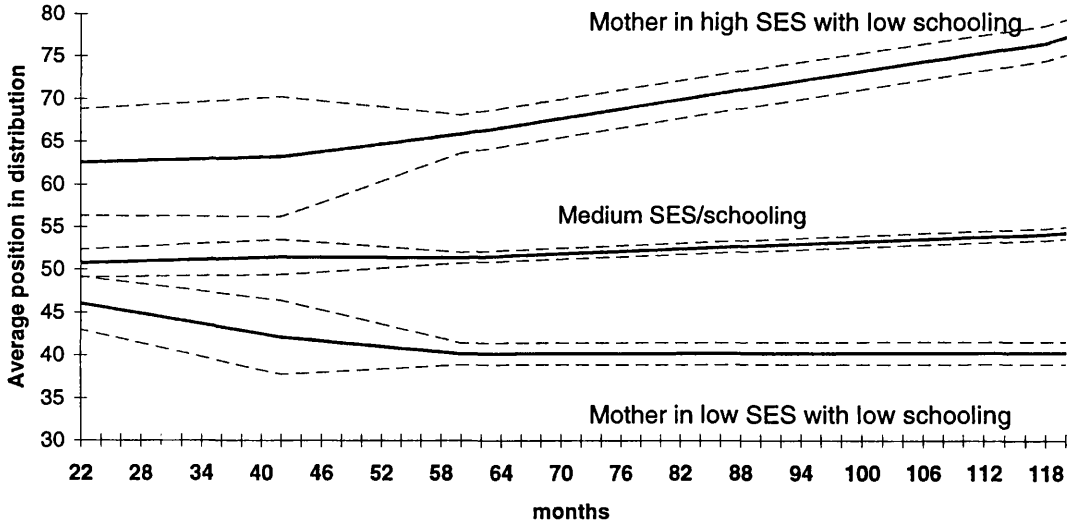
Concentrating instead on differences in the backgrounds of one parent only, Figures 3.3 and 3.4 show that whether the mother or father is selected, significant differences between children have already emerged. The effect is slightly clearer where children are classified according to the education and occupational category of their mothers but children of fathers in the top group are already scoring significantly more highly than those in the middle group by 22 months.

3.3. By SES and schooling of fathers



Notes: Dotted lines represent intervals of two standard errors. High SES, high schooling fathers are in professional or managerial occupations with at least an A'Level. Low SES, low schooling fathers are in unskilled or semi-skilled occupations and have no educational qualifications. Fathers classified as medium SES/schooling are those omitted from top and bottom categories.

3.4. By SES and schooling of mothers



Notes: Dotted lines represent intervals of two standard errors. Mothers classified in the same way as fathers were in Figure 3.3. Occupational categories are based on previous employment where mothers are not currently working. Mothers who have never worked are treated as medium SES.

The ability trajectories also show that as children mature, the social class association strengthens. As suggested above, the trajectories should not be considered as time-series even though they are mapped here over a time axis. This is done in order to highlight the way in which the most advantaged children start from a higher position in the distribution at 22 months and then move to steadily higher positions at later ages. The improvement in their position, moreover, is fairly steady and there is no obvious change induced by schooling. The decline in position of the least-advantaged children, however, does appear to slow after they have entered school, suggesting that schooling provides important opportunities for learning particularly for the most educationally dis-advantaged children.

However, social class, of course, has many facets and these raw associations say nothing about which aspect of social class is important. The simple occupational classification used in the ability trajectories is associated with almost every aspect of a child's upbringing. Appendix Table A3.2 reports basic statistics for the social class information available in the BCS. Table 3.8 shows the associations of these general, background variables with the occupational classifications, reporting the results from twenty-seven regressions. The first column shows the dependent variable, each regressed on two dummy variables, indicating fathers in top or middle occupational classifications.

Table 3.8: *Channels for SES effects, marginal effects from OLS and probit regressions.*

	Father's SES				
	1,2		3M, 3NM		Obs
	Est	t,z	Est	t,z	
1. Mother educ>min	0.38	29.3	0.07	5.9	12884
2. Father educ>min	0.56	41.1	0.17	14.0	12796
3. Mother's age	1.95	13.1	0.44	3.4	12792
4. No. of older sibs, 1970	-0.24	7.1	-0.08	3.5	17099
5. No. of younger sibs, 1975	-0.07	4.1	-0.02	1.4	12939
6. Weight at birth, 1970	0.13	10.1	0.07	7.6	16868
7. Weight , 1972	0.49	4.7	0.27	3.0	1938
8. Weight , 1973	0.67	4.8	0.23	2.0	1854
9. Height , 1975	1.68	12.5	0.70	6.0	12707
10. Multiple birth	0.02	0.8	0.01	1.0	2445
11. Postmature birth	-0.04	1.2	-0.00	0.1	2445
12. Small for dates	-0.10	3.7	-0.05	2.6	2445
13. Mother's interest in ed., 1980	0.68	23.4	0.21	8.2	11228
14. Father's interest in ed., 1980	1.37	41.4	0.65	28.5	11374
15. Mother full-time, 1972	-0.01	1.4	-0.01	1.7	2003
16. Mother full-time, 1973	-0.02	2.0	-0.01	0.6	1943
17. Mother full-time, 1975	-0.02	3.3	-0.02	4.0	12939
18. Mother full-time, 1980	-0.01	0.6	-0.02	1.8	12611
19. Mother part-time, 1972	0.01	0.5	0.03	1.5	2003
20. Mother part-time, 1973	-0.04	1.6	0.02	0.8	1943
21. Mother part-time, 1975	0.02	1.4	0.05	5.0	12939
22. Mother part-time, 1980	0.06	4.6	0.08	7.0	12611
23. Mother's Malaise score (0-23), 1975	-2.0	21.6	-0.7	9.0	12789
24. Lone mother, 1975	-0.04	8.8	-0.04	10.5	12680
25. Lone mother, 1980	-0.04	6.4	-0.04	8.4	12805
26. Telephone, 1975	0.44	36.3	0.24	22.7	12654
27. Persons per room, 1975	-0.24	26.5	-0.09	13.1	12494

Notes: SES groups 1 and 2 denote fathers in professional or intermediate occupations, respectively. SES 3NM and 3M denote fathers in skilled manual and non-manual occupations. The default group is fathers in semi-skilled and unskilled occupations.
The z-stat reported in the second and fourth columns is the probit regressions equivalent of a t-statistic for an OLS regression with identical critical values.

It can be seen that children with parents in more manual occupations are likely to get less of what is everything that is generally found to be supportive of academic success and more of what is found to be bad. For example, as Haveman and Wolfe (1995) describe, family size and low parental education are almost universally found to be negatively associated with the educational attainment of children. Table 3.8 shows that working-class children in the sample came from larger families with lower levels of

parental education. This is, perhaps, the result of the additional time spent with children by women with degrees observed by Hill and Stafford (1980)[13] although, as discussed above, the quality of time spent might also be important. Genetic inheritance is also a plausible interpretation of this finding. Working-class children are also likely to have lower levels of nutrition and hence birth weight and a greater liklihood of being small relative to gestation period. (Douglas *et al.* (1968) have described the negative effects of low nutrition and poor health on ability at age eight for the 1946 Cohort.) Family breakdown is also more likely as is over-crowding. Again, many previous studies have found associations of poor housing with school age performance. (See, for example, Davie *et al.* (1972), Douglas (1964))

Chapter 4 shows that the interest parents take in their children's education is the major determining factor in their children's educational success, either as a proxy for educational inputs or as a direct determinant. Rows fourteen and fifteen show that parental interest is strongly correlated with social class. The mother's malaise score is an index of psychiatric well-being. Mortimore and Blackstone (1980) summarise evidence that the mother's psychological state is important to the early development of the child. Again, Table 3.8 shows that this factor in educational development works against children with fathers in lower SES groups[14].

Finally, Table 3.8 shows that mothers married to men in the higher SES groups are more likely to postpone employment when children are young. Thus, for this 1970-1980 sample of mothers, working-class mothers were more likely to be working full-time before the child had entered school and less likely to be working part-time, although these associations are not statistically significant. Once the child had started school, top and particularly middle SES mothers were much more likely to be working part-time. Leibowitz (1974) found that the hours mothers spent with their pre-school children was significantly and positively associated with the subsequent IQ of their children. This is by no means, however, an invariant finding. Other researchers, Blau and Grossberg (1990), for example, found smaller effects of mother's labour market status and then only for mothers working in the first year of their child's life. Desai *et al.* (1989) also only found

[13] Hill and Stafford (1980) find that, conditioning on family size, mothers of children under three years old, in the US, with at least some college education spend just over two more hours per week on child care than mothers with less education. In an earlier study (1973) they also find that women from high SES groups spend between two and three times as much time in pre-school child care than lower status mothers.

negative effects for mothers working in the first year of their child's life and then only for boys from high income families. Much depends on the data set chosen, in particular the detail of information about the ways in which children spend time, and the model used. Nonetheless, Table 3.8 clarifies the point that working-class mothers are those most unable to give up time for childcare in the early years of their children's lives.

Clearly, therefore, the raw association with social class masks a number of possible kinds of effect.

3.4. Aspects of class associated with early attainment

A simple approach to the question of what aspects of social class are most strongly associated with early attainment is that of a conditional expectation. No structural model is suggested and no claims of causality are made but the conditional expectation is suggestive of general patterns of association. As Rutter and Madge (1976) point out, although there is substantial evidence that material and social class factors influence the educational performance of children, many of the associations are indirect and the channels are unclear. Thus, although the quality of housing is clearly important in explaining the variance of schooling outcomes, it is entirely plausible that it acts as a proxy for unobserved schooling variables. That criticism is accepted here for all the dependent variables used below. Moreover, it is unclear whether and to what extent, the underlying processes are genetic, material, or psychological. The interest, however, lies in the question of whether these there is segmentation of children by aspects of social class before they have even entered school and which aspects of the observed background appear to dominate.

Table 3.9 reports conditional expectations for attainment in terms of some of the broad aspects of social class shown in Table 3.8. Weighted OLS is used to reduce the importance of over-sampled observations but none of the conclusions described depend on sampling bias, transformations of the data or problems of discreteness or censoring[15].

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[14] Since 24% of mothers scored zero or one on the malaise score, co-efficients of 2 and 0.7 imply quite large movements along the distribution of psychiatric well-being. They are also highly significant.

[15] If variation in the control group is higher than for the fetally undernourished groups then parameter estimates based on the latter groups might be biased downwards but the pattern of results described below changes very little if only control group observations are used. Inferences are also unchanged if the rank score dependent variable is replaced by the continuous test score variables using tobit regression to correct for some evident lower censoring which might also have caused downward bias.

For the reported regressions, observations were grouped across genders but separate regressions were also run. In those cases where the pattern was significantly altered, this is discussed in the text and footnotes.

Table 3.9: *Conditional expectation - Test ranks regressed on background variables*

	22 months		42 months		5 years		10 years	
	Est.	t	Est.	t	Est.	t	Est.	t
Rank at 42 months					0.39	13.3		
Rank at 60 months							0.40	41.6
Girl=1	5.9	4.1	7.8	3.9	-0.5	0.3	-1.9	3.7
One non-UK parent	-5.5	1.7	-6.3	1.4	-1.7	0.4	-4.9	4.1
Mother educ > min.	0.6	0.3	3.1	1.3	1.9	0.9	7.3	11.5
Mother degree	12.4	2.3	13.3	2.1	6.4	1.2	6.1	3.6
Mother's age	0.3	1.6	0.4	1.4	0.0	0.0	0.3	4.8
Father educ. > min.	0.4	0.2	8.3	3.4	1.4	0.7	5.3	7.8
Father's degree	3.9	1.6	0.4	0.1	3.1	1.0	4.2	4.6
Father's age	0.0	0.4	0.0	0.0	-0.1	0.7	0.0	0.5
Father's SES=1,2	2.1	0.9	8.1	2.4	5.7	1.8	8.1	9.4
Father's SES=3M,3NM	-1.5	0.8	6.9	2.5	1.0	0.4	3.3	4.7
No. of older sibs.	-2.8	4.2	-4.6	4.4	0.7	0.8	-3.7	12.2
No. of younger sibs			-2.3	1.2	-2.1	1.3	-1.4	4.0
constant	-8.9	0.5	-126.1	3.8	32.3	5.6	23.2	12.2
obs		1628		835		900		7496
R^2		0.06		0.14		0.23		0.36

Notes: Observations are re-weighted by the formula $w_2=w*w_1$ where w_1 and w_2 are the weights of randomly sampled and over-sampled observations and w is the ratio of observations in the sub-sample as a whole to the full BCS sample at birth, 0.143. The number of observations is maintained at the level of unweighted OLS by the formula $n_1w_1+n_2w_2 = n_r$ where n_1 and n_2 are the numbers of randomly sampled and over-sampled observations in the regression at each age and n_r is the number of observations in the unweighted OLS regression. Controls for reason for inclusion in the sub-sample and precise age when test was taken are also included but not reported here.

Table 3.9 shows that, conditioning for parental education and family structure, significant raw differences between children classified by their father's occupation do not emerge until 42 months. At 22 months, family size is important and girls do much better than boys but the largest association is with mother's having a degree. Children of mothers with degrees are more than 12 percentage points higher up the distribution of scores than those without. Interestingly, for boys taken separately, this figure is 21 percentage points (standard error: 7, significant at 1%), whereas for girls the advantage at 22 months of a mother with a degree is only 3.1 (standard error: 8.4)!

At 42 months, the association with mother's education is still much the strongest but associations with other variables have also become stronger, in particular the SES variables and the father's education. The mother's education is again particularly

important but even controlling for education and family size, children in the lowest SES groups are already falling behind children in other SES groups in terms of the development of educational ability[16].

Between 42 months and five years there is no evident catch-up for children from less-educated families but their relative decline is halted. Boys also catch-up a little with girls but children from higher SES groups accelerate away between these ages, particularly those from families with professional fathers. Then between five and ten years, the education of parents, occupational category and family size all play a large role in further segregating children into ability groups. These results also hold across genders. Thus, school entry does appear to temporarily slow the effects of advantages accruing to children from more highly educated families but occupational status becomes more important, perhaps because of peer groups or other aspects of school quality. In any case, this slowing of parental education effects appears to be temporary.

Although the significance of parameter estimates at 22 months is lower than that observed at 42 months, the pattern of results is the same. These effects then persist to five and ten years, even conditioning on lagged dependent variables. The important features of the child's environment, therefore, begin to have effects early on but these are compounded throughout childhood, driving educational inequality between children.

Table 3.9 considered attainment in terms of broad aspects of social class but a number of finer measures are also available in the BCS, proxies for social exclusion, nutrition, attitudes and maternal working patterns. Table 3.10 reports the associations of rank positions with these variables at each age, conditioning on the variables in Table 3.9. Because not all information was requested in the sub-sample surveys, some of these variables are only available when the children were age five or ten. The measurement error implicit in the assumption that, for example, families without telephones in 1975 were also without telephones in 1972 or 1973 will bias regression coefficients towards zero, strengthening interpretation of observed significance levels.

[16] There are three significant gender differences at 42 months. Mother's age predicts the rank of girls while being insignificant to that of boys. Membership of the top social class by father's occupation is more important to boys than to girls. For boys the coefficient is 14.0 (standard error: 4.7), for girls it is 1.8 (standard error: 5.2). Finally, each younger sibling loses boys 5.1 percentage points (standard error: 2.6) while the coefficients for girls is positive though insignificant at 10%. The generally larger coefficients for boys can be partly explained by the fact that there are substantially more girls than boys in the top of the distribution.

Table 3.10: *Conditional expectation including further indices of social exclusion, conditioning on background variables in Table 3.10.*

	22 months		42 months		5 years		10 years	
	Est.	t	Est.	t	Est.	t	Est.	t
Telephone, 1975	3.4	2.0	5.1	2.2	5.8	2.5	2.7	3.0
Persons per room, current	-6.0	1.7	-14.5	3.1	0.3	0.1	-0.7	0.5
Father unemployed, current	-4.4	1.2	-0.4	0.0	-0.9	0.1	-4.2	1.9
Mother works full-time, current	0.7	0.1	-9.9	1.7	0.4	0.1	0.1	0.1
Mother works part-time, current	1.7	0.7	-0.3	0.1	0.5	0.2	0.4	0.4
Mother's Malaise Score, 1975	-0.1	0.5	-0.8	2.6	-0.7	2.1	-0.4	3.5
Height, current	0.3	1.7	0.6	2.7	0.7	3.8	0.4	5.4
obs	1433		760		581		3225	
R^2	0.06		0.18		0.27		0.37	

Notes: Reweighting as described in notes to Table 3.9. Lagged dependent variables and background variables also as Table 3.9.

57% of the children in the full sample lived in households with a telephone in 1975. Table 3.10 shows that children in families without a telephone were already lower in the distribution of development than other children by 22 months and that this effect was exacerbated in later years. Over-crowding was also associated with a steadily worsening position. Fathers' unemployment was important between five and ten years[17]. Machin and Gregg (1997) found that NCDS children had significantly worse school attendence records at age 16 if their father had been unemployed at age seven. This finding shows that at least part of this association lies in early effects on educational performance. Nutrition, as proxied by height at each age is also clearly important. An extra half a standard deviation of 42 month height (2.4cm) is worth one and a half points advancement in the distribution of scores.

There is no strong association with mothers' labour market activity, except, perhaps, at 42 months where this is a strong negative effect of full-time employment at the margins of significance, though this may, of course, be a selection effect[18].

[17] There is not a large negative unemployment effect at five years but this is, perhaps, due to the fact that unemployment was not directly observed in the age five data but has been inferred from answers to more general questions about unemployment during the year.

[18] Of the 77 mothers with degrees in the sub-sample, none were working full-time when the sub-sample children were 42 months. This negative association of development rank with full-time work may, therefore, be due to unobserved factors associated with the need to work full-time. It is interesting to note that there was a strong gender difference found in relation to the association with mother's labour force status. The coefficient for boys was 0.8 (standard error: 7.0) but that for girls was -37.9 (s.e.: 10.9).

More important than whether mothers were working or not, is how happy they are. At 42 months, a Malaise Score of 10 points, indicating likely psychiatric problems for the mother, was associated with a 8 percentage point reduction in the child's rank. This association is not restricted to the early developmental tests but can be seen to continue to weaken performance in the more academic, later scores.

The picture that emerges from these regressions is that pre-school attainment is clearly associated with family background in terms of housing, social exclusion, the mental health of the mother, parental education and, at 42 months, time poverty. All of these factors influence the position of children in the distribution of tested ability before they have entered school, some even at 22 months.

3.4.1. The association of income with early attainment

So far nothing has been said about income yet income is clearly central to household production, presumably being an important cause of many of the differences between children in terms of housing, nutrition, health and time constraints. Unfortunately household income was only requested in the age ten sweep of the BCS. However, information about possession of consumer durables was requested at age five and at age ten, together with tenure and other housing variables. basic statistics for which are shown in Appendix Table A3.3. Using this information, observed at both ages, it is possible to construct a prediction for income at age five. This can be thought of as a general consumption index. Under permanent income conditions, one would expect income at ten to represent a reasonable proxy for income at any other age of the child. The additional gain of predicting income at five is that no permanent income assumption need be made and that advantage can be taken of the additional household information. The results of the forecast equation are also reported in Appendix Table A3.3.

If the labour force participation decision of mothers is similar for pre-school and age five children and fathers' incomes are assumed to be constant, then household income is stable between these years. The age five income forecast could, therefore, also be included, with some measurement error, in the conditional expectations at 22 and 42 months. It has already been shown that the probabilities of mothers with degrees working full-time were similar at 22 months, 42 months and five years and that the big increase in participation came subsequently. Table 3.11 reports the probabilities of mothers working

at different ages of the BCS children. It can be seen that the big expansion of working came after the children were five years old.

Table 3.11: *Mothers' labour force probabilities*

	Full-time	Part-time	Any hours	Observations
22 months	0.03 (0.003)	0.13 (0.007)	0.16 (0.008)	2413
42 months	0.04 (0.004)	0.23 (0.009)	0.27 (0.009)	2275
5 years	0.07 (0.002)	0.34 (0.004)	0.40 (0.004)	13062
10 years	0.20 (0.004)	0.43 (0.004)	0.64 (0.004)	13001

Notes: Standard errors in brackets.

Table 3.12 provides an answer to the descriptive question of whether children from higher income groups were advanced in the distribution of scores at each age, conditioning on the variables in Table 3.9.

Table 3.12: *Test ranks regressed on household income, conditioning on other background variables.*

	household income forecast		household income	
	Est.	t	Est.	t
22 months	0.02	0.6		
42 months	0.11	2.8		
5 years	0.12	3.8		
10 years			0.03	4.8

Notes: Weighting as described in notes to Table 3.9

Observed household income is positive and significant at 1% for the movement along the ability distribution between the ages of five and ten. A hundred pound increase in household income is associated with a movement of three percentage points. The association is strongly significant but weak in magnitude. However, coefficients are larger for the income forecast at 42 months and five years. This is presumably associated with the fact, observed in the profiles of Figures 3.1-3.4, that the decline of children in the bottom SES group relative to those in the middle group is halted. The strongest effects of income are, perhaps surprisingly, in the pre-school years. Income does not dominate the effects of the social class variables already observed to be important but does appear to provide an additional explanation of variance.

3.5. Conclusions to Chapter 3

The first empirical question addressed in this chapter is whether or not early measures of ability are correlated with later ability and qualifications. Clear differences have been shown in the educational performance of children from different social groups before they enter school. Although this result is far from being novel, the chapter has shown that these early differences are not greatly off-set by the schooling system in the UK. These early differences are shown to influence ultimate schooling outcomes but the chapter has also shown that when children enter school, the weakening position of children in less educated or lower SES families is, at least, halted. This suggests that schooling institutions are capable of influencing developmental trajecteries.

Given that early ability does forecast economic outcomes, the second question is; what determines early ability? The chapter finds that the primary source of differences in early development is the education of the child's mother, presumably as the primary carer. Other factors such as family size, father's social class, income, nutrition, housing and maternal well-being have also been shown to be important but the implication of the strong mother's degree and well-being effects is that parenting skills are crucial, particularly in the early years. This finding raises the policy question of whether or Government-led interventions can reduce educational inequality.

The traditional intervention is through investments in pre-school institutions. Chapter 2, however, provides evidence that once selection issues are confronted, pre-school institutions such as nursery schools might have negative effects on educational development, perhaps because of excessive class sizes. This was found to be true for children of all broad social groups so that investment in extra-familial institutions will possibly not reduce inequality and might just lessen the mean level of development. It is clearly crucial that additional resources are spent on improving the quality of pre-school provision so that interactions with adults are maintained and the early effects of poor peer groups are addressed.

Investments in families might well be more productive. The £540 million of the Sure-Start programme will primarily be devoted to bringing together child-care organisations so that communities have access to organised and co-ordinated systems of support. Professionals and carers are provided with evidence-based guidance about practice. The evidence of this chapter is that this expenditure can reduce early inequalities

if the actual programmes can provide children from dis-advantaged families with the kind of interactions that are the every-day experiences of children from richer and more educated families. The programme is a clear and positive attempt to reduce the process of inter-generational disadvantage. It is also necessarily experimental and it is welcome that the DfEE places such a high emphasis on evaluation. The Guidance to local areas applying for Sure-Start funding states that Sure-Start "will learn from what works and spread good practice[19]." This is also to be welcomed but there is still much to learn.

It is to be hoped that evaluation programmes attempt to control for the importance of parental education in dis-advantage and so consider how different specific interventions take account of different levels of parental education. Moreover, to the extent that it is the children of interested parents who will benefit from the possibilities facilitated by Sure-Start, evaluation will also face a selection problem. It is shown in Chapter 4 that children of parents who take an interest in their education are much more likely to do well at school. In these data, of the at risk group of 124 children in the lowest quartile of the development index at 42 months, 24 had mothers who showed little or no interest in their children's schooling as assessed by teachers when the children were ten years old. Of these 24 children, only 2 (8%) went on to achieve A'Levels or higher. On the other hand, of the 98 whose parents showed some or high interest in education, 30 (31%) went on to get A'Levels or above. To the extent that parents choose to participate in Sure-Start programmes, the raw results of the programme will look a lot better than they would if the selection issue was controlled for.

The non-coverage of those who do not choose to get involved in programmes or do so only indirectly will clearly be a concern. It is also important to note that Sure-Start is an area-based intervention and will, therefore, completely miss those families that happen to live outside targetted areas and are, therefore, excluded from social exclusion programmes. This suggests that, as well as through Sure-Start, such skills should be taught at school, rather than waiting until the period of compulsory schooling is over.

Finally, although parenting skills are important, it is not yet known how well they can be taught. Research summarised by Waldfogel (1999) suggests that there is considerable room for optimism about intervention programmes but this is based on US research and little is yet known about interventions in the context of UK inequality. It

[19] DfEE, *op.cit.*

must also be recognised that the material aspects of dis-advantage also have strong effects on educational inequality. Investments in human capital to diminish future inequality cannot ignore the contributions of low incomes, unemployment, bad housing and poor health to educational inequality. Despite these concerns, the chapter has provided evidence that the investment of additional time and resources in supporting the development of pre-school children is not simply a cheap cover for the failure of Governments to increase direct income redistribution but could provide large potential benefits if interventions can, as proponents believe, genuinely intervene in the production of pre-school ability.

3.6. Data Appendix to Chapter 3

Appendix Table A3.1: *Tests undertaken by CHES, with Correlation Matrices*

22 Month											
Cube stacking	1.00										
Language use	0.27	1.00									
Personal development I	0.34	0.46	1.00								
Personal development II	0.20	0.29	0.31	1.00							
Drawing	0.31	0.22	0.30	0.25	1.00						
Gross Locomotor	0.19	0.31	0.27	0.32	0.27	1.00					
42 Month											
Counting	1.00										
Speaking	0.40	1.00									
Copying designs I	0.35	0.31	1.00								
Copying designs II	0.28	0.19	0.38	1.00							
Building	0.30	0.26	0.35	0.19	1.00						
Cube stacking	0.16	0.16	0.17	0.08	0.34	1.00					
Picture test I	0.26	0.43	0.23	0.11	0.29	0.26	1.00				
Picture test II	0.35	0.50	0.33	0.19	0.34	0.24	0.57	1.00			
Line drawing	0.25	0.31	0.26	0.11	0.29	0.19	0.27	0.38	1.00		
Gross Locomotor	0.22	0.32	0.24	0.11	0.22	0.15	0.24	0.29	0.19	1.00	
Parts of the body	0.26	0.48	0.27	0.14	0.28	0.26	0.43	0.48	0.29	0.35	1.00
5 Year											
Copying designs	1.00										
Vocabulary	0.30	1.00									
Human Figure Drawing I	0.39	0.22	1.00								
Human Figure Drawing II	0.39	0.22	0.81	1.00							
Profile drawing	0.20	0.19	0.23	0.23	1.00						
10 Year											
Reading	1.00										
Maths	0.49	1.00									
Picture language test	0.53	0.34	1.00								
British Ability Scales	0.74	0.48	0.57	1.00							

Notes: Two Human Figure Drawing tests are reported here for the children at age five. These are both based on the same test but weighted by different procedures developed in the educational literature (Koppitz, 1968 and Harris, 1963). The HFD score used in the text is the average of these two different measures of HFD This avoids the need for assumptions about which weighting procedure is preferable. The correlation between the two scores is, in any case, 0.81, perhaps too high for separate entry in the principal components analysis.

Appendix Table A3.2: *Basic statistics for background information*

	Obs	Mean	S.d.	Min	Max
Mother educ>min	13064	0.32	0.47	0	1
Father educ>min	12961	0.32	0.47	0	1
Mother's age	17543	25.99	5.55	14	53
No. of older sibs, 1970	17196	1.17	1.40	0	17
No. of younger sibs, 1973	2277	0.39	0.56	0	3
No. of younger sibs, 1975	13135	0.52	0.64	0	5
No. of younger sibs, 1980	10890	1.62	0.92	0	12
Weight at birth, 1970, kg *	16961	3.29	0.53	1.0	6.5
Weight , 1972, kilos	2348	11.92	1.56	6.4	20.4
Weight , 1973, kilos	2193	15.04	2.01	8.3	28.0
Height , 1975, cm	12892	108.74	5.25	84	130
Height , 1980, cm *	6718	137.77	6.54	50	150
Multiple birth	2457	0.09	0.29	0	1
Postmature birth	2457	0.30	0.46	0	1
Small for dates	2457	0.23	0.42	0	1
Mother's interest in ed., 1980	12771	2.04	1.12	0	3
Father's interest in ed., 1980	12917	1.36	1.34	0	3
Mother full-time, 1972	2434	0.03	0.18	0	1
Mother full-time, 1973	2292	0.04	0.20	0	1
Mother full-time, 1975	13135	0.07	0.25	0	1
Mother full-time, 1980	13089	0.20	0.40	0	1
Mother part-time, 1972	2434	0.13	0.34	0	1
Mother part-time, 1973	2292	0.22	0.42	0	1
Mother part-time, 1975	13135	0.34	0.47	0	1
Mother part-time, 1980	13089	0.43	0.50	0	1
Mother's Malaise score (0-23), 1975	12975	4.38	3.68	0	23
Lone mother, 1975	13135	0.05	0.22	0	1
Lone mother, 1980	13871	0.07	0.26	0	1
Persons per room, 1975	12943	0.90	0.33	0.1	6
Father unemployed, 1972	2345	0.08	0.27	0	1
Father unemployed, 1973	2186	0.03	0.16	0	1
Father unemployed, 1975	8504	0.02	0.15	0	1
Father unemployed, 1980	12640	0.06	0.24	0	1

Appendix Table A3.3: ***Basic statistics for income forecast variables with coefficients for forecast equation.***

	Obs	Mean	S.d.	Min	Max	Est.	t-stat
Household income , 1980	12459	128.7	64.5	18	300		
Forecast income, 1975	12526	69.9	31.7	-14.4	114.5		
Fridge, 1975	15490	0.78	0.41	0	1		
Washer, 1975	15490	0.76	0.43	0	1		
Drier, 1975	15490	0.69	0.46	0	1		
Car, 1975	15490	0.59	0.49	0	1		
Telephone, 1975	15490	0.49	0.50	0	1		
Owner-occupier, 1975	13094	0.13	0.34	0	1		
Mortgaged property, 1975	13094	0.43	0.50	0	1		
Council rented, 1975	13094	0.32	0.47	0	1		
privately rented, 1975	13094	0.06	0.24	0	1		
Own kitchen, 1975	12922	0.99	0.09	0	1		
Own kitchen > 6 sq. ft. , 1975	15209	0.70	0.46	0	1		
Own bathroom, 1975	12929	0.96	0.19	0	1		
Fridge, 1980	15520	0.86	0.35	0	1	-6.4	(1.9)
Washer, 1980	15520	0.82	0.38	0	1	8.5	(3.7)
Drier, 1980	15520	0.71	0.46	0	1	2.3	(1.7)
Car, 1980	15520	0.65	0.48	0	1	29.1	(21.8)
Telephone, 1980	15520	0.70	0.46	0	1	18.2	(12.7)
Owner-occupier, 1980	13609	0.11	0.32	0	1	5.9	(1.8)
Mortgaged property, 1980	13609	0.50	0.50	0	1	27.4	(9.3)
Council rented, 1980	13609	0.32	0.47	0	1	-10.9	(3.6)
privately rented, 1980	13609	0.03	0.18	0	1	-6.7	(1.7)
Own kitchen, 1980	13608	1.00	0.04	0	1	3.0	(0.2)
Own kitchen > 6 sq. ft. , 1980	13647	0.95	0.21	0	1	11.2	(4.5)
Own bathroom, 1980	13643	0.99	0.09	0	1	14.8	(2.2)
Constant						50.7	(3.6)
Obs						12278	
R^2						0.22	

Chapter 4. Attainment in Secondary School

4.1. Introduction

Chapters 2 and 3 have considered the importance of different inputs to the learning process in the early years of childhood. Parental education, particularly that of the mother, is seen to be very strongly associated with the development of pre-school ability. Perhaps because of excessive numbers of children per carer, pre-schools do not appear to have been successful in substituting for parental time in the 1970s in the UK. Chapter 4 now looks at the relative importance of different inputs to education for children in later years of childhood into adolescence.

This chapter estimates an education production function to test the importance of parental, peer group and conventional school inputs for educational improvement in secondary school. The analysis is in the tradition of the Coleman Report (Coleman *et al.*, 1966) and our aim is to quantify the effects of changes in these variables. The novelty of the chapter lies in its successful handling of the endogeneity of the inputs, in the British context. We also have good measures of inputs to household production which enable us to rank the importance of family, schooling and peer group. Inputs vary in the extent to which they can be changed by educational policy and it is important to consider the relative effects on attainment of variables which differ in their susceptibility to policy change.

The data we consider record teachers' impressions of the interest parents take in the education of their children. This variable has, in the past, been found to be very strongly associated with educational attainment of children. Both Douglas (1964) and Plowden (1967) find that parental interest dominates other social class factors. We believe it is reasonable to interpret this as a good proxy for active parental involvement. We find, for example, that it is positively correlated with such measures of active parental involvement as reading to children. Unlike Douglas and Plowden, however, we are able to deal with the potential endogeneity of parental interest and consider the direction of bias.

We discuss endogeneity in some detail below. Essentially, the estimation of production functions is complicated by the fact that the explanators are usually choice variables and thus endogenous. We employ indicators of location as instruments. We shall see that in most cases these instruments are quite well correlated with the potentially endogenous variables as well as being orthogonal to equation error. As discussed in

Chapter 2, recent econometric literature (e.g. Staiger and Stock, 1997) has emphasised the biases that can arise with instruments that are only moderately correlated with endogenous variables. As in Chapter 2 we investigate the properties of our estimators by Monte Carlo simulation.

The data considered are provided by the NCDS. Sample children entered secondary education in 1969 when the education system in the UK was undergoing considerable change. Selection by examination, formerly widespread, had been extensively replaced by non-selective comprehensive schools (see Table 4.1). Clearly, choices of schools by parents render peer groups endogenous, but this is compounded when schools choose children by examination. To some extent, this is evaded by controlling for early attainment.

In the next section we describe the theoretical framework and introduce the variables used to describe inputs and outputs. We present results in Section 4.3.

4.2. Theoretical Framework

The theoretical concept underlying our analysis is the educational production function. Attainment is generated by family inputs, conventional schooling inputs and peer group inputs. We follow Hanushek (1992) in writing

$$A_t = \phi(A_{t-1}, F_t, S_t, P_t) \qquad (1)$$

where A_t denotes attainment at date t, F_t refers to family inputs during period t, S_t denotes schooling inputs and P_t denotes peer group effects. One can think of this as a value-added formulation: the inputs at t act on initial attainment A_{t-1} to produce attainment at t.

It is possible to argue for the endogeneity of nearly all right hand side variables in socio-economic analysis of the kind conducted here. As stated above, as a production function, (1) is subject to bias. This arises from correlation between observed and unobserved inputs. Measurement error is another source of bias, typically in the opposite direction. In practice, however, the scarcity of instruments limits the amount of endogeneity that can be handled. Here, we introduce our variables and consider the

endogenity of the explanators. Subsequently we discuss our choice of instruments and consider the implications for inference.

4.2.1. Measures of attainment

The dependent variables in the analysis are reading and mathematics ability at 16 as well as an index of overall exam performance in all subjects. The NCDS administered tests in both reading and maths. We use the NCDS mathematics score at 16 as our measure of attainment. We found, however, low discriminatory power in the reading test: about one third of the population scored in the top seventh of the reading scale. Robertson and Symons (1996) encountered a similar problem in analysis of the tests at age 7. As our measure of attainment in reading, we use an index of highest grade attained in national examinations in English at any time (up to age 21).[1]

We construct a value-added model using NCDS scores of reading and maths at age 11 as lagged dependent variables in the English and maths regressions. Ideally, the lagged dependent variable is true attainment at age 11. Since a test score inevitably contains measurement error (with respect to true attainment) some instrumentation is required.[2] For the dependent variables, pure measurement error does not bias parameter estimates. Our third dependent variable, All Exams, is less subject to measurement error as it is not the outcome of a single test but, rather, an index of actual qualifications attained. It is, therefore, an overall measure of success in the education system.

4.2.2. Measures of parental inputs

We concentrate first on parental inputs, which are commonly found to be immensely significant in determining attainment and have been shown to be so at earlier ages in Chapters 2 and 3. (See Haveman & Wolfe (1995) for a comprehensive discussion.) As the earlier chapters have shown, there are a number of channels for parents to influence their children's educational performance and these are briefly reviewed here. They have often been classified as measures of the amount of time devoted

[1] The All Exams and English indices are discrete variables, having 12 and 8 categories respectively. The discrete nature of the dependent variable may raise some doubts about the properties of the residuals but experiments with ordered probit regression indicate that this is not a problem. For ease of interpretation we have scaled all dependent variables to lie between zero and one hundred. The standard logarithmic transformation to map these scores into $(-\infty, \infty)$ is unavailable because some candidates score 0 or 100.

[2] The SSRU Cohort Studies User Support Group has provided us with estimates of reliability coefficients of these tests. For maths and reading they find 0.94 and 0.82 respectively at 11 and 0.85 and 0.86 at 16.

to children and measures of the educational quality of that time. Hanushek (1992) finds that attainment decreases with family size and explains this using Becker's theory of time allocation within the family (Becker, 1991). As Haveman and Wolfe highlight, it is also generally found that children of parents with high levels of schooling perform better than children with less educated parents. This might be due to the transmission of genetic endowments or to environmental factors such as the higher educational quality of the time of educated or able parents. It is also normally found that children from higher social classes perform better but the channels for this effect remain somewhat uncertain. Again, productivity, income and culture are all possible sources for this.

The NCDS has recorded teachers' impressions of the interest parents take in the progress of their children at ages 7, 11 and 16, available separately for mothers and fathers. One pleasant feature of the parental interest variable is that it seems likely to be correlated with parental time spent with the child, a more conventional economic input to a production function. Hanushek(1992) makes an important distinction between 'public' and 'private' time of parents. Public time refers to the establishment within the household of a common environment comprised of attitudes towards learning, ambition, morality, language, etc.. Private time refers to active parental involvement with the education of specific children, correcting homework, for example. As noted above it seems plausible that the parental interest variable reflects both of these factors. Neither of them can be easily changed by public policy. The Plowden (1967) survey of 3,000 children in 187 British primary schools concluded that lack of parental interest was the main reason some children fail at primary school and recommended policies to increase parental interest in education. This variable, however, appears to be hard to change.

Moreover, as Acland (1980) and Plowden observed, parental interest is likely to be endogenous. Parents may show high levels of interest in children who do exceptionally well at school: for example, they might regularly attend parent teacher evenings to bask in reflected glory. On the other hand parents of children who do unexpectedly badly might attend PTA meetings to see what can be done to improve their child's performance. Thus endogeneity bias can go either way.[3] We find below, in fact, that it is probably negative.

[3] An additional endogeneity bias might be induced if unobserved teacher input to the child responds to parental interest. This could go either way: teachers might work to offset low interest or, more likely, respond positively to parental pressure.

In our empirical work, we experimented with the inclusion of mother's labour force status, finding no significant effects. In principle, working women have less time to spend on their children. Robertson and Symons (1996) find in NCDS data that, while the children of working women have lower attainment at 7, the increase in attainment between 7 and 11 is unaffected by the mother's labour force status. Similar results are shown in Chapter 2 for ten and eleven year old children. *A fortiori,* one expects to find no effect between 11 and 16. Hill and Stafford's (1980) time diary study finds that the reduction in time devoted to adolescent children by working women is quite modest.

4.2.3. Measures of peer group inputs

The Coleman Report emphasises the importance of a child's peer group for attainment but these findings have been controversial. See Smith (1972), Averch (1972) and Hanushek (1971, 1972) for the early response to Coleman. More recently Summers and Wolfe (1977) and Henderson *et al.* (1978) have found positive peer group effects as have Robertson and Symons (1996). In other contexts peer group effects have been found to be important in teenage pregnancy and school drop-out behaviour (Evans *et al.*, 1992). Educational theory provides support for peer group effects. For example Foot *et al.* (1990) stress the importance of strengthening teaching interactions between children.

The precise nature of the functional form of the peer group variable is important because, with diminishing returns, system-wide average attainment is increased by mixing children, increasing returns having the opposite result.[4] Robertson and Symons (1997) found some weak evidence of diminishing returns for primary school children. Henderson *et al.* (1978) report stronger evidence of diminishing returns, in a more homogenous sample. In the sociological literature, Crane (1991) has emphasised the existence of epidemic effects whereby the deterioration of peer groups beyond a critical threshold leads to a dramatic decline in the probability of outcomes such as staying on at school. We experiment with including a quadratic term in the model.

Evans *et al.* consider the endogeneity of peer groups, finding that OLS estimation of peer group effects is positively biased due to selection of peer groups by parents, in their case, choice of location. More generally, endogeneity problems arise from choices by

[4] A property of linear models where the effect of peer group is represented, as here, by averages, is that there is no effect on average attainment of any re-allocation of any children between peer groups: all effects cancel out.

parents and choices by schools. In the first place, ambitious parents will tend to choose good peer groups for their children as well as helping them in other unobserved ways, perhaps not captured by the parental interest variables. Secondly, if some schools are better than others in ways observed by parents but not by the NCDS, these schools will have positive control over their selection intake. The peer group effect will then be conflated with the unobserved school quality. One strength of the NCDS data is that the inclusion of parental interest can eliminate much of this bias if it captures a large part of otherwise unobserved parental input.

The NCDS has a number of measures of peer group at age 16. Four were used in this study: the proportion of children in the class with fathers in non-manual occupations, the proportion of children in the class only taking GCE examinations, the proportion of children in the class only taking CSE examinations and the proportion of children from the previous year's class who stayed on in education after the then minimum leaving age of 15. We constructed a single peer group index as the simple average of these variables (the CSE proportion entering negatively). The index was scaled to range between 0 and 1. An alternative procedure[5] is to take the first principle component from these four variables. We found however that, for the new variable, the weights on the four measures stood in the ratio 1 : 1.1 : 0.9 : 0.9 with a correlation between the two variables of 0.97. In view of this, we persisted with the simple average.

We classify school type (grammar, comprehensive, secondary modern, private) as a peer group input. Clearly, there might be differences between school types in terms of such unobserved factors as teacher quality, curriculum and school facilities. Secondary moderns, for example, were intended to meet the educational and future occupational requirements of less academically able children. We expect these children to do less well in exams, partly reflecting the lower expectations and perhaps motivation of teachers in these schools as well as curriculum differences. In large part, however, these institutional differences ultimately reflect differences in the intake of schools. Moreover, since entrance to grammar schools and secondary moderns (unlike comprehensives) was based on selection by examination at 11, these schools do provide homogenous intellectual peer groups.

[5] Suggested by a referee.

Table 4.1 shows the proportion of cohort members in different school types. In 1974, at age 16, 59% of the NCDS cohort members attended comprehensive schools. We exclude children who attended special schools from the empirical analysis.

Table 4.1: *School type and streaming*

			% streamed		*Mean peer*
	No	*%*	*English*	*Maths*	*group index*
Comprehensive	7454	58.5	75.5	83.3	0.45
Grammar	1347	10.6	50.4	82.0	0.81
Secondary Modern	2738	21.5	68.7	77.0	0.32
Private	764	6.0	49.2	77.9	0.89
Special	446	3.5	28.3	30.0	0.44
Total	12749	100			

As well as school type itself, ability groups within schools also create peer group effects. Table 4.1 shows that streaming was much more common in comprehensive schools than elsewhere. A pupil in a high stream receives good peer group effects as well as advanced instruction. These advantages are to some extent controlled for in our analysis by the peer group variable itself but we do include dummy variables for the pupil's stream. These variables will be endogenous if pupils who show unexpected development between 11 and 16 tend to be allocated to a high stream.

Table 4.1 also shows the strong differences in intake between school types. On average, the index in grammar schools and private schools is nearly twice that in comprehensives.

Another form of peer group is provided by the child's non-school environment. Previous studies have been unable to differentiate neighbourhood effects from school peer group effects and Crane (1991) suggests the term 'social context effect' to describe the overall influence of combined peer group and neighbourhood effects. We experimented with such variables as local unemployment rate, the proportion of unskilled manual workers, the proportion living in council housing, and the proportion of immigrants both at the level of the Local Authority (average population of the order of 300,000) and at the level of the OPCS Enumeration District (average population 460).

4.2.4. Measures of schooling inputs

Variables such as class size and teacher experience are usually found to have little effect on attainment. Hanushek (1986) provides an extensive discussion of this evidence. Some recent studies have found more positive evidence. Card and Kreuger (1992) showed that the returns to education across states in the US are correlated with state-wide educational expenditure. The STAR experiment in Tennessee shows significant benefits of smaller classes but these seem to occur only for fairly dramatic reductions in class size and mainly in the first year. (See Blatchford and Mortimore (1994) for a discussion of this in the UK context.)

The difficulty of finding an effect of class size on attainment is curious at first glance. It is popularly believed that children perform better in small classes and if pushy parents choose schools with low class sizes as well as fostering development in unobserved ways, apparently significant correlations should be easy to find. The problem appears to be that schools tend to put children who are performing badly in smaller classes. For example top streams in the NCDS are significantly larger than bottom streams. Akerheilm (1995) uses the average subject-specific class-size in a given school and school size itself as instruments for class-size, finding correctly signed but relatively small effects. Such instruments deal with endogeneity arising from allocation of children to classes by schools but are not proof against choice of schools by parents. In any case, this information is not available in our data.

To some extent this endogeneity problem can be reduced by using the pupil-teacher ratio as a general measure of the school's endowment of teachers. This variable has the added advantage that children in secondary school attend different classes. Moreover, we are considering improvement over a number of years during which class size will change. Again, however, it is usually found (Darlington and Cullen, 1982) that the pupil-teacher ratio itself is wrongly signed in attainment regressions. The reason is perhaps analogous to the placement of less able children in small classes within given schools: it may be that schools in deprived areas seek or are given low pupil-teacher ratios, reflecting their particular teaching and disciplinary needs. Thus the Ofsted Report (1995) finds that Local Education Authorities in inner-urban schools in the UK tend to have lower pupil-teacher ratios than other schools. This problem is to some extent offset by controlling for social class and peer groups but in any case, we shall experiment with instrumentation.

4.2.5. Instrumentation

The discussion of the inputs above has highlighted the potential endogeneity of a number of variables. We will focus on measurement error in the lagged dependent variable and reverse causality in the parental interest and peer group variables, including school type. Finally we instrument the pupil-teacher ratio because it is a choice variable for parents and schools.

To deal with the measurement error in early attainment we instrument attainment at 11 using teachers' assessments of children's abilities, as reported in the NCDS. Additionally, in the maths equation the lagged reading score enters the instrument set and *vice versa*. The use of primary school teachers' assessments of the child at age 11 as instruments is open to the objection that teachers might have better knowledge of a child's future attainment than is revealed by the test at 11. This would invalidate use of the assessments as instruments. However, the assessments used are not those of teachers responsible for stream allocation and may have no further relevance to that decision once score at eleven is controlled for. In any case, a Sargan test (Sargan, 1988) of the orthogonality between instruments and equation error can assess whether this is a problem.

To instrument average parental interest between 11 and 16 we use mothers' and fathers' interest at 7. The use of instruments depends on the source of endogeneity bias believed to be important. Here we attempt to deal with current parental interest changing in response to a child's unexpected performance, for given attainment at 11. Unexpected improvement is likely to be fairly orthogonal to interest at 7, while a high degree of persistence of interest is also likely.

Local Authority dummies are used to instrument for peer groups and the pupil-teacher ratio. This requires some discussion. Again, the appropriateness of instruments is related to the source of potential endogeneity. We consider here the peer group variables, though very similar remarks could be made about the pupil-teacher ratio.[6] If, as argued above, ambitious parents choose good peer groups for their children as well as helping them in other ways, then the peer group parameter will be biased upwards when peer group is treated as exogenous. The question then is whether especially ambitious parents are likely to be clustered in certain areas: if so geographical variables are inappropriate as

[6] See Ehrenberg and Brewer (1994) for a previous example of the use of locational measures as instruments for school characteristics.

instruments. However, since we control for social class, parental interest and education, the question becomes whether a family of given social class, parental interest and education is likely to be more ambitious for its children in Wandsworth, say, than in Clapham. This seems unlikely. Robertson and Symons (1996) find that the search for better schools is not a significant determinant of migration between regions and conclude that location effects are not an important source of bias. We work at a finer level of disaggregation but, in any case, the Sargan methodology offers a test of instruments.

As stated above, endogeneity can also arise because of the choices of schools: if certain schools are good in ways observed by parents but unobserved in our data (for example, because of a good headmistress) these schools may 'cream' the best students. This means that the peer group effect is conflated with the unobserved school quality. The question is then whether such unobserved quality, unrelated to observable school type and peer group, is correlated with Local Authority area. We do not find this compelling.

4.3. Results

In spite of the number of reasons for expecting endogeneity bias, we shall see below in Table 4.3 that, in fact, the evidence for it is not particularly strong. In Table 4.2, therefore, we present OLS estimates of production functions for attainment in English, maths and for the overall index of examination success. Inputs are loosely classified as family, peer group or schooling variables. A dummy variable for gender is also included.

Of the family inputs, only parental interest has a consistently strong impact. In contrast to what is usually found, social class, family size and parental education are not always significant and have relatively small effect in magnitude. For example, the combined advantage of coming from a high social class with parents who stayed on in school after 16 is still only 5.98 percentage points in the All Exams index, compared to an effect of 24.40 from moving from no parental interest to the highest level of interest.[7]

[7] The equivalent ratios for the English index and the maths score were 2.2:17.5 and 4.2:15.0 respectively.

Table 4.2: *Attainment at 16 by OLS*

	English		*Maths*		*All Exams*	
	Est	*t-stat*	*Est*	*t-stat*	*Est*	*t-stat*
Score at 11	0.31	14.4	0.47	36.1	0.45	17.7
Parent quality and time inputs						
Father in top SES	1.03	1.0	1.70	2.0	2.80	2.2
Father in middle SES	0.22	0.3	0.30	0.5	-0.17	0.2
Father stayed on at school	1.10	1.4	0.72	1.1	1.43	1.5
Mother stayed on at school	0.08	0.1	1.74	2.9	1.75	2.0
Number of older children	-0.29	1.2	-0.62	3.1	-0.69	2.3
Number of younger children	-0.41	1.4	-0.09	0.4	-0.29	0.8
Father plays a role in upbringing	0.66	0.6	0.03	0.0	-0.19	0.2
Parental interest	17.48	6.9	15.02	7.0	24.40	7.7
Peer group inputs						
Peer group	9.39	4.2	9.38	5.1	10.29	3.8
Top stream	5.51	8.0	7.97	14.1	7.57	8.0
Streamed class	-5.46	4.6	-4.92	4.9	-5.42	3.2
Grammar school	6.38	4.8	4.35	4.2	7.56	4.6
Secondary modern school	-3.92	4.9	0.26	0.4	-2.32	2.3
Private school	2.45	1.3	0.09	0.1	0.45	0.2
Schooling inputs						
Pupil-teacher ratio	-0.13	0.9	-0.07	0.7	-0.03	0.2
Gender (=1 if girl)	6.26	4.8	-2.94	2.9	2.22	1.4
Mixed school	0.44	0.4	0.51	0.6	-1.32	1.0
Girl in mixed school	-3.66	2.5	-2.21	1.9	-1.95	1.0
Constant	-3.29	0.9	13.09	4.4	4.47	0.9
R-squared	0.52		0.66		0.64	
Number of observations	2487		3181		2403	

Notes: i) All dependent variables are scaled to take values between 0 and 100. See footnote 1. "All Exams" is a composite index of school examination results. Peer group and parental interest are scaled to take values between 0 and 1.
ii) In the All Exams regressions, score at 11 was represented by the average of maths and English scores. Dummy variables of ability streams of both English and maths were required, though only the maths stream dummy is reported here.
iii) When parental interest at 7, 11, or 16 was missing, either because it was unreported or a parent was missing, it was set to zero. Dummy variables were introduced for missing mothers and fathers as well as for genuinely unreported observations at 7, 11, and 16 (12 dummies in all). These are not reported.
iv) Maths and English scores at 11 are treated as endogenous and instrumented by the score in the other subject (maths by English and vice versa) as well as teachers' assessments at 11.
v) Top SES refers to fathers in the socio-economic occupational classifications I and II. Medium SES refers to IIIa and IIIb. Where the father is absent, SES is predicted by mothers education.

Recall that parental interest is measured as the average of mother's and father's interest. When entered separately, mother's and father's interest attracted roughly equal parameters: the average of the two is therefore a convenient simplification. It will also

minimise the number of endogenous variables requiring instrumentation when we come to consider endogeneity bias. When a parent was absent from the family, that parent's interest was set to zero and a dummy variable was introduced in the regressions in Table 4.2 (not reported). The parameter on the parental absence dummies thus estimates any effect of an absent parent beyond that channeled through missing parental interest. Of these fifteen dummies,[8] only two were ever significant at the 5% level.

If these are discounted, it follows that the effect of absence of a parent who takes (or would have taken) maximum interest is represented by *half* the parameter on parental interest in Table 4.2, while the absence of a parent taking minimum interest has no effect at all. Note that the former effect is significant and important in magnitude.

The main peer group variable is also very strong. Being at the top of the peer group scale adds about ten points to each attainment index (compared to being at the bottom). This is about half the effect of maximum parental interest but still dwarfs the effect of SES variables. The quadratic peer group term turned out to be significant and negative for English (t=2.3) but was insignificant elsewhere. There is, therefore, only mild evidence for diminishing returns (and thus the advantages of mixing) in these data. This is probably not the last word on this issue. Given the evidence of Henderson *et.al.*, Crane and others, it may be that there are, indeed, non-linearities in the peer group effect, with obvious implications for policy. This is an important area for future research, perhaps in a richer data set with more detailed information on *all* members of classes and schools.

Being in the top stream of a streamed school also has a powerful effect on attainment. Since the parameter on the dummy variable 'streamed class' measures the effect of being in the bottom stream, a pupil in the bottom stream for English scores 5.5% less than a student in a non-streamed school (and 11% less than a student in the top-stream), *ceteris paribus*. The mixed school parameter measures the average advantage to boys of being in a mixed-sex school. This tends not to be significant. However, girls in mixed schools do worse than in single sex schools although the effect is only significant at 5% for English. Grammar schools appear to have a strong positive effect on performance relative to the default group, comprehensive schools. We also observe a negative effect of secondary modern attendance, especially for English. Contrary to received wisdom in the UK, attendance at private schools is nowhere significant. This is

[8] Three regressions each with dummies on mothers' absence at eleven and sixteen and fathers' absence at seven, eleven and sixteen. We have ignored the two children whose mothers were absent at seven.

due to the inclusion of the peer group variable. If the peer group variable is omitted, the private school parameters generally become significant at 5% (t=3.0, 2.3 and 1.6 for the three scores in the order of Table 4.2). We discuss below further implications of the omission of the parental interest and peer group variables.

The pupil-teacher ratio has a negative effect on attainment but is not significant in any of the three regressions. As commonly found, girls perform better than boys in English and worse in maths. Girls perform a little better than boys in overall academic attainment but not significantly.

We tested a number of variables in this model to represent effects from the neighbourhood (non-school peer group effects). Both at the level of the Local Authority (average population about 300,000) and at the level of the OPCS Enumeration District (average population about 460), we tried the unemployment rate, the proportion of unskilled manual workers, the proportion living in council housing, and the proportion of new Commonwealth immigrants, all of which we assumed to enter negatively. Only once was the parameter correctly signed and significant at 5%, the unemployment rate measured at ED level in the maths regression. This was not due to co-linearity of the neighbourhood variables. We conducted experiments with the first principal component of the four neighbourhood variables. We also experimented with the principal component of the first three neighbourhood variables on the grounds that the fourth variable, the proportion of new Commonwealth immigrants, tended to be wrongly signed. Both measures, at the ED level, entered negatively but were never significant at 10%. The first principal component of the LA level variables was never correctly signed, perhaps reflecting the over-aggregation of the variable as a proxy for localised neighbourhood factors. We conclude that the school provides by far the most influential peer group and we have reported results with neighbourhood variables omitted.

4.3.1. Sub-groups

To assess the adequacy of the model we decomposed the sample into a number of sub-groups based, separately, on school types (grammar schools, secondary moderns and comprehensives), gender and the socio-economic status of fathers. We have not controlled for sample selection bias in these models, though this might be important. We leave the issue to future research. Fitted to these sub-groups, the parental interest and peer group

parameters remained essentially the same with the following notable exceptions, all of which are on the margin of statistical significance. There is some suggestion that peer groups are more important in grammar schools than on average and that parental interest is more important in secondary moderns than on average. Girls seem to respond a little more to parental interest than do boys. For other parameters we found that girls in private schools do worse than girls in comprehensives *ceteris paribus*, perhaps reflecting the non-academic curricula of some private girls' schools at this time. Grammar schools seem to convey larger benefits on the lowest SES group.

4.3.2. Endogeneity issues

We have argued above that parental interest and all the variables classified as peer group inputs in Table 4.2 could be considered as endogenous. Table 4.3 (columns 3 and 4) gives the results of treating them so using Local Authority area dummies and earlier parental interest (at age seven) as extra instruments. This instrument set passes the Sargan specification test: we do not reject orthogonality of instruments and residuals from the instrumented equations for any of the three attainment measures at the 20% level. These instruments also explain a moderate proportion of the variation in nominated endogenous variables. Recent US econometric literature (in particular Staiger and Stock, 1997) has drawn attention to biases that can arise when instruments are only moderately correlated with endogenous variables and we shall assess below the properties of this IV estimator in our data, showing that inference is not distorted. First, however, we consider the effect of instrumentation. Table 4.3 (columns 1 and 2) gives the estimates from Table 4.2 where the nominated variables are treated as exogenous. We can thus perform tests similar to those of Hausman (1978) for the change in the parameter when a variable is treated as endogenous.

We do not reject the null hypothesis of exogeneity of parental interest. There is some suggestion, however, of *downward* bias by OLS for the English and All Exams indices. This suggests that Plowden's finding that parental interest was of major importance in explaining children's attainment was not, in fact, undermined by endogeneity problems as argued by, for example, Acland (1980). Indeed, IV estimates tend to be larger than those by OLS so it appears either that there is measurement error in

the parental interest variable or that parents of children who perform unexpectedly badly tend to show higher interest to teachers.[9]

Instrumenting the peer group variable leads to much increased standard errors but the change in point estimate is only substantial for the maths regression. Thus, counter to Evans *et al.* (1992), we do not reject the null hypothesis that peer group is exogenous. This holds not only for the main peer group variable but also for school type and presence in the high stream. We have argued above for a likely upwards bias in OLS estimates of peer group effects caused by ambitious parents choosing good peer groups, so this result requires some discussion. Firstly, since measurement error would operate in the opposite direction it may well be that the two effects cancel out on balance. Secondly, we control for the score at eleven and it is likely that this captures most of the effect of unobserved parental ambition. Thirdly, as a general point, it may well be the case that selection of peer groups by parents was much less of an issue in late 1960s Britain than it was in the 1980s American data of Evans *et al.*.[10] We believe that the allocation of children to schools at this time was mainly determined by schools themselves on the basis of observed ability and location, especially in the state school system.

Though not significantly different, IV parameters tend to be lower than OLS parameters for the High Stream dummy. This is consistent with teachers placing children in streams according to information unobserved in these data.

We have also instrumented the lagged dependent variables for the errors in variables reason mentioned above. The changes are significant for maths and of an important magnitude for English. Since, given measurement error, the reliability coefficient and the proportional bias should sum to unity, the estimates of reliability provided by the SSRU can be used as a check against estimates of bias derived from Table 4.3: 0.21 and 0.13 for reading and maths at eleven respectively. These compare with reliability coefficients of 0.82 and 0.94 respectively. The estimated proportional bias is therefore fairly consistent with measurement error.

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[9] This latter explanation would correspond to the notion discussed by Hanushek (1992) of compensatory time allocation within families to children who perform worse than the sibling average, i.e. that parents devote resources to minimise the variance of attainment within the family. Hanushek's two other possibilities for families are non-discriminatory time allocation and achievement maximisation.

[10] Current concern with school performance data ('league tables') indicates that this kind of selection bias would be more evident in data for Britain in the 1990s.

Table 4.3: *Treating key variables as endogenous in the attainment equation*

	Variables treated as				*t-stat on*
	Exogenous		*Endogenous*		*difference*
	Estimate	*s.e.*	*Estimate*	*s.e.*	
LDV					
English	0.31	0.02	0.39	0.06	1.26
Maths	0.47	0.01	0.54	0.03	2.21
All Exams	0.45	0.03	0.49	0.06	0.60
Parental interest					
English	17.48	2.53	26.96	6.89	1.29
Maths	15.02	2.14	12.31	6.00	-0.43
All Exams	24.40	3.15	41.95	8.72	1.89
Peer group					
English	9.39	2.21	9.15	5.19	-0.04
Maths	9.38	1.83	5.84	4.81	-0.69
All-exams	10.29	2.73	13.16	6.49	0.41
High stream					
English	5.51	0.68	3.56	2.25	-0.83
Maths	7.97	0.57	7.59	2.03	-0.18
All Exams	7.57	0.95	2.80	3.04	-1.50
Private school;					
English	2.45	1.91	1.66	6.01	-0.13
Maths	0.09	1.43	0.90	5.12	0.15
All Exams	0.45	2.38	6.68	7.17	0.82
Grammar school					
English	6.38	1.33	6.86	3.53	0.13
Maths	4.35	1.04	8.58	2.92	1.36
All Exams	7.56	1.63	11.11	4.33	0.77
Secondary Modern					
English	-3.92	0.81	-2.37	1.75	0.80
Maths	0.26	0.67	-1.09	1.52	-0.81
All Exams	-2.32	1.00	-2.06	2.20	0.11
Pupil-teacher ratio					
English	-0.13	0.15	-0.07	0.28	0.19
Maths	-0.07	0.11	-0.33	0.23	-1.02
All Exams	-0.03	0.19	0.19	0.34	0.56

Note:The table describes the effects of making each of the seven tabulated variables endogenous in the regressions in Table 4.2. The instruments were Local Authority dummies, parental interest at 7 and early attainment. Standard linear IV is used.[11]

[11] Some of the endogenous variables are limited variables and better IV estimation might take this into account. Computed standard errors by linear IV are, however, asymptotically correct.

All in all the comparison of OLS and IV estimates suggests that endogeneity bias is not an important issue in these data. It seems, in fact, that the OLS estimates presented in Table 4.2 give a fair picture of the attainment production function.

The shift in instrumented lagged attainment, however, is quite large. Failure to take account of this is likely to lead to bias in the estimates of inputs other than those instrumented in Table 4.3, where they are correlated with lagged attainment. If the correction for measurement error is not made, initial attainment is biased down and the regression acquires more of the nature of a cross-section in which such exogenous variables as family size and social class appear to have stronger effects than they otherwise would. Thus in the IV model reported in Table 4.3, the (unreported) SES variables are consistently smaller in magnitude (roughly halved) and significance than those in Table 4.2. In fact, only one SES variable is ever even marginally significant at the 5% level: the number of older children in the maths regression. We performed chi-squared tests for the exclusion of these seven variables in each of the three equations, obtaining values of 1.3, 8.6 and 4.2 for English, maths and All Exams respectively. Thus, we do not find joint significance of the seven background variables in any regression even at the 20% level. In contrast, if the parental interest variable is excluded, we find joint significance of these SES variables at the 1% level for both maths and All Exams.

Thus, to a great extent, parental interest explains the variance in attainment otherwise explained by class, education and family size. This conclusion is an advance on that of the Plowden Committee (1967) who note the attenuation of these variables for primary school children when parental interest is introduced. We show that the influence of parental interest continues between the ages of eleven and sixteen and that the attenuation studied by Plowden is effectively complete. Our finding should be more persuasive, moreover, in that we have dealt with the possibility of endogeneity bias which troubled the Plowden Committee.

We observe a similar but weaker phenomenon when we exclude the peer group: SES variables become significant overall at about the 10% level for maths and All Exams.[12] Thus both parental interest and peer group appear to be essential elements in the production function. Their omission leads to an over-emphasis of SES and school type variables. Table 4.3 shows the associations between parental interest and peer group on

[12] Additionally, as noted above for private school, omission of peer group increases both the magnitude and significance of the school-type variables.

the one hand and the SES variables on the other. Successful and educated parents with smaller families generally show higher interest in their child's education and find better peer groups.

Table 4.4: *Channels for parental inputs*

	Parental interest at 16				*Peer Group*	
	Father		*Mother*			
	Estimate	*t-stat*	*Estimate*	*t-stat*	*Estimate*	*t-stat*
Father in top SES	0.11	10.1	0.13	12.1	0.12	13.3
Father in middle SES	0.03	3.9	0.04	5.2	0.02	3.1
Father stayed on at school	0.07	8.1	0.07	8.6	0.08	11.2
Mother stayed on at school	0.09	12.2	0.09	10.8	0.08	12.0
Number of older children	-0.03	13.0	-0.03	13.2	-0.01	5.9
Number younger children	-0.03	8.9	-0.03	8.3	-0.01	4.6
Mother works	0.02	3.3	0.01	1.2	0.01	1.2
Father not present			-0.25	16.9	-0.03	2.6
Gender (=1 if girl)	0.02	3.0	-0.01	1.8	0.00	0.2
Constant	0.46	47.2	0.45	41.9	0.44	50.1
R-squared	0.13		0.18		0.17	
Number of observations	6961		6656		5861	

Note: The dependent variables take values between 0 and 1.

The finding that higher SES groups are perceived by teachers to show more interest in the education of their children parallels direct estimates of time allocation by Hill and Stafford (1974, 80). The fact that parents of large families show reduced interest in each child is consistent with a parental time constraint. Lone mothers also appear to show substantially less interest in their children's education than do mothers in two parent families. This again follows naturally from a parental time constraint. However, Hill and Stafford's 1980 study shows that the direct time absorbed by adolescents tends to be rather small (about 26 minutes for all mothers, though 60 for women who have been to university). It may be that, in some circumstances, large numbers of children or the absence of a spouse make it difficult, for reasons unrelated to time, to establish discipline about such things as homework.

Note that working women show no less interest in their adolescent children. Chapter 2 observes, in these data, that if a women is working when her child is 7, or if she has ever worked over the preceding 7 years, she is reported as showing lower interest. This accords well with Hill and Stafford's (1980) finding that working women spend substantially less time with younger children, reflecting the time constraint in early years. If we interpret parental interest as a measure of parental input, we conclude that this input

is lower for women who work when their children are young but not when their children are older.

Overall, these regressions indicate that the socio-economic variables commonly found to be associated with educational performance do affect attainment but via parental interest and peer group. It is by these means that educational attainment and economic success are transmitted from generation to generation.

4.3.3. Properties of the estimator

We stated above that F-statistics for the correlation of instruments and endogenous variables are in the region of unreliability highlighted by Staiger and Stock (1997): see Table 4.5.

Table 4.5: *F-statistics for regressions of instruments on endogenous variables in attainment regressions at 16 years.*

	English	*Maths*	*All Exams*
Score at 11	17.07	27.06	19.25
Parental interest	4.61	5.72	4.28
Grammar school	3.01	3.85	2.85
Secondary school	4.29	5.19	4.03
Private	1.39	1.26	1.49
Peer group	6.65	6.75	3.27
Pupil-teacher ratio	3.91	4.59	6.12
High stream	6.33	5.88	6.10

A low degree of correlation leads to bias in IV estimates. The school type variables are of particular concern. To gauge the extent of this problem we have conducted a Monte Carlo analysis of our estimators identical to that discussed in Chapter 2. A brief review, however, is in order. Taking the parameters obtained by IV on the original data, we compute the variance-covariance matrix of the implicit errors in the structural equation and the errors from each of the (first-stage) regressions of the endogenous variables on all the instruments. Residual vectors with this covariance structure were then used to create artificial data (holding the instruments fixed) from which artificial estimates of the parameter vector were obtained. Summary statistics on the basis of 100 replications are reported in Table 4.6.

Table 4.6: *Bias in estimates of endogenous variables based on 100 replications in Monte Carlo experiments with IV estimates generating the data.*

	Truth	*OLS bias*	*2SLS bias (s.d.)*	*Rel. rmse OLS/2SLS*
	(I)	*(II)*	*(III)*	*(IV)*
LDV				
Engbest	0.40	-0.09	-0.02 (0.02)	2.85
Maths	0.54	-0.07	-0.01 (0.03)	2.33
Examtot.	0.49	-0.04	0.01 (0.05)	0.86
Parental interest				
Engbest	26.96	-9.76	-2.85 (5.26)	0.59
Maths	12.31	2.56	1.48 (4.91)	0.66
Examtot.	41.95	-17.22	-5.79 (7.81)	1.80
Grammar School				
Engbest	6.86	-0.58	0.38 (2.26)	1.53
Maths	8.58	-4.29	-1.78 (2.51)	1.28
Examtot.	11.11	-3.59	-1.23 (3.54)	1.04
Secondary Modern				
Engbest	-2.37	-1.55	-0.59 (1.57)	1.05
Maths	-1.09	1.31	0.50 (1.45)	0.96
Examtot.	-2.06	-0.30	0.52 (1.86)	0.50
Private School				
Engbest	1.66	0.61	0.73 (4.79)	0.43
Maths	0.90	-0.81	-0.64 (3.90)	0.41
Examtot.	6.68	-6.71	-3.03 (5.88)	1.08
High Stream				
Engbest	3.56	1.96	0.78 (1.65)	1.13
Maths	7.59	0.36	0.42 (1.63)	0.42
Examtot.	2.80	4.73	1.60 (2.21)	1.76
Peer group				
Engbest	9.14	0.23	0.08 (4.41)	0.51
Maths	5.84	3.70	1.18 (4.10)	0.96
Examtot.	13.16	-2.84	-1.67 (5.23)	0.68
Ratio				
Engbest	-0.07	-0.05	0.04 (0.24)	0.66
Maths	-0.33	0.25	0.05 (0.21)	1.24
Examtot.	0.19	-0.23	-0.06 (0.32)	0.91

In column 1, we report the IV parameter estimates. Column 2 gives the bias by OLS when the data are generated by the parameters in column 1. This gives an indication of the degree of endogeneity bias under OLS. It is notable that OLS bias on the parental interest variable is about one third of the parameter for English and All Exams, confirming the endogeneity discussed above. OLS bias is positive for High Stream across the three scores, particularly strongly for All Exams as suggested by the Hausman test for this variable.

Column 3 gives the bias by IV, due to low correlation of endogenous variables and instruments. Only for private school is this bias large relative to the parameter estimate for

all three scores. For All Exams, taking bias into account, it may be that children in private schools out-perform children in comprehensives by a greater margin than the IV parameter in Table 4.4 would suggest. Note in Table 4.5 that the F-statistic on private school is very weak so that bias by IV is to be expected. On balance, the IV estimates reported in the Hausman table seem not to be importantly biased. Column 4 gives the ratio of root mean square errors by OLS and IV. Smaller bias by IV is offset to some extent by the greater diffusion of the IV estimates. In fact, neither estimator dominates the other by the root mean square error criterion, indicating the usefulness of presenting both sets of estimates.

4.4. Conclusions to Chapter 4

In this chapter we consider the influence of family, schooling and peer groups on the development of children in the NCDS between the ages of 11 and 16. We estimate a structural model of educational attainment as determined by family background variables, schooling and peer group effects. Our instruments seem to handle endogeneity problems satisfactorily. In fact, we encounter less endogeneity than is suggested by the literature surveyed.

Pupil-teacher ratios seem to have minimal effects on attainment at 16, consistent with recent research. The major influence on attainment is parental interest, presumably through motivation, discipline and support. This dwarfs the direct effects of parental education and class, but is itself strongly correlated with these. Our study reaffirms the finding of Douglas (1964) that parental interest is the principal means by which the attainments of each generation are passed on to the next. In common with other researchers, we find that peer groups also have a significant effect on attainment but we do not reject the exogeneity of the peer group variable. Thus, we confirm the "parents and peers" theory of educational attainment for children in British secondary schools, as emphasised by Robertson and Symons (1996) for children in primary schools. Families select or determine peer groups in ways associated with social class, family structure and parental education but the peer group together with parental interest, rather than these background variables, then provides the major input during the period between 11 and 16.

Does the importance of parental interest have implications for public policy? For example, do our results lend support to the current Government's intention actively to

teach "parenting skills"? It may well be that the inputs corresponding to parental interest are derived from an optimisation over parental time and resources of a utility function conditioned by deeply engrained tastes. These may prove difficult to change by schools or government. Waldfogel (1999) has provided more optimistic evidence for the US but more study needs to be undertaken in the UK context. This will be facilitated by the Sure-Start programme discussed in Chapter 3.

Other inputs in the production function such as the constitution of the state school system and overall school expenditures are more easily influenced by policy makers, at least in principle. The former entails change of the degree of mixing of children in schools in terms of peer group. We have found little evidence against the linear model, implying that the average attainments of British children would be unchanged by any such policy prescription. There might be, however, distributional effects of changes which advantage particular children at the expense of others. Thus, the previous Conservative Government's desire to have "a grammar school in every town," would, in this framework, produce no effects on average attainment but would almost certainly, given peer group effects, increase the variance of attainment, as the more able children left comprehensives for the new grammar schools.[13] Similarly, the Assisted Places Scheme which currently subsidises the private school fees of able children from poor families, has no overall effect on average attainment in a linear model of peer group effects. It does, however, advantage the assisted children at the expense of the unassisted, who lose the positive influence of their departed peers.[14] Such evidence as we have found in these data supports linearity or, perhaps, diminishing returns to the peer group. The latter would imply that both of these schemes reduce average attainment as well as increasing the variance.[15]

[13] The implicit assumption here is that the effect of school type on attainment is purely a peer group effect, that is, there is no effect on attainment of merely renaming a school.
[14] Note that if the aim is to minimise the variance of outcomes one would do better to subsidise the *least* able, poor children to attend private schools.
[15] We thank an anonymous referee for the suggestion that we pursue the implications of these policies.

4.5. Data Appendix to Chapter 4

Appendix Table A4.1: *Summary statistics for variables in Table 4.2*

	Mean	*s.d.*
Dependent variables		
English score	19.5	20.2
Maths score	41.5	22.4
All Exams	31.9	28.2
Lagged dependent variables		
Reading at 11	46.0	17.6
Maths at 11	42.0	25.7
Parent quality and time inputs		
Father in top SES	0.20	0.40
Father in middle SES	0.55	0.49
Father stayed on at school	0.23	0.42
Mother stayed on at school	0.25	0.43
Number of older children	1.30	1.55
Number of younger children	1.03	1.07
Father plays role in upbringing	0.89	0.31
Parental interest	0.47	0.21
Peer group inputs		
Peer group	0.49	0.23
Top stream (English)	0.48	0.50
Streamed class (English)	0.71	0.46
Comprehensive school	0.61	0.49
Grammar school	0.11	0.31
Secondary modern school	0.22	0.42
Private school	0.06	0.24
Schooling inputs		
Pupil-teacher ratio	18.05	8.38
Gender (=1 if girl)	0.49	0.50
Mixed school	0.75	0.43
Girl in mixed school	0.36	0.48

Appendix Table A4.2: *Correlation matrix for some variables in Table 4.2*

	All Exam	Par. int.	Peer gp.	SES1	SES2	Ed: Dad	Ed:Mum
All Exam	1.00						
Par. int.	0.50	1.00					
Peer gp.	0.37	0.35	1.00				
SES1	0.33	0.36	0.35	1.00			
SES2	-0.10	-0.10	-0.14	-0.59	1.00		
Ed:Dad	0.34	0.34	0.32	0.44	-0.18	1.00	
Ed:Mum	0.32	0.34	0.31	0.39	-0.17	0.36	1.00
No.child	-0.24	-0.28	-0.15	-0.10	-0.04	-0.09	-0.08

Chapter 5. The relative economic importance of academic, psychological and behavioural attributes developed in childhood.

It is well known that the observed academic ability of school children is associated with subsequent earnings even conditioning for qualifications obtained. It is also established that omission of ability leads to over-estimates of the return to schooling or qualifications. Only recently, however, have economists begun to address the importance of what has been called "psychological capital" for productivity and hence wages and this research is still at a very early stage. There has as yet been no longitudinal investigation of the relative importance of the academic and non-academic abilities developed in childhood for subsequent economic outcomes including wages.

This chapter considers a wide range of assessments of the abilities that children have already developed by age ten and uses a sequential analysis to consider the importance these different aspects of age ten ability have for subsequent development and economic success. As is well-known, the social class a child is born into has a strong bearing on how well he or she performs at school, qualifications attained and subsequent productivity and earnings[1]. The chapter explores how the development of children by ten influences subsequent educational and economic progress differently for children from different social backgrounds. This wider set of abilities and attributes, therefore, also enables an assessment of the role of the wider range of childhood attributes and skills as channels for inter-generational transmission of education and earnings. By showing that measures of psychological and behavioural attributes provide important signals about future economic outcomes, the chapter suggests that schooling should not be too narrowly assessed. The chapter also makes use of the age ten scores to show how different are the processes of human capital development and the determinants of individual productivity in work

The data come from the 1970 British Cohort Study (BCS). Particular use is made of the 1980 Child Health and Education Study (CHES) and 1996 sweeps. At age ten, under the supervision of the Department of Child Health at Bristol University, the

[1] Coleman *et al.* (1966), cited in Chapter 2, remains an influential early study that effectively disregarded the contributions of schools. However, some recent studies and reports such as those of Krueger (1998), OFSTED (1998) or the National Commission on Education (1995) have re-emphasised the importance of schooling while still accepting that parenting and background is important context. See Plowden (1967) for a major investigation in the UK context.

children were tested for standard maths and reading ability but also for the psychological attributes of self-esteem and locus of control described below and for the behavioural attributes of conduct disorder, peer relations, attentiveness and extraversion. Age twenty-six information is then available on highest qualification attained, earnings and periods of unemployment.

The first section describes the methodology and data. The second considers the importance of age ten attributes and abilities for subsequent educational progress, the third for labour market outcomes. Having then established their importance, the fourth section considers the production of the age ten abilities themselves and concludes.

5.1. Data and methodology

5.1.1. Estimation methodology

This chapter undertakes a sequential analysis of the development of the 1970 cohort. The age ten scores discussed below are used to predict subsequent educational and economic outcomes. Step-wise regression analysis assesses the size and significance of age ten intellectual and psychological parameters vis-a-vis each other and relative to standard indices of family background. We show that different psychological scores predict different aspects of economic success or failure. In other words, there is not one single measure of age ten success that predicts all aspects of adult performance, rather, it is the case that different aspects of development have importance for different facets of adult, economic life.

As discussed in previous chapters, the established explanations for the strong association between educational ability and social class range through cultural, genetic and financial mechanisms. Cultural explanations have focussed on variations in family human capital and associated methods of child-rearing or psychological interactions between mother and child (see, for example, Bowlby, 1953, Mortimore and Blackstone, 1980, or Bee, 1969). Genetic explanations associate the social class of parents with their genetic endowments to children (for example, Wilson, 1977). Financial explanations such as those of Becker (1967) make the assumption that children from poorer families have less easy access to finance and so higher marginal costs of education after minimum leaving age. This affects their motivation at earlier stages and presumably might interact with the cultural forces already mentioned in that a high opportunity cost of education

might lead to a low valuation of education within the cultural sphere of the family and wider community. Thus, it is possible that pro and anti-education cultures could grow up on the basis of, perhaps, false or out-dated evaluations of the return to education. In any case, it is clear that there might be more than one channel for the perpetuation of inter-generational educational inequality.

The second empirical section looks at labour market outcomes, in particular unemployment probabilities and earnings. We show that productivity is less influenced by family background than is educational progress but that age ten psychological attributes are, in fact, more important.

5.1.2. The psychological and academic test scores

There has been substantial scepticism about the use of subjective data in economics. Goldsmith *et al.* (1997) ascribe this to doubts about valid measurement or interpersonal comparison and to a lack of familiarity with psychological testing. However, psychologists are less cautious about such testing and have established strong links between psychological test scores and subsequent outcomes such as schooling achievements (Purkey, 1970, Thomas, 1973, Keltikangas-Jarvinen, 1992), criminality (McKinney *et al.*, 1978) or psychiatric disorders (Rutter *et al.*, 1970). The causal relations, however, are unclear and may remain so. As the psychiatrist Rutter (1970) argues, in the context of a relation between his score for anti-social behaviour and subsequent educational failure, both may be a response to similar, unidentified, underlying deviance. There is also, clearly, two-way causality between educational ability and psychological attributes such as self-esteem, the development of each facilitating the development of the other. Nonetheless, if the psychological test scores do predict subsequent outcomes, economists should test the implications for economic outcomes, especially considering the economic importance that may be attached to the traits one is hoping to measure. The first objective must be to test whether the scores carry information about labour market outcomes or not. If the psychological scores are not genuinely measuring the conceptual ability for which psychologists have developed them, it then remains for critics to explain what is actually being identified. This chapter is concerned to establish their predictive power and so enables an initial assessment of the degree of previously omitted individual heterogeneity.

It is important, however, to be as clear as possible about what is being tested and there are a number of guidelines that have been established in the psychological literature. Test scores should satisfy four particular requirements. Firstly, scores from any given test for a particular psychological attribute must give similar results to other tests for that attribute (convergence). Responses to individual items within the test must be highly correlated (reliability). There is a third requirement of good discrimination between children. Finally, there is the requirement of re-test stability. These requirements are met by the psychological tests developed by the CHES[2]. Summary statistics for the tests are given in Table 5.1.

Table 5.1: *Age ten abilities and attributes*

Variable	Obs	Mean	Sd	Min	Max	pc:20	pc:80	20/80 range
Academic scores								
Maths	11719	0	1	-3.43	2.22	-0.81	0.87	1.67
Reading	12790	0	1	-2.91	1.92	-0.98	0.95	1.93
Psychological scores								
Locus of control (CAROLOC)	12444	0	1	-2.64	2.72	-0.97	1.05	2.01
Self-esteem (LAWSEQ)	12519	0	1	-2.93	1.87	-0.93	1.07	2.00
Behavioural scores								
Anti-social behaviour (RUTTER)	12757	0	1	-1.51	4.39	-0.81	0.69	1.50
Peer relations	12757	0	1	-3.45	2.02	-0.83	0.92	1.74
Attentiveness	12757	0	1	-2.93	1.78	-0.95	0.96	1.91
Extraversion	12757	0	1	-3.07	2.11	-0.85	0.91	1.76

Notes: The penultimate two columns of Table 5.1 show the 20th and 80th percentiles of distributions. The 20/80 range is used in the analysis, below, to assess relative magnitudes of test score associations.

The use of academic ability scores has a strong history in economics so little more need be added here. The maths test was created by the Department of Child Health, Bristol University who supervised the surveys in 1975 and 1980. The reading test is the Edinburgh Reading Test. Both show good properties of discrimination without censoring although there is some bunching at zero for the maths score.

5.1.2a Psychological capital; self-esteem and the locus of control

The CAROLOC score for the locus of control (Gammage, 1975) and the LAWSEQ self-esteem score (Lawrence, 1973, 1978) are based on childrens' responses. Both scores satisfy the requirements of re-test stability, reliability, discrimination and convergence to similar test frameworks[3].

[2] See Butler *et al.* (1982)

[3] The LAWSEQ score has been shown to have a four month re-test corelation of 0.64 and a high correlation with the Coopersmith Self-esteem inventory (r=0.73). See Hart (1985) for these and other tests

Self-esteem can be regarded as a fairly well-established notion (at least outside the psychological literature where it is more problematic). Lawrence, who developed the test used here, has defined self-esteem as "the child's affective evaluation of the sum total of his or her characteristics both mental and physical.[4]" Brockner (1988) reports that managers perceive workers with high self-esteem to have higher productivity in work as a result of using time more effectively, requiring less guidance and considering a wider range of solutions to problems. Self-esteem should, therefore, increase wages directly. It might also lead to a higher probability of employment if job searchers are more confident in interviews.

The locus of control is, perhaps, a more vague notion referring to an individual's sense of control of their own destiny. Rotter (1954) isolates four aspects of this sense of self. Individuals with a high locus of control are better able to process information from the outside world, are concerned to improve both their circumstances and themselves and, finally, are more stable in response to external influences. It might be expected that such individuals will make better decisions about educational and career choices and have a higher degree of patience.

In a rare paper considering psychological capital in the field of economics, Goldsmith *et al.* (1997) observe self-esteem concurrently with wages at two dates, using the NSLY. They estimate both simultaneously using the locus of control score as an instrument for self-esteem in the wage equation. This approach has the virtue of recognising the reverse causality between earnings and self-esteem but relies on a fairly dubious exclusion restriction. The required assumption described by Goldsmith *et al.* is that self-esteem is the more unstable of the two aspects of the individual's psychology and that the locus of control is well-established by adulthood, unlikely to change but a good predictor of the more time-variant variable, self-esteem. Although Goldsmith *et al.* refer to psychologists to support this assertion it is equally possible to find psychologists who would resist it[5].

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of the performance of the LAWSEQ scale. The Caraloc test of the CHES closely mirrors the locus of control test of Nowicki and Strickland (1973). It was initially piloted on 800 children and tested for reliability, uniqueness and discrimination.

4 Lawrence, D., (1981). "The development of a self-esteem questionnaire." British Journal of Educational Psychology. Vol 51(2), p246.

[5] It is surely not more surprising that the nature and measurement of the self is a problematic research issue for psychologists than that, say, the relationship between macro- and micro-economics is not yet sewn up for economists.

Goldsmith *et al.* follow Rosenberg (1965) who treats self-esteem as a relatively unstable feature of personality rather than a permanent trait. However, Coopersmith (1967) views self-esteem as fairly stable after an individual is seven to ten years old. Damon and Hart (1982) suggest that locus of control will influence choices (and hence earnings) not solely through self-esteem but also directly. Shavelson and March (1986) discuss the difficulties of distinguishing the two notions empirically.

Rather than making strong psychological identification assumptions, this study will investigate the relative predictive power of the two test scores. Although they are clearly related, Gamage (1982), who developed the score used here, is strongly resistant to the idea of equating self-esteem and locus of control. Goldsmith *et al.* make the strong assumption that whereas self-esteem is fairly changeable, locus of control is time-invariant and unaffected by earnings later in life. This exclusion restriction is rejected by the data presented here. In fact, this study finds that the two variables have different predictive properties for different variables of interest and for different groups of the sample. A further advantage of the current study is that we test the relative influence of these psychological variables on education decisions and success and unemployment as well as on earnings.

5.1.2b Behavioural scoress; Anti-social behaviour, peer relations, attentiveness and extraversion.

The Rutter score for anti-social behaviour (Rutter, 1967) is based on the responses of class teachers to questions about conduct disorder such as whether children bully, tease or quarrel with other children. It has been found to predict ratings based on a standard psychiatric assessment and children with a high score have been found to be at risk of psychiatric deviancy[6]. The other behavioural scores are also based on teachers' responses, hypothesised by CHES to indicate aspects of behaviour, taken from particular items of the behaviour scales developed by Rutter (1967) and Conners (1969). Each score is the standardised result of principal components analysis conducted on individual items, described in more detail in Osborn & Milbank (1987).

As stated above, anti-social behavior may be both the result and the cause of educational failure. The interest here, however, is particularly in how age ten social/anti-

[6] It has also been found to have a re-test reliablity over a two-month interval with a product-moment correlation, +0.89 and a reliability for re-testing by a different set of teachers after two months with correlation, 0.72, see Rutter (1967).

social behaviour predicts employment outcomes. Are children who are well behaved more likely to find work, either through increased desire to do so or better social skills? It may be that some underlying psychological issue is the root cause of behaviour and employability but a positive correlation between them would clearly signal the economic importance of assessing and confronting childhood behavioural problems. In fact, some work in the psychiatric and sociological literature has already concluded that conduct disorder is likely to predict problems in entry to the labour market, seen as a crucial threshold in adolescent development (Caspi *et al.*, 1998, Sanford *et al.*, 1993). However, such studies have not considered wages and do not have the range of scores available in these data[7].

The peer relations and extraversion scores are interesting because of recent concern by Human Resources consultants about the importance of "key skills" in the workplace. The importance of good communication and the ability to work in teams is being increasingly recognised (e.g. CBI, 1995, DfEE and Cabinet Office, 1996.) In a hedonic wage equation, Green (1998) finds an eight per cent wage return to verbal skills for women but only three per cent for men. However, these figures were based on self-reported skills, given contemporaneously to earnings so that, although the analysis suggests that the market appears to value good communication skills and team-working, it cannot discriminate between genuine skill and the self-esteem that is assessed in the BCS data and might lead both to higher wages and higher self-assessments of skill. Moreover, the data does not control for the background of employees. Clearly, therefore, further studies are required to build on this work.

Attentiveness is obviously important for the development of human capital but it may also be that children who do not intend to stay at school or do not have high expectations of success are already beginning to pay less attention by age ten. The attentiveness variable might have implications, therefore, not just for educational development but also as a proxy for the student's interest in education.

Table 5.2 shows that the maths and reading scores are strongly correlated. Attentiveness and locus of control are also well correlated with the academic scores. There is less association of self-esteem or anti-social behaviour with age ten academic ability: although the correlations take the sign one would expect, the coefficients are not

[7] My thanks are due to Barbara Maugham of the Institute of Psychiatry for introducing me to this literature.

large in magnitude. Children with good peer relations also tend to be slightly better at maths and reading, as are extrovert children although, again, correlation coefficients are not large.

Table 5.2: *Correlation coefficients amongst age 10 attribute variables.*

	Maths	Reading	Loc. of C	Self-est.	Anti-soc.	Peers	Attentive
Maths	1.00						
Reading	0.74	1.00					
Loc. of C	0.40	0.41	1.00				
Self-est.	0.20	0.19	0.44	1.00			
Anti-soc	-0.20	-0.23	-0.11	-0.14	1.00		
Peers	0.23	0.24	0.19	0.20	-0.39	1.00	
Attentive	0.50	0.54	0.31	0.20	-0.55	0.48	1.00
Extravert	0.09	0.10	0.10	0.05	0.19	0.42	0.10

Self-esteem is moderately correlated with locus of control but not particularly with the other behaviour scores. Extrovert children are considered by teachers to have better peer relations but, although the peer relations and attentiveness scores are quite strongly positively correlated, extraversion and attentiveness are not. This suggests, as CHES hypothesised, that these behaviour scores pick up quite different aspects of behaviour. Table 5.3 shows that all the age ten scores are strongly associated with social class, with expected signs.

Table 5.3: *Regression of age 10 attribute variables on occupational classification of fathers.*

		SES 1	SES 2	SES 3nm	SES 3m	SES 4
Maths	Est.	1.00	0.69	0.63	0.20	0.06
	t-stat	(0.22)	(0.21)	(0.15)	(0.07)	(0.02)
Reading	Est.	1.01	0.71	0.64	0.19	0.08
	t-stat	(0.23)	(0.22)	(0.16)	(0.07)	(0.02)
Loc. of C	Est.	0.65	0.46	0.39	0.12	0.05
	t-stat	(0.14)	(0.14)	(0.09)	(0.04)	(0.01)
Self-est.	Est.	0.38	0.31	0.19	0.08	0.05
	t-stat	(0.08)	(0.09)	(0.05)	(0.03)	(0.01)
Anti-soc	Est.	-0.40	-0.27	-0.27	-0.15	-0.09
	t-stat	(0.09)	(0.08)	(0.07)	(0.05)	(0.02)
Peers	Est.	0.34	0.27	0.23	0.13	0.02
	t-stat	(0.07)	(0.08)	(0.06)	(0.04)	(0.01)
Attentive	Est.	0.69	0.45	0.44	0.15	0.11
	t-stat	(0.15)	(0.14)	(0.11)	(0.05)	(0.03)
Extravert	Est.	0.17	0.19	0.09	0.05	0.02
	t-stat	(0.04)	(0.06)	(0.02)	(0.02)	(0.00)

Notes: The default group is SES 5.

The associations are of larger magnitude for the academic ability scores than for non-academic scores but children in higher SES groups score more highly in tests of psychological and behavioural attributes. This might be the result of psychological production in the home due to easier material circumstances or the particular child-rearing abilities or aspirations of middle class families. Alternatively and less substantively, this might merely reflect the higher confidence of middle class children in educational environment or the prejudices of teachers. Because a wide-range of indicators of social class are observed, regressions can control for biases that might result from the teacher prejudice explanation. I also test whether these assessments made by teachers transfer to the labour market in which case they would have value as important indicators for schools.

In conclusion, the non-academic scores clearly provide information about the development of children that is associated with academic scores but not collinear with them. The scores also show the propensity to channel inter-generational social capital.

5.1.3. The Outcome variables

Section 5.2 considers the predictive power of the age ten scores for three sets of outcomes. The first outcome variable is educational progress assessed as the achievement of the three levels of qualifications shown in Table 5.4. It should be pointed out that the attainment of at least one O'Level is a qualitatively different form of success than the other two levels of attainment in that it only represents an educational choice to the extent that students have to choose to apply themselves to study. It is more in the manner of a mimimal test of human capital accumulation. A'Level and Degree attainment, however, represent active choice on the part of students to postpone labour market entry.

Table 5.4: *Outcome variables in the BCS*

Outcome	Mean	s.d.	obs	min	max
Educational Qualifications					
At least one O'Level	0.77	0.42	8422	0	1
At least one A' Level	0.36	0.48	8422	0	1
Degree	0.21	0.40	8422	0	1
Labour market					
Unemployment	0.30	0.46	8678	0	1
Long-term unemployment	0.39	0.49	2581	0	1
Earnings at 26: net hourly wage	1.57	0.38	6080	0	4.61

Notes: The three educational qualifications are not exclusive. Children with a positive outcome for degree will also have positive outcomes for the O' and A'Level dummy variables.

The labour market outcomes considered are unemployment probabilities and hourly wages. It is expected that these outcomes may be more strongly correlated with the psychological and behavioural scores than are the educational outcomes since, although, productivity should be rewarded in the labour market, it is hypothesised that educational progress is more closely linked to academic ability than is market productivity. Hence, it should also be the case that the predictive power of academic scores will be less for the market than for the educational outcomes.

Appendix Table A5.1 shows that the BCS earnings data matches that of the LFS for 1996 by gender and qualifications and can be taken, therefore, to be a reliable measure of wages. Sample members are, however, at an early stage of the age-earnings trajectory. Given that, as is well known, the slope of the average wage profile increases with education, returns to education and possibly age ten attributes might, if anything, be biased downwards. The unemployment variable is derived from a job history variable generously provided by the CLS[8], broadly indicating length of longest period of unemployment. I have coded the unemployment variable to take the following values: 0=continuously employed or unemployed only intermittently and never for more than four months, 1=longest period of unemployment more than four months. Individuals who have never been employed are dropped. The long-term unemployed are defined here in the form of a conditional expectation, namely those who have experienced unemployment of more than four months duration for whom that unemployment has also been of over one year's duration. Although this is an unusual interpretation of long-term unemployment in that it censors those individuals who have not experienced any substantial unemployment, the intention is to examine the power of age ten attributes to differentiate individuals at risk of long-term unemployment from those whose unemployment is not so likely to be long-lasting[9]. As discussed in Section 5.3.1, the relative values and significance of

[8] This variable was derived by Pierella Paci at the Centre for Longitudinal Studies, Institute of Education. See Bynner *et al.* (1997).

[9] An alternative coding would be a variable that ranged from 1-5, increasing in the banded lengths of unemployment durations. Ordered probit regression on this variable would allow for non-linearities in the contribution of the age ten scores to the estimated probabilities of membership of any of the five bands. Marginal effects could then be calculated for the contributions of each age ten score to the probability of being in any group. However, this procedure would constrain the weights in calculation of the marginal effects to being the same for each age ten score, namely the probability of being in the grouping. Instead, the procedure adopted loses information by dropping individuals who have not been unemployed but simplifies the estimation process and allows particular age ten scores to influence the long-term unemployment

parameters in the analysis are reasonably robust to different transformations of these unemployment probabilities.

5.2. The association of age ten abilities and attributes with educational progress

This section considers two issues. Firstly, which age ten attributes and abilities predict educational attainment? As stated above, because of the rich cross-sectional data in the BCS, it is possible to consider this issue while also controlling for a great variety of background factors. This will enable us to see the extent to which children's backgrounds have direct effects on their educational attainment but also how children have already internalised these factors by age ten in terms of self-esteem, attentiveness, academic ability and so on. Secondly, the consideration of the prediction of educational qualification by age ten abilities for particular sub-groups suggests that different abilities have predictive power for different groups of the population. It is hypothesised that on the basis of differential reading of childrens' abilities and differential knowledge of the labour market, parents and schools form different expectations for children and influence them in different ways.

5.2.1. The importance of age ten abilities for education probabilities

Table 5.5 reports marginal effects from probit regressions of minimum educational qualification, O'Level, A'Level and Degree, on age ten abilities and attributes, controlling for gender.

Academic ability is the most important age ten predictor of subsequent educational qualifications. Since the ability scores are scaled with standard deviation equal to one, it can be observed, for example, that an increase of one standard deviation in reading ability is associated with a 9% increase in the individual's likelihood of gaining at least one O'Level. Of the psychological scores, self-esteem is not a significant predictor of academic progress, in contrast to the locus of control. Attentiveness is particularly important. An increase in attentiveness of one standard deviation is associated with a 6% increase in the O'Level probability and a similar increase in the probability of getting a

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probability without influencing the short-term probability. It also gives more easily derivable standard errors.

degree[10]. Going from the 20th decile of attentiveness to the 80th adds 16% to the probability of getting an A'Level and in terms of locus of control 80th percentile children are 9% more likely to get an A'Level than children at the 20th percentile.

Table 5.5: *Age ten attributes and abilities as predictors of minimum educational qualifications, marginal effects from probit regressions.*

	O'Level		A'Level		Degree	
	dF/dx *100	(S.E.) *100	dF/dx *100	(S.E.) *100	dF/dx *100	(S.E.) *100
Girl	2.73	(1.1)	-0.97	(1.4)	-2.23	(1.0)
Maths	7.19	(0.8)	12.45	(1.1)	8.55	(0.8)
Reading	9.42	(0.8)	12.43	(1.1)	7.63	(0.8)
Locus of Control	2.88	(0.6)	4.30	(0.8)	2.88	(0.6)
Self-esteem	1.19	(0.6)	1.14	(0.7)	0.30	(0.5)
Anti-social	-0.08	(0.7)	-0.89	(1.0)	0.11	(0.8)
Peer relations	-1.21	(0.7)	-1.46	(0.9)	-1.39	(0.6)
Attentiveness	6.19	(0.8)	8.40	(1.1)	6.07	(0.8)
Extraversion	-0.78	(0.6)	-1.38	(0.8)	-0.06	(0.6)
Observed Probability	0.77		0.35		0.20	
Observations	5968		5992		5979	
Pseudo R-squared	0.22		0.21		0.21	

Notes: Parameters and standard errors are multiplied by 100 to give percentage increase in probability of getting qualification for one standard error change in age ten score. As well as the variables listed, a control variable is introduced for children assessed as being in the special educational category in the medical examination file. This is never significant once age ten scores are also introduced.

However, although these range effects seem fairly large, it is not yet possible to put these magnitudes into relative context because the regressions in Table 5.5 take no account of family background. It is also possible that the age ten attributes are merely picking up the effects of social class and other background influences but without providing any additional information. If teachers assess middle class children as more attentive, for example, due to the ratings bias discussed above, the score might only be important because it proxies for parental wealth and education in the home. In Table 5.7 background variables are introduced. Occupational classification (SES), parental education, average weekly income, parental interest in education, SES of grand-parents

[10] These regressions were run across gender. If two separate models are estimated the only significant changes is that maths is more important for boys than for girls as a predictor of the A'level and degree probability (at 1%). The marginal effects for boys are 14.3% and 10.2% as opposed to 10.4% and 7.4% for girls.

and ethnicity are all assessed when the sample children were ten years old and are standard background variables in regressions of this kind. These variables have all been shown to be strongly associated with subsequent academic and sociological outcomes[11].

First, for descriptive purposes, Table 5.6 reports cell mean attainments for children stratified by background variables. Results are reported by row from fourteen separate probit regressions conditioning only on the row variable listed in the first column. Thus, it can be seen, for example, that without conditioning on age ten abilities or any other background variables, sample girls are nearly four percentage points more likely than boys to get at least one O'Level but one point less likely to get at least an A'Level and three points less likely to get a degree.

Table 5.6: *Cell mean probabilities of minimum educational qualifications for children by family background.*

	O'Level dF/dx *100	p-value	A'Level dF/dx *100	p-value	Degree dF/dx *100	p-value
Girl	3.61	0.001	-1.24	0.320	-2.71	0.010
Bottom income range	-12.66	0.000	-15.88	0.000	-13.33	0.000
Top income range	15.83	0.000	30.76	0.000	27.80	0.000
Father SES1	19.40	0.000	40.11	0.000	35.33	0.000
West-Indian parents	-2.45	0.701	-5.90	0.412	-11.25	0.057
Asian parents	13.68	0.002	20.58	0.000	18.65	0.000
Father O'level/vocational	0.39	0.726	-0.61	0.638	-2.11	0.051
Father A'Level	10.57	0.000	9.48	0.000	6.38	0.001
Father degree	19.57	0.000	43.27	0.000	37.74	0.000
Mother O'level/vocational	11.54	0.000	12.31	0.000	7.12	0.000
Mother A'Level	16.04	0.000	29.91	0.000	29.51	0.000
Mother degree	21.39	0.000	51.77	0.000	52.66	0.000
Father's father SES1	17.79	0.000	33.64	0.000	27.29	0.000
Mother's father SES1	15.02	0.000	33.82	0.000	36.42	0.000
Average probability	0.77		0.35		0.20	

Notes: The three educational attainment variables are each regressed by probit, separately on each of the background variables listed in the first column. Marginal effects are reported. Parental education dummy variables represents maximum attained and so are mutually exclusive categories.

[11] See Haveman and Wolfe (1995) for a summary, Leslie and Drinkwater (1999) for a recent consideration of the staying-on rates of ethnic minorities in the UK and Hill and O'Neill (1994) for an analysis of third-generation effects.

In terms of these raw cell mean associations, income is clearly important, there are strong association of children's education attainments with parental education and also with grand-fathers' SES. The association with mother's degree is particularly strong. Only 3% of the 224 children whose mother has a degree failed to get at least one O'Level and nearly three-quarters went on to get a degree themselves. Children from Asian families are much more likely to stay on and achieve further qualifications that those from the ethnic majority. Children from West-Indian families are less likely to get these qualifications, although this association is not significant. These are standard results.

In Table 5.7, we control for all of these background factors together with a wider range of variables, similar to those in previous chapters, and the age ten attributes and abilities[12]. Table 5.7 reports the results from regression on the full set of independent variables. Some collinearity is clearly to be expected with so many background variables. However, this procedure allows us to see which background variables dominate and still assess the extent to which age ten scores merely pick up background effects but have no further predictive power once we control for background directly. Broadly, how much significant human capital has been accumulated by age ten and how are future educational attainments then influenced by background factors? Measurement error will reduce the magnitude of age ten scores and so the results in answer to the first question can be thought of as a descriptive lower bound. We find that although there is a significant reduction in some of the age ten score parameters the broad picture remains. Moreover, controlling for age ten abilities highlights a number of interesting features of the importance of family background and illuminates the nature of the inter-generational transmission of educational inequality.

[12] We condition, for example, not just on SES1 but on dummy variables for all SES groups. Similarly finer specifications are introduced for the parental education and grand-fathers' SES variables. The "general family background" variables are number of older and younger children, parental interest in education, the mother's age, absent parents and a dummy variable on children being in a residential home.

Table 5.7: *Probit regression of minimum educational qualifications on family background, and age ten attributes and abilities.*

	O'Level dF/dx *100	(S.E.) *100	A'Level dF/dx *100	(S.E.) *100	Degree dF/dx *100	(S.E.) *100
Maths	5.60	(0.8)	9.79	(1.2)	5.81	(0.7)
Reading	7.64	(0.8)	10.34	(1.2)	5.21	(0.8)
Locus of Control	2.51	(0.6)	4.12	(0.8)	2.28	(0.5)
Self-esteem	0.64	(0.5)	0.18	(0.8)	-0.35	(0.5)
Anti-social	0.51	(0.7)	0.07	(1.1)	0.68	(0.7)
Peer relations	-1.00	(0.7)	-1.14	(0.9)	-0.98	(0.6)
Attentiveness	5.50	(0.7)	7.73	(1.1)	5.26	(0.7)
Extraversion	-1.08	(0.6)	-2.33	(0.9)	-0.41	(0.5)
Selected other variables						
Girl	2.91	(1.0)	-0.24	(1.4)	-2.46	(0.9)
Number of older siblings	-2.11	(0.5)	-3.36	(0.8)	-2.11	(0.5)
Income (£100)	2.17	(1.1)	3.88	(1.4)	2.67	(0.8)
Mother's age	0.40	(0.1)	0.84	(0.2)	0.63	(0.1)
West-Indian parents	12.11	(1.5)	42.60	(7.3)	24.56	(10.5)
Asian parents	14.32	(0.9)	46.66	(6.2)	35.00	(8.2)
Father SES1	7.13	(2.9)	17.99	(6.9)	12.89	(7.0)
Mother O'level/vocational	4.27	(1.2)	7.86	(1.8)	6.05	(1.2)
Mother A'Level	5.43	(2.0)	12.01	(3.2)	12.47	(2.6)
Mother degree	10.69	(2.8)	24.37	(6.0)	20.16	(4.7)
Father O'level/vocational	-0.96	(1.3)	2.38	(1.9)	1.32	(1.3)
Father A'Level	3.12	(1.9)	1.42	(2.8)	1.06	(1.8)
Father degree	2.95	(2.5)	14.50	(3.4)	6.36	(2.3)
Mother's father SES1	3.13	(4.3)	13.78	(6.5)	11.67	(5.1)
Father's father SES1	7.45	(3.8)	6.26	(6.4)	2.26	(3.8)
P-value of Control variables						
General family background		0.000		0.000		0.000
Ethnicity		0.000		0.000		0.000
Father's SES		0.040		0.000		0.007
Mother's SES		0.040		0.003		0.054
Mother's quals		0.001		0.000		0.000
Father's quals		0.123		0.000		0.008
Mother's father's SES		0.854		0.170		0.000
Father's father's SES		0.095		0.011		0.330
Region		0.000		0.000		0.444
Observations	5968		5992		5979	
R-squared	0.27		0.30		0.33	

Notes: When either parent was absent parental variables were set at zero and dummy variables were introduced as a control. Missing values are set to the variable's average value and indicated by a 0/1 control variable. This reduces standard errors. Parameter estimates for these dummy variables are not reported but do not have large or significant effects on results.

Academic ability tests pick up the influence of personal background quite strongly because of their stronger correlation with the added variables. The maths and reading score parameters fall by between 1.9 and 3.4 standard errors in the three regressions. However, overall, even conditioning on all this background information, academic scores still carry considerable additional forecast information. Only 35% of children in the bottom quintile of age ten reading scores, for example, are predicted to get even one O'Level or CSE equivalent as compared with 95% of top quintile children. Thus, even knowing about the family background of children, performance by age ten is itself crucial for further development[13].

Moreover, non-academic scores at age ten also still provide predictive power and the broad pattern described above is maintained. The attentiveness score falls by only just over one standard error in the degree regression and less elsewhere. The extraversion score becomes significantly negative for the A'Level probability. The other age ten scores, in particular attentiveness and locus of control, are not simply proxies for background effects, although they are, to some extent, channels for them[14].

Family background, however, is still a strong predictor of educational progress, even given age ten ability. SES matters but parental education has a still more substantial effect. Having a mother with a degree adds 11, 24 and 20 percentage points to the probabilities of attaining an O'Level, A'level and degree, respectively, controlling for the age ten scores and all background variables. These are very large magnitudes, roughly equivalent to four standard deviations gain in maths ability for the degree probability of the sample child. The education of the father is also important, although less so than that of the mother. This mirrors, in early adulthood, the effects of parental education in early childhood discussed in Chapter 3. A child whose parents are both educated to degree level

[13] The equivalent A'level probabilities are 4% for the bottom quintile and 62% for those in the top reading quintile by age ten. The degree probabilities are 1% and 41%.

[14] That they are channels can be observed from the discovery that with no age ten scores entered the marginal effect of having a father in SES1 on the O'Level probability is 16.2 (standard error, 1.8). When age ten scores are entered this falls to 9.5 (standard error, 2.4), a change significant at 1%. Even when only non-academic age ten scores (i.e. those other than maths and reading) are entered this falls to 12.9 (standard error, 2.0), a change also significant at 1%. The reductions in the association of SES1 with A'Level and degree probabilities when all age ten scores or only non-academic abilities are included are also significant at 1%. The combined test of changes in both SES1 and SES2 associations are all also significant at 1%. In fact, even when the non-academic scores are added to regressions that include the academic scores the change in association with SES1 is significant at 1% for the A'Level and Degree probabilities and at 5% for the O'Level probability. Similar levels of significance are recorded for the joint tests of changes in both SES1 and SES2 associations.

is 39 points more likely to get at least one A'Level than a child with the same level of age ten ability but whose parents do not have any qualifications.

The magnitude of the parental education parameters compared to that of the SES variables is important because it is currently standard Ofsted practice to control, broadly, for the average SES of a school's intake when estimating the quality effect of individual schools. The residual element of school performance that cannot be explained by SES is considered to be the result of the school quality. Failure to consider sufficient conditioning variables will, on this evidence, clearly allocate value-added responsibility to schools that is actually due to the education levels of the parents of the schools' intake. Income is also important. Increasing family income by £100 adds four points to the probability of a child getting at least one A'Level. The age of the mother and the number of older children also proved to be important. The child of a mother ten years older than average will be six points more likely to get a degree. Each older sibling reduces this probability by two points[15].

It is striking (though a standard finding) that when we condition for age ten ability, children of West-Indian parents are much more likely to gain qualifications than are children from the ethnic majority. Thus, as Table 5.6 shows, although they are nearly six points less likely than the default group to get a degree overall, West-Indian children are twenty-five points more likely to get a degree, once we control for age ten ability[16]. More generally, given their age ten performance children from all ethnic minorities are more likely to stay on and do well at school than children from the ethnic majority. This might reflect extra pressure for children to gain qualifications to overcome discrimination or poor contacts in the labour market or, alternatively, a higher degree of educational culture within families. It also suggests that ethnic educational inequality begins in primary school or earlier.

Region at age ten appears to be important for O' and A'Level probabilities but is insignificant even at 20% for the degree probability. This is mainly due to the fact that

[15] The number of younger siblings was not significant, neither were the other family control variables. Chapter 4 shows parental interest to be the most important determinant of educational success but this was using NCDS data which has better measures of parental interest and for which parental interest is assessed at age sixteen.

[16] This is not an artefact of conditioning on the other background variables but can be reproduced by conditioning solely on age ten reading and maths scores. It is not due, therefore, to the fact that parental education is commonly not observed for ethnic minority parents.

Scottish children have much higher O' or A'Level equivalent probabilities than English children and that this advantage is not maintained to degree level.

Another interesting feature of these data is that we have information not just on the occupational classification (SES) of fathers but also of paternal and maternal grandfathers. This enables us to identify effects across three generations. To the extent that staying on decisions are influenced by the opportunity cost of education, it is commonly expected (for example, Card, 1995, and Becker, 1967) that children from poorer families will be more likely to decline educational possibilities. Family income will, therefore, be positively associated with educational probabilities, as we find in Table 5.7, for this reason as well as due to other material benefits . Our family income variable, however, is only a snapshot of family income (in 1980) and might not be a good proxy for wealth. The SES of grandfathers will contain some proxy information on wealth through inheritance and so might be important for the educational probabilities of sample children. Grandfather's SES will also provide information about cultural capital. Table 5.7 shows that children whose maternal grandfather was in SES 1 are twelve points more likely to get a degree than other children of the same age ten ability. This is significant at 1% and equivalent to two standard errors of age ten maths ability[17].

Overall, then, although the age ten test scores are important predictors of subsequent educational attainment family background continues to play an important role through a number of channels. Children from more wealthy, more educated and professional families are more likely to progress academically, even given their age ten academic ability. As we see below in Section 5.3 this is a different picture to that for the inter-generational transmission of wages.

5.2.2. The importance of age ten abilities for the education probabilities of children in different SES groups

However, first we ask whether the age ten attributes play different roles for children from different kinds of background, in other words, whether there is evidence of important interaction terms.

[17] It is interesting that it is the effect of the mother's father that dominates for the A'Level and degree choices, counter to simple explanations by genetic endowment. The difference between parameters on the two grandfathers is, however, not significant.

Table 5.8 presents the results of probit regressions of qualification level on age ten skills and attributes interacted with terms for two groups of children, stratified by the social class rating of their families as assessed by the SES of fathers and grand-fathers[18]. For presentational economy, the O'Level regression is omitted from Table 5.8. In any case the more interesting results emerge for the higher level qualifications shown, as these involve a participation decision as well as educational success.

Table 5.8: *Predictive power of age ten reading, maths and attentiveness scores for children from different parental backgrounds.*

	A'Level		Degree	
	dF/dx *100	**p-value**	**dF/dx *100**	**p-value**
High SES				
Level	31.99	0.000	26.59	0.000
* Reading	3.96	0.344	3.11	0.219
* Maths	19.22	0.000	10.05	0.000
* Attentiveness	6.16	0.000	5.73	0.003
Medium SES*				
* Reading	14.03	0.000	8.32	0.000
* Maths	12.71	0.000	10.13	0.000
* Attentiveness	8.79	0.000	5.50	0.000
Low SES*				
Level	-9.07	0.002	-7.53	0.003
* Reading	19.20	0.000	10.97	0.006
* Maths	-0.16	0.678	-0.06	0.987
* Attentiveness	9.18	0.007	5.42	0.095
Obs	4202		4202	
Observed Probability	0.37		0.21	
P-value, H_o: High SES*Maths= High SES*Reading & LowSES Maths=LowSESReading				
	0.001		0.051	

Notes: Table 5.8 reports marginal effects for maths, reading and attentiveness scores from probit regressions of educational probabilities on these three age ten scores each interacted with membership of the three SES sub-groups. The default group is medium SES.

For the high SES group, the age ten maths score predicts A'Level and degree probabilities more effectively than does the reading score. For the low SES group this picture is reversed. Thus, a standard deviation of maths ability is associated with a nineteen per cent increase in A'Level probability for the high SES group, on top of the

[18] The high SES group had either a father or a grand-father in SES 1. The low SES group had fathers either in SES4 or SES5 and no grand-fathers on either side in SES1 or SES2. Results are robust to weaker or stronger restrictions on pooling.

thirty-two per cent gain for membership of that group. A standard deviation of reading ability, however, adds only four per cent. For the low SES group, on the other hand, the reading gain is nineteen per cent and the maths gain is zero.

This finding suggests that children, families and/or schools differ in how they respond to ability in forming expectations and support for further schooling. Thus, children in the high SES group are particularly likely to progress academically if they are performing well at maths at age ten rather than reading but for children from low SES backgrounds, the age ten maths score is not even a significant predictor of A'Level or degree probabilities[19]. A number of hypotheses suggest themselves. It may be that reading is more easily observed by low SES parents and so they are more likely to push or support children who are doing well at reading but may miss the signals provided by good maths performance. Another possibility is that, rather than differential information about age ten performance, families differ in their knowledge of the labour market and the returns to ability. It is also possible that, for whatever reason, maths is not well taught in the secondary schools attended by most of the low SES group and so the early ability is not developed.

Although it is not possible to identify the cause of this interaction, it does suggest a possible an hitherto unexplored channel for the perpetuation of educational and hence economic inequality. Future research must be based on better information about the formation of child and parental expectations.

It is also interesting to note that the attentiveness score is particularly important for the O'Level probability of low SES children[20]. The high SES children are likely to get O'Levels whatever their level of attentiveness early on but, one presumes, are more likely to progress after this if their interest in education is high. Low SES children, however, need to show attentiveness early on or risk being effectively selected out of education.

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[19] This finding is not due to there being more collinearity of maths and reading for children in the low SES group. The correlation coefficient for these children is 0.69 as opposed to 0.70 for the high SES children. It is also not the case that there are fewer low SES group children performing well at reading than at maths. Of 944 low SES group children, 121 were in the top quartile for maths, 131 for reading.

[20] For the high SES group the effect of a standard error of attentiveness is to increase the O'Level probability by only 2.35%, not significant even at 20%.The equivalent attentiveness interaction term for the low SES group is 6.95, significant at 5%.

5.3. Labour market outcomes

We now consider the question of whether age ten skills provide any predictive information for labour market outcomes. We consider first how age ten attributes and abilities influence participation.

5.3.1. Age ten scores and employment at age twenty-six

Discounting any initial unemployment in the three months after leaving full-time education, 35% of the twenty-six year olds in this survey had been in continuous employment since leaving education. A further 35% had experienced intermittent unemployment, the remainder having experienced spells of unemployment of over four months duration. Table 5.9 reports marginal effects of the age ten scores in predicting unemployment probabilities. Although we have omitted family and background variables they do not change the results in any substantive way. In line with the sequential methodology, we should also omit qualifications as they are obtained after the age ten scores. However, we include them in order to counter the observation that test scores might only be important for unemployment probabilities because of their implications for qualifications attained. It is also important to control for individuals with degrees because we find, for example, that males with degrees are 9% more likely to be unemployed for a period of over four months duration (significant at 1%) but of those males, graduates are 14% less likely to experience a spell that lasts more than a year (significant at 10%). This suggests that some unemployment is due to confidence about job search, leisure or delaying entry into the labour market. In any case, results are robust to the inclusion of qualifications. We also control for the age ten Local Education Authority as a proxy for local labour market conditions.

Table 5.9: *Probit regression of unemployment duration variable on age ten attributes and abilities.*

	Boys				Girls			
	(1) Unemployed > 4 months		(2) Unemployed > 12 months if column(1)=1		(3) Unemployed > 4 months		(4) Unemployed > 12 months if column(1)=1	
	Coef. *100	(S.E.) *100	Coef. *100	(S.E.) *100	Coef. *100	(S.E.) *100	Coef. *100	(S.E.) *100
Maths	-3.68	(1.6)	-2.05	(3.2)	-4.17	(1.3)	-3.63	(3.4)
Reading	0.66	(1.6)	-3.54	(3.2)	1.63	(1.3)	0.77	(3.1)
Locus of Control	0.47	(1.2)	3.88	(2.4)	-1.23	(1.0)	-5.00	(2.5)
Self-esteem	-0.83	(1.1)	-4.52	(2.3)	-1.53	(0.9)	6.19	(2.2)
Anti-social	4.14	(1.3)	-2.11	(2.6)	-0.05	(1.2)	3.66	(2.9)
Peer relations	-1.79	(1.2)	-3.49	(2.5)	-2.85	(1.1)	1.51	(2.8)
Attentiveness	-1.24	(1.4)	-0.59	(2.8)	-2.90	(1.3)	-3.39	(3.1)
Extraversion	-3.41	(1.2)	2.25	(2.3)	-0.19	(1.0)	-1.16	(2.5)
One O'Level	-6.75	(2.6)	-17.93	(4.9)	-8.97	(2.3)	-13.73	(5.1)
One A'Level	-2.74	(3.1)	2.18	(7.0)	-6.59	(2.3)	-12.18	(6.7)
Degree	9.22	(3.5)	-13.58	(6.6)	13.49	(3.3)	4.55	(8.6)
Observed		0.32		0.39		0.25		0.38
Pseudo R-squared		0.07		0.12		0.08		0.13
Observations		2604		789		3187		733

Notes: See discussion of Table 5.4 for the precise derivation of the dependent variable. As well as the specified variables controls are also introduced for the 123 age ten Local Education Areas. Parameters and standard errors are multiplied by 100 as in previous tables.

First, the age ten maths score dominates the reading score as a negative predictor of both male and female unemployment (columns 1 and 3). Reading ability becomes more important for reducing the conditional male long-term unemployment probability (column 2). Second, the anti-social behaviour score is as strong (and more precise) a predictor of male unemployment as the maths score. Going from the 20th to 80th percentile of the anti-social disorder range adds 6% to the likelihood of experiencing a serious episode of unemployment, i.e. of more than four months. This is roughly equivalent to the effect of getting at least one O'Level and might reflect influences of behaviour on success in interviews or be the result of the underlying disaffection that turns the individual away from labour market activities, making them both less attractive to employers and less interested. It might also be that boys who were anti-social at age ten have higher entry rates to unemployment later on. In fact, we observe in column (2), within the group of

those who have experienced a significant spell of unemployment, boys who were anti-social are not more likely to suffer a very long-term spell of unemployment. This supports the suggestion that boys with high anti-social scores are getting jobs and then losing them.

Third, extrovert boys are much less likely to experience unemployment, again with substantial range effects.

Fourth, anti-social behaviour and introversion are not strong predictors of shorter-term female unemployment which depends more on poor peer relations and inattentiveness. These effects may reflect a choice against paid work by individuals who are un-interested in school, their peers and labour force activity or they might indicate that it is harder for such individuals to find paid work.

Locus of control and self-esteem have important effects that differ between genders. For males, low self-esteem is a particularly strong indicator of the difference between those whose unemployment will be relatively short and those more likely to experience long-term unemployment. For those males who have been unemployed for more that four months, a standard error of self-esteem will reduce the probability of longer-term unemployment by 4.5%. The 20/80 range effect is 9%[21].

For girls, on the other hand, self-esteem is positively associated with the long-term unemployment probability and it is the locus of control score which predicts with the expected sign. Thus, girls with higher self-esteem are more likely to have long periods of unemployment. This result is robust to excluding girls who have had episodes out of the labour force, to excluding students or to controlling for the presence of children. The experiments with functional form, however, have shown that the finding may be due to differences between the tails of the distribution. When we include the dummy variables for being in the top or bottom decile of all eight scores we find that the self-esteem parameter is effectively zero (-2%, standard error; 3) but that the marginal effects are -27% (standard error; 5) for the lowest self-esteem decile and 43% (standard error; 11) for

[21] It should also be remembered that the unemployment variables are coded in the particular form described in the discussion to Table 5.4. Results, however, are reasonably robust to alternative codings. One such experiment was to code the unemployment variable to take a value of 0 for those who have been continously employed, 1 for those intermittently unemployed, 2 for those with a spell over four months, 3 for a spell of more than a year and 4 for a two year spell. An ordered probit regression then gives coefficients of 10.3 for the anti-social score (significant at 1%) and of -4.6 for self-esteem (significant at 10%). This maintains the broad pattern of the results given in Table 5.9 but loses some of the non-linearity that self-esteem is particularly important in distinguishing those able to emerge from shorter periods of unemployment from those perhaps more at risk of greater unemployment scaring.

those in the highest decile. It may be that self-esteem gives the confidence to stay out of work longer[22].

5.3.2. Age ten scores and earnings at age twenty-six

We next address earnings, first without conditioning on other intervening variables, although the regressions do control for region at age ten. The question being asked is: however sample members move through the maze of adolescent and early adult choices, what can we know about their future earnings from their age ten test scores? Methodologically, the approach adopted is to ignore the path through future choices such as industry sector or location and to consider how age ten attributes predict the subsequent economic outcome. Thus, sample members may choose to move into, for example, well-paid industries but, to the extent that this choice is correlated with the age ten attribute, this is taken to be part of the return to that attribute[23].

Whether or not we control for background variables, it can be seen in Table 5.10 that the age ten maths, reading and self-esteem scores strongly predict male market wages. In terms of the family background effects, the statistical effect of going from the 20th decile of self-esteem to the 80th is a 5.6% increase in the hourly wage. These are very large effects, equivalent to the effect of increasing family income during childhood by £100 a week or moving from a family headed by a male with no qualifications to one with A'Levels or a degree.

[22] These unemployment effects will be better assessed when the more detailed information from the 1999 sweep becomes available.

[23] It should be noted that only a small proportion of wage variance is explained because no age 26 environmental characteristics such as firm size, tenure, region of employment and so on, are included and qualifications are also so far omitted. Including regional and industry dummies as well as variables for the number of children and qualifications increases the R-squared to 0.36 for boys and 0.38 for girls.

Table 5.10: *OLS regression of log wages on family background, and age ten attributes and abilities.*

	Boys				Girls			
	Coeff *100	(S.E.) *100	Coeff *100	(S.E.) *100	Coeff *100	(S.E.) *100	Coeff *100	(S.E.) *100
Maths	3.76	(1.3)	3.10	(1.3)	5.77	(1.3)	4.91	(1.3)
Reading	4.00	(1.3)	2.87	(1.3)	4.05	(1.3)	3.18	(1.3)
Locus of Control	0.94	(1.0)	0.64	(1.0)	2.93	(0.9)	2.09	(0.9)
Self-esteem	3.15	(0.9)	2.78	(0.9)	1.22	(0.8)	0.93	(0.8)
Anti-social	-0.85	(1.1)	-0.78	(1.1)	2.77	(1.3)	3.00	(1.3)
Peer relations	0.62	(1.0)	0.51	(1.0)	2.52	(1.1)	2.69	(1.1)
Attentiveness	1.95	(1.2)	2.13	(1.2)	3.53	(1.3)	3.32	(1.3)
Extraversion	1.26	(0.9)	1.19	(0.9)	-0.55	(0.9)	-1.09	(0.9)
Selected other variables								
No. older siblings			0.49	(0.8)			-0.68	(0.9)
Income (£100)			5.54	(1.6)			7.61	(1.5)
Mother's age			-0.12	(0.2)			0.13	(0.2)
West-Indian parents			0.73	(11.2)			23.78	(9.9)
Asian parents			11.28	(8.8)			4.20	(8.2)
Father SES1			11.00	(6.5)			6.90	(6.6)
Mother O'level/voc'l			1.39	(2.0)			1.39	(1.9)
Mother A'Level			8.45	(3.5)			-2.42	(3.2)
Mother degree			0.17	(5.1)			9.26	(5.2)
Father O'level/voc'l			3.92	(2.2)			-1.57	(2.1)
Father A'Level			4.04	(3.1)			-4.59	(3.0)
Father degree			6.77	(3.4)			-1.13	(3.4)
Mother's father SES1			-2.80	(6.2)			2.00	(5.9)
Father's father SES1			4.45	(6.3)			5.98	(7.1)
Control variable, P-val.								
General background				0.008				0.000
Ethnicity				0.307				0.283
Father's SES				0.290				0.553
Mother's SES				0.040				0.931
Mother's quals				0.101				0.123
Father's quals				0.179				0.496
Mother's father's SES				0.880				0.814
Father's father's SES				0.879				0.382
Region		0.000		0.000		0.000		0.000
Constant	169.1	(1.5)	151.0	(12.3)	158.2	(1.5)	138.6	(11.7)
Observations		2019		2019		2171		2171
R-squared		0.12		0.16		0.14		0.18

Notes: As in previous tables parameters are multiplied by 100 to give percentage returns for one standard deviation change in age ten score. Observations with unreported qualifications or family background are dropped. Absent parents or missing values were treated as in Table 5.7.

For female earnings, however, self-esteem does not play a significant role but the locus of control and behavioural scores are much more important. Controlling for parental background, the effect of going from 20th to 80th decile of attentiveness is a 6.3% increase in wages, the same as the 20/80 range effect for the reading distribution and roughly equivalent to £100 per week more family income during childhood. The range effect of increasing the peer relations score is also high at 5%. All of these results are robust to controlling for part-time working. It is interesting that the anti-social score enters positively for female wages, suggesting that teachers rate more motivated or ambitious girls as less "social." Thus, it may be that the underlying attributes assessed by the age ten scores have different labour market rewards for men and women but also that the underlying attributes are themselves gender-specific.

Taken together, Tables 5.9 and 5.10 suggest strongly that more attention might be paid to the non-academic behaviour and development of children as a means of identifying future difficulties and labour market opportunities. It also suggests that schooling ought not be assessed solely on the basis of the production of reading and maths ability. There might be economic returns to thinking more imaginatively about the role of schooling and the way schools interact with families and children in generating well-educated, productive but also well-rounded and confident individuals. We consider this issue in the concluding section below.

It is also important to note that the effect of the family background variables is much weaker for market productivity than for educational progress. There are a number of interesting differences. Family income plays a much more substantial role for wages than for education. Mother's education and grand-parents' social class is much less important although mother's degree does carry substantial weight for the prediction of daughters' wages. Children of older mothers are not predicted to earn more even though they are predicted to progress further educationally. The p-values in Table 5.10 show that fathers' qualifications or SES, ethnicity and grandfathers' SES are not significant sets of controls in the earnings equation although they were very important in the qualifications regressions in Table 5.7.

Future earnings appear, on this analysis, to be governed by a different set of factors than future educational progress which is influenced to a greater extent by family background factors that proxy the cultural environment of the child. Market productivity is not, therefore, the later correlate of education production, governed by the same factors,

simply transferred to the labour market. This picture is supported by the fact that different age ten tests scores are important for predicting the two sets of achievements. For educational progress, the locus of control and attentiveness are particularly important. For income, peer relations and self-esteem plays a much greater role. Moreover, whereas anti-social behaviour is strongly associated with male unemployment probabilities, it plays little role for earnings.

I emphasise the distinction between productivity and the production of productivity in order to bring attention to the social and psychological complexity of each. This is important to modern economics. Human capital is central to much endogenous growth theory, for example, as well as to the analysis of inequality. In modelling the relationship of human capital and growth rates, it may be important to recognise the complexity of the process of human capital production on the one hand and the links between what is produced and productivity, on the other.

5.3.3. The returns to education

From Table 5.11, below, it is apparent that a number of the age ten scores are important for wages even conditioning on qualifications. Academic ability scores are less important when qualifications are taken into account although there is some direct earnings return to academic ability in addition to the indirect return through qualifications. Conditioning on qualifications, self-esteem is the most quantitatively important age ten test score for male earnings. The parameter estimate is not significantly reduced when qualifications are introduced into the model. The estimate on locus of control for female earnings falls by more because of its strong association with educational progress but is still significant (at 5%) and of non-negligible magnitude. There does, therefore appear to be a return to locus of control for women in addition to the indirect benefit that it is associated with higher levels of education.

Table 5.11: *Wage equations with qualifications.*

	Males		Females	
	Coef. *100	(S.E.) *100	Coef. *100	(S.E.) *100
Maths	1.96	(1.3)	3.69	(1.3)
Reading	2.46	(1.3)	1.34	(1.3)
Locus of Control	0.64	(0.9)	1.86	(0.9)
Self-esteem	2.86	(0.9)	1.01	(0.8)
Anti-social	-0.64	(1.1)	3.04	(1.3)
Peer relations	1.01	(1.0)	2.88	(1.0)
Attentiveness	0.72	(1.2)	2.34	(1.3)
Extraversion	1.28	(0.9)	-0.41	(0.9)
At least one O'Level	4.81	(2.1)	9.09	(2.3)
At least one A'Level	5.19	(2.3)	10.76	(2.1)
Degree	7.67	(2.6)	5.82	(2.4)
Pseudo R-squared		0.14		0.18
Observations		2019		2171

Notes: Coefficients and standard errors are multiplied by 100. Standard errors in brackets.

Omission of maths and reading scores leads to ability bias in estimates of the return to education. This is well-established (see, for example, Dearden, 1998). However because of the relatively low correlation of non-academic ability and qualifications, no significant bias arises from omission of the psychological and behavioural scores so long as academic ability is included[24].

It might be argued that since age ten academic ability is measured with error, the non-academic variables are biased upwards. As a check of robustness, therefore, experiments have been made in which the intellectual ability scores are instrumented by earlier scores taken at age five. The maths and reading scores were replaced by a single ability measure, the British Ability Scale, a composite test of maths and reading, see Butler (1987). This means that only one variable needs to be instrumented. The

[24] In our data, when no age ten scores are included, the returns to the three educational qualifications for males are 9.6%, 8.1% and 10.0% respectively, where returns to higher qualifications must be added to those already attained so that the degree return, for example, is 27.7%. These fall to 5.5%, 5.7% and a further 7.9% when the maths and reading scores are included. The degree return falls, therefore, to 19.1%. The test that the changes are not jointly significant is rejected at 5%. However, adding the other age ten scores only reduces the education returns to 4.9%, 5.1% and 7.6% and the test of no joint change is not rejected even at 20%. The parameters do, however, all fall in magnitude which highlights the difficulty of measuring any precise investment return to education.

instruments are test scores from the earlier (1975), age five sweep of the data. There was some evidence that measurement error is important but only for the male wage equation. In neither case, however, was there any significant and substantive change in the important psychological or behavioural age ten scores[25].

5.4. Conclusions to Chapter 5

This chapter has found substantial labour market returns to non-academic human capital production. Although this does not in any way offset the importance of Government programmes to improve literacy and numeracy, it does suggest that there is a possible economic return to thinking more broadly about the benefits and possibilities of schooling.

To summarise, attentiveness in school has been shown to be a key aspect of human capital production, also influencing female wages even conditioning on qualifications. Boys with high level of conduct disorder are much more likely to experience unemployment but higher self-esteem will both reduce the liklihood of that unemployment lasting more than a year and, for all males, increase wages. The locus of control measure of psychological development is an important predictor of female wages reflecting, perhaps, the fact that the observed self-esteem of boys is higher than that of girls. Good peer relations are important in the labour market, particularly for girls, reducing the probability of unemployment and increasing female wages.

Moreover, these behavioural and psychological measures have been shown to be important channels of the inter-generational transmission of inequality. Although it is far from being the case that these scores explain all the variance in outcomes that would otherwise be proxied by social class differences, they have been shown to do so to a significant extent. Given the implications of these observations for inequality and growth the question is whether or not Government-led interventions can influence how children develop in the ways assessed by these tests. The two main institutions for achieving this are, of course, families and schools, although peer groups and wider communities are

[25] F-statistics from regression of the instruments on the endogenous variable are, not surprisingly, very high, 45.0 and 30.6. Exclusion restrictions are also clearly satisfied with sargan tests of instruments on residuals of 0.925 for the male regression and 0.996 for the female wage equation. This is, again, not surprising given the plethora of age ten information. The self-esteem parameter for males is unchanged as were the locus of control and peer relations parameters for women. The attentiveness score becomes much

important links and conditioning factors between these two. That parenting is the crucial arena for the development of the kind of human capital emphasised in this chapter can be seen from Table 5.12 which reports ordinary least squares regressions of age ten scores on proxy measures of schooling and parenting quality.

Table 5.12: *Estimation of age ten scores.*

	Maths		**Locus of control**		**Self-esteem**		**Conduct disorder**	
	Est.	(s.e.)	Est.	(s.e.)	Est.	(s.e.)	Est.	(s.e.)
Girl	-0.09	(0.02)	-0.18	(0.02)	-0.24	(0.02)	-0.25	(0.02)
Schooling								
Good peers	0.15	(0.02)	0.03	(0.03)	0.01	(0.03)	-0.02	(0.03)
Bad peers	-0.20	(0.02)	-0.05	(0.02)	-0.03	(0.02)	0.06	(0.02)
No instructional reading	0.21	(0.04)	0.15	(0.04)	0.09	(0.04)	-0.19	(0.04)
No sport in curriculum	-0.16	(0.02)	-0.12	(0.02)	-0.12	(0.02)	-0.01	(0.02)
Parental attitudes								
Mother hostile	-0.18	(0.15)	-0.26	(0.17)	-0.41	(0.17)	1.48	(0.16)
Father hostile	-0.43	(0.18)	-0.36	(0.20)	-0.10	(0.20)	0.67	(0.19)
Father's interest in education	0.36	(0.08)	0.39	(0.09)	0.32	(0.09)	-0.53	(0.08)
Mother's interest in education	0.90	(0.07)	0.63	(0.08)	0.33	(0.08)	-0.79	(0.08)
Parental background								
No mother	-0.07	(0.11)	-0.08	(0.12)	-0.30	(0.12)	0.34	(0.12)
Number of siblings	-0.04	(0.01)	-0.03	(0.01)	-0.03	(0.01)	0.01	(0.01)
High SES	0.45	(0.05)	0.36	(0.05)	0.16	(0.06)	-0.03	(0.05)
Medium SES	0.21	(0.05)	0.20	(0.05)	0.06	(0.05)	-0.01	(0.05)
Mother O'level/vocational	0.18	(0.02)	0.15	(0.02)	0.06	(0.02)	0.00	(0.02)
Mother A'Level	0.38	(0.04)	0.27	(0.04)	0.09	(0.04)	-0.01	(0.04)
Mother degree	0.60	(0.06)	0.42	(0.07)	0.23	(0.07)	-0.10	(0.07)
Constant	-0.87	(0.07)	-0.67	(0.07)	-0.26	(0.07)	0.90	(0.07)
Observations	9699		9959		10017		10257	
R-squared	0.22		0.11		0.06		0.09	

(i) Children at special educational institutions excluded.

(ii) Schooling and parental attitude variables reported by teachers. The parental interest variables range from 0 to 0.75

(iii) Good peer group is a dummy variable indicating children in classes that have a high proportion of parents in professional occupations, a low proportion of parents in manual occupations and a high proportion of children judged by te teacher to be of good academic standard. The bad peer group indicates the opposite environment.

The estimated model groups boys and girls which obscures important differences between genders in the influence of the background and schooling variables. Crucially, however, the broad findings are the same across gender. Firstly, explanation of the psychological and behavioural variables is even less than that of the maths score which

smaller in the male wage equation but was in any case not significant at 5% in Table 5.10. The Hausman test t-statistic for change in instrumented variable is 2.3 for males, 0.5 for females.

has been shown in Chapter 4 to be only poorly explained by observed inputs. The production of these aspects of human capital are even more random and subject to unobserved heterogeneity than is the production of academic ability. The very large effect of maternal hostility on conduct dis-order and the insignificance of standard measures of SES and maternal education reflect the importance of only marginally systematic shocks to the development of individuals, relevant to economic outcomes as has been shown but subject to very individual-specific environmental influences. Social class and maternal education are more important for psychological capital but the R-squareds for these regressions are still lower than that for the explanation of maths.

Second, the explanatory role of schooling variables is substantially less than that of measures of parental interest and hostility. Partly, this may be due to the point just made that influences on behaviour and psychological development are very proximal to the individual. School peer groups, which have substantive and significant associations with maths ability, play no role in explaining psychological development. However, even for maths, parental attitudes are substantively more important than peer groups. These attitudes may well be linked to SES, poverty, housing and other aspects of material well-being since bad housing and the stress of low income, for example, are likely to lead to tensions in households that will be picked up by children. However, it is the tensions and attitudes that are the mediating factors in the production of human capital[26].

Third, schooling does appear to matter. Standard measures of school quality such as class size and school expenditures are commonly shown not to be statistically significant predictors of educational outcomes. In Table 5.12, instead, aspects of curricula are introduced. Children at schools which emphasise non-instructional teaching of reading, emphasising instead creative reading or reading for pleasure can be seen to score better in all four scores. To an extent, this may reflect selection effects but regressions do control for peer groups. In fact, the results hold for models run only on children in good peer groups. This suggests that the way children are taught can make a difference to their general development as well as to the production of academic ability. Similarly, children

[26] Although results are presented for regressions grouped by gender there were a number of interesting distinctions. Particularly revealing was the fact that for every score except conduct disorder maternal interest was more important for girls than for boys and paternal interest less important. Thus for maths, for example, the highest level of father's interest increases boys' scores by 0.52 (s.e.: 0.11) and girls' scores by 0.15 (0.11). The highest level of mother's interest increases boys' scores by 0.73 (0.11) and girls' scores by 1.07 (0.10). The maternal interest parameter was significantly higher in girls' maths scores than in those of boys at 1%. The reverse was true for the paternal interest parameter, again at 1%.

at schools in which no sport was scheduled in the curriculum also score worse for maths and the psychological variables. The effect on maths scores emphasises the fact that selection effects are important here and that the curriculum variables are also proxy measures for unobserved school quality and neighbourhood. However, the results imply that what happens in school is important.

Traditionally, the school and the local area have commonly been seen as the arenas most amenable to Government intervention. Most schooling is Government funded and much intervention to alleviate what used to be called poverty has been at the area level. Recently, however, the Government has emphasised early years as crucial and this has led to funding of the Sure-Start programme to support parenting skills. This is, in many ways, a new venture for Treasury-supported policy but the evidence of this chapter is that there are perhaps more considerable returns to such funding if schemes can influence behavioural and psychological development as well as the academic ability of children. It is not obvious that parental hostility, for example, can be seriously influenced by (self-selected) parenting classes but interventions at the margins may make a difference and the programme will, at the very least, be an important step towards better understanding of mechanisms for positively influencing the formative experiences of children. The contribution of this chapter is to show that the attempt may be worth making even in the purely economic terms of the Exchequer costs of unemployment or the generation of wealth.

Evidence has also been presented to suggest that different aspects of non-academic human capital are important for different labour market outcomes. For example, anti-social behaviour strongly predicts unemployment for males but self-esteem is more important for wages. Similarly, different academic abilities are important predictors for different groups of the population. Human capital is not, therefore, a single entity that develops along a single trajectory influencing every aspect of economic life. Skills and their production are much more diverse than this.

Finally, the findings of the chapter suggest that schooling choices and successes are not influenced solely by productivity forecasts but also by individual preferences, perhaps shaped by financial constraints and household attitudes. On these grounds, this chapter concludes that human capital production is a much more subtle and complex process than it has so far been possible to assess. A child of a given level of age ten ability has been shown to be 40% more likely to go on to A'Levels if his or her parents have

degrees. On average such a child will have better knowledge of the returns to education, better access to finance and a lower opportunity cost of earnings and time foregone. The experience of the child, however, is of the preference or willingness to stay-on. These tastes are obviously heavily influenced by the home environment. It will be left to further research to consider whether the actual returns to education depend on such preferences and how the tastes themselves are determined in the context of information about indivividual-specific potential returns based on knowledge of personal productivity.

5.5. Data Appendix to Chapter 5

Appendix Table A5.1: ***Mean wages by education and gender in the Labour Force Survey and BCS***

	LFS		BCS70	
	mean	s.d.	mean	s.d.
Male				
All	5.77	0.19	5.47	0.06
None	4.54	0.21	4.22	0.09
Other	4.76	0.25	4.57	0.11
Lower vocational	5.57	0.26	5.25	0.11
Middle vocational	5.81	0.33	5.34	0.15
A Levels	5.86	0.42	5.75	0.16
Higher vocational	6.79	0.43	5.99	0.16
Degree	7.33	2.02	6.30	0.30
Female				
All	5.28	0.19	4.97	0.07
None	3.85	0.24	4.24	0.05
Other	4.22	0.26	4.60	0.07
Lower vocational	5.13	0.26	4.73	0.09
Middle vocational	5.27	0.27	5.15	0.13
A Levels	5.60	0.27	5.18	0.26
Higher vocational	6.36	0.49	5.33	0.58
Degree	6.99	1.14	5.97	0.98

Notes: The table reports mean wages for all individuals aged between 24 and 30 for the LFS in the first quarter of 1996 and for all BCS individuals who are all aged 26 in 1996 sweep.

Chapter 6. Conclusions

The four papers in this thesis investigate the effects of different aspects of upbringing on human capital formation. The cumulative effects of material, attitudinal, schooling and peer group influences are brought out and considered at different stages of childhood. The thesis, therefore, brings together aspects of education, psychology and economics to see how the experiences of childhood help form the opportunities of later life. Abilities that are either created or sustained in early life help adults to respond to and create later economic circumstances. These are then passed on to the next generation with important implications for the economic welfare of individuals, communities and nations.

The first paper looks at pre-school institutions, emphasising the importance of selection and examining the endogeniety that results. This is an important issue econometrically because it may be that parents who choose to send their children to pre-schools may also help their children in other, unobserved ways that would otherwise then emerge as treatment effects. The paper develops a model of the allocation of day-time care for pre-school children and uses local area dummy variables to instrument for selection into pre-school as proxies for the cost and availability of pre-schools. This Instrumental Variables model gives substantially different results to those that ignore the endogeniety problem and suggests that substantially fewer benefits result from pre-schools than is often thought. There may even be negative results for academic development by the end of primary school from the loss of pre-school interactions with adults. The implications of this paper are that expanding pre-school provision cannot be done on the cheap. If pre-schools are to be genuine institutions of learning, appropriate to the age of participating children, and not just places for children to spend time, then considerably more resources need to be devoted to training of staff and to the maintenance of high carer-child ratios.

Perhaps more surprising is the persistence of some of the negative effects of poor quality provision. The second paper picks up on the endurance of these pre-school treatment effects by asking how much predictive power there is, generally, in early indicators of ability. This paper makes use of the unique longitudinal wealth of the 1970 Cohort data which includes measures of ability at 22 and 42 months for a sub-sample of cohort members, as well as information on adult outcomes. The paper shows that position in the distribution of scores, as early as 22 months, predicts final educational attainment

and hence, one assumes, earnings. Moreover, as well as showing that the effects of the domestic environment are so strong that children are already strongly sorted in the distribution of academic ability by social class before they have entered school, it is also the case that schooling appears to do very little to reduce or contain this process of fanning out once children enter school, although the relative decline of children of parents from the lowest socio-economic group is halted. Finally, the paper asks which aspects of social class are most associated with this pattern of development, finding that, in the early years particularly, it is the education of the mother which is much the most important aspect of the child's environment. This suggests that interactions between the child and the primary carer need to be better understood if interventions, such as teaching parenting skills to children in schools, are to seriously reduce educational inequality. There is not much evidence yet on which to base optimism but it may be that it is not only expensive material interventions that are productive.

The third paper also looks at the relative importance of different aspects of background and schooling for the development of ability, this time for 16 year olds. The paper finds that much the most important variable in predicting exam success and success in tests of maths and reading is the interest parents take in the education of their children, as assessed by teachers. This paper makes use of the changes in parental interest over time to develop instruments for parental interest and test for its endogeniety. In principle, this endogeniety bias could be either positive or negative depending on whether parents respond more actively to those children they perceive to be achieving or failing. In these data, however, endogeniety bias is found not to be a problem.

In regression analysis, the parental interest variable knocks out the effects of standard background variables such as the socio-economic classification of fathers or parental education. This suggests that these latter variables only proxy in a very broad sense for those features of the domestic environment that are more specifically important for the production of human capital. Time inputs such as helping with homework may be behind this result. Alternatively, attitudinal factors such as taking an interest, being concerned about teachers' reports or persuading children about the value of education may be more important. The effect of parental role models is another explanation. Crucially, however, further research should provide more detail about the cost-effectiveness of policies to influence the different factors underlying this result. It may be that there are possible interventions that are much cheaper than decreasing pupil-teacher

ratios and that are more effective because they influence the interactions between parents and children.

The final paper widens the focus of human capital to consider the importance of age ten psychological and behavioural development, alongside academic scores, in predicting final educational outcomes and age 26 labour market performance. The paper finds that self-esteem and other measures of psychological well-being are important for earnings and that behavioural scores, particularly anti-social behaviour, have predictive power for unemployment. Attentiveness in school is strongly associated with educational progress. Beyond these general findings, the paper also finds that different aspects of development are important for different outcomes. This strongly suggests that human capital should not be thought of too narrowly as a uni-dimensional concept of ability that begets all successes. Rather, economic success or failure depends on a diverse range of attributes which are determined by slightly different processes and have implications for different aspects of economic life. This also suggests that individuals may make decisions on the basis of self-assessments of their own comparative advantages. Moreover, different aspects of development are important predictors for different groups within the overall population, for example for stratification by gender or social class. Educational economics might gain from the application of models that endogenise this decision-making process in order to study whether or not changes in educational participation are socially optimal.

Finally, the paper also finds that, once these aspects of personality are controlled for, those environmental factors that are important in the production of educational human capital are very different to those that matter as inputs to the development of the productivity of the individual, as assessed by age 26 wages. Thus, although, for example, grandparents' social class is important in the educational staying on decisions at 16 and 18, it has no bearing on wages. Similar results hold for mother's age and for parental education which have very strong associations with the staying on decisions but not with wages. This suggests that the development of educational ability and the taste for it or the ability to finance it are influenced by different factors than those which lead to productivity itself. Factors that lead to the passing of exams are not altogether the same as those that lead to high productivity or wages. This is important because it highlights, again, the complexity of the process of human capital formation, different inputs being important for different outputs.

If there was to be one general conclusion of this thesis, it would be that interactions in the home between parents and children are so crucial in the early development of human capital that other institutions can, in general, at best, only intervene in the process and not determine the production of ability. Although wider influences such as peer groups become important later on, these domestic interactions continue to be important well into adolescence with important implications for economic welfare. It may be that interventions that have the capacity to support interactions between parents and children are more efficient at alleviating educational (and hence economic) inequality than interventions based around the material inputs to education such as school expenditures. However, much more research needs to be done on the cost-effectiveness of these different kinds of intervention.

Beyond this, however, it may be said that the returns to development are not just returns to academic ability but also to psychological and behavioural aspects of personality. These other aspects of development are important to economic outcomes and need considerably more attention from economists than has so far been possible. Finally, although it is parent-child interactions that dominate as inputs to the production of individual human capital, schooling institutions need not play a negligible role in ameliorating the circumstances of the poorest in society but, because of peer groups and selection processes, it is often the poorest who receive the worst schooling.

References

Akerheilm, K. (1995) "Does Class Size Matter." Economics of Education Review. **14**, 229-41.

Andersson, B-E. (1992) "Effects of Day-care on Cognitive and Socio-emotional Competence of Thirteen-year-old Swedish Schoolchildren." Child Development, **63**. 20-36

Angrist, J.D. and Krueger, A.B. (1991) "Does Compulsory School Attendance Effect Schooling and Earnings." Quarterly Journal of Economics, **106**, 979-1014.

Barro, R.J. and Sala-I-Martin, X., (1995). *Economic Growth.* McGraw-Hill Inc.

Bartholomew, D. (1973) *Stochastic Model for Social processes.* London: Wiley.

Becker, G.S., (1967). *Human Capital and the Personal Distribution of Income.* Ann Arbor: University of Michigan Press.

Becker, G.S. (1981) *A Treatise on the Family.* Harvard University Press, Cambridge, Mass.

Becker, G.S.(1991) *A Treatise on the Family.* Cambridge Mass: Harvard University Press.

Becker, G.S. and Lewis, H.G, (1973) "On the Interaction Between the Quantity and Quality of Children." Journal of Political Economy. Part II. March-April, S279-88.

Becker, G.S. and Tomes, N. (1979) "An Equilibrium Theory of the Distribution of Income and Inter-generational Mobility." Journal of Political Economy, **87**, Dec., 1153-89

Becker, G.S. and Tomes, N. (1986) "Human Capital and the Rise and Fall of Families." Journal of Labour Economics **4** (3 Part 2). S1-S39

Bee, H.L. (1969) "Social Class Differences in Maternal Teaching Strategies and Speech patterns." Development Psychology, **1**, 6

Ben-Porath, Y., (1967). "The Production of Human Capital and the Life-Cycle of Earnings," Journal of Political Economy, **75**, 352-65.

Benhabib, J and Spiegel, M.M., (1993). "The Role of Human Capital and Political Instability in Economic Development." Unpublished paper, New York University.

Berrueta-Clement, J., Schweinhart, L.J., Barnett, W.S., Epstein, A.S. and Weikart, D.P., (1984). "Changed Lives: the Effects of the Perry Pre-school Programme on Youths through Age Nineteen." Monograph of the High/Scope Educational Research Foundation. No. **8**.

Betts, J., (1995). "Does School Quality Matter? Evidence from the National Longitudinal Survey of Youth." The Review of Economic and Statistics, Vol. **77**, 231-250.

Blau, F.D. and Grossberg, A. (1990) "Maternal labour Supply and Children's Cognitive Development." NBER Working Paper Series, No. **3536**

Blaug, M., (1970). *An Introduction to the Economics of Education.* Penguin: Middlesex.

Blundell, R., Dearden, L., Goodman, A. and Reed, H., (1997). *Higher Education, Employment and Earnings in Britain.* Institute of Fiscal Studies

Borjas, G.S. (1995) "Ethnicity, Neighbourhoods and Human-Capital Externalities." American Economic Review. **85**, 365-89

Bowlby, J. (1953) *Child Care and the Growth of Love.* Pelican.

Bowlby, J. (1969) *Attachment.* New York: Basic Books

Brockner, J., (1988). *Self-Esteem at Work.* Lexington, Mass.: Lexington Books.

Bronfenbrenner, U. (1979) *The Ecology of Human Development: Experiments by Nature and Design.* Cambridge Mass: Harvard University Press.

Brooks-Gunn, J., Duncan, D.J., Klebenov, P.K., and Sealand, N. (1993) "Do Neighbourhoods Influence Child and Adolescent Development." American Journal of Sociology, **99**, 353-95.

Butler, N.R., Haslum, M.N., Barker, W. and Morris, A.C., (1982). *Child Health and Education Study: First Report to the Department of Education and Science on the 10-Year Follow-up.* University of Bristol, Department of Child Health.

Bynner, J., Ferri, E. and Shepherd, P., (1997). *Twenty-something in the 1990s.* Ashgate.

Card, D., (1994). "Earnings, Schooling and Ability Revisited." Research in Labour Economics, vol **14**, 23-48.

Card, D. and Krueger, A. (1992) "Does School Quality matter? Returns to Educationa nd the Characteristics of Public Schools in the US." Journal of Political Economy **100**, 1-40.

Case, A.C. and Katz, L.F. (1991) "The Company You Keep: The Effects of Family and Neighbourhood on Disadvantaged Youths." NBER Working Paper No **3705**, NBER.

CASE: Centre for Analysis of Social Exclusion, (1999). "Persistent Poverty and Lifetime Inequality: The Evidence. Proceedings from a Workshop held at H .M. Treasury." CASE Report, **5**, March.

Caspi, A., Moffitt, T.E., Entner Wright, B.R. and Silva, P.A., (1998). "Early Failure in the Labour Market: Childhood and Adolescent Predictors of Unemployment in the Transition to Adulthood." American Sociological Review, Vol. **63** (June:424-451).

CBI, (1995). *A Skills Passport.* London, CBI.

Chamberlain, R. and Davey, A., (1976). "Cross-sectional study of Developmental Test Items in Children aged 94-97 Weeks: Report of the British Births Child Study." Developmental Medicine and Child Neurology, **18**, 54-70.

Coleman, J.S., Campbell, E.Q., Hobson, C.J., McPartland, J., Mood, A.M., Weinfeld, F.D. and York R.L., (1966). *Equality of Educational Opportunity.* Washington D.C: US Government Printing Office.

Conners, C.K., (1969). "A Teacher rating scale for use in drug studies with children." American Journal of Psychiatry, **126**: 6, 884-8.

Coopersmith, S., (1967). *The Antecedents of Self-Esteem.* San Francisco: Freeman.

Culp, R.E., Applebaum, M.I., Osofsky, J.D., Levy, J.A., (1988). "Adolescent and Older Mothers: Comparison between Prenatal, Maternal variables and Newborn Interaction Measures." Infant Behaviour and Development **11**:353-362.

Damon, W. and Hart, D. (1982) "The development of self-understanding from infancy through adolescence." Child Development. Vol **53**(4): 841-864

Darlington, J.K. and Cullen, B.D. (1982) *Pilot Study of School Examination Performance and Associated Factors.* London:DES.

Davie, R. Butler, N. and Goldstein, H. (1972) *From Birth to Seven, A Report of the National Child Development Survey*, Longman.

Dearden, L., (1998). "Ability, Families, Education and Earnings in Britain." Unpublished mimeo., IFS, London.

Dearden, L., Ferri, J., and Meghir, C. (1997) "The Effect of School Quality on Educational Attainment and Wages." Institute of Fiscal Studies.

Desai, S., Chase-Londale, P.L. and Michael, R.T. "Mother or Market? Effects of Maternal Employment on the Intellectual Ability of 4-Year-Old Children." Demography, Vol. **26**, No. 4.

DfEE and Cabinet Office, (1996) *The Skills Audit: A Report from an Interdepartmental Group*, London: DfEE and Cabinet Office.

DfEE, (1999). *Sure-Start: A Guide for Trailblazers.* DfEE, London

Dougherty, T. and Haith, M., (1997). "Infant Expectations and Reaction Time as Predictors of Childhood Speed and Processing of IQ." Development Psychology, Vol **33**, No 1, 146-155.

Douglas, J.W.B. (1964) *The Home and The School*, MacGibbon & Kee

Douglas, J.W.B., Ross, J.M. and Simpson, H.R. (1968) *All Our Futures: A Longitudinal Survey of Secondary Education*, Peter Davies

Ehrenberg, R.G. and Brewer, D.J. (1994) "Do School and Teacher Characteristics Matter? Evidence from *High School and Beyond.*" Economics of Education Review, **13**, 1-17.

Evans, W.N., Oates,W.E. and Schwab, R.M.. (1992) "Measuring Peer Group Effects: A Study of Teenage Behaviour." Journal of Political Economy, **100s**, 966-91.

Foot, H., Morgan, M., and Shute, R. (1990) *Children Helping Children* Chichester: Wylie.

Gammage, P., (1975). *Socialisation, Schooling and Locus of Control*, Bristol University: PhD. thesis.

Gammage, P., (1982). *Children and Schooling: Issues in Childhood Socialisation.* George Allen & Unwin, London.

Glass, G., L Cahan, M.S., and Falby, N.. (1982) *School Class Size: Research and Policy* Beverly Hills: Sage

Goldsmith, A.H., Veum, J.R., and Darity, W. Jr., (1997). "The Impact of Psychological and Human Capital on Wages." Economic Inquiry, Vol. **XXXV**, 815-829.

Gorsuch, R.L., (1983). *Factor Analysis.* Hillsdale: Lawrence Erlbaum Associates.

Green, F., (1998). "The Value of Skills." Studies in Economics, University of Kent, **98/19**.

Gregg, P. and Machin, S. (1997) "Child Development and Success or Failure in the Youth Labour Market." Unpublished Mimeo.

Hanushek, E.A. (1986) "The Economics of Schooling: Production and Efficiency in Public Schools." Journal of Economic Literature. **24**, 1141-77

Hanushek, E.A.. (1992) "The Trade-off between Child Quantity and Quality" Journal of Political Economy, **100**, 84-117.

Harris, D.B., (1963). *Children's Drawings as Measures of Intellectual Maturity.* New York: Harcourt, Brace and World Inc.

Hausman, J. (1978), 'Specification Tests in Econometrics', Econometrica, **46**, pp1251-72

Haveman, R. and Wolfe, B. (1995), 'The Determinants of Children's Attainments: A Review of Methods and Findings', Journal of Economic Literature, **33**, pp. 1829-78.

Henderson, V, Mieszkowski, P. and Sauvageau, Y. (1978) *Peer Group Effects and Educational Production Functions*, Ottowa, Canada: Economic Council of Canada.

Hill, C.R. and Stafford, F.P. (1973) "Allocation of Time to Preschool Children and Educational Opportunity." Journal of Human Resources. **IX**, 3. pp323-341.

Hill, C.R. and Stafford, F.P. (1980) "Parental Care of Children: Time Diary estimates of Quantity, Predictability and Variety." Journal of Human Resources. **XV**, 2. pp219-239.

Hill,M.A. and O'Neill,-J. (1994) "Family Endowments and the Achievement of Young Children with Special Reference to the Underclass." Journal-of-Human-Resources. 29(4), Fall.

Howe, C. (1990) "Can the Age of Entry into Child-care and the Quality of Childcare Predict Adjustment in Kindergarten?" Developmental Psychology **26**, No. 2 292-303.

Jolliffe, I.T., (1986). *Principal Components Analysis.* New York:Springer-Verlag.

Jordan, N.C., Huttenlocher, J., Cohen Levine, S., (1992). "Differential Calculation Abilities in Young Children from Middle and Low Income Families." Developmental Psychology, Vol. **28**, 644-653.

Kaiser, H.F., (1960). "The Application of Electronic Computers to Factor Analysis." Educational and Psychological Measurement, **20**: 141-151.

Keltikangas-Jarvinen, L.,(1992). "Self-esteem as a Predictor of Future School Achievement." European Journal of Psychology of Education, Vol. **VII**, 2, 123-30.

Klebanov, P., Brooks-Gunn, J., McCarton, C. and McCormick, M., (1998). "The Contribution of Neighbourhood and Family Income to Developmental Test Scores over the First Three Years of Life." Child Development, Vol **96**, No. 5, 1420-1436.

Koppitz, E.M., (1968). *Psychological Evaluation of Children's Human Figure Drawings.* New York: Grure and Stratton.

Krueger, A.B., (1998). "Reassessing the View that American Schools are Broken." FRBNY Economic Policy Review, March.

Lawrence, D., (1973). *Improved Reading Through Counselling.* London: Ward Lock.

Lawrence, D., (1978). *Counselling Students with Reading Difficulties: A Handbook for Tutors and Organisors*. London: Good Reading.

Lawrence, D., (1981). "The development of a self-esteem questionnaire." British Journal of Educational Psychology. Vol **51**(2): 245-251.

Leibowitz, A. (1974) "Home Investments in Children." In Schultz, T.W. (ed.) *Economics of the Family*. University of Chicago Press, Chicago.

Liaw, F. and Brooks-Gunn, J., (1994). "Cumulative Familial Risks and Low Birth-Weight Children's Cognitive and Behavioural Development." Journal of Child Psychology, **23**, 360-372.

Liebowitz, A. (1974) "Home Investments in Children." Journal of Political Economy, **82**(2): 111-31.

Lucas, R. E. Jr., (1988). "On the Mechanics of Development Planning." Journal of Monetary Economics, **22**, 1, 3-42.

McCloskey, D.N., (1990). *If You're So Smart: The Narrative of Economic Expertise.* Chicago: University of Chicago Press, p13.

McKinney, F., Miller, P.J., Beier, I. and Bohannon, S.R., (1978). "Self-Concept, Delinquency, and Positive Peer culture." Criminology, Vol. **15**, 529-38.

Mincer, J., (1974). *Schooling, Experience and earnings*. NBER.

Mortimore, J. and Blackstone, T. (1980) *Disadvantage and Education*, Heinemann Educational Books, London.

Mroz, T.A. (1987) "The Sensitivity of an Empirical Model of Married Women"s Hours of Work to Economic and Statistical Assumptions." Econometrica, **55**, 765-99.

National Commission on Education, (1995). *Success Against the Odds: Effective Schools in Disadvantaged Areas*. London: Routledge.

Neligan, G. and Prudham, D., (1969). "Norms for Four Standard Development Milestones by Sex, Social Class and Palce in Family." Developmental Medicine and Child Neurology, **11**, 413.

Neumark, D., (1994). "Biases in Twin Estimates of the Return to Schooling: A Note on Recent Research." NBER Technical Working paper No. **158**, Cambridge, MA.

Nowicki, S., and Strickland, B.R., (1973). "A Locus of Control Scale for Children." Journal of Consulting and Clinical Psychology, **40**, 148-154.

OFSTED (1995) *Class Size and the Quality of Education*. HMSO.

OFSTED, (1998). Secondary Education 1993-97. *A Review of Secondary Schools in England*. London: OFSTED

Osborn, A.F. and Milbank, J.E. (1987) *The Effects of Early Education: A Report from the Child Health and Education Study.* Clarendon Press, Oxford.

Osborn, A.F., Butler, N.R. and Morris, A.C. (1984) *The Social Life of Britain's Five-year-olds, a report of the Child Health and Education Study*, London: Routledge and Kegan Paul.

Parke, R.D. and Gary W.L. (eds.) (1992) *Family-Peer Relationships: Models of Linkage.* Lawrence Erlbaum.

Plowden, B.H., (1967). *The Plowden Report: Children and their primary schools : a report of the Central Advisory Council of Education, England.* Central Advisory Council for Education (England), HMSO London,

Purkey, W.W., (1970). *Self-Concept and School Achievement.* New York: Prentice Hall

Robertson D. and J. Symons (1996) "Do Peer Groups Matter? Peer Group Versus Schooling Effects on Academic Attainment", London School of Economics, Centre for Economic Performance, Discussion Paper No **311**.

Romer, P., (1986). "Increasing Returns and Long-Run Growth." Journal of Political Economy, **94**, 5, 1002-1037

Rosenberg, M., (1965). *Society and the adolescent Self-Image.* Princeton, N.J.: Princeton University Press.

Rotter, J.B., (1954). *Social Learning and Clinical Psychology.* New York: Prentice Hall.

Rutter, M., (1967). "A Children's Behaviour Questionnaire for Completion by Teachers: Preliminary Findings." Journal of Child Psychology and Psychiatry, Vol **8**, pp1-11.

Rutter, M. (1987) "Continuities and Discontinuities from Infancy," in The Handbook of Infant Development, Osofsy, J.D., (ed.). John Wiley and Sons: New York.

Rutter, M., Tizard, J. and Whitmore, K., (1970). *Education, Health and Behaviour.* Longman: London.

Rutter, M.L. and Madge, N. (1976) *Cycles of Disadvantage*, Heinemann.

Sanford, M., Offord, D., McLeod, K., Boyle, M., Byrne, C. and Hall, B., (1993). "Pathways into the Workforce: Antecedents of School and Workforce Status." Journal of the American Academy of Child and Adolescent Psychiatry, **33**:7, September.

Sargan, D. (1988) *Lectures on Advanced Econometric Theory.* Oxford: Blackwell.

Schneider, B. (1993) *Children"s Social Competence in Context: the Contribution of Family, School and Culture.* Ottowa:University of Ottowa.

Schulz, T.W., (1961a). "Investment in Human Capital." American Economic Review, **51**, 1-17.

Schulz, T.W., (1961b). "Investment in Human Capital: reply." American Economic Review, **52**, 4, 1026-1035.

Schweinhart, L., Weikart, C. and Larner, M. (1986) "Consequences of Three Pre-school Curriculum Models through Age Fifteen." Early Education Research Quarterly, **1**, 15-45.

Shaffer, H.G., (1961). "Investment in Human Capital: comment." American Economic Review, **52**, 4, 1026-1035.

Shavelson, R. and Marsh, H.W., (1986). "Self-concept: Its multifaceted, hierarchical structure." Educational-Psychologist. Vol **20**(3): 107-123

Shorrocks, A. (1978) "The Measurement of Mobility." Econometrica, vol **46**, pp 1013-24

Staiger,D. and Stock, J. (1997) "Instrumental Variables Regression with Weak Instruments." Econometrica Vol **65**, No.3, May, 557-586.

Stevenson, H. and Newman, R., (1986). "Long-Term Prediction of Achievement and Attitudes in Mathematics and Reading." Child Development, **57**, 646-659.

Stott, P (1965) *Manual of the Bristol Social Adjustment Guide*, unpublished, available from the ESRC Data Archive, University of essx, Colchester.

Thomas, J.B., (1973). *Self-Concept in Psychology and Education: A Review of Research.* Windsor: NFER.

Waldfogel, J., (1999) "Early Childhood Interventions and Outcomes." CASE paper **21**. Centre for the Analysis of Social Exclusion, London School of Economics.

Wilson, R.S., (1977) "Mental Development in Twins." In Oliverio, A. (Ed.), *Genetics, Environment and Intelligence.* Amsterdam: North Holland.

Zeanah, C.H., Boris, N.W. and Larrieu, J.A., (1997). "Infant Development and Developmental Risk: A Review of the Past Ten Years." Journal of the American Academy of Child and Adolescent Psychiatry, **36**:2, February.