Institute for Fiscal Studies

When you are born matters: evidence for England

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Nuffield Foundation

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Preface

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Executive Summary

There is a long history of research in the UK and elsewhere showing that children who are born at the end of the academic year tend to have lower educational attainment than children born at the start of the academic year. In England, where the academic year runs from 1 September to 31 August, this means that children born in the summer tend to perform worse than children born in the autumn. There is also growing evidence that the month in which children are born matters for a range of other skills and behaviours as well, such as the likelihood of being assessed as having special educational needs at school, and children's self-esteem and confidence in their own ability.

Why should this matter to policymakers? There are at least two reasons: first, because these differences in educational attainment and other skills and behaviours may affect children's well-being in the short term; and second, because they may have potentially serious long-term consequences for children's lives.

This report aims to inform the policy debate on this important issue by providing clear evidence on the magnitude of the differences in outcomes between children and adults born at the start and end of the academic year in England and, more importantly, offering new insight into the drivers of these differences. This is vital in order to determine the most appropriate policy response.

We make use of data from a variety of studies, including the National Pupil Database (NPD), the Millennium Cohort Study (MCS), the Avon Longitudinal Study of Parents and Children (ALSPAC), the Longitudinal Study of Young People in England (LSYPE), the Labour Force Survey (LFS) and Understanding Society. For most of our analysis, we use simple regression models to identify mean differences in outcomes between individuals born at different times of the year.

Key findings

Differences in outcomes by month of birth relative to academic year cut-off

We find large differences in educational attainment between children born at the start and end of the academic year in England. These differences are largest soon after children start school and decrease as they get older (as the difference in relative age declines), but the gap remains educationally and statistically significant at the end of compulsory schooling, when young people are starting to make choices about further and higher education.

For example, relative to children born in September, children born in August are:

- 6.4 percentage points less likely to achieve five GCSEs or equivalents at grades A*–C;

- around 2 percentage points less likely to go to university at age 18 or 19, and around 2.3 percentage points less likely to attend a high-status Russell Group institution if they do;
- around 1 percentage point less likely to graduate with a degree.

Whilst the difference relative to those born in September is largest for August-born children, even a one-month difference in age has an effect. For instance, those born in January are 2.8 percentage points less likely to achieve five A*–C grades in GCSE or equivalent exams than September-born children, while for those born in May the difference is 4.4 percentage points.

It is not only educational attainment where children born towards the end of the academic year are at a disadvantage compared with their relatively older peers. For example, relative to those born in September, those born in August are 5.4 percentage points **more likely to be labelled as having mild special educational needs at age 11**. When outcomes from survey data are compared as if they had all been measured *on the same date* (replicating the situation for national assessments), those born at the end of the academic year are also:

- likely to exhibit significantly poorer socio-emotional development;
- likely to have significantly lower confidence in their own ability;
- significantly less likely to believe that their own actions make a difference (i.e. more likely to have an external locus of control).

When outcomes are assessed *at the same age*, we also find evidence that children born at the end of the academic year are more likely to engage in risky behaviours such as underage smoking.

However, despite the large and significant differences that we observe between those born at the start and end of the academic year in terms of educational attainment and a range of non-cognitive outcomes during childhood, **we find little evidence that these detrimental effects persist into adulthood**. In particular, individuals born at the end of the academic year:

- are no more or less likely to be in work than those born at the start of the academic year (although they are slightly more likely to be unemployed);
- do not earn more or less per hour or week than those born at the start of the academic year;
- are (subjectively) no healthier or happier during adulthood than those born at the start of the academic year.

Drivers of the month-of-birth differences that we observe

There are four potential reasons why we might expect outcomes to differ between children born at the start and end of the academic year:

- The children are different ages when the outcome is observed (**age-at-test effect**): if all children in a particular cohort sit exams on the same date, then those born later in the academic year will always be younger than their peers when taking such tests. If this is the main driver of the differences in test scores that we observe, then age-adjusting test scores or allowing children to sit exams when they are 'ready' (for example, at a particular age rather than on a particular date) would overcome the problem of testing children born at the start and end of the academic year when they are very different ages.

- The children start school at different ages (**age-of-starting-school effect**): those born later in the academic year tend to start school up to a year younger than those born earlier in the year. If these children are not ready to start school (for example, if they cannot engage with the more formal curriculum followed at school compared with nursery), then this may help explain their lower test scores. If this is the main driver of the differences that we observe, then allowing children born later in the academic year to defer entry to school might help to overcome this issue.

- The amount of schooling the children receive prior to assessment differs (**length-of-schooling effect**): some local authorities follow admissions policies that mean that children born later in the academic year start school one or two terms later than those born at the start of the academic year, which means that they potentially receive one or two terms less tuition before sitting national achievement tests. If this is the main driver of the differences that we observe, then allowing all children to start school at the same time might help to overcome this issue.

- The children's age relative to others in their class or year group differs (**relative-age effect**): under this hypothesis, younger children tend to perform more poorly not because they are the youngest in absolute terms but because they are the youngest relative to others in their class or year group. The implication is that if all children started school and sat the exams on their birthday, then the scores of the youngest would still not be as high as those of the oldest. This is potentially the most challenging of the potential drivers to deal with, as at least one child must always be the youngest in the class.

(Note that we rule out season of birth as a viable explanation because month-of-birth differences exist across a variety of education systems in which children born in different months are the relatively youngest and oldest in their academic cohort.)

It is difficult to identify separately the contributions of each of these factors to the overall differences in test scores that we observe, because they are all either perfectly or highly correlated with one another. We adopt a novel methodological approach and take advantage of variation in age of starting school and length of schooling arising from different admissions policies adopted in different areas, variation in the date on which outcomes are assessed in survey data and variation in relative age arising from differences in the age composition of particular year groups to identify all four effects separately for the first time to our knowledge.

We find that age at test is the key driver of the differences in educational attainment and cognitive test scores between children born at the start and end of the academic year. This means that children born in August tend to end up with worse exam results than children born in September simply because they are 11 months younger when they sit the tests. By contrast, we find that the age at which children start school and the amount of schooling they receive prior to the test explain very little of the differences that we observe.

The age at which outcomes are measured also appears to explain most of the difference in children's self-esteem and locus of control, but there remain sizeable differences in terms of parent- and teacher-reported socio-emotional development, a child's ability beliefs and their engagement in a range of risky behaviours, even when we compare children at the same age.

At least some of the remaining difference in these outcomes is likely to be explained by differences in relative (rather than absolute) age between those born at the start and end of the academic year: for example, children born in August may be more likely to start smoking at a younger age because they are the relatively youngest amongst a group of older peers. There also appears to be some role for relative age in helping to explain differences in national achievement test scores and the differential perceptions of children's socio-emotional development amongst parents and teachers.

Policy implications

We argue that policy intervention to overcome the disadvantage of being born later in the academic year is justified, for two reasons. First, these differences arise purely as a result of the organisation of the educational system: there is nothing fundamentally different about August-born children; somebody has to be the youngest in each academic cohort, and in England it happens to be those born in August. Our view is that this policy 'accident' should not be allowed to affect negatively those born towards the end of the (arbitrarily defined) academic year. Second, despite the fact that we find little evidence of significant differences persisting into adulthood, being born at the end of the academic year seems to have a detrimental effect on children's well-being: for example, they have lower self-confidence and are more likely to engage in risky behaviours at younger ages. There is also a danger that some young people will drop out of school or not receive the support that they need whilst they are at school, simply because of the month in which they were born. Policymakers should do as much as they can to remedy these inequities.

As age at test is the key driver of differences in educational attainment between those born at the start and end of the academic year, age-adjusting national achievement test scores is a simple and straightforward way of ensuring that those born towards the end of the academic year are not disadvantaged by taking the tests younger. This would effectively mean that the expected level would now apply to a particular age rather than a particular point in time. To maintain the proportion of children reaching the expected level given their age, one could increase the number of points required to attain a particular level for those born between September and January, maintain it for those born in February and March, and reduce it for those born between April and August. Alternatively, if policymakers did not want to increase the number of points required for pupils born earlier in the year to reach a particular level, then cut-offs could be reduced for pupils born from October onwards. This latter option might be particularly pertinent when considering whether pupils have the potential to continue into further education.

We show that such adjustments can effectively eliminate month-of-birth differences in national achievement test scores, including the proportion of children reaching the government's expected level, which would now take into account the age at which they sit the tests. While this might not improve the absolute standard obtained by pupils who are relatively young in their academic year, it will help to ensure that pupils are judged fairly, by accounting for differences in the age at which pupils born at different times of the year sit Key Stage tests.

However, the extent to which age-adjustment of national achievement test scores would help to address some or all of the differences in other outcomes that we observe is less clear. In some cases, it seems likely that the age-normalisation of national achievement test scores would go a long way in that direction. For example, we find that prior attainment explains 60–85 per cent of the difference in ability beliefs between children born at the start and end of the academic year, thus providing some suggestive evidence that removing the differences in test scores that arise specifically as a result of differences in age at test might also reduce differences in ability beliefs between these children.

In other cases, however, the likely effect of such a policy is less clear. For example, age-adjusting test scores may or may not help to address the differences in risky behaviours amongst those born at the start and end of the academic year, depending on the mechanism through which participation in these behaviours occurs. If those with lower test scores are more likely to have lower ability beliefs and those with lower ability beliefs are in turn more likely to disengage from the education system and engage in rebellious behaviours such as underage smoking, then age-adjustment may help to correct this to some extent. However, if the mechanism through which these differences arise is simply that those born towards the end of the academic year are the relatively youngest amongst a group of older peers, then age-adjustment of test scores is unlikely to offset this.

Engagement in risky behaviours is not the only area in which relative age seems likely to play a role: the different perceptions of children's socio-emotional development amongst parents and teachers also seem likely to be driven at least in part by the fact that comparisons are being made within academic cohorts, and there also seems to be a role for relative age as a driver of differences in national achievement test scores. The policy response in such situations is much less clear, as at least one child must always be the youngest in the class, and hence disadvantaged if relative age plays a role. Unlike the relatively straightforward approach that could be taken to address the problem of testing children at very different ages, there is no easy way to overcome this disadvantage. This means that it is even more important to ensure that schools, teachers and parents are aware of the potential disadvantages that children born later in the academic year may face, over and above the lower test scores that they receive.

Policy recommendations

On the basis of our results, we recommend that the following policy actions are taken to help address the differences in test scores and wider outcomes between those born at the start and end of the academic year:

- National achievement test scores should be age-adjusted to account for the fact that children born at different times of the year have to sit the tests when they are different ages.
- These age-adjusted scores should be used to calculate school league table positions, to determine entry to schools that select on the basis of ability, and potentially to assign pupils to ability groups within schools.
- They should also be used to assess whether a pupil can continue into further and higher education. But when pupils leave school, they should take with them their non-age-adjusted grades, to ensure that employers can be confident that pupils have achieved a particular absolute standard.
- It is not necessary to give parents greater flexibility over the age at which children start school, as this is not the main driver of the differences in attainment between children born at the start and end of the academic year.
- Schools, teachers and parents should be made more aware of the potential disadvantages that children born later in the academic year may face, and more could be done to document and share best practice in reducing inequalities between children born at the start and end of the academic year.

1. Introduction

There is a long history of research in the UK[1] and elsewhere[2] showing that children who are born at the end of the academic year tend to have lower educational attainment than children born at the start of the academic year. In England, where the academic year runs from 1 September to 31 August, this means that children born in the summer tend to perform worse than children born in the autumn.

There is also growing evidence that when during the academic year children are born matters for a range of other childhood skills and behaviours as well. For example, children born at the end of the academic year are more likely to be classified as having special educational needs,[3] more likely to be bullied,[4] more likely to be hyperactive[5] and to exhibit other emotional and behavioural problems,[6] more likely to commit a crime[7] and less likely to take up leadership positions in high school.[8]

Why should this matter to policymakers? There are at least two reasons: first, because these differences in educational attainment and other skills and behaviours may affect children's well-being in the short term; and second, because they may have potentially serious long-term consequences for children's lives. The mechanisms through which this might occur are particularly clear in the case of educational attainment – which has been shown to have a causal impact on a variety of adult outcomes, from employment status and wages, to health and participation in crime[9] – but non-cognitive skills and behaviours

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[1] See, for example, Russell and Startup (1986), Bell and Daniels (1990), Sharp, Hutchison and Whetton (1994), Thomas (1995) and Alton and Massey (1998).

[2] See studies for the US (Datar, 2006; Elder and Lubotsky, 2009; Aliprantis, 2011; Robertson, 2011), Canada (Smith, 2009 and 2010), Germany (Jurges and Schneider, 2007; Puhani and Weber, 2007; Mühlenweg and Puhani, 2010), Sweden (Fredriksson and Ockert, 2005), Norway (Strom, 2004), Chile (McEwan and Shapiro, 2008), Australia (Buddelmeyer and Le, 2011), Italy (Ponzo and Scoppa, 2011), Japan (Kawaguchi, 2011), Hungary (Hamori and Kollo, 2011), Malta (Borg and Falzon, 1995) and Brazil (Sampaio et al., 2011). Studies using cross-country international data sets include Bedard and Dhuey (2006), Borghans and Diris (2010) and Sprietsma (2010).

[3] Gledhill, Ford and Goodman, 2002; Elder and Lubotsky, 2009; Department for Education, 2010; Dhuey and Lipscomb, 2010.

[4] Department for Education, 2010; Mühlenweg, 2010.

[5] Mühlenweg, Blomeyer and Laucht, 2011; Chen et al., 2013.

[6] Goodman, Gledhill and Ford, 2003.

[7] Landersø, Nielsen and Simonsen, 2013.

[8] Dhuey and Lipscomb, 2008.

[9] For the UK, see, for example, Dearden (1999), Feinstein (2002a and 2002b), Blundell, Dearden and Sianesi (2005), Sabates and Feinstein (2007), Silles (2008), Powdthavee (2010) and Machin, Marie and Vujić (2011).

exhibited during childhood have also been shown to be strongly positively correlated with a variety of adult outcomes.[10]

Some work has already been done examining the extent to which birth date relative to academic year cut-off matters for adult labour market outcomes in other countries, but the evidence is mixed: some studies find that those born towards the end of the academic year have significantly lower wages than those born earlier in the academic year;[11] others find little effect on the likelihood of being in work[12] or on wages conditional on being in work.[13]

Of course, what really matters to policymakers is understanding whether the differences in outcomes between those born at the start and end of the academic year are sizeable enough to warrant policy intervention and, if so, how best to address them, which relies on a robust understanding of the drivers of these differences, as this is ultimately what will identify the most effective policy response.

There are four potential reasons why we might expect outcomes to differ between children born at the start and end of the academic year:[14]

- The children are different ages when the outcome is observed: if all children in a particular cohort sit exams on the same date, then those born later in the academic year will always be younger than their peers when taking such tests. If this is the main driver of the differences in test scores that we observe, then age-adjusting test scores or allowing children to sit exams when they are 'ready' (for example, at a particular age rather than on a particular date) would overcome the problem of testing children born at the start and end of the academic year when they are very different ages.

- The children start school at different ages: those born later in the academic year tend to start school up to a year younger than those born earlier in the year. If these children are not ready to start school (for example, if they cannot engage with the more formal curriculum followed at school compared with nursery), then this may help explain their lower test scores. If this is the

[10] See, for example, Heckman, Stixrud and Urzua (2006), Carneiro, Crawford and Goodman (2007) and Heckman et al. (2011).

[11] See, for example, Fredriksson and Ockert (2005), Bedard and Dhuey (2009), Kawaguchi (2011), Solli (2011) and Zweimüller (2011).

[12] Dobkin and Ferreira, 2010.

[13] Black, Devereux and Salvanes, 2008; Dobkin and Ferreira, 2010.

[14] While it is sometimes claimed that season of birth may help to explain these differences, the evidence does not support this hypothesis, because differences exist for children across a variety of educational systems in which the academic year starts and ends at different times (see references in footnotes 1 and 2). As an example, children born in August are the youngest in the academic year in England, while children born in February are the youngest in the academic year in Scotland. HEFCE (2005) finds evidence that those born in August in England but February in Scotland are the least likely to go to university.

main driver of the differences that we observe, then allowing children born later in the academic year to defer entry to school might help to overcome this issue.

- The amount of schooling the children receive prior to assessment differs: some local authorities follow admissions policies that mean that children born later in the academic year start school one or two terms later than those born at the start of the academic year, which means that they potentially receive one or two terms less tuition before sitting national achievement tests. If this is the main driver of the differences that we observe, then allowing all children to start school at the same time might help to overcome this issue.[15]

- The children's age relative to others in their class or year group differs: under this hypothesis, younger children tend to perform more poorly not because they are the youngest in absolute terms but because they are the youngest relative to others in their class or year group. The implication is that if all children started school and sat the exams on their birthday, then the scores of the youngest would still not be as high as those of the oldest. This is potentially the most challenging of the potential drivers to deal with, as at least one child must always be the youngest in the class.

There is, however, relatively little robust evidence available that identifies which of these four factors can explain the differences in outcomes between children born at the start and end of the academic year that we observe. This is because, in most countries, there is an exact linear relationship between age of starting school, age at test and length of schooling up to the time the test is taken, since all children start school and sit tests at the same time:

Age at test = Age of starting school + Length of schooling.

Relative age is also highly correlated with age at test, as the oldest children in each cohort will also tend to be the oldest relative to others in their year group. This means that it is extremely difficult to identify separately the contributions of each of these factors to the overall differences in test scores that we observe.[16]

Our own work to date has contributed extensively to the literature attempting to document these differences in attainment, skills and behaviours during childhood, by providing new and more robust evidence on these issues for England.[17] We are also publishing alongside this report three new working papers, which aim to provide new insight into the extent to which these

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[15] Note that this might potentially conflict with the findings of the age-of-starting-school effect.

[16] Chapter 4 describes in detail how other researchers have tried to identify separately the drivers of the differences in outcomes between children born at the start and end of the academic year, with varying degrees of success.

[17] See Crawford, Dearden and Meghir (2007 and 2010) and Crawford, Dearden and Greaves (2011).

disparities continue into adulthood[18] and more robust evidence on the drivers of the differences in attainment, skills and behaviours between children born at the start and end of the academic year.[19]

The purpose of this report is to draw together the evidence we have produced, with a view to providing clear conclusions and policy implications.

In particular, it:

- documents the magnitude of the differences in educational attainment between children born at different points of the academic year and how these relationships change as children get older (Section 3.1);
- uses survey data covering three recent cohorts of children at different ages to present a picture of the extent to which children born at different times of the year but interviewed on the same date have different attitudes and are more or less likely to engage in particular behaviours (Section 3.2);
- illustrates the extent to which children born at different times of the year are more or less likely to go on to further or higher education and hence end up with different educational qualifications (Section 3.3);
- investigates the extent to which date of birth continues to influence individuals in adulthood, by examining differences in a range of outcomes, including employment status and wages (Section 3.4);
- uses a variety of methodological approaches to provide new insights into the drivers of the differences in attainment, skills and behaviours that we observe (Chapter 4);
- summarises the evidence across all of these areas and offers some conclusions and policy implications on the basis of these results (Chapter 5).

[18] Crawford, Dearden and Greaves, 2013a.

[19] Crawford, Dearden and Greaves, 2013b and 2013c.

2. Background, Data and Methods

This chapter provides some background information on the educational system in England (Section 2.1), describes the data sets that we use (Section 2.2) and briefly summarises the main methods underlying most of our descriptive analysis (Section 2.3).

2.1 Background on the English educational system

School entry and school leaving policies

The academic year in England runs from 1 September to 31 August and is split into three terms (autumn, spring and summer). It is a statutory requirement for children in England to start school by the beginning of the term after they turn 5, but within these confines school admissions policies are set by local (rather than central) authorities, and in most cases children start school considerably earlier than this.[20]

Table 2.1 summarises the main local authority admissions policies in operation in England, for children starting school in 1990–91, 2000–01 and 2008–09. It shows that the most common admissions policy in operation over the last 20 years has been for all children to start school in the September after they turn 4. There has been a duty in place since 2011–12 for local authorities to ensure that all children in their areas can start school at this time if they wish to do so.[21] This means that children born in September tend to be the oldest in the academic year and children born in August tend to be the youngest.[22]

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[20] It is possible for parents to defer the date on which their child starts school up to and including the statutory date (with the agreement of their local authority). This means that their child can start school later, but would be placed into the correct academic year for their age, thus reducing the amount of time that they spend in school overall. This means it is relatively rare for parents to do this. (http://media.education.gov.uk/assets/files/pdf/s/school%20admissions%20code%201%20february%202012.pdf.)

[21] Only schools under local authority control (for example, community schools) must follow the local admissions policy, while other schools (such as those that are voluntary aided, voluntary controlled, academies, foundation schools or free schools) can set their own. For the cohorts covered in this report, the proportion of children attending community schools in primary school was high. For instance, for children entering school in 2000–01, 2001–02 or 2002–03, 69 per cent of schools were community schools (source: authors' calculations based on data from the National Pupil Database), but this proportion is shrinking rapidly following the government's recent expansion of the academies programme, plus the introduction of free schools. We are therefore likely to see more variation in primary school admissions policies at school level in future.

[22] The same is also true in Wales. In Scotland, children born in March are the oldest in the academic year (and children born in February the youngest), while in Northern Ireland the oldest and youngest are those born in July and June respectively. In Scotland, it is possible for parents to delay their child's entry to primary school for one year if they are born between August and February (although only those born in January and February are guaranteed a state-funded nursery place in the intervening period). Source: http://www.edinburgh.gov.uk/info/851/nurseries_and_playgroups/566/pre-school_nursery_education/4.

Table 2.1. Regional variation in admissions policies over time

Admissions policy	Admissions policy for children starting school in: 1990–91	2000–01	2008–09	Description
	No. of local authorities (% of local authorities)[a]			
Single entry date	54 (42.5%)	66 (51.6%)	104 (70.3%)	All children start school in the September after they turn 4
Two entry dates	16 (12.6%)	30 (23.4%)	32 (21.6%)	For example, children born 1 September to 29 February start school in the September after they turn 4 and children born 1 March to 31 August start school in the January after they turn 4[b]
Three entry dates	41 (32.3%)	19 (14.8%)	7 (4.7%)	Children either start school at the beginning of the term *in which* they turn 5 (so children born 1 September to 31 December start in September, children born 1 January to 30 April start in January and children born 1 May to 31 August start in April[c]) or at the beginning the term *after* they turn 5[d]
Other policy	16 (12.6%)	13 (10.2%)	5 (3.4%)	Schools can choose their own admissions policy
Unknown or unclear	23	22	2	Admissions policy in place is not known or not clear

[a] Local authorities that did not provide information or for which policies are unclear are not included in the calculation of percentages.
[b] Some areas that follow a two entry date system use slightly different cut-off dates, but these are the most popular dates used.
[c] In practice, the timing of the break around April and May is determined by the timing of the Easter holidays and hence varies slightly from year to year.
[d] The proportion of local authorities that follow the statutory admissions policy is very small.
Source: Authors' calculations from a repeated survey of local authorities.

The fact that admissions policies are determined locally means that there is considerable variation both geographically and over time in the age at which children born at different times of the year start school. Table 2.1 shows that the adoption of single and dual entry point systems has become increasingly common over time; at the same time, local authorities have been moving away from policies that enable pupils to enter at the start of each term (either in the term in which they turn 5 or the term after they turn 5).

This variation is extremely important for our attempts to identify separately the factors that are driving the differences in outcomes that we observe, because it generates variation in the age at which children born on the same day start school and in how much schooling they receive before they sit the tests.[23] For example, the second most common admissions policy in operation for children starting school in 2008–09 suggests that those born between September and February start school in the September after they turn 4, while those born between March and August start school in the January after they turn 4. This means that a child born in August will start school when they are 4 years and 5 months old (rather than 4 years and 1 month old) if they live in an area that follows this policy rather than the single entry date policy; they would also receive one term less tuition in their first year at school.

In terms of when pupils in England can leave school, they are currently required to remain in school until the last Friday in June of the academic year in which they turn 16. This is the case for all of the cohorts for which we investigate differences in childhood outcomes in this report. There have been some changes to the school leaving age and dates over time, however, affecting the cohorts for which we investigate adult outcomes. These changes are summarised in Appendix A. This means that it is important for us to account for birth cohort in our analysis of adult outcomes (see Section 3.4 for more details on this issue).

National achievement tests and further and higher education

Pupils in England sit a number of national achievement tests at different ages. All children attending state schools in England are assessed at ages 5, 7 and 11 (and some of our older cohorts were also assessed at age 14, although these tests have since been abolished). At the end of their first year at school (age 5), pupils are assessed by their teachers on the basis of a range of cognitive and non-cognitive skills, including literacy, numeracy, and social and emotional development, as part of the Foundation Stage Profile. At the end of Key Stage 1 (age 7), pupils are assessed on the basis of reading, writing, speaking and listening, maths and science, and are expected to attain at least a Level 2B in these tests. At the end of primary school (age 11, Key Stage 2) (and midway through secondary school – age 14, Key Stage 3 – for older cohorts), they are assessed and tested in English, maths and science. The expectation is that pupils will obtain at least a Level 4 at Key Stage 2 and at least a Level 5 at Key Stage 3.

More importantly, all pupils in England sit exams at the end of compulsory schooling (age 16) in a range of subjects – usually around eight to ten in total – including English, maths and science, which lead to General Certificate of Secondary Education (GCSE) or equivalent qualifications. These are high-stakes exams that are often used to assess pupils' ability to continue into post-compulsory education. The government's target is for all pupils to achieve at least five A*–C grades at this level (equivalent to a National Qualifications Framework Level 2 qualification).

[23] See Chapter 4 for further discussion of the ways in which we utilise this variation.

The majority of pupils (just under 90 per cent at age 16 and just under 80 per cent at age 17 in 2011–12[24]) stay in full- or part-time education beyond the end of compulsory schooling and can choose from a range of academic and vocational courses. The most popular route sees pupils following three or four Advanced Level (A-level) courses for two years, with high-stakes exams being taken at age 18. To achieve the National Qualifications Framework (NQF) Level 3 threshold, pupils must obtain two A-level passes at grades A–E (or equivalent).

Most young people who go on to higher education do so either straight after further education or following a single gap year, with about 35 per cent of the cohort doing so in 2010–11.[25] Our analysis focuses not only on differences in the likelihood of going to university, but also on the type of institution that the young person attends. There are various ways of assessing institutional quality, but one common way of doing so identifies a group of 20 research-intensive institutions known as the Russell Group.[26] Around a fifth of young university participants attend one of these universities.[27]

2.2 Main data sets used

This report summarises evidence from a number of different reports and papers which make use of a variety of data sources. For young people, we use data from the National Pupil Database (NPD), the Millennium Cohort Study (MCS), the Avon Longitudinal Study of Parents and Children (ALSPAC) and the Longitudinal Study of Young People in England (LSYPE). For adults, we use data from the Labour Force Survey (LFS) and Understanding Society. Each of these data sources is described in more detail below.

National Pupil Database

The National Pupil Database combines data on results of national achievement tests (described in Section 2.1) with a limited range of characteristics for all pupils in state schools in England, which are provided by schools via the annual (now termly) school census.[28] It has been a statutory requirement for all state-

[24] Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167494/webtables.xls.xls.

[25] Source: https://www.gov.uk/government/publications/participation-rates-in-higher-education-2006-to-2012.

[26] The 20 Russell Group institutions are: Birmingham, Bristol, Cambridge, Cardiff, Edinburgh, Glasgow, Imperial College London, King's College London, Leeds, Liverpool, London School of Economics, Manchester, Newcastle, Nottingham, Oxford, Queen's University Belfast, Sheffield, Southampton, University College London and Warwick. A further four universities – Durham, Exeter, Queen Mary University of London and York – were added to the Russell Group in March 2012, but this is not relevant for the period covered by our data. See http://www.russellgroup.ac.uk/ for more details on the Russell Group of universities.

[27] Authors' calculations based on administrative data for the cohort sitting their GCSEs in 2001–02. The number of places at these universities has been relatively stable until recently.

[28] For more information on the NPD, see http://nationalpupildatabase.wikispaces.com/.

funded (and partially state-funded) schools in England to provide this information since January 2002; the data are therefore accurate and reliable. The characteristics included in the school census cover pupil-level information such as gender, ethnicity, eligibility for free school meals (a proxy for very low family income)[29] and special educational needs (SEN) status, as well as school and local area identifiers.

The NPD has also been linked to data from the Higher Education Statistics Agency (HESA) – a census of students attending UK higher education institutions – from 2004–05 onwards. This means that it is possible to follow a small number of cohorts in England through compulsory schooling, further education and on to higher education at any UK institution if they choose to participate. For these individuals, we can observe the institution they attend, the subject they study, whether they complete their degree and, if so, what grade they are awarded.

Millennium Cohort Study

The Millennium Cohort Study is a longitudinal study that has followed approximately 18,500 children sampled from all live births in the UK between September 2000 and January 2002.[30] The first survey was conducted when the study child was around 9 months old, with follow-ups to date at ages 3, 5 and 7 years. The MCS provides rich background information on both the study child and their parents, as well as interviewer-assessed measures of cognitive ability, and parent and teacher reports of the child's socio-emotional development, at ages 3, 5 and 7. MCS cohort members have also been linked to their teacher's assessment of their academic performance in the Foundation Stage Profile and Key Stage 1 (ages 5 and 7 respectively) from the NPD.

Avon Longitudinal Study of Parents and Children

The Avon Longitudinal Study of Parents and Children is a longitudinal study that has followed the children of around 14,000 pregnant women whose expected date of delivery fell between 1 April 1991 and 31 December 1992, and who were resident in the Avon area of England at that time.[31] This means that ALSPAC cohort members are up to 10 years older than MCS cohort members.

ALSPAC cohort members and their families have been surveyed via high-frequency postal questionnaires from the time of pregnancy onwards, building up a rich picture of their lives. In addition, they have been invited to participate in

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[29] Pupils are *entitled* to free school meals if their parents receive various means-tested benefits or tax credits and have a gross household income of less than £16,190 (in 2012–13 prices). They are *eligible* for free school meals if they are both entitled and registered as such with their local authority.

[30] For more details on the MCS, see http://www.cls.ioe.ac.uk/page.aspx?&sitesectionid=851&sitesectiontitle=Welcome+to+the+Millennium+Cohort+Study.

[31] For more details on the ALSPAC data, see http://www.bristol.ac.uk/alspac/sci-com/.

a number of clinic sessions, during which staff administer a range of physical, psychometric and psychological tests. This provides us with a series of objective measures of skills and behaviours that are less commonly available in other survey data sets.

ALSPAC cohort members have also been linked to their national achievement test scores at ages 7, 11, 14 and 16 (Key Stages 1 to 4 respectively) from the NPD. Because ALSPAC was designed to be a census of births in a particular area, it is a highly clustered sample, with many cohort members attending the same schools.

Longitudinal Study of Young People in England

The Longitudinal Study of Young People in England is a longitudinal study following around 16,000 young people in England who were born between 1 September 1989 and 31 August 1990 from the time that they were in Year 9 (aged 13/14, in 2003–04) annually until they were aged 19/20.[32] LSYPE cohort members are thus slightly older than ALSPAC cohort members. The survey was a stratified clustered design, with several cohort members observed in each school. Data have been collected on a range of background characteristics, and detailed information is available on the attitudes and aspirations of children and their parents towards education, their engagement in a range of risky behaviours, and their post-compulsory education choices and outcomes. LSYPE cohort members have also been linked to their national achievement test scores at ages 11, 14, 16 and 18 (Key Stages 2 to 5 respectively) from the NPD.

Labour Force Survey

The Labour Force Survey is a survey of households living at private addresses in the UK. Its focus is on employment and earnings, as its main purpose is to provide information on the UK labour market, which is used for official measures of employment and unemployment.[33] As such, it includes a relatively limited set of background characteristics compared with the cohort studies described above, but it does include information on educational qualifications. The LFS has a large sample size – around 46,200 households are interviewed each quarter[34] – and uses a rotational sampling design, in which a household is retained in the sample for a total of five consecutive quarters and then replaced. Information about employment status is asked in each wave, but details of earnings and income are requested only in the first and fifth waves. We focus our attention on individuals surveyed for the first time between 2002 and 2011 and who were born in England.

[32] For more details on the LSYPE, see http://www.esds.ac.uk/longitudinal/access/lsype/L5545.asp.

[33] See http://www.ons.gov.uk/ons/guide-method/method-quality/specific/labour-market/labour-market-statistics/volume-1---2011.pdf.

[34] The LFS has been carried out quarterly since 1992. Before this, it occurred annually (from 1986), but information on wages was not collected prior to 1992.

Understanding Society

Understanding Society is a large longitudinal panel study following around 40,000 households in the UK. It collects information on a wide range of topics, including educational qualifications, labour market status and history, and self-reported health and well-being.[35] Information is collected from all individuals aged 16 and upwards in the household, with a separate questionnaire for 10- to 15-year-olds. Panel members are followed if they leave the household (as are members of their new household), and new members of existing households are also added to the survey. The first wave of Understanding Society – which we use in this report – took place between January 2009 and January 2011, although it built on and extended the long-running British Household Panel Survey (BHPS), with households due to be surveyed approximately annually going forward.

2.3 Main methods used

The majority of analysis presented in this report is based on linear regression models in which our main covariates of interest are a series of binary variables indicating the month in which a child is born (relative to the oldest children – those born in September in England). This means that we are identifying mean differences in outcomes between children born at different times of the year. Where we use models for binary outcomes (such as the probability of continuing into higher education), we report the calculated marginal effects, so the impact of month of birth on both continuous and binary outcomes is interpreted as the difference, on average, between those born in September and those born in the relevant month later in the academic year.

In the data sets in which outcomes are not all measured on the same date (i.e. MCS, ALSPAC, LSYPE, LFS and Understanding Society), we include controls for month or quarter of interview in order to recreate the scenario in which all individuals are observed on the same date. We do so in order to ensure that all results are comparable across data sets and in particular that they are comparable to the findings in terms of national achievement tests, which all tend to be taken around the same point in time for our cohorts. In the data sets in which we observe multiple birth cohorts (i.e. LFS and Understanding Society), we additionally include a series of binary variables indicating the five-year period during which individuals were born. Finally, in the data sets in which we observe multiple pupils per school (i.e. NPD, ALSPAC and LSYPE), we often include school fixed effects (or at least cluster our standard errors) to account for unobserved common factors affecting pupils in the same class or school – for example, teacher quality.

In principle, if date of birth relative to academic year cut-off were randomly assigned, there would be no need to include individual or family background

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[35] For more details on Understanding Society, see https://www.understandingsociety.ac.uk/.

characteristics in our models. In contrast to some studies,[36] we find little evidence of any systematic differences in either the number or characteristics of children born in different months relative to the academic year.[37] Nonetheless, we include background characteristics in our models to improve the precision of our estimates. In some of our models – especially those in which we aim to identify separately the drivers of month-of-birth differences using regional policy variation[38] – it is also important for us to account for the selection of children into areas; hence we include a variety of local area characteristics as well.

The results presented in this report are based on this methodology unless otherwise stated. The other methods used are discussed in the relevant chapters.

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[36] For example, Gans and Leigh (2009) and Buckles and Hungerman (2013).

[37] See, for example, Brewer and Crawford (2010), Crawford, Dearden and Meghir (2010) and Crawford, Dearden and Greaves (2011).

[38] For example, Crawford, Dearden and Greaves (2011 and 2013c).

3. Month-of-Birth Differences in Child and Adult Outcomes

This chapter documents differences in a variety of outcomes between individuals born at the start and end of the academic year. In particular, it considers educational attainment and cognitive test scores (Section 3.1), a variety of non-cognitive skills such as attitudes and behaviours (Section 3.2), further and higher education participation and attainment (Section 3.3) and a variety of adult outcomes, including employment and wages (Section 3.4). Section 3.5 summarises these differences.

3.1 Educational attainment and cognitive test scores

Crawford, Dearden and Meghir (2007) used national achievement test scores for all pupils in England to document the magnitude of the differences in educational attainment between pupils born in different months and showed how this relationship changed as children got older. This work built on previous evidence for England[39] by focusing on more recent cohorts and taking advantage of the large sample sizes available in administrative data to estimate more robust relationships and carry out subgroup analysis.

Figure 3.1 updates this analysis to show how the proportion of children obtaining at least the government's expected level varies by date of birth for three cohorts for which we observe externally-assessed Key Stage 1 to Key Stage 4 results (children born between September 1990 and August 1993).[40] The vertical lines represent the academic year cut-off (1 September). Comparing the outcomes of individuals born either side of this line illustrates the difference between individuals born just a few days apart but who end up in different academic year groups as a result of the cut-off date: this is a *cross-cohort comparison*. On the other hand, comparing the outcomes of individuals born at either end of a particular academic year illustrates the difference between individuals born nearly a year apart but who end up in the same academic year group: this is a *within-cohort comparison*. In practice, whether we make these comparisons across or within cohorts makes little difference to our results.[41]

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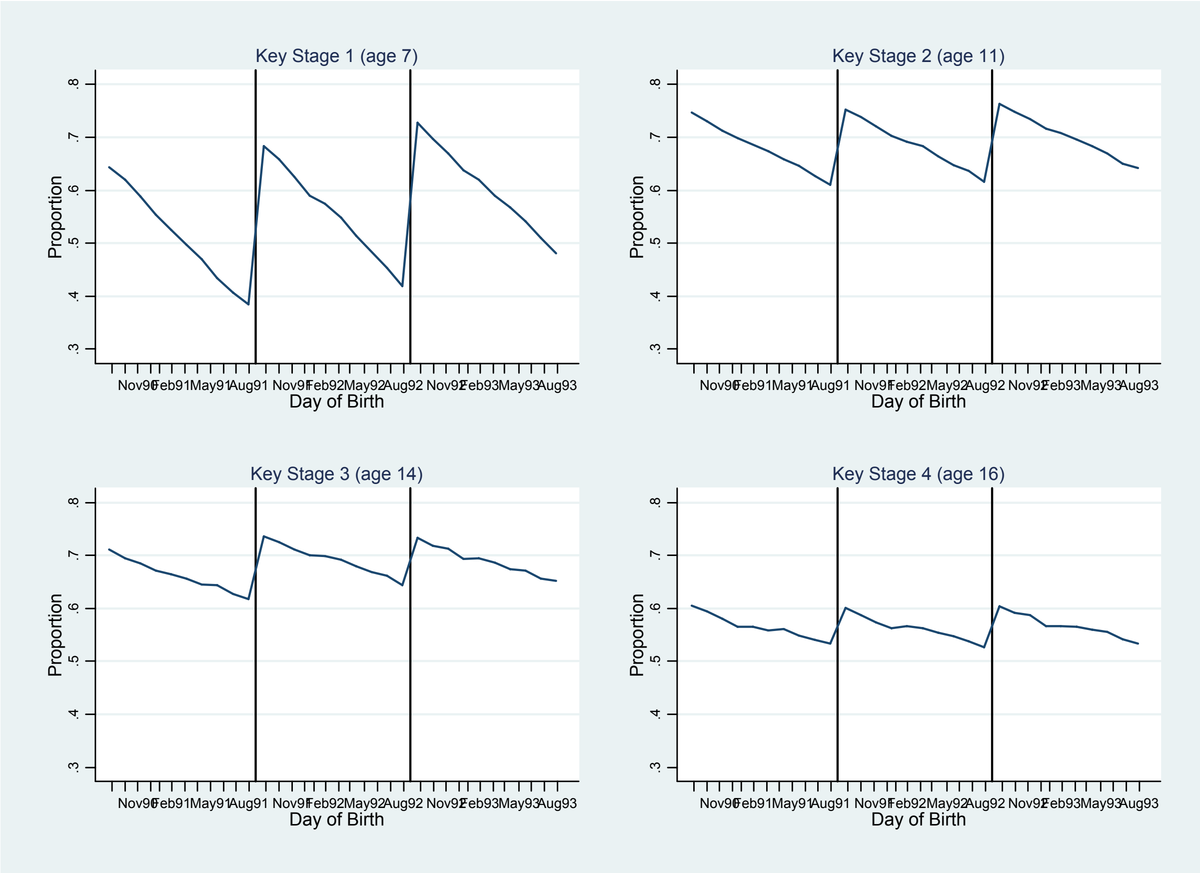
[39] See, for example, Russell and Startup (1986), Bell and Daniels (1990), Sharp, Hutchison and Whetton (1994), Thomas (1995) and Alton and Massey (1998).

[40] An equivalent figure using standardised average point scores is shown in Appendix B.

[41] This is important for comparability purposes, because different methods and data sets implicitly or explicitly make different comparisons. For example, Crawford, Dearden and Greaves (2013b) use a regression discontinuity design, which compares individuals born immediately either side of the academic year cut-off (i.e. it is a cross-cohort comparison). By contrast, all of the analysis based on individuals in the MCS or LSYPE is forced to use a within-cohort comparison, because both surveys focus on individuals born within a particular academic year in England.

Figure 3.1. Proportion of pupils obtaining at least the expected level at Key Stages 1, 2, 3 and 4 (ages 7, 11, 14 and 16), by date of birth



Source: Authors' calculations using Key Stage 1, 2, 3 and 4 test results from the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

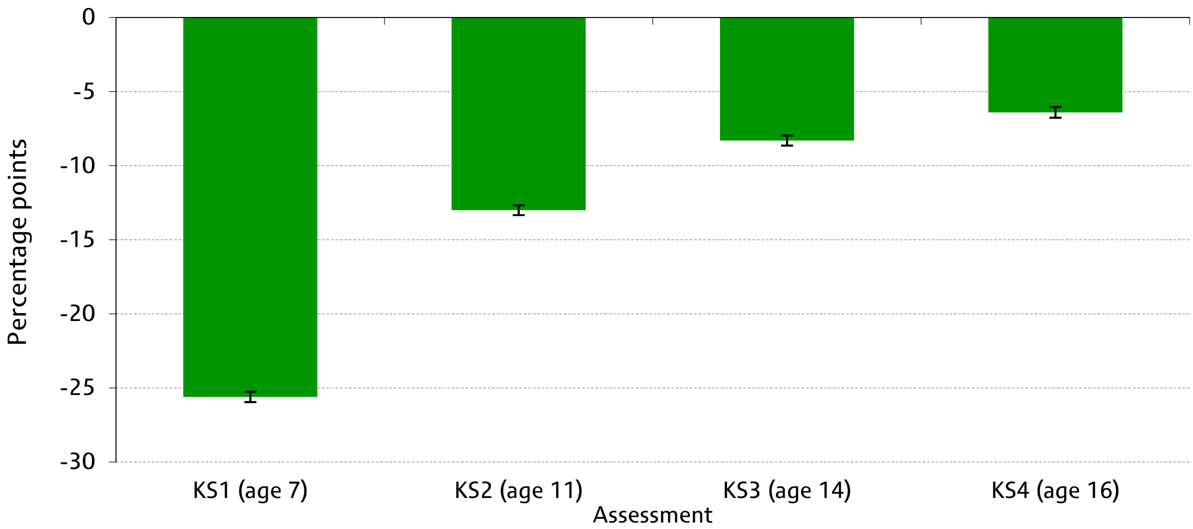
Figure 3.1 illustrates the sizeable raw differences in educational attainment between children born at the start and end of the academic year. These differences are largest soon after children have started school, but are still present – and both statistically and educationally significant – at age 16, when young people are making decisions about further education at least partly on the basis of their performance in these high-stakes exams.

Figure 3.2 illustrates this point more clearly, by showing the average within-cohort difference in the proportion of pupils obtaining at least the government's expected level at each Key Stage between the oldest and youngest children in each academic year (those born in August relative to those born in September), after accounting for some other ways in which children born at different times of the academic year may differ from one another.[42] It shows that, at age 7, August-

[42] An equivalent figure using standardised average point scores is shown in Appendix B. Both that and Figure 3.2 control for differences in individual and family background characteristics, and also account for school fixed effects. Crawford, Dearden and Greaves (2011) found little evidence that children born in different months differed significantly from one another and this is also true here, as the inclusion of these characteristics makes very little difference to the observed gaps, such that Figures 3.1 and 3.2 tell very similar stories.

born pupils are 26 percentage points less likely to reach the government's expected level than otherwise-identical September-born pupils. By the end of primary school (age 11), this difference has fallen to 13 percentage points, suggesting that children who are young in their academic year catch up with their peers over time, as the difference in relative age decreases.

Figure 3.2. Percentage obtaining at least the expected level: August-born children relative to September-born children at Key Stages 1–4



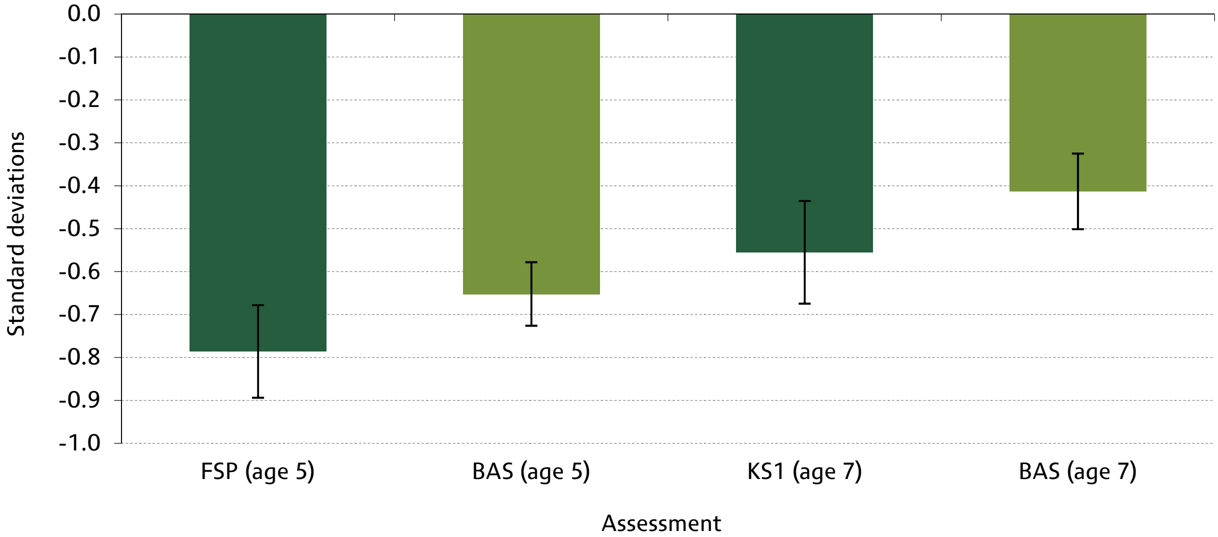
Note: Error bars represent 95 per cent confidence intervals.
Source: Authors' calculations using Key Stage (KS) 1, 2, 3 and 4 test results from the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

This process continues throughout secondary school, such that by the end of compulsory education (age 16), the gap in attainment between those born at the start and end of the academic year has fallen to around 6.4 percentage points (equivalent to 12 per cent of a standard deviation). While Sharp et al. (2009) do not regard such a gap as being 'educationally significant', it means that August-born pupils are 6.4 percentage points less likely to achieve five A*–C grades in GCSE or equivalent exams, which is the standard typically required for young people to continue into further or higher education. Such differences may therefore have potentially serious consequences for young people's post-compulsory education decisions, as well as for their chances of securing (well-paid) work during adulthood.

Moreover, whilst the difference relative to those born in September is largest for August-born children, even a one-month difference in age has an effect. For instance, those born in January are 2.8 percentage points less likely to achieve five A*–C grades in GCSE or equivalent exams than September-born children, while for those born in May the difference is 4.4 percentage points. We discuss the extent to which these differences go on to affect young people throughout their lives by presenting evidence on month-of-birth differences in further and higher education participation and a range of adult outcomes in Sections 3.3 and 3.4.

Crawford, Dearden and Greaves (2011) went on to show that it is not only performance on tests taken in school that is affected by date of birth relative to 1 September, but that tests taken outside school (on the same date) also show significant differences between children born at different points of the academic year.[43]

Figure 3.3. Standardised average point scores from Key Stage and British Ability Scale tests for the MCS cohort: performance of August-born children relative to September-born children



Note: The bars represent the average difference in performance for those born in August relative to those born in September, conditional on month of interview (entered linearly), plus a range of individual and family background characteristics. Error bars represent 95 per cent confidence intervals. FSP stands for Foundation Stage Profile, which is teacher assessed at the end of a child's first year at school (age 5). KS1 stands for Key Stage 1, for which this cohort were assessed by their class teacher at the end of their third year of school (age 7). See Section 2.1 for further details of these tests. BAS stands for British Ability Scale tests, which were conducted during survey interviews when the child was aged around 5 and 7. At age 5, the BAS tests covered vocabulary, picture similarity and pattern construction. At age 7, they covered reading, pattern construction and maths.
Source: Millennium Cohort Study. See Crawford, Dearden and Greaves (2011) for further discussion of the model and results.

For example, Figure 3.3 plots the difference in standardised average test scores[44] between children born in August (at the end of the academic year) and those born in September (at the start of the academic year) for children in the Millennium Cohort Study (born in 2000–01) in terms of their performance in

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[43] Unlike the national achievement tests, the survey interviews during which the non-school tests were taken did not occur on the same date in practice; however, it is possible to produce a similar effect by controlling for the date on which the interview occurred. This is crucial to ensure that we are comparing like with like in terms of the school and non-school test results.

[44] We standardise test scores by subtracting the average test score within our sample for each cohort from each individual's test score and dividing the result by the standard deviation of test scores in our sample. This ensures that we can compare differences in test scores by month of birth across cohorts and tests in a consistent way.

national achievement tests at age 5 (the Foundation Stage Profile) and age 7 (Key Stage 1) and in terms of their performance in British Ability Scale (BAS) tests at the same ages.[45]

The figure shows that there are sizeable differences in terms of British Ability Scale test scores (taken on the same date) as well as in terms of national achievement test scores at ages 5 and 7. The differences in BAS test scores are slightly smaller than those for national achievement test scores – for example, the gap at age 5 is 79 per cent of a standard deviation in terms of the Foundation Stage Profile, while it is 65 per cent of a standard deviation in terms of BAS tests – although they are not significantly different from one another in our sample.[46] These differences in BAS scores are still large and statistically significant, however, and are equivalent to about 75 per cent of the difference at age 5 between children born to mothers with at least a degree and children born to mothers with no formal qualifications, and 50 per cent of the difference at age 7.

The difference between August- and September-born children might be slightly larger in terms of Key Stage tests than in terms of BAS tests because those born at the end of the academic year are less well prepared to deal with the curriculum when they first start school, or because their performance could be negatively affected by their own or their teacher's expectations of their performance relative to their classmates.

Alternatively, the difference could arise because the national achievement test scores are based on teacher assessments of children's performance for this cohort, while the BAS tests are based on more objective measures. Previous work has shown that teachers tend to 'over-assess' some groups (i.e. award them a higher level than they receive in externally-marked tests) and 'under-assess' others (vice versa).[47]

This also appears to be the case for children born at different times of the academic year: Figure 3.4 shows that amongst those who were awarded the median (expected) level in externally-marked tests in English at Key Stage 2 (age 11), those born in August were around 4 percentage points (one-third) more likely to be 'under-assessed' by their teacher than those born in September. The difference was 2 percentage points (40 per cent) in maths. Those born in August are also less likely to receive a higher teacher assessment than Key Stage test score.

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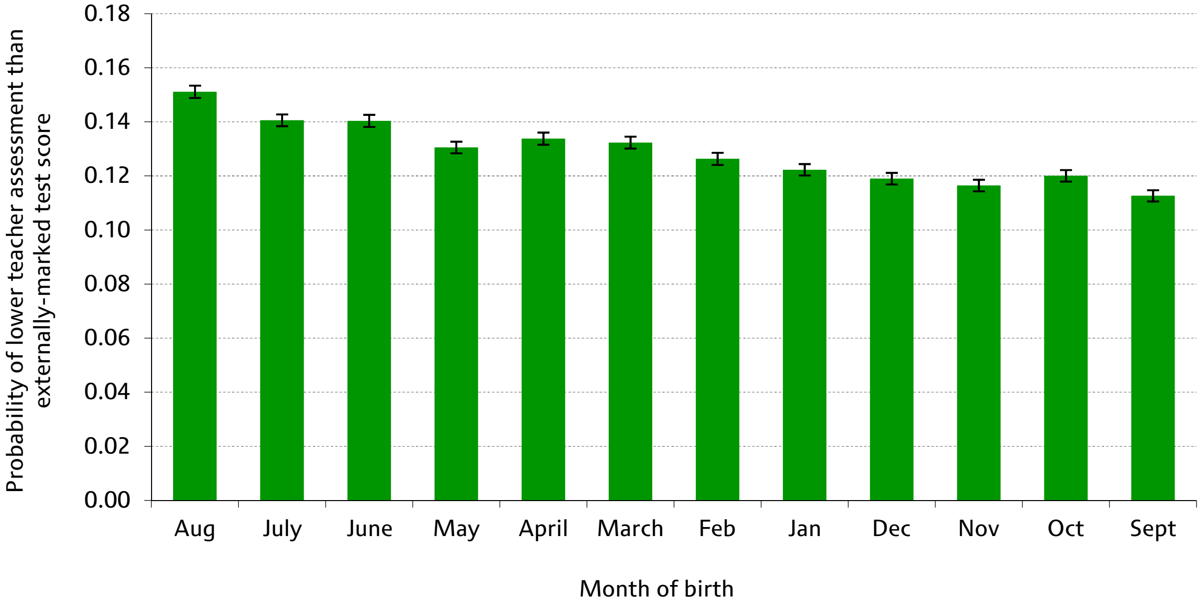
[45] At age 5, the BAS tests cover vocabulary, picture similarity and pattern construction. At age 7, they cover reading, pattern construction and maths. For more details, see http://www.gl-assessment.co.uk/health_and_psychology/resources/british_ability_scales/british_ability_scales.asp?css=1.

[46] This can be seen by the fact that the confidence intervals for the differences in BAS and Key Stage test scores overlap at each age.

[47] See, for example, Burgess and Greaves (2013).

Figure 3.4. Difference between teacher assessments and externally-marked tests in KS2 English, for those with median external scores



Note: Error bars represent 95 per cent confidence intervals. The sample includes those aged 10 at the start of the academic year and those who scored the median (expected) level in externally-marked tests.
Source: Key Stage 2 English test results in 2001–02 from the National Pupil Database.

This suggests that teacher assessments might penalise the performance of relatively young pupils in the cohort. As children's performance throughout primary school is now based largely on teacher assessments, unless teachers are made more aware of this danger this may have potentially serious consequences for the relative performance of children born at different points of the academic year in future.

Finally, in terms of subgroup analysis, neither Crawford, Dearden and Meghir (2007) nor Crawford, Dearden and Greaves (2011) found any consistent evidence of significant differences in the absolute magnitude of these effects of date of birth relative to academic year cut-off across a range of individual and family background characteristics.[48]

3.2 Childhood attitudes and behaviours

In addition to there being substantial differences in educational attainment between children born at the start and end of the academic year, there are also significant differences in terms of a range of other skills and behaviours exhibited during childhood.

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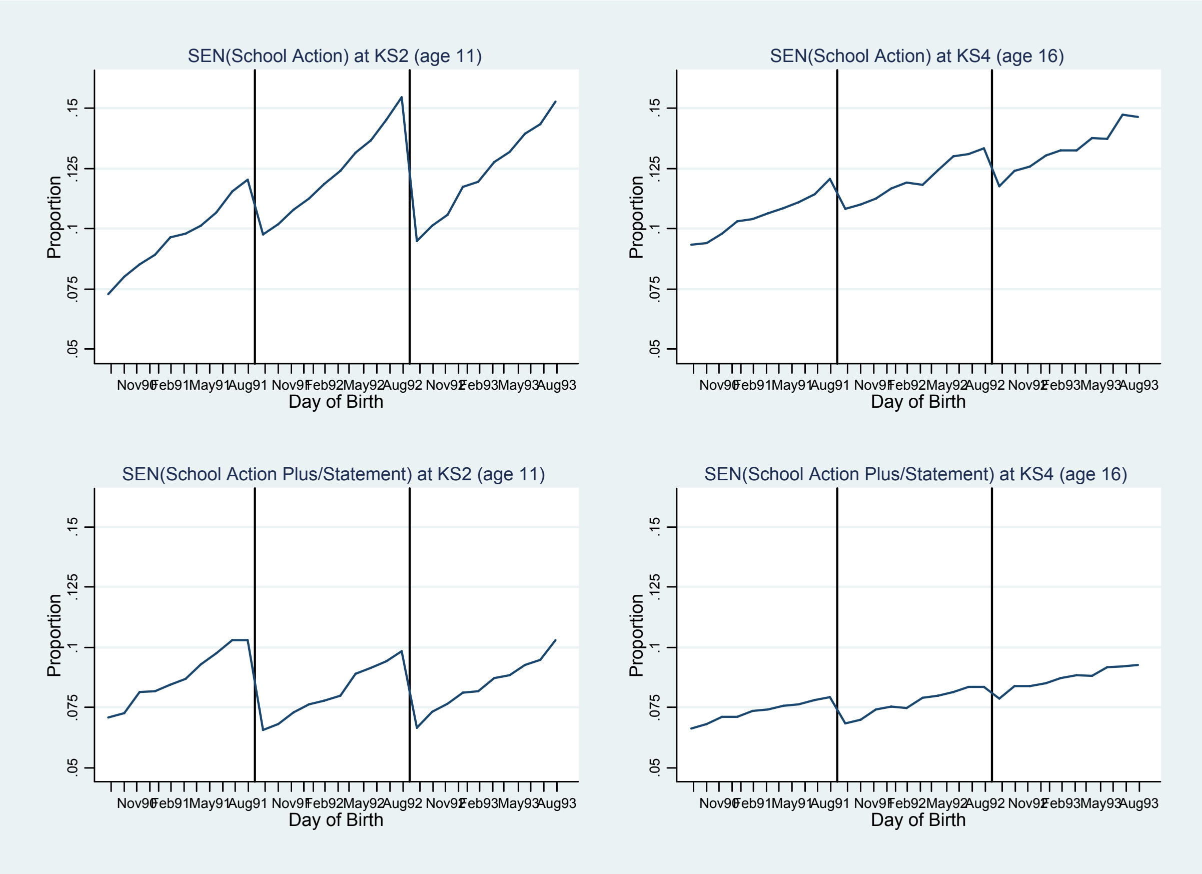
[48] It is worth pointing out, however, that because different groups have higher or lower base levels of attainment, the same absolute differences will translate into greater or smaller relative differences for different groups.

For example, Crawford, Dearden and Meghir (2007) used administrative data covering all pupils attending state schools in England to show that the relatively youngest children in each cohort were significantly more likely to be identified as having special educational needs (SEN) than their relatively older peers. Figures 3.5 and 3.6 update this analysis to consider the differences in identification at ages 11 and 16 for pupils born in 1990–91, 1991–92 and 1992–93 (the same cohorts as in Figures 3.1 and 3.2).

Figure 3.5. Proportion of pupils identified as having special educational needs, by date of birth

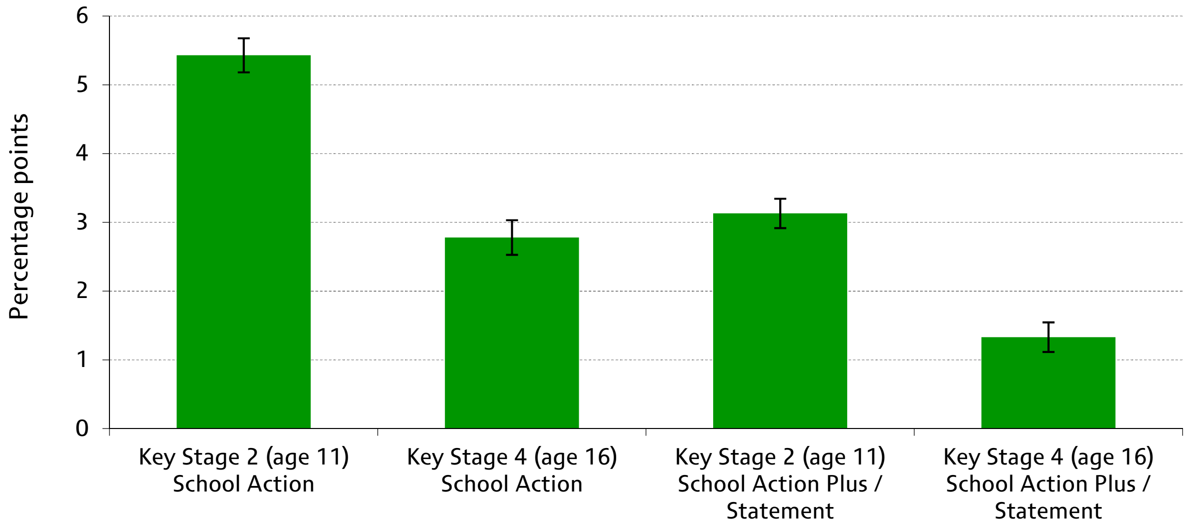


Note: ‘School Action’ (top panel) identifies needs that require the mildest level of support from the school. ‘School Action Plus / Statement’ (bottom panel) identifies needs that require additional support to be resourced in from outside the school.
Source: Authors’ calculations using the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

Figure 3.5 highlights the inexorable rise in the proportion of children being identified as having special educational needs over time – particularly amongst those with the lowest categories of need – with substantially more pupils born in a particular month identified as having special educational needs in cohort 3 (those born in 1992–93) than in cohort 1 (those born in 1990–91).

However, it is also clear that there is a steep, almost linear, relative-age gradient in terms of special educational needs status, with the relatively younger pupils in each academic cohort being substantially more likely to be labelled than the relatively older pupils in each cohort. Figure 3.6 highlights the within-cohort differences in the likelihood of being labelled between August- and September-born pupils (after accounting for some other ways in which these children differ from one another[49]) and shows that those born in August are 5.4 percentage points more likely to be labelled as having special educational needs requiring school action at age 11 and 2.8 percentage points more likely at age 16. There are significant differences for children born in other months as well.

Figure 3.6. Percentage of pupils identified as having special educational needs: August-born children relative to September-born children



Note: 'School Action' identifies needs that require the mildest level of support from the school. 'School Action Plus / Statement' identifies needs that require additional support to be resourced in from outside the school.
Source: Authors' calculations using the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

Crawford, Dearden and Meghir (2007) also highlighted some important gender differences: while the absolute differences between pupils born in August and September in terms of the likelihood of being labelled as having special educational needs are larger for boys than for girls, the relative differences are larger for girls (i.e. the proportionate increase associated with being born in August is larger for girls than for boys) because boys are substantially more likely to be labelled than girls.

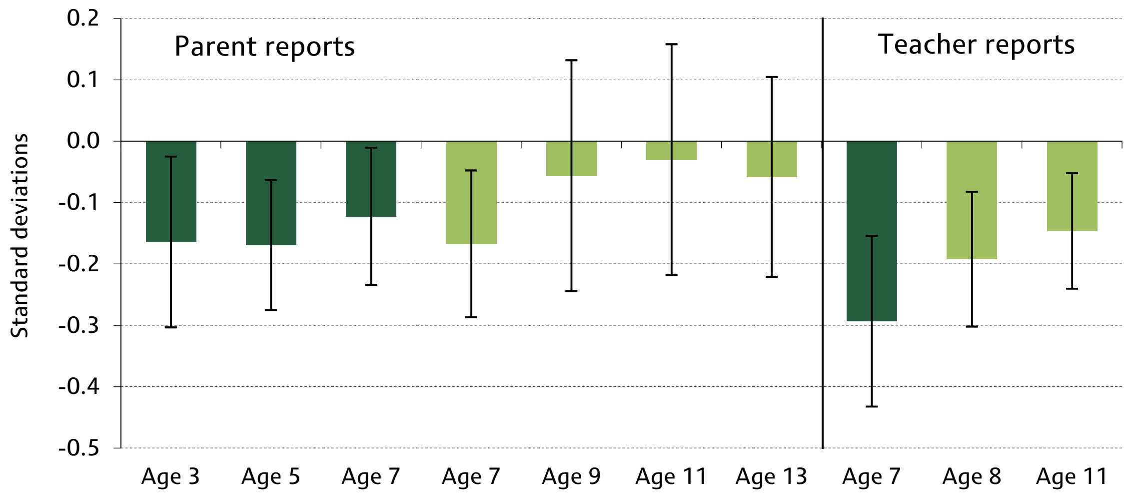
Crawford, Dearden and Greaves (2011) built on the relatively limited evidence on month-of-birth differences in other non-cognitive skills and behaviours by showing how children born at different times of the year differ in terms of a variety of attitudes and behaviours. We used data from three of the UK's cohort studies – the Millennium Cohort Study (MCS), the Avon Longitudinal Study of Parents and Children (ALSPAC) and the Longitudinal Study of Young People in

[49] Figure 3.6 controls for differences in individual and family background characteristics, and also accounts for school fixed effects.

England (LSYPE) – in order to show how these differences varied as children got older. We report some of the key differences here.

It is important to note that this work presented month-of-birth differences in these outcomes *as if they had all been observed on the same date*. We did this so that the differences we identified were comparable to those available from national achievement tests (which are all taken on the same date). It was achieved in a similar way to that described above for the BAS tests – i.e. by controlling linearly for month of interview – and ensured that our results were comparable across outcomes and data sets.[50] It is also worth noting that the differences presented in this section are all estimated within cohort.

Figure 3.7. Socio-emotional development – standardised parent and teacher assessments: August-born children relative to September-born children



Note: The bars represent the average difference in socio-emotional development for those born in August relative to those born in September, conditional on month of interview (entered linearly), plus a range of individual and family background characteristics. Error bars represent 95 per cent confidence intervals. Dark green bars represent data from the Millennium Cohort Study. Lighter green bars represent data from the Avon Longitudinal Study of Parents and Children. In both cases, the outcome of interest is a total standardised SDQ score calculated on the basis of responses from parents or teachers in terms of the child's behaviour in various respects. See Crawford, Dearden and Greaves (2011) for further details.

Figure 3.7 presents differences between the assessments of socio-emotional development for August- and September-born children at a variety of ages made by a child's parents (on the left-hand side of the figure) and their class teacher (on the right-hand side). These assessments are based on the Strengths and Difficulties Questionnaire (SDQ), a short behavioural screening exercise for

[50] Section 4.3 compares the differences including and excluding controls for date of interview. This provides some insight into the potential drivers of the month-of-birth differences that we observe, as it allows age at test to vary to a greater (if we control for date of interview) or lesser (if we do not) extent.

children aged 3–16, designed to capture emotional symptoms, conduct problems, hyperactivity/inattention and peer relationship problems. We calculate a total score based on the responses received across these four domains,[51] standardise it[52] and invert it to create a measure of positive rather than negative behaviour.

Figure 3.7 shows that August-born children are generally reported to have poorer socio-emotional development than September-born children, although these differences are smaller than those in terms of cognitive test scores: for example, the (teacher-assessed) difference in performance between August- and September-born children during Key Stage 1 (assessed at age 7) was 56 per cent of a standard deviation, compared with 29 per cent of a standard deviation in terms of teacher-assessed socio-emotional development at the same age.

This confirms the findings of other studies using the SDQ[53] and other measures of particular elements of the SDQ, such as hyperactivity.[54] In fact, we find that the average differences in behaviour between children born at the start and end of the academic year are greatest for the hyperactivity and conduct domains: the difference at age 5 in the MCS between those born in August and September is 0.12 standard deviations for the peer relationships subscale, 0.16 standard deviations for the emotion subscale, 0.22 standard deviations for the conduct subscale and 0.37 standard deviations for the hyperactivity subscale.

The differences in socio-emotional development reported by the child's class teacher are generally larger – and remain significant for longer – than those reported by the child's parent, perhaps suggesting that teachers are more explicitly comparing children within their class or academic cohort, while parents may be taking into account a wider range of peers of different ages. This seems consistent with the findings above, whereby the difference in educational attainment between those born at the start and end of the academic year is larger when using teacher assessments than when using externally-marked tests.

As was the case for educational attainment, the difference in socio-emotional development between children born at the start and end of the academic year declines over time, suggesting that August-born children are 'catching up' with their September-born peers as they get older and the difference in relative age declines. However, while the differences suggested by parent reports are no longer statistically significant by age 9, the differences suggested by teacher reports remain significantly different from zero until at least age 11 – the latest

[51] Respondents are presented with a series of statements about the child's behaviour and asked to decide whether the statement is 'not true' (receiving a score of 0), 'somewhat true' (receiving a score of 1) or 'certainly true' (receiving a score of 2). The total score is calculated by summing the scores received across these four domains. The SDQ also includes questions on pro-social behaviour, but these are not included in the overall score. See http://www.sdqinfo.org/ for more information.

[52] By subtracting the mean and dividing by the standard deviation.

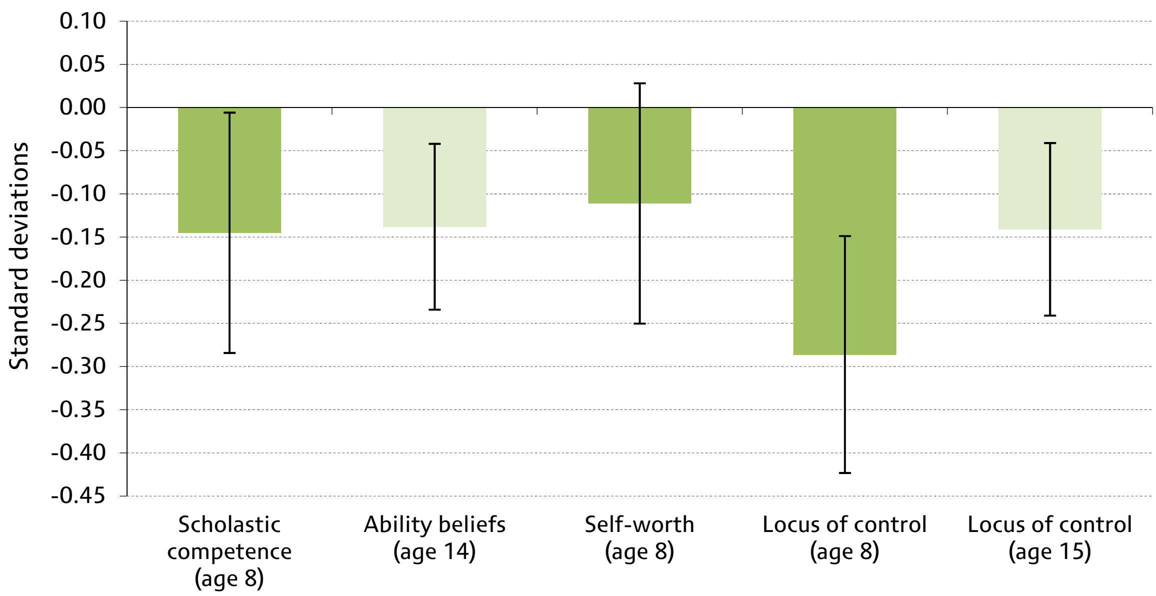
[53] For example, Goodman, Gledhill and Ford (2003), who focus on season-of-birth differences.

[54] For example, Mühlenweg, Blomeyer and Laucht (2011) and Chen et al. (2013).

age for which we have data. This provides some further suggestive evidence that teacher perceptions might be perpetuating (or at least not diminishing) the relative performance of children born at different times of the academic year.

Figure 3.8 shows not only that parents and teachers perceive August-born children differently from September-born children, but also that the children have different views of themselves and their own abilities too.[55] For example, August-born children rate their own academic competence significantly lower than do September-born children at ages 8 and 14. Around 60 per cent of the difference at age 8 can be explained by lower performance at Key Stage 1, while Key Stage 2 test results can explain 85 per cent of the variation at age 14. This suggests that while the majority of the difference in ability beliefs between those born at the start and end of the academic year stems from differences in exam results, a sizeable proportion stems from other experiences and thus might be less susceptible to policy changes focused on correcting differences in test scores that arise simply as a result of the age at which children are assessed.

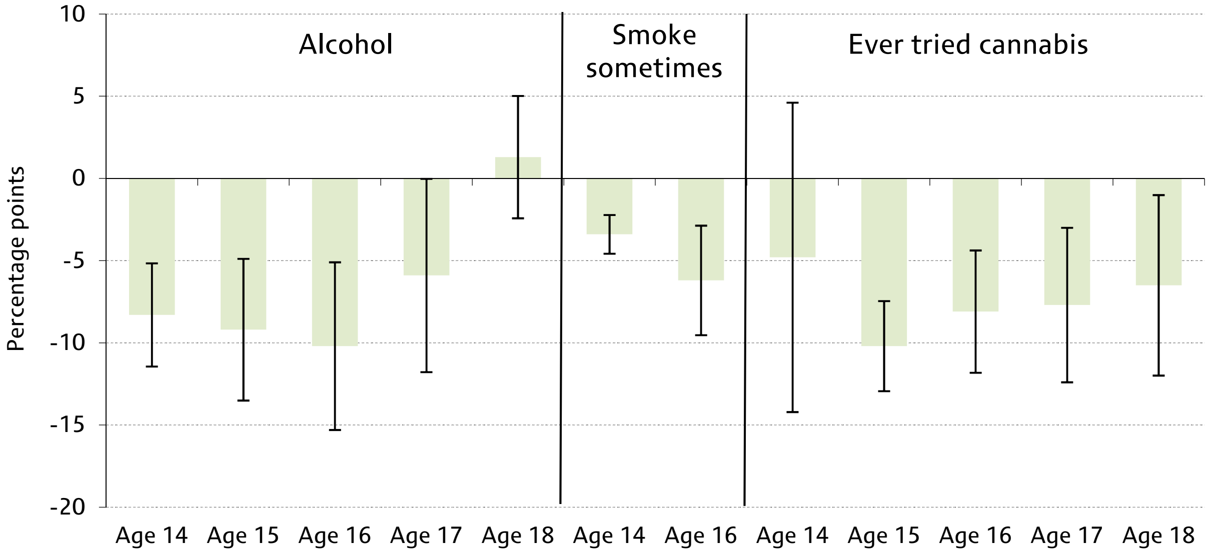
Figure 3.8. Self-perceptions – standardised self-assessments: August-born children relative to September-born children



Note: The bars represent the average difference in the outcome of interest for those born in August relative to those born in September, conditional on month of interview (entered linearly), plus a range of individual and family background characteristics. Error bars represent 95 per cent confidence intervals. Darker green bars represent data from the Avon Longitudinal Study of Parents and Children. Lighter green bars represent data from the Longitudinal Study of Young People in England. See Crawford, Dearden and Greaves (2011) for full details of the construction of these measures, as well as further discussion of the model and results.

[55] See Crawford, Dearden and Greaves (2011) for further details of the construction of these measures.

Figure 3.9. Participation in risky behaviours: August-born children relative to September-born children



Note: The bars represent the average difference in engagement in risky behaviours for those born in August relative to those born in September, conditional on month of interview (entered linearly), plus a range of individual and family background characteristics. Error bars represent 95 per cent confidence intervals.
Source: Longitudinal Study of Young People in England. See Crawford, Dearden and Greaves (2011) for further discussion of the model and results.

This lower confidence in their own ability appears to affect young people's expectations in terms of their participation in post-compulsory education, with those born at the end of the academic year 6.1 percentage points less likely to report (at age 14) that they are very likely to apply to university at some point in future than those born at the start of the academic year.[56] However, it does not appear to significantly affect their self-esteem more generally (although the point estimates are not very different from those for ability beliefs at the same age).

Young people born in August are also significantly more likely to have an external locus of control – i.e. to believe that their actions do not matter; that they are not in control of their own destiny – at similar ages. Given evidence linking such perceptions to later education and labour market outcomes,[57] these results suggest a further route (in addition to educational attainment) through which month of birth might potentially have consequences that last into adulthood.

Figure 3.9 shows that there are also significant differences between those born at the start and end of the academic year in terms of engagement in risky behaviours (such as smoking, drinking and illicit drug use). When we compare

[56] Crawford, Dearden and Meghir, 2010.

[57] For example, Coleman and DeLeire (2003), Goodman and Gregg (2010) and Chowdry, Crawford and Goodman (2011).

young people in the same academic cohort who are very different ages when they are interviewed, it is clear that, towards the end of compulsory education (around age 16), those born in August are over 6 percentage points less likely to smoke, over 8 percentage points less likely to have tried cannabis and over 10 percentage points less likely to drink at least once a week than their September-born counterparts. There is, however, some evidence that, as was the case for educational attainment and socio-emotional development, those born in August 'catch up' with their September-born peers as they get older, with the differences in participation generally falling over time.

We must exercise some caution when interpreting these results, however, as Section 4.3 shows that the context in which these estimates were obtained matters a great deal: in contrast to our findings for most other outcomes in this report, within-cohort and between-cohort comparisons tell very different stories from each other in terms of engagement in risky behaviours. Thus, while the within-cohort comparisons shown in Figure 3.9 would seem to be a 'good news' story as far as relatively younger pupils are concerned, the between-cohort comparisons shown in Section 4.3 highlight that this is not the whole story. We thus do not emphasise this result in our summary of findings at the end of this chapter.

In line with other literature,[58] Crawford, Dearden and Greaves (2011) also find some evidence that August-born children are more likely to report being bullied than September-born children, but only at younger ages; moreover, these findings from self-reports are not replicated by responses given by parents about whether their child is being bullied, even at younger ages.

In terms of subgroup analysis, Crawford, Dearden and Greaves (2011) again find little evidence of any significant differences in the absolute magnitude of these effects of date of birth relative to academic year cut-off across a range of individual and family background characteristics.

3.3 Post-compulsory education choices and qualifications

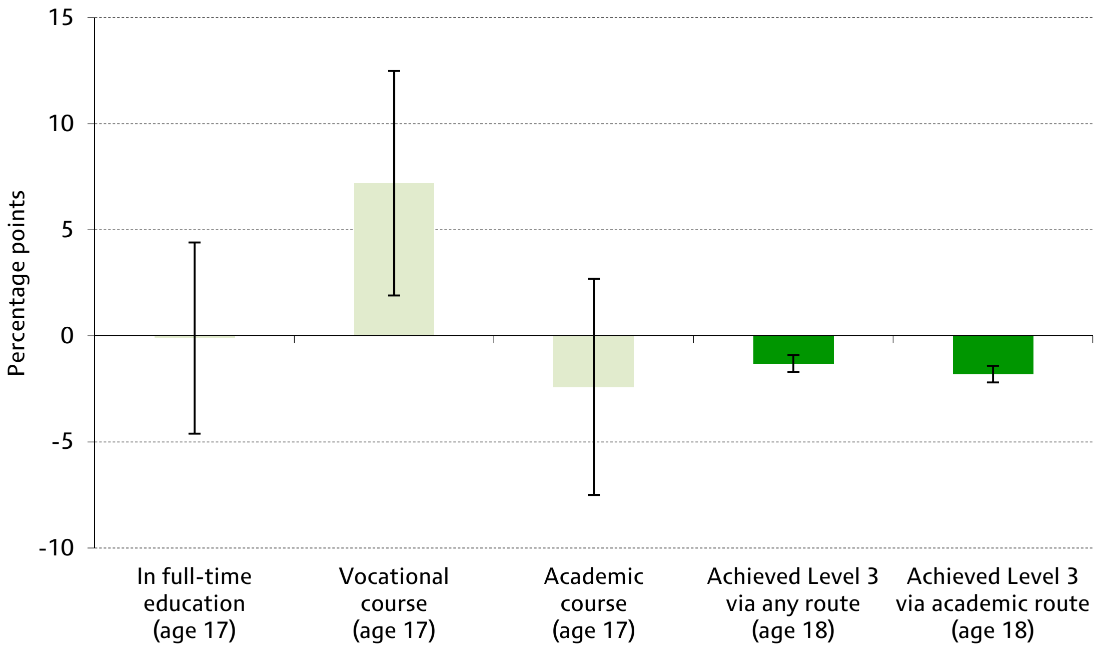
We saw above that young people born at the end of the academic year are significantly less likely to achieve five A*–C grades in GCSE or equivalent qualifications at age 16 than young people born at the start of the academic year, and that they have significantly lower expectations in terms of their future education participation. Given that they are less likely to meet the standard typically required to continue into post-compulsory education, and that their confidence in their own ability is also lower, it is plausible that some young people will drop out at the end of compulsory schooling, simply because of the

[58] For example, Department for Education (2010) and Mühlenweg (2010).

month in which they were born. This section investigates the extent to which there is evidence to support this potentially worrying conclusion.

Crawford, Dearden and Greaves (2011) showed that while there was almost no difference in terms of the likelihood of being in full-time education at age 17 according to the month in which young people were born, there were significant differences in the types of course in which they were enrolled. For example, Figure 3.10 shows that, amongst those who are in full-time education at age 17, those born in August are 7.2 percentage points more likely to be studying for vocational qualifications and 2.4 percentage points less likely to be studying for academic qualifications than those born in September (although this latter estimate is not significantly different from zero). Interestingly, these differences in course choice seem to be driven by individuals from low income groups, one of the few pieces of evidence that any of these effects differ in absolute magnitude across particular subgroups.

Figure 3.10. Participation, course choice and achievement in post-compulsory education: August-born children relative to September-born children



Note: The bars represent the average difference in the outcome of interest for those born in August relative to those born in September, conditional on month of interview (entered linearly, for outcomes from the LSYPE only), plus a range of individual and family background characteristics. Error bars represent 95 per cent confidence intervals. Darker green bars represent data from the National Pupil Database for individuals born between 1985–86 and 1987–88. Lighter green bars represent data from the Longitudinal Study of Young People in England.

In addition, Crawford, Dearden and Meghir (2007) showed that those born in August were 1.3 percentage points less likely to achieve a Level 3 qualification (equivalent to two A-level passes or equivalent) and 1.8 percentage points less likely to do so via an academic (rather than a vocational) route.[59] Given the well-known differences in returns to academic and vocational qualifications,[60] this suggests that the choices made by (or forced upon) young people born at the end of the academic year may lead to long-run differences in labour market outcomes (such as employment status and wages). Moreover, there is some evidence that it might be the low income groups who are more likely to suffer the long-term consequences of being born later in the year. We discuss the evidence on month-of-birth differences in adult outcomes in Section 3.4.

These differences in participation between young people born at the start and end of the academic year persist into higher education as well. For example, Crawford, Dearden and Greaves (2011) showed that, amongst the LSYPE sample, young people born in August were slightly less likely to go to university and slightly less likely to attend a high-status Russell Group institution at age 19 than young people born in September; however, the relatively small sample sizes available meant that these differences were not significantly different from zero.

Figure 3.11 builds on the results based on administrative data in Crawford, Dearden and Meghir (2010) to show that young people born in August are 2.3 percentage points less likely to go to university at age 18 or 19 (i.e. straight after finishing further education or following a single gap year) than young people born in September. These results are similar to those summarised in HEFCE (2005) using different administrative data. The figure also shows that amongst young people who go to university at this age, August-borns are 2.3 percentage points less likely to attend a Russell Group institution in their first year than September-borns. (Amongst the cohort as a whole, they are 0.9 percentage points less likely to attend a Russell Group institution at age 18 or 19.)

This report extends the existing evidence for England to show that, interestingly, amongst those young people who make it into higher education, August-borns actually go on to outperform their September-born counterparts. For example, Figure 3.11 shows that those born at the end of the academic year are 2.5 percentage points more likely to complete their degree and 1 percentage point more likely to get a first or a 2:1 (the two best degree grades) than those born at the start of the academic year (although this latter estimate is not significantly different from zero). Moreover, these gaps increase once we account for attainment at Key Stage 5, suggesting that amongst young people with the same A-level grades, August-borns are even more likely to complete their degree and be awarded a high grade than September-borns.

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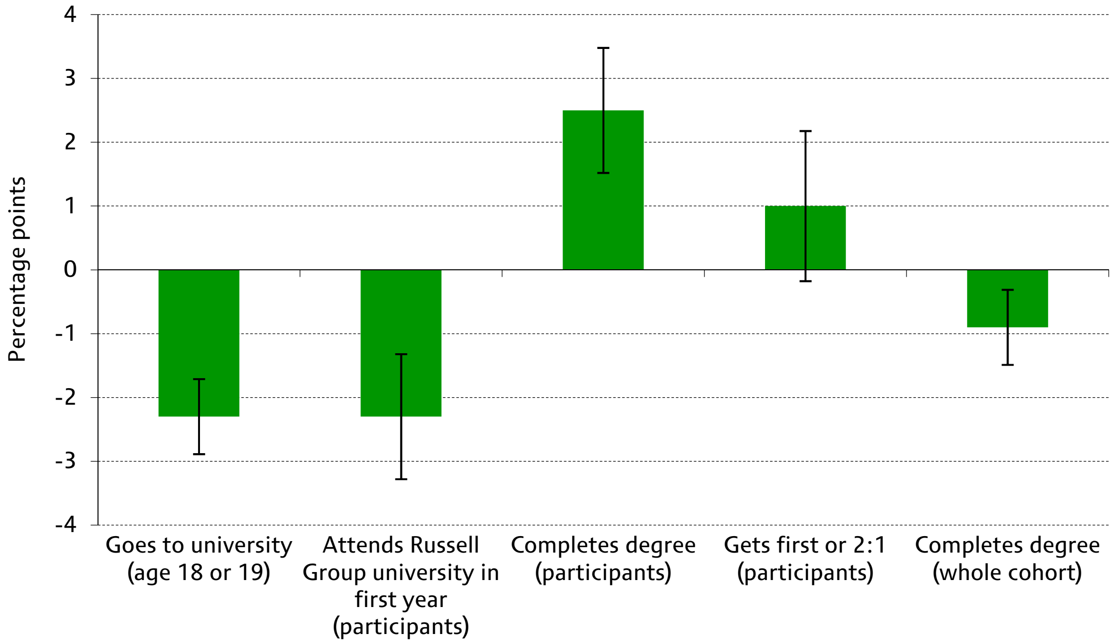
[59] These figures are weighted averages of the results for boys and girls from table 5.3 on page 35 of Crawford et al. (2007). Crawford, Dearden and Meghir (2010) estimated the difference in terms of achieving a Level 3 qualification via an academic route to be slightly higher, at 2.3 percentage points.

[60] See, for example, Dearden (1999), Blundell, Dearden and Sianesi (2005) and Jenkins, Greenwood and Vignoles (2007).

Figure 3.11. Participation and attainment in higher education: August-born children relative to September-born children



Note: The bars represent the average difference in the outcome of interest for those born in August relative to those born in September, conditional on gender, ethnicity, language status and quintiles of a deprivation index calculated on the basis of eligibility for free school meals and local area characteristics (see Chowdry et al. (2013) for more details of this index). Error bars represent 95 per cent confidence intervals. Sample focuses on students attending state schools who were eligible to sit their GCSEs in 2001–02. The first and last bars show results for the whole cohort, while the other bars show results for those who go to university at age 18 or 19 only.
Source: Linked NPD–HESA data.

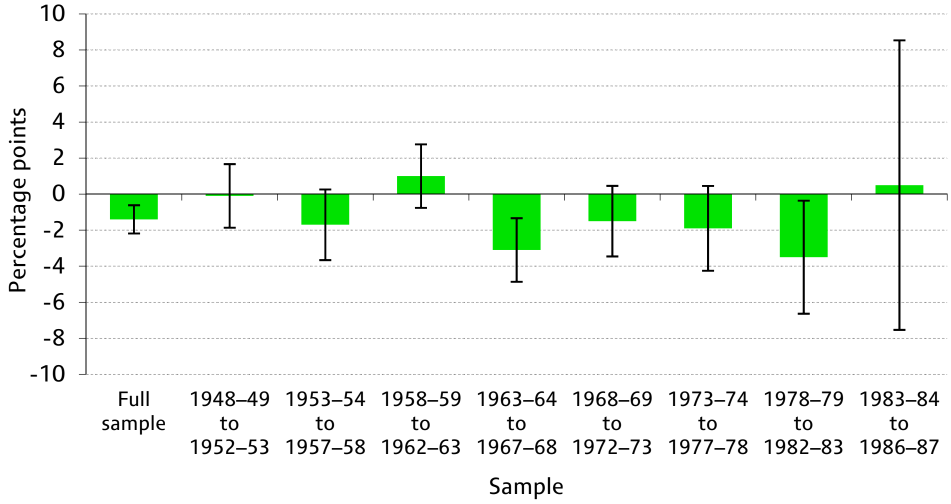
These results are perhaps not overly surprising. The fact that young people born towards the end of the academic year are significantly less likely to achieve a Level 3 qualification and go on to university than those born at the start of the academic year means that the average 'quality' (in terms of unobservable characteristics such as motivation) of those who achieve these feats is likely to be higher amongst August-borns than amongst September-borns. This makes it plausible that – amongst those who go to university and/or achieve certain A-level grades – those born towards the end of the academic year are more likely to complete their degree (to a high standard).

It is worth pointing out, however, that this higher likelihood of degree completion amongst those born towards the end of the academic year is not sufficient to overcome the lower probability that they will start a degree course in the first place: the last bar of Figure 3.11 shows that, amongst the cohort as a whole, August-borns are still 0.9 percentage points less likely to achieve a degree than their September-born counterparts.

Figure 3.12 provides new evidence that this finding also holds for degree acquisition at later ages and for a variety of older cohorts as well. It is based on data from individuals interviewed aged 25–64 as part of the UK's Labour Force

Survey for the first time between 2002 and 2011, who were born in England. It shows the difference in the probability of obtaining a degree between the relatively oldest and relatively youngest in each cohort. It does so both for the sample as a whole (first bar) and split by five-year birth cohort windows (remaining bars) to illustrate the extent to which this difference varies over time.

Figure 3.12. Probability of obtaining a degree, by birth cohort: relatively youngest compared with relatively oldest in academic cohort



Note: The bars represent the average difference in the probability of obtaining a degree for those born in the final month of the academic year relative to those born in the first month of the academic year, conditional on birth cohort and quarter of interview, plus a range of individual background characteristics. Error bars represent 95 per cent confidence intervals. 'Full sample' includes all those born between 1948 and 1987 who were interviewed for the first time as part of the UK's Labour Force Survey between 2002 and 2011, and who were born in England.

For the sample as a whole, the results are actually very similar to those shown in Figure 3.11 for a single recent cohort starting university at age 18 or 19: the relatively youngest in their academic cohort are 1.4 percentage points less likely to obtain a degree than the relatively oldest in their academic cohort. The estimate is, if anything, slightly larger (but not significantly different from zero as a result of the smaller sample sizes) for individuals surveyed as part of the first wave of Understanding Society, the new UK household panel study, in 2010. (See Crawford, Dearden and Greaves (2013a) for full details of these estimates.)

Interestingly, the effect of age within academic cohort on the likelihood of acquiring a degree is larger for females than for males in both data sets, with this difference appearing to increase over time. For example, females born at the end of the academic year and interviewed as part of the LFS are 1.6 percentage points less likely to acquire a degree than their relatively older female counterparts, compared with a 1.1 percentage point difference between relatively older and younger men. (For further discussion of these results, see Crawford, Dearden and Greaves (2013a).)

3.4 Adult outcomes

We have seen in previous sections that children who are born towards the end of the academic year in England have significantly lower educational attainment, exhibit significantly poorer attitudes and behaviours during childhood and are significantly less likely to go on to further and higher education and to graduate with a degree. Given the well-known evidence on the causal relationship between educational attainment and a range of adult outcomes,[61] as well as the strong correlations that exist between non-cognitive skills and behaviours and similar outcomes,[62] it seems plausible that an individual's birth date might continue to affect them during adulthood as well. This section sheds new light on the extent to which relative age within academic cohort continues to matter later in life, drawing on the results described in Crawford, Dearden and Greaves (2013a).

We start by considering whether the likelihood of being in work (either employed or self-employed) or being unemployed varies by age relative to academic year cut-off (shown in Figures 3.13 and 3.14 respectively), before moving on to consider whether there are any differences in terms of real gross hourly wages (Figure 3.15) amongst those in work. All figures are based on individuals aged 25–64 surveyed for the first time between 2002 and 2011 as part of the UK's Labour Force Survey and who were born in England.

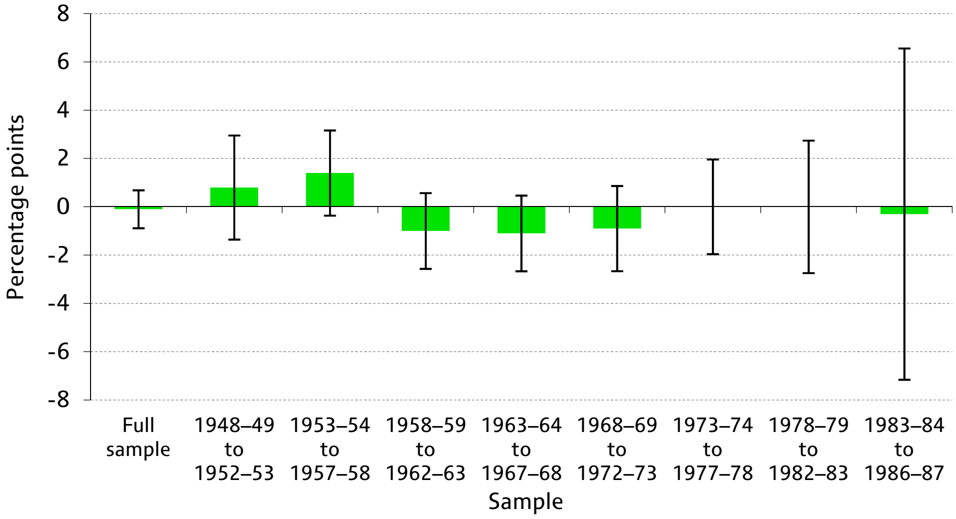
Figure 3.13 shows that those born at the end of the academic year are marginally less likely to be in work than those born at the start of the academic year, but not significantly so. Crawford et al. (2013a) confirm that this is also true if we focus on employment or self-employment only. While it is possible that these estimates might be attenuated (i.e. biased downwards) by the fact that we cannot perfectly observe the country in which individuals started school, we do not anticipate this being a major driving force behind our results.

Figure 3.14 shows that those born at the end of the academic year are significantly more likely to be unemployed than those born earlier, but not by very much. For example, amongst the sample as a whole, the relatively youngest in their academic cohort are 0.4 percentage points more likely to be unemployed than the relatively oldest. This effect is slightly larger for women than for men, with females born at the end of the academic year 0.6 percentage points more likely to be unemployed than their relatively older female counterparts, while the difference for men is just 0.1 percentage points. Crawford et al. (2013a) show that these estimates are similarly small and not statistically different from zero when using data from Understanding Society.

[61] For example, Dearden (1999), Blundell, Dearden and Sianesi (2005), Sabates and Feinstein (2007), Silles (2008), Powdthavee (2010) and Machin, Marie and Vujić (2011).

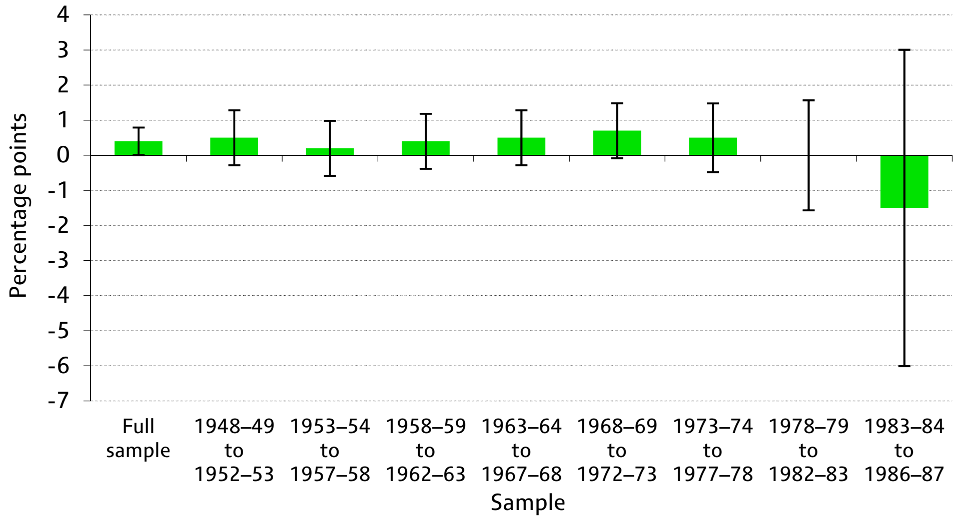
[62] For example, Heckman, Stixrud and Urzua (2006), Carneiro, Crawford and Goodman (2007) and Heckman et al. (2011).

Figure 3.13. Probability of being in work, by birth cohort: relatively youngest compared with relatively oldest in academic cohort



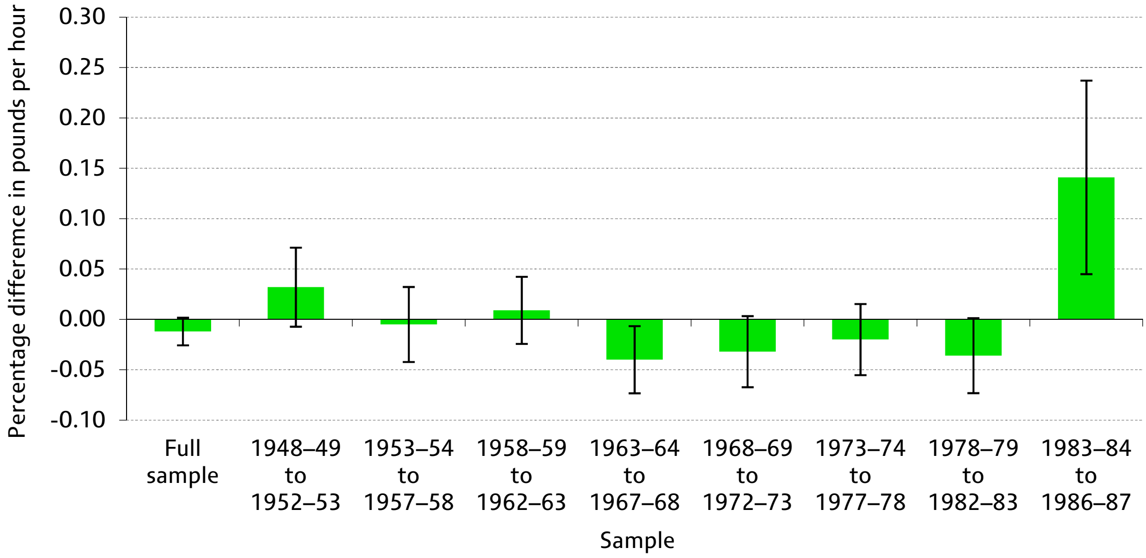
Note: The bars represent the average difference in the probability of being in work (employed or self-employed) for those born in the final month of the academic year relative to those born in the first month of the academic year, conditional on birth cohort and quarter of interview, plus a range of individual background characteristics. Error bars represent 95 per cent confidence intervals. 'Full sample' includes all those born between 1948 and 1987 who were interviewed for the first time as part of the UK's Labour Force Survey between 2002 and 2011, and who were born in England.

Figure 3.14. Probability of being unemployed, by birth cohort: relatively youngest compared with relatively oldest in academic cohort



Note: The bars represent the average difference in the probability of being unemployed for those born in the final month of the academic year relative to those born in the first month of the academic year, conditional on birth cohort and quarter of interview, plus a range of individual background characteristics. Error bars represent 95 per cent confidence intervals. 'Full sample' includes all those born between 1948 and 1987 who were interviewed for the first time as part of the UK's Labour Force Survey between 2002 and 2011, and who were born in England.

Figure 3.15. Real gross hourly wages, by birth cohort: relatively youngest compared with relatively oldest in academic cohort



Note: The bars represent the percentage difference in gross hourly wages in 2012 prices for those born in the final month of the academic year relative to those born in the first month of the academic year, conditional on birth cohort and quarter of interview, plus a range of individual background characteristics. Error bars represent 95 per cent confidence intervals. 'Full sample' includes all those born between 1948 and 1987 who were interviewed for the first time as part of the UK's Labour Force Survey between 2002 and 2011, and who were born in England.

Figure 3.15 shows that those born at the end of the academic year earn slightly less per hour, on average, than those born at the start of the academic year, but this difference is not significantly different from zero. The gap also varies in both sign and magnitude by birth cohort. In fact, amongst the most recent birth cohorts, those born in August earn significantly *more* per hour than those born in September. It is plausible that this is an effect of labour market experience: if those born in August are more likely to have left education early and got a job, then they may be reaping the rewards of doing so relatively early in their careers. This is supported by the finding in Figure 3.14 that August-borns amongst the most recent birth cohorts are significantly *less* likely to be unemployed early in their careers (while they are significantly more likely to be so later on).[63] A similar explanation was offered by Black, Devereux and Salvanes (2008), who found evidence of a small positive effect on earnings of starting school younger, which had disappeared by around age 30.

Crawford et al. (2013a) find little evidence of a systematic relationship between birth date relative to academic year cut-off and gross hourly wages when using Understanding Society rather than Labour Force Survey data, nor for weekly earnings, thus highlighting that age within academic cohort does not appear to affect hours of work either. Moreover, this relationship also holds if we assign zero wages to those who are not in work, confirming that these results are not

[63] This assumes that the effects seen for older birth cohorts at older ages would be similar to those found for more recent cohorts at older ages.

being driven by small differences between the proportions of individuals born in different months who are in work (as we saw above).

Finally, Crawford et al. (2013a) find no evidence of significant differences between individuals born at the start and end of the academic year in terms of occupation, household income, various measures of intergenerational mobility, self-reported health status or mental well-being using data from Understanding Society.

This section has highlighted an important message arising from our research: while we find substantial differences between children born in different months in terms of educational attainment, attitudes and behaviours observed during childhood, and further and higher education decisions and outcomes, we find very little evidence that any of these differences persist into adulthood. Thus, while there are some small differences in labour market outcomes that go in the expected direction, only one of these (the likelihood of being unemployed) is statistically significantly different from zero, and even then the effect is small: less than 0.5 percentage points.

It is not completely clear why the sizeable differences in educational attainment that we observe between those born at the start and end of the academic year do not persist into the labour market. It is possible that if we had population data – such as those available to Fredriksson and Ockert (2005) and Black, Devereux and Salvanes (2008) – then we might find evidence of significant differences: the point estimates found above certainly all point in the 'expected' direction, with those born in August less likely to be in work, more likely to be unemployed and likely to earn less than those born in September. However, if we believe that what employers really care about is productivity and that they will reward productivity equally as they learn more about their workers, irrespective of their educational attainment, then this lack of significant differences, especially amongst older workers, may not be particularly surprising.

3.5 Summary

This chapter has shown that there are significant differences between those born at the start and end of the academic year in terms of educational attainment, attitudes and behaviours during childhood, and further and higher education participation and attainment.

In particular, relative to those born at the start of the academic year, those born at the end of the academic year are:

- 5.4 percentage points more likely to be labelled as having mild special educational needs at age 11;
- 6.4 percentage points less likely to achieve five GCSEs or equivalents at grades A*–C;

- around 2 percentage points less likely to go to university at age 18 or 19, and around 2.3 percentage points less likely to attend a Russell Group institution if they do;
- around 1 percentage point less likely to graduate with a degree.

These differences are all significantly different from zero at conventional levels.

When outcomes are measured *on the same date during childhood*, those born at the end of the academic year are also:

- likely to exhibit significantly poorer socio-emotional development;
- likely to have significantly lower confidence in their own ability;
- significantly less likely to believe that their own actions make a difference.

However, in spite of the large and significant differences that we observe between those born at the start and end of the academic year across a range of outcomes during childhood, we find little evidence of any significant detrimental effects that persist into adulthood.

In particular, individuals born at the end of the academic year:

- are no more or less likely to be in work than those born at the start of the academic year (although they are slightly more likely to be unemployed);
- do not earn more or less per hour than those born at the start of the academic year;
- are (subjectively) no healthier or happier during adulthood than those born at the start of the academic year.

Chapter 4 explores in detail what might be driving the significant differences in educational attainment and non-cognitive skills that we observe during childhood, and Chapter 5 discusses what the results presented in this chapter and the next might mean in terms of potential policy implications.

4. Drivers of Month-of-Birth Differences in Outcomes

This chapter investigates the drivers of the differences in educational attainment and non-cognitive skills between children born at the start and end of the academic year. It starts by summarising how this has been done in other papers in the literature (Section 4.1), before discussing the drivers of differences in educational attainment (Section 4.2) and the drivers of differences in selected skills and behaviours (Section 4.3). Section 4.4 summarises the chapter.

4.1 Previous research

As set out in the introduction, there are four reasons why we might expect the outcomes of individuals born at the start and end of the academic year to differ:[64]

- they are different ages when the outcome is observed (age-at-test effect);
- they start school at different ages (age-of-starting-school effect);
- the amount of schooling they receive prior to assessment differs (length-of-schooling effect);
- their age relative to others in their class or year group differs (relative-age effect).

However, it is very challenging to identify which of these effects drives the differences in outcomes that we observe, because there is an exact linear relationship between age of starting school, age at test and length of schooling up to the time the test is taken (as all children start school and sit tests at the same time). This means that it is not possible to estimate the effect of each factor using standard regression techniques, unless functional form restrictions are imposed (for example, by assuming that the impact of one effect is linear).[65] Moreover, relative age is also highly correlated with absolute age.

Some studies have overcome this difficulty by focusing on outcomes measured at around the same age for individuals beyond the end of compulsory schooling, which breaks the perfect correlation between age at test and age at school entry. For example, Black, Devereux and Salvanes (2008) identify the impact of school starting age on IQ scores taken as part of men's enrolment to military service at around age 18 (as well as the likelihood of teenage pregnancy and earnings)

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[64] We do not view season of birth as a viable explanatory factor, as differences between those born at the start and end of the academic year exist even when the timing of the academic year differs (for example, see HEFCE (2005) for university results for people in England and Scotland).

[65] If all factors were measured in months and we assumed that age at test was linear, for example, then this would involve including a series of binary indicators for age of starting school (in months) and length of schooling prior to the test (in months), but controlling linearly for age at test, i.e. including a single variable taking values 1 to 12 (where 1 applies to those born at the end of the academic year – August in England – and 12 applies to those born at the start of the academic year – September in England).

using Norwegian administrative data. They find that starting school younger has a small positive effect on IQ scores, as well as on the probability of teenage pregnancy. By contrast, they find a large and significant positive effect on IQ scores arising from sitting the test at an older age.

Other studies have attempted to separate these effects during compulsory education. For example, Datar (2006) relies on a functional form assumption to separate the age-of-starting-school and the age-at-test (absolute-age) effect, by assuming that the age-at-test effect is linear, i.e. that the difference in test scores between children who are six months apart in age is the same regardless of how old those children are. Under this (strong) assumption, and using the difference in pupils' test scores over time as the dependent variable, the effect of absolute age on test scores is differenced out, leaving only the age-of-starting-school effect.

Using data from the Early Childhood Longitudinal Study in the US, Datar (2006) finds that the test scores of older entrants increase by 0.12 standard deviations more than those of the youngest entrants over a two-year period, implying that it is better for children to start kindergarten when they are older. There is no length-of-schooling effect (as all children enter kindergarten at the same time), but it is unclear whether or how the relative-age effect features in the analysis.

Fogelman and Gorbach (1978) use data on a cohort of children born in a particular week in March 1958 in Great Britain (from the National Child Development Study), which effectively enables them to eliminate the absolute- and relative-age effects. Furthermore, regional variation in school admissions policies creates variation in length of schooling, but also age of starting school, of around six months. The authors find that starting school at an older age and hence having fewer terms of schooling prior to the test reduces test outcomes at age 11 by between 2.3 and 2.6 months. While they report this finding as a length-of-schooling effect, their identification strategy is actually estimating a combined effect of this and an age-of-starting-school effect.

Fredriksson and Ockert (2005) use within-school variation in relative age (arising from variation in the age composition of particular cohorts) to separate the impact of relative age from the combined effects of age at test and age of starting school. They find that increasing school starting age (and age at test) by one year increases grade point average at age 16 by 0.2 standard deviations, but that relative age accounts for only 6 per cent of the difference in test scores at that age.

Smith (2010) positions himself as building on Crawford, Dearden and Meghir (2007) – who used regional variation in school admissions policies in England to identify separately the age-at-test effect, the relative-age effect and a combined age-of-starting-school and length-of-schooling effect. He uses variation in school admissions policies in British Columbia to estimate an upper bound on the age-at-test effect and a lower bound on the age-of-starting-school effect (neither of which can be separated from the length-of-schooling effect). Using administrative data on grade repetition at grade 3 (age 8/9) and literacy and numeracy scores at grade 10 (age 15/16), he finds – in line with Crawford et al. (2007) – relatively large age-at-test effects and relatively small age-of-starting-school effects.

For example, Smith (2010) finds that a one-year increase in age at test is associated with a 5.8 percentage point reduction in the likelihood of repeating grade 3, compared with just a 0.6 percentage point reduction associated with a one-year increase in age at entry. Similarly, he finds a reduction of around 10 per cent of a standard deviation in literacy and numeracy test scores at age 15/16 as a result of a one-year reduction in age at test, compared with less than 5 per cent of a standard deviation associated with the same change in age of starting school.

As is clear from this brief summary, to our knowledge none of the papers available in the literature to date has been able to identify separately the effects of all four potential drivers described above. Our work aims to shed new light on this important issue. We discuss below some of the ways in which we have tried to isolate particular effects (or combinations of effects) under certain assumptions (described in more detail in Crawford, Dearden and Meghir (2007 and 2010) and Crawford, Dearden and Greaves (2013b)). We also discuss a more structured way of separately identifying all four effects, applied for one of the first times in economics and for the first time in this context in Crawford, Dearden and Greaves (2013c).

4.2 Educational attainment and cognitive test scores

The importance of the age-at-test effect

Some of the analysis presented in Chapter 3 made use of information from surveys following particular cohorts of children in the UK over time, such as the Millennium Cohort Study. The MCS was designed to interview/test children as close as possible to a particular age rather than at a particular point in time (as is the case for the national achievement tests). In the limit, if all children were tested on their birthday, then the age-at-test effect would effectively be zero, meaning that any remaining difference in outcomes between children born at the start and end of the academic year would have to be explained by differences in age of starting school, length of schooling and/or relative age.

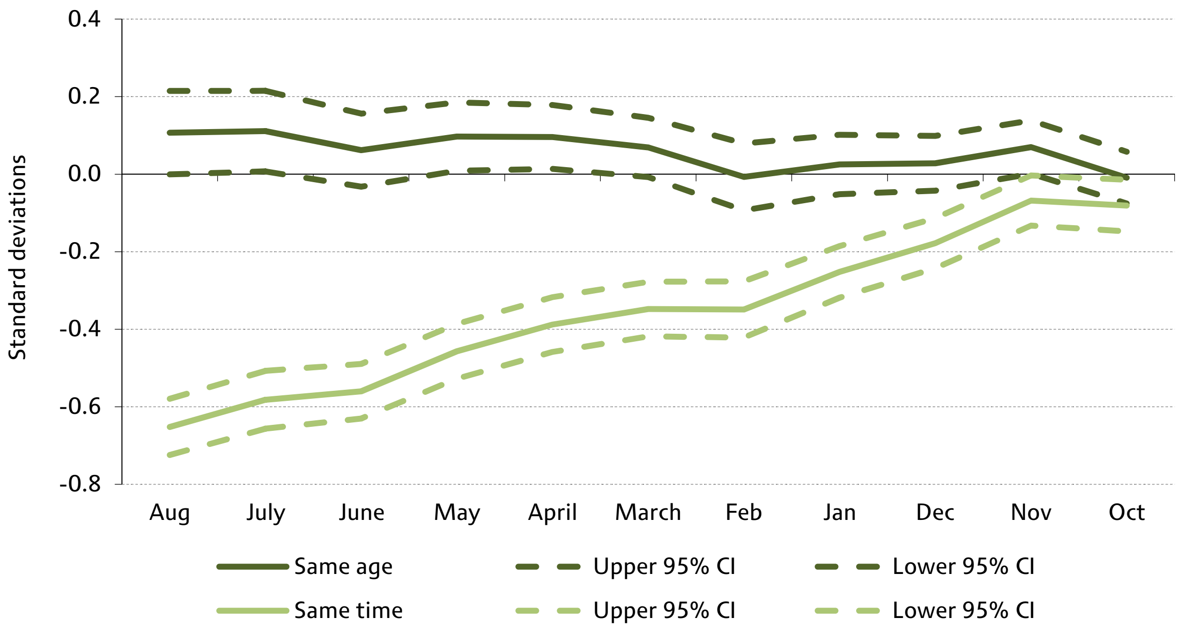
Figure 4.1 plots the average difference in British Ability Scale vocabulary test scores amongst children born in England in different months compared with September (the start of the academic year) when outcomes are measured at around the same age (age 5) (dark green line).[66] These estimates are all small and almost none are significantly different from zero, therefore providing the first piece of suggestive evidence that age at test (or absolute age) is a key driver of

[66] We achieve this by controlling linearly for age at interview in addition to month of birth in our model. Appendix C provides some evidence to support this approach as it shows that there is a reasonable amount of variation in age at interview, conditional on month of birth. It also shows that these results are similar if we use BAS tests from around age 7 rather than age 5.

the month-of-birth differences that we saw in Chapter 3: when children are tested around their own birthday, these differences largely disappear.

Of course, to be able to identify the magnitude of the age-at-test effect, one must compare the differences observed when the age-at-test effect is effectively zero with those observed when it is not (for example, when tests are taken at the same point in time rather than at the same age). Figure 4.1 allows us to do this by plotting the difference in BAS tests between children born in different months of the year relative to September after controlling for date (rather than age) of interview in our model (lighter green line). This effectively mimics the scenario in which tests are taken at the same point in time rather than at the same age.[67]

Figure 4.1. Difference in BAS vocabulary test at age 5, when measured at the same age or same point in time



Note: The darker green lines represent the differences in BAS test scores, on average, between those born in September and those born in other months of the year when tests are taken at around the same age. The lighter green lines represent the differences controlling for date of interview, thus mimicking the results of a test taken at the same point in time (such as Key Stage assessments in schools). Both sets of estimates also account for a variety of individual and family background characteristics. The dashed lines in each case represent the 95 per cent confidence interval around these estimates.
Source: Millennium Cohort Study.

Subtracting the difference in test scores when children are assessed at the same age from the difference in test scores when children are assessed at the same time identifies a *lower bound* of the age-at-test effect under the assumption that the length-of-schooling effect is positive (and that the four effects identified in Section 4.1 are separable). This is because when comparing tests taken by those born in August and September *at the same age*:

[67] Again, Appendix C provides some evidence to support this approach as it shows that there is a high degree of overlap in month of interview, conditional on month of birth.

1. there is no age-at-test effect because all children are assessed at the same age;
2. those born in September start school older than those born in August;
3. those born in September would have *fewer* terms of schooling prior to being tested than those born in August (because they start school older);[68]
4. those born in September would be amongst the oldest in their class/year, while those born in August would be amongst the youngest.

On the other hand, when comparing tests taken by those born in August and September *at the same time*:

1. those born in September are older when they sit the test;
2. those born in September start school older than those born in August;
3. those born in September would have *the same amount or more* schooling prior to being tested than those born in August (because August-borns start school either at the same time as September-borns or slightly later, depending on the admissions policy in place in their school/area);
4. those born in September would be amongst the oldest in their class/year, while those born in August would be amongst the youngest.

Effects 2 and 4 are the same in both cases; thus, subtracting one from the other will eliminate these two effects. However, the length-of-schooling effect does not cancel out, because when tests are taken at the same time, those born in September have the same amount of schooling as those born in August (or more), while when tests are taken at the same age, those born in September are likely to have fewer terms of schooling than those born in August.

This means that if we subtract the difference in test scores between children born at the start and end of the academic year when tests are taken at the same age from the difference when tests are taken at the same point in time, then we get the age-at-test effect plus the difference between a negative (and likely larger) length-of-schooling effect and a positive (and likely smaller) length-of-schooling effect, i.e. a zero or (more likely) negative length-of-schooling effect. This means that, assuming more time in school has a positive effect on test scores, the difference between the two will provide a lower bound on the age-at-test effect.

Comparing the difference in test scores between those born in August and September when tests are taken at the same point in time (lighter green line) versus at the same age (darker green line) shows that the age-at-test effect explains the vast majority of the difference in test scores that we observe in Figure 3.3 and thus that it seems to be the key driver of the month-of-birth

[68] It would be possible for August- and September-born children to have the same amount of schooling prior to a given birthday in the unlikely event that those born in August start school a whole year later than those born in September. (We say 'unlikely' because this would only be possible if August-borns started school at the statutory age (i.e. the term after they turn 5), while September-borns started in the term in which they turn 4, which is earlier than under most admissions policies currently in operation in England.)

differences that we observe.[69] This suggests that the reason why those born at the end of the academic year tend to perform worse in national achievement tests (which are all taken on the same date) than those born at the start of the academic year is simply that they are younger when they sit the test. In a sense, this is 'good news': it means that enabling children to sit exams at similar ages (or age-adjusting scores when tests are taken on the same date) might in a sense 'solve' this problem (or at least help to ensure that pupils are judged fairly) when it comes to performance in national achievement tests.

The following subsection provides further insights into the potential drivers of month-of-birth differences in educational attainment by considering whether the importance of the age-at-test effect is confirmed when using an alternative identification strategy. It also provides new insights into the magnitude of the remaining potential drivers: age of starting school, length of schooling and relative age.

Separately identifying all four effects

As described above, the fundamental problem that we are trying to overcome is the fact that there is an exact linear relationship between age of starting school, age at test and length of schooling when children born on a particular day start school and sit the tests at the same time (as is the case in most countries). In addition, relative age is highly correlated with absolute age, making these two effects very difficult to distinguish as well.

The problem is analogous to the so-called 'age–period–cohort' (APC) problem in which researchers attempt to estimate the separate effects of age at interview, time period and cohort on a particular outcome of interest. There is also an exact linear relationship between these three factors:

$$\textit{Age at interview} = \textit{Birth date} + \textit{Time}.$$

As described in Section 4.1, one way to solve this problem is to impose a functional form restriction on one of the factors of interest: for example, Datar (2006) assumed that the age-at-test effect was linear in order to identify the age-of-starting-school effect. An alternative approach has recently been applied to the APC problem for the first time in economics to our knowledge by Browning, Crawford and Knoef (2012), who apply the method to the analysis of mortality data for females in the US and labour force participation by women in the UK. Crawford, Dearden and Greaves (2013c) adopt a similar approach for the first time in the present context, enabling separate identification of the age-at-test,

[69] Crawford, Dearden and Greaves (2013b) adopt an alternative strategy to identify the same combined age-at-test and length-of-schooling effect and find similar results. There we make comparisons across, rather than within, cohorts using a regression discontinuity design applied to the Avon Longitudinal Study of Parents and Children – which covers children born across three academic cohorts – and rely on the comparability of tests taken at the same point in time (Key Stage tests) and those taken at the same age (other cognitive tests included as part of the survey).

age-of-starting-school and length-of-schooling effects (and the relative-age effect via other identification strategies) for the first time to our knowledge.

The intuition behind the approach is simple: unless there is a reason for believing otherwise, each of our linearly dependent variables (age at test, age of starting school and length of schooling) is assumed to have the same impact on the dependent variable (in this case, test scores). Only if we observe (for example) that children who are older when they sit the test have higher test scores, all other things being equal, would the effect of age at test be increased relative to the effect of the other potential drivers. Some further intuition is given in Appendix D and Crawford, Dearden and Greaves (2013c), and a more technical discussion is available in Browning, Crawford and Knoef (2012).

For this method to provide us with any insight into the relative importance of age at test, age of starting school and length of schooling in driving the month-of-birth differences in test scores that we observe, there must be some variation in these factors across pupils: if all pupils were born on the same day, started school on the same day and sat the test on the same day, then these factors would not help us to understand why there is variation in test scores across pupils; hence, this method would assume that the relative contributions of age at test, age of starting school and length of schooling are equal.

Having sufficient variation in these three linearly dependent factors of interest is therefore vital for identification of the model, as is having less than perfect correlation between these three factors and the fourth factor of interest, relative age. Some examples of the sources of variation that we use are as follows:

1. Children born on different days start school on the same date (at different ages) and receive the same amount of schooling prior to tests that are taken on the same date. This arises naturally as a result of a school admissions policy in which, for example, all children start school in the September after they turn 4.

2. Children born on the same day start school on different dates (at different ages), and hence receive different amounts of schooling prior to tests that are taken on the same date, as a result of regional variation in school admissions policies. For example, a child born on 31 August will start school on or shortly after 1 September in an area with a single entry point, whereas they will start school on or shortly after 1 January or 1 April in other areas.

3. Children born on the same day who start school on the same date (at the same age) and receive the same amount of schooling prior to tests that are taken on the same date happen to start school in an area in which they are relatively younger or older within their year group, thus inducing variation in relative age conditional on these other factors. In the limit, a child born on 1 January would be the oldest in their year group in the unlikely event that no children born between September and December attend their school, while they would be the youngest in their year group in the even more unlikely

event that no children born between 2 January and 31 August attend their school.

4. Children born on the same day start school on the same date (at the same age) but are tested on different dates and hence receive different amounts of schooling prior to the test of interest. This can arise in survey data when tests are carried out as part of an interview that occurs at some point during a particular period rather than on a given date – for example, in the case of the British Ability Scale tests that were carried out as part of the Millennium Cohort Study.

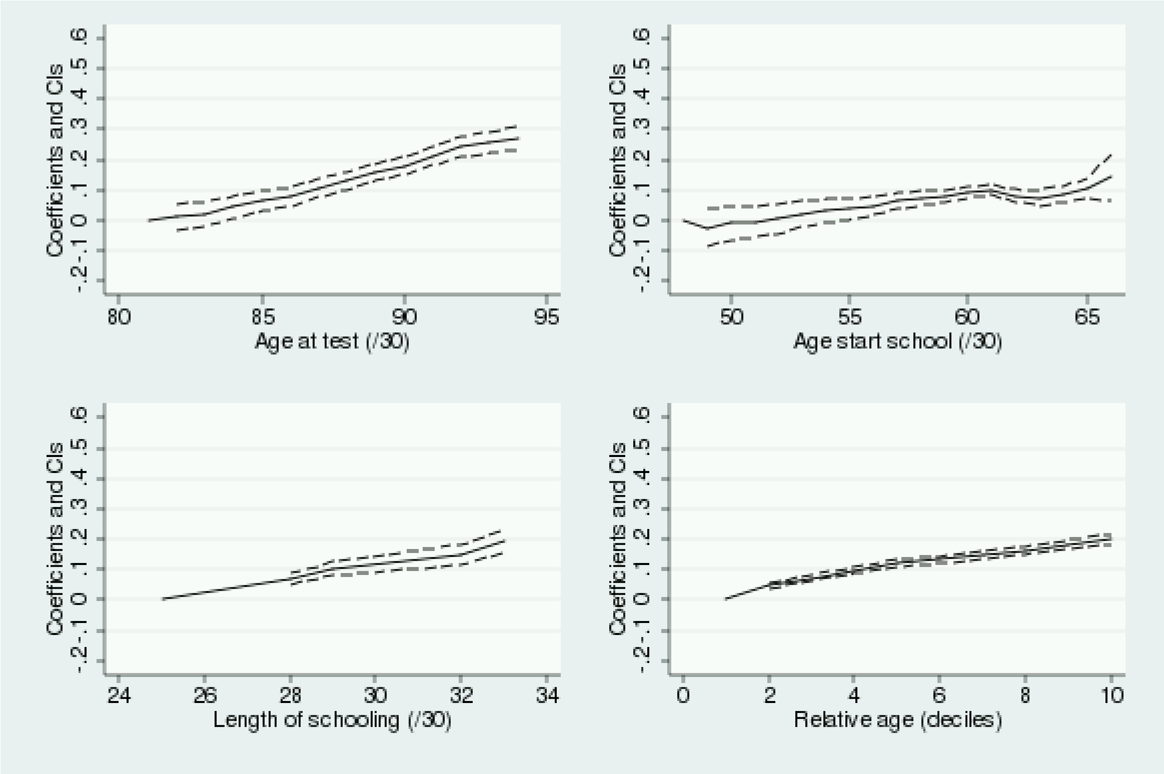
The first three sources of variation are exactly the same as the sources used in Crawford, Dearden and Meghir (2007 and 2010) to try to identify the relative contributions of these four effects (age at test, age of starting school, length of schooling and relative age) using parametric and non-parametric methods respectively. They are also the key sources that are relevant in Crawford, Dearden and Greaves (2013c) when using administrative data from the National Pupil Database. All four sources of variation are relevant when Crawford et al. (2013c) apply the same approach to the Millennium Cohort Study.

The appendix to Crawford et al. (2013c) highlights the relative merits of these two different sources of data by showing the correlations between the four factors of interest in the NPD and MCS samples that we use for our analysis. The advantage of the NPD data (and in particular the cohorts that we use) is that they cover a large number of older pupils for whom there is more regional variation in school admissions policies (and hence greater variation in the age of starting school and length of schooling across pupils born on the same date); the disadvantage is that absolute and relative age are very highly correlated, as pupils are assessed at the same point in time. On the other hand, the MCS data cover a much smaller number of pupils, but have the advantage that pupils are interviewed and hence assessed at different points in time via the BAS tests, thus reducing the correlation between relative age and age at test. As we shall see, these two data sources provide us with important complementary information on the key drivers of the differences in test scores that we observe.

The results of this approach when applied to standardised Key Stage 1 test scores for our NPD sample (those born between September 1996 and August 1999) are illustrated graphically in Figure 4.2. It shows that all four factors have a positive impact on Key Stage 1 attainment: test scores are higher, on average, for pupils who are tested at an older age, have more terms of schooling prior to the test, start school at an older age and are relatively older in their academic cohort.

Consistent with the findings discussed above (and in Crawford, Dearden and Meghir (2007 and 2010)), age at test has the strongest influence on test scores amongst the four factors of interest: the difference between being the oldest and youngest in a particular academic cohort on the date of the test is around 0.3 standard deviations, compared with a difference of around 0.2 standard deviations between being the relatively oldest and youngest in the cohort, and receiving the most and least amount of schooling prior to the tests. Age of starting school appears to have the smallest impact on attainment at Key Stage 1.

Figure 4.2. Impact of age at test, age of starting school, length of schooling and relative age on standardised test scores at age 7 for the NPD sample



Note: Based on cohorts of pupils born between September 1996 and August 1999 (who sat Key Stage 1 in 2003–04, 2004–05 or 2005–06). Cohort dummies and a range of other individual characteristics are included in the model. Those starting school outside standard dates are excluded from the sample. The label '(/30)' represents that each of the three linearly dependent factors has been rounded to be in terms of months rather than days.

Amongst the admissions policies currently in operation in England, there is a trade-off between starting school older and the number of terms of schooling received prior to assessment (because children born on a particular date who start school older do so because they join a term or more later and hence receive less schooling prior to the test): based on the findings in Figure 4.2, on balance, within the confines of the current system, it is better for a child to start school younger and receive more schooling, as the length-of-schooling effect is larger than the age-of-starting-school effect.[70] This was the same conclusion reached by Crawford, Dearden and Meghir (2007 and 2010), who estimated that the combined effect of age of starting school and length of schooling was positive (i.e.

[70] Of course, this does not say anything about whether it would be better for all children to start school a whole year older, for example in the September after they turn 5 rather than 4. Unfortunately, there is not sufficient variation in our data for us to be able to draw robust conclusions about this important question.

that the positive effect of having more terms of schooling prior to the tests outweighed the potentially negative effect of starting school younger).

Table 4.1 uses these estimates of the impact of age at test, age of starting school, length of schooling and relative age on standardised Key Stage 1 scores from the NPD to predict the overall difference in test scores between those born in September and those born in all other months of the year, which it does quite successfully (compare the 'OLS' and 'Total implied by APC model' columns). More importantly, it also shows the proportion of this total gap that is accounted for by each of these factors of interest.

Table 4.1. Contribution of each factor to the overall difference in Key Stage 1 standardised scores for the NPD sample, by month of birth

Month of birth	(1) OLS (relative to Sept)	(2) Total implied by APC model (relative to Sept)	(3) Percentage accounted for by age at test	(4) Percentage accounted for by age of starting school	(5) Percentage accounted for by length of schooling	(6) Percentage accounted for by relative age
Aug	–0.583	–0.600	44.8	11.2	12.2	31.8
July	–0.534	–0.542	45.4	12.4	13.5	28.8
June	–0.477	–0.480	43.8	12.3	15.2	28.8
May	–0.423	–0.409	44.5	10.0	17.9	27.6
April	–0.368	–0.400	44.5	9.0	18.3	28.3
Mar	–0.313	–0.271	54.6	12.6	0.0	32.8
Feb	–0.259	–0.241	56.0	14.1	0.0	29.9
Jan	–0.210	–0.191	59.2	14.1	0.0	26.7
Dec	–0.149	–0.145	72.4	7.6	0.0	20.0
Nov	–0.092	–0.103	64.1	7.8	0.0	28.2
Oct	–0.041	–0.047	57.5	19.2	0.0	23.4
Sept	Reference	Reference	N/A	N/A	N/A	N/A

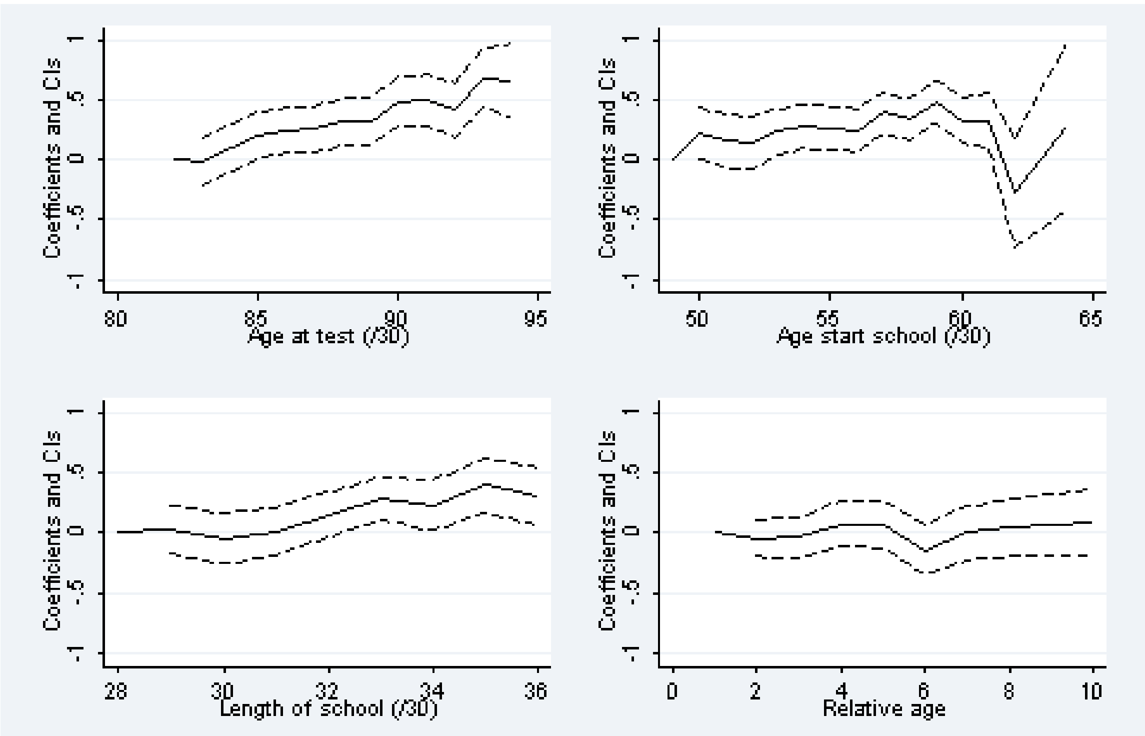
Note: Based on cohorts of pupils born between September 1996 and August 1999 (who sat Key Stage 1 in 2003–04, 2004–05 or 2005–06). Those starting school outside standard dates are excluded from the sample. Column 1 reports the relevant coefficient from a linear regression where the dependent variable is standardised Key Stage 1 scores and the independent variables are binary indicators for month of birth and a set of background characteristics. Column 2 reports the calculated difference based on the median characteristics of those born in each month and the estimates from the APC model. The remaining columns report the calculated contribution of each factor to the median (representative) pupil born in each month. Note that the contribution of length of schooling is zero for those born between October and March, as the median pupil in each of these months starts school at the same time as the median pupil born in September.

Consistent with Figure 4.2 and the discussion above, Table 4.1 shows that age at test is the biggest contributor to the difference, on average, between the test scores of those born at the start and end of the academic year. For example, the difference in age at test between those born in August and in September accounts for 45 per cent of the total difference in Key Stage 1 scores, while the difference in age of starting school accounts for 11 per cent, the difference in length of schooling accounts for 12 per cent and the difference in relative age accounts for 32 per cent. This pattern is similar for other months of the year: in all cases, age at test is the largest contributing factor, followed by relative age.

Our key concern with applying the APC model to NPD data, however, is that there remains a high degree of correlation between age at test and relative age. This is important because if the model cannot distinguish between the two, then it will tend to equalise the values associated with these two drivers; hence, it might mistakenly attribute too much weight to one factor and too little weight to the other, simply because there is insufficient variation in the data to do otherwise. To overcome this concern (at least to some extent), we next present results from the MCS, where the correlation between age at test and relative age is reduced.

Figure 4.3 and Table 4.2 present the results based on the MCS sample. Here, we pool standardised Key Stage 1 and BAS test scores in reading and maths in order to maximise the sources of variation available (and hence implicitly assume that the tests are sufficiently similar that the effects of each driver are the same on both tests). Crawford, Dearden and Greaves (2013c) discuss in detail why we believe this to be a reasonable assumption, but it is worth noting that our results are broadly similar if we focus on BAS test scores only (see Crawford et al. (2013c) for details).

Figure 4.3. Impact of age at test, age of starting school, length of schooling and relative age on standardised test scores at age 7 for the MCS sample



Note: Based on cohorts of pupils born between September 2000 and August 2001 (who sat Key Stage 1 and BAS assessments in 2007–08). A range of other individual characteristics are included in the model. Those starting school outside standard dates are excluded from the sample. The label '(/30)' represents that each of the three linearly dependent factors has been rounded to be in terms of months rather than days. Relative age is shown in deciles.

Table 4.2. Contribution of each factor to the overall difference in Key Stage 1 and BAS standardised scores for the MCS sample, by month of birth

Month of birth	(1) OLS (relative to Sept)	(2) Total implied by APC model (relative to Sept)	(3) Percentage accounted for by age at test	(4) Percentage accounted for by age of starting school	(5) Percentage accounted for by length of schooling	(6) Percentage accounted for by relative age
Aug	–0.835	–0.881	77.6	12.5	0.0	9.9
July	–0.791	–1.011	69.6	17.4	0.0	13.0
June	–0.730	–0.895	64.8	21.2	0.0	14.0
May	–0.557	–0.700	68.1	14.0	0.0	17.9
April	–0.385	–0.493	87.8	10.3	0.0	1.8
Mar	–0.391	–0.502	84.7	13.0	0.0	2.4
Feb	–0.585	–0.658	55.3	9.9	0.0	34.8
Jan	–0.457	–0.662	54.8	12.2	19.6	13.3
Dec	–0.192	–0.176	108.5	–34.7	0.0	26.1
Nov	–0.147	–0.220	83.2	–4.1	0.0	20.9
Oct	–0.151	–0.117	223.1	–135.9	0.0	12.8
Sept	Reference	Reference	N/A	N/A	N/A	N/A

Note: Based on cohorts of pupils born between September 2000 and August 2001 (who sat Key Stage 1 and BAS assessments in 2007–08). Those starting school outside standard dates are excluded from the sample. Column 1 reports the relevant coefficient from a linear regression where the dependent variable is standardised Key Stage 1 and BAS scores and the independent variables are binary indicators for month of birth and a set of background characteristics. Column 2 reports the calculated difference based on the median characteristics of those born in each month and the estimates from the APC model. The remaining columns report the calculated contribution of each factor to the median (representative) pupil born in each month. Note that the contribution of length of schooling is zero for those born between October and December and between February and August, as the median pupil in each of these months starts school at the same time as the median pupil born in September. The small estimated differences between those born in September and other autumn months give rise to some unusual proportional contributions: contributions above 100 per cent suggest that these effects are associated with point estimates larger than the overall effects, which are in turn offset by other factors operating in the opposite direction (those with a negative sign in the table).

In terms of the impacts of length of schooling and age of starting school, the results from the MCS sample are, on the whole, broadly similar to those shown in Figure 4.2 and Table 4.1 for the NPD sample at Key Stage 1 (with the exception of the decline in average outcomes for those who start school at the statutory age in the MCS sample, which is not present for the NPD sample[71]).

[71] This is likely to be because it was more common for children to start school at the statutory age in our older NPD sample than in the younger MCS sample; hence, the effects are estimated from a more select group of pupils in the MCS than in the NPD.

There is, however, a key difference in terms of the estimated effects of relative and absolute age: in the MCS sample, the impact of a child's relative age is found to be much smaller than it was in the NPD sample, while the contribution of absolute age (or age at test) is found to be substantially larger. For example, amongst children born in August in the MCS sample, age at test is estimated to explain 78 per cent of the difference in test scores compared with children born in September, while it is only estimated to explain 45 per cent of the difference in the NPD sample. Similarly, relative age is estimated to account for just 10 per cent of the difference in test scores in the MCS sample, compared with 32 per cent in the NPD.

This suggests either that the high correlation between age at test and relative age in the national sample introduced spurious correlation between relative age and children's outcomes, or that relative age matters more for tests taken inside than outside school. Both are plausible explanations, but it is unfortunately not possible to distinguish between them on the basis of the data available. If the true contribution of relative age is minimal, as observed in the MCS sample, then a policy designed to address differences in test scores that result from the age at which children are tested (for example age-adjustment) would be sufficient to ensure that children born later in the academic year are not disadvantaged simply because of when they were born. On the other hand, if relative age does contribute to the differences in assessed performance between those born earlier and later in the academic year (i.e. if the true contributions are as estimated in the NPD sample), then policies that address the age-at-test effect only are likely to be less effective: policymakers would be left with the more challenging problem of how to combat relative-age effects (which is challenging because at least one child must always be the youngest in the class).

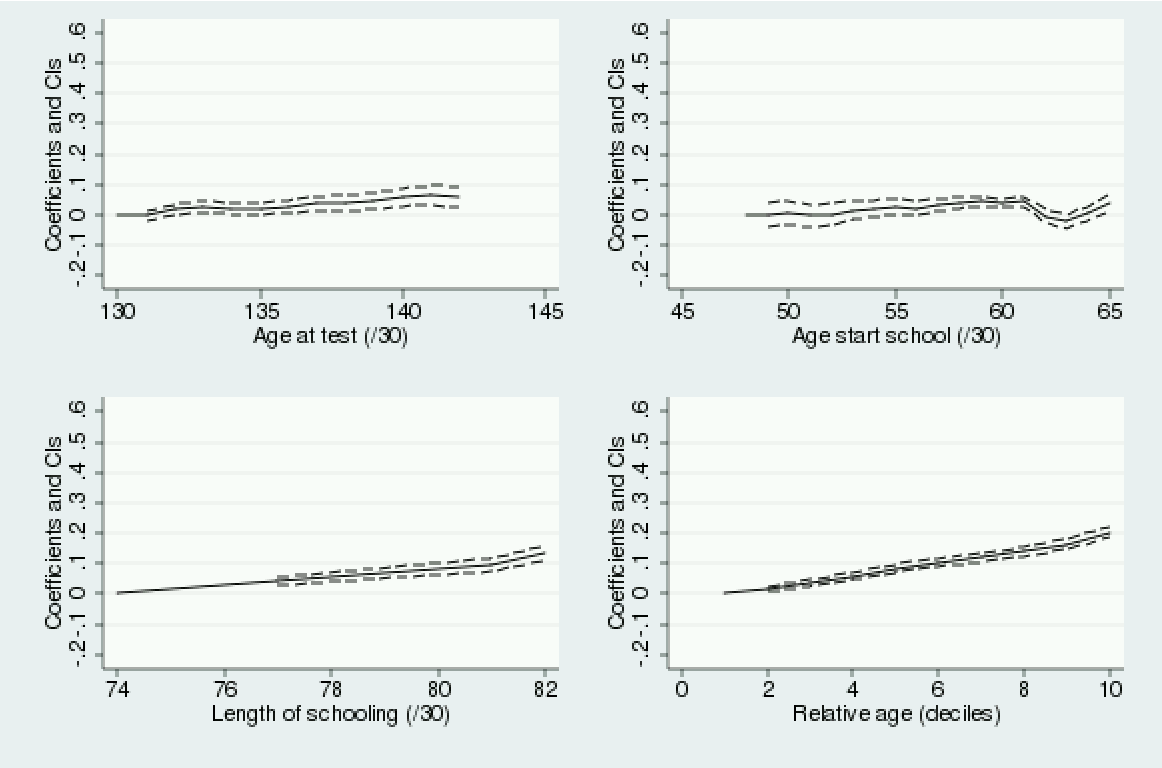
Finally, we repeat this analysis for the NPD sample using standardised Key Stage 2 rather than Key Stage 1 test scores as the outcome. The results are shown in Figure 4.4 and Table 4.3. These findings confirm the results of Crawford, Dearden and Meghir (2007 and 2010) by showing that almost none of the difference in test scores between pupils born at the start and end of the academic year arises as a result of differences in age of starting school or length of schooling. This highlights that changing the age at which pupils can start school is highly unlikely to offer a long-term solution to the differences in test scores between those born at different points of the academic year that we observe in England.

Interestingly, however, the relative contributions of age at test and relative age appear to have been reversed since Key Stage 1, with relative age now accounting for about twice as much of the difference in outcomes as age at test (while the reverse was true at Key Stage 1). For example, about one-third of the difference in test scores between pupils born in August and September can be attributed to age at test at Key Stage 2 (and two-thirds to relative age), while at Key Stage 1 the figures were 45 per cent and 32 per cent respectively.

While it is tempting to draw strong policy conclusions on the basis of these results, we are cautious about doing so, because of the very strong correlation between age at test and relative age in the NPD data (marginally stronger even than at Key Stage 1). This means that the APC model might be incorrectly attributing explanatory power to relative age when it cannot easily separate its effect from that of age at test. Moreover, these results contradict those reported by Crawford, Dearden and Meghir (2007 and 2010), who found that relative age continued to explain only a small proportion of the difference in test scores between children born at the start and end of the academic year.

What might help us to be more confident about the veracity of these results is repeating the analysis using the greater variation available in the MCS sample from the combination of Key Stage 2 and BAS cognitive test scores at age 11, but unfortunately these scores are not yet available for the MCS cohort. Once they are made available, we will rerun this analysis, which should hopefully provide clearer insight into the extent to which this apparent increasing importance of relative age is 'real' or spurious.

Figure 4.4. Impact of age at test, age of starting school, length of schooling and relative age on standardised test scores at age 11 for the NPD sample



Note: Based on cohorts of pupils born between September 1996 and August 1999 (who sat Key Stage 2 in 2007–08, 2008–09 or 2009–10). Cohort dummies and a range of other individual characteristics are included in the model. Those starting school outside standard dates are excluded from the sample. The label '(/30)' represents that each of the three linearly dependent factors has been rounded to be in terms of months rather than days.

Table 4.3. Contribution of each factor to the overall difference in Key Stage 2 standardised test scores for the NPD sample, by month of birth

Month of birth	(1) OLS (relative to Sept)	(2) Total implied by APC model (relative to Sept)	(3) Percentage accounted for by age at test	(4) Percentage accounted for by age of starting school	(5) Percentage accounted for by length of schooling	(6) Percentage accounted for by relative age
Aug	–0.319	–0.285	37.2	–3.5	0.0	66.3
July	–0.292	–0.259	27.4	1.9	0.0	70.7
June	–0.261	–0.222	21.6	1.4	0.0	77.0
May	–0.240	–0.189	25.9	–5.8	0.0	79.9
April	–0.206	–0.192	30.2	–8.9	0.0	78.7
Mar	–0.181	–0.157	33.8	–12.1	0.0	78.3
Feb	–0.151	–0.139	33.8	–5.8	0.0	71.9
Jan	–0.124	–0.116	44.8	–12.9	0.0	68.1
Dec	–0.092	–0.085	54.1	–18.8	0.0	64.7
Nov	–0.055	–0.068	36.8	–17.7	0.0	80.9
Oct	–0.027	–0.037	8.1	2.7	0.0	89.2
Sept	Reference	Reference	N/A	N/A	N/A	N/A

Note: Based on cohorts of pupils born between September 1996 and August 1999 (who sat Key Stage 2 in 2007–08, 2008–09 or 2009–10). Those starting school outside standard dates are excluded from the sample. Column 1 reports the relevant coefficient from a linear regression where the dependent variable is standardised Key Stage 2 scores and the independent variables are binary indicators for month of birth and a set of background characteristics. Column 2 reports the calculated difference based on the median characteristics of those born in each month and the estimates from the APC model. The remaining columns report the calculated contribution of each factor to the median (representative) pupil born in each month. Note that the contribution of length of schooling is zero for those born between October and August, as the median pupil in each of these months starts school at the same time as the median pupil born in September. Negative contributions should be interpreted as factors that serve to increase (rather than reduce) the gap in test scores between children born in particular months relative to September.

Summary

This section has shown that age at test appears to be the key driver of the differences in test scores that we observe between pupils born at the start and end of the academic year, while age of starting school and length of schooling appear to explain almost none of the gap. There is a mixed picture in terms of the likely contribution of relative age, with some methods pointing towards a negligible effect, but others pointing to a more sizeable effect that is increasing over time. The policy implications of these results will be discussed in more detail in Chapter 5 of this report, but if we accept the conclusion that age at test is the key driving force of the differences in test scores that we observe, then this lends itself to a policy of 'testing when ready' or age-normalisation of test scores.

What is less clear, however, is whether such a policy response would address some or all of the differences in attitudes and behaviours that we saw in Chapter 3. The next section moves on to investigate this issue in more detail, in order to provide additional insight into the extent to which a policy designed to counteract differences in age at tests taken in school will also help to overcome differences in wider skills and behaviours.

4.3 Childhood attitudes and behaviours

The previous section showed that the age at which a child sits the test has the largest impact on the difference in educational attainment of pupils born in different months. As such, a policy that allows for age-normalisation of test scores or 'testing when ready' would seem to be the most appropriate policy response and is likely to help overcome the month-of-birth differences in test scores that arise because those born at the end of the academic year sit the tests at a younger age.

What is less clear, however, is what effect such policies would have on children's wider development – for example, in terms of their socio-emotional development or self-esteem, or engagement in a range of risky behaviours. On the plus side, they would reduce the gap in reported test scores (although not absolute attainment) between children born in different months; hence, receiving feedback about their performance relative to others on the basis of these scores may reduce feelings of being 'left behind' and so increase the self-esteem and improve the behaviour of relatively younger pupils. However, the extent to which such feelings are driven entirely by test scores or from wider classroom and peer group experiences is unclear: to what extent would appropriately-adjusted information offset the negative feelings and behaviours of those who are the youngest in their class?

Section 3.2 provided some initial insight into this important issue, showing that the ability beliefs of children born towards the end of the academic year are not entirely explained by their prior attainment and thus suggesting that wider experiences may also be important. This section investigates the issue further, providing some additional pieces of evidence that offer greater insight into the extent to which age at test is the key driver of the differences in non-cognitive skills and behaviours that we observe. We do so in three ways:

- First, we follow the approach used in Figure 4.1 to compare month-of-birth differences in BAS test scores in the MCS at the same age versus on the same date – i.e. we run two separate regressions, one controlling for age at interview and the other controlling for date of interview and then compare the two – but this time we apply the method to parent-reported differences in the child's socio-emotional development using the Strengths and Difficulties Questionnaire (SDQ).
- Second, we summarise evidence from Crawford, Dearden and Greaves (2013b) in which we adopt a regression discontinuity design in order to compare the differences in ability beliefs, self-esteem and locus of control when children are interviewed at approximately the same age. This approach is discussed in detail in Crawford et al. (2013b), but essentially it is a cross-

cohort comparison focusing on children born close to the academic year cut-off (in this case, those born in August and September). Here, children are interviewed at almost the same age *and* the same point in time (and the method enables us to account for this marginal difference in age and just identify the effect of the discontinuity, i.e. the effect of being born just before rather than just after the academic year cut-off), so there is no age-at-test effect. This means that any remaining difference in outcomes must be accounted for by some combination of age of starting school, length of schooling and relative age.[72] This analysis therefore provides us with an alternative means of assessing the extent to which ability beliefs, self-esteem and locus of control differ even once we account for the age at which these measures are assessed.

- Third, we compare the difference in outcomes between those born at the start and end of the academic year obtained by making comparisons within versus across cohorts using a data set focusing on engagement in risky behaviours amongst pupils in secondary school, known as the Survey of Smoking, Drinking and Drug Use (SDD).[73] This analysis forms part of the paper by Crawford, Greaves and Parey (2013). Of particular importance for our purposes is the fact that pupils in all year groups were assessed at the same point in time. This means that we can compare the difference in outcomes between August- and September-born children in the same academic year, who will be very different ages when their outcomes are measured (the within-cohort approach) with the difference in outcomes between August- and September-born children in different academic years but who are almost the same age when their outcomes are measured (the between-cohort approach). This will enable us to identify the lower bound on the age-at-test effect, for the same reasons as set out for the MCS example in Section 4.2.

Socio-emotional development in the Millennium Cohort Study

Figures 4.5 and 4.6 plot the average standardised differences in parent-reported SDQ scores for children born in all months relative to September at ages 5 and 7 respectively. They highlight the differences when outcomes are measured at around the same age (dark green line) and those when outcomes are measured at around the same point in time (lighter green line). The picture is much less clear than it was for cognitive test scores (shown in Figure 4.1), not least because the overall differences that we are seeking to explain are so much smaller.

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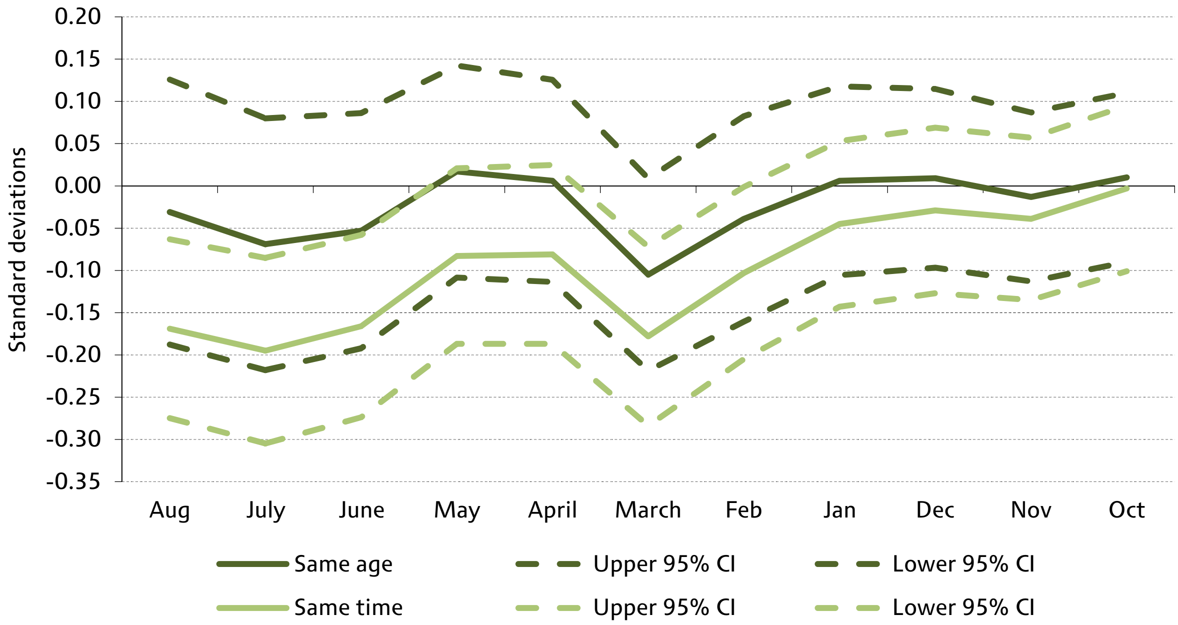
[72] As was the case for the MCS comparisons, those born in September will have started school older than those born in August and will also be amongst the oldest rather than amongst the youngest in their class; however, they will have received *fewer* terms of schooling prior to being interviewed than those born in August.

[73] For more details, see http://discover.ukdataservice.ac.uk/catalogue/?sn=4125&type=Data%20catalogue.

At age 5, the patterns are generally similar to those found for cognitive test scores: the difference in socio-emotional development between those born in September and those born later in the academic year is larger when behaviour is assessed at the same point in time (i.e. when we account for date of interview) than when it is assessed at the same age (i.e. when we account for age at interview). For example, the socio-emotional development of August-born children is assessed to be 17 per cent of a standard deviation lower than that of September-born children when it is assessed at the same point in time, but only 3 per cent of a standard deviation lower (and not significantly different from zero) when it is assessed at the same age.

Figure 4.5. Difference in parent-reported socio-emotional development at age 5, when measured at the same age or same point in time

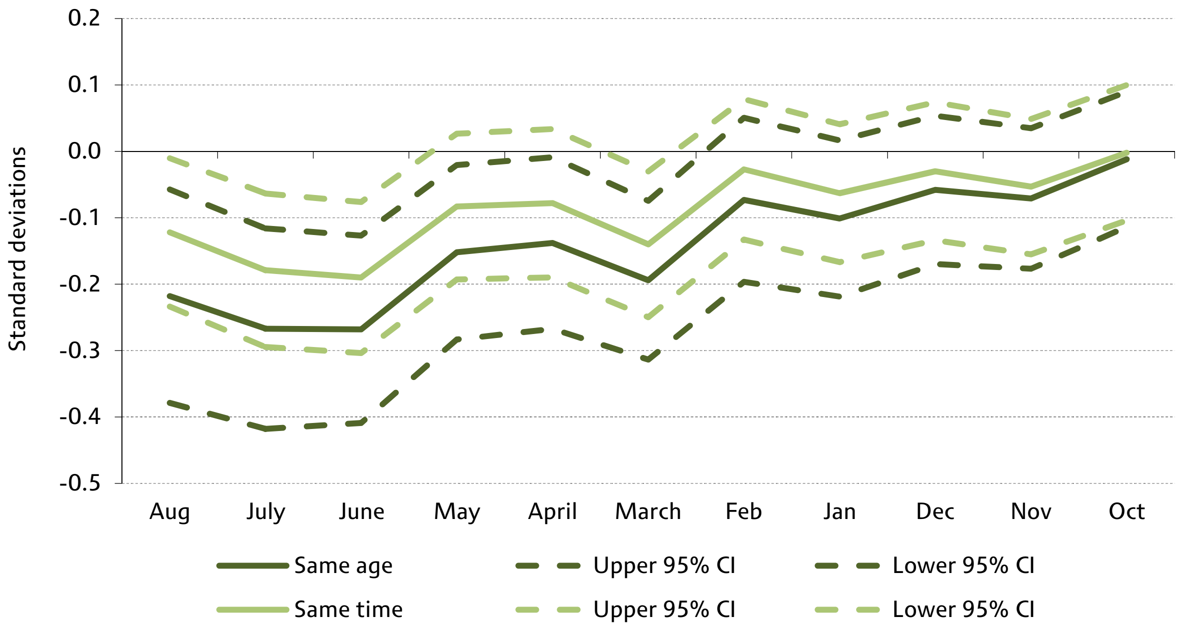


Note: The darker green lines represent the differences in socio-emotional development scores, on average, between those born in September and those born in other months of the year when tests are taken at around the same age. The lighter green lines represent the differences controlling for date of interview, thus mimicking the results of a test taken at the same point in time (such as Key Stage assessments in schools). Both sets of estimates account for a variety of individual and family background characteristics. The dashed lines in each case represent the 95 per cent confidence interval around these estimates.
Source: Millennium Cohort Study.

On the basis of this information alone, we might be tempted to conclude that, in line with the findings for cognitive test scores, the age at which outcomes are measured seems to be the key driver of differences in socio-emotional development between children born at different times of the academic year. There is, however, some suggestion that this may not hold at later ages.

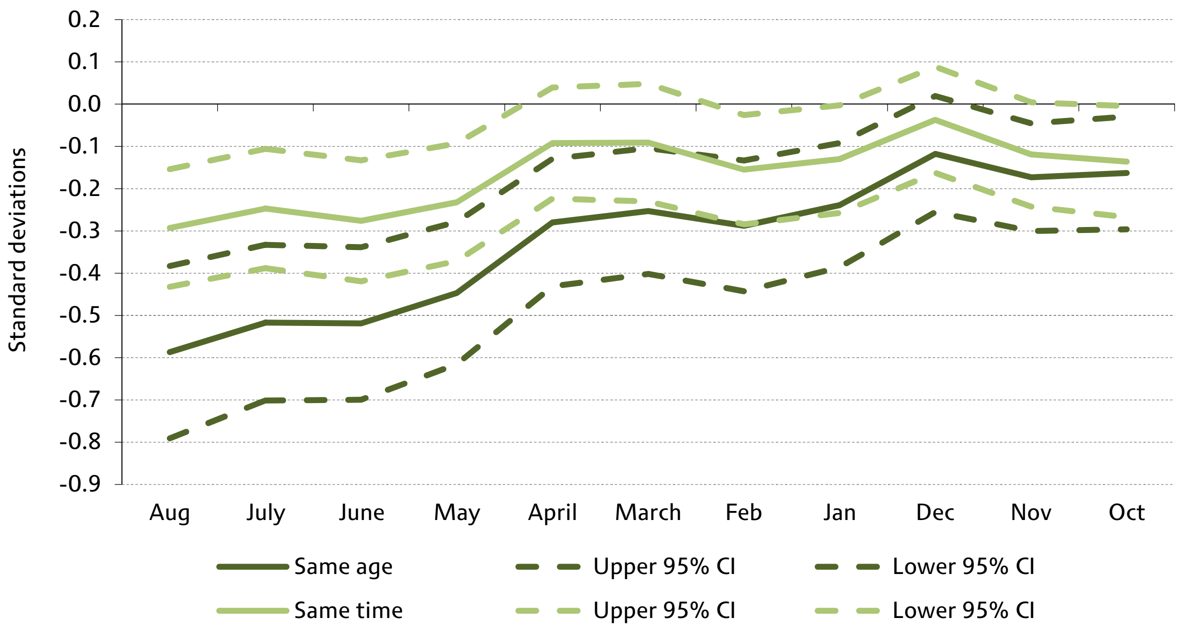
Figure 4.6 shows that, at age 7, the difference between those born in September and those born later in the academic year is greater when assessed at the same age than when assessed at the same point in time (although these estimates are never significantly different from one another). The same is also true for socio-emotional development reported by the child's class teacher at the same age (see Figure 4.7). At a minimum, this suggests that the age at which outcomes are assessed can no longer explain the majority of the gap in socio-emotional development between children born in different months.

Figure 4.6. Difference in parent-reported socio-emotional development at age 7, when measured at the same age or same point in time



Note: See Figure 4.5.

Figure 4.7. Difference in teacher-reported socio-emotional development at age 7, when measured at the same age or same point in time



Note: See Figure 4.5.

It is not clear why the drivers of these differences in socio-emotional development might change over time, but it is important to understand whether the differences are 'real' differences in behaviour or differences in perceptions of the same behaviour amongst children of different ages (which it is unfortunately not possible to do empirically using our data). If the latter effect is more pertinent – such that the differences arise solely or largely because parents and teachers of those born at different times of the year perceive them differently – then the policy implication might be to make teachers in particular more aware of these potential differences, so as to ensure that children born at the end of the academic year are not being 'under-assessed' in terms of their behaviour as well as their educational attainment (as seemed to be the case in Section 3.1).

However, if this latter effect is not the key explanation for why age at assessment seems to become a relatively less important driver of the differences in socio-emotional development between children born in different months over time, then this might suggest that there is some kind of cumulative effect associated with being relatively young within year group, through which those born towards the end of the academic year get used to being bottom of the class and adjust their expectations and behaviours accordingly. This perhaps points more towards relative age as an explanation for the differences that we observe, and would support the very tentative finding reported above in terms of educational attainment – that relative age becomes a more important driver of the differences in test scores that we observe over time.

Self-perception in the Avon Longitudinal Study of Parents and Children

Figure 4.8 presents estimates of the standardised differences in children's perceptions of their own ability, as well as self-esteem and locus of control, measured at age 8 in the Avon Longitudinal Study of Parents and Children, between those born in August and September using a regression discontinuity design. This approach ensures that the children are of approximately the same age when they are interviewed and hence provides us with some information about the extent to which age at test can explain the differences in outcomes between children born at the start and end of the academic year.[74]

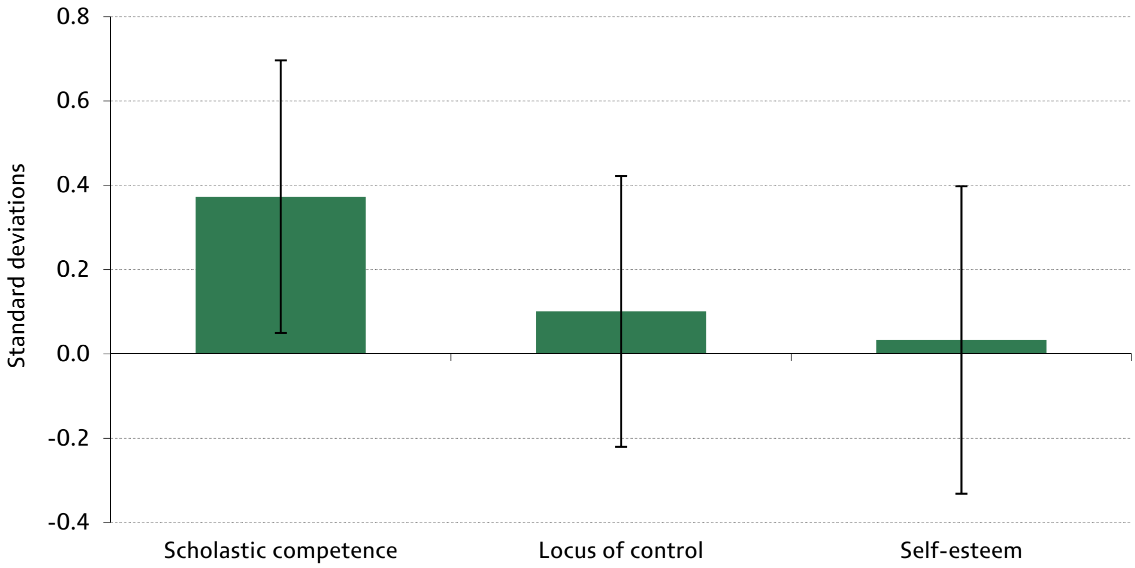
Figure 4.8 shows that, when children's perceptions are measured at the same age, there are no significant differences in terms of their locus of control or general self-esteem, but there remains a sizeable and significant difference in terms of their self-reported scholastic competence at age 8. This suggests that while age at assessment seems to be the key driver of the differences in locus of control and

[74] It is worth pointing out that these differences estimate the effect of the discontinuity itself (i.e. the effect of being born on 31 August rather than 1 September), rather than the average effect of being born in the month of August versus the month of September, such that in the absence of any other differences, we would expect the estimates produced by a regression discontinuity analysis to be larger than those presented in Section 3.2. We thus do not draw conclusions based on a comparison of the magnitude of the differences between the two sections and instead focus on what the differences here can tell us about the age-at-test effect.

general self-esteem that we observe, there is more going on when it comes to a young person's beliefs in their own ability.

Of course, what is not clear from these estimates is the extent to which differences in a child's perception of their scholastic competence is driven by the test scores that they receive and what stems from a more general perception of their position relative to others in their class or peer group. Section 3.2 suggested that a sizeable proportion – but not all – of the differences observed could be explained by prior attainment, suggesting that while age-adjusting test scores might go a significant way towards reducing the differences in ability beliefs between children born at the start and end of the academic year, other policy responses may be required in order to resolve fully the differences in self-perception that exist.

Figure 4.8. Regression discontinuity estimates of the differences in self-perception at age 8 between those born on 31 August and 1 September when interviewed at the same age

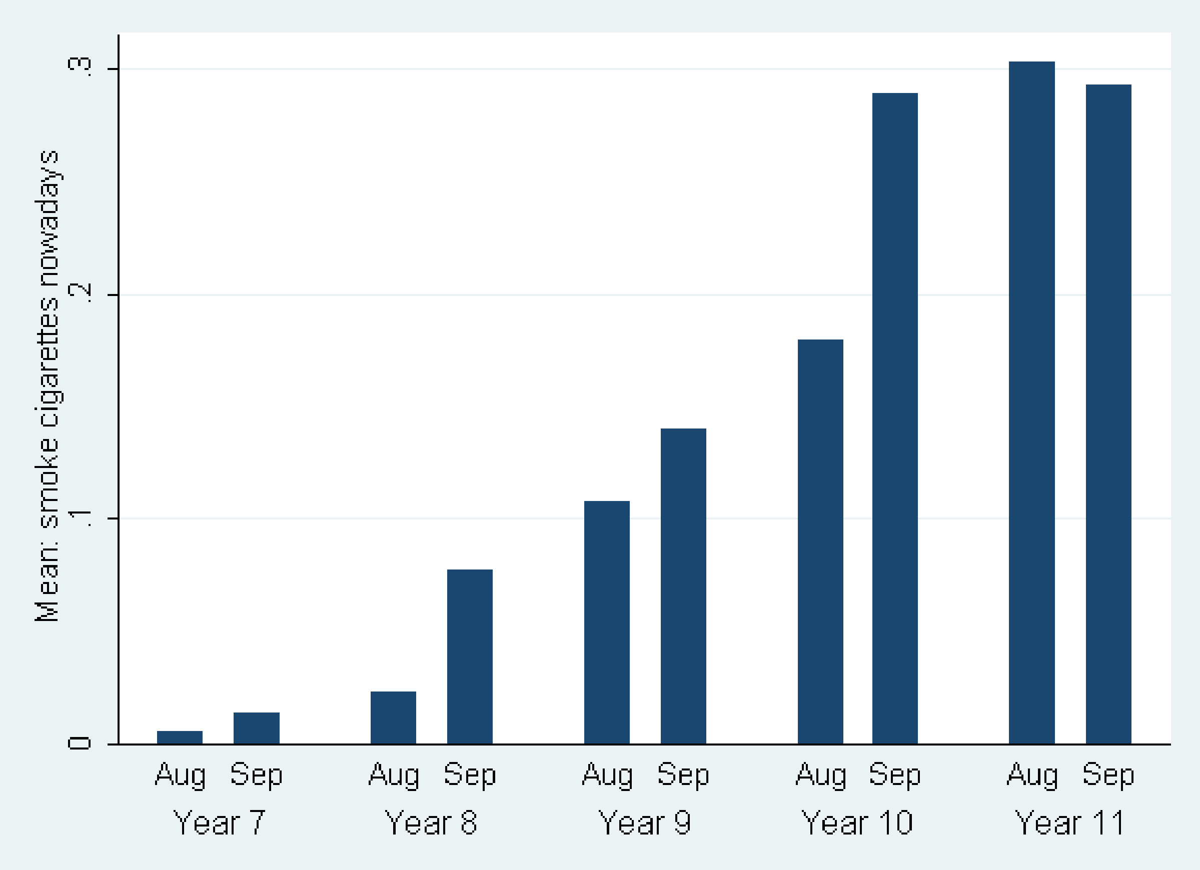


Note: Error bars represent 95 per cent confidence intervals.
Source: Avon Longitudinal Study of Parents and Children. See Crawford, Dearden and Greaves (2013b) for further discussion of the measures used and of the models and estimated differences.

Risky behaviours in the Survey of Smoking, Drinking and Drug Use

Finally in this section, we reproduce evidence from Crawford, Greaves and Parey (2013) illustrating how the differences in participation in risky behaviours between those born at the start and end of the academic year differ if we make comparisons within rather than between cohorts. Figure 4.9 presents the proportions of pupils born in August and September in each academic year surveyed as part of the Survey of Smoking, Drinking and Drug Use in England and Wales between 1988 and 1999 who answered yes to the question 'Do you smoke nowadays?'.

Figure 4.9. Proportion of August- and September-born children who report smoking 'nowadays' when interviewed at a point in time



Note: Average proportions of secondary school pupils in England and Wales who report smoking 'nowadays' when interviewed as part of the Survey of Smoking, Drinking and Drug Use in England and Wales between 1988 and 1999. This analysis forms part of Crawford, Greaves and Parey (2013).

Comparing young people born in August and September in the same academic year who are interviewed at the same point in time is identical to the approach underlying the comparisons made using the sample of pupils surveyed as part of the Longitudinal Study of Young People in England and reported in Figure 3.9. For example, amongst young people surveyed in Year 9, those born in August are 3.2 percentage points less likely to report that they smoke 'nowadays' than those born in September using the SDD data. This is very similar to the estimate from the LSYPE sample in Year 9 (age 14 in Figure 3.9).

When we compare children who are interviewed at the same age (and the same point in time), however, the picture is very different. For example, amongst young people who are aged 14 when the survey takes place (August-borns in Year 10 and September-borns in Year 9), Figure 4.9 shows that those born in August are 4 percentage points *more* likely to report that they smoke 'nowadays' than their counterparts of a similar age in the year below. This suggests that the lower participation in risky behaviours amongst children born at the end of the academic year observed when making comparisons within cohorts is driven to a large extent by the fact that the children are younger when they are interviewed; once we account for this, the relationship is reversed.

Depending on the mechanism through which this differential engagement occurs, age-adjusting test scores may help to address these differences in smoking behaviour amongst those born at the start and end of the academic year to a greater or lesser extent. For example, if those with lower test scores are more likely to have lower ability beliefs and those with lower ability beliefs are in turn more likely to disengage from the education system and engage in rebellious behaviours such as underage smoking, then age-adjustment may help to correct this to some extent. However, if the mechanism through which these differences arise is relative age via contact with older peers, then the age-adjustment of test scores is unlikely to help very much. From a policy perspective, it is much less clear what to do in such a situation, as at least one child must always be the youngest in the class.

4.4 Summary

This chapter has shown that age at test appears to be the key driver of the differences in educational attainment and cognitive test scores that we observe between pupils born at the start and end of the academic year, while age of starting school and length of schooling appear to explain almost none of the gap. This suggests that age-normalising test scores or testing children when they are ready would ensure that those born towards the end of the academic year are not disadvantaged by taking the tests at a younger age.

The age at which outcomes are measured also appears to explain most of the difference in children's self-esteem and locus of control, but there remain sizeable differences in terms of parent- and teacher-reported socio-emotional development, a child's ability beliefs and their engagement in a range of risky behaviours, even when we compare children at the same age.

In some cases, it seems likely that the age-normalisation of national achievement test scores might go a long way towards helping to reduce the differences in outcomes that we observe even when children are the same age. For example, we saw in Section 3.2 that prior attainment explained 60–85 per cent of the difference in ability beliefs between children born at the start and end of the academic year, thus providing some suggestive evidence that removing the differences in test scores that arise specifically as a result of differences in age at test might also reduce the differences in ability beliefs that we observe. In other cases, however, the likely effect of such a policy is less clear.

This is particularly true in the case of engagement in risky behaviours, where it seems likely that the driving force behind the differences that we observe is that August-borns are the relatively youngest amongst a group of older peers. This is not the only area in which relative age seems likely to play a role: Section 4.2 showed that relative age can explain at least part of the difference in national achievement test scores between children born at the start and end of the academic year (and it provided some very tentative evidence that this role might become more important as children get older). The differential perceptions of children's socio-emotional development amongst parents and teachers also seem likely to be driven at least in part by the fact that comparisons are being made within academic cohorts. The policy response in such situations is less clear: at least one child must always be the youngest in the class.

5. Conclusions and policy implications

This chapter summarises our key findings (Section 5.1), discusses the policy implications arising from these results (Section 5.2) and concludes by offering some policy recommendations (Section 5.3).

5.1 Key findings

This report has highlighted large differences in educational attainment between children born at the start and end of the academic year. These differences are largest soon after children start school and decrease as they get older (as the difference in relative age declines), but the gap remains educationally and statistically significant at the end of compulsory schooling. For example, children born in August are 6.4 percentage points less likely to achieve five A*–C grades in GCSE or equivalent exams than children born in September. This difference persists into further and higher education participation and attainment as well, with those born in August about 2 percentage points less likely to go to university at age 18 or 19, particularly a high-status Russell Group institution, and 1 percentage point less likely to graduate with a degree.

Whilst the difference relative to those born in September (the oldest in the academic cohort) is largest for August-born children (the youngest), even a one-month difference in age has an effect. For instance, those born in January are 2.8 percentage points less likely to achieve five A*–C grades in GCSE or equivalent exams than September-born children, while for those born in May the difference is 4.4 percentage points.

It is not only educational attainment where children born towards the end of the academic year are at a disadvantage compared with their relatively older peers. For example, August-born children are 5.4 percentage points more likely to be labelled as having mild special educational needs at age 11. When outcomes from survey data are compared as if they had all been measured on the same date (replicating the situation for national assessments), those born at the end of the academic year are also likely to exhibit significantly poorer socio-emotional development, have significantly lower confidence in their ability and are significantly less likely to believe that their own actions matter for the future.

However, despite the large and significant differences that we observe between those born at the start and end of the academic year in terms of educational attainment and a range of non-cognitive skills and behaviours during childhood, we find little evidence that these detrimental effects persist into adulthood. Thus, whilst individuals who were the relatively youngest in their academic year are around 0.5 percentage points more likely to be unemployed as an adult than their relatively older counterparts, they are no more or less likely to be in work, do not earn more or less per hour or week than those born at the start of the academic year and are (subjectively) no healthier or happier during adulthood than those born at the start of the academic year.

Does this levelling-out mean that no policy response is required? We argue that policy intervention is still justified for both equity and efficiency reasons. As we have seen, children born later in the academic year have lower belief in their own ability, have lower self-esteem and are less likely to believe that they control their own destiny. When compared with other children of the same age, they are also more likely to engage in a range of illicit behaviours, such as underage smoking. This suggests that the well-being of these children is lower than that of their relatively older peers, simply because they were unfortunate enough to be born later in the academic year. For efficiency reasons, it is also important to ensure that those with the highest potential take the correct subject mix, and participate in higher and further education, and that additional resources are targeted towards those with the greatest need, not those who may potentially have been misidentified as having (or not having) special educational needs.

We also argue that policy intervention to overcome the disadvantage of being born towards the end of the academic year is justified, even though there are other systematic differences in test scores (for example, by gender or socio-economic status) that we might also regard as inequitable. Our rationale is that month-of-birth differences are an artefact of the organisation of the educational system in terms of the start and end of the academic year: there is nothing fundamentally different about August-born children; somebody has to be the youngest in each academic cohort, and in England it happens to be those born in August. In other countries, it is those born in February (Scotland) or June (Northern Ireland). Our view is that this policy 'accident' should not be allowed to affect negatively those born towards the end of the (arbitrarily defined) academic year and that policymakers should do as much as they can to remedy this inequity.

Of course, the most appropriate policy response depends on what drives the differences in outcomes between relatively older and relatively younger children. The evidence presented in this report has concluded strongly in favour of age at test being the key driver of the differences in educational attainment and cognitive test scores that we observe. By contrast, age of starting school and length of schooling appear to explain very little of the difference.

The age at which outcomes are measured also appears to explain most of the difference in children's self-esteem and locus of control, but there remain sizeable differences in terms of parent- and teacher-reported socio-emotional development, a child's ability beliefs and their engagement in a range of risky behaviours, even when we compare children at the same age.

The evidence presented in this report suggests that at least some of the remaining difference in these outcomes is likely to be explained by differences in relative (rather than absolute) age between those born at the start and end of the academic year: for example, children born in August may be more likely to start smoking at a younger age because they are the relatively youngest amongst a group of older peers. There also appears to be some role for relative age in helping to explain differences in national achievement test scores and the differential perceptions of children's socio-emotional development amongst parents and teachers.

We discuss in the next section the implications of these findings in terms of the most appropriate policy responses to address the differences that we observe between individuals born at different times of the academic year.

5.2 Discussion of policy implications

Educational attainment

As described above, the evidence presented in this report strongly points towards age at test being the key driver of the differences in educational attainment between those born at the start and end of the academic year. This means that age-adjusting national achievement test scores is a simple and straightforward way of ensuring that those born towards the end of the academic year are not disadvantaged by taking the tests younger, by assessing whether pupils have met the expected level given their age. An alternative option that would achieve the same effect in principle would be to test children 'when they are ready', but this would be much more difficult to implement in practice, as it would mean conducting assessments throughout the year. We therefore prefer age-adjustment, and discuss how this could work in practice below.

Age-adjustment

On the basis of their performance in national achievement tests, pupils currently receive a test level and an assessment of whether they have met the expected level of attainment for their Key Stage, as set by the Department for Education. This feedback could be adjusted so as to provide information on attainment at a particular age (rather than at a particular point in time) in one of two ways: first, by adjusting test scores for children born in different months while keeping the same absolute cut-off for levels, including the expected level; second, by adjusting the cut-off at which children born in different months would be deemed to have met each level, including the expected level. We favour the latter approach as it has the advantage of maintaining an absolute measure of pupils' performance based on test scores, which could be given to teachers and parents if required, while providing an age-appropriate assessment of whether a child is at, above or below the expected level of attainment.

It is possible to carry out this age-adjustment so as to maintain the current proportion of pupils reaching the expected level (by increasing the cut-off for those born earlier in the year and reducing it for those born later) or by increasing the proportion of pupils reaching this level (by reducing the cut-off for anyone born later than September). In the example that follows, we assume that the current proportion of pupils reaching the expected level should be maintained and illustrate how straightforward it is to age-adjust the cut-off in order to remove month-of-birth differences in test scores.

As an example, we use Key Stage 2 test results in English from the National Pupil Database for the cohort that sat them in 2008–09.[75] For this cohort, we find that pupils born in August score around 7 points lower than pupils born in September. To maintain the proportion of pupils reaching the expected level, the cut-off for those born in the middle of the academic year (in February and March) would remain unchanged. The cut-off required for those born in September would increase by 3 points, so that the oldest children would have to perform slightly better than they do at the moment in order to reach the expected level (which would now be an expected level *for a given age* rather than at a particular point in time). The cut-off would be increased by 2 points for those born in October and November, and by 1 point for those born in December and January. For those born later in the academic year, the cut-off would be reduced: by 1 point for those born in April and May, by 2 points for those born in June and July, and by 3 points for those born in August.[76,77]

This adjustment results in an age-specific indicator for whether a child reaches the expected level, and therefore results in there being no difference (on average) in the likelihood of reaching the expected level amongst pupils born in different months of the year, while preserving the proportion of pupils who do so overall. Figure 5.1 illustrates the difference between the proportion of pupils born in September who reach the expected level compared with the proportion in all other months of the year using the current (dark green line) and age-adjusted (lighter green line) measures. It shows that there are large and significant differences by month of birth in terms of the proportions of pupils reaching the expected level when we use the same cut-off for all pupils, while there are almost no differences once we use our age-adjusted cut-offs.

Similar adjustments could be made for all other Key Stage 2 levels, as well as the expected level, and could also be used for the purposes of calculating school league table positions. This would help prevent a situation in which fluctuations in the composition of birth dates across particular cohorts of pupils might result in changes in league table positions that are unrelated to underlying performance: for example, if a school goes from having a disproportionately large proportion of autumn-born pupils to a disproportionately large proportion of

[75] We have tested this process for maths in 2008–09 and also using a number of other years of Key Stage 2 data, with similar results.

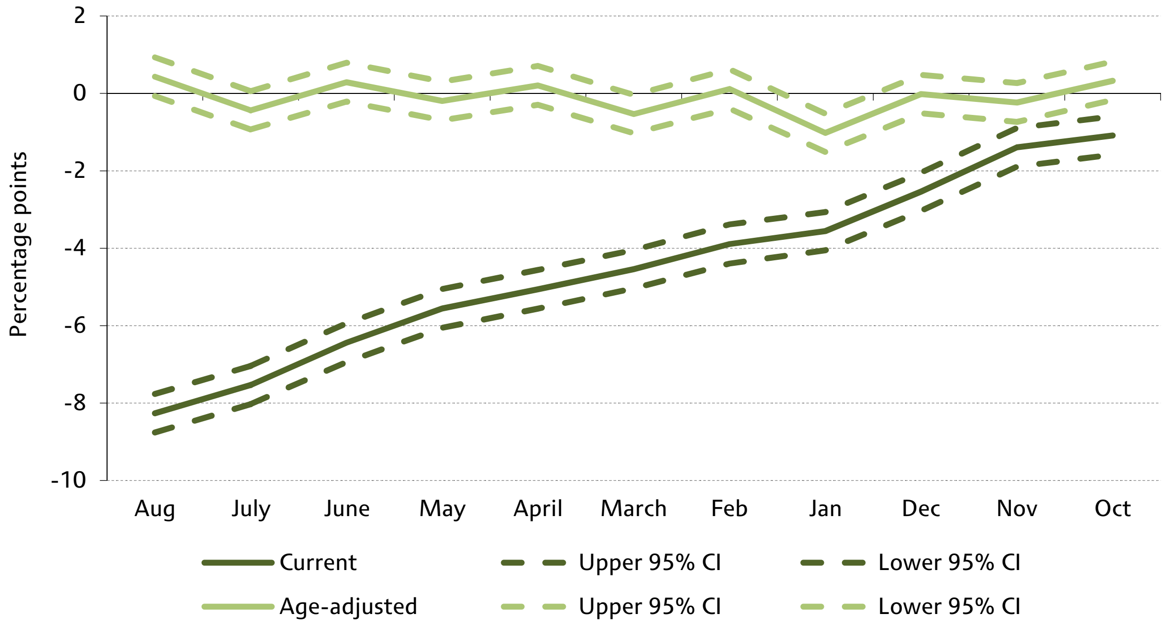
[76] Note that pupils born in adjacent months are grouped together in this example. This is because the difference in test scores between children born in adjacent months is less than 1 point; we have therefore rounded to the nearest point the adjustment required.

[77] It should be noted that this example effectively corrects for the difference in test scores that arises from the total of the four potential drivers (age at test, age of starting school, length of schooling and relative age), rather than age at test alone. As our work shows that age at test accounts for the vast majority of the differences in test scores that we observe between children born in different months, however, our view is that this is the simplest and most straightforward way of correcting for this problem.

summer-born pupils, then it may end up with a poorer league table position, even though the quality of its teaching, for example, has not changed.

It may also be appropriate for setting and streaming policies – which separate pupils into different groups or classes on the basis of ability and are becoming increasingly prevalent even in primary schools in England – to be applied on the basis of potential (or age-adjusted) ability in order to ensure that August-born children are not disproportionately assigned to the lowest groups, as is the case at the moment.[78] The same approach should also be taken when assessing entry requirements for schools that select on the basis of ability.

Figure 5.1. Difference in the proportion of pupils reaching the expected level in Key Stage 2 English in 2008–09 using current and age-adjusted cut-offs



Note: Age-adjustment is based on the universe of pupils taking Key Stage 2 assessments in 2008–09. The age-adjustment changes the points (or cut-offs) that a pupil born in each month of the year must reach in order to be classified as reaching the expected level of attainment.
Source: National Pupil Database.

A similar process could be carried out for scores from the Foundation Stage Profile, Key Stage 1 and Key Stage 3 assessments, as well as Key Stage 4 assessments if the underlying scores were provided in the NPD. Although the average differences between those born in different months are relatively small by age 16, we recommend that age-adjusted measures should still be used to determine whether pupils have the potential to continue into further and higher education. A similar approach to that described above for Key Stage 2 tests could be applied, although it should be borne in mind that in order to maintain the proportion of pupils reaching the expected level at Key Stage 4, some children

[78] Campbell, 2013.

born earlier in the year may no longer be deemed to have met the standard required for their age to continue into post-compulsory schooling. If it were considered preferable to ensure that no children lost out as a result of such a reform, then the cut-offs required for each grade would need to be progressively lowered for those born between October and August.

Of course, a key challenge with age-adjustment comes when young people are ready to leave school. Should they be given an absolute or an age-adjusted measure of their performance to report to the outside world? We presume that employers would find an absolute measure of attainment more valuable, as it should signify the skills that a young person has already acquired. Moreover, the fact that we find no evidence of month-of-birth differences in employment status or wages, despite very different proportions of individuals achieving key qualification benchmarks by month of birth, suggests that employers already look beyond formal grades when deciding on recruitment and pay. We would therefore be reluctant to suggest any changes to the status quo.[79]

Other policies

Some commentators argue that the solution to the differences in test scores between children born at the start and end of the academic year is for parents to be given more flexibility over when their child starts school. However, our results make clear that such an approach would NOT solve the large and significant differences in test scores that we observe, particularly amongst children at later ages, as neither the age at which children start school nor the amount of schooling they receive prior to the tests is found to be a significant driver of the differences in test scores between children born in different months of the year.

In fact, within the confines of the current education system – in which parents can *defer* their child's entry to primary school until the term after they turn 5 (i.e. so that they join the same academic cohort a year later) but not *delay* it (i.e. hold them back a year so that they join the subsequent academic cohort) – we find that it is actually better for relatively younger children to start school earlier, as the positive benefit of receiving more tuition prior to national achievement tests is more than outweighed by the potentially negative effect of starting school younger. This finding was initially reported by Crawford, Dearden and Meghir (2007) and influenced the recommendations made by the Rose Review[80] that all primary schools should make provision for children born in each month to start school in the September of the academic year in which they turn 5 if their parents wished them to do so.

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[79] If it were deemed confusing for both absolute and age-adjusted scores to be provided at Key Stage 4, then we would suggest producing absolute measures only, but ensuring that schools and colleges account for a pupil's month of birth when making offers for post-compulsory education places. This could be achieved by applying a simple age-adjustment to their test scores along the lines of the adjustments described above.

[80] Rose, 2009.

While our findings do not directly address the issue of whether parents should be allowed to delay (rather than defer) their child's entry to school, we would argue against introducing such a policy for three reasons. First, the evidence on whether it benefits the children who are delayed is mixed. While some studies find positive effects in terms of attainment and academic progress during the first few years of school,[81] it is not clear how long these effects last. There is also some evidence that children who are relatively older in their cohort as a result of delayed entry are more likely to exhibit behavioural problems.[82] In countries that currently permit delayed entry for some pupils – such as Scotland – there have also been recent movements to try to limit its prevalence due to perceived negative impacts on children.[83] Second, a policy of allowing delayed entry might exacerbate the problem for those who start school at the expected time, as the youngest in the year group would now be over a year younger than the oldest. This may exacerbate any relative-age effects, and may make it harder to offer inclusive classroom teaching. Finally, some families may be more willing or able to hold their child back from school than others, thus potentially creating greater inequities in terms of other socio-economic or family background characteristics.

Finally, in addition to age-adjustment of test scores, the promotion of awareness and understanding of the issue of month-of-birth differences in educational attainment (and indeed a whole range of other outcomes) amongst schools, teachers and parents would also seem to be important. For example, we saw in Chapter 3 that teachers tend to 'under-assess' the performance of pupils born towards the end of the academic year compared with their performance in externally-marked assessments. In a world in which teacher assessments are becoming an increasingly common way of grading children's performance, we need to guard against biases against particular pupils or groups of pupils as far as possible. This 'under-assessment' may also be indicative of lower expectations for pupils who start school with lower development, suggesting that teachers should continue to review the performance and development of all pupils.

The introduction of judgements about the performance of summer-born children as part of the standard schools inspection framework should have increased awareness of this issue amongst teachers and headteachers, but to our knowledge schools receive no guidance or training regarding the most appropriate ways of reducing inequalities between the oldest and youngest in the year, and more could be done to share best practice. Some simple steps that have been adopted in some schools include arranging the register according to date of birth in order to promote awareness of potential differences in development.

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[81] See, for example, Datar (2006).

[82] See, for example, Byrd, Weitzman and Auinger (1997).

[83] See, for example, http://www.edinburgh.gov.uk/news/article/492/education_leader_discusses_delaying_entry_to_primary_school.

One thing that is clear from the literature, however, is that setting and streaming policies tend to increase the gap in attainment between those born at the start and end of the academic year, but that they do so by increasing the performance of relatively older pupils rather than worsening the performance of relatively younger pupils.[84] Schools therefore face a trade-off between enabling children of all ages and abilities to reach their potential and widening the gap in attainment between those of different ages, and they will need to consider this carefully when making decisions over such policies in future.

While making schools, teachers and parents more aware of these issues is important in the context of educational attainment, it may potentially be even more important in the context of dealing with some of the differences in other skills and behaviours that we observe between children born in different months of the year, as we discuss below.

Non-cognitive skills and behaviours

As outlined above, this report has documented differences in attitudes, beliefs and behaviours for children born at the start and end of the academic year that cannot be explained by a pupil's age when assessed. For example, those born in August have a significantly lower view of their scholastic competence and are more likely to engage in illicit behaviours such as underage smoking than their relatively older counterparts.

We have proposed that national achievement test scores are adjusted so as to account for the large difference in age when pupils born in different months of the year take these tests. We demonstrated above that such a policy would essentially eliminate month-of-birth differences in the test scores that would be fed back to pupils or used to assess whether they had the potential to continue into further or higher education. The fact that month-of-birth differences in wider skills and behaviours remain even after accounting for age of assessment, however, leaves open the question of whether and to what extent age-adjustment of national achievement test scores would help to address some or all of the differences in other outcomes that we observe.

In some cases, it seems likely that the age-normalisation of national achievement test scores might go a long way towards helping to reduce the differences in outcomes that we observe even when children are the same age. For example, Chapter 3 showed that prior attainment explained 60–85 per cent of the difference in ability beliefs between children born at the start and end of the academic year, providing some suggestive evidence that removing the differences in test scores that arise specifically as a result of differences in age at test might also reduce the differences in ability beliefs that we observe.

[84] Campbell, 2013.

In other cases, however, the likely effect of such a policy is less clear. For example, age-adjusting test scores may or may not help to address the differences in risky behaviours amongst those born at the start and end of the academic year, depending on the mechanism through which participation in these behaviours occurs. If those with lower test scores are more likely to have lower ability beliefs and those with lower ability beliefs are in turn more likely to disengage from the education system and engage in rebellious behaviours such as underage smoking, then age-adjustment may help to correct this to some extent. However, if the mechanism through which these differences arise is simply that those born towards the end of the academic year are the relatively youngest amongst a group of older peers, then age-adjustment of test scores is unlikely to offset this.

Engagement in risky behaviours is not the only area in which relative age seems likely to play a role: the different perceptions of children's socio-emotional development amongst parents and teachers also seem likely to be driven at least in part by the fact that comparisons are being made within academic cohorts. Moreover, Section 4.2 showed that relative age can explain at least part of the difference in national achievement test scores between children born at the start and end of the academic year (and provided some very tentative evidence that this role might become more important as children get older – although these results must be taken with caution).

The policy response in such situations is much less clear, as at least one child must always be the youngest in the class, and hence disadvantaged if relative age plays a role. Unlike the relatively straightforward approach that could be taken to address the problem of testing children at very different ages, there is no easy way to overcome this disadvantage. This means that it is even more important to ensure that schools, teachers and parents are aware of the potential disadvantages that children born later in the academic year may face, over and above the lower test scores that they receive.

5.3 Policy recommendations

On the basis of our results, we recommend that the following policy actions are taken to help address the differences in test scores and wider outcomes between those born at the start and end of the academic year:

- National achievement test scores should be age-adjusted to account for the fact that children born at different times of the year have to sit the tests when they are different ages.
- These age-adjusted scores should be used to calculate school league table positions, to determine entry to schools that select on the basis of ability, and potentially to assign pupils to ability groups within schools.
- They should also be used to assess whether a pupil can continue into further and higher education. When pupils leave school, however, they should take

with them their non-age-adjusted grades, to ensure that employers can be confident that pupils have achieved a particular absolute standard.

- It is not necessary to give parents more flexibility over the age at which their children start school, as it is clear that this is not the main driver of the differences in attainment between children born at the start and end of the academic year.
- Schools, teachers and parents should be made more aware of the potential disadvantages that children born later in the academic year may face, and more could be done to document and share best practice in reducing inequalities between children born at the start and end of the academic year.

Appendix A. Education context for different cohorts of pupils

Academic cohort	School leaving age[a,b]	Exam system[c]	Higher education[d]
1934–35 to 1947–48	15	O	
1948–49 to 1956–57	15 (Easter/summer)	O/CSE	
1957–58 to 1959–60	16 (Easter/summer)	O/CSE	
1960–61 to 1970–71	16 (Easter/May)	O/CSE	
1971–72 to 1973–74	16 (Easter/May)	GCSE	
1974–75 to 1980–81	16 (Easter/May)	GCSE	University expansion (polytechnic)
1981–82 to 1996–97	16 (summer)	GCSE	University expansion (polytechnic)
1997–98[e]	17 (summer)	GCSE	University expansion (polytechnic)
1998–99 onwards[e]	18	GCSE	University expansion (polytechnic)

[a] The Education Act of 1944 raised the school leaving age to 15 (which was enforced from April 1947). This meant that all those born in or after April 1932 had to remain in school until age 15. From 1 September 1973, the compulsory school leaving age was 16. This meant that those born in or after September 1957 could not leave school before age 16.

[b] Between 1976 and 1997, those born between September and January could leave school at the end of the Easter term and those born February to August could leave on the last Monday in May. This applied to those born between September 1960 and August 1981. Prior to this (from September 1963), the two dates had been the 'end of the Easter term' and the 'end of the summer term' – affecting those born in or after September 1948 – (Education Act 1962); prior to this, a pupil was able to leave school on their fifteenth birthday (Education Act 1944). The current school leaving date ('summer') is the last Friday in June in the academic year in which the pupil turns 16. This has been in place from academic year 1997–98, affecting those born in or after September 1981 (Education Act 1996).

[c] GCSEs were first taken in academic year 1987–88, and so affected those born in or after September 1971. O Levels were first taken in academic year 1950–51, and so affected those born in or after September 1934. CSEs were first taken in academic year 1964–65, and so affected those born in or after September 1948.

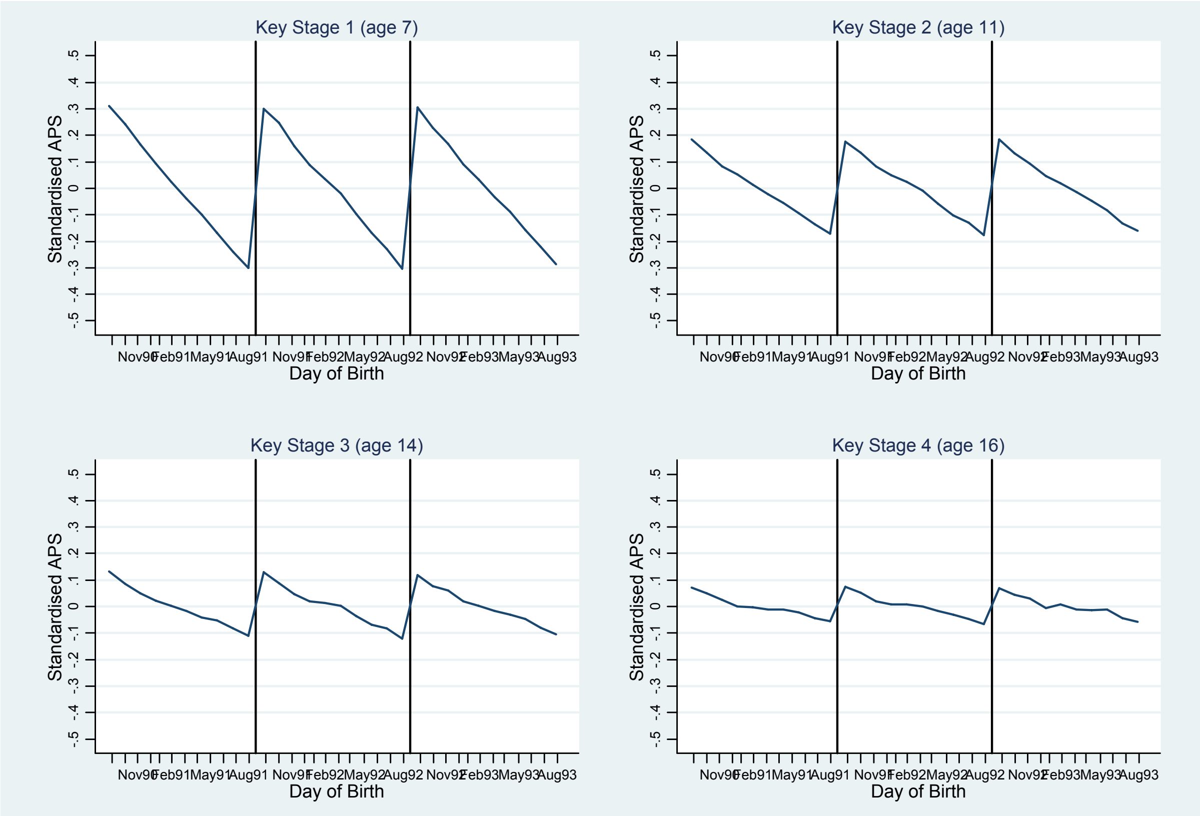
[d] Polytechnics were able to become universities in 1992, following the Further and Higher Education Act 1992. This would have affected all those born around 1974.

[e] For these cohorts of pupils, 'participation leaving age' should be read in place of 'school leaving age', as young people may be employed full-time with part-time education or training, or take an apprenticeship (Education and Skills Act 2008).

Source: Education Act 1944, Education Act 1962, Further and Higher Education Act 1992, Education Act 1996 and Education and Skills Act 2008.

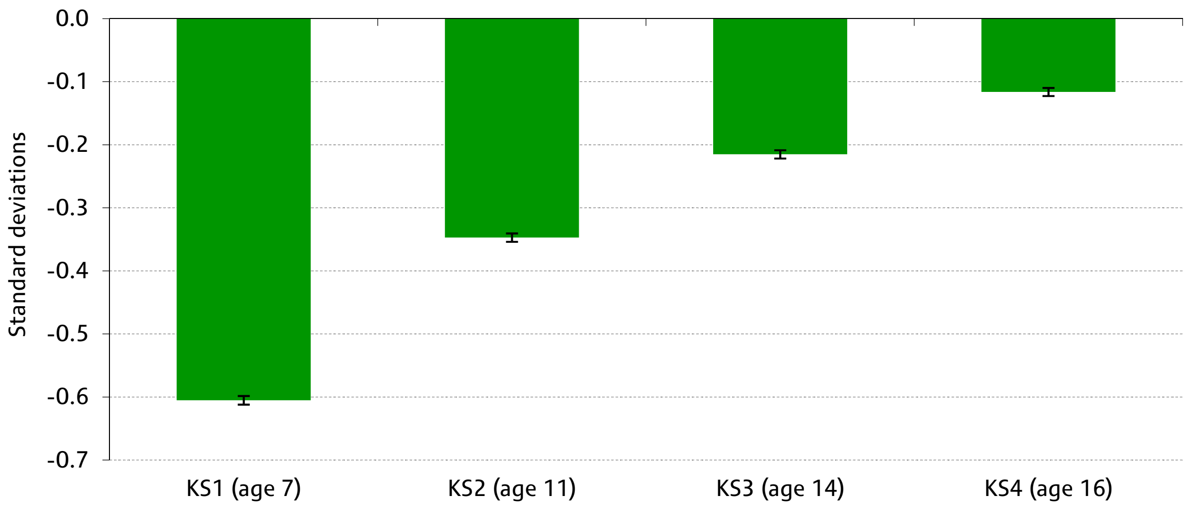
Appendix B. Additional figures for 3.1

Figure B.1. Standardised average point score (APS) at Key Stages 1, 2, 3 and 4 (ages 7, 11, 14 and 16), by date of birth



Source: Authors' calculations using Key Stage 1, 2, 3 and 4 test results from the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

Figure B.2. Standardised average point scores: performance of August-born children relative to September-born children at Key Stages 1–4



Source: Authors' calculations using Key Stage (KS) 1, 2, 3 and 4 test results from the National Pupil Database for pupils born in 1990–91, 1991–92 and 1992–93.

Appendix C. Additional figures for 4.2

Figure C.1. Distribution of interview dates by month of birth, MCS age 5

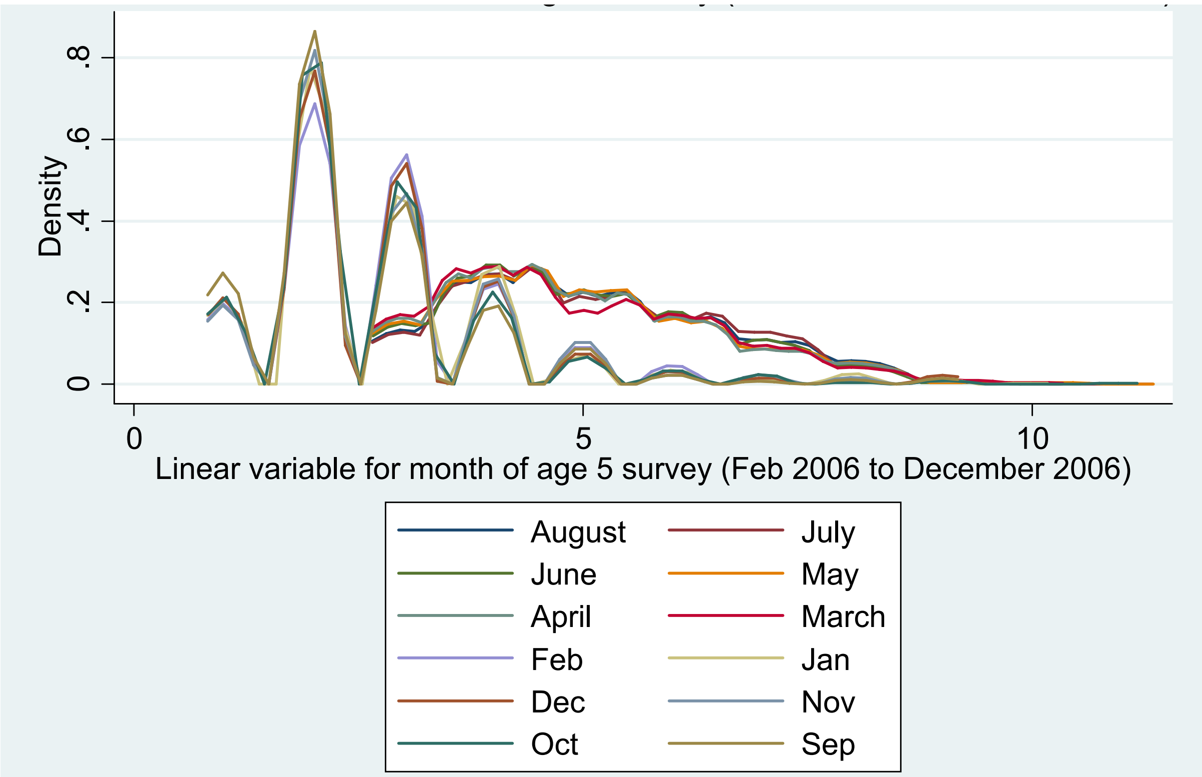


Figure C.2. Distribution of age at interview by month of birth, MCS age 5

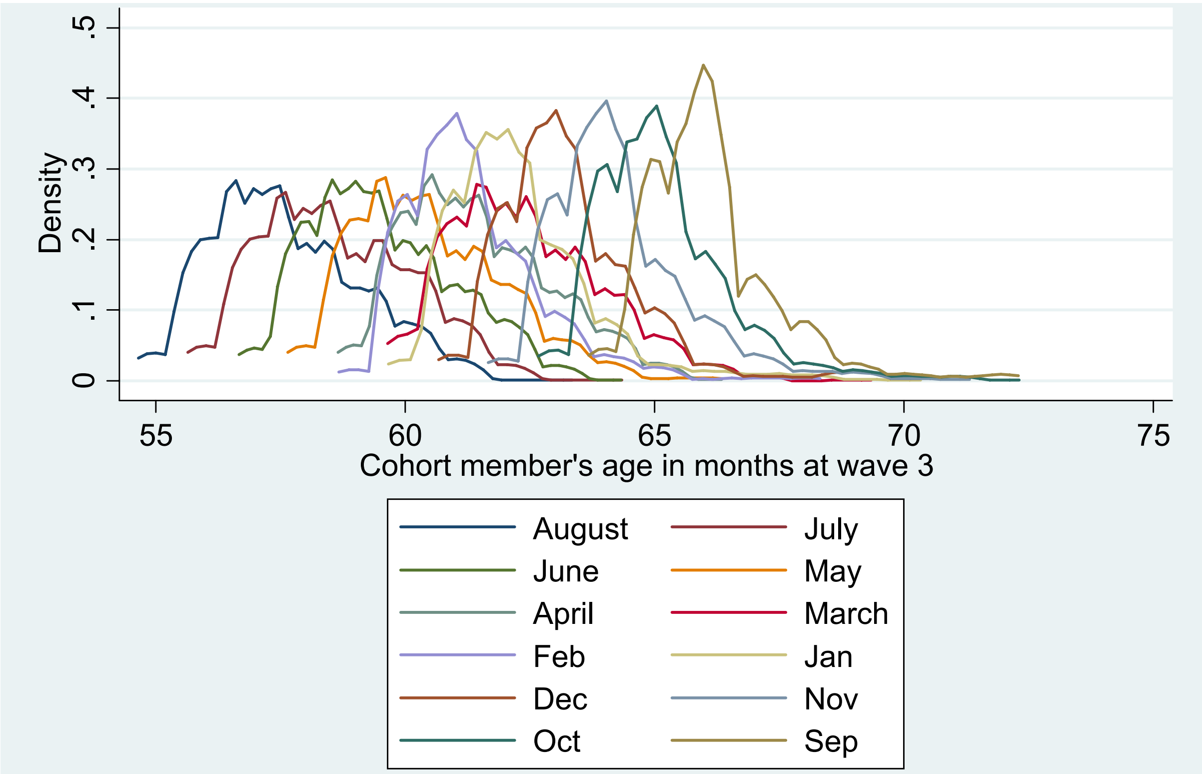
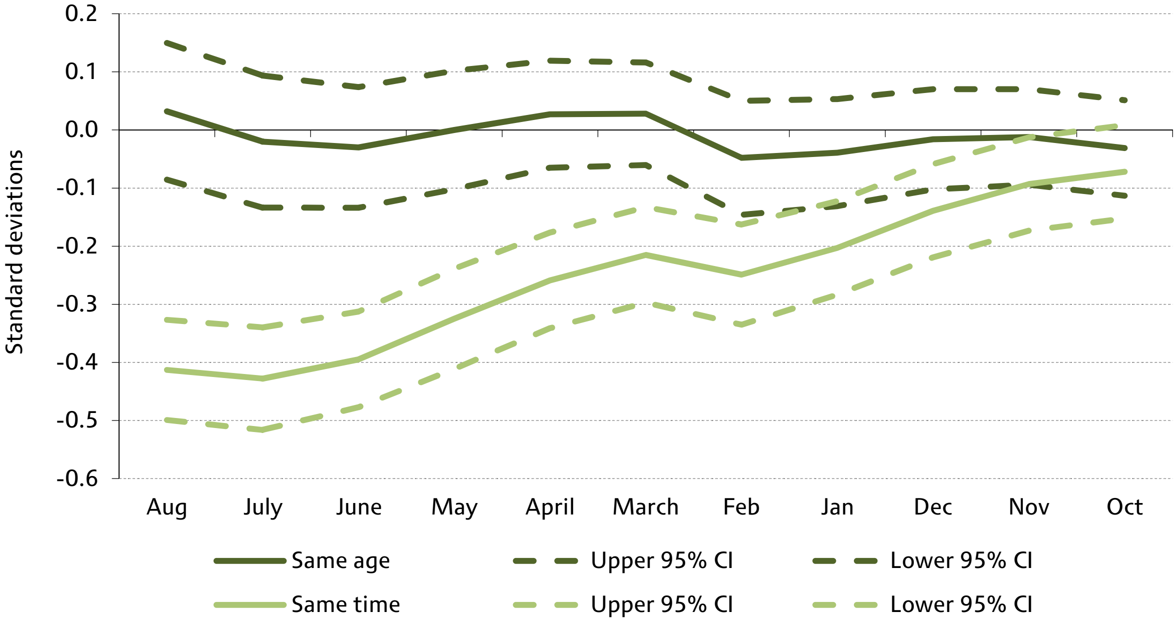


Figure C.3. Difference in BAS vocabulary test at age 7, when measured at the same age or same point in time



Note: The darker green lines represent the differences in BAS test scores, on average, between those born in September and those born in other months of the year when tests are taken at around the same age. The lighter green lines represent the differences controlling for date of interview, thus mimicking the results of a test taken at the same point in time (such as Key Stage assessments in schools). Both sets of estimates also account for a variety of individual and family background characteristics. The dashed lines in each case represent the 95 per cent confidence interval around these estimates.
Source: Millennium Cohort Study.

Appendix D. Intuition behind our identification approach

The 'age–period–cohort' (APC) model is based on a maximum entropy approach and rests on two key insights: first, when the dependent variable (test score) has a fixed maximum and minimum, the effect of the independent variables (age at test, age of starting school and length of schooling) must also be bounded. Second, in order to achieve point identification, our starting point is that, unless there is a reason for believing otherwise, each independent variable has the same impact on the dependent variable. This is an extension of Laplace's Principle of Insufficient Reason.[85]

To illustrate this concept, we repeat an example covered in more depth in Browning, Crawford and Knoef (2012), known as 'Jaynes' dice problem'.[86] We have a six-sided die that has been rolled a large number of times to produce a sample average (which we observe). We know that the die has six sides, that each side is labelled from one to six, and that the probability distribution meets standard conditions (i.e. that all probabilities are non-negative and sum to 1). We do not know, however, whether the sides have equal probability of occurring (i.e. whether the die is 'fair'). The sample average will provide us with some information about the probability distribution: if the die is fair, we expect the sample average to be 3.5; if the die is weighted towards high numbers, we expect the sample average to be higher than 3.5 (and vice versa if it is weighted towards low numbers).

How can we calculate the vector of probabilities that gives rise to the sample average that we observe? Laplace's Principle of Insufficient Reason provides us with a starting point: each side should be regarded as being equally likely to occur, unless there is a reason to believe otherwise. The problem is then solved by constrained optimisation, finding the vector of probabilities that are as equal as possible, while at the same time being consistent with the observed sample average. Thus, if the sample average is 3.5, then this method will conclude that the die is fair (i.e. that the probability of the dice landing on each side is $^1/_6$). If, however, the sample average is higher (lower) than 3.5, then the probabilities will be higher (lower) for higher values of the die and lower (higher) for lower values of the die.

The same intuition can be applied to our problem: if the data tell us that children who are older when they sit the test have higher test scores, on average, then the proposed solution would result in a higher weight being given to the independent variable that represents being older when the test is sat.

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[85] Sinn, 1980; Browning, Crawford and Knoef, 2012.

[86] Jaynes, 1957a and 1957b.

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