National Research and Development Centre
for adult literacy and numeracy

Research report

The value of basic skills in the British labour market

Anna Vignoles, Augustin de Coulon and
Oscar Marcenaro-Gutierrez
October 2008

Leading education and social research
Institute of Education
University of London

Published by the National Research and Development Centre
for Adult Literacy and Numeracy

For information on alternative formats, or to give feedback on the content
and accessibility of this publication, please contact:
Publications
NRDC
Institute of Education
20 Bedford Way
London WC1H 0AL

Telephone: +44 (0)20 7612 6476
Fax: +44 (0)20 7612 6671
Email: publications@nrdc.org.uk

NRDC is a consortium of partners led by the Institute of Education,
University of London (see back cover for a list of members) **www.ioe.ac.uk**

Design: www.chapmandesign.net

The value of basic skills in the British labour market

Anna Vignoles, Augustin de Coulon and
Oscar Marcenaro-Gutierrez

CONTENTS

The authors

Anna Vignoles, Centre for the Economics of Education, Institute of Education, University of London.

Augustin De Coulon, National Research and Development Centre for Adult Literacy and Numeracy, Institute of Education, University of London.

Oscar Marcenaro-Gutierrez, University of Malaga.

Executive summary

In his influential report on basic skills issues in the late 1990s, Moser (DfEE 1999) suggested that approximately 20 per cent of adults in England had severe literacy difficulties, whilst around 40 per cent had some numeracy problems. The situation has improved somewhat in literacy for younger workers. We find that 8 per cent of 34-year-olds had severe literacy difficulties in 2004. Of course having poor literacy and/or numeracy is potentially a great impediment to one's personal well-being. Having low skills may also have economic implications. One way to explore this issue is to consider the economic value of these basic skills in the labour market. In our work we assess whether individuals who are more numerate and literate earn significantly more than otherwise very similar individuals who have poorer basic skills.

We find that literacy and numeracy continue to be highly valued in the labour market. Specifically, literacy and numeracy skills retained their high value in the UK labour market over the period 1995 to 2004, despite numerous policy attempts to increase the supply of these skills during this period. In other words, although the population has got somewhat more skilled, in terms of literacy, the value of both literacy and numeracy remained high because the demand for such skills remained strong. We also find that having better basic skills improves a worker's chances of being in employment. Specifically, for women, higher levels of literacy are associated with a higher probability of being in employment, whilst men with higher levels of numeracy have significantly higher employment rates.

Our findings imply that literacy and numeracy skills are still very much valued in today's UK labour market. Even if there have been substantial gains in the skills of the UK workforce over the last decade, it appears this has not been sufficient to reduce the price paid for these skills by employers. These results imply that continued efforts to improve the skills of the UK workforce are needed, and that investment in initiatives that genuinely do improve individuals' basic skills are likely to yield relatively high wage (and potentially employment) returns.

1 Introduction

The UK has a poor record in terms of the literacy and numeracy skills of its workforce. An influential report by Sir Claus Moser (DfEE 1999), commissioned by the UK Government, suggested that approximately 20 per cent of adults in England had severe literacy difficulties, whilst around 40 per cent had some numeracy problems[1]. The supply of these skills in the UK certainly compares poorly to other countries (although similarly to the US): the UK is in the bottom half of the OECD distribution of the proportion of adults having very low levels of literacy or numeracy (Leitch 2006). Of course it is perfectly possible that a low supply of skills in the economy reflects relatively low demand for such skills, although the literature on skill-biased technological change (Berman et al. 1994 and 1998) would seem to suggest that this explanation is unlikely. Indeed, some studies using data from the mid-1990s have suggested that the price of basic literacy and numeracy skills was much higher in the UK labour market than in many competitor countries (Denny et al. 2003; Hansen and Vignoles 2005). Such a high price for these skills is consistent with a deficiency in supply. This is the view taken by the UK Government and in recent years there have been concerted policy efforts to improve the supply of literacy and numeracy skills in the UK. We investigate whether, following on from this policy focus, there has been any change in the price paid for such skills in the UK labour market.

For the analysis we use new data from the British Cohort Study (BCS)[2] to determine the labour market value of literacy and numeracy in the current (2004) UK labour market for a cohort of adults in their thirties. We then compare this to the value of these same skills for an older cohort, the 1958 National Child Development Study (NCDS) cohort that was surveyed in the mid-1990s. This paper contributes to the existing literature[3] in a number of ways. The data we use contain specific measures of adult literacy and numeracy. These tests are not synonymous with other general cognitive ability tests, nor are they curriculum-based mathematics or English tests, although clearly the correlation between general ability and literacy/numeracy may be high. It is therefore the first paper, to our knowledge, to examine changes in the value of literacy and numeracy specifically over time (as distinct from changes in the value of other cognitive skills or schooling). This is important as we have a priori reason to believe that in the UK the supply of literacy and numeracy skills may have changed in the intervening period, as discussed earlier. Another crucial advantage of the data we use is that we have separate measures of schooling, early cognitive ability (at age five to seven), and adult literacy and numeracy. Notwithstanding the problems of measuring the distinct contribution of these distinct elements of human capital on earnings (Cawley et al. 1997 and

1. Full details and a table showing the equivalencies of the different UK literacy/numeracy levels are given in Appendix A.
2. This study follows a cohort born in 1970.
3. UK evidence is summarised in Leitch (2006). See also Tyler (2004a) for US evidence.

2001; Heckman and Vytlacil, 2001), the data are incredibly rich and allow us to try to tease out the specific value of literacy and numeracy (as distinct from schooling or cognitive ability). Lastly, although the evidence is from the UK, it is likely to be of wider interest since the UK experience is somewhat similar to that of the US. Both countries have relatively low levels of literacy and numeracy.

The paper is set out as follows. The next section provides a brief overview of the literature that has examined the relationship between skills and labour market outcomes. Section 3 then discusses data and method. Section 4 presents results on the wage effects of literacy and numeracy and the relationship between these skills and employment. Section 5 concludes.

2 Overview of existing literature

A useful summary of the current literature on the labour market value of cognitive skills is given by Tyler (2004a). There is in fact limited US research on the labour market value of adult literacy and numeracy skills specifically, although there is a body of literature that has examined the role of cognitive and more academic skills in determining earnings, often in the context of dealing with ability bias in estimates of the return to schooling. This literature suggests a substantial premium for cognitive skill in the US labour market at least (Howell and Wolff 1991; Murnane et al. 1995; Murnane et al. 2000; Bowles et al. 2001). Furthermore, a number of key studies have suggested that the return to such academic or cognitive skills have increased over time (Howell and Wolff 1991; Murnane et al. 1995), although the evidence on this point is not necessarily conclusive (Bowles et al. 2001). Furthermore, cognitive skills play a more important part in determining earnings for some groups of students. For example, Tyler (2004a) suggested a substantial labour market value for basic cognitive skills particularly for young people who have dropped out of high school and who are early on in their careers. There are also important interactions between cognitive skills and schooling. Blackburn and Neumark (1993), for example, found a higher return to graduating from college for those with higher levels of cognitive skill, although this was not by and large supported by Murnane and Willett (2004).

For the UK there is some evidence on the value of literacy and numeracy skills specifically (see Grinyer 2005 for a useful summary)[4]. Key papers by Dearden et al. (2002) and McIntosh and Vignoles (2001), using UK data from the 1990s, showed that numeracy and literacy skills have important positive effects on individuals' labour market outcomes. The results from these papers were derived from two data sources. The first is a data set that contains information on a cohort of individuals born in 1958, the National Child Development Study (NCDS). Individuals in this data set were assessed in terms of their literacy and numeracy in 1995. These data were limited by the fact that only 10 per cent of the NCDS sample undertook literacy and numeracy tests and sample sizes are therefore extremely small. The second source is the International Adult Literacy Survey (IALS), which surveyed the literacy and numeracy skills of a cross-section of individuals aged 16 to 64 in 1996. This latter data set is limited by the fact that it is not particularly rich in terms of family background variables.

Acknowledging the caveats about the data, Dearden et al. (2002) found a large positive effect on earnings and employment rates from having better *numeracy* skills. The same study also found a positive relationship between *literacy* and economic outcomes, although the results varied according to the data set used and the effects tended to be smaller and/or

4. See also Ananiadou et al. 2004.

insignificant. Other studies, namely McIntosh and Vignoles (2001) on the same data sets, and more recently Grinyer (2005) with cross-section data, confirm the positive relationship between better literacy and numeracy and earnings and employment rates.

Dearden et al. (2001) also analysed the impact of *improvements* in adult literacy and numeracy skills, as opposed to just identifying the effect of having a particular level of skill. They tested a number of different measures of skill improvement, including whether respondents had taken a literacy or numeracy course, whether respondents believed that their skills had improved and whether there had been real changes in respondents' literacy and numeracy test scores between the ages of 16[5] and 37. They found that individuals who *reported* that their skills had *improved* generally earned more than those who did not believe that their skill levels had improved. Most of the other skill improvement measures were insignificant in the model.

The evidence cited above is derived from estimates of the economic value of literacy and numeracy in the UK labour market in the 1990s[6]. Since that time, the UK Government Department for Education and Skills (DfES) reported that the proportion of adults aged 16 to 65 who have literacy skills below the minimum target of Level 1 (equivalent to age 11 reading) fell from 7 million in 1997 to around 5.2 million adults in 2004 (NAO 2004). The number of individuals with numeracy skills below the minimum target of Entry 3 (the standard expected of 9- to 11-year-olds) has also apparently been reduced from the 7 million estimated in 1997 to 6.8 million adults. Such significant changes may have affected the supply of these skills in the labour market and there is a need to update the evidence base and obtain more current estimates of the economic value of these skills.

5. The tests administered at age 16 to the NCDS were not designed specifically to assess literacy and numeracy, however.
6. More precisely, in 1991 for studies relying on the 1970 BCS data, 1995 for studies relying on NCDS data and 1996 for studies relying on IALS data.

3 Data and methods

3.1 Data and descriptive statistics

For much of the analysis below, we use a face-to-face survey of the British Cohort Study 1970 (BSC70) cohort that was carried out in 2004. In addition to being asked about their home life and economic activity, all respondents were also assessed in terms of their literacy and numeracy skills[7]. A preliminary but comprehensive account of the literacy and numeracy profiles of this cohort and details of the survey are given in Bynner and Parsons (2005). In addition, we make comparisons over time using the 1995 survey of the NCDS 1958 cohort, which provides basic skill assessments for 10 per cent of that cohort. Full details of this survey can be found in McIntosh and Vignoles (2001).

Table 1: Literacy and numeracy levels amongst 30-year-olds

		NCDS (1958) cohort surveyed in 1995		BCS (1970) cohort surveyed in 2004	
Level	**Average age expected to achieve level**	**Literacy (% of sample)**	**Numeracy (% of sample)**	**Literacy (% of sample)**	**Numeracy (% of sample)**
Entry 2 or below		6	23	4	14
Entry 3 or below *(minimum target level for numeracy)*	Age 7	13	25	4	25
Level 1 (*minimum target level for literacy*)	Age 11	38	24	30	34
Level 2 or above	Age 16	43	27	62	27

Source: BCS data comes from Bynner and Parsons (2005), Figures 3.5a and 3.6a. NCDS data comes from McIntosh and Vignoles (2001).

The tests used by the BCS cohort are similar to those taken by the NCDS cohort in 1995. We can therefore compare changes over time in levels of adult literacy and numeracy across these two cohorts (Table 1). The first two columns show the profile for the earlier NCDS cohort, based on the literacy and numeracy assessment undertaken in 1995, i.e. at age 37. This can be contrasted with the second two columns that show the profile for the later BCS cohort, based on an assessment undertaken in 2004, i.e. at age 34. Thus even by 2004, 8 per cent of individuals in their mid-thirties still have literacy skills below the minimum target of

7. See Appendix B for a brief discussion of these data.

Level 1, whilst in numeracy 14 per cent of the sample fall below the Government target of Entry 3 skills[8].

Table 1 certainly shows some change between the two cohorts. The proportion of the 1970 cohort with poor literacy and numeracy skills is smaller than in the earlier 1958 cohort. This could potentially be due to policies aimed at improving the skills of *adults* during this period, such as the Skills for Life strategy[9]. However, it may also be due to the fact that school leavers have been improving over time in the UK, in terms of their qualification levels, and therefore by implication they may have also been improving their literacy and numeracy skills. Certainly the more recent cohort acquired more education than the 1958 cohort and we would therefore anticipate a reduction in the proportion with poor skills. For example, by their mid-thirties, 30 per cent of the 1958 NCDS cohort had acquired a degree-level qualification or above. By contrast, nearly 40 per cent of the 1970 BCS cohort had acquired a degree-level qualification or above by their mid-thirties. This evidence is not conclusive of course and depends on the metric used to measure skill. For instance, TIMSS[10] data suggests that the average mathematics skills of English 14-year-olds have been quite constant since the early 1990s.

3.2 Methodology

We model the link between literacy and numeracy skills and labour market outcomes, namely earnings and employment. For the wage analyses, we use the following adaptation of the basic Mincer (1974) earnings model:

$$\ln Yi = \propto + \beta Xi + \delta Zi + \mu i$$

where Y is an individual's gross hourly earnings, X is a vector of individual characteristics and Z is a vector including normalised literacy and numeracy test scores. We include a range of individual characteristics (X)[11] from these very rich cohort data, including gender and ethnicity, as well as a number of family background variables such as parental social class when the children were age 5, whether the individual experienced financial hardship during their childhood, whether they were eligible for free school meals[12] at age 10 and their parents' education level and interest in the cohort member's education at age 16. It is of course rare to find such rich information in cross-section and/or administrative data sets. Such family background variables are important since other evidence does suggest that they affect an individual's education level and hence their skills, as well potentially having a direct impact on subsequent earnings.

It is well known that estimates of the return to education may suffer from ability bias (Griliches 1977). Likewise with estimates of the return to literacy and numeracy skills, it may

8. This is broadly consistent with the results from the Skills for Life Survey cited extensively by the Leitch review (2006).
9. Another possibility is that the tests used may vary across the two cohorts. Bynner and Parsons (2005) highlight the differences between the assessment methods used for the NCDS age 37 survey and the BCS 2004 survey. However, the 2004 BCS survey deliberately combined elements of the earlier NCDS assessments, with new literacy and numeracy items, as set out by Brooks et al. (2005). This ensures a high degree of comparability between the earlier NCDS data and the BCS tests (Bynner and Parsons 2005).
10. Trends in international mathematics and science study.
11. Appendix C contains means of all the variables used in the analysis for the sample for our preferred specification.
12. In the UK children whose parents are on low income or unemployed are eligible for free meals at school. This indicator is widely used as a proxy for socio-economic disadvantage in UK education research.

be that some of the apparent role of skills in determining earnings is actually due to the fact that more able individuals (who would earn more anyway) also have better basic skills. The data set used in this analysis has the additional advantage of containing a range of proxy indicators of the individual's ability, and the model therefore also controls for test scores from cognitive skill tests undertaken at ages 5 and 10. The age 5 tests in particular should proxy an individual's ability rather than simply measuring the effects of their schooling.

In some specifications of the model, variables describing the individual's current situation are included. These include whether the individual is disabled, whether they have children, and descriptions of their labour market history. These variables may of course be endogenous[13] and we therefore include them only for illustration. In some specifications we also attempt to tease out the distinct effects of education from the effects of literacy and numeracy skills. The specification measures the marginal impact of having better literacy and numeracy skills conditional on a given level of education achieved. We recognise that one of the major routes by which having poor skills impacts on an individual's subsequent labour market success is by ensuring poor educational achievement. In models that control for educational achievement, we are limiting the effect of having poor literacy and numeracy skills to an additional effect over and above any impact poor skills may have on a person's education level. This is made clear in the discussion of results.

3.3 Causality

Ideally of course one wants to estimate the causal impact of literacy and numeracy skills on individuals' earnings. We have a twofold estimation strategy. Firstly, we use the richness of the BCS data to control for the widest range of observable characteristics possible, thereby limiting the likelihood of omitted variable bias. The specifications we use are extremely rich and can arguably be said to allow for ability bias. Furthermore, we are able to include a range of individual and family characteristics that have been found to significantly affect educational achievement, and may well also be proxy measures for unobserved factors that influence both literacy and numeracy and subsequent earnings. For instance, by controlling for parental attitudes towards education, we attempt to allow for what are normally unobservable characteristics of parents that influence children's educational achievement, and which may well also eventually influence their earnings.

Whilst including a rich range of family background controls does go some way to reassuring us that we are uncovering causal relationships, such an approach does not take care of unobservable factors. Another potential problem we face is that our OLS[14] estimates may also be biased by measurement error in the literacy and numeracy tests, which is an issue that has been recognised as a particular problem in this literature (Tyler 2004a). Classical measurement error will produce downward bias in OLS estimates. An IV[15] approach can be used to both address the issue of causality and the problem of measurement bias (Dearden 1999). We therefore undertake a series of robustness checks to attempt to take account of both endogeneity and measurement error bias. Firstly, we include lagged measures of both wages and basic skills in the models. This is an attempt to control for constant unobserved factors that determine both current and previous skills and wages. We also adopt the use of

13. By endogenous, we mean that those variables may themselves be functions of the levels in numeracy and literacy.
14. Ordinary least squares.
15. Instrumental variable.

the method of instrumental variables. We have a number of potential instruments, arising from the rich data collected throughout these individuals' lifetimes, and particularly during their childhood. We used some variables measured early in the individual's childhood to avoid capturing the effect of their education. Specifically, we considered a number of potential instruments, namely:

- indicators of the extent to which the cohort member was read to as a young child (age 5)
- whether or not the mother was the one doing most of the reading to the child at the age of 5
- whether the mother smoked during pregnancy.

The above instruments potentially identify individuals' basic skill levels but arguably do not directly impact on their wages. We also consider a set of instruments to deal with measurement error. The BCS data include indicators of the individual's early childhood ability, as measured by three tests undertaken at age 5 (a human figure drawing test, a copying designs test and an English picture vocabulary test) as well as later measures such as the mathematics tests at age 10. Whilst these tests are not measuring literacy and numeracy skills per se, they are correlated with such skills. We use these measures as instruments for adult skills to assess the extent to which measurement error may be an issue in these data.

3.4 Employment outcomes

For the analysis of the relationship between literacy and numeracy and employment, we rely on simple probit models in which the outcome measure takes a value of 1 if the person spent more months in employment than in any other state (i.e. unemployment, inactivity, long-term sickness, working in the home, full-time education) between the ages of 33 and 34, and a value of 0 otherwise. The proportion of the cohort in employment at any one time is high, so variation is limited using this measure. We are also interested in the relationship between adult skills and different types of employment. As there is evidence that part-time jobs in the UK are of disproportionately low quality, we also consider the effect of basic skills on full-time employment specifically. We use a binary variable that takes the value of 1 if the person spent more months in full-time employment during the last year than in any other state. Again our estimation strategy is to rely on the richness of the data to enable us to fully control for a number of observable characteristics that might be correlated with skills and also influence employment. We were unsuccessful in estimating IV probit models and therefore we acknowledge that, in the case of the employment analysis, we are not as confident that we have established causality.

4 Results

4.1 The impact of literacy and numeracy on earnings in 2004

Column 1 of Table 2 shows the relationship between continuous[16] measures of literacy and numeracy and earnings in 2004 for the BCS cohort, with no other controls in the model. Variation in adult literacy and numeracy explains around 10 per cent of the variation in log gross hourly earnings in this specification. Both literacy and numeracy are highly significant in the model. Better literacy and numeracy skills are positively related to earnings and the relationship is non-linear[17], suggesting higher skill levels are associated with higher earnings at an increasing rate. An additional standard deviation of literacy skill yields on average 20 per cent[18] higher earnings, whilst an additional standard deviation of numeracy skill yields just over 17 per cent higher earnings. Given that our measures are normalised this implies that an individual who moves from the median of the literacy (or numeracy) distribution to the 84th percentile will increase his/her hourly wage by 20 per cent (or 17 per cent, respectively).

Column 2 then adds in some early ability measures, i.e. test scores at age 10. We know that early test scores are an important determinant of literacy and numeracy skills at age 34, and other evidence suggests that ability also has a direct impact on earnings. This model therefore tests whether the estimates of the impact of literacy and numeracy are attenuated once we attempt to allow for ability bias. The age 10 mathematics score and the general ability test score are significant but the age 10 literacy score is not. However, the inclusion of the early ability scores does reduce the magnitude of the effect from literacy and numeracy on current earnings. Nonetheless, literacy and numeracy remain highly significant in the model and show the same non-linear relationship with earnings. An additional standard deviation on the literacy test score is associated with 16 per cent higher earnings, whilst an additional standard deviation on the numeracy score is associated with approximately 13 per cent higher earnings.

Column 3 of Table 2 includes the full range of family background variables discussed earlier and is our preferred model[19]. Literacy and numeracy continue to be significant. The inclusion of the family background variables does appreciably reduce the wage premium associated with having better literacy and numeracy skills. An additional standard deviation in literacy

16. We also have done an analysis using the Skills for Life standard levels (see Appendix D). We explain there the reasons why we favour continuous measures of literacy and numeracy in the main text.
17. We tested for non-linearities in the effects of basic skills by adding quintile indicators of individuals' literacy and numeracy scores but found no additional non-linearities in the effects.
18. Note that this is calculated including the effect of the non-linear term.
19. Full specifications are in Appendix E.

Table 2: The relationship between age 34 basic skills and earnings: men and women

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Standardised age 34 literacy score	0.164***	(0.016)	0.134***	(0.018)	0.114***	(0.018)	0.091***	(0.017)
Standardised age 34 literacy score squared	0.032***	(0.008)	0.030***	(0.010)	0.026***	(0.010)	0.022**	(0.010)
Standardised age 34 numeracy score	0.138***	(0.012)	0.094***	(0.015)	0.084***	(0.015)	0.064***	(0.015)
Standardised age 34 numeracy score squared	0.038***	(0.010)	0.033***	(0.008)	0.025***	(0.008)	0.025***	(0.009)
Controls:								
Gender	X		X		X		X	
Age 10 ability test scores			X		X		X	
Family background variables					X		X	
Labour market variables							X	
Highest education level at age 34							X	
Sample size	6,255		4,664		4,664		4,662	
R-squared	0.10		0.11		0.15		0.19	
Adj R-squared	0.10		0.10		0.15		0.18	

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34.
Results are for men and women combined. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

results in approximately 14 per cent higher earnings, whilst an additional standard deviation in numeracy results in 11 per cent higher earnings.

For completeness, column 4 then includes a range of additional variables describing the individual's current situation. These variables include the person's highest education level, whether or not the person is registered disabled, months of total unemployment to 2004, months out of the labour market to 2004 and whether or not the individual has a child. Including these variables is forcing the model to include potential outcomes from having poor literacy or numeracy, thereby reducing the potential effect from literacy and numeracy on earnings. We do not stress these results but note that inclusion of these variables reduces the coefficients on literacy and numeracy as expected. The impact of literacy and numeracy on earnings, however, remains significant. Given that we control for highest education level, the model in column 4 essentially measures the effect of literacy and numeracy skills on earnings within a given level of education. Thus these skills still have a significant relationship with earnings, even for individuals with similar levels of education.

Men and women have very different patterns of work in the labour market, particularly in their early thirties when a significant proportion of the women have (temporarily) withdrawn from the labour market. We therefore estimate wage equations separately for men and women. We do not estimate sample selection models for women and therefore these results apply only to women who choose to participate in the labour market in their early thirties, who may not be representative of all women.

Table 3: The relationship between age 34 basic skills and earnings: males

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Standardised age 34 literacy score	0.153***	(0.023)	0.137***	(0.025)	0.124***	(0.025)	0.103***	(0.025)
Standardised age 34 literacy score squared	0.030***	(0.009)	0.035***	(0.008)	0.033***	(0.008)	0.031***	(0.009)
Standardised age 34 numeracy score	0.140***	(0.018)	0.095***	(0.020)	0.089***	(0.020)	0.074***	(0.020)
Standardised age 34 numeracy score squared	0.031**	(0.014)	0.037***	(0.012)	0.029**	(0.012)	0.025**	(0.012)
Controls:								
Age 10 ability test scores			X		X		X	
Family background variables					X		X	
Labour market variables							X	
Highest education level at age 34							X	
Sample size	3,257		2,396		2,396		2,394	
R-squared	0.10		0.11		0.14		0.16	
Adj R-squared	0.10		0.10		0.13		0.15	

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34.
Results are for men. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 3 summarises results for men, whilst Table 4 provides results for women. In the first specification from each table that has no additional controls, an extra standard deviation of literacy yields 18 per cent higher earnings for men and just under 22 per cent for women. An additional standard deviation of numeracy yields higher earnings of 17 per cent for males and 19 per cent for females. In the preferred specification that controls both for early ability and family background, an extra standard deviation of literacy yields 15 per cent higher earnings for men and 13 per cent for women. An additional standard deviation of numeracy gives 11 to 12 per cent higher earnings for both men and women. In other words, although other characteristics affect male and female pay quite differently (e.g. ethnicity), men and women with better numeracy earn similar wage premiums in the labour market.

It may also be the case that adult literacy and numeracy skills are more important for individuals who do not have high levels of education. We tested whether the return to literacy and numeracy varied by education level. For example, we estimated the return to these skills for individuals with low levels of education (i.e. less than high school education) and those with higher levels of education (high school or above). In fact the returns to literacy and numeracy were not significantly different for either group of workers.

4.2 Robustness checks and inferring causality

From a policy perspective we would like to know the potential effect of increasing individuals' adult skill levels on their wages, and by implication, their productivity. This requires us to take a causal interpretation of our results. The richness of our OLS results gives us some

Table 4: The relationship between age 34 basic skills and earnings: females

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Standardised age 34 literacy score	0.175***	(0.020)	0.130***	(0.026)	0.108***	(0.025)	0.080***	(0.024)
Standardised age 34 literacy score squared	0.035***	(0.013)	0.023	(0.018)	0.020	(0.018)	0.015	(0.019)
Standardised age 34 numeracy score	0.138***	(0.017)	0.094***	(0.023)	0.083***	(0.022)	0.060***	(0.023)
Standardised age 34 numeracy score squared	0.045***	(0.014)	0.035***	(0.012)	0.027**	(0.012)	0.027**	(0.013)
Controls:								
Age 10 ability test scores			X		X		X	
Family background variables					X		X	
Labour market variables							X	
Highest education level at age 34							X	
Sample size	2,998		2,268		2,268		2,268	
R-squared	0.09		0.10		0.13		0.17	
Adj R-squared	0.08		0.09		0.12		0.16	

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34. Results are for women. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

confidence that we are controlling for a myriad of observed characteristics that may otherwise be omitted from most models. There is still the possibility, however, that there may be unobserved characteristics of the individual that determine both their basic skill levels and their subsequent earnings in the labour market. For example, if particularly highly-motivated individuals tend to have better basic skills and as well as earn more in the labour market, we may be spuriously attributing the impact of being more motivated to having better basic skills. To some extent we already address this by controlling for early ability, as well as the rich range of family background variables available in the BCS data. However, it is still possible that our estimates suffer from residual endogeneity bias. Another issue we face is the problem of measurement error in the literacy and numeracy measures obtained at age 34. The tests were administered in a home environment setting, albeit with trained test administrators supervising the tests. We therefore recognise that measurement error is likely to be more of a problem than test scores obtained in a more controlled educational setting. To address these issues of endogeneity and measurement error, we undertake a number of robustness checks, including taking an IV approach.

Firstly, we have prior measures of wages (from BCS surveys at age 26 and, for a 10 per cent sub-sample, at age 21) and prior measures of literacy and numeracy (from age 21 for a 10 per cent sub-sample of the BCS). We therefore include lagged measures of both wages and basic skills in our model, to test whether we continue to get significant effects from current (2004) measures of literacy and numeracy on earnings. Inclusion of lagged measures of earnings should control for the effect of constant unobserved characteristics that determine previous wages. Inclusion of lagged literacy and numeracy measures provides a rigorous check of the

Table 5: Robustness checks: including lagged wage and literacy/numeracy measures

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	Coeff.	Std.	Coeff.	Std.	Coeff.	Std.	Coeff.	Std.
Standardised age 34 literacy score	0.132***	(0.022)	0.161***	(0.054)	0.152***	(0.050)	0.121***	(0.034)
Standardised age 34 literacy score squared	0.023	(0.017)	-0.069	(0.074)	-0.024	(0.058)	0.040***	(0.013)
Standardised age 34 numeracy score	0.072***	(0.018)	0.080**	(0.041)	0.027	(0.039)	0.022	(0.033)
Standardised age 34 numeracy score squared	0.035***	(0.013)	0.088**	(0.043)	0.047**	(0.024)	0.004	(0.016)
Controls:								
Log wage at age 26	0.135***	(0.018)	0.178***	(0.045)				
Log wage at age 21			0.073	(0.052)				
Standardised age 21 numeracy scores					0.065*	(0.036)		
Standardised age 21 literacy scores					0.103***	(0.037)		
Standardised age 16 math scores							0.083***	(0.029)
Age 10 ability test scores	X		X		X		X	
Family background variables	X		X		X		X	
Sample size	2,827		343		608		1,332	
R-squared	0.165		0.349		0.172		0.165	
Adj R-squared	0.156		0.282		0.126		0.145	

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34. Results are for men and women combined. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

effect of current literacy and numeracy, conditional on a person's basic skills towards the beginning of their working life (age 21). The results of these robustness checks are presented in Table 5. The effects of age 34 literacy and numeracy on current earnings continue to be highly significant and of similar magnitude even after controlling for previous wages.

When we include previous measures of literacy and numeracy for the 10 per cent sub-sample of the BCS in 1991, the age 21 measures of basic skill are positive and significant. Inclusion of these age 21 measures reduces the overall effect of the age 34 measures, as expected, but they remain positively and significantly related to current earnings. In column 4 of Table 5, an alternative measure of lagged numeracy is included in the model, namely, the person's mathematics test score taken from the age 16 survey of the BCS[20]. This age 16 measure is highly significant in the model and age 34 numeracy does not remain significant once this lagged measure is included. However, the age 10, the age 16 and the age 34 numeracy measures are correlated (of the order of 0.60 in pairwise correlations). It is probable that the

20. The BCS age 16 test scores in mathematics are not available from the Economic and Social Research Council (ESRC) data archive. We are grateful to Jon Johnson and the BCS team at the Centre for Longitudinal Studies, Institute of Education, University of London, for providing these data.

age 10 and age 16 measures are capturing most of the effect of numeracy at age 34. Overall, however, the results imply that, conditional on early literacy and numeracy, individuals with better skills at age 34 still earn a wage premium to those skills[21].

Our IV results are presented in Tables 6 (for literacy) and 7 (for numeracy). We present only the coefficients on the instrumented literacy and numeracy variables and we present several IV estimates that vary by choice of instrument. The primary purpose of the IV estimation is to establish the extent of bias in the OLS estimates caused by measurement error and, in as much as we have plausible exogenous instruments, endogeneity.

Table 6: IV estimates of the impact of literacy on earnings at age 34

	Effect of literacy on hourly wage at 34				
	Estimated coeff. for literacy	Std.	First stage F-stat of excl. instrument	Hansen's J statistic (P-value)	N
	(1)	(2)	(3)	(4)	(5)
OLS	0.095***	0.018			3,136
2SLS[22]					
Instruments:					
Age 5 ability test scores	0.455***	0.131	14.84	0.778	3,136
Same + mother does most of the reading to child aged 5; days/week reading to child aged 5	0.378***	0.113	11.37	0.537	3,139
Same +mother smoked during pregnancy	0.321***	0.104	10.51	0.327	3,136
LIML[23]					
Instruments:					
Age 5 ability test scores; mother does most of the reading to child aged 5; days/week reading to child aged 5; mother smoked during pregnancy	0.339***	0.113	–	0.334	3,136

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34. Results are for men and women combined.

*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 6 shows the return to literacy. In each case the instruments are good predictors of adult literacy scores (the F test from the first stage regression exceeds the value of around 8 or more in each case). The estimates of the effect of literacy on earnings range from 0.32 to 0.46. This compares to an OLS coefficient of just 0.095 in an identical specification[24]. In the specification that only uses age 5 ability tests as instruments, the estimate of the return to literacy is particularly high at 0.46. This result implies that our OLS coefficients are underestimates of the true impact of adult literacy due to measurement error. In the specifications that include other instruments that predict literacy, such as the reading

21. A first difference model regressing the change in wages between 1991 and 2004 against the change in standardised literacy and numeracy scores over the same period did not yield a significant correlation, partly due to small sample sizes and very large standard errors.
22. Two stage least squares.
23. Limited information likelihood estimation.
24. Note these estimates are linear, i.e. we include only the literacy score and not its square as in previous tables.

environment of the child in early childhood, the estimate of the return to literacy remains much higher than the OLS estimate. This result is consistent with the returns to education literature that has generally found higher returns to education using IV methods (Card 1998). The IV method always generates a Local Average Treatment Effect (LATE) (Card 1998). This means that those individuals affected by the instrument, for example, those individuals for whom early exposure to reading did affect their adult literacy, earn a higher return to literacy in the labour market.

Table 7: IV estimates of the impact of numeracy on earnings at age 34

	Effect of literacy on hourly wage at 34				
	Estimated coeff. for literacy	Std.	First stage F-stat of excl. instrument	Hansen's J statistic (P-value)	N
	(1)	(2)	(3)	(4)	(5)
OLS	0.102***	0.016			3,129
2SLS					
Instruments:					
Age 5 ability test scores	0.310**	0.137	15.19	0.029	3,132
Age 5 ability; mother does most of the reading to child aged 5; days/week reading to child aged 5	0.301**	0.130	9.79	0.084	3,132
Same +mother smoked during pregnancy	0.282**	0.126	8.65	0.098	3,129
Age 16 test maths score	0.306***	0.076	160.99	-	3,132
LIML					
Instruments:					
Age 5 ability test scores; mother does most of the reading to child aged 5; days/week reading to child aged 5; mother smoked during pregnancy	0.315**	0.149	-	0.096	3,129

Data source: 1970 BCS Age 34 survey. Dependent variable is log gross hourly earnings at age 34. Results are for men and women combined.

*** significant at 1%, ** significant at 5%, * significant at 10%.

The results for numeracy in Table 7 mirror those for literacy, although we also use the age 16 mathematics test score mentioned earlier as a potential instrument for age 34 numeracy. All the instruments chosen work in the first stage and the F statistics exceed 8 in each case, although the Hansen's J test statistic is less reassuring about the validity of the instruments. The IV estimates of the effect of numeracy on earnings range from 0.28 to 0.31. This compares to a somewhat lower OLS coefficient of 0.102 from the same model. Again, this can be attributable to measurement error and/or because a LATE effect is being estimated. The LIML estimates produce similar coefficients and only slightly higher standard errors. In a further check of our instruments we perform JIVE's[25] estimations (Angrist et al. 1999a). They produce very similar coefficient estimates and standard errors (not presented).

In summary, our IV approach suggested a positive and stronger relationship between basic

25. Jacknife instrumental variable estimation.

skills and earnings than was the case for our standard OLS model. This is consistent with our fear that our OLS estimates suffer from attenuation bias caused by measurement error in the basic skills measures.

4.3 Changes over time

We then undertook a cross-cohort analysis of the relationship between literacy and numeracy and earnings for two cohorts in their thirties, one in 1995 (NCDS) the other in 2004 (BCS) (Table 8). Thus we compare the return to basic skills for a similar age sample at two points in time, to try to uncover any major change in the economic value of basic skills in the UK labour market for this age group. We adopt our preferred specification (column 3 of Table 2), and we are able to estimate virtually identical specifications using the NCDS and BCS data sets. In both data we are able to control for parental social class, whether the individual lived in financial hardship during their childhood, parents' education levels and interest in the cohort member's education in childhood. In both data we are also able to control for early ability, although the early ability tests were administered at age 10 in the BCS data and age 11 in the NCDS data.

Table 8: Changes over time: the relationship between basic skills and earnings for men and women (combined sample) in their thirties

	1995		2004	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Standardised age 34 literacy score	0.109	(0.025)**	0.114	(0.019)**
Standardised age 34 literacy score squared	0.038	(0.009)**	0.026	(0.007)**
Standardised age 34 numeracy score	0.150	(0.026)**	0.084	(0.015)**
Standardised age 34 numeracy score squared	0.018	(0.013)	0.025	(0.009)**
Controls:				
Gender	X		X	
Age 10/11 ability test scores	X		X	
Family background variables	X		X	
Sample size	854		4,664	
R-squared	0.33		0.15	
Adj R-squared	0.33		0.15	

Data source: For 1995 regression, NCDS Age 31 and Age 37 surveys. For 2004 regression, 1970 BCS Age 34 survey.
Dependent variable is log gross hourly earnings at age 31 for NCDS and age 34 for BCS.
Results are for men and women combined. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Column 1 of Table 8 suggests that for the NCDS cohort surveyed in 1995, a one standard deviation increase in literacy and numeracy was associated with a 15 per cent increase in earnings, after controlling for early ability and family background. Column 2 of Table 8 indicates that a one standard deviation increase in literacy and numeracy in the 2004 labour market for the BCS cohort was associated with a 14 per cent and 11 per cent increase in earnings respectively. Given that both cohorts were at a similar age when they were surveyed, we conclude that the return to literacy is quite similar across the two cohorts. The magnitude of the relationship between numeracy and earnings is somewhat reduced in the later cohort but the results are not significantly different from those in the earlier one.

On the basis of this evidence, the value of basic skills in the labour market appears to have remained remarkably stable since the 1990s, despite the large increase in educational achievement across the two cohorts. Recall that only 30 per cent of the NCDS cohort has a degree, for example, whilst 40 per cent of the BCS cohort achieved a degree. Also, the adult skills tests administered to the two cohorts indicate a rise in the actual skill levels across the two cohorts. All this would seem to indicate that the increase in the supply of literacy and numeracy skills since the early 1990s has been at least matched by the increased demand for them, causing the return to these skills to remain stable. We note, however, that we are only considering the value of such skills for one particular age group.

4.4 The relationship between basic skills and employment

Thus far we have focused exclusively on the relationship between basic skills and wages, with the implicit assumption being that wages are a good proxy measure of a person's productivity. From a policy perspective, however, employability is at least as important as wages. In this section we therefore present the results of a probit model of employment, which examines the determinants of being in employment at age 34. Since we know that men and women have very different labour market participation patterns at this age, we present results for men and women separately.

Table 9 shows the model for women. Column 1 provides estimates of the relationship between literacy and numeracy at age 34 and employment. The dependent variable has a value of 1 if the person spent more time in employment than any other state in the previous year, i.e. age 33 to 34. The model in column 1 does not include any other controls. The results suggest that there is a positive and significant relationship between literacy and numeracy and being in employment. The second column includes early ability tests, in a similar manner to the wage regressions discussed above. This second model therefore identifies the relationship between basic skills and employment, conditional on the early ability of the individual (at age 10). The results still suggest a significant relationship between literacy and numeracy and employment, although the numeracy coefficient is only significant at the 10 per cent level. The third and final column includes a number of other family background measures (identical to those used in Tables 4 to 6) and even earlier ability, as measured at age 5[26]. Once these measures of family background and early ability are included, we still find a positive and significant relationship between literacy and employment, for women. Specifically, an additional standard deviation of literacy is associated with a 3.5 percentage point higher probability of being mostly in employment at age 33/34. The relationship between numeracy and employment becomes insignificant in this model.

Table 10 shows similar specifications for men. Column 1 suggests a significant relationship between literacy and numeracy and employment for men, in a model with no other controls. Even in the third column, which includes family background and age 10 ability measures, we still see a positive and significant relationship between numeracy and employment. Specifically, an additional standard deviation of numeracy is associated with a two percentage point higher probability of being mostly employed at age 33/34.

Tables 11 and 12 show the relationship between basic literacy and numeracy and full-time

26. In previous wage models, we used the age 5 tests as instruments. As we do not estimate IV models for employment, we also present an employment specification which includes these very early ability test scores.

Table 9: The relationship between age 34 basic skills and employment: women only

Variables	Regression 1		Regression 2		Regression 3	
	Coef.	Std.	Coef.	Std.	Coef.	Std.
Standardised age 34 literacy score	0.040***	(0.008)	0.037***	(0.009)	0.035***	(0.010)
Standardised age 34 numeracy score	0.035***	(0.008)	0.020*	(0.009)	0.018	(0.010)
Age 10 ability test scores			X		X	
Family background					X	
Highest educational level at age 34					X	
Age 5 ability test scores					X	
Sample size	4,945		3,659		3,659	

Data source: 1970 BCS Age 34 survey. Dependent variable takes value of 1 if the individual spent more months in employment between the age of 33 and 34 than in any other status (unemployment, inactivity, long-term sickness, working in the home, full-time education). Marginal effects are reported. Results are for women only. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 10: The relationship between age 34 basic skills and employment: men only

Variables	Regression 1		Regression 2		Regression 3	
	Coef.	Std.	Coef.	Std.	Coef.	Std.
Standardised age 34 literacy score	0.011**	(0.004)	0.010*	(0.005)	0.007	(0.005)
Standardised age 34 numeracy score	0.022***	(0.004)	0.023***	(0.005)	0.023***	(0.007)
Female	X		X		X	
Age 10 ability test scores			X		X	
Family background					X	
Highest educational level at age 34					X	
Age 5 ability test scores					X	
Sample size	4,514		3,280		3,280	

Data source: 1970 BCS Age 34 survey. Dependent variable takes value of 1 if the individual spent more months in employment between the age of 33 and 34 than in any other status (unemployment, inactivity, long-term sickness, working in the home, full-time education). Marginal effects are reported. Results are for men only. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

employment, where the dependent variable takes a value of 1 if the person has spent more time in full-time employment than in any other state over the previous year (age 33 to 34). For women, the relationship between literacy and full-time employment is stronger than the relationship between literacy and any employment.

For males, the relationship between literacy and full-time employment is by and large insignificant. However, numeracy and full-time employment are significantly related for males.

In summary therefore, for both men and women, literacy is strongly associated with being in employment at age 33/34. For men, there is also a positive relationship between numeracy skills and the probability of being in employment. To the extent that we control for observed differences between individuals, we can also conclude that for women, literacy and numeracy

Table 11: The relationship between age 34 basic skills and full-time employment: women only

Variables	Regression 1		Regression 2		Regression 3	
	Coef.	Std.	Coef.	Std.	Coef.	Std.
Standardised age 34 literacy score	0.060***	(0.025)	0.050***	(0.032)	0.047***	(0.013)
Standardised age 34 numeracy score	0.052***	(0.024)	0.029*	(0.030)	0.027*	(0.012)
Age 10 ability test scores			X		X	
Family background					X	
Highest educational level at age 34					X	
Age 5 ability test scores						
Sample size	4,945		3,659		2,597	

Data source: 1970 BCS Age 34 survey. Dependent variable takes value of 1 if the individual spent more months in full-time employment between the age of 33 and 34 than in any other status (unemployment, inactivity, long-term sickness, working in the home, full-time education). Marginal effects are reported. Results are for women only. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 12: The relationship between age 34 basic skills and full-time employment: men only

Variables	Regression 1		Regression 2		Regression 3	
	Coef.	Std.	Coef.	Std.	Coef.	Std.
Standardised age 34 literacy score	0.011*	(0.036)	0.006	(0.048)	0.003	(0.060)
Standardised age 34 numeracy score	0.028***	(0.038)	0.034***	(0.050)	0.034***	(0.063)
Age 10 ability test scores			X		X	
Family background					X	
Age 5 ability test scores					X	
Sample size	4,514		3,280		3,280	

Data source: 1970 BCS Age 34 survey. Dependent variable takes value of 1 if the individual spent more months in full-time employment between the age of 33 and 34 than in any other status (unemployment, inactivity, long-term sickness, working in the home, full-time education). Marginal effects are reported. Results are for men only. Both literacy and numeracy measures are included in the same model.
*** significant at 1%, ** significant at 5%, * significant at 10%.

are positive determinants of the likelihood of being in full-time employment. For men only numeracy seems to be important in determining the likelihood of being in full-time employment.

5 Conclusions and discussion

This paper provides evidence on the current (2004) value of literacy and numeracy in the UK labour market, as measured by both earnings and employability, as well as changes over time.

In 2004 an additional standard deviation in literacy skill results in approximately 14 per cent higher earnings, whilst an additional standard deviation in numeracy skill results in 11 per cent higher earnings for a cohort of 34-year-olds. Results were quite similar for men and women and robust to various specifications. We find literacy and numeracy effects on earnings that are over and above any general effect on earnings from a person being more cognitively able. The IV estimates were larger, consistent with attenuation bias in the OLS estimates caused by measurement error in the skill measures. We therefore conclude that the OLS estimates cited above are lower bound estimates of the effect of literacy and numeracy on earnings in the 2004 UK labour market.

We also undertook a cross-cohort analysis, comparing the wage premium from having better basic skills in the 1990s and the 2004 labour markets, for cohorts in their thirties. This analysis suggested that the value of basic skills has remained stable during the late 1990s and early 2000s. One might infer from this that the increase in supply of skills (as the workforce has become more educated) has therefore at least been matched by increased demand in the labour market for such skills.

Another important result found is that having better basic skills is significantly associated with the likelihood of being in employment and full-time employment at age 33/34. Specifically, for women, higher levels of literacy are associated with a higher probability of being in employment, whilst men with higher levels of numeracy have significantly higher employment rates. Although we are more cautious about whether we have identified a causal relationship between literacy and numeracy skills and employment than was the case with wages, we do provide evidence that points to large potential employment benefits from having better basic skills.

Our findings imply that literacy and numeracy skills are still very much a valued form of human capital in today's UK labour market. Our evidence also confirms that the return to these skills is particularly high in the UK, as compared to some other countries (Hansen and Vignoles 2005). Even if there have been substantial gains in the skills of the UK workforce over the last decade, it appears that these have not been sufficient to reduce the price paid for such skills by employers. These results imply that continued efforts to improve the skills of the UK workforce are needed, and that investment in initiatives that genuinely do improve individuals' basic skills are likely to yield relatively high wage (and potentially employment) returns. Of course our paper can say nothing about the types of intervention that would be effective in bringing about improvements in adults' literacy and numeracy skills, an issue which merits further robust research.

References and bibliography

Ananiadou, K., Jenkins, A. and Wolf, A. (2004) 'Basic skills and workplace learning: what do we actually know about their benefits?'. *Studies in Continuing Education*, 26(2):289–308.

Angrist, J., Imbens, G. and Krueger, A. (1999a) 'Jackknife Instrumental Variables Estimation'. *Journal of Applied Econometrics*, 14(1):57–67.

Angrist, J. and Krueger, A. (1999b) 'Empirical Strategies in Labor Economics'. In O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics. Volume 3A.* New York and Amsterdam: North Holland, 1277–1366.

Basic Skills Agency (1997) *International numeracy survey: A comparison of the basic numeracy skills of adults 16–60 in seven countries*. London: Basic Skills Agency.

Behrman, J.R., Rosenzweig, M.R. and Taubman, P. (1994) 'Endowments and the allocation of schooling in the family and in the marriage market: the twins experiment'. *Journal of Political Economy*, 512:1131–1174.

Berman, E., Bound, J. and Griliches, Z. (1994) 'Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufacturers'. *The Quarterly Journal of Economics*, 109(2):367–397.

Berman, E., Bound, J. and Machin, S. (1998) 'Implications of Skill-Biased Technological Change: International Evidence'. *The Quarterly Journal of Economics*, 113(4):1245–1279.

Blackburn, M. L. and Neumark, D. (1993) 'Omitted-ability bias and the increase in the return to schooling'. *Journal of Labor Economics,* 11(3):521–544.

Bowles, S., Gintis, H. and Osborne, M. (2001) 'The Determinants of Individual Earnings: Skills, Preferences, and Schooling'. *Journal of Economic Literature*, 39(4):1137–1176.

Brooks, G., Heath, K. and Pollard, A. (2005) *Assessing adult literacy and numeracy: a review of research instruments.* London: NRDC.

Bynner, J., Dearden, H., McIntosh, S., Reed, J., Van Reenen, J. and Vignoles, A. (2001) *Improving Adult Basic Skills: Benefits to the Individual and to Society.* DfEE Research Brief 251.

Bynner, J. and Parsons, S. (1997a) *It Doesn't Get Any Better: The Impact of Poor Basic Skills on the Lives of 37-year-olds.* London: Basic Skills Agency.

Bynner, J. and Parsons, S. (1997b) *Does Numeracy Matter?* London: Basic Skills Agency.

Bynner, J. and Parsons, S. (2005) *New Light on Literacy and Numeracy*. London: NRDC.

Bynner, J. and Steedman, J. (1995) *Difficulties with basic skills*. London: Basic Skills Agency.

Card, D. (1998) 'The causal effect of education on earnings'. In O. Ashenfelter and D. Card, (eds) *Handbook of Labor Economics. Volume 3A*. New York and Amsterdam: North Holland, 1801–64.

Carey, S., Low, S. and Hansbro, J. (1997) *Adult Literacy in Britain*. London: The Stationery Office.

Carneiro, P., Crawford, C. and Goodman, A. (2006) 'Which Skills Matter?'. CEE Discussion Paper CEEDP0059.

Cawley, J., Conneely, K., Heckman, J. J., and Vytlacil, E. (1997) 'Cognitive Ability, Wages, and Meritocracy'. In B. Devlin, D. Fienberg, K. Resnick and K. Roeder (eds) *Intelligence, Genes, and Success: Scientists Respond to the Bell Curve*. New York: Springer Verlag, 179–92.

Cawley, J., Heckman, J. J. and Vytlacil, E. (2001) 'Three observations on wages and measured cognitive ability'. *Labour Economics*, 8(4):419–422.

Dearden, L. (1999) 'The effects of families and ability on men's education and earnings in Britain'. *Labour Economics*, 6:551–567.

Dearden, L., McIntosh, S., Myck, M. and Vignoles, A. (2002) 'The Returns to Academic, Vocational and Basic Skills in Britain'. *Bulletin of Economic Research*, 54(3):249–274.

Dearden, L., McIntosh, S. and Vignoles, A. (2001) *Basic Skills, Soft Skills and Labour Market Outcomes: Secondary Analysis of the NCDS*. DfEE Research Report 250 and Research Brief 250; CEE Discussion Papers 3 and 4.

Denny, K.J., Harmon, C.P. and O'Sullivan, V. (2003) 'Education, Earnings and Skills: A Multi-country Comparison'. Institute for Fiscal Studies working paper W04/08.

DfEE (Department for Education and Employment) (1999) *Improving literacy and numeracy: a fresh start*. Great Britain Working Group on Post-School Basic Skills chaired by Sir Claus Moser. London: DfEE.

Green, F., McIntosh, S. and Vignoles, A. (2002) 'Overeducation and Skills – Clarifying the Concepts'. *Manchester School*, 70(6):792–811.

Griliches, Z. (1977) 'Estimating the returns to schooling: some econometric problems' *Econometrica*, 45:1–22.

Grinyer, J. (2005) *Literacy, Numeracy and the labour market: Further analysis of the Skills for Life survey.* London: DfES.

Hansen, K. and Vignoles, A. (2005) 'The United Kingdom Education System in a Comparative Context'. In S. Machin and A. Vignoles (eds), *What's the Good of Education?: The Economics of Education in the UK*. Princeton and Oxford: Princeton University Press, 13–36.

Heckman, J. J., and Vytlacil, E. (2001) 'Identifying the role of cognitive ability in explaining the level of change in the returns to schooling'. *Review of Economics and Statistics*, 83(1):1–12.

House of Commons Committee of Public Accounts (2006) *Skills for Life: Improving Adult Literacy and Numeracy*, 21st report of session 2005–06, HC792.

Howell, D.R. and Wolff, E.N. (1991) 'Trends in the growth and distribution of skills in the US workforce, 1960–1985'. *Industrial and Labor Relations Review*, 44(3):486–502.

Leitch Review of Skills (2006) *Prosperity for all in the global economy – world class skills. Final Report*. London: HMSO.

McIntosh, S. and Vignoles, A. (2001) 'Measuring and assessing the impact of basic skills on labour market outcomes'. *Oxford Economic Papers*, 53(3):453–481.

Mincer, J. (1974) *Schooling, experience and earnings*. New York: National Bureau of Economic Research.

Murnane, R.J. and Willett, J.B. (2004) 'The Devil's in the Details: Evidence from the GED on the Large Effects of Small Differences in High Stakes Exams'. *Economics of Education Review*, 23(4):336–49.

Murnane, R.J., Willett, J.B. and Boudett, K.P. (1995) 'Do high school dropouts benefit from obtaining a GED?'. *Education Evaluation and Policy Analysis*,17(2):133–47.

Murnane, R.J., Willett, J.B., Duhaldeborde, Y. and Tyler, J.H. (2000) 'How important are cognitive skills of teenagers in predicting subsequent earnings?'. *Journal of Policy Analysis and Management*, 19(4):547–568.

NAO (National Audit Office) (2004) *Skills for Life: Improving Adult Literacy and Numeracy.* London: The Stationery Office. Retrieved October 23, 2007 from www.nao.org.uk/publications/nao_reports/04–05/040520.pdf

Parsons, S. and Bynner, J. (1998) *Influences on Adult Basic Skills: Factors affecting the development of literacy and numeracy from birth to 37*. London: The Basic Skills Agency.

Parsons, S. and Bynner, J. (2005) *Does Numeracy Matter More?* London: NRDC.

Tyler, J. H. (2004a) 'Basic Skills and the Earnings of Dropouts'. *Economics of Education Review,* 23(3):221–35.

Tyler, J.H. (2004b) 'Does the GED Improve Earnings? Estimates from a Sample of Both Successful and Unsuccessful GED Candidates'. *Industrial and Labor Relations Review,* 57(4):579–98.

Appendix A

UK classifications of levels of literacy and numeracy

QCA National Framework of qualifications level	Basic Skills Agency standards	Equivalent vocational qualifications	Equivalent levels in schools
Below entry level	Below entry level	–	
Entry level	Entry level	–	2 (age 7)
Foundation	Level 1	NVQ Level 1	4 (age 11)
Intermediate	Level 2	NVQ Level 2	GCSE A*–C (age 16)

* Figure includes all those at Level 2 or above.

Source: The Moser Report (DfEE 1999).

Appendix B
British Cohort Study 1970–2004 sweep at age 34

The literacy and numeracy assessment tests in the age 34 survey of the 1970 BCS were based on the new Skills for Life standards, which differ somewhat from the literacy and numeracy assessments used in previous surveys of both the BCS and the NCDS. Thus an attempt was made to ensure continuity by combining elements of the tests used in previous sweeps of the NCDS and the BCS, as well as the new Skills for Life assessments. Two methods of questioning were used: open-response (as used in previous NCDS and BCS literacy and numeracy assessments) and multiple choice (as used in the 2002 Skills for Life National Baseline Survey). The tests were also designed to give more information on the profile of respondents with particularly poor basic skills, with less information at the upper range of the distribution (i.e. the test scores are truncated). There were fewer items in the literacy and numeracy tests administered at age 34 in the BCS. As a result the standards of reliability are lower. For a detailed discussion of this issue see Bynner and Parsons (2005).

Appendix C

Means and standard errors of the preferred BCS sample (N=3,131)

	Men		Women	
	Means	Std.	Means	Std.
Log hourly wage	2.406	(0.612)	2.172	(0.732)
Literacy test at age 34 (min: 4, max: 27)	22.561	(0.089)	22.725	(0.082)
Numeracy test at age 34 (min: 1, max: 23)	18.699	(0.094)	17.608	(0.095)
Highest qualification level (min: 0, max: 5)	2.147	(0.042)	2.367	(0.040)
Non-white British or Irish	0.014	(0.003)	0.021	(0.004)
Early family background:				
Social class of parents, age 5, i	0.052	(0.006)	0.062	(0.006)
Social class of parents, age 5, ii	0.181	(0.010)	0.208	(0.010)
Social class of parents, age 5, iii m				
Social class of parents, age 5, iii nm	0.107	(0.008)	0.092	(0.007)
Social class of parents, age 5, iv	0.131	(0.009)	0.132	(0.008)
Social class of parents, age 5, v	0.043	(0.005)	0.028	(0.004)
Father has a degree, age 5	0.130	(0.009)	0.131	(0.008)
Father has A Level, age 5	0.065	(0.006)	0.073	(0.006)
Mother has a degree, age 5	0.024	(0.004)	0.019	(0.003)
Mother has A Level, age 5	0.036	(0.005)	0.028	(0.004)
Free school meal at age 10 (mother self qu.)	0.094	(0.007)	0.112	(0.008)
Missing data on free school meals	0.048	(0.005)	0.037	(0.005)
Financial hardship at age 16 (par. interv.)	0.075	(0.007)	0.084	(0.007)
Missing data on financial hardship	0.187	(0.010)	0.149	(0.009)
Interest of parents in child's education at age 10 (teacher's view):				
Father very interested	0.365	(0.012)	0.364	(0.012)
Father moderately interested	0.212	(0.010)	0.198	(0.010)
Father very little interested	0.029	(0.004)	0.018	(0.003)
Father uninterested	0.021	(0.004)	0.018	(0.003)
Missing data on father interest variable	0.373	(0.012)	0.402	(0.012)
Mother very interested	0.497	(0.013)	0.541	(0.012)
Mother moderately interested	0.304	(0.012)	0.287	(0.011)
Mother very little interested	0.039	(0.005)	0.026	(0.004)
Mother uninterested	0.017	(0.003)	0.011	(0.003)
Missing data on mother interest variable	0.143	(0.009)	0.134	(0.009)
Early test scores:				
Age 5 vocabulary score (min: 0, max: 51)	34.958	(0.223)	33.720	(0.228)

	Men		Women	
	Means	Std.	Means	Std.
Age 5 copying score (min: 0, max: 8)	4.852	(0.050)	4.882	(0.047)
Age 5 draw a man score (min: 1, max: 23)	10.046	(0.080)	10.914	(0.073)
Age 10 math score (min: 10, max: 72)	46.124	(0.289)	45.536	(0.251)
Age 10 Edinburgh reading score (min: 2, max: 64)	37.251	(0.345)	39.996	(0.310)
Age 10 British ability score (min:0, max:125)	76.583	(0.391)	76.754	(0.353)
Labour market variables (between 21 and 34):				
Months of disability	0.253	(0.011)	0.240	(0.011)
Months of unemployment	2.461	(0.344)	0.958	(0.206)
Months stayed at home	0.164	(0.073)	10.346	(0.779)
% Employed	0.941	(0.237)	0.764	(0.424)
% Employed full time	0.926#	(0.261)	0.449#	(0.498)
Number of children under age 5 in 2004	0.247	(0.014)	0.241	(0.013)
N 1,528	1,603			

Notes: Mean hourly wages are 11.10 for men and 8.77 for women. #For the employment regressions the sample size for men is 2,107 and for women 2,597.

Appendix D
Using Skills for Life standard levels to investigate the wage impact of literacy and numeracy in 2004

In Table D1 we show the association between literacy and numeracy standard levels used in Skills for Life at age 34 and the log of gross hourly earnings at the same age. To aid interpretation we have also reproduced results from earlier work by one of the authors, which examined the relationship between literacy and numeracy for the 1958 NCDS cohort in 1991. In 1991 the NCDS cohort was approximately the same age as the BCS cohort in 2004, and thus one can compare the return to basic skills for a similar age sample at two points in time, to try to uncover any major change in the economic value of basic skills in the UK labour market.

Table D1: Wage effects associated with Level 1 and Level 2 numeracy and literacy skills: comparisons between 1991 and 2004

	Sample age 33 in 1991	Sample age 33 in 1991	Sample age 34 in 2004	Sample age 34 in 2004
Numeracy Level 1	0.147***	0.057**	0.221***	0.082***
	(0.041)	(0.037)	(0.020)	(0.023)
Numeracy Level 2	0.332***	0.076**	0.398***	0.151***
	(0.040)	(0.040)	(0.021)	(0.027)
Literacy Level 1	0.148***	0.013	0.064*	-0.017
	(0.044)	(0.041)	(0.036)	(0.042)
Literacy Level 2	0.282***	0.080	0.172***	0.014
	(0.046)	(0.046)	(0.035)	(0.041)
Controls				
Family background		X		X
Early cognitive ability		X		X
Education level		X		X

* 10% significance level,** 5% significance level,*** 1% significance level

Data source: McIntosh and Vignoles (2001) for sample age 33 in 1991, BCS70 2004 sweep for sample age 34 in 2004.

Note: Results are for men and women combined. Dependent variable is log gross hourly earnings. Standard errors are given in brackets. The coefficients shown are from regressions which control for a range of family background measures and early cognitive ability (see McIntosh and Vignoles, 2001). Both literacy and numeracy measures are included in the same model. Base case is individuals with skill levels below Level 1.

Although our preferred specification (used in the main text) uses continuous measures of literacy and numeracy, it is useful to examine also the value of literacy and numeracy in terms of the nationally agreed levels, both to aid comparison with previous work on this issue

and because the levels are the subject of specific Government targets. We start by considering the wage premium associated with Level 1 skills (the target level in literacy). Table D1 shows both the raw relationship between Level 1 literacy and numeracy skills and individuals' earnings for both the NCDS sample in 1991 and the BCS sample in 2004, as well as the results after taking account of a range of background factors as discussed in Section 3. Level 2 results are also shown for completeness and the base case in this model is all workers with skill levels below Level 1.

The first two columns of Table D1 are derived from previous work in McIntosh and Vignoles (2001). The first column shows the results of a regression that does not allow for any family background factors, neither early cognitive skills, nor education level. It suggests that in the 1991 labour market, individuals aged 33 with Level 1 numeracy or literacy earned around 16 per cent[27] more than those with skill levels below Level 1. The second model shows the results of a model that accounts for other differences between those with differing skill levels, particularly family background, early cognitive ability and education level. Now of course one of the ways in which poor basic skills influence individuals' life chances is via the education level they are able (or unable) to achieve. By controlling for education therefore we are asking whether, for a given level of education, individuals with better skills earn more. The model is therefore quite stringent. The results from the second column in Table D1 suggest that the wage impact from having Level 1 skills in numeracy was 6 per cent in 1991 for this particular age group, whilst no significant literacy effect could be found.

The last two columns in Table D1 provide similar estimates for individuals working in the labour market in 2004. As has been said, both samples are of similar age (early thirties)[28] so comparisons across time are more straightforward. The raw relationship shown in column 3 suggests that in 2004, workers with Level 1 numeracy skills for example, earned 25 per cent more than workers with below Level 1 skills, whilst workers with Level 1 literacy skills earned 7 per cent more than those with below Level 1 skills. In column 4, the model accounts for other differences between individuals and indicates that those with Level 1 numeracy skills earned 9 per cent more than workers with below Level 1 skills. As was the case for 1991, there was no significant literacy effect.

The value of basic numeracy in the labour market has increased since the 1990s. This implies that the increase in the supply of numeracy skills (approximately 200,000 fewer people now have very low numeracy skills, i.e. below Entry 3, as compared to the late 1990s) has been outstripped by the increased in demand for these skills. Specifically, we find that the raw wage premium from having Level 1 numeracy and the conditional wage premium are greater in 2004 than in 1991. By contrast, the raw wage premium from having Level 1 literacy is somewhat lower in 2004, and in both time periods no significant relationship between literacy and earnings can be found in models that control for family background, early ability and education. This latter finding does not, of course, imply that literacy does not matter in the labour market. Rather it suggests that when we use the nationally agreed levels, poor literacy skills impact on education levels but that for a given level of education, we find no additional premium from having Level 1 literacy skills.

27. To calculate this we take the exponential of the coefficient from Table D1 and subtract 1.
28. The controls in the model are as similar as is possible given the two different data sets. See McIntosh and Vignoles (2001) for details for the 1991 analysis.

Whilst the above analysis has the appeal that it expresses individuals' literacy and numeracy skills in terms of policy-relevant metrics, it does have the disadvantage of discarding useful variation in individuals' literacy and numeracy. For example, we find no significant effect from having Level 1 literacy in our preferred specification in Table D1. When we use these national levels, it appears literacy has no impact on wages. This may simply reflect the fact that when we use the levels, we are by definition reducing the variance in the literacy measure (by grouping differently-skilled individuals into the same level) and we are therefore not able to identify the impact of finer differences in literacy on wages. We therefore selected in the main text our preferred specification using standardised continuous measures of literacy and numeracy. And we include square terms to test for non-linearity in the relationship between literacy and numeracy skills and earnings, as suggested by this analysis using levels.

Appendix E
The relationship between age 34 basic skills and earnings: men and women

(Full specification for Table 2)

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Standardised age 34 literacy score	0.164***	(0.016)	0.134***	(0.018)	0.114***	(0.018)	0.091***	(0.017)
Standardised age 34 literacy score squared	0.032***	(0.008)	0.030***	(0.010)	0.026***	(0.010)	0.022**	(0.010)
Standardised age 34 numeracy score	0.138***	(0.012)	0.094***	(0.015)	0.084***	(0.015)	0.064***	(0.015)
Standardised age 34 numeracy score squared	0.038***	(0.010)	0.033***	(0.008)	0.025***	(0.008)	0.025***	(0.009)
Female	-0.185***	(0.016)	-0.205***	(0.019)	-0.207***	(0.019)	-0.171***	(0.019)
Age 10 mathematics test score			0.004***	(0.001)	0.003**	(0.001)	0.002	(0.001)
Age 10 English and reading test			0.002*	(0.001)	0.001	(0.001)	0.001	(0.001)
Age 10 British ability scale			0.002**	(0.001)	0.001	(0.001)	0.001	(0.001)
Non-white					0.161***	(0.053)	0.150***	(0.051)
Early family background:								
Eligible for free school meals					-0.042	(0.032)	-0.012	(0.030)
Missing data on free school meals					0.012	(0.033)	0.029	(0.032)
Financial hardship at age 16					-0.105***	(0.028)	-0.069**	(0.027)
Missing data on financial hardship at age 16					-0.062***	(0.024)	-0.047**	(0.024)
Age 5 social class I					0.049	(0.049)	0.024	(0.048)
Age 5 social class II					-0.008	(0.028)	-0.023	(0.028)
Age 5 social class III non manual					0.094***	(0.035)	0.085**	(0.034)
Age 5 social class IV					-0.066**	(0.029)	-0.055**	(0.028)
Age 5 social class V					-0.133**	(0.056)	-0.095*	(0.052)
Father has degree					0.093***	(0.033)	0.000	(0.000)
Father has A Level					0.064	(0.040)	0.089***	(0.033)
Mother has degree					0.115*	(0.059)	0.057	(0.040)
Mother has A Level					0.010	(0.047)	0.108*	(0.058)

	Regression 1		Regression 2		Regression 3		Regression 4	
Variables	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**	**Coeff.**	**Std.**
Interest of parents in child's education at age 10 (teacher's view):								
Father very interested					0.079	(0.073)	0.066	(0.069)
Father moderately interested					0.009	(0.071)	0.008	(0.067)
Father very little interest					0.013	(0.076)	0.018	(0.073)
Missing data on father interest variable					0.004	(0.070)	0.004	(0.066)
Mother very interested					0.028	(0.077)	-0.038	(0.072)
Mother moderately interested					-0.012	(0.075)	-0.067	(0.071)
Mother very little interest					-0.033	(0.074)	-0.077	(0.070)
Missing data on mother interest variable					-0.015	(0.077)	-0.076	(0.073)
Labour market variables (between 21 and 34):								
Highest qualification at age 34							0.041***	(0.006)
Disabled							-0.021	(0.020)
Total unemployment to 2004							-0.004***	(0.001)
Total months in home care to 2004							-0.004***	(0.000)
Number of children less than 5 in 2004							0.007	(0.017)
R-squared	0.119		0.131		0.153		0.189	
R-squared adjusted	0.118		0.129		0.148		0.183	
Sample size	6,255		4,664		4,664		4,662	

This report is funded by the Department for Innovation, Universities and Skills as part of Skills for Life: the national strategy for improving adult literacy and numeracy skills. The views expressed are those of the authors and do not necessarily reflect those of the Department.

www.nrdc.org.uk

NRDC
Institute of Education
University of London
20 Bedford Way
London WC1H 0AL
Telephone: +44 (0)20 7612 6476
Fax: +44 (0)20 7612 6671
email: info@nrdc.org.uk
website: www.nrdc.org.uk

NRDC is a consortium of partners led by the Institute of Education, University of London with:
- Lancaster University
- The University of Nottingham
- The University of Sheffield
- Learning and Skills Network
- LLU+, London South Bank University
- National Institute of Adult Continuing Education
- King's College London