A comparison of Academic Achievement in Independent and State Schools

Report for the Independent Schools Council

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Executive summary

1. This report compared the academic achievements of students of independent schools to those of state schools. The comparison was based on the performances of schools in the two sectors in the Performance Indicators In Primary Schools (PIPS) assessments produced by CEM and in the GCSE exams.

2. Only few studies in England have investigated the differences between the academic achievements of independent and state schools and none of these studies compared the students of the two sectors at their early stages in education. This is the first study that has compared the performances of students in independent and state schools from the age of four years.

3. Results of this study indicate that differences existed between the academic achievements of independent and state schools from as early as the age of four years. Independent schools had lower average deprivation index (IDACI) which indicated that their students came from areas that were more privileged than the areas that students of state schools came from. These differences were taken into consideration to make a fair comparison of the academic achievements of the two sectors. Differences in the PIPS scores in Reading and Mathematics were found in favour of independent schools at ages 4, 8, 10 and at age 16 (GCSEs). At GCSE, independent schools had higher average scores than state schools in all the subjects included in the study and in the average of best 8 GCSEs.

4. The difference between independent and state schools in the average of best 8 GCSEs was just under 2 GCSE grades based on the mean of three cohorts. However, when the prior academic ability, deprivation, student's gender, single sex and compositional variable were taken into account, the difference between the two sectors was 0.64 GCSE grades.

5. The difference of 0.64 GCSE grades translates to an average difference of 0.41 standard deviation units between the GCSE performances of independent and state schools. This difference equates to a gain of about two years' normal progress and suggests that attending an independent school is associated with the equivalent of two additional years of schooling by the age of 16. Interpreting the difference on the scale of international PISA outcomes equates it to raising the UK's latest PISA

results to be above the highest European performers, such as Finland, Switzerland and the Netherlands, and on a par with (or close to) countries such as Japan and Korea.

6. The differences between the scores of independent and state schools in individual GCSE subjects were in the range of 0.13 to 0.77 of a grade and the highest was in History.

7. At GCSE the differences between schools in the two sectors were highest in French, History and Geography and lowest in Chemistry, Physics and Biology.

8. Students' prior ability was the single highest contributing factor to predicting the GCSE outcome of the models.

9. This study found that students of state schools were likely to come from more deprived areas than those from independent schools. The study also showed that students from more deprived areas were more likely than those from less deprived areas to achieve lower GCSE grades.

10. Although there might be factors which we have not controlled for, the evidence from this study suggests that similar students achieve more in independent schools than in state schools when cross-sector differences are controlled.

11. There are a number of particular limitations to this observational study:

    - The IDACI measure used for estimating the levels of children's deprivation is measured only at the postcode level. Therefore two students of different socioeconomic status may have the same IDACI value.

    - It was observed that students of independent schools had higher entry levels. If the higher entry levels resulted from family background or other factors that continue to support the student through education it will be very difficult to accurately assess the differences between the independent and state school sectors as this variable is not accounted for.

    - The identification of single sex schools was achieved by calculation since they were not specifically identified in the datasets and the calculation allowed for the possibility that a few students could have been misclassified. The number of schools identified is quite small so interpretations around these variables should be treated with caution.

- It is possible that we have not identified all the external factors that should have been controlled for in the analysis. Any unobserved factors would further affect our estimate of the differences between the educational outcomes of independent and state schools at GCSE. Due to these limitations the results must be interpreted with caution.

12. Based on the data we had and the analysis we have carried out the difference between the academic achievement of independent and state schools at GCSE in 2014 was 0.64 of a grade in favour of independent schools, after controlling for a range of known variables. It is possible that this is an overestimate of any genuine causal effect of attending an Independent school because of unobserved factors that would have affected the estimate.

1. Introduction

Independent schools currently educate around 625,000 children (6.5%) in the United Kingdom and for England the proportion of independent to state students is about 7% (ISC website, 2015). A report by Ryan and Sibiesta (2010) suggested that over a period of 10 years, only a small variation occurred in the percentage of students attending independent schools in England.

Many parents in England send their children to independent schools where, according to the Social Market Foundation research report, tuition fees averaged £12,582 and £28,500 in 2014 for day and boarding places respectively (Winch, 2014). It is hardly surprising that parents make this choice over free state-funded education because evidence exists in the literature in support of the notion that former students of private schools enjoy relatively higher returns from their education than their state school counterparts. For example, a study commissioned by Sutton Trust in 2005 found that in 2004 over two thirds of barristers at top chambers attended independent schools although the population of students in independent schools did not average more than 10% over many years. The study also reported that 73% of barristers and 76% of judges in 1989 had attended fee-paying schools. Green et al (2010) investigated the economic returns to private schooling over time, comparing children born in the late 1950s and those born in the 1970s. They found that the education and earning differentials between children that attended independent schools and those that attended state schools had widened. Others (Giddens & Stanworth, 1978 and McKinnon, 1987) also found that former independent schools students occupied top posts in the cabinet, civil service, judiciary, the armed forces and the bench in numbers disproportionate to their number in the population. A Sutton Trust study carried out in 2005 to investigate the educational backgrounds of Members of Parliament found that 32% of them attended independent schools which educated only about 7% of student population. Another study carried out for Sutton Trust in 2008 found that 100 elite schools – making up under 3% of 3,700 schools with sixth forms and sixth form colleges in the UK – accounted for a third of admissions to Oxbridge during the previous five years.

Green et al. (2010) attributed a large proportion of the increase in earnings differential between former students of independent schools and those of state schools to the increased difference in educational attainment.

This raises an important question. Do students of independent schools perform better academically than their state school counterparts? Although general opinion seems to be that this is the case, there is certainly the need to verify whether the differences are results of selection bias or school type. This is

important because despite the high cost of private education in the UK, only few studies have been carried out to investigate the differences in the academic performances of students in the two educational sectors. In order to describe the results of this study in the appropriate context we present firstly, a brief review of some of the studies carried out in the UK and some other parts of the world to investigate the differences between the academic achievements of students of independent and state schools.

Evidence from the U.K

Dearden et al (2002) analysed a National Child Development Survey data that tracked people born in 1958 in the UK and examined the impact of the pupil-teacher ratio and school type on educational achievement and employment among other things in England and Wales while controlling for ability and family background. They found that attending a selective school positively and significantly affected educational outcomes for both male and female. However, they found that the probability of employment did not depend on school type.

Sullivan and Heath (2002) investigated the educational success of students at different types of state and private schools in England and Wales based on a large-scale panel study that included prior measures of students' social backgrounds and cognitive skills. The study found that students at state grammar schools and private schools achieved superior educational outcomes compared to students at comprehensive schools after intake to the schools had been controlled for. They reported that significant differences persisted after taking various school characteristics into account.

Using statistical data obtained from the Department of Education and Science (DES) Halsey et al (1984) produced the most complete account of the relationship between school type and high school achievement in England. They reported the remarkable improvement in academic output by the private sector from 1961 to 1981 (from 14.5% to 45% of students achieving three or more A-levels) which the state sector (3.1 % to 7.1% achieving three or more A-levels) could not match and concluded that "the chances of emerging with three A-levels from private school compared with state school widened between 1961 and 1981." Using linear regression of A-level results on several student background variables they showed that when social origins and school leaving age were controlled for, the observed differences between state and private school students' achievements at 'A' levels were reduced but still remained statistically significant. The drawback of their study was that they did not control for students' prior academic ability. However, they concluded that "private education conferred some, albeit small, educational advantage on those fortunate enough or affluent enough to receive it" but suggested that the increasing selectivity practised by

independent schools could have raised their academic entry requirements resulting in the difference observed in academic achievement at A levels.

In consideration of these findings, it would be naïve to completely disregard those studies that suggest that students of independent schools in England gain higher academic achievement than their state schools counterparts. However, what remained to be established was the extent to which the differences in academic achievement could be credited to attendance at independent schools.

It is clear that studies carried out in the UK tend to support the view that independent schools confer higher academic ability on students than state schools but some of the studies had clear limitations. For example, some of them did not control for students' prior ability and none of the studies looked at differences between the two sectors from early stages of students' education. Although they mostly suggest that independent schools have academic advantage over state schools, doubts still remain that the advantage is solely a result of school type. Therefore the jury is still out with regard to the true extent to which attendance at independent schools in England enhance the academic achievements of students when student and school-level differences are accounted for.

Evidence from Australia and the U.S.A

In Australia, although the over-representation in the professions by former students of independent schools had been reported by several authors (Higley et al, 1976, Higley et al 1979, Commonwealth Dept. of Education), some did not agree that the observed differences in academic achievement in favour of independent schools would be sustainable if students' backgrounds were accounted for. They argued that the students of independent schools came from medium and high class family backgrounds and were often selected based on prior ability and of course, the ability to pay (Graetz (1990). It was also suggested that many of the students of independent schools were more likely than the rest to have parents who had attended independent schools (Ryan and Sibieta, 2010).

Also in Australia, after controlling for student attributes Williams et al., (1981) found only small between-sector differences in the performances of primary school pupils in independent and state schools on a word knowledge test but found no differences between the two groups in the tests for basic reading and numeracy skills.

Graetz (1990) reported that the advantages of attending private schools in Australia were mostly seen in those students whose parents were also educated in private schools and that school effects accounted for

only a small proportion of the variance in educational attainments. He posited that his results indicated that "inequalities in educational attainments were primarily due not to the type of school people attended, nor to differences between so-called working class and ruling-class schools but to the background, gender and abilities of individuals". He concluded that school-sector differences were relatively modest and in some cases not statistically significant.

William and Carpenter (1991) investigated the benefit of educational achievement and attainments that accrued to Australian families who bought non-government schooling for their children instead of accepting the state-sponsored free schooling. They concluded from their data analysis that although those parents who bought private schooling for their children, in fact, got a return on their investment, but that the return was probably not as much as they thought.

In the USA, Coleman et. al. (1982) studied the performances of 10^{th} and 12^{th} graders on achievement tests and found that students from Catholic and other private schools achieved higher than students from public schools in vocabulary and mathematics after controlling for differences within students and schools. Results from further analysis by these authors demonstrated that school policies in the areas of discipline and student behaviour were responsible for the differences observed.

Braun et al. (2006) examined the differences between the mean National Assessment and Progress (NAEP) Reading and Mathematics scores between public and private schools in the USA taking into account gender, ethnicity, disability status, English Language learner status, school size, location and student composition. For grade 4 students in the study, they found that after controlling for student differences the difference in the mean scores of public and private students in Reading were not statistically significant. Results for Grade 8 students also showed that when student characteristics were taken into account students from private schools had higher Reading scores that were also statistically significant, although the difference in Mathematics was not statistically significant.

Goldhaber (1996), using the 1988 US National Education Longitudinal Study data investigated the influence of the choice to attend private school on students' achievements. He found that students in private schools tended to come from families with more educated parents that had substantially higher incomes and that the private school students outscored their public school counterparts in Mathematics and Reading tests. However, his results also showed that student differences seemed to account for the majority of the differences compared to school sector effects, student characteristic effects and selection effects.

In similarity to those carried out in England, studies in Australia and the United States found little or no significant differences between the educational outcomes of independent and state schools. In fact they attributed whatever little difference found in favour of independent schools to differences in family backgrounds of the students.

Evidence from developing countries

In India, Chudgar and Quin (2012) studied the role of private schools in Indian education using a household dataset from India with a rich set of household covariates and student performance data on Reading, Writing and Mathematics. Using regression analysis they produced results which indicated that private school students performed better than public school students in both rural and urban India when appropriate covariates were accounted for. However, the private school benefit became statistically insignificant when the analysis was carried out on data balanced using the propensity score matching technique.

Desai et al. (2008) examined the effects of private school enrolment in India on educational quality. The results suggested that controlling for the likely effects of school choice, children in private schools had higher Reading and Arithmetic skills than those in government schools. They observed that although overall gains were modest in size, about one fourth to one third of a standard deviation, the gains for students from lower economic strata were higher than those for upper income students.

In Nepal, using data from the survey of the Ministry of Education, Nepal-2005 for School Leaving Certificate Exam, Thapa (2012) analysed public and private school performance in Nepal by applying ordinary least square regression and produced results which suggested that private school students performed better than public school students. However, he gave no indication of the magnitude of the gain of attending private schools.

Tooley et al (2011) using performance data from randomly selected schools in Nigeria and controlling for socioeconomic factors showed that children enrolled in private schools significantly outperformed children enrolled in the state-run schools despite much greater teacher salary expenditures in the latter.

Ashley et al. (2014) reviewed evidence of the role and impact of private schools on the education of school age children in developing countries and found strong evidence to suggest that teaching was better in private schools than in state schools in terms of higher levels of teacher presence and teaching activity as well as teaching approaches that were more likely to lead to improved learning outcomes. They also found

moderate evidence that private school pupils achieved better learning outcomes when compared with state schools although there was ambiguity about the size of the true private school effect.

Although the schools systems in India, Nepal, Nigeria and other developing countries are expected to be significantly different from the systems in England, Australia and the U.S.A it is interesting to note that studies in those countries reported higher educational output for private schools compared to state schools. It is also important to note that only modest advantages were recorded after students' backgrounds were controlled for.

Conclusions from existing evidence

It is apparent from the available literature that the effect of attending independent schools on the academic achievements of students has been a subject of interest for a long time in several parts of the world. Although many researchers provided evidence in support of the notion that independent schools conferred higher educational advantage on students over students of state schools there is also evidence that any differences between the academic achievements of the two sectors diminished substantially when social background of the students were accounted for (Coleman 1966), Williams and Carpenter (1990). Clearly, robust statistical evidence would be required to determine whether the academic advantage that students of independent schools seem to have over their state school counterparts is real or a reflection of their advantages in family background and prior academic ability.

In this study we have investigated the differences between the academic achievements of students in independent and state schools after controlling for the effects of prior ability of students, students' socioeconomic status, students' gender as well as school level differences.

We have also provided answers to questions regarding (i) whether there is any particular stage during their education at which students from independent and state schools differ in their academic performances (ii) whether there are any particular subjects in which the performances of students from the two educational sectors differ at GCSE (iii) how each of the different student and school differences controlled for affect differences in the academic performances of students from independent and state schools, and (iv) whether the fact that a school is single or mixed gender affect any differences that might exist between the academic performances of students in independent and state schools.

2. Methodology and Data analysis

The aim of this study was to investigate the differences between the academic attainments of students of independent and state schools and to provide answers to pertinent questions. Most of the studies carried out in England were not fair comparisons of students of the two sectors because the cross-sector differences in the characteristics of the students such as socioeconomic status were not taken into account. Moreover, the studies were carried out on data that had no information on students' academic ability at a very early age in education, therefore differences in academic attainments of students from independent and state schools at early stages of education have yet to be reported. In this study the datasets that were analysed had information on pupils' prior academic ability from their early age as well as their socioeconomic status.

2.1. Data analysed

In this study we have used the Performance Indicators in Primary Schools (PIPS) assessment data and GCSE results as measures of educational attainment. PIPS (Tymms et al., 2014) is one of CEM's monitoring systems from which a lot of data has been collected over many years from both independent and state schools. The PIPS assessments system is for primary school pupils (Reception to Year 6) and evaluates performance in mathematics, literacy and developed ability. It also monitors progress and provides predictions to later outcomes as well as value added measures from previous PIPS assessments. The availability of assessment data from Reception class widened the scope of this study enabling us to extend the investigation of the differences between students of the two educational sectors down to the period before students enrolled into primary schools.

We have used the PIPS assessment data of students from Start of Reception (SOR) at age 4 to primary school at Year 6. We have predicted PIPS Year 4 scores using PIPS Start of Reception (SOR) average scores and PIPS Year 6 scores using PIPS Year 4 average scores. We have also used PIPS (SOR), PIPS Year 4 and PIPS Year 6 to predict GCSEs. The average PIPS scores for all the regression models meant the average of Reading and Mathematics scores of the appropriate PIPS year. GCSE results used in the study were obtained from the National Pupil Database (NPD) at the Department for Education (DfE) and the outcome subjects focussed on were Mathematics, English Language, English Literature, Chemistry, Biology, Physics, French, History and Geography as well as the average of best 8 subjects at GCSE. The GCSE grades were assigned numerical values as follows: A* = 8, A = 7, B = 6, C = 5, D = 4, E = 3, F = 2 and G = 1.

2.2. Method of analysis

A comparison of the PIPS and GCSE mean scores of independent and state schools indicated that independent schools had higher mean scores. However, the extent to which attendance at independent school contributed to the differences was unknown. Therefore a statistical procedure was required to find out the extent to which the differences in the mean scores were due to attendance at independent schools.

The data analysis was carried out using the Ordinary Least Squares (OLS) regression method. The OLS regression method estimates the unknown parameters in a linear regression model by minimizing the differences between the observed outcomes and the responses predicted by the linear approximation of the data. The resulting estimate can be expressed by a simple formula allowing particularly easy interpretation. The method allowed us to control for cross-sector differences thereby enabling a fair comparison. The underlying principle is that if the observed sector-differences in educational achievements disappear when student-linked attributes are taken into account in the model, then there would be no basis to think that attending an independent school had any academic advantage over state schools. If on the other hand differences remain after controlling for the student attributes then we can say that there is a potential basis to claim advantage of attending independent schools over state schools. However, it is almost impossible to control for all factors in analysis like this.

Multi-level modelling method would also have been useful if we had wanted to include schools as individual factors within the model. However, we know historically that the school level effects from these models tend to be very small and with potentially small data sets lead to a greatly increased risk of overfitting the data (Snijders and Bosker, 1999).

2.3. Variables of interest

2.3.1. Outcome variables

The outcome measures for the regression models that investigated differences within primary schools were the Mathematics and Reading scores of the PIPS Year 4 and Year 6 assessments. For the outcome measures used to investigate differences at GCSE level the measures of academic achievement were the grades scored at GCSE in Mathematics, English Language, English Literature, Physics, Chemistry, Biology, French, History and Geography as well as the average of best eight subjects at GCSE.

2.3.2. Input variables (variables controlled for)

The variables controlled for were:

(i) Prior academic ability: The measures of prior academic ability of the students were the average scores in Mathematics and Reading of PIPS Start of Reception (SOR) which assesses children at age 4 , PIPS Year 4 or PIPS Year 6. The PIPS Reading and Mathematics scores were standardised to a have a mean of 50 and standard deviation of 10. The descriptive statistics of these variables are shown in the *Results and Discussion* section.

(ii) Deprivation: The level of deprivation of students was measured by the Index of Deprivation Affecting Children Index (**IDACI**). The IDACI values of the pupil population were standardised to a mean of 0 and standard deviation of 1. The descriptive statistics of this variable are shown in the *table below.*

	No of students		**Mean of IDACI**		**Std. dev. of IDACI**	
Regression models	**Indep.**	**State**	**Indep.**	**State**	**Indep.**	**State**
PIPS SOR, 2010 to Year 4, 2014	476	1273	-0.72	-0.29	0.37	0.82
PIPS Year 4, 2012 to PIPS Year 6, 2014	339	221	-0.67	-0.21	0.45	1.24
PIPS SOR, 2003 to GCSE 2014	3540	60450	-0.70	0.03	0.61	1.00
PIPS Year 4, 2007 to GCSE 2014	2423	13389	-0.58	0.97	0.64	0.23
PIPS Year 6, 2009 to GCSE 2014	1549	1709	-0.58	0.26	0.53	1.09

Table (a): Descriptive statistics of the deprivation index (IDACI)

(iii) Gender: Students gender had a value of 1 for girls and 0 for boys

(iv) Whether a school was all girls: All_Girls school was a variable that had 1 if it was a girls' school and 0 if it was not.

(v) Whether a school was all boys: All_Boys school was a variable that had 1 if the school was all boys and 0 if it was not.

(vi) Independent school indicator: Independent was an indicator variable that indicated whether the school was an independent school or not. The indicator variable was assigned a value of 1 if the school was an independent school and 0 when it was a state school. The coefficient of the indicator variable was a measure of the difference in the performance of independent and state school students.

(vii) Compositional variable: A compositional variable was included to indicate the characteristics of the composition of a body of students in a school. It was an average school performance derived by aggregating the average of the students' prior academic ability.

2.3.2.1. Definitions

(i) There was no variable in the datasets we analysed that identified schools as single sex, therefore whether or not a school was single sex was determined by calculating directly from the data. The vast majority of schools in the data had mix of pupils with between 30% and 70% who were female with a few additional schools which were all male or all female. However a small number of schools also appeared to be almost single sex with a very small number of pupils of the opposite sex and it was not clear whether this was due to errors in the data. Therefore to reduce the risk of falsely excluding single sex schools from the classification, cut points based on 10% and 90% of pupils in each school were used to determine if the school was all male or all female respectively. We note, even with this broad definition the number of single sex schools in the subsequent analysis is often lower than ideal.

(ii) The set of independent schools involved in the study were defined by the ISC. They provided a list of independent schools.

2.4. Measures taken to reduce bias

In addition to the raw datasets we analysed other sets of data on which the processes of imputation or/and propensity score matching were carried out.

Imputation

It is not uncommon to find one or more missing values for pupils in datasets and excluding those pupils from the analysis may affect the representativeness of the data and introduce bias to the results. The process of imputation replaces missing data with simulated values and thereby avoids the potential pitfalls otherwise involved with simply removing all pupils that have any missing values. The estimated values are based on other available information for that pupil. Once all missing values have been imputed, the data set can then be analysed. There are various risks with imputing data where the resulting analysis unduly reflects the imputed values and not the true underlying distribution, so results of imputation should be interpreted with some caution. We have carried out imputation using the Amelia package in the R software and applied the process separately for each subject across the following variables: “Overall PIPS score”, “Female”, “Independent school”, “All girls school”, “All boys school”, “PIPS average score of school” and “IDACI”. Only a single imputation was computed on each occasion and hence results were just indicative of the potential biases that may be caused by missing data. More information about imputation can be found at https://cran.r-project.org/web/packages/Amelia/index.html.

Propensity score matching (PSM)

There is a possibility of bias within the original data because the observed difference in outcome between the two groups of students may also depend on characteristics that affected whether or not a pupil attended an independent school instead of being a result of the effect of independent schooling per se. In randomised experiments, the randomisation enables unbiased estimation of treatment effects for each covariate. Randomization implies that treatment-groups will be balanced. Unfortunately, for observational studies such as this, the assignment of treatments to research subjects is not random and the two groups being compared can be quite different in their known characteristics. Clearly this is the case here, with the samples of Independent and State pupils differing appreciably in, for example, their deprivation (IDACI) and prior attainment (PIPS) scores. When regression models are used to estimate residual differences between such groups, these initial differences can bias the resulting estimates.

Propensity score matching (PSM) attempts to address this by creating a sample of units that received the treatment that is comparable on all observed covariates to a sample of units that did not receive the treatment. PSM allowed us to attempt to estimate the effect of independent schooling by accounting for the covariates that predict that a pupil would attend an independent school. PSM attempts to reduce the bias due to confounding variables that could be found in an estimate of the treatment effect obtained from simply comparing outcomes among pupils that attended independent schools versus those that did not. The technique was first published by Paul Rosenbaum and Donald Rubin in 1983 (Rosenbaum and Rubin, 1983). Although PSM can provide a useful check on whether an estimate of the difference between two groups is sensitive to the lack of overlap in the covariates being controlled for, it cannot of course provide any information about the effects of any unobserved differences.

Using the MatchIt package in R, propensity score matching was applied to the independent school flag against the following set of variables: "Overall PIPS score", "Female", "All girls school", "All boys school" and "PIPS average score of school".

	Before PSM	**after PSM**
zMaths (Independent)	56.2 (8.75)	56.3 (8.75)
zMaths (State)	50.2 (9.79)	55.9 (9.5)
zReading (Independent)	58.1 (9.63)	58.2(9.63)
zReading (State)	50.5 (10.12)	56.5 (10.14)

Table (b): z-scores for PIPS Year 4 Mathematics and Reading of 2014 before and after Propensity Score Matching was carried out

Table (b) shows the effect of Propensity score matching on scores. Before the matching the values for state schools were very low compared to those of independent schools but matching had the effect of increasing the similarity between them

There were four sets of results for each comparison to enable the reader to see the effects that imputation, propensity scores matching, propensity score matching on imputed data and not carrying out any of these procedures had on the differences between the academic achievements of independent and state schools.

2.5. Representativeness of data

All PIPS data used in this study were obtained from the CEM database at Durham University while all Key Stage 4 results were obtained from the National Pupil Database (NPD) at the Department of Education (DfE).

In order for the results of this study to be generalisable to the whole population it was important to investigate whether the samples that were going to be analysed were representative of the population from which they were obtained.

To determine the representativeness of our samples we compared the means and standard deviations of the average of best eight GCSEs of the various populations (national data) to those of their corresponding samples (CEM data). We also compared the distributions of the average of the best eight GCSEs of each population to that of the corresponding samples.

Data from five cohorts of students were analysed in this project and only selected graphs and tables were presented. The evidence that have been presented in support of the representativeness of the samples were derived from the cohort of students whose data were used for the regression analysis from PIPS SOR to GCSEs. A thorough examination of data from other cohorts confirmed that all the datasets showed the same trend to this cohort. The evidence is shown in Tables (i), (ii) and (iii) and Figures (i) Figures (ii) and (iii).

	Mean		**Std. dev.**	
Regression model	**Whole Population**	**CEM Sample**	**std. dev. for population**	**std. dev. For sample**
PIPS SOR, 1999 to GCSE 2010	4.9	4.8	1.7	1.6
PIPS SOR, 2000 to GCSE 2011	4.8	4.8	1.7	1.7
PIPS SOR, 2001 to GCSE 2012	4.9	4.8	1.7	1.7
PIPS SOR, 2002 to GCSE 2013	4.9	4.9	1.7	1.7
PIPS SOR, 2003 to GCSE 2014	5.1	5.2	1.6	1.6

Table (i): Summary statistics of the average of best 8 GCSEs for whole population and whole sample

Table (i) shows the means and standard deviations of the average of 8 best GCSEs. The population consisted of all schools in England including state and independent schools while the sample was all schools in CEM that were used in this study. The values for sample and population were very similar.

	Mean		Std. dev.	
Regression model	**Independent school population**	**Independent school sample**	**Population std. dev.**	**Sample std. dev.**
PIPS SOR, 1999 to GCSE 2010	6.6	6.7	1.0	1.0
PIPS SOR, 2000 to GCSE 2011	6.6	6.8	1.1	0.9
PIPS SOR, 2001 to GCSE 2012	6.8	6.9	1.1	1.0
PIPS SOR, 2002 to GCSE 2013	6.7	6.8	1.1	1.0
PIPS SOR, 2003 to GCSE 2014	6.5	6.6	1.1	1.1

Table (ii): Summary statistics of the mean of best 8 GCSEs for Independent schools in the population and sample

Table (ii) compares the means and standard deviations of the average of best 8 GCSEs for the independent schools population and sample. The population of independent schools consisted of all independent schools that had GCSE results in the data acquired from the NPD while the independent schools sample were the independent schools in CEM data that were used in this study. The means and standard deviations of population and sample are very similar.

	Mean		Std. dev.	
Regression models	**State school population**	**State school sample**	**Population std. dev.**	**Sample std. dev.**
PIPS SOR, 1999 to GCSE 2010	4.8	4.7	1.7	1.6
PIPS SOR, 2000 to GCSE 2011	4.8	4.8	1.7	1.7
PIPS SOR, 2001 to GCSE 2012	4.8	4.7	1.7	1.7
PIPS SOR, 2002 to GCSE 2013	4.8	4.8	1.7	1.7
PIPS SOR, 2003 to GCSE 2014	5.1	5.1	1.6	1.6

Table (iii): Summary statistics of the average of best 8 GCSEs for state schools in the population and sample

Summary statistics for the state school population and sample are shown in Table (iii). The population consisted of all state schools in England while the sample was all state schools in the CEM data used in the analysis. The sample and population values were quite similar.

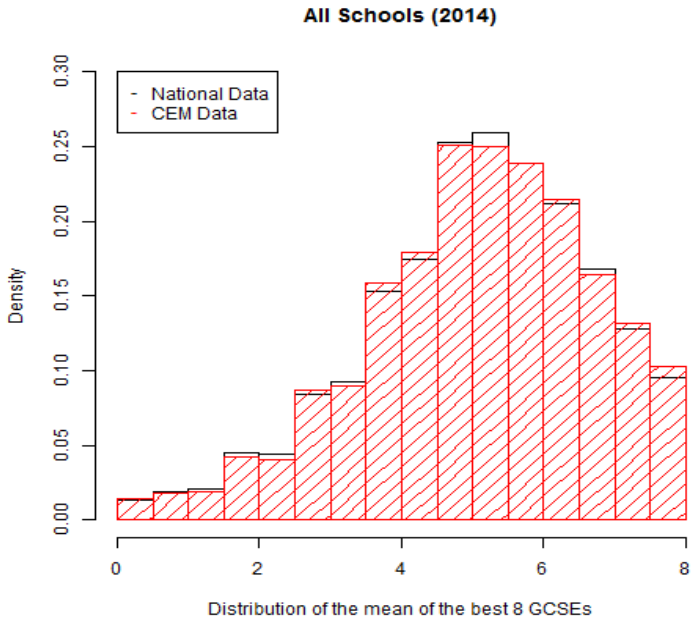

Figure (i): Distributions of the average GCSEs of 2014 for whole population and whole sample

Figure (i) shows the distribution of the mean of best 8 GCSEs for all National data (whole population) and all CEM data (whole sample) used in the analysis. The graph shows that the two sets of data are very similar.

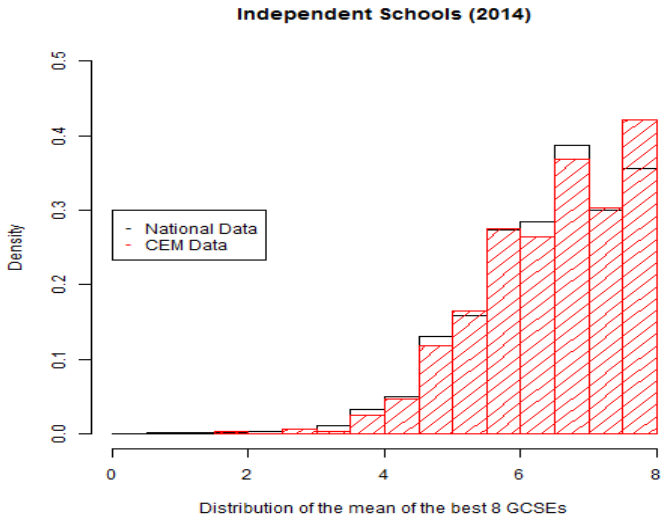

Figure (ii): The distributions of the average of 8 best GCSEs of 2014 of both population and sample of independent schools

Figure (ii) shows the distribution of the mean of best 8 GCSEs for independent schools in the national and CEM data used in the analysis. This graph shows that the distribution both population and sample of independent schools are similar.

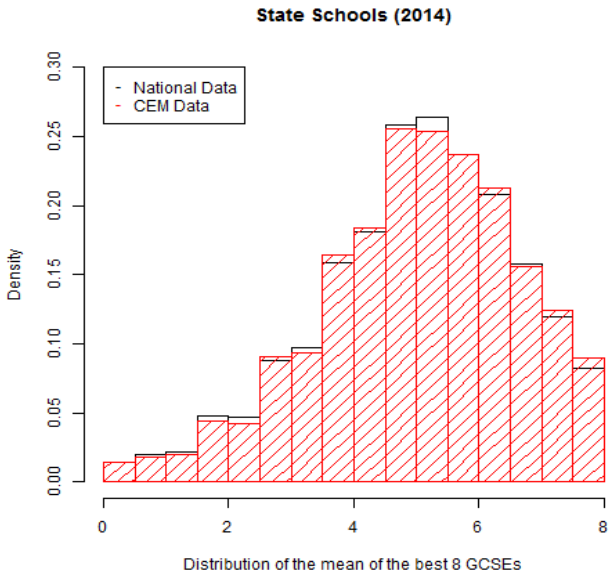

Figure (iii): The distributions of the average of best 8 GCSEs of 2014 of both population and sample of state schools.

The distribution of the mean of the best 8 GCSEs for state schools in the population and sample is shown in Figure (iii). This figure shows that state schools in the population and sample are similar.

We have conducted equivalent checks for representativeness of our samples for each set of regression model. The average PIPS scores as well as average GCSE scores were very similar for each cohort thereby confirming the representativeness of our samples.

2.5.1. Summary of representativeness

Tables (i), (ii) and (iii) as well as Figure (i), (ii), and (iii) show how close the summary statistics and the distributions of population and sample are in all the cohorts of students we have studied. We believe that the CEM data that were used in the study closely represented the data obtained from the DfE.

3. Results and Discussions

In this study we have used the Reading and Mathematics scores of the PIPS start of reception (SOR), the PIPS Year 4 and the PIPS Year 6 assessment datasets in several regression analyses that in some cases also involved GCSE results of the students.

3.1. Evidence from PIPS Start of Reception datasets (SOR)

In this section we present the results of the analysis using the average of the scores in Reading and Mathematics of the PIPS (SOR) datasets to predict the results of PIPS Year 4 and GCSE.

3.1.1. Analysis of PIPS SOR to PIPS Year 4 assessment

3.1.1.1. Description of the SOR dataset for regression to PIPS Year 4

The PIPS (SOR) datasets that were used for this analysis were:
PIPS SOR 1999 to PIPS Year 4, 2003
PIPS SOR 2000 to PIPS Year 4, 2004
PIPS SOR 2001 to PIPS Year 4, 2005
PIPS SOR 2002 to PIPS Year 4, 2006
PIPS SOR 2003 to PIPS Year 4, 2007
PIPS SOR 2008 to PIPS Year 4, 2012
PIPS SOR 2010 to PIPS Year 4, 2014

Each of these datasets was produced by matching the appropriate PIPS SOR assessment scores of students to the PIPS Year 4 assessments scores of the year that the cohort of students had PIPS Year 4 assessment. The numbers of schools and students in each dataset are shown in Table 1.

	Number of schools		Number of pupils	
Regression models	**Independent**	**State**	**Independent**	**State**
PIPS SOR 1999 to PIPS Year 4, 2003	24	949	368	21647
PIPS SOR 2000 to PIPS Year 4, 2004	32	902	523	19659
PIPS SOR 2001 to PIPS Year 4, 2005	46	900	654	16853
PIPS SOR 2002 to PIPS Year 4, 2006	54	863	793	20242
PIPS SOR 2003 to PIPS Year 4, 2007	54	771	805	16917
PIPS SOR 2008 to PIPS Year 4, 2012	41	149	697	2938
PIPS SOR 2010 to PIPS Year 4, 2014	24	69	478	1289

Table 1: Numbers of schools and students in the PIPS SOR to PIPS Year 4 regression analysis by school type

The numbers of schools and students in each dataset are presented by school type and they only include schools and pupils with data at SOR and PIPS Year 4.

	Number of students		Mean		Std. dev.	
Subject	**Independent**	**State**	**Independent**	**State**	**Independent**	**State**
Reading	478	1289	56.1	49.14	8.07	9.24
Mathematics	478	1289	56.08	49.1	8.08	9.63

Table 2: Summary statistics of the PIPS (SOR) average scores of 2012 in Reading and Mathematics by school type

Table 2 shows that independent schools had higher average scores in Reading and Mathematics of the PIPS SOR of 2010. It is important to note that independent schools had a higher ability intake even at this very early stage of education.

	Number of students		Mean		Std. dev.	
Subject	**Independent**	**State**	**Independent**	**State**	**Independent**	**State**
Reading	478	1289	55.85	49.33	8.27	9.14
Mathematics	478	1289	57.29	49.87	8.53	9.4
Deprivation (IDACI)	476	1273	-0.72	-0.29	0.37	0.82

Table 3: Summary of PIPS Year 4 assessment scores of 2014 in Reading and Mathematics by school type

Table 3 shows the summary of the PIPS Year 4 assessment of 2014. The students that were assessed with the PIPS SOR in 2010 had their PIPS Year 4 assessment results in the dataset that was analysed. Independent schools had higher average scores in both Reading and Mathematics. They also had lower average IDACI which indicated that their students came from areas that were less deprived than the areas state school students came from. Apparently there were differences between the students of independent and state schools and these differences needed to be taken into account before a fair comparison between the two sectors can be made.

Table 4 shows the results of OLS regression analysis of PIPS SOR 2010 to PIPS year 4, 2014 assessments in which deprivation (IDACI), prior ability (mean of PIPS SOR Reading and Mathematics), gender as well as other school-level variables were controlled. A compositional variable derived from aggregating the PIPS SOR of students by school was also controlled for.

	Mathematics	Reading
Intercept (s.e)	51.17 (0.3)	49.3 (0.28)
Overall PIPS score (s.e)	5.73 (0.22)	5.96 (0.21)
IDACI (s.e)	-0.47 (0.29)	-0.26 (0.27)
Female (s.e)	-1.9 (0.38)	1.09 (0.35)
Independent_school (s.e)	3.34 (0.59)	1.54 (0.54)
All_Girls school (s.e)	0.05 (1.1)	0.17 (1.02)
All_Boys school (s.e)	2.48 (1.15)	0.98 (1.06)
SchoolAveragePIPS	-1.22 (0.6)	-0.1 (0.55)
df	1759	1757
R^2	0.39	0.44
N	1767	1765
No. of pupils (indep.)	478	477
No. of pupils (state)	1289	1288
No. of schools (indep.)	24	24
No. of schools (state)	69	69

Table 4: Results of the regression from PIPS SOR 2010 to PIPS Year 4, 2014 assessments

The results showed that the prior ability variable, 'Overall PIPS score' was the highest contributing factor and was positive and statistically significant for both Y4 Reading and Y4 Mathematics ability. The deprivation (IDACI) variable had a small non-statistically significant negative effect on the outcome. Being a female student was associated with decreased scores in Mathematics but increased scores in Reading. Being an All_girls school did not significantly affect the outcome for Reading and Mathematics but being an All_boys school significantly enhanced the average performance in Mathematics, however these findings should be treated with caution because of the small number of single sex schools involved. The coefficients of the independent school variable for predicting Y4 Reading and Mathematics were both positive and statistically significant. Bringing all these factors together, independent schools still produced higher average PIPS Year 4 scores than state schools even after a range of socioeconomic, prior ability and school-level factors were controlled for.

	Coefficients of the independent school variable	
	Mathematics	**Reading**
Original analysis (s.e)	3.34 (0.59)	1.54 (0.54)
Propensity matched on raw data (s.e)	3.42 (0.64)	1.61 (0.6)
Imputation (s.e)	2.95 (0.43)	1.45 (0.41)
Propensity on Imputed data (s.e)	3.3 (0.45)	1.81 (0.44)

Table 5: Regression coefficients of the independent school variable obtained from data matched by different methods (PIPS SOR, 2010 to PIPS Year 4, 2014)

The analysis was repeated for six other datasets but we have pulled out one set of coefficients in each case to demonstrate the robustness of the data.

Table 5 shows the coefficients of the independent schools variable after the data was subjected to propensity score matching (PSM) and imputation before analysis. There were no major differences between the coefficients and each coefficient remained positive and statistically significant. Therefore imputation and propensity score matching did not affect the results.

In order to ascertain the consistency of results obtained from this analysis, datasets from seven different cohorts of students were analysed. The seven groups consisted of students that had the PIPS SOR assessments in 1999, 2000, 2001, 2002, 2003, 2008 and 2010 and therefore had PIPS Year 4 assessments in 2003, 2004, 2005, 2006, 2007, 2012 and 2014 respectively. Results of the analysis are shown in Table 6.

	Coefficients of the independent school variable	
Regression model	**Mathematics**	**Reading**
PIPS SOR 1999 to PIPS Year 4, 2003	2.77 (0.47)	4.51 (0.48)
PIPS SOR 2000 to PIPS Year 4, 2004	3.1 (0.41)	4.65 (0.4)
PIPS SOR 2001 to PIPS Year 4, 2005	4.11 (0.36)	4.78 (0.35)
PIPS SOR 2002 to PIPS Year 4, 2006	2.93 (0.31)	4.20 (0.32)
PIPS SOR 2003 to PIPS Year 4, 2007	2.50 (0.32)	4.04 (0.32)
PIPS SOR 2008 to PIPS Year 4, 2012	1.91 (0.45)	1.25 (0.41)
PIPS SOR 2010 to PIPS Year 4, 2014	3.34 (0.59)	1.54 (0.54)

Table 6: Independent schools regression coefficients for seven cohorts of students

Table 6 shows the regression coefficients of the independent schools variable for Mathematics and Reading for the seven cohorts of students. The coefficients were all positive and statistically significant. Therefore attendance at independent schools had positive effects on the PIPS Year 4 assessment score of each cohort after controlling for socioeconomic status, students' academic ability, gender and school-level factors.

3.1.1.2. Summary of evidence from the PIPS SOR to PIPS Year 4 regression

Independent schools had higher average scores in Reading and Mathematics in both PIPS SOR and PIPS Year 4 assessments. Prior attainment was the single highest contributing factor to the PIPS Year 4 assessment outcome. Attending an independent school also had a statistically significant effect on the PIPS Year 4 assessment scores and this effect was consistently positive and significant for all year groups analysed. It is important to note that independent schools had higher average scores than state schools even at the very early stage of education. This suggests that their intakes were of higher ability compared to the intakes of state schools.

3.1.2. Analysis of the PIPS SOR to GCSE dataset

3.1.2.1. Description of the dataset for PIPS SOR to GCSE regression analysis

The datasets used in the analysis were:

PIPS SOR 1999 to GCSE, 2010
PIPS SOR 2000 to GCSE, 2011
PIPS SOR 2001 to GCSE, 2012
PIPS SOR 2002 to GCSE, 2013
PIPS SOR 2003 to GCSE, 2014
The numbers of schools and students in each dataset are shown in Table 7

	Number of schools		Number of students	
Regression model	**Independent**	**State**	**Independent**	**State**
PIPS SOR 1999 to GCSE 2010	409	2506	2297	47436
PIPS SOR 2000 to GCSE 2011	454	2753	3327	57330
PIPS SOR 2001 to GCSE 2012	449	2897	3189	60451
PIPS SOR 2002 to GCSE 2013	463	3040	3822	67071
PIPS SOR 2003 to GCSE 2014	479	3077	3540	60450

Table 7: No of schools and students by school type
Schools and students that did not have prior attainment data were excluded from this table.

	Number of students		Mean (sd)	
Subject	**Independent**	**State**	**Independent**	**State**
Average PIPS score	3540	60450	57.8 (8.1)	50.1 (9.27)
Reading	3540	60450	58.7 (9.0)	50.0 (9.8)
Mathematics	3540	60450	56.9 (8.6)	50.1 (9.9)

Table 8: Descriptive statistics of PIPS SOR assessment scores for the PIPS SOR 2003 to GCSE 2014 regression model

Table 8 shows the descriptive statistics by school type of the PIPS SOR assessment scores for students who had the assessment in the 2003. The descriptive statistics of the assessment scores of students who were assessed in 1999, 2000, 2001 and 2002 were also examined and in each case independent schools had higher average scores than their state schools counterparts. Evidently independent schools had a higher ability intake than state schools. The students that were assessed using the PIPS SOR in 2003 went on to sit for GCSEs in 2014 and the descriptive statistics of the GCSE results for that cohort are shown in Table 9.

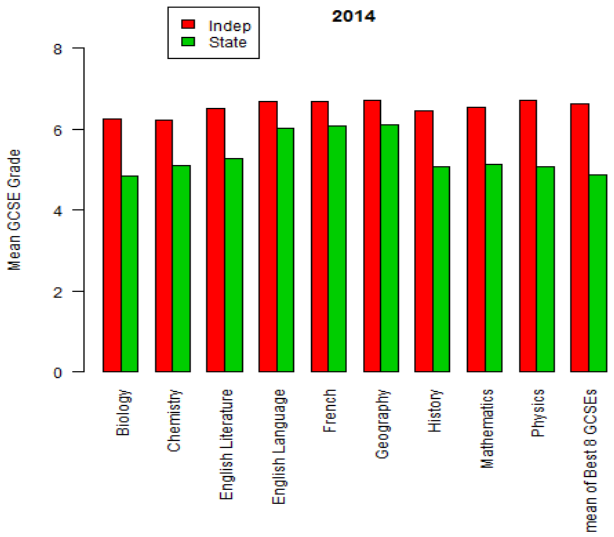

Figure 1: A comparison of the average GCSEs for the 2014 cohort who had PIPS SOR in 2003, by school type

Figure 1 shows that the independent schools had higher average GCSEs in all subjects than the state schools. They also had higher average scores in the mean of best eight GCSEs.

	Number of students		Mean		Standard deviation	
Subject	**Indep.**	**State**	**Indep.**	**State**	**Indep.**	**State**
Mathematics	1574	59878	6.25	4.84	1.31	1.84
English Language	1508	58595	6.23	5.1	1.25	1.43
English Literature	1533	43292	6.52	5.28	1.11	1.57
Biology	985	13488	6.67	6.03	1.17	1.35
Chemistry	884	12984	6.69	6.07	1.15	1.27
Physics	849	13053	6.7	6.12	1.17	1.25
French	1287	15151	6.44	5.07	1.4	1.52
Geography	1577	20065	6.54	5.14	1.3	1.74
History	1798	24162	6.72	5.07	1.29	1.93
Mean of Best 8 GCSEs	3540	60450	6.62	4.86	1.09	1.63
Deprivation (IDACI)	3540	60450	-0.7	0.03	0.61	1

Table 9: Descriptive statistics of GCSE results of 2014 for the students who had PIPS SOR in 2003

Table 9 shows that students of independent schools had an average GCSE score of 6.62, (between grades A and B) while students of state schools had an average of 4.86 (grades C and D). This meant that the average GCSE grade of students of independent schools was higher than that of students of state schools by just below 2 GCSE grades. In the individual GCSE grades the average performance of students of independent school students was also generally higher than those of state school students. Similar trends were observed for the cohorts of students that had PIPS SOR assessments in 1999, 2000, 2001 and 2002

and GCSEs in 2010, 2011, 2012 and 2013 respectively. It is worthy to note that the average IDACI for state schools was higher than that of independent schools, indicating that students of state schools came from areas that were more deprived than those of students of independent schools.
These differences between students of independent and state schools needed to be taken into account for a fair comparison of the two sectors to be made.

In Table 10 we present the results of a regression analysis from PIPS SOR, 2003 to a range of GCSEs taken in 2014 in which deprivation (IDACI), prior ability, gender, school-level variables and a compositional variable have been controlled for.

	Maths	**English**	**Eng. Lit.**	**Biology**	**Chem.**	**Phys.**	**Fren.**	**Geog.**	**Hist.**	**Mean of Best 8 GCSEs**
Intercept (s.e)	4.87 (0.01)	4.84 (0.01)	4.82 (0.01)	5.59 (0.02)	5.72 (0.02)	5.82 (0.02)	4.51 (0.02)	4.74 (0.01)	4.71 (0.02)	4.69 (0.01)
Overall PIPS score (s.e)	0.82 (0.01)	0.59 (0.01)	0.52 (0.01)	0.32 (0.01)	0.26 (0.01)	0.25 (0.01)	0.45 (0.01)	0.58 (0.01)	0.6 (0.01)	0.68 (0.01)
IDACI (s.e)	-0.25 (0.01)	-0.19 (0.01)	-0.26 (0.01)	-0.22 (0.01)	-0.16 (0.01)	-0.18 (0.01)	-0.19 (0.01)	-0.3 (0.01)	-0.3 (0.01)	-0.28 (0.01)
Female (s.e)	-0.14 (0.01)	0.46 (0.01)	0.57 (0.01)	0.18 (0.02)	0.1 (0.02)	-0.06 (0.02)	0.44 (0.02)	0.29 (0.02)	0.23 (0.02)	0.29 (0.01)
Independent sch. (s.e)	0.41 (0.04)	0.36 (0.03)	0.42 (0.04)	0.13 (0.04)	0.19 (0.04)	0.14 (0.04)	0.63 (0.04)	0.50 (0.04)	0.62 (0.05)	0.54 (0.02)
All_Girls School (s.e)	0.52 (0.03)	0.27 (0.02)	0.38 (0.03)	0.27 (0.04)	0.2 (0.04)	0.24 (0.04)	0.37 (0.04)	0.4 (0.04)	0.52 (0.04)	0.47 (0.02)
All_Boys School (s.e)	0.47 (0.03)	0.42 (0.03)	0.64 (0.03)	0.39 (0.04)	0.33 (0.04)	0.31 (0.04)	0.72 (0.05)	0.48 (0.05)	0.52 (0.05)	0.51 (0.03)
SchoolAverage PIPS score (s.e)	0.12 (0.01)	0.1 (0.01)	0.15 (0.01)	0.2 (0.01)	0.18 (0.01)	0.21 (0.01)	0.22 (0.01)	0.21 (0.01)	0.21 (0.01)	0.19 (0.01)
df	61444	60095	44817	14465	13860	13894	16430	21634	25952	63982
R2	0.3	0.3	0.27	0.17	0.13	0.14	0.25	0.27	0.24	0.38
N	61452	60103	44825	14473	13868	13902	16438	21642	25960	63990
No. of Indep. School students	1574	1508	1533	985	884	849	1287	1577	1798	3540
No. of State school students	59878	58595	43292	13488	12984	13053	15151	20065	24162	60450
No. of Indep. Schools	290	269	265	203	192	187	278	345	357	479
No. of State schools	3026	2940	2472	1541	1512	1513	1754	2036	2190	3077

Table 10: Result of regression analysis of PIPS SOR assessment score to GCSE 2014

The results show that the single highest contributing factor to the outcome of the model was the prior academic ability of the students. However, other factors such as the student gender and whether the school was an all_boys/all_girls school also had statistically significant effects. An increased deprivation (IDACI) was associated with a decreased GCSE outcome for all subjects.

The differences between independent and state schools as seen in the coefficients of the variable named 'Independent school' were positive and statistically significant for all subjects even after mitigating factors were controlled for. Therefore the average GCSE scores of independent schools were higher than those of state schools. The differences between the two school sectors were greater in French, History, Geography and Mathematics. They were smallest in Chemistry, Biology and Physics. It is worth noting the effects of single gender schools on the outcome in particular. Except in Geography and History the effect of being an all-boys school was higher than that of being an independent school. The effect of all-girls schools was also greater than that of being an independent school for Mathematics, Biology and Physics. The results also showed that controlling for student and school level factors dramatically reduced the differences in the average of best 8 GCSEs between the two sectors from just below 2 GCSE grades to 0.54 of a grade.

	Maths	**English**	**Eng. Lit.**	**Biology**	**Chem.**	**Phys.**	**Fren.**	**Geog.**	**Hist.**	**Mean of Best 8 GCSEs**
Original data (s.e)	0.41 (0.04)	0.36 (0.03)	0.42 (0.04)	0.13 (0.04)	0.19 (0.04)	0.14 (0.04)	0.63 (0.04)	0.50 (0.04)	0.62 (0.05)	0.54 (0.02)
Propensity matched on raw data (s.e)	0.33 (0.04)	0.26 (0.04)	0.43 (0.04)	0.13 (0.05)	0.13 (0.05)	0.13 (0.06)	0.55 (0.05)	0.50 (0.04)	0.57 (0.04)	0.46 (0.03)
Imputation (s.e)	0.41 (0.03)	0.37 (0.02)	0.40 (0.02)	0.10 (0.02)	0.21 (0.02)	0.05 (0.02)	0.62 (0.02)	0.47 (0.03)	0.61 (0.03)	0.53 (0.02)
Propensity matched on Imputed data (s.e)	0.26 (0.03)	0.30 (0.03)	0.41 (0.03)	0.13 (0.03)	0.18 (0.03)	0.05 (0.03)	0.60 (0.03)	0.47 (0.03)	0.59 (0.03)	0.45 (0.02)

Table 11: Regression coefficients of the independent school variable obtained from data matched by different methods (PIPS SOR, 2003 to GCSE 2014)

The analysis was repeated for four other datasets but we have pulled out one set of coefficients in each case to demonstrate the robustness of the data.

Table 11 showed that imputation generally resulted in little changes to the differences between the academic achievements of independent and state schools.

	PIPS SOR 1999 to GCSE 2010	PIPS SOR 2000 to GCSE 2011	PIPS SOR 2001 to GCSE 2012	PIPS SOR 2002 to GCSE 2013	PIPS SOR 2003 to GCSE 2014	Means of coefficients
Mathematics	0.47 (0.04)	0.68 (0.03)	0.72 (0.03)	0.65 (0.03)	0.41 (0.04)	0.59 (0.14)
English Language	0.58 (0.03)	0.60 (0.02)	0.65 (0.02)	0.48 (0.03)	0.36 (0.03)	0.51 (0.11)
English Literature	0.53 (0.03)	0.60 (0.03)	0.69 (0.03)	0.49 (0.03)	0.42 (0.04)	0.55 (0.10)
Biology	0.33 (0.04)	0.32 (0.03)	0.36 (0.03)	0.42 (0.03)	0.13 (0.04)	0.31 (0.10)
Chemistry	0.38 (0.04)	0.40 (0.03)	0.37 (0.03)	0.42 (0.03)	0.19 (0.04)	0.35 (0.09)
Physics	0.36 (0.04)	0.43 (0.03)	0.4 (0.03)	0.48 (0.03)	0.14 (0.04)	0.36 (0.13)
French	0.71 (0.04)	0.76 (0.04)	0.76 (0.04)	0.74 (0.04)	0.63 (0.04)	0.72 (0.05)
Geography	0.62 (0.05)	0.52 (0.04)	0.54 (0.04)	0.56 (0.04)	0.50 (0.04)	0.55 (0.05)
History	0.73 (0.05)	0.67 (0.05)	0.68 (0.05)	0.74 (0.04)	0.62 (0.05)	0.69 (0.05)
Mean of Best 8 GCSEs	0.64 (0.03)	0.76 (0.03)	0.79 (0.03)	0.69 (0.02)	0.54 (0.02)	0.68 (0.10)

Table 12: Independent schools coefficients for different years for the regression analysis of PIPS SOR to GCSEs

Datasets for student cohorts who were assessed with the PIPS SOR in 1999, 2000, 2001 and 2002 and therefore sat GCSEs in 2010, 2011, 2012 and 2013 respectively were also analysed and the differences between the results of independent and state schools are shown in Table 12. While there is fluctuation across different year groups, every coefficient is positive and significantly greater than zero. It is however notable that every subject had a lower coefficient in 2014 than any of the preceding years and the reason for this is not known.

3.1.2.2. Summary of evidence from PIPS SOR data

Prior academic ability was the single highest contributing factor to the GCSE outcome. It increased the outcome significantly for all subjects. Higher deprivation decreased both PIPS Year 4 and GCSE outcomes.

Being a girl was associated with reduced PIPS Year 4 outcome in Mathematics but an increased increase in Reading score. It is also associated with a decrease in the GCSE outcome in Mathematics and Physics.

Independent schools had higher average scores than state schools in the PIPS SOR (2003) assessment as well as the GCSE results. The greatest effects of independent schooling were mostly recorded in History, French and Geography and the lowest were in Chemistry, Biology and Physics.

Differences between the two sectors remained almost constant over the period 2010 to 2013. They were lower in 2014. This should be investigated in more detail and followed up in future years to try and identify the cause.

3.2. Evidence from PIPS Year 4 assessments

3.2.1. PIPS Year 4 to PIPS Year 6

3.2.1.1. Description of PIPS Year 4 assessment dataset

The PIPS Year 4 assessment data used for this analysis were:
PIPS Year 4, 2003 to PIPS Year 6, 2005
PIPS Year 4, 2004 to PIPS Year 6, 2006
PIPS Year 4, 2005 to PIPS Year 6, 2007
PIPS Year 4, 2006 to PIPS Year 6, 2008
PIPS Year 4, 2007 to PIPS Year 6, 2009
PIPS Year 4, 2012 to PIPS Year 6, 2014

The numbers of schools and students in each of the datasets are shown in Table 13.

PIPS Year 4, 2008 to 2011 was omitted because we were interested in Year 4, 2003 to 2007 that had GCSE results at the time of this research. PIPS Year 4, 2012 was included because we also wanted to show results from a recent cohort.

	Number of schools		Number of pupils	
Regression models	**Independent**	**State**	**Independent**	**State**
Pips Year 4, 2003 to PIPS Year 6, 2005	28	171	642	3859
Pips Year 4, 2004 to PIPS Year 6, 2006	29	109	682	2289
Pips Year 4, 2005 to PIPS Year 6, 2007	36	73	902	1399
Pips Year 4, 2006 to PIPS Year 6, 2008	35	51	937	1004
Pips Year 4, 2007 to PIPS Year 6, 2009	34	39	838	638
Pips Year 4, 2012 to PIPS Year 6, 2014	18	10	340	222

Table 13: Numbers of schools and students involved in the PIPS Year 4 to PIPS Year 6 regression by school type

Table 13 shows the numbers of schools and pupils with Year 4 and Year 6 that were used in the regression analysis from PIPS Year 4 to PIPS Year 6. Schools that had no prior attainment data were not included in Table 13.

	Number of students		Mean		Std. dev.	
Subject	**Independent**	**State**	**Independent**	**State**	**Independent**	**State**
Reading	339	221	51.03	48.22	8.51	9.85
Mathematics	340	222	52.6	48.69	8.53	8.89

Table 14: Summary statistics of PIPS Year 4, 2012 scores

Table 14 shows the summary statistics of the PIPS Year 4, 2012 scores. It shows that independent schools had higher average scores than state schools.

	Number of students		Mean		Std. dev.	
Subject	**Independent**	**State**	**Independent**	**State**	**Independent**	**State**
Reading	340	222	53.14	49.87	8.73	8.86
Mathematics	340	222	52.96	49.69	8.36	9.47
IDACI	339	221	-0.67	-0.21	0.45	1.24

Table 15: Summary of PIPS Year 6 assessment scores in 2014 by school type

Tables 15 showed that independent schools had higher average scores than state schools in Year 6 assessments. Independent schools had lower deprivation indicating that their students were from areas of higher socioeconomic status than students of state schools. It is evident from Tables 14 and 15 that independent schools scored higher than state schools in the PIPS Year 4 and Year 6 assessments. However the differences in prior ability, deprivation and school-level factors had not yet been taken into consideration.

Therefore we have carried out regression analyses from PIPS Year 4 to PIPS Year 6 and controlled for deprivation, prior ability, gender and other school-level variables. The results of the analysis are shown in Table 16.

	Mathematics	**Reading**
Intercept (s.e)	49.28 (0.47)	48.07 (0.47)
Overall PIPS score (s.e)	7.7 (0.31)	8.47 (0.31)
IDACI (s.e)	0.32 (0.31)	0.57 (0.31)
Female (s.e)	-1.33 (0.54)	0.71 (0.53)
Independent (s.e)	1.01 (0.6)	-0.74 (0.59)
All_Girls (s.e)	0.29 (0.86)	0.82 (0.84)
All_Boys (s.e)	0.24 (1.03)	-1.89 (1.01)
SchoolAveragePIPS (s.e)	1.19 (0.98)	1.63 (0.96)
df	554	552
R2	0.58	0.63
N	562	560
No. of pupils (indep.)	340	339
No. of pupils (state)	222	221
No. of schools (indep.)	18	18
No. of schools (state)	10	10

Table 16: Results of the regression from PIPS Years 4, 2012 to PIPS 6 assessments 2014

The results show that prior ability was the single highest contributing factor to the PIPS Year 6 outcome. Interestingly the deprivation index (IDACI) showed a positive, albeit, statistically insignificant effect. Being

female was associated with a negative but insignificant influence on the PIPS Year 6 outcome. It did not matter whether the school was all-boys or all-girls because the coefficients of these variables were statistically insignificant. The independent school variable was positive but not statistically significant for Mathematics but negative and statistically not significant for Reading. Therefore attending an independent school did not enhance the PIPS Year 6 assessment scores of students beyond the variation that might have been expected by chance. However we must be cautious while interpreting these results because of the small sample size.

	Coefficients of the independent school variable	
	Mathematics	**Reading**
Raw data (s.e)	1.01 (0.6)	-0.74 (0.59)
Propensity on raw data (s.e)	2.2 (0.92)	-1.38 (0.92)
Imputation (s.e)	0.7 (0.26)	0.74 (0.27)
Propensity on Imputed data (s.e)	0.59 (0.39)	0.47 (0.41)

Table 17: Regression coefficients of the independent school variable obtained from data matched by different methods (PIPS Years 4, 2012 to PIPS 6 assessments 2014)

Table 17 showed that analysis of the data after imputation gave rise to statistically significant coefficient for Mathematics and Reading. Propensity scores matching on raw data gave statistically significant coefficient only in Mathematics. Again, we must treat this with caution because of small sample size and the inconsistency of results from different models.

	Regression coefficients for the independent schools variable	
Regression models	**Mathematics**	**Reading**
PIPS Year 4, 2003 to PIPS Year 6, 2005	0.55 (0.28)	1.85 (0.27)
PIPS Year 4, 2004 to PIPS Year 6, 2006	0.5 (0.33)	1.06 (0.31)
PIPS Year 4, 2005 to PIPS Year 6, 2007	-0.32 (0.35)	0.73 (0.32)
PIPS Year 4, 2006 to PIPS Year 6, 2008	-1.19 (0.34)	-0.36 (0.34)
PIPS Year 4, 2007 to PIPS Year 6, 2009	0.08 (0.41)	0.67 (0.38)
PIPS Year 4, 2012 to PIPS Year 6, 2014	1.01 (0.6)	-0.74 (0.59)

Table 18: Coefficients for the regression from PIPS Year 4 to PIPS Year 6 for different cohorts of students

PIPS assessment scores from groups of students that had PIPS Year 4 assessments in 2003, 2004, 2005, 2006, 2007 and 2012 and PIPS Year 6 assessments in 2005, 2006, 2007, 2008, 2009 and 2014 respectively were also analysed and the coefficients of the independent school variable are shown in Table 18. There were positive and significant coefficients in Reading for the cohorts that were assessed with PIPS Year 4 in

2003, 2004 and 2005. For the cohort that was assessed in 2006 their coefficient was negative but statistically significant in Mathematics. The independent school coefficients for Mathematics and Reading for the six regression models above are too inconsistent to be reliable. They present an unclear picture of the differences in the educational outcomes of independent and state schools for the year group studied.

3.2.2. Analysis for PIPS Year 4 to GCSE

3.2.2.1. PIPS Year 4 to GCSE

3.2.2.2. Description of datasets used in the analysis

The datasets used for this analysis were:

PIPS Year 4, 2003 to GCSE, 2010
PIPS Year 4, 2004 to GCSE, 2011
PIPS Year 4, 2005 to GCSE, 2012
PIPS Year 4, 2006 to GCSE, 2013
PIPS Year 4, 2007 to GCSE, 2014

	Number of schools		Number of students	
Regression models	**Independent**	**State**	**Independent**	**State**
PIPS Year 4, 2003 to GCSE 2010	361	1506	2122	17243
PIPS Year 4, 2004 to GCSE 2011	366	1531	2185	15861
PIPS Year 4, 2005 to GCSE 2012	396	1640	2547	16605
PIPS Year 4, 2006 to GCSE 2013	399	1582	2785	15042
PIPS Year 4, 2007 to GCSE 2014	375	1423	2377	13237

Table 19: Numbers of schools and students used in the regression analysis from PIPS Year 4 to GCSE by school type

Table 19 presents the numbers of schools and pupils split by independent and state schools over the various datasets. Only schools and pupils that had both PIPS Year 4 and GCSE data were included in the table.

	Number of students		Mean (sd)	
Subject	**Independent**	**State**	**Independent**	**State**
Average PIPS score	2377	13237	57.3 (8.1)	50.5 (9.1)
Reading	2377	13237	58.3 (9.6)	50.6 (10.1)
Mathematics	2377	13237	56.7 (8.7)	50.3 (9.8)

Table 20: Summary statistics of Year 4 PIPS scores of 2007

Table 20 is the summary statistics of PIPS Year 4 scores of 2007 which shows that independent schools had higher average scores than state schools.

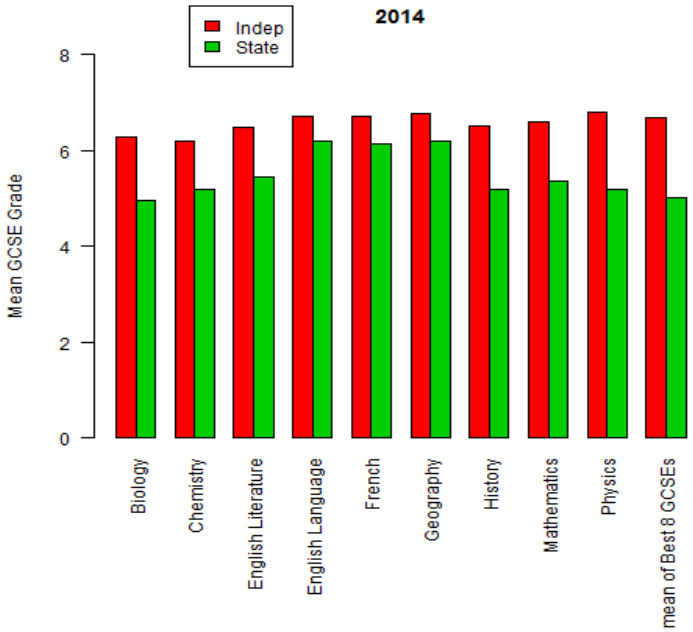

Figure 2: Average GCSE result by school type, PIPS Year 4 2007 to GCSE 2014

The average GCSE scores by subject and school type for students who had PIPS Year 4 assessment in 2007 and sat GCSEs in 2014 are shown in Figure 2. Summary statistics of the GCSE results are shown in Table 21 which also included the average of the deprivation index (IDACI) for the two school sectors. Independent schools had higher GCSE scores in all subjects compared to state schools.

	Number of students		Mean		Standard deviation	
Subject	**Indep.**	**State**	**Indep.**	**State**	**Indep.**	**State**
Mathematics	1070	13136	6.27	4.95	1.32	1.86
English Language	1026	12901	6.19	5.18	1.23	1.45
English Literature	1065	9610	6.49	5.45	1.13	1.53
Biology	693	3467	6.72	6.19	1.16	1.23
Chemistry	638	3367	6.71	6.13	1.25	1.27
Physics	606	3445	6.77	6.18	1.22	1.25
French	944	3434	6.51	5.2	1.38	1.5
Geography	1075	4577	6.6	5.35	1.3	1.69
History	1210	5434	6.81	5.2	1.22	1.89
Mean of Best 8 GCSEs	2377	13237	6.68	5.01	1.06	1.64
IDACI	2423	13389	-0.58	0.97	0.64	0.23

Table 21: Summary statistics of GCSE scores, PIPS Year 4 2007 to GCSE 2014

Table 21 shows that the mean of the average of best eight GCSEs (2014) for this cohort was 6.68 (between A and B grades) while the state schools' average score was 5.01 (a C grade), indicating that the average of

best 8 GCSEs of independent schools was just under 2 grades better than that of state schools. Independent schools also had better results than state schools in each subject. The average of the deprivation index (IDACI) was higher for state schools which meant that students of state schools came from areas that were more deprived than their independent school counterparts.

	Maths	**English**	**Eng. Lit.**	**Biology**	**Chem.**	**Phys.**	**Fren.**	**Geog.**	**Hist.**	**Mean of Best 8 GCSEs**
Intercept (s.e)	4.96 (0.02)	4.88 (0.01)	4.88 (0.02)	5.55 (0.03)	5.51 (0.03)	5.61 (0.03)	4.42 (0.03)	4.81 (0.03)	4.65 (0.03)	4.82 (0.01)
Overall PIPS score (s.e)	1.23 (0.01)	0.89 (0.01)	0.83 (0.01)	0.54 (0.02)	0.59 (0.03)	0.58 (0.02)	0.81 (0.02)	0.92 (0.02)	0.99 (0.02)	0.99 (0.01)
IDACI (s.e)	-0.13 (0.01)	-0.13 (0.01)	-0.2 (0.01)	-0.16 (0.02)	-0.14 (0.02)	-0.15 (0.02)	-0.13 (0.02)	-0.21 (0.02)	-0.22 (0.02)	-0.19 (0.01)
Female (s.e)	-0.11 (0.02)	0.51 (0.02)	0.59 (0.02)	0.19 (0.04)	0.1 (0.04)	-0.04 (0.04)	0.5 (0.04)	0.32 (0.04)	0.27 (0.04)	0.32 (0.02)
Independent sch. (s.e)	0.40 (0.04)	0.32 (0.04)	0.36 (0.04)	0.24 (0.05)	0.27 (0.05)	0.28 (0.05)	0.67 (0.05)	0.56 (0.05)	0.67 (0.05)	0.49 (0.03)
All_Girls School (s.e)	0.19 (0.05)	0.1 (0.04)	0.22 (0.04)	0.06 (0.06)	0.09 (0.06)	0.12 (0.06)	0.12 (0.06)	0.22 (0.07)	0.30 (0.07)	0.18 (0.03)
All_Boys School (s.e)	0.13 (0.06)	0.03 (0.05)	0.28 (0.06)	0.03 (0.07)	0.13 (0.08)	0.08 (0.07)	0.43 (0.08)	0.21 (0.07)	0.29 (0.08)	0.13 (0.04)
SchoolAverage PIPS score (s.e)	0.18 (0.02)	0.12 (0.01)	0.14 (0.02)	0.2 (0.02)	0.2 (0.02)	0.23 (0.02)	0.26 (0.03)	0.16 (0.03)	0.15 (0.03)	0.22 (0.01)
df	14198	13919	10667	4152	3997	4043	4370	5644	6636	15606
R2	0.53	0.49	0.43	0.25	0.25	0.27	0.43	0.4	0.4	0.59
N	14206	13927	10675	4160	4005	4051	4378	5652	6644	15614
No. of Indep. School students	1070	1026	1065	693	638	606	944	1075	1210	2377
No. of State school students	13136	12901	9610	3467	3367	3445	3434	4577	5434	13237
No. of Indep. Schools	214	201	203	147	142	139	216	256	270	375
No. of State schools	1407	1371	1101	554	544	546	663	777	861	1423

Table 22: Regression analysis of PIPS Year 4 of 2003 to GCSE 2014

The result of the OLS regression analysis for PIPS Year 4, 2003 to GCSE 2014 is shown in Table 22. The result showed that prior academic ability was the single highest contributing independent variable to the GCSE outcome of the model. Other variables such as All_Girl school made positive and significant contributions except in Biology and Chemistry. On the other hand, All_Boys school made statistically significant effects except in English Language, Biology, Chemistry and Physics. The deprivation index (IDACI) had negative and significant effects indicating that students that came from more deprived areas had lower academic achievements at GCSE in 2014. Incidentally these were more likely to be students of state schools.

The coefficients of the independent school variable were positive and statistically significant for all subjects as well as the average of best 8 GCSEs. This showed that the GCSE results of independent schools were higher than those of state schools when deprivation, prior ability, gender as well as school-level variables were controlled for. However, controlling for these variables reduced the difference in academic achievement of the two sectors based on their mean best 8 GCSE scores from just under 2 GCSE grades to about 0.5 of a grade. At the individual subjects level the differences between the GCSE outcomes of independent and state schools were highest for French, History and Geography and lowest for Chemistry, Biology and Physics

	PIPS Year 4, 2003 to GCSE 2010	**PIPS Year 4, 2004 to GCSE 2011**	**PIPS Year 4, 2005 to GCSE 2012**	**PIPS Year 4, 2006 to GCSE 2013**	**PIPS Year 4, 2007 to GCSE 2014**	**Means of coefficients**
Mathematics	0.51 (0.04)	0.52 (0.03)	0.49 (0.03)	0.56 (0.03)	0.40 (0.04)	0.5(0.05)
English Language	0.49 (0.03)	0.47 (0.03)	0.48 (0.03)	0.4 (0.03)	0.32 (0.04)	0.43 (0.07)
English Literature	0.42 (0.03)	0.48 (0.03)	0.55 (0.03)	0.46 (0.03)	0.36 (0.04)	0.45 (0.07)
Biology	0.42 (0.04)	0.37 (0.04)	0.43 (0.03)	0.48 (0.03)	0.24 (0.05)	0.39 (0.09)
Chemistry	0.43 (0.04)	0.43 (0.04)	0.45 (0.04)	0.46 (0.04)	0.27 (0.05)	0.41 (0.08)
Physics	0.46 (0.04)	0.45 (0.04)	0.44 (0.04)	0.50 (0.03)	0.28 (0.05)	0.43 (0.08)
French	0.76 (0.04)	0.8 (0.04)	0.75 (0.04)	0.76 (0.04)	0.67 (0.05)	0.75 (0.05)
Geography	0.68 (0.05)	0.63 (0.05)	0.67 (0.05)	0.69 (0.04)	0.56 (0.05)	0.65 (0.05)
History	0.62 (0.05)	0.63 (0.05)	0.6 (0.05)	0.7 (0.05)	0.67 (0.05)	0.64 (0.04)
mean of Best 8 GCSEs	0.58 (0.03)	0.64 (0.03)	0.63 (0.03)	0.64 (0.03)	0.49 (0.03)	0.60 (0.06)

Table 23: The coefficients for independent schools variable for the regression analysis of PIPS Year 4 to GCSE results for 5 cohorts of students

Table 23 shows the coefficients of the independent school variable for the five cohorts of students that had PIPS Year 4 assessments in 2003, 2004, 2005, 2006 and 2007 and sat GCSEs in 2010, 2011, 2012, 2013 and 2014 respectively. The independent school coefficient was positive and statistically significant for each subject. This indicated that after controlling for initial ability, deprivation, gender and other school-level factors the GCSE grades associated with independent schools were higher than those of state schools for each of the five consecutive years. The table also showed that for each cohort the difference between the two sectors was highest in French, History and Geography. We note that the effect for 2014 was lower than those of the four previous years.

	Maths	English	Eng. Lit.	Biology	Chem.	Phys.	Fren.	Geog.	Hist.	Mean of Best 8 GCSEs
Raw data (s.e)	0.40 (0.04)	0.32 (0.04)	0.36 (0.04)	0.24 (0.05)	0.27 (0.05)	0.28 (0.05)	0.67 (0.05)	0.56 (0.05)	0.67 (0.05)	0.49 (0.03)
Propensity on raw data (s.e)	0.33 (0.05)	0.29 (0.04)	0.35 (0.04)	0.25 (0.06)	0.28 (0.06)	0.28 (0.06)	0.68 (0.05)	0.5 (0.05)	0.62 (0.05)	0.46 (0.03)
Imputed data (s.e)	0.39 (0.03)	0.36 (0.02)	0.38 (0.03)	0.21 (0.03)	0.27 (0.03)	0.27 (0.02)	0.64 (0.03)	0.58 (0.03)	0.54 (0.03)	0.48 (0.02)
Propensity on Imputed data (s.e)	0.39 (0.03)	0.38 (0.03)	0.39 (0.03)	0.20 (0.03)	0.25 (0.03)	0.28 (0.03)	0.59 (0.03)	0.55 (0.03)	0.52 (0.04)	0.48 (0.02)

Table 24: Regression coefficients of the independent school variable obtained from data matched by different methods (PIPS Year 4 to GCSE 2014)

Table 24 shows that pre-treatment of data by imputation or propensity score matching had little effect on the differences between independent and state schools.

3.2.2.3. Summary of evidence from Year 4 to GCSE

Independent schools had higher average PIPS Year 4 assessment scores than state schools in the individual subjects. The mean of their average of best 8 GCSEs was also higher than that of state schools by just under 2 GCSE grades. This difference shrank to about 0.5 of a GCSE grade when students' deprivation, prior academic ability, gender and other school-level factors were taken into consideration.

Regression analysis showed that prior ability was the single highest contributing factor to the GCSE outcome. Deprivation index (IDACI) had negative effect and was therefore associated with decreases in the GCSE outcome. Being female was associated with decreased GCSE outcome in Mathematics and Physics but significantly increased the outcome in other subjects. Single sex schools increased the GCSE outcome in all subjects but this effect was not statistically significant in Biology, Chemistry and Physics. Overall, attending independent schools was associated with higher GCSE grades.

3.3. Evidence from PIPS Year 6 assessment

3.3.1. Regression analysis of PIPS Year 6 assessment score to GCSE grades

3.3.1.1. Description of PIPS Year 6 assessment data dataset

The PIPS Year 6 datasets used for this analysis were:
PIPS Year 6, 2005 to GCSE, 2010
PIPS Year 6, 2006 to GCSE, 2011
PIPS Year 6, 2007 to GCSE, 2012
PIPS Year 6, 2008 to GCSE, 2013
PIPS Year 6, 2009 to GCSE, 2014.

The numbers of schools and students in each of the datasets are shown in Table 25.

	Number of schools		Number of students	
Regression models	**Independent**	**State**	**Independent**	**State**
PIPS Year 6, 2005 to GCSE 2010	258	625	1461	3169
PIPS Year 6, 2006 to GCSE 2011	242	535	1510	2595
PIPS Year 6, 2007 to GCSE 2012	235	504	1329	2121
PIPS Year 6, 2008 to GCSE 2013	236	467	1419	1871
PIPS Year 6, 2009 to GCSE 2014	266	422	1536	1694

Table 25: Numbers of schools and students used in the PIPS Year 6 to GCSE regression by school type

Table 25 shows the numbers of schools and students that were involved in this investigation. Schools and students that did not have PIPS Year 6 scores and GCSE results were not included in the table.

	Number of students		Mean (sd)	
Subject	**Independent**	**State**	**Independent**	**State**
Average PIPS score	1536	1694	54.4 (7.8)	48.1 (8.9)
Reading	1536	1694	54.9 (8.6)	48.0 (9.6)
Mathematics	1536	1694	53.9 (8.7)	48.2 (9.6)

Table 26: Summary statistics of PIPS Year 6 scores of 2014 by school type

Table 26 is the summary statistics of the average PIPS Year 6 scores of 2014 and it shows that independent schools had higher average scores than state schools. Figure 3 shows the average GCSE scores of independent and state schools by subject. The students were assessed in 2009 using PIPS Year 6 assessment system and went on to sit GCSEs in 2014. Independent schools had higher average GCSE grades than state schools in each subject.

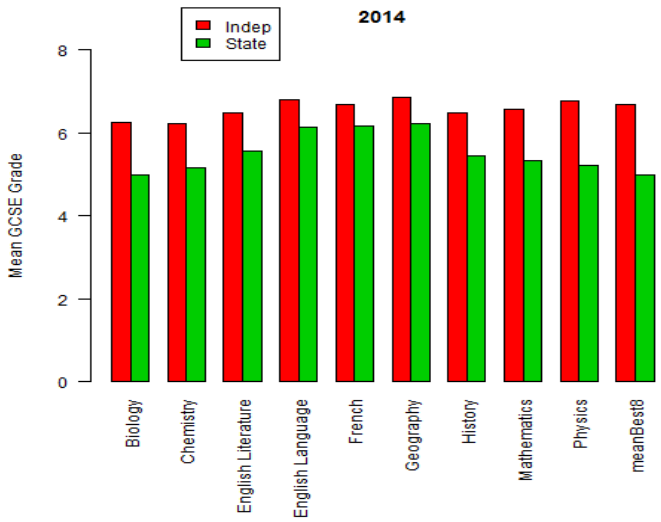

Figure 3: Average GCSE result by school type, PIPS Year 6, 2009 to GCSE 2014.

Table 27 shows the summary statistics of the GCSE results of the students including the average of their best 8 GCSEs and their mean IDACI. The mean of the average of best 8 GCSEs for independent schools is higher than that of state schools. State schools had higher mean of the deprivation index (IDACI) than independent schools. Students of state schools came from areas that were more deprived than the areas independent school students came from. The average of best 8 GCSEs scores for independent schools was 6.68 (between A and B grades) while that of state schools which was 4.99 (equivalent to a C grade). The difference in the average scores of the two cohorts was just under 2 GCSE grades.

	Number of students		**Mean**		**Standard deviation**	
Subject	**Indep.**	**State**	**Indep.**	**State**	**Indep.**	**State**
Mathematics	640	1701	6.24	4.99	1.25	1.85
English Language	692	1646	6.21	5.15	1.19	1.42
English Literature	726	1164	6.49	5.55	1.09	1.45
Biology	421	413	6.79	6.13	1.1	1.43
Chemistry	410	402	6.69	6.16	1.17	1.46
Physics	397	408	6.85	6.21	1.12	1.4
French	566	464	6.48	5.45	1.35	1.51
Geography	695	576	6.57	5.32	1.31	1.76
History	775	647	6.77	5.22	1.27	1.91
Mean of Best 8 GCSEs	1549	1709	6.68	4.99	1.04	1.63
Deprivation (IDACI)	1549	1709	-0.58	0.26	0.53	1.09

Table 27: Summary statistics of GCSE scores, PIPS Year 6, 2009 to GCSE 2014

The results of a regression analyses for PIPS Year 6, 2009 assessment scores to GCSEs of 2014 that controlled for prior ability, deprivation, gender as well as other school-level variables are shown in Table 28.

	Maths	English	Eng. Lit.	Biology	Chem.	Phys.	Fren.	Geog.	Hist.	Mean of Best 8 GCSEs
Intercept (s.e)	5.44 (0.04)	5.2 (0.04)	5.28 (0.04)	5.65 (0.07)	5.67 (0.07)	5.76 (0.07)	4.89 (0.07)	5.08 (0.06)	4.99 (0.07)	5.19 (0.03)
Overall PIPS score (s.e)	1.22 (0.03)	0.91 (0.03)	0.84 (0.04)	0.7 (0.06)	0.75 (0.06)	0.74 (0.06)	0.85 (0.05)	0.88 (0.05)	0.94 (0.05)	0.91 (0.02)
IDACI (s.e)	-0.15 (0.03)	-0.12 (0.02)	-0.16 (0.03)	-0.21 (0.05)	-0.2 (0.05)	-0.18 (0.05)	-0.11 (0.05)	-0.26 (0.05)	-0.21 (0.04)	-0.21 (0.02)
Female (s.e)	-0.22 (0.05)	0.42 (0.05)	0.51 (0.06)	0.1 (0.09)	0.04 (0.1)	-0.12 (0.09)	0.4 (0.09)	0.31 (0.08)	0.35 (0.08)	0.28 (0.04)
Independent sch. (s.e)	0.44 (0.06)	0.36 (0.05)	0.38 (0.06)	0.35 (0.08)	0.22 (0.08)	0.35 (0.08)	0.72 (0.08)	0.62 (0.08)	0.77 (0.08)	0.64 (0.04)
All_Girls School (s.e)	0.21 (0.09)	0.08 (0.07)	0.06 (0.08)	0.09 (0.11)	0.14 (0.12)	0.22 (0.11)	0.08 (0.1)	0.09 (0.11)	0.0 (0.11)	0.09 (0.05)
All_Boys School (s.e)	0.09 (0.09)	0.22 (0.08)	0.2 (0.09)	0.06 (0.12)	0.08 (0.13)	0.16 (0.12)	0.41 (0.12)	0.18 (0.12)	0.22 (0.11)	0.17 (0.06)
SchoolAverage PIPS score (s.e)	0.13 (0.04)	0.07 (0.03)	0.08 (0.04)	0.26 (0.06)	0.25 (0.06)	0.24 (0.06)	0.24 (0.06)	0.25 (0.05)	0.2 (0.06)	0.21 (0.03)
df	2313	2311	1869	822	800	794	1016	1258	1398	3222
R^2	0.6	0.55	0.47	0.38	0.36	0.38	0.45	0.48	0.47	0.67
N	2321	2319	1877	830	808	802	1024	1266	1406	3230
No. of Indep. School students	635	688	722	420	409	396	562	692	766	1536
No. of State school students	1686	1631	1155	410	399	406	462	574	640	1694
No. of Indep. Schools	132	133	133	92	90	86	141	166	184	266
No. of State schools	417	405	324	155	151	153	193	211	232	422

Table 28: Results for the regression analysis from PIPS Year 6, 2009 to GCSE 2014

Prior academic ability was the highest single contributing factor to the GCSE outcome. Being a All_boys school had a positive significant effect only in English, English Literature, French and History. Being an all-girls school did not have statistically significant effect in the subjects reported except in Mathematics and Physics where it was positive and statistically significant. Deprivation had statistically significant negative coefficients for all subjects which meant that lower deprivation as observed in Table 27 for independent schools was associated with higher GCSE grades. The coefficients of the independent school variable were also positive and statistically significant for all subjects which meant that attending independent schools was associated with higher grades. However, the difference between the academic achievements of schools in the two sectors on the basis of the mean of the averages of their best 8 GCSEs was reduced from just under 2 GCSE grades to 0.64 of a grade. The differences between schools in the two sectors were highest in French, History and Geography and lowest for Biology, Chemistry and Physics.

	Maths	English	Eng. Lit.	Biology	Chem.	Phys.	Fren.	Geog.	Hist.	Mean of Best 8 GCSEs
Raw data (s.e)	0.44 (0.06)	0.36 (0.05)	0.38 (0.06)	0.35 (0.08)	0.22 (0.08)	0.35 (0.08)	0.72 (0.08)	0.62 (0.08)	0.77 (0.08)	0.64 (0.04)
Propensity on raw data (s.e)	0.41 (0.06)	0.35 (0.05)	0.37 (0.05)	0.36 (0.08)	0.23 (0.09)	0.35 (0.08)	0.64 (0.09)	0.58 (0.09)	0.72 (0.09)	0.65 (0.04)
Imputed data (s.e)	0.40 (0.03)	0.34 (0.03)	0.26 (0.03)	0.07 (0.03)	-0.03 (0.03)	0.05 (0.03)	0.56 (0.03)	0.4 (0.04)	0.48 (0.04)	0.57 (0.03)
Propensity on imputed data (s.e)	0.43 (0.03)	0.33 (0.03)	0.29 (0.03)	0.06 (0.03)	-0.02 (0.03)	0.03 (0.03)	0.57 (0.03)	0.41 (0.04)	0.51 (0.04)	0.54 (0.03)

Table 29*: Regression coefficients of the independent school variable obtained from data matched by different methods (PIPS Year 6, 2009 to GCSE 2014)*

Table 29 shows that for Biology, Chemistry and Physics, data imputation and propensity score matching on imputed data caused decreases in the differences between independent and state schools.

Regression analyses were also carried out on data obtained from similar cohorts of students from previous years and the coefficients of the independent school variable are shown in Table 30.

	PIPS Year 6, 2005 to GCSE 2010	PIPS Year 6, 2006 to GCSE 2011	PIPS Year 6, 2007 to GCSE 2012	PIPS Year 6, 2008 to GCSE 2013	PIPS Year 6, 2009 to GCSE 2014	Means of coefficients
Mathematics (s.e)	0.66 (0.05)	0.57 (0.04)	0.63 (0.05)	0.55 (0.04)	0.44 (0.06)	0.57 (0.09)
English Language (s.e)	0.62 (0.04)	0.59 (0.04)	0.46 (0.04)	0.32 (0.04)	0.36 (0.05)	0.47 (0.13)
English Literature (s.e)	0.60 (0.04)	0.45 (0.04)	0.53 (0.05)	0.38 (0.04)	0.39 (0.06)	0.47 (0.09)
Biology (s.e)	0.47 (0.06)	0.36 (0.05)	0.43 (0.06)	0.51 (0.06)	0.36 (0.08)	0.43 (0.07)
Chemistry (s.e)	0.50 (0.06)	0.49 (0.06)	0.43 (0.06)	0.46 (0.06)	0.22 (0.08)	0.42 (0.12)
Physics (s.e)	0.59 (0.06)	0.47 (0.06)	0.42 (0.06)	0.54 (0.06)	0.35 (0.08)	0.47 (0.10)
French (s.e)	0.99 (0.06)	0.78 (0.06)	0.65 (0.07)	0.61 (0.07)	0.71 (0.08)	0.75 (0.15)
Geography (s.e)	0.91 (0.07)	0.59 (0.07)	0.72 (0.07)	0.62 (0.07)	0.61 (0.08)	0.69 (0.13)
History (s.e)	0.77 (0.07)	0.79 (0.08)	0.76 (0.07)	0.60 (0.07)	0.78 (0.08)	0.74 (0.08)
Mean of Best 8 GCSEs (s.e)	0.75 (0.04)	0.68 (0.04)	0.72 (0.04)	0.55 (0.04)	0.64 (0.04)	0.67 (0.08)

Table 30: Showing coefficients of the independent school variable for five cohorts

These cohorts of students had PIPS Year 6 assessments in 2005, 2006, 2007, 2008 and 2009 and sat GCSEs in 2010, 2011, 2012, 2013 and 2014 respectively. For each cohort the independent school coefficient was positive and statistically significant.

3.3.1.2. Summary of the evidence from PIPS Year 6 assessment scores

Independent schools had higher average PIPS Year 6 and GCSEs results than state schools. Independent schools had a lower average of deprivation index (IDACI) which means that typically, students that attended independent schools came from homes in more affluent areas than state school students.

A comparison of the average of best 8 GCSEs of independent and state schools without controlling for student and school-level differences showed a difference that was just under 2 GCSE grades in favour of independent schools. This associated effect decreased to 0.64 of a grade when deprivation, prior ability, gender and some school-level variables were taken into account. However, the differences in the academic achievements of independent and state schools were still positive and statistically significant.

3.3.1.3. Differences between the GCSE results of independent and state schools obtained from different year groups

Regression models	Means (& SE) of the differences between the best 8 GCSE scores of independent and state schools (GCSE grades)
PIPS SOR to GCSE	0.68 (0.10)
PIPS Year 4 to GCSE	0.60 (0.06)
PIPS Year 6 to GCSE	0.67 (0.08)
Weighted average across all samples	0.64 (0.04)

Table 31: Means of differences between independent and state schools based on best 8 GCSE scores
Each mean was derived from five or seven regression analyses of data from different cohorts

For each regression model, 5 or 7 sets of data were analysed therefore Table 31 shows the means of independent schools coefficient from 5 or 7 regression analyses that predicted average of best 8 GCSE grades. This suggests that based on the best 8 GCSE scores, the difference between the academic achievements of independent and state schools was approximately 0.64 of a GCSE grade in favour of independent schools after the prior ability and deprivation of the students as well as some school-level variables were controlled for.

It is not surprising that the differences between the GCSE grades of independent and state schools for the three cohorts of students were similar as shown in Table 31 because the vast majority of pupils in each cohort will complete a full seven years of primary school in a given sector. A pupil benefiting from

independent schooling in Y6 has probably already had 6 years independent schooling and a pupil in Reception or Y4 at an independent school will probably remain in that sector at least to Y6.

	PIPS Year 4		GCSE
	Maths (std. deviations)	**Reading (std. deviations)**	**Average of best 8 GCSEs (GCSE grades)**
Difference before controlling for variables	0.8	0.7	1.71 (0.05)
Difference after controlling for variables	0.3	0.2	0.64 (0.04)

Table 32: Summary of the differences between the educational outcomes of independent and state schools before and after student and school variables were controlled

Table 32 summarises the effects of student and school-level factors on the differences between the educational outcomes of independent and state schools. Undoubtedly, controlling for student and school variables reduced the differences between the academic outcomes of the two sectors considerably.

To translate this difference of 0.64 grades into an effect size measure, we can estimate the pupil level standard deviation of GCSE best 8 average scores from Tables 9, 21 and 27, using weighted, pooled estimates from state and independent samples. The overall estimate of this population standard deviation is 1.59. From this we can calculate that the average difference between GCSE performances in the two sectors is 0.41 in standard deviation units.

One question we might ask is whether a standardised effect size difference between independent and state sectors of 0.41 constitutes a big effect? Some accounts of effect sizes (eg Hattie, 2009; Cohen, 1969) suggest that 0.4 is not large. On the other hand, we know that the typical annual growth for students aged 14-16 on tests of Mathematics and Reading are equivalent to about 0.2 of the within cohort standard deviation (Hill et al, 2007). In other words, a gain of 0.41 could be interpreted as about two years' normal progress. On this interpretation, attending an independent school is associated with the equivalent of two additional years of schooling by the age of 16. Another way to interpret a difference of 0.41 would be as 41 points on the scale of international PISA outcomes. A gain of this size would raise the UK above the highest European performers, such as Finland, Switzerland and the Netherlands in the latest PISA results (OECD, 2014, p5) and on a par with (or close to) countries such as Japan and Korea.

3.4. Limitations of the study

There are a number of limitations within this study. In particular we note that the IDACI measure used to inform children's deprivation levels is only measured at a postcode level and is not actually specific to the child. It would seem likely that if there are two children living in the same postcode area where one attends a fee charging school that that child's parents will have a higher income and at a household level would have lower level of deprivation. The IDACI measure must therefore be seen as controlling only partly for differences in the socioeconomic backgrounds of the two groups.

There is also concern with the high entry level of students of independent schools compared to those of state schools. If this is due to family background or some other background variables which continue to support the child through their education then this also may need accounting for to get a true comparison between state and independent schools.

The identification of single sex schools is rather ad hoc, but also the resulting number of schools identified is quite small so interpretations around these variables should be treated with caution.

A significant limitation is that we are unable to give a confident and precise estimate of the causal effect of attending an independent school. We have controlled statistically for the initial differences between pupils in state and independent sectors, so far as we are able. However, we know that, even where strong predictors are included in a model the omission of unobserved differences can significantly bias estimates of causal effects (Coe, 2009). There are likely to be some school-sector differences at student or school level which we were unable to detect or observe perfectly that would have affected the 0.64 grade estimate of independent school advantage that we have reported. We therefore advise that this estimate be viewed with caution. Moreover, it seems likely that any unobserved differences between pupils in the two sectors might well reduce this estimate, were they to be included. This would be the case, for example, if any unobserved (or imperfectly observed) variable existed that was positively correlated with educational achievement at GCSE and also favoured independent school pupils.

4. General conclusions

Particular questions were asked within the research proposal, therefore this conclusion has been written in a format that directly answers those questions.

What differences exist in the attainment of students in independent and state schools after controlling for the effects of prior ability (represented by early reading and mathematics development) and other factors?

Evidence from the data analysis suggested that independent schools performed better than state schools in PIPS SOR, PIPS Year 4, and PIPS Year 6 assessments as well as in GCSE exams. The average of the best 8 GCSEs of independent and state schools differed by just under 2 GCSE grades before deprivation, prior academic ability and school-level factors were taken into consideration. However, the difference was reduced to 0.64 of a GCSE grade when these factors were controlled for. The difference translates to a gain of about two years' normal progress and suggests that attending an independent school is associated with the equivalent of two additional years of schooling by the age of 16. Interpreting the difference on the scale of international PISA outcomes equates it to raising the UK's latest PISA results to be above the highest European performers, such as Finland, Switzerland and the Netherlands and on a par with (or close to) countries such as Japan and Korea.

For individual GCSE subjects the differences ranged between 0.13 and 0.77 GCSE grades and the highest differences between the two sectors occurred in French, History and Geography. The differences between schools in the two educational sectors based on the average PIPS Year 4 were 0.8 and 0.7 pupil level standard deviations for Mathematics and Reading respectively before the differences between students were controlled for. However these differences decreased to 0.3 and 0.2 pupil level standard deviations when deprivation, prior academic ability, gender and school-level variables were considered.

How do these differences vary for different ages? For example, is there any particular stage during their education at which students from independent and state schools differ in their academic performances?

Data was analysed for four year olds (PIPS SOR), eight year olds (PIPS Year 4), ten year olds (PIPS Year 6) and sixteen year olds (GCSEs). The results showed that differences existed between the academic achievement of independent and state schools at every age group even after underlying differences between the two sectors had been controlled for.

How do these differences vary for different subjects taken? For example, are there any particular subjects in which the performances of students from the two educational sectors differ at GCSE?

The differences between the academic achievements of independent and state schools at GCSE varied from one subject to another. The differences were typically highest in French, History and Geography after students' differences were accounted for. They were lowest in Chemistry, Biology and Physics.

How do these differences vary for different factors controlled for? For example: How does each of the different factors controlled for, such as prior ability, parents' occupation and deprivation index (if available), and other student and school-level factors affect differences in the academic performances of students from independent and state schools?

The effects of the factors controlled for on the GCSE outcomes of the models varied from one factor to the other. For example, prior ability had the highest positive association with the GCSE outcome. The deprivation index (IDACI) had a negative relationship with GCSE outcome. Being a girl was negatively associated with GCSE outcome for Mathematics and Physics but positively on the other subjects.

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