

School achievement effects on subsequent educational attainment: results from a policy-induced natural experiment

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Abstract: This paper exploits a policy-induced natural experiment that occurred in South Australia in the mid-1980s with the aim of generating a ‘causal’ estimate of the effect of improved literacy and numeracy performance on school students’ later educational attainment. The *Early Years of School* policy increased the time an identifiable subset of students spent in junior primary school and improved their literacy and numeracy performance compared with their predecessors. The impact of this policy change is captured between two waves of longitudinal data. Estimates of the effect of this improved school achievement on students’ later educational participation and attainment presented here are no smaller than those produced by regression techniques that ignore the endogeneity of achievement. These estimated achievement effects, however, appear to reflect student self-confidence and occupational and educational aspirations on their eventual attainment, not solely the effect of their improved literacy and numeracy performance.

Keywords: natural experiment; achievement; school completion; university participation.

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1 Introduction

Studies that include measures of academic achievement, for example literacy and numeracy performance, typically find that such variables are key predictors of individuals' subsequent educational attainment (see Bynner and Joshi, 2002, Murnane, Willett, and Frank, 1995, Eckstein and Wolpin, 1999 and Le and Miller, 2002, for example). One problem with such studies is that unobserved ability is likely to influence both achievement and attainment. The magnitude of the achievement effect on attainment cannot be estimated consistently if unobserved ability has a separate effect on both.

In other circumstances, economists have used a number of approaches to identify the effect of dimensions of schooling on the subsequent outcomes of individuals, independent of the effect of ability and other factors. One approach exploits the existence of some external phenomenon that 'causes' a group of individuals to obtain a different level or quality of schooling from their peers and predecessors to estimate how that different schooling influences their later outcomes (see Angrist and Krueger, 1999 and Rosenzweig and Wolpin, 2000 for discussion). This approach is pursued in this paper.

A policy-induced natural experiment is exploited here to estimate the effect of additional literacy and numeracy skills on the educational attainment of young Australians. In this case, the additional literacy and numeracy skills obtained by a subset of students arose from a change of policy by one Australian State government. The *Early Years of School* policy required students whose birthdays occurred in specific months of the year to undertake an additional year of junior school in South Australia. Individuals born in other months were not affected directly by the policy. Ryan (2004) found that students affected by this policy change had improved school achievement levels compared with their predecessors. The purpose of this paper is to assess whether these improved achievement levels translated into increased levels of Year 12 completion and participation in post-school studies at university and in vocational education courses.

The research questions addressed here include: does the estimated achievement effect change when its endogeneity in educational attainment equations is taken into account? Is the achievement effect different in its impact on various educational attainment measures, for example, Year 12 completion and university participation? Where in the distribution of achievement are the effects greatest across the various educational attainment measures? Are the effects similar for male and female students? Do they vary according to the social backgrounds of students? Answers to such questions can inform policy directions in a number of areas in Australia and elsewhere: what is the scope for programs designed to improve achievement to influence later student behaviour? Can programs targeted towards redressing perceived problems in the education of boys improve their attainment levels? Can such programs influence the behaviour of students from socially disadvantaged backgrounds? Should programs designed to increase achievement with a view to increase eventual participation in specific educational activities (such as completion of Year 12) be targeted to specific regions of the achievement distribution or be directed at the student population in general?

The next section sets out literature relevant to these issues and the methodology pursued in this paper. Section 3 describes the policy change exploited in this study and the following section the data used here. Section 5 contains the results and section 6 the conclusions and policy implications.

2 Literature and methodology

Literature

There are at least two strands of literature relevant to this paper. The first deals with the relationship between achievement (literacy and numeracy performance) and educational attainment. The second deals with how to estimate properly the impact of potentially

endogenous variables on phenomena they are thought to determine. Much of the focus of this latter literature has been on the estimation of the impact of completed schooling on wages, which is problematic for two reasons — first, the schooling choice may be made with the better wage outcomes in mind; and second, unobserved ability may influence both schooling and wages and bias the schooling parameter estimates.

Studies that find a positive relationship between school achievement or high school grades and educational attainment are numerous, both those based on Australian and on international data. Studies from the United States include Cameron and Heckman (1998), Murnane, Willett, and Frank (1995) and Eckstein and Wolpin (1999). Studies from the United Kingdom include Bynner and Joshi (2002), Dearden (2002), Dearden, Ferri, and Meghir (2002) and Gregg and Machin (2000) and for New Zealand, Maani and Kalb (2003).

Australian studies that find a positive relationship between school achievement and educational attainment include Williams and Carpenter (1990), Vella and Karmel (1999), Marks and McMillan (2000) and Le and Miller (2002), among many others.

One approach to estimating the effect of various dimensions of schooling on later outcomes (generally, labour market outcomes in economic applications) exploits some source of systematic variation in the schooling obtained by individuals (see Angrist and Krueger, 1999 for discussion). The hope is that the identified source of variation is exogenous in that it is unrelated to individual characteristics and does not affect the later outcomes of individuals other than through the variation in schooling it induces. That is, this exogenous variation is assumed to be independent of the unobserved factors that drive other aspects of the education choices of individuals. The source of the exogenous variation is often described as a ‘natural experiment’ in such studies.

Rosenzweig and Wolpin (2000) distinguish between ‘natural natural experiments’ and ‘man-made’ natural experiments. The man-made experiments include social experiments

in which institutional arrangements and policy parameters are varied. The ‘natural natural experiments’ include biological and climate mechanisms that are plausibly independent of ability and preferences, such as birth date, sibling gender, identical twin studies and climatic conditions.

Rosenzweig and Wolpin (2000) show that while ‘natural natural experiments’ can allow identification of the effect of schooling on later outcomes, the validity of the instrument alone cannot guarantee that parameter estimates will be unbiased. Other aspects of the estimated equations need to be specified correctly for that to occur. Moreover, where the effect of schooling on labour market outcomes may vary between groups, ‘natural natural experiments’ will identify the effect of schooling only for that group affected by the natural experiment.

The policy change exploited here affected individuals born in specific months of the year. It seems unlikely that it might be associated with ability or other unobservable factors, such as intrinsic motivation, that might influence attainment. Moreover, since it affected a group whose common feature was that they were born in particular months, any estimated impact it had can reasonably be interpreted as one applicable to the population in general.

Ryan (2004) analysed the effect of the policy change used here on the literacy and numeracy performance of school children in their middle years of secondary school. Ryan (2004) found a large effect — of the order of one-third to one-half of a standard deviation in performance for an additional year of junior primary school. While this effect is very large, it is consistent with findings about the impact of early childhood interventions reviewed in Currie (2001), Barnett (2002) and Karoly, Greenwood, Everingham, Hoube, Kilburn, Rydell, Sanders, and Chiesa (1998). Discussion of the degree of ‘exogeneity’ of the policy change is postponed until after it is described in section 3.

Methodology

In the spirit of the ‘natural experiment’ literature, assume that the following two linear equations characterise adequately the determination of individual school achievement, p_i , and subsequent educational attainment, y_i . Individual i ’s educational attainment is determined by her background characteristics (X_i), the characteristics of the school she attended (Z_i) and her observed school achievement levels (p_i). These observed achievement levels are also influenced by her background and school characteristics, as well as when in her schooling she is tested (S_i). The components of this schooling vector include her age when tested, the grade she was in and birth group dummies described below that indicate how and whether the individual was affected by the policy change. This set-up is reflected in the following two equations:

$$y_i = X_i'\beta + Z_i'\gamma + p_i\pi + e_{yi}. \quad (1)$$

$$p_i = X_i'\varphi + Z_i'\lambda + S_i'\vartheta + e_{pi}. \quad (2)$$

where the Greek letters are parameters. The effects need not be linear, specifically the effect of achievement on attainment, so estimates from a partial linear version of equation (1) (described in Yatchew, 1998) are also presented, that is

$$y_i = X_i'\beta + Z_i'\gamma + f(p_i) + e_{yi}. \quad (3)$$

The econometric problem with the set-up in equations (1) and (2) is a standard omitted variable problem. The residual term of equation (2), e_{pi} , consists of unobserved ability (g_i) and other unobserved factors that influence p . To the extent that unobserved ability also influences subsequent educational attainment through the error term in equation (1), e_{yi} , the parameter estimates from equation (1) will be biased and inconsistent.

The response to this problem utilised in this paper is to use exogenous variation in the elements of S_i caused by policy changes to identify the effect of school achievement (p_i) on later educational outcomes y_i . Essentially, in Instrumental Variable estimation the predicted value of equation (2), \widehat{p}_i , is used in equation (1) in place of p_i .

However, the educational attainment measures estimated here are not linear. Rather, they reflect categorical outcomes. These are binary in the case of some measures: completion of Year 12 or not; participation at university or not; participation in a vocational education course or not. The remaining measure reflects completion of specific educational levels or qualification types. That is, for these education measures, equation (1) is replaced by a relationship of the form

$$y_i^* = X_i'\beta + Z_i'\gamma + p_i\pi + e_{yi}. \quad (4)$$

where y_i^* is an underlying or latent variable whose values determine the observed outcome, y_i . For the first three categorical outcomes, the observed outcome

$$y_i = 1 \text{ iff } y_i^* > 0 \Leftrightarrow e_{yi} > -(X_i'\beta + Z_i'\gamma + p_i\pi). \quad (5)$$

The probability that $y = 1$ is then

$$Prob(y_i = 1) = Prob(y_i^* > 0) = Prob(e_{yi} > -(X_i'\beta + Z_i'\gamma + p_i\pi)). \quad (6)$$

Where the probit specification is used for this probability, then

$$Prob(y_i = 1) = \Phi(e_{yi} < (X_i'\beta + Z_i'\gamma + p_i\pi)) = \Phi(X_i'\beta + Z_i'\gamma + p_i\pi). \quad (7)$$

For the first three categorical outcomes, maximum likelihood probit instrumental variable estimation is required in the presence of any endogeneity in achievement (see

Wooldridge, 2002 for discussion). The equation of principal interest for the first three education measures, equation (4), is estimated by probit instrumental variable estimation where necessary (based on the outcome of exogeneity tests proposed by Rivers and Vuong, 1988) in this paper.¹

The remaining equation, with a dependent variable that can take one of a number of ordered levels, will be estimated via two-stage methods in the presence of any endogeneity in achievement. This involves estimation of equation (2) in the first stage and inclusion of the estimated residual from that equation, along with actual achievement, in the ordered equivalent of equation (4) (see Vella, 1998 for discussion of this approach).

3 *The Early Years of School policy*

The *Early Years of School* policy was announced in 1984 in South Australia, with implementation to start in 1985. The elements of the policy and its rationale were set out in Education Department of South Australia (1983) and the final report of the Committee of Enquiry into Education in South Australia (Keeves Enquiry) (1982). The objective of the policy was to provide a better foundation for children's subsequent educational achievement by extending and enriching their junior primary education (that is, levels below Year 3). Its effect was to add an additional year of introductory schooling for students born at specific times of the year. The cohorts affected by the policy change reached secondary school (which commences in Year 8 in South Australia) in 1990 and Year 9 in 1991.

¹Where the partial linear model of equation (3) was estimated, the semiparametric procedure set out in Yatchew (1998) was adopted. That is: the data were ordered in terms of p_i ; first differences in y_i were then regressed on first differences in X_i and Z_i to generate consistent estimates of β and γ (imposing a linear probability model on equation (3) by assumption); finally the effect of p_i on the constructed variable ($y_i - X_i'\hat{\beta} - Z_i'\hat{\gamma}$) was estimated nonparametrically. To account for the potential endogeneity of p_i in this relationship, the procedure of Blundell et al. (1998) was followed. This involves including the (first-differenced) estimated residual from equation (2) as an additional regressor in the first differences regression and the consequent construction of the adjusted dependent variable.

South Australia has a ‘continuous admission’ policy for 5 year olds (see Trethewey, 1997 for a description of the history of this policy). It involves regular (not less than once a term) admission of recently turned five year olds into individual schools over the school year. The way it operated prior to the *Early Years of School* policy meant that those five year olds who began school at the start of the school year moved directly into Year 2, having compressed Reception (a pre-Year 1 year of schooling) and Year 1 into just one year.

Figure 1 captures the key aspects of the *Early Years of School* policy change on the years of primary schooling undertaken by students. Those born between October and February who commenced school at the beginning of the school year completed nine terms of junior school (or eight years of primary school in total) after the policy change. Prior to the change, about two thirds of that group completed just six terms (or only seven years of primary school). About one half of those born in the September quarter undertook ten terms of junior primary school (over eight years of primary school) after the policy change. Prior to it, almost the entire group undertook seven terms of junior primary school (less than eight years of primary school). The *Early Years of School* policy did not affect the years of schooling of those born between March and June.

4 Data and key variables

Data used in this study

This paper utilizes data from two Longitudinal Surveys of Australian Youth (LSAY) cohorts to assess the impact of the Early Years of School policy change. The Youth in Transition 1975 birth cohort (YIT 75) and the Longitudinal Surveys of Australian Youth Year 9 cohort (LSAY 95) fall either side of the policy change and should capture its impact.

The cohorts affected by the policy reached secondary school in South Australia after 1990 and Year 12 from 1994 onwards. The grade cohorts in YIT 75 reached Year 12 from 1991 through 1993. The LSAY 95 cohort started school after the policy change took effect and reached Year 8 in 1994. South Australian children in Year 9 in the LSAY 95 cohort should be older for their grade level than those in the YIT 75 cohort. Hereafter, the YIT 75 cohort is generally referred to as the ‘late 80s’ cohort and the LSAY 95 cohort as the ‘mid-90s’, which reflects the time when their members undertook the literacy and numeracy tests.

These cohorts are drawn from two-stage cluster samples of Australian school children. In the first stage, schools were randomly selected. In the second stage, students from those schools were randomly selected. In the late 80s cohort, individual 14 year old students were randomly selected; in the mid-90s cohort intact classes were randomly selected. The samples were stratified by school sector (government, Catholic or independent private schools). Population means in this paper are estimated with weighted data to account for this stratification, but the regression equations are estimated over un-weighted data. The literacy and numeracy tests were completed by students at their schools, along with a short questionnaire to elicit background information. Participants were surveyed in subsequent years by mail and/or telephone questionnaires.

The major difference in the design of the two surveys is summarised in table 1. The first collection was an age-based sample of young Australians, the second a grade-based one. Consequently, individuals aged fourteen years (as of 1 October in the year they were surveyed) were distributed across grades or levels in South Australia in the first cohort as follows: 5 per cent were in Year 8; 70 per cent in Year 9; and 25 per cent in Year 10. For the second cohort, individuals in Year 9 were distributed across single years of age (on 1 October) as follows: 2 per cent were aged thirteen; 79 per cent were aged fourteen; and 19 per cent were aged fifteen. Had the *Early Years of School* policy not changed the

age-grade structure in South Australia, these proportions would have been approximately 25, 70 and 5 per cent respectively, that is, the (reverse order) proportions from the earlier cohort.²

The number of observations available for the analysis of Year 12 completion is shown in table 2. Sample sizes are shown separately for each cohort and for each birth group within the cohort, where the birth groups reflect the extent to which individuals were affected by the policy change.

The literacy and numeracy scales

Achievement scales have a variety of forms. One common approach is to use a scale that reflects individual students' standardised performance - that is relative to the average number of questions all students in their specific sample answered correctly and scaled by the standard deviation of correct answers. In the student achievement literature, such scales tend to be heavily (negatively) skewed - with many students getting all or nearly all questions correct. Such scales do not take into account the relative difficulty of questions, nor do they allow comparisons of performance over time, since the scales are measured relative to average performance in the students' specific cohort.

Consequently, the testing literature has developed alternative approaches to the construction of test scales that incorporate the degree of difficulty of questions. The main methodological tool used in international studies to construct such scales is known as Item Response Theory (IRT).³ It allows estimation of the probability that a person will answer specific items correctly from a pool of test items. This probability incorporates

²Analysis of data from the mid-90s cohort in Appendix 2 of Ryan (2003) indicates that the *Early Years of School* policy change is reflected in the age-grade structure of individuals in the data in exactly the way it would be anticipated to be, once aspects of the survey design of the later sample are taken into account.

³For example, the literacy and numeracy scales in the Organisation for Economic Co-operation and Development's Programme for International Student Assessment (PISA), the literacy scales used in the International Adult Literacy Survey (IALS) and the mathematics and science achievement scales used in the Trends in Mathematics and Science Study (TIMSS) were all developed using IRT.

both the difficulty of the task and the proficiency of the individual in terms of the specific ability tested through the questionnaire items. The resulting scales are less skewed and allow comparisons between student performances where they do not answer identical sets of questions. This means it is possible to compare literacy and numeracy performance over time.

The IRT literacy and numeracy scales used in this paper were developed in Rothman (2002). They have been constructed to have a mean of 50 and standard deviation of 10. The scales were used in Rothman (2002) to compare literacy and numeracy performance across cohorts of Australian mid-secondary school students from the mid-1970s to the late 1990s. The regression results reported in this paper use only the IRT scales - results based on the standardised scores were qualitatively similar to those reported below. The achievement measure used in section 5 is the simple average of the literacy and numeracy scales. It has a mean of 50 and standard deviation of 8.5.

Educational attainment and participation measures

Four measures of educational participation or attainment are analysed in this paper. Three are measures of participation in identified levels of education in specific years. The last measure is of the educational attainment of individuals.

The first participation measure is whether or not individuals undertook Year 12, the highest level of secondary school in Australia in either the first or second possible calendar year they could have undertaken it, given their grade or level in the first year they were surveyed. For the LSAY 95 cohort this is straightforward. Individuals were in Year 9 when first surveyed in 1995. The participation measure for this cohort is whether they undertook Year 12 in either 1998, the first year they could possibly have done so (assuming no accelerated progression) or in 1999. For the earlier cohort, those in Year 12 in either 1992 or 1993 who were in Year 9 in 1989 were assigned the value one and

those not in Year 12 in either year were assigned the value zero. For those in Year 10 in 1989, their participation was measured in 1991 and 1992 and those in Year 8 in 1993 and 1994. The reason for analysing such a participation measure is that proportion of commencing secondary school grade cohorts who progress to Year 12 in the minimum number of years has been an important measure of school system performance and the target of government policy over the years in Australia.

The reason for measuring participation in either of two years has more to do with the second participation measure — study at university — than Year 12 completion. At the time the first cohort completed their schooling in South Australia there was a substantial spike in the proportion of students who repeated Year 12. In fact, in these data, almost a quarter of those who were in Year 12 in 1992 in South Australia repeated Year 12 in 1993. If university participation was measured only in the first possible year students could attend, participation in the first cohort would be substantially underestimated. Hence, university participation is measured in either the first two possible years individuals could have attended university, given their grade level when first surveyed.

The third participation measure is whether individuals engaged in some form of vocational education and training in either of the first two years after they left school. This will be described as VET participation, since it incorporates study at both TAFE colleges and at other types of training providers. This VET participation measure is less subject to distortion by variable rates of Year 12 repetition between the cohorts.⁴

The attainment measure reflects the highest level of education attempted or attended by individuals by age 22. It is an ordinal variable that takes five possible values: university participation (the highest category); other post-school (VET) study by those who undertook Year 12; Year 12 and no subsequent post-school study; post-school (VET) study by those who did not undertake Year 12; and left school before Year 12 and undertook no sub-

⁴Results where this measure was based on participation in any year after individuals left school up to age 22 years were qualitatively similar to those presented below and are available from the author.

sequent post-school study (the lowest category).⁵ Data from a nationally-representative survey indicate that the proportion employed full-time, the wages of full-time employees and the ‘status’ or prestige associated with the occupations filled by full-time workers all increase across this ordering of education levels for both males and females in Australia.⁶

Cameron and Heckman (1998) and Lauer (2003) are critical of the type of economic model that lies behind estimation of series of binary education participation equations. Such estimation implies the errors or unobserved contributions to the decision at the heart of each equation must be independent, which seems unlikely in an education context. Instead Cameron and Heckman (1998) and Lauer (2003) argue that attainment-type measures should be analysed. The approach used here is simpler (and more restrictive) than that of either of the papers mentioned. However, the purpose of this paper differs from those papers. The emphasis here is not on endeavouring to account for the role of unobserved factors that affect the observed outcome through the estimation process. Rather, the policy-induced natural experiment used here allows the analysis to abstract from the contribution of these factors to the changes in educational attainment between the cohorts and instead allows us to focus on the causal effect of additional school achievement.

5 Results

Relationship between achievement and attainment in the data

Two issues are addressed in this subsection with the aid of some simple comparisons and figures. First, how much did achievement and attainment change between the cohorts

⁵The proportions of the sample in these categories were 32, 21, 20, 10 and 17 per cent respectively. Such proportions accord broadly with Australian Bureau of Statistics data on school transitions, which just one year out from school provide proportions of 29, 18, 20, 12 and 20 per cent.

⁶The data were taken from the second wave of the Household, Income and Labour Dynamics in Australia survey. The analysis was conducted for individuals aged 30 years or older. The sole exception to the statement above was that the average occupational status of female full-time employees who were VET graduates but had not undertaken Year 12 was slightly higher (but not significantly) than that of Year 12 graduates.

for the various birth groups studied here? Second, what is the relationship between achievement and the various measures of attainment or participation apparent in the data and did the relationship appear to change between the cohorts for the birth groups?

The first issue is addressed with the aid of table 3. It shows the change in average achievement levels between the cohorts for the policy groups, along with the levels and changes in educational participation for those groups.

Consistent with the intention of the policy, achievement increased significantly between the two cohorts for the October to February birth group.⁷ The magnitude was about one third of a standard deviation.⁸ The changes in achievement for the comparison group and the September quarter birth group were not significant.⁹

Year 12 completion rates also increased significantly between the cohorts for the October to February birth group, but not the other two groups. However, the change between the cohorts for the October to February birth group was not significantly greater than the change for the March to June comparison group.

The university participation rates increased significantly for both the March to June comparison group and the October to February birth group between the two cohorts. Once more, the difference in the change between the groups was not significant. The increases are substantial for the two groups and reflect the expansion in higher education in South Australia between the cohorts.¹⁰

⁷This effect was specific to South Australia. It did not occur among individuals born in the same months in other jurisdictions (see Ryan, 2004).

⁸This increase in relative achievement performance did not result from differential changes in the background characteristics of members of the birth groups between the cohorts. Ryan (2003) in Appendix 4 provides evidence that any changes in background characteristics between cohorts were the same for the three birth groups.

⁹Evidence presented in Ryan (2004) shows that the effect of the intervention on the September quarter birth group was much less pronounced than for the October to February birth group. In part, this seemed to stem from those born in July, where a more obvious selection process for which individuals should undertake the additional year of junior primary school appeared to take place. When those born in July were excluded, the estimated effect for this birth group increased and was no longer statistically different from that of the October to February group.

¹⁰An increase in ‘continuation’ rates from Year 12 to university is also apparent in the same period in administrative data from the higher education sector — see Department of Education Science and

The relationships between school achievement and the three measures of educational participation are shown in figure 2. Achievement is shown on the horizontal axis and the participation measures on the vertical scale. These curves represent the conditional means of the probability of Year 12, university and VET participation, respectively, conditional on student achievement. Estimates of these conditional means based on the partial linear model of equation (3) are also shown in figure 2. These latter estimates net out the impact of the other factors taken into account in the regression results reported below and take account of the potential endogeneity of achievement.¹¹

The relationship between achievement and Year 12 completion appears to be slightly non-linear — the estimated increases in the probability of Year 12 completion are smaller at higher levels of achievement. The relationship between achievement and university participation is steeper than the other observed relationships. This probably reflects the allocation of university places on the basis of achievement, since university applications exceed available slots in Australia. In contrast with the other two participation measures, VET participation falls among students with above average levels of achievement. The estimates of the relationships that net out the impact of other factors on attainment follow the observed relationships quite closely, except at the bottom of the achievement distribution. Low performing students have other characteristics that make them more likely to participate at university and less likely in VET courses than might be expected, given their achievement levels alone.

For the reasons outlined earlier in this paper, the observed relationships between achievement and attainment, as in figure 2, may not be reliable indicators of the true relationships between the phenomena. Essentially, what is required is two observations of the relationship, where the achievement in one group provides an observation that is

Training (various years).

¹¹These conditional means were estimated with the *lowess* routine in *STATA*, using a bandwidth of 0.5.

different from the other, but the average ability levels of the two groups (and all other relevant characteristics) should be the same.

Essentially, this is what the policy-induced natural experiment used here provides. Specifically, the slope of the relationship between achievement and attainment should be almost identical in the two cohorts for the March to June comparison group. The estimated probabilities of participation in the second cohort may lie above those of the first because of trend growth in educational participation, but individuals with similar achievement levels between the cohorts should have similar levels of unobserved ability. Average achievement changed very little between the cohorts for this group (table 3) and there is no obvious reason why the average ability of children born at the same time of the year should differ between the cohorts. Year 12 participation probabilities by achievement level in the two cohorts for the March to June comparison group are shown in figure 3. The two curves show very similar relationships between achievement and Year 12 completion in the two cohorts, though the curve for the second cohort lies a little above that of the first, since Year 12 completion increased marginally between the cohorts.

The situation differs for the October to February birth group. While the average ability of children in this group would not have been expected to change, their estimated average achievement did (table 3). Hence the participation probabilities of those with specific achievement levels in the first cohort should be compared with those some designated distance to their right in the second cohort to get an ‘ability-held-constant’ estimate of the effect of changes in achievement on Year 12 for the figure 3-equivalent graph for this group. From table 3, this designated difference should be about 3 points to the right of each and every achievement level from the first cohort. Year 12 participation probabilities by achievement level in the two cohorts for the October to February birth

group are shown in figure 4.¹² The estimated Year 12 completion probabilities for the second cohort lie above those of the first. In conjunction with the increase in achievement, this implies that the ‘true’ relationship between achievement and Year 12 completion may be larger than the observed relationship. This is shown in figure 4, where the steepest line links the probability of Year 12 completion for someone with an achievement level of 50 with that of an individual with an achievement level of 53 in the second cohort. There are a whole family of such curves, linking individuals across the cohorts who are alike in terms of their assumed ability levels. Most such curves in figure 4 would be steeper than the observed relationship in either of the cohorts.

This is an unexpected, informal ‘result’ that nevertheless carries over to the Year 12 completion regression results reported below. Consideration of what might lie behind such a result is left over until a later subsection where the implications of the results are discussed.

L&N effect on educational participation and attainment

The effects of achievement on Year 12 completion and VET and university participation are analyzed in this sub-section via regression analysis of the form set out in equations (2) and (7).

Essentially, a probit equation is estimated for each of the first three outcome measures, while an ordered probit equation is estimated for educational attainment. The list of explanatory variables includes achievement, student gender, parental education, occupation and language background, school type and average school characteristics (gender, parental occupation and proportion of students from non-English speaking backgrounds) and a dummy variable identifying members of the second cohort. The summary statistics

¹²These show a ‘net’ change in Year 12 completion. The average change in completion between cohorts for the comparison group from figure 3 has been subtracted from the probability of completion in the second cohort for the group affected by the policy change. This removes an estimate of any secular growth in Year 12 completion.

for these variables appear in table A.1 of the appendix.

The detailed regression results are presented in table A.2 of the appendix for the various educational measures. The specification reported there for each measure reflects the outcome of a series of specification tests. The tests for the exogeneity of achievement and for its linearity in the index used in equation (7) are summarised in table 4.¹³ Essentially, the exogeneity of achievement is rejected at the five per cent level in the Year 12 completion equation and is close to rejection in the educational attainment equation. The linearity of the achievement effect on the probit index was rejected at the five per cent level for the VET participation equation, but in none of the other equations. Hence, the Year 12 completion equation is estimated by GMM, the VET and university participation equations by standard probit estimation, and educational attainment by the two-step process. The results for the first stage achievement regression for the Year 12 completion equation are presented in table A.1. The age of students, their grade and whether they were members of the October to February birth group were highly significant in explaining achievement.

Since the results for the other explanatory variables are consistent with the existing literature, discussion is restricted solely to the estimated achievement effect on the various outcome measures.¹⁴

The marginal effect of achievement on Year 12 completion, university participation and VET participation across the three estimation approaches are shown in the top panel of table 5. The estimated marginal effects depend on where they are evaluated — the estimates presented here are calculated at the average sample values for the explanatory variables, or at specific values of achievement in conjunction with the average values of

¹³The tests of the exogeneity of achievement were Hausman (1978)–like tests proposed in Rivers and Vuong (1988). These involved inclusion of the achievement equation residual along with actual achievement in the simple probit equations explaining the educational participation outcomes. The linearity tests involved inclusion of a quadratic achievement term in the estimated equations.

¹⁴The marginal effects for these other variables are also reported in table A.2 of the appendix.

all other variables.¹⁵ At the mean values, the marginal effects imply that the change in average achievement of close to three units translated into increase probability of Year 12 and university participation of about 6 and 8 percentage points, respectively, and a reduction in the probability of VET participation of about 3 percentage points.

These estimated marginal effects calculated at the means of variables are far from representative of the estimated effects at other values of achievement. Just how the estimated marginal effects of achievement change at different levels of achievement are also summarised in table 5. Once more, these are estimated at the average values of all other variables, with only the value of achievement allowed to change in the calculation. These suggest that the estimated marginal effects of achievement are greatest at below-average levels of achievement for Year 12 participation and at above-average levels for university participation.¹⁶ The marginal effect of achievement on VET participation is positive at low levels of achievement, but negative at above-average levels.

A clearer picture of how the estimated marginal effects change with achievement is provided in figure 5. It shows how the estimated marginal effects for each participation measure for individuals change in the data with achievement. These marginal effects are averaged over individuals in the data, not estimated at the sample means of other variables.¹⁷ Figure 5 also contains the estimated marginal effects from semiparametric estimation of the partial linear model of equation (3) for each participation measure. The estimated parametric effects reflect the patterns in table 5.

The semiparametric estimates differ a little from the estimated parametric effects, but are broadly consistent with them. In both sets of estimates, the marginal effect of

¹⁵The averages of the estimated marginal effects calculated for each individual for the various educational measures were similar to those presented. This approach is used below.

¹⁶In part, this reflects the probit specification, where the marginal effect is greatest where the estimated probability of participation in the activity is equal to 0.5. For Year 12 participation, this occurs at below-average levels of achievement and for university at above-average levels. However, in the actual data the increases in the proportion participating in these activities also is greatest in these regions.

¹⁷Once more, all of these conditional means were estimated with the *lowess* routine in *STATA*, using a bandwidth of 0.5.

achievement on Year 12 completion is higher in the lower half of the achievement distribution than the top half; while for university participation, marginal effect of achievement on is higher in the lower half of the distribution; and the marginal effect of achievement on VET participation is negative and falling over much of the achievement distribution. Therefore, while the shape of the parametric marginal effects reflect the probit functional form, the non-parametric estimates are also broadly consistent with their pattern.

The lower panel of table 5 contains the marginal effects of achievement on educational attainment. Essentially, increased achievement pushes individuals towards higher levels of educational attainment, with the effects greatest on university participation. The magnitudes of the comparable marginal effects between the bottom and top of table 5 are quite similar. The estimated marginal effects of achievement on university participation are similar across the distribution of achievement; the sum of the three right-hand columns in the bottom panel are similar to the Year 12 marginal effects in the top panel; and the sum of the second and fourth columns of the bottom panel are similar in magnitude and in the pattern they follow to the VET marginal effects in the top panel. The educational attainment equation, therefore, implies a similar effect of achievement on educational involvement as do the results from the individual participation equations.

One last element of table 5 is of note. Where achievement is treated as endogenous, the marginal effects estimated at sample means tend to be greater in absolute terms than if the endogeneity of achievement is ignored. This result repeats the informal ‘result’ described earlier in the discussion of figure 4. Potential explanations for this results are discussed below.

Adequacy of the specification

The predictive power of the three participation equations appears to be quite reasonable. In excess of 60 per cent of individuals were correctly allocated to the educational choice they actually made in these three equations (see table A.2). The equations sur-

vived Hosmer-Lemeshow tests of the specifications based on comparisons of predicted and actual values (see Hosmer and Lemeshow, 1989). Neither did the normality assumption appear to drive the results — alternative parametric specifications provided results with very similar implications for the implied marginal effects to those presented here.¹⁸ Further, the semiparametric marginal effect estimates presented in figure 5 are consistent with those estimated with the probit specification.

A further issue surrounds the ‘exogeneity’ of the age and grade variables for school achievement and their exclusion from the attainment equations. After all, students may be old or young for their grades because their progression through school was slower or faster than normal because of their school performance. These instruments survived over-identification tests when equation (1) was estimated as a linear probability model (the over-identification test is described in Wooldridge, 2002 – its *p-value* was 0.946). Moreover, when age and grade were alternately excluded from the instrument list, but included in the Year 12 completion equation as explanatory variables in their own right, these variables were not significant.¹⁹

Gender and social background differences in the achievement effects

There was no evidence of either gender or social background differences in the effect of achievement on the various educational outcome measures analysed here. The importance of gender effects was assessed via the inclusion of an interaction term between achievement

¹⁸These included estimation of the three participation equations and the educational attainment assuming an asymmetric log log or Gompertz distribution for the probability distribution in equation (6). The estimated marginal effects of achievement on the educational outcomes were slightly smaller than with the probit specification, but other aspects of the results were qualitatively the same (the outcomes of the exogeneity tests, the increase in the magnitude of the effects when the endogeneity of achievement was taken into account and so on).

¹⁹The *p-values* were 0.173 for grade and 0.101 for age.

and gender in the probit equations.²⁰ The following procedure was used to estimate any potential social background–achievement interaction effects. The sample was split into three groups on the basis of their parental occupational status score and interaction between achievement and dummy variable terms for the middle and top groups included in the regression equations. The social background–achievement interaction effects were not significant in the Year 12, university participation or attainment equations, suggesting that achievement operates independently of both gender and social background in its impact on these educational outcomes. The top–SES effect was negative and significant in the VET participation equation, suggesting that among high SES groups increased achievement had a more negative impact on VET participation than among the lowest SES group.²¹

Discussion

This paper commenced with discussion that the estimated effect of school achievement on later educational outcomes might be an unreliable estimate of the true effect because unobserved innate ability might affect both phenomena independently. In such circumstances, the parameter on achievement might overstate its true effect on attainment. Somewhat surprisingly, the results here suggest that in the case of Year 12 completion at least, the estimated achievement effects may be too low. What factors might explain such an outcome for that participation measure and not VET or university participation?

One explanation for the increase in the estimated achievement effect for these participation measures relates to omitted variables and measurement error. Essentially, ability is not the only common elements of the residuals of equations (1) and (2). Other candidates

²⁰In the Year 12 participation equation, for example, the *z-value* on the interaction term was 0.08. It was higher in the other equations, but never significant.

²¹The *p-values* on the likelihood ratio tests for the two interaction terms were 0.90, 0.29 and 0.25 in the Year 12, university participation and attainment equations, respectively, so the two terms could be excluded from those equations. The *p-value* in the VET equation was 0.03.

include student maturity, motivation, ambition, and their own and other's expectations about the level of education they should complete. These factors, along with ability, might be thought of as jointly making up a set of 'education success factors' that might affect attainment in conjunction with student achievement. To the extent that achievement is a 'noisy' measure of this set of education success factors, parameter estimates of the effect of achievement will suffer from the standard mis-measurement attenuation bias (see Griliches, 1977 and Ashenfelter and Krueger, 1994). IV estimates in the presence of such measurement problems are typically larger than those based on standard regression approaches (see Card, 1999 for discussion of education-related examples).

There is evidence that the group affected by the policy change experienced improved levels of at least some of these other education success factors, in addition to their higher achievement levels. From information available for some of these measures in the data, it appears that the group affected by the policy change had higher levels of ambition, in terms of their future occupations, increased levels of self-confidence, and higher expectations about the level of education they intended to complete (see table 6).

Therefore, to the extent that all of these factors are: related to achievement; influence attainment; and were affected by the policy change, then the IV achievement parameter estimates will exceed the estimates based on standard regression approaches.

However, university places in Australia are allocated on the basis of school achievement. The impact of these other education success factors would therefore be expected to be more muted for this education participation measure. This may explain why the Hausman-type test did not reject the exogeneity of achievement for that equation, though even in this case the two stage and GMM parameter estimates (not reported) were larger than were the 'standard' estimates. Participation in VET is subject to other phenomena, notably the economic cycle which has traditionally 'driven' apprentice numbers. At the top of the achievement distribution, increases in university participation associated with

increased achievement is partly at the expense of VET participation. If achievement can be treated as exogenous in determining university participation in this range, this may explain why its exogeneity was not rejected in the VET equation also.

The research questions addressed here include: does the estimated achievement effect change when its endogeneity in educational attainment equations is taken into account? Is the achievement effect different in its impact on various educational attainment measures, for example, Year 12 completion and university participation? Where in the distribution of achievement are the effects greatest across the various educational attainment measures? Are the effects similar for male and female students? Do they vary according to the social backgrounds of students? Answers to such questions can inform policy directions in a number of areas in Australia and elsewhere: what is the scope for programs designed to improve achievement to influence later student behaviour? Can programs targeted towards redressing perceived problems in the education of boys improve their attainment levels? Can such programs influence the behaviour of students from socially disadvantaged backgrounds? Should programs designed to increase achievement with a view to increase eventual participation in specific educational activities (such as completion of Year 12) be targeted to specific regions of the achievement distribution or be directed at the student population in general?

In terms of the research questions set out in the introduction to this paper, it appears that estimated achievement effects on attainment that take account of the endogeneity of achievement are no smaller than those that ignore it. Achievement effects differ between attainment measures and across the distribution of achievement. Increases in achievement have more impact on Year 12 completion at below-average levels of achievement than they do at above-average levels; with the converse true for achievement effects on university participation. Increases in achievement at the bottom of the distribution appear have very little impact on attainment, and at the top of the distribution, on Year

12 completion. Therefore, policies and programs designed to meet specific attainment objectives via improved achievement performance need to be targeted appropriately to the specific attainment measures. The results here also suggest that the achievement effects on attainment are the same for males and females, and with the exception of VET participation at the top of the distribution, the same across the social background distribution.

6 Conclusion

Unfortunately, at the end of this analysis we appear no closer to an estimate of the ‘true’ effect of achievement on attainment. Essentially, the policy change turned out not to be a good instrument for achievement in that there appear to have been other channels through which it affected attainment. The policy change resulted in increases in the school achievement of individuals, as well as in their levels of self-confidence, and occupational and educational aspirations. These changes could affect Year 12 completion, which is subject to individual decision-making in Australia. These increases could also act to redistribute university places in Australia between students, but not the actual proportion who went to university, since aggregate demand exceeds the Government-determined number of places.

While the policy change was not an ideal instrument for estimation of the effect of achievement on attainment, the results nevertheless provide a ‘good news’ story. Interventions that improve the quality of the early schooling of students can have a positive impact on their later education choices, both through improving their literacy and numeracy performance and influencing other phenomena that can be broadly thought of as education success factors. General interventions have the same impact on boys as girls, and for educational outcomes other than VET participation, on children from all parts

of the social background distribution. But the results also mean that the school achievement effects on attainment estimated in other studies probably also capture the effects of these other education success factors as well as achievement effects. Since achievement is likely to be so bound up with these other factors, the prospects for disentangling their separate effects seem likely to be poor.

References

- Angrist, J. D. and A. B. Krueger (1999). *Handbook of Labour Economics*, Volume 3A, Chapter Empirical strategies in labor economics, Chapter 23. Holland: Elsevier Science.
- Ashenfelter, O. and A. B. Krueger (1994). Estimates of the economic return to schooling from a new sample of twins. *American Economic Review* 84, 1157 – 73.
- Barnett, S. (2002). *The Battle over Head Start: What the Research Shows*.
- Blundell, R., A. Duncan, and K. Pendakur (1998). Semiparametric estimation and consumer demand. *Journal of Applied Econometrics* 13, 435 – 461.
- Bynner, J. and H. Joshi (2002). Equality and opportunity in education: evidence from the 1958 and 1970 birth cohort studies. *Oxford Review of Education* 28, 405–425.
- Cameron, S. V. and J. J. Heckman (1998). Life cycle schooling and dynamic selection bias: models and evidence for five cohorts of american males. *Journal of Political Economy* 106, 262–333.
- Card, D. (1999). Chapter The causal effect of education on earnings, Chapter 30.
- Committee of Enquiry into Education in South Australia (Keeves Enquiry) (1982). *Education and Change in South Australia*. South Australia: Government Printer.
- Currie, J. (2001). Early childhood education programs. *Journal of Economic Perspectives* 15, 213 – 238.
- Dearden, L. (2002). The effects of families and ability on men’s education and earnings in Britain. *Labour Economics* 6(4), 551–567.
- Dearden, L., J. Ferri, and C. Meghir (2002). The effect of school quality on educational attainment and wages. *Review of Economics and Statistics* 81(1), 1–20.
- Eckstein, Z. and K. I. Wolpin (1999). Why youths drop out of high school: The impact of preferences, opportunities and abilities. *Econometrica* 67(6), 1295–1339.
- Education Department of South Australia (1983). *The Early Years of School*. South Australia: Government Printer.

- Gregg, P. and S. Machin (2000). *Youth employment and joblessness in advanced countries*, Volume NBER Comparative Labor Market Series, Chapter Child Development and Success or Failure in the Youth Labor Market. Chicago and London: University of Chicago Press.
- Griliches, Z. (1977). Estimating the returns to schooling: some econometric problems. *Econometrica* 45, 1 – 22.
- Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica* 46, 1251 – 1271.
- Hosmer, D. and S. Lemeshow (1989). *Applied Logistic Regression*. New York: John Wiley and Sons.
- Karoly, L., P. Greenwood, S. Everingham, J. Hoube, M. Kilburn, C. Rydell, M. Sanders, and J. Chiesa (1998). *Investing in our Children: What We Know and Don't know about the Costs and Benefits of Early Childhood Intervention*. Santa Monica: RAND Corporation.
- Lauer, C. (2003). Family background, cohort and education: a French–German comparison based on a multivariate ordered probit model of educational attainment. *Labour Economics* 10, 231 – 251.
- Le, A. and P. Miller (2002). Choice of school in Australia: Determinants and consequences. *Australian Economic Review* 36(1), 55–78.
- Maani, S. A. and G. Kalb (2003). Childhood economic resources, academic performance and the choice to leave school at age sixteen. Working Paper No. 1/03, Melbourne Institute of Applied Economic and Social Research, Melbourne.
- Marks, G.N., F. N. L. M. and J. McMillan (2000). Patterns of participation in year 12 and higher education in australia: Trends and issues. Longitudinal Surveys of Australian Youth Research Report No. 17, Australian Council for Educational Research, Melbourne.

- Murnane, R. J., J. B. Willett, and L. Frank (1995). The growing importance of cognitive skills in wage determination. *Review of Economics and Statistics* 77(2), 251–366.
- Rivers, D. and Q. Vuong (1988). Limited information estimators and exogeneity tests for simultaneous probit models. *Journal of Econometrics* 39, 347 – 366.
- Rosenzweig, M. and K. Wolpin (2000). Natural “natural experiments” in economics. *Journal of Economic Literature* 38, 827 – 74.
- Rothman, S. (2002). Achievement in literacy and numeracy by Australian 14 year-olds, 1975 - 1998. Longitudinal Surveys of Australian Youth Research Report No. 29, Australian Council for Educational Research, Melbourne.
- Ryan, C. (2003). A “causal” estimate of the effect of schooling on full-time employment among young Australians. Longitudinal Surveys of Australian Youth Research Report No. 35, Australian Council for Educational Research, Melbourne.
- Ryan, C. (2004). The impact of early schooling on subsequent literacy and numeracy performance - estimates from a policy-induced ‘natural’ experiment. Centre for Economic Policy Research Discussion Paper No. 470, Australian National University, Canberra.
- Trethewey, L. (1997). Beginning school in the 1970s and 80s: the (re-) introduction of continuous admission in South Australia. *New Zealand Journal of Educational Studies* 32, 175–189.
- Vella, F. (1998). Estimating models with sample selection bias: A survey. *Journal of Human Resources* 33, 127 – 169.
- Vella, F. and T. S. Karmel (1999). Evaluating the impact of educational expansion on the occupational status of youth. *Australian Economic Papers* 38(3), 310–327.
- Williams, T. and P. Carpenter (1990). Private schooling and public achievement. *Australian Journal of Education* 34, 3 – 24.
- Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. Massachusetts: Massachusetts Institute of Technology Press.

Yatchew, A. (1998). Nonparametric regression techniques in economics. *Journal of Economic Literature* 36, 669 – 721.

Table 1: Age, grade and years of schooling relationships in the two surveys

Grade or level	Late 1980s	Mid-1990s		
	Age 14	13	Age 14	15
		Years of schooling		
		8 to < 9	9 to < 10	≥ 10
8	5			
9	70	2 (25)	79 (70)	19 (5)
10	25			

Source: Estimated from YIT 75 and LSAY 95.

Table 2: Sample size for analysis of Year 12 completion

	<i>Comparison Group</i>	<i>September Quarter</i>	<i>October to February</i>	<i>Total</i>
Late 1980s	167	131	194	494
Mid-1990s	456	331	517	1304
	623	462	713	1798

Source: Estimated from YIT 75 and LSAY 95.

Table 3: Year 12 completion and VET and university participation

	<i>Comparison Group</i>	<i>September Quarter</i>	<i>October to February</i>	<i>Total</i>
<i>Achievement</i>				
Change	0.1	0.3	2.7***	1.2***
<i>Year 12</i>		Per cent		
Late 1980s	77.1	74.3	68.1	72.8
Mid-1990s	79.1	75.9	76.3	77.2
Change	2.0	1.6	8.3**	4.4*
<i>VET</i>		Per cent		
Late 1980s	35.6	31.6	36.4	34.7
Mid-1990s	30.1	36.7	29.5	31.8
Change	-5.5	5.1	-6.9	-2.9
<i>University</i>		Per cent		
Late 1980s	22.2	33.8	20.3	24.5
Mid-1990s	35.4	37.4	39.6	37.6
Change	13.3***	3.6	19.3***	13.1***

Source: Estimated from YIT 75 and LSAY 95, with weighted data. ‘***’, ‘**’ and ‘*’ denote significance at the 1, 5 and 10 per cent level respectively. Differences in the changes between cohorts for the Oct – Feb group and the Comparison group are not significant.

Table 4: P-values of tests of the exogeneity and 'linearity' of achievement

	Year 12	VET	Uni	Attainment
Linearity of achievement effect (assuming exogeneity of achievement)	0.084	0.000	0.234	0.296
Exogeneity of achievement	0.018	0.331	0.295	0.070
Linearity of achievement effect	0.114	0.737	0.720	0.899

Table 5: Marginal effects of achievement on education participation and attainment at different achievement levels

		<i>Year 12</i>	<i>VET</i>	<i>Uni</i>		
<i>Achievement level</i>						
Achievement treated	Average	0.012	-0.010	0.027		
as exogenous		(9.27)	(-5.74)	(13.83)		
Achievement treated		0.022				
as endogenous		(2.76)				
	30	0.017	0.015	0.005		
	40	0.049	0.004	0.014		
	50	0.029	-0.008	0.025		
	60	0.004	-0.016	0.027		
	70	0.000	-0.011	0.018		
		<i>< Year 12</i>	<i>< Year 12</i>	<i>Year 12</i>	<i>Year 12</i>	<i>Uni</i>
			<i>& VET</i>		<i>& VET</i>	
<i>Achievement level</i>						
Achievement treated	Average	-0.008	-0.006	-0.008	0.000	0.022
as exogenous		(-11.27)	(-14.17)	(-9.61)	(-0.02)	(10.50)
Achievement treated		-0.014	-0.005	-0.005	0.000	0.024
as endogenous		(-4.14)	(-4.23)	(-3.72)	(-0.02)	(4.02)
	30	-0.029	0.006	0.012	0.007	0.004
	40	-0.029	-0.003	0.006	0.011	0.015
	50	-0.015	-0.008	-0.008	0.002	0.029
	60	-0.004	-0.005	-0.011	-0.009	0.030
	70	-0.001	-0.001	-0.005	-0.009	0.016

Table 6: Changes in idiosyncratic education ‘success factors’ between the two cohorts

Success factor	Variables available	<i>Change in Oct to Feb group compared with Mar to June group</i>
Motivation		
Self-confidence	Self-assessed school performance relative to peers	0.23**
	Residual of regression on self-assessed school performance (regressors included achievement)	0.25**
Ambition	Anticipated occupation in the future	10.1***
Maturity		
Individual, teacher and parental expectations	Plan to complete Year 12	7.3*
	Plan to go to university	15.9***
	Parental encouragement to study-full time after leaving school	10.3**
	Teacher encouragement to study-full time after leaving school	

Figure 1: Impact of the *Early Years of School* policy change on terms in junior primary school in South Australia(a)

	Pre-policy change		Post-policy change	
October to February birth group	6 Terms	9 Terms	9 Terms	
July to September birth group	7 Terms		7 Terms	10 Terms
March to June comparison group	8 Terms		8 Terms	

(a) Junior primary school consists of Reception, Year 1 and Year 2 in South Australia. After the implementation of the *Early Years of School* policy, the number of school terms per year was introduced from three to four.

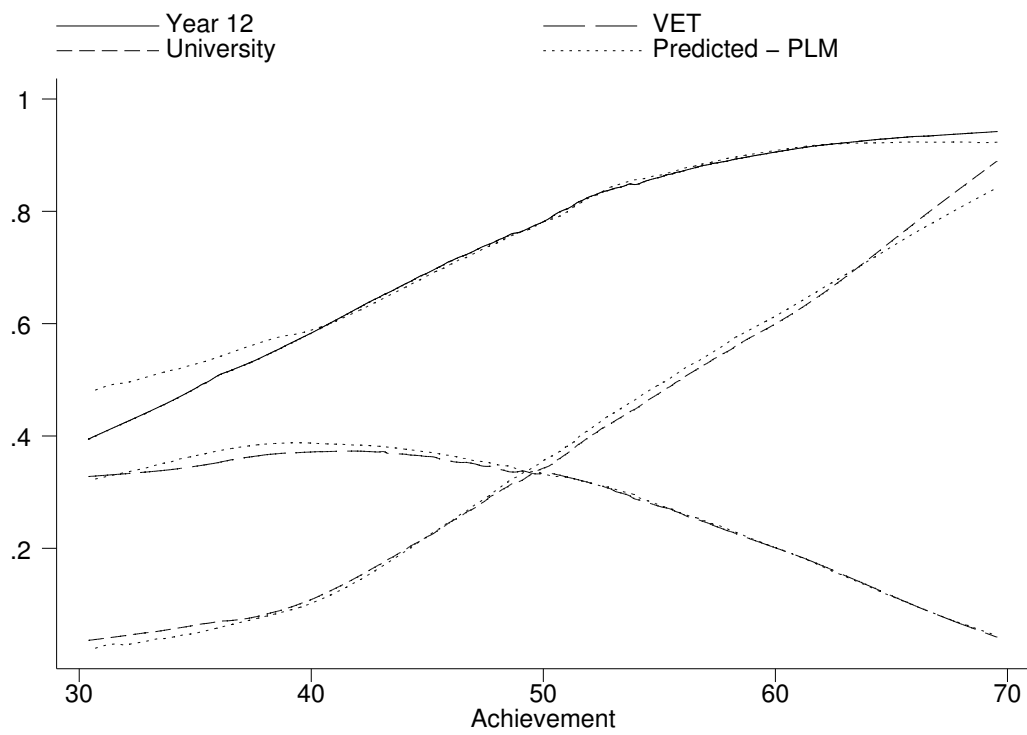


Figure 2: Effect of achievement on Year 12 completion and post-school VET and University participation?

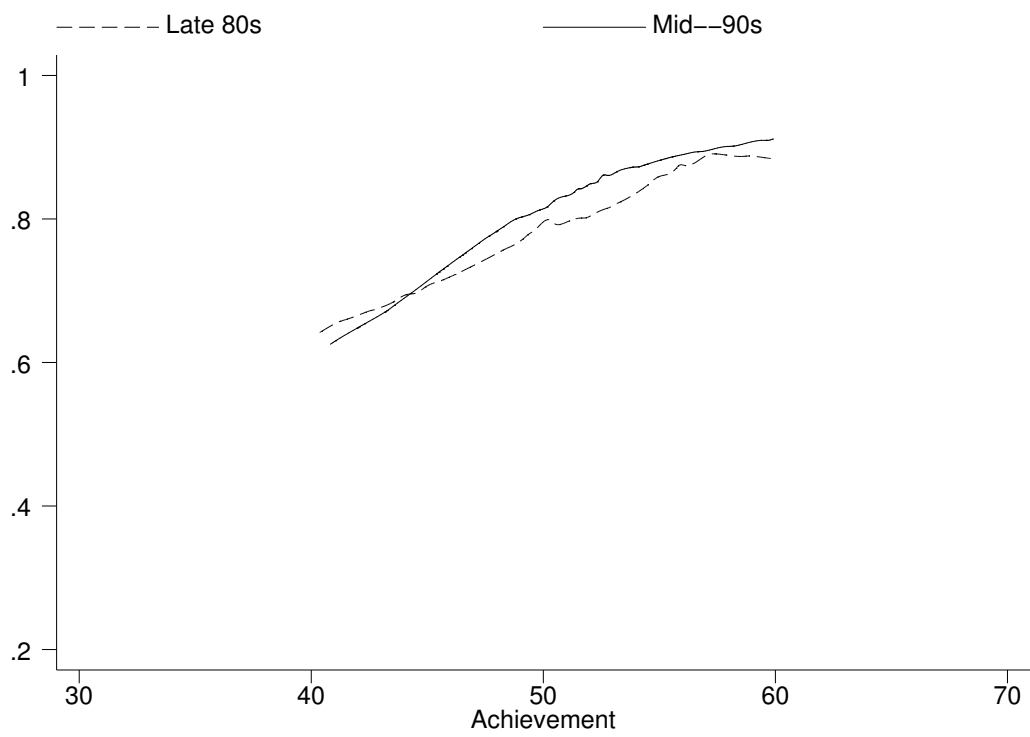


Figure 3: Achievement and Year 12 completion in two cohorts — comparison group

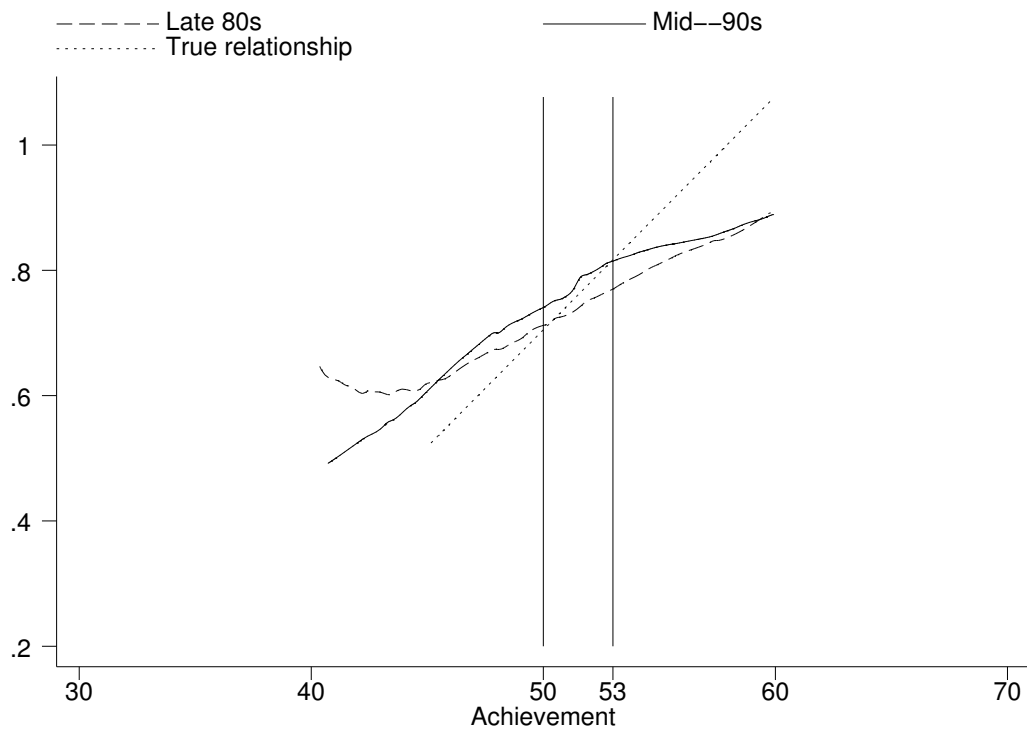


Figure 4: Achievement and Year 12 completion in two cohorts — group affected by the policy change

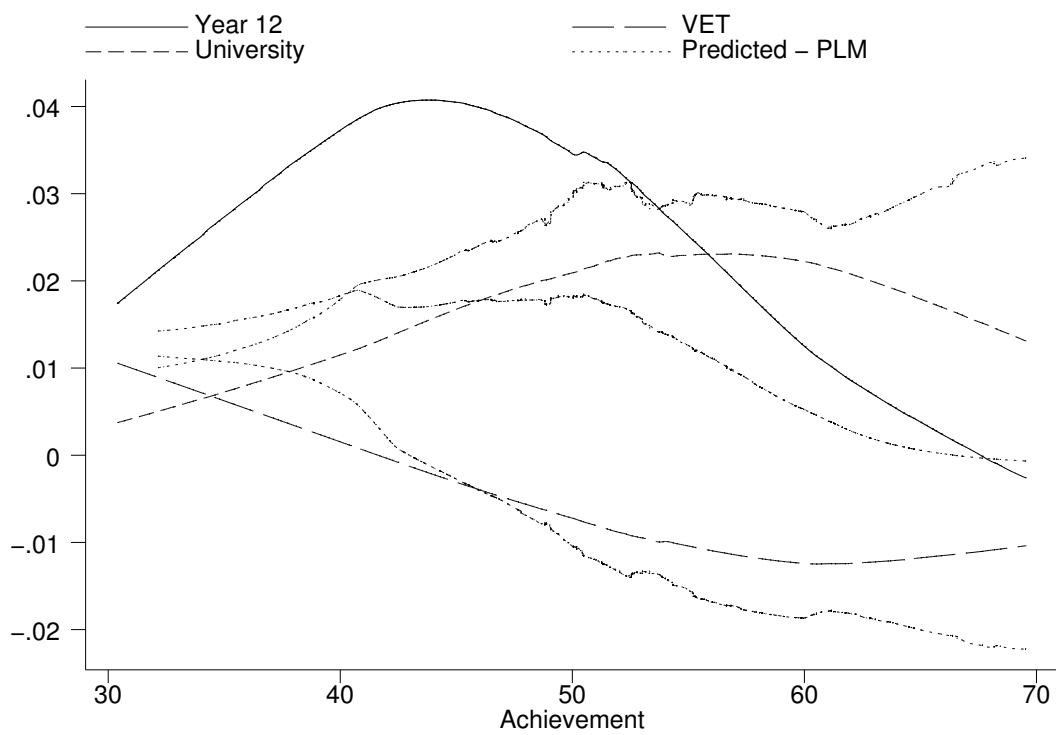


Figure 5: Average marginal effects of achievement on participation at different levels of achievement

Table A: Summary statistics and results of first stage achievement regression

Variable	Summary statistics		Achievement regression	
	<i>Means</i>	<i>Std dev.</i>	β	$z - stat$
Constant			45.17	4.16
Metropolitan	0.60	0.49	0.65	1.20
Independent school	0.14	0.34	-0.35	-0.55
Catholic school	0.17	0.38	0.45	0.73
Mother born in NESB country	0.13	0.34	-0.78	-1.14
Mother born in English-speaking country	0.12	0.33	0.71	1.16
Proportion male at school	0.48	0.24	-1.23	-1.17
Average SES of school	39.3	9.9	0.16	5.51
Proportion at school from NESB background	0.18	0.16	-6.53	-2.97
Parental SES	39.6	22.0	0.04	4.14
Father with degree	0.17	0.37	3.27	5.27
Mother with degree	0.15	0.35	1.41	2.40
Both parents with degree	0.08	0.28	-0.62	-0.68
Male	0.47	0.50	0.79	1.56
1995 Cohort dummy	0.68	0.47	-0.69	-0.84
Grade	9.1	0.3	5.47	7.71
Age	14.1	0.4	-3.54	-5.79
1975 October to February group	0.13	0.33	-4.42	-4.00
1975 September quarter group	0.09	0.28	-0.03	-0.03
Average achievement	50.9	8.3		
Year 12 participation	0.758	0.429		
University participation	0.325	0.47		
VET participation	0.327	0.47		
N				1656
F(18, 1637)				25.61
R-squared				0.220

Table B: Participation and attainment parameter estimates

	Year 12(a)			VET(b))			Uni(b)			Attainment(c)			
	β	$z\ stat$	$M. eff$	β	$z\ stat$	$M. eff$	β	$z\ stat$	$M. eff$	β	$z\ stat$	$M. eff$	β
Constant	-6.518	-2.97	-2.699	-2.60	-5.635	-0.049	0.098	0.77	0.037	-0.04	-4.25	-4.611	-0.321
Metropolitan	-0.161	-1.26	0.026	-0.143	-1.57	-0.020	0.095	0.49	0.036	0.07	0.423	0.481	0.08
Independent school	-0.044	-0.24	0.006	-0.059	-0.37	-0.017	0.055	0.27	0.021	0.08	0.481	0.481	0.08
Catholic school	0.273	1.45	0.059	-0.052	-1.69	-0.058	0.445	3.52	0.174	0.50	5.237	-1.330	-0.12
Mother born NESB country	0.718	2.89	0.098	-0.180	-0.01	-0.001	-0.127	-0.99	-0.047	-0.12	-1.330	-0.12	-0.17
Mother born in English-speaking country	-0.227	-1.40	0.028	-0.002	0.23	0.017	-0.277	-0.96	-0.105	-0.17	-0.687	1.981	0.02
Proportion male at school	0.243	0.83	0.038	0.049	-2.41	-0.004	0.022	3.03	0.008	0.02	1.981	2.119	1.06
Average SES of school	0.022	2.40	0.004	-0.011	-1.44	-0.217	1.360	2.55	0.516	1.06	2.119	1.082	0.00
Proportion at school from NESB background	1.417	2.13	0.257	-0.642	-1.14	-0.001	0.004	1.91	0.002	0.00	1.082	2.793	0.42
Parental SES	0.000	-0.14	0.0002	-0.002	-1.26	-0.067	0.558	3.95	0.217	0.42	2.793	1.357	0.16
Father with degree	0.283	1.10	0.034	-0.208	-1.46	-0.068	0.435	3.26	0.170	0.16	1.357	-1.774	-0.32
Mother with degree	0.047	0.23	0.022	-0.209	0.26	0.023	-0.521	-2.56	-0.179	-0.32	-1.774	-3.851	-0.26
Both parents with degree	-0.402	-1.08	0.088	0.068	3.60	0.101	-0.373	-3.96	-0.140	-0.26	-3.851	3.006	0.46
Male	-0.420	-3.33	0.081	0.297	-1.34	-0.056	0.549	3.30	0.196	0.46	3.006	4.595	0.09
1995 Cohort dummy	0.331	1.91	0.058	-0.161	3.72	-0.010	0.070	13.83	0.027	0.09	4.595	-0.03	-1.719
Achievement	0.125	2.76	0.024	0.146	-0.169	-4.38							
Achievement squared/100													
Achievement residual													
Cut-off values													
$\mu(1)$													
$\mu(2)$													
$\mu(3)$													
N		1656		1553		1520		1553		1553		1553	
McFaddens R-squared		$n/a^{(d)}$		0.08		0.25		0.08		0.08		0.08	
Correct predictions (criteria)		0.75		0.33		0.33		0.33		0.33		0.33	
Participants		79.5		63.7		64.0		64.0		64.0		64.0	
Non-participants		62.2		60.6		81.4		81.4		81.4		81.4	
Total correct		76.0		62.7		71.0		71.0		71.0		71.0	43

(a) Estimated by GMM to deal with the endogeneity of achievement. (b) Estimated by probit, ignoring any endogeneity in achievement. (c) Two step estimation of the equation, dealing with the endogeneity of achievement through the inclusion of the residual from the achievement equation. (d) But equal to 0.16 in the standard probit equation and 0.11 in a two-stage equation.