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Pre-school Education and Attainment in the NCDS and BCS

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Abstract

This paper considers the effect of how children pass time before entrance to school on attainment in primary school. We find in NCDS data that children perform marginally better at seven and eleven if they spent time with their mother, or at a pre-school, rather than in informal care. This holds when one controls for parental education, social class, and assessed parental interest in the child's education, as well as the quality of the peer group. In the BCS, however, time spent in nurseries effected no improvement in maths at ten as compared to time in informal care and pre-school children were performing much worse in reading. This worse performance was traceable to reduced vocabulary at five. 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.

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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. Parents in particular are concerned about the quality of education their children receive. For pre-school children, this is especially pertinent now that it is common for both parents to be working. This study 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* 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 Child Health and Education Study, now known as the British 1970 Cohort Study (BCS), which follows all children born in Britain in one week in April 1970. Further information on family background, pre-school experience and attainment was gathered when the children were five and ten years old. 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 as an independent variable, they do not allow for any interaction between mother's labour force 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, 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 3 discusses the results. The final section concludes.

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). 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 (informal care)

and is given by

$$a = a_m h_m + a_p h_p + a_o h_o \tag{1}$$

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

$$1 = h_m + h_p + h_o \quad \text{(child's time);} \tag{2}$$
$$1 = h_m + n + l \quad \text{(mother's time),} \tag{3}$$

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

$$y + nw_m = c + h_n p_p + h_o p_o \tag{4}$$

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 non-pre-school care respectively. The household's static optimisation problem is captured by a utility function

$$u = u(c, l, a) \tag{5}$$

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

$$h_m = h_m(y, w_m, p_p, p_o) \qquad h_p = h_p(y, w_m, p_p, p_o) \tag{6}$$

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

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

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). 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 availablity 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.

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 test is considered a good measure of cognitive development (Osborn *et al*, 1984). At age ten, as with the NCDS, we have measures of mathematics, reading and social development.

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, *ie* 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 nine 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 per cent of BCS children attended some form of pre-school provision, excluding those who started school early. In the NCDS, only 20 per cent 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 per cent. (These variables are described in more detail in the Data Appendix.) 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 per cent of NCDS children attended playgroups compared to 46 per cent of BCS children. If we exclude playgroups the participation rate in the BCS falls from 72 per cent to 48 per cent. 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 1.

Table 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 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 2-5, we loosely group our explanators into five main classes. 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.

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 Feinstein and Symons (1997) 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 per cent 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 2-5 are computed on this basis. With the instrument set filtered in this way, Sargan tests are no longer significant at the 1 per cent level for any of the six regressions in the NCDS data. None of the Sargan tests in the BCS were significant at the 1 per cent level so we did not repeat the above exercise for the BCS.

Estimates of (7) for the NCDS sample are presented in Table 2 for the three measures of attainment at seven years: mathematics score, reading score and social adjustment.

Table 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 peergroup 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 per cent 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, *ie* 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. We discuss the importance of parental interest in more detail in Feinstein & Symons (1997). 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 per cent 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 all three 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 3 gives the results of similar regressions at five years in the BCS for copying,

vocabulary and social adjustment. 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 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 vocab at five in the BCS.

Table 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.

Generally, the pattern of effects of the other variables in Table 3 is similar to that in Table 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.[1]

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 vocab 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 4 and 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 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 is also nowhere significant. Parental interest is very important in both data sets.

[1] In Feinstein and Symons (1997) we show that parental interest drives out the effects of other parental and family variables in attainment regressions.

Table 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 *	-3.1 (0.7)	1.4 (0.6)	1.4 (0.3)
	Mother working when child was 7 *	-3.9 (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 for Table 2. In addition to control for measurement error, the lagged dependent variable is instrumented by teachers assessments at 7.

Table 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 for Table 3. As in Table 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.

In the NCDS, 32 per cent of children were in streamed classes in primary school at age eleven (in 1969) as opposed to only 9 per cent of the BCS sample at age ten (in 1980). However, 44 per cent of the BCS were in streamed groups for maths and 40 per cent 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.

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 disadvantages 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 6 shows the overall effects of time distribution on mathematics and reading scores, factoring in the initial effects (Tables 2 and 3) through the lagged dependent variable.

Table 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_n and h_m in Tables 4 and 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 per cent. 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 1.

We noted above that the negative effect of pre-school hours on vocab 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 per cent level by that age.

Good data are available in the NCDS for attainment at sixteen. When we extend the model in Table 4 using the variables described in Feinstein and Symons (1997) we find that there are no persistent effects of pre-school time by that age, *ie* the total effects for pre-school attendance, equivalent to those in Table 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 per cent 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.

4. Robustness

Endogeneity and the Weak Instrument Problem

The results presented in Tables 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 endogenity 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 Feinstein and Symons (1997) we performed Hausman tests for similar variables in attainment regressions, finding significant endogeneity only for the lagged dependent variables and, marginally, for the parental interest variables. Here, we concentrate on the time allocation. In Table 7 we present Hausman tests of endogeneity for the hours variables in the first sweep of the two surveys. 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 per cent level in four out of the twelve regressions.

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

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.[2] Table A6 in

[2] 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

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 8.

Looking first at the 2SLS results, note that bias is almost always significant, at high levels.[3] 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 per cent 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 the sample of estimates from normality for any of the models.[4] Moreover, there appears to be roughly Gaussian weight in the tails of the empirical distribution.[5] 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 2-5.

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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identical distributions even if one has ten and the other has a million observations.

[3] Recall that the reported standard deviation in parentheses in Table 8 must be divided by 10 to give the standard error of the bias.

[4] 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.

[5] 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 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 %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 8 (above) 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.[6]

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.

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 per cent level (maths at seven in the NCDS, vocabulary at five in the BCS) and both of these passed at the 1 per cent 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 regressions fail at the 1 per cent level and a further two at the 5 per cent level. It is not surprising that equating different quantities of pre-school participation is rejected by the data.

Comparison with the Findings of Osborn and 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 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 2-5.

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[6] 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.

Table 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 2-5, as are the other conditioning variables.

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.[7] 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. 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 vocab: children who attend pre-school (including early infant school) are likely to have worse vocab scores than those who didn't attend any form of pre-school, although this negative effect is not significant at 10 per cent. 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 per cent. Thus controlling for early school attendance brings the results into line with those in Table 3.

We conclude that Osborn and Milbank's positive results for vocab 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 3 are negative for both copying and vocab.

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

5. Conclusion

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 disadvantaged backgrounds and hence with high marginal benefits of tiume 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 acheive 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.

Data Appendix

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_n (hours with mother and at pre-school, respectively) were constructed as shown in Table A1.

Table A1
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_n	h_m	h_n	h_m	h_n	h_m	h_n
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, *ie* 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 A1 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 paper 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 and the weighted significance of each phrase. The sum of scores for each of the 12 syndromes gives a total BSAG score. The method adopted here is to group 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 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 gives basic statistics for the test scores and hours variables.

Table A2
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

Table A3
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
Parent time	Mother working currently	0.27	0.33
	Number of older children	1.3	1.6
	Number of younger children	1.0	1.1
	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

Table A4
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

Table A5

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.

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