Department for Education

Factors associated with achievement: key stage 4

Research report

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Executive Summary

Introduction

RAND Europe and the Faculty of Education at the University of Cambridge were commissioned by the Department for Education (DfE) to assess the quality of the current measure of socio-economic deprivation used by DfE, namely free school meals (FSM) eligibility, and to identify potential alternative proxy indicators.

Aims and objectives

The government currently uses pupils' histories of eligibility for FSM (whether they have been eligible during the last six years) to allocate the pupil premium and other school funding, and to provide accountability for the attainment of disadvantaged children. With changes to the benefits system expected to occur in the next few years affecting the underlying eligibility criteria for FSM, it is timely to reflect on the range of data which might be used as a proxy for deprivation and how it is associated with attainment. This research explores which possible proxies for deprivation are the strongest predictors of achievement at the end of secondary school.

The central tasks of this project were to assess the relationship between FSM eligibility, pupil achievement and measures that may act as proxies for socio-economic status (SES). The research is exploratory but pragmatic – a broad range of measures were explored, but with the knowledge that not all of these measures would be available to DfE in the future. The research questions framing the project are:

1. **Can FSM histories be improved on as a proxy for social deprivation?**

   If so, what measures can be used and what improvement do they make?

   Within that: who are the FSM eligible children and what are their characteristics?

2. **What alternative (practical) proxy measures of SES can be used that better capture variation in achievement?**

   For example, are models using neighbourhood and geographic indicators better at predicting variation in achievement than models that rely on FSM; or than models that use a combination of both?

3. **Do alternative proxy measures better enable us to identify pupils at risk of low achievement?**

Methodology

At the core of the study is a combination of survey and administrative data on more than 15,000 young people taken from the first Longitudinal Study of Young People in England (LSYPE1), matched with data from the National Pupil Database (NPD). The research uses multi-level models to assess the relationship between the factors used as predictors

of achievement. The outcome variable used in this research was the total capped GCSE points score, also known as the 'Best 8' measure.

Key Findings

Deprivation indicators and attainment gaps

- A measure of whether the pupil was **ever eligible for FSM in the last five years** (Ever5FSM)[1] explains 23.3% of the variation in pupil achievement at GCSE when entered in a model alongside a set of basic controls[2]. In practical terms, there was a 56 GCSE point[3] difference between pupils who have ever been FSM eligible in the last five years and those who have not. This equates to the difference between a pupil gaining one grade better across seven GCSEs (e.g. moving from a C to a B) and two grades better on an eighth GCSE (nine 'letter grades' in total), a substantial difference.
- The Ever5FSM variable performs better, in terms of predictive power, than simply using **current (2006)[4] FSM eligibility** (explaining 23.3% of the variance compared to 20.7%, respectively). For current (2006) FSM eligibility, there was a 44 GCSE point difference between pupils being eligible for FSM in the final GCSE year and those who were not, equating to gaining one grade better across seven GCSEs.
- The individual **neighbourhood based** proxy measure examined in the modelling, Income Deprivation Affecting Children Index (IDACI), did not perform as well as FSM eligibility in terms of predictive power, explaining 20.8% of the variance, with each additional point on the IDACI scale (i.e. as deprivation worsens) associated with one less GCSE point. Some combinations of neighbourhood based measures can provide more predictive power than FSM eligibility, but they are difficult to interpret and do not provide data on the individual child.
- Parental **occupation**, parental **education**, and **other household characteristics** are slightly better predictors of pupil achievement than FSM eligibility (current or Ever5FSM), accounting for 25.6%, 25.8% and 24.4% of the variance, respectively. For example, for household occupational status, there was between a 70 and 95 point difference between the bottom and top groups, with a similar picture observed at the extremes of parental education. Pupils

[1] The research team were unable to use Ever6FSM, the measure commonly used, due to the age and stage of the pupils involved in the LSYPE1 survey.

[2] The basic controls consist of individual demographic measures such as age, gender and ethnicity; area measures relating to region of residence and urban/rural; and school level characteristics such as school size, proportion of pupils with special educational needs statements.

[3] A difference of six GCSE points equates to one grade better on a single GCSE. A difference of 12 points would mean either one grade better on two GCSEs or two grades better on one GCSE and so on.

[4] Current (2006) FSM eligibility refers to FSM eligibility in the school year GCSE exams were taken, which in the LSYPE1 sample was 2006.

from households with a qualification at level 1 or no qualifications achieved, on average, 80-91 fewer points at key stage 4 than children from households where at least one parent holds a degree level or equivalent qualification. For these measures, the above differences are approximately equivalent to a pupil attaining two letter grades better in seven of the eight GCSEs counted for the 'Best 8' measure. However, these proxies have the problem that at-scale collection of this information is likely to be impractical and difficult.

- Parental **income** accounted for 20.6% of the variance, the lowest of all the considered proxies: after controlling for basic pupil and school characteristics, an increase of £10,000 in household income was associated with a five point increase in key stage 4 attainment, i.e. less than the difference between a B and an A on a single GCSE. This is likely to be because income was measured via self-report, which is likely to include a degree of error, and is likely to reduce the strength of relationship between income and attainment. This finding highlights the difficulties of collecting high quality income data on parents 'at scale' through survey means. Exploring the use of higher quality administrative measures of parental income is one option, though it would require data linkage with data from other government departments.
- Overall, **FSM history** is the preferred measure of deprivation, measured either as cumulative years of eligibility over the pupil's school life, or as FSM eligibility ever in the years preceding the outcome of interest.

Prior attainment

- Setting aside data that describe the socio-economic circumstances of children, **prior attainment** at the end of primary school is found to be the most powerful available predictor of secondary school attainment. However, while prior attainment could be used to identify children at risk of low attainment, it would not address the main policy aim of ensuring better representation of socio-economically disadvantaged pupils at higher levels of attainment.

Pupil characteristics

- There were significant **regional** variations in attainment at the end of secondary school after controlling for basic characteristics and deprivation proxies. However, these effects are mostly already present at the end of primary education and accounting for prior achievement at this age largely eliminates the regional differences found.
- In keeping with previous research, there were residual differences in attainment when comparing **ethnic** minorities to White British children, after controlling for socio-economic deprivation proxies that account for much of the underachievement by some minority ethnic groups. When the fact that different ethnic groups start at different levels of key stage 2 achievement is accounted for by controlling for prior attainment, it was found that ethnic-minority pupils make more progress during secondary school than White British pupils,

effectively reducing the ethnic differences in attainment by the end of secondary school[5].

Conclusions

The socioeconomic gaps reported in this document are stark and substantial. However, these gaps may have been even larger if there had not been a long-running redistributive and compensatory system aimed at alleviating disadvantage in place. This highlights why it is crucial to identify poor / disadvantaged pupils at risk of underachievement as early as possible – in order that additional resources can be targeted at this group in particular.

Some combinations of neighbourhood based measures are stronger predictors of pupil achievement, but using neighbourhood based measures may be harder to interpret and in any case neighbourhood measures are not associated with the individual child. Indeed, if one measures socio-economic deprivation only at the neighbourhood level, measuring the attainment and progress of the disadvantaged pupil group within a school or area will not be possible and this is a major drawback of the area based approach to measuring deprivation. Combining individual pupil FSM histories with neighbourhood based measures of deprivation was found to have small predictive gains in terms of key stage 4 outcomes. However, the interpretation of any such combination is particularly difficult, and would require a re-evaluation of how deprivation is defined.

Survey measures of SES such as parental education and occupation, perform slightly better than pupils' histories of FSM. However, these measures of parental background are currently not available to government and there are likely to be substantial costs associated with collecting such data at scale. For example, parental education is a strong predictor of pupil achievement but collecting robust data on parental education level for all pupils would be difficult and involve significant additional data collection costs.

Stepping aside from data that describe the socio-economic circumstances of children, prior achievement at the end of primary school is found to be the most powerful available predictor of secondary school attainment. However, this does not address the policy aim of closing deprivation-specific attainment gaps and ensuring better social mobility for children born into deprived families. While prior attainment could be used to identify children at risk of low attainment, it would not of itself ensure better representation of socio-economically disadvantaged pupils at higher levels of attainment.

Recommendation

The overall recommendation is that FSM history is retained as the preferred measure of deprivation, measured either as cumulative years of eligibility over the pupil's school life,

[5] Similarly, the research found that **younger children within the year group** make more progress than older children, thus reducing the effect of age on attainment by the end of secondary school.

or as FSM eligibility ever in the years preceding the outcome of interest. The latter is already used by DfE and so for continuity reasons may be preferred at this time. Other options might usefully be explored in future work, such as using data on household income held by other government departments or combining FSM history with prior attainment.

1. Introduction and background

1.1 Introduction

Socio-economic achievement gaps – differences in educational attainment between socio-economic groups – remain one of the most important unresolved problems of most educational systems. National and international research has shown that household income (e.g. Blanden and Gregg, 2004), parental[6] education (e.g. ESRC, no date; Chowdry et al., 2010) and parental occupation (e.g. Letourneau et al., 2013) are consistently related to differences in educational attainment (for further details see OECD, 2010a, 2010b). Just as important is the finding that while the magnitude of differences vary over time, socio-economic achievement gaps persist throughout the early years and carry on into adolescence, with the effects of such gaps echoing well into later life (see e.g. Feinstein, 2003; DCSF, 2009; OECD, 2010a; Anders, 2012; House of Commons Education Committee, 2014; but see Goldthorpe, 2012 arguing that from a sociological perspective, mobility in terms of social class has increased).

Given that individual and family background characteristics are associated with pupils' attainment (as well as progression through educational systems and beyond), and policies may have limited impact on reducing socio-economic gaps (see e.g. DCSF, 2009), better tracking and understanding of these gaps is crucial. However, it is not always clear how socio-economic disadvantage should be measured. Depending on the pupil's age, these measures might relate to different aspects of home life or household characteristics (see e.g. Field, 2010). One of the practical and established ways of measuring disadvantage in England and elsewhere revolves around using pupil's eligibility for certain types of government assistance (financial, material, etc.). These measures, in turn, require that the families of those children meet a set of purposefully-designed government eligibility criteria.

1.1.1 What is free school meal eligibility and what are its limitations?

Free school meal (FSM) eligibility is one such indicator, which the government in England has used for more than two decades. To qualify, families (or children) must be claiming one of several benefits and notify the school of this.[7] It is well known that there are problems with using FSM as a proxy for economic disadvantage (see e.g. Hobbs and Vignoles, 2009). For example, some children in "working poor" households[8] are not identified, nor are children whose families are entitled but who choose not to claim a free

[6] In accordance with LSYPE1 documentation, parent refers to either the biological parent or the carer at the time of the survey.

[7] For a list see https://www.gov.uk/apply-free-school-meals.

[8] Such as those who earn just above income thresholds for FSM eligibility and do not claim (or are not eligible) for other benefits.

meal for dietary, cultural or other reasons (Iniesta-Martinez and Evans, 2012; Lord, Easby and Evans, 2013). Hobbs and Vignoles (2009) point out that FSM-eligibility was a good proxy of those in 'workless' families, but did not necessarily identify those in very poor but working households.[9] Eligibility for FSM 'is not a fixed quality' (DCSF, 2009: 10) and is linked to economic cycles. In an economic downturn the proportion of pupils who are eligible rises. Ideally one would use a measure that indicates a child's persistent educational disadvantage, such as low parental education. Temporary unemployment of a parent can trigger eligibility for FSM but may not signify that a child is educationally disadvantaged. Conversely, in an economic upturn, the proportion of FSM eligible children falls. These children may still suffer long-term educational disadvantage associated with low parental education and insecure household income, despite a temporary upturn in their economic circumstances as their parent secures a job. Further, one might want to identify low-middle income pupils i.e. those who are low income but not in the poorest fifth of families.

Gorard (2012) also highlights how issues of data quality affect the use of FSM eligibility as an indicator of deprivation. This research found that a proportion of pupils who were eligible for FSM according to school census data were not claiming this benefit. The project found that pupils who are missing from the FSM records constitute a distinct group from both those eligible for and those not eligible for FSM, particularly in terms of attainment. Partly in response to these issues, and as a consequence of accepting that long-term trends need to be taken into account when comparing FSM eligible children with non-FSM eligible ones, the government is currently pursuing a variety of FSM eligibility versions: for the allocation of the pupil premium, the government shifted from FSM eligibility in the year of interest (usually at the end of a key stage) to FSM eligibility ever in the past six years ('Ever six'). Local authorities may choose between either of those two or the Income Deprivation Affecting Children Index (IDACI).

1.1.2 Statistics on FSM eligibility

National statistics data illustrate that FSM eligibility varies by region within England. For example, the national average for FSM eligibility is around 15% of the state-funded secondary school population (depending on whether data from the National Pupil Database (NPD) or performance tables is used), but this ranges from around 10% in the South East and South West of England, to nearly one-third in Inner London (DfE, 2013; DfE, 2014). Overall, the highest number of FSM eligible children reside in the Yorkshire and the Humber and North West regions of England[10], and in recent years, the overall number of pupils eligible for FSM in state funded secondary schools has been around 500,000 (16% of the state-funded secondary school population in 2013; DfE, 2014).

[9] This is not to say that the parental employment–child attainment relationship is straightforward. For example, Ermisch and Francesconi (2013) found that maternal employment during a child's 0-5 years was negatively related to educational attainment.

[10] These two regions include major metropolitan centres such as Manchester, Liverpool and Leeds.

1.1.3 The relationship between FSM and pupil attainment

Whichever measure is used, there is a persistent attainment gap between those eligible and claiming versus those ineligible / not claiming FSM, as Figures 1 and 2 (below) set out. Simplistic analyses such as these do not account for other differences between FSM and non-FSM pupils that lessen or reduce differences in outcomes; nevertheless, they make clear that since measures began, and despite some successful initiatives aimed at reducing this gap, pupils from deprived backgrounds have poorer attainment than their peers.

1.1.4 Measures to supplement FSM

There are other measures that are used as proxies for economic disadvantage: geographic measures for example, including the Index of Multiple Deprivation (IMD) and the Income Deprivation Affecting Children Index (IDACI). These measures have previously been used to supplement FSM eligibility history as a socio-economic measure (Chowdry et al., 2012) and are still used as proxies for economic disadvantage by local authorities. Geographic data refer to areas rather than individuals, however, and there are arguments that geographic measures do not provide richer information than the original FSM variable and misidentify children living in highly polarised regions (e.g. Gorard, 2012). Further, geographic indicators relating to neighbourhoods may be both a proxy for individual socio-economic circumstances in the household, selection into neighbourhoods and be measuring the causal impact of neighbourhood on achievement. For example, Nicoletti and Rabe (2010) estimated that neighbourhood effects could explain around 10-15% of the variation in achievement of 11 year olds in England. There is also the difficulty of capturing the interplay between pupils' 'membership' of neighbourhoods and schools simultaneously (Leckie, 2009).

Given that the overall aim was to investigate which of the currently-available measures best explain variations in pupil achievement, the analytical approach included investigating the predictive power of geographic indicators, relying on administrative data from the NPD and Census at Lower-layer Super Output Area (LSOA) level.[11] The following neighbourhood proxy measures were considered:

[11] There are approximately 33,000 LSOAs in England, and 1,900 in Wales, each containing a minimum of 1,000 people / 400 households (ONS, no date).

Figure 1 Attainment at key stage 2 and FSM eligibility 2005/06 – 2012/13[12]

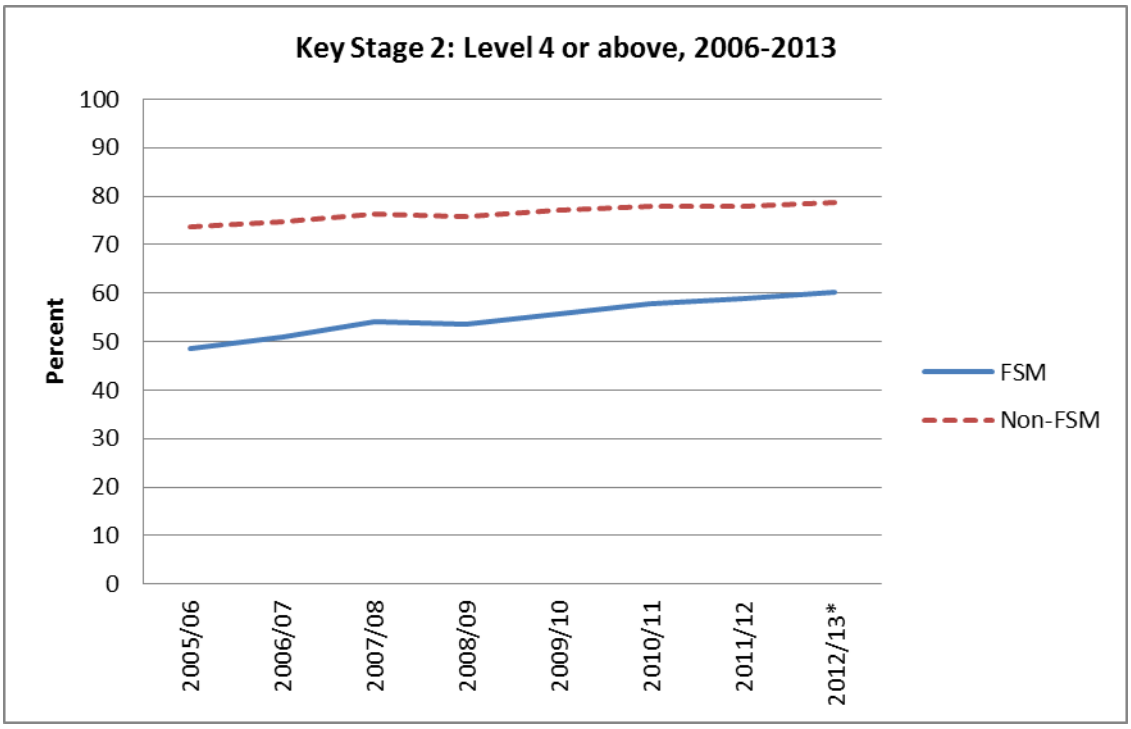
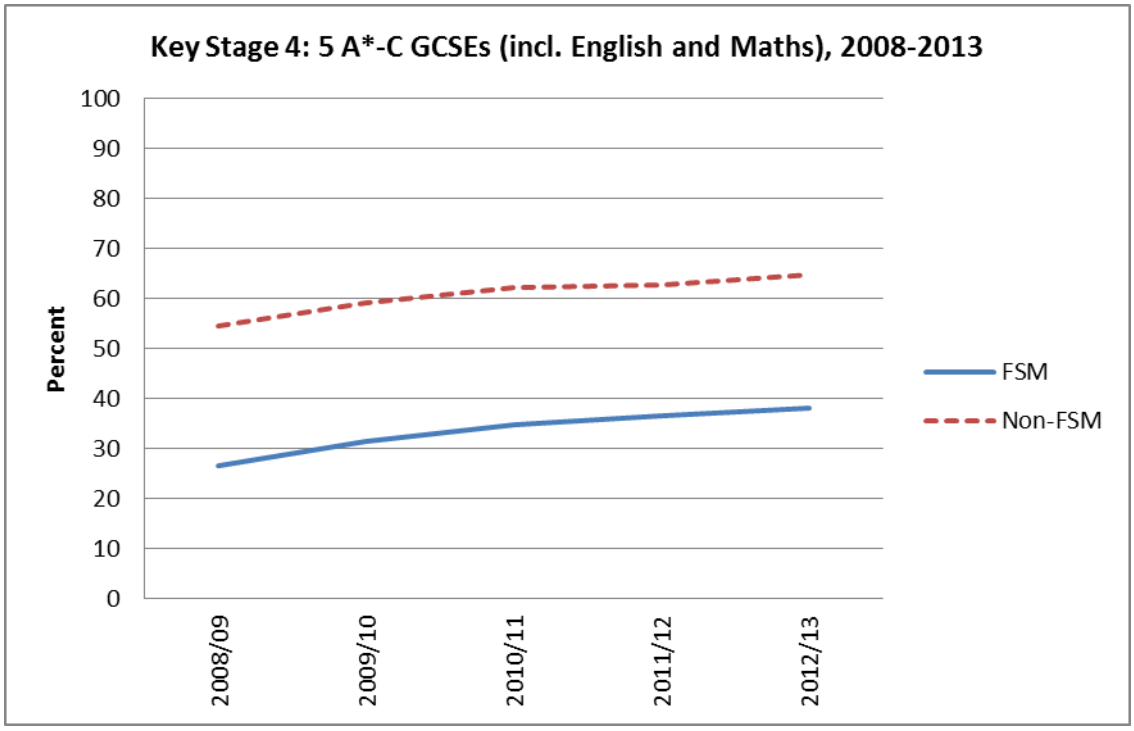


Figure 2 Attainment at key stage 4 and FSM eligibility 2008/09 – 2012/13



- IMD
- IDACI

[12] Figures for 2012/13 provisional. Sources for both figures given in references (p.68)

- the proportions of adults and of young people currently participating in higher education (HE), as a proxy measure for local educational levels
- as a potential replacement for the HE participation measure above, the proportion of the local population with a degree, again as a proxy measure for local educational levels
- occupational groups, e.g. the proportion of the working population in 'Higher managerial, administrative and professional occupations' based on the five-class occupational (NS-SEC) grouping, as a proxy for the overall economic wellbeing of the local area

In order to assess the predictive power of the geographic indicators discussed above, the models controlled for a limited range of factors (the covariates described below), namely variables that DfE would have access to in the administrative data (NPD). These models made it possible to determine the variation in achievement that could be explained by the neighbourhood proxy variables in the absence of any richer measures of family background. The predictive power of neighbourhood indicators was then compared to the predictive power of a richer set of covariates (demographic, socio-economic and others) known to be causally associated with pupil achievement. The next section summarises the covariates included in all the models. Before proceeding, it is worth making clear that different data –such as large scale administrative data held by other government departments[13]– may lead to different proxy measures being used or created.[14] Here, attention was restricted to proxy measures that are currently available in routine data sets.

Socio-economic covariates

There is a long-standing tradition of research that highlights the important role of family background and SES in influencing pupil achievement (e.g. Selden, 1990; Caldas, 1993; Rumberger, 1995; Jacobs and Harvey, 2005). The following variables are generally used as indicators for family background:

- parental occupational class
- family type: single-parent or 'traditional' (two-parent) families
- parental educational level
- parental involvement in school-related activities
- parental expectations, attitudes towards and plans for the young person's learning and progression including the young person's educational trajectory post-16
- parental involvement with the child and their schooling (e.g. attending parent-teacher evening)

[13] Data held by HMRC and/or DWP data systems may be useful for these purposes.

[14] For example, the then DCSF developed an alternative measure of neighbourhood deprivation based on tax credits (see DCSF, 2009: 9).

- parenting style

The data used for this project provides rich information on each of these aspects. However, there is some evidence (Davis-Kean, 2005) that the relationships of the above factors with attainment are not all direct, but may need to be specified as interactions. This may be particularly true of the interaction between parental educational levels and their attitudes towards education and schooling.[15] In this report the causal routes by which these factors influence pupil achievement are not considered. Instead, a range of rich covariates from the LSYPE1 data that are justified by the previous literature were selected. The extent to which these measures can better explain variation in pupil achievement, as compared to the FSM eligibility measure and the alternative geographic proxy indicators described above, was then assessed.

[15] Parents' educational level and their aspirations for their children are highly positively correlated. In the LSYPE1 data, overall, a large majority of parents have high expectations for their children's educational trajectories. A report for the Social Mobility Commission (Crawford, Macmillan and Vignoles, 2014) also finds that poorer parents are more likely than richer parents to think education is essential for progression.

2. Research questions and purpose of the project

The research questions framing the project were:

1. **Can FSM histories be improved on as a proxy for social deprivation?**

   If so, what measures can be used and what improvement do they make?

   Within that: who are the FSM eligible children and what are their characteristics?

2. **What alternative (practical) proxy measures of SES can be used that better capture variation in achievement?**

   For example, are models using neighbourhood and geographic indicators better at predicting variation in achievement than models that rely on FSM; or than models that use a combination of both?

3. **Do alternative proxy measures better enable us to identify pupils at risk of low achievement?**

2.1 This study is not about causation or school effectiveness

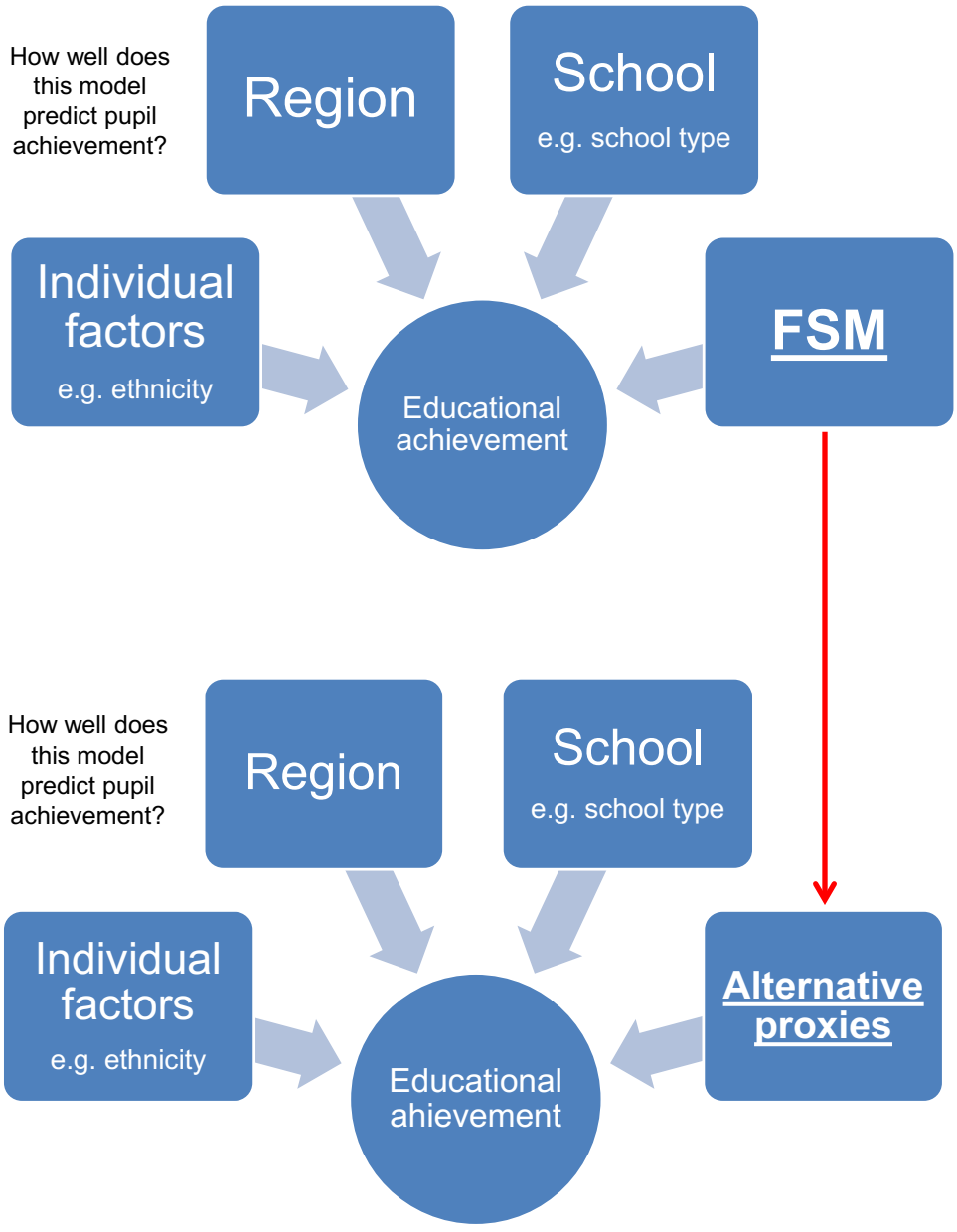
It is widely recognised that schools impact upon pupil achievement, and that schools can take steps to reduce attainment gaps (see DCSF, 2009), but this project did not set out to assess school effectiveness and as such does not discuss this literature or make any claims about school effectiveness. Similarly, this research was never intended to establish causal relationships between different measures of deprivation and attainment. To truly understand the causal association between such measures and educational attainment requires a different research design and approach to analysis. Instead, the aim of the research is to address the above research questions and to provide an evidence base on which to judge the quality of the FSM eligibility indicator.

2.2 Overview of analysis approach

As described in the next section, the analysis made use of LSYPE1 data, combined with publicly-available data from the Census and linked administrative data. The initial stages of the analysis consisted of a series of linear regression models fitted by ordinary least squares estimation that explored the explanatory power of a wide range of potential proxies for SES. These preliminary results led to the removal of several candidate proxies, for reasons related to practicality, statistical robustness or data availability. The remaining proxies and full sets of controls were analysed using multi-level models, accounting for the clustering of pupils in schools. The analysis followed the pattern illustrated by Figure 3 below. Specifically, all models control for a range of factors that influence pupil achievement (individual factors, region, and school). In the first model the

FSM eligibility measure was added as the indicator of pupil socio-economic background and the predictive power of the model was assessed. The FSM eligibility measure was then removed and replaced with each alternative proxy variable separately and sequentially, testing in each case the predictive power of the proxy in the model. By doing this it is possible to compare the predictive power of the different proxy variables.

Figure 3 Summary of the modelling approach



3. Data sources used in the study

Longitudinal Study of Young People in England (LSYPE1)

The main data used for this project come from LSYPE1, a nationally-representative study. This study has been detailed elsewhere (see DfE, no date), so an overview of the information used for this project is set out here. LSYPE1 participants were in year 9 in wave 1 of the study (aged 13/14 when the study began), meaning they sat GCSEs during wave 3 (15/16). LSYPE1 data were collected using a stratified random sample, with schools as the primary sampling unit. This means that *a priori* the data are clustered by school, which had implications for the analyses undertaken.

Additional data merged for analysis

The following 12 datasets were merged to create the analysis file:

1. young person file from LSYPE1 wave 1[16]
2. young person sensitive variables from LSYPE1 wave 1
3. school variables, from Census and NPD extracts
4. parental attitudes file from LSYPE1 wave 1
5. geography variables file from LSYPE1 wave 1
6. family background file from LSYPE1 wave 1
7. additional imputed values file from LSYPE1 wave 1[17]
8. all pupil level achievement data, from NPD and school/individual pupil census referring to the period 2002-2006
9. a new NPD extract file, containing previously unreleased key stage 4 and key stage 2 data (referred to in what follows as 'new' extract). This contained data on 2,866 LSYPE1 participants who had dropped out of the study at wave 4 or later and whose data has not previously been used for research purposes
10. a FSM eligibility file, containing FSM variables from NPD for the period 2002-2006
11. neighbourhood characteristics file (downloaded from the Census 2001 website and cleaned)[18]
12. neighbourhood HE participation data file (from 2001), created by merging original files from the Higher Education Funding Council for England's archive with a postcode-to-LSOA look-up file

The first 10 files were merged directly (one-to-one) using the survey ID variable included in each file. Files 11 and 12 were merged using LSOAs (lower super output area) in a many-to-one procedure, since in the survey files LSOAs do not uniquely identify observations (i.e. there may be more than one pupil from the same LSOA).

[16] All LSYPE1 wave 1 data were collected in 2004, when participants were aged 13-14

[17] Note that any imputed variables used have been supplied by DfE analysts, meaning that the imputation procedure has not been reviewed by the research team.

[18] In 2001, LSYPE1 young people were aged 10, so these data relate to their neighbourhoods at that point in time.

4. Sample and measures

4.1 Sample

The original wave 1 sample from LSYPE1 consisted of 15,770 pupils who agreed to NPD matching. Merging with the new key stage 4 attainment data extract (following waves 3 and 4) removes 173 observations from analysis that were missing in wave 4 for sensitive reasons (amongst which included death) and therefore are not included in the NPD extract. It is important to note that pupils in special schools were also removed from the analysis by dropping all the special schools (type defined at key stage 4). This was done because these schools are a-typical both in terms of the intake of pupils and the likely relationship between achievement and background measures. The following categories of schools and corresponding observations were dropped:

- community school, special: 126 observations deleted
- foundation school, special: 21 observations deleted
- independent school approved for children with special needs: two observations deleted
- pupil referral units: 56 observations deleted
- secure units: two observations deleted

This reduces the sample by a further 207 observations. The wave 4 booster sample was also excluded because this does not include the full set of information from wave 1. The final maximum sample was n=15,390 (97.5% of the original LSYPE1 sample who agreed to NPD matching)[19].

4.1.1 Missing data

There were numerous missing values present in the original data files – primarily in the LSYPE1 data (overall, around 70% of the main sample contains data on all the variables used below). When coding the dummy variables to be used in the analyses, the missing cases were retained; consequently all dummy variables can take the value of “0”, “1” or “missing”. In what follows, the exact number of cases used is reported for each of the estimated models. The main analysis upon which the presented results draw was performed using only a ‘standard sample’ (i.e. a sample where none of the observations are missing values on any of the variables in the analysis, i.e. a complete case analysis).

Imputed variables and not the original variables from the survey are used, because using the imputed variables provides a larger number of observations with data on variables which otherwise would be lost for analysis. However, the inclusion of the imputation flags

[19] When variables were extracted from multiple sources, the team agreed with DfE to use those coming from LSYPE1. Therefore, the variables below reflect this.

in the analysis at every stage makes it possible to approximately assess if the imputation significantly affects the estimates.

4.2 Control measures

To allow for direct comparisons of chosen candidate proxies in the models that follow, the analysis relies on a consistent set of controls in each of the models. Several groups of variables make up this basic controls set. The first group comprises individual demographic measures, which are well established as key predictors in achievement-related research and hence are important factors to control for:

- month of birth, to account for the starting point of the academic year and age thresholds
- gender, to account for known developmental differences between boys and girls that are reflected in their academic outcomes
- ethnicity, using the self-reported measure contained in the LSYPE1 questionnaire
- English as an additional language (EAL), again derived from the LSYPE1 questionnaire
- disability, although behavioural-based disabilities which will be reflected in the type of provision some children may get in school were not the focus; the LSYPE1 variable asking pupils' parents whether the pupil has a disability that directly affects their schooling was used
- care responsibilities within the home, a LSYPE1 measure indicating whether the pupil is providing care to any member of their household

Variables indicating the region of residence are added as a means of controlling for any regional differences in achievement and also to control for the influence of living in an urban environment (as opposed to a rural environment). Specifically, the following were included in all models:

- region, with Yorkshire and the Humber as the baseline
- urban/rural environment, where 'urban' identifies all pupils who, at the time of the wave 1 in LSYPE1, resided in a densely-populated urban area

The models also control for a set of school-level characteristics, to account for the differences between the different institutions the pupils in the sample attend. These consist of 'objective' characteristics and official measures that are not expected to be confounded with the socio-economic characteristics of parents and families that may influence pupils attending a particular school. The school variables are:

- school size, measured as number of pupils
- proportion of pupils eligible for FSM, as an indicator of the over-all level of deprivation in the school

- proportion of Special Educational Needs (SEN) pupils with statements
- proportion of SEN pupils without statements
- proportion of pupils self-identifying as White in the school, as a rough proxy for the ethnic make-up of the institution
- school type (foundation school, community school, etc.)

Statistically significant school effects over and above individual-level measures in the models that follow may reflect different aspects of school organisation, behavioural policy, intake, or 'climate' more broadly (see Rutter, 1982).

4.3 Outcome measure

The outcome of interest for this analysis is achievement at key stage 4 and therefore the research used the total capped GCSE points score, also known as the 'Best 8' measure. This is a measure of the combined points scores of the highest eight GCSE grades a pupil achieves, including equivalent qualifications. Since the LSYPE1 cohort sat GCSE exams in 2006 and the scores were derived at the same time, they will have abided by the regulations regarding points awarded for qualifications and the equivalence procedures in force in 2006. The unstandardised version of this measure was used because it has practical relevance and is directly interpretable (i.e. it is possible to relate differences in points score with GCSE attainment).[20] At the time, points scores for grades began at 16 (G) and increased by six points, up to 52 (A) and 58 (A*), so when interpreting the results presented in this report, a difference of six points equates to one grade better on a single GCSE. A difference of 12 points would mean either one grade better on two GCSEs or two grades better on one GCSE and so on.

4.4 Choosing and describing potential proxies

4.4.1 Proxy measure selection process

The development work for this project consisted of cycling through different potential proxy measures and assessing model fit for each scenario. This analysis consisted of approximately 250 statistical models and was based on two approaches:

1.1 single-level linear regression models with cluster-robust standard errors (to take into account the clustering of pupils within schools)[21]

[20] To test the robustness of the findings to slightly different ways of measuring key stage 4 achievement, the total uncapped GCSE score was also used, with similar conclusions.

[21] This procedure accounts for the clustering of pupils in schools by adjusting the standard errors of the coefficients accordingly.

2.1 single-level school fixed-effects models that included 'dummy' variables (0/1) for n-1 schools and school cluster- robust standard errors (to take into account the clustering of pupils within schools)[22]

Both approaches were pursued because with both of them one is able to use model R^2 to compare results. With (2.1), the addition of dummy variables for school membership means that all between-school variation is accounted for, meaning that results pertain solely to pupil level differences.

Based on the results of the preliminary models, decisions were made in collaboration with DfE analysts about which controls and candidate proxies to eliminate from further analyses. The main criteria for which proxies to pursue further were:

- **practicality:** are the data currently collected by NPD or other government departments at scale?
- **availability**: is it feasible that the data could ever be collected at scale?
- **data quality**: if it were possible to collect at scale, would there be any concerns about data quality?

On the basis of these criteria, and in particular the predictive power of the various proxy variables being considered, a set of potentially feasible proxy indicators that merited further investigation and modelling were selected. These variables are discussed below.

For each of the variables discussed in sections 4.4.2 to 4.4.10, a table in Appendix I details which variables from LSYPE1 were used to construct the measure and how the measures used in the present study were coded. Appendix II reports descriptive statistics for all measures.

4.4.2 FSM eligibility

FSM eligibility is the current proxy measure for SES. The analysis explored three different variations of eligibility:

- FSM eligibility in the school year GCSE exams were taken (in this case 2006)
- FSM eligibility ever in the five years preceding GCSE exams[23]
- years of FSM eligibility preceding GCSE exams, creating dummy variables identifying whether pupils were eligible for FSM for none, one, two, three, four or five years

[22] School fixed effects models (whereby a dummy indicator is used for each except one school – to act as reference – is included in the model) capture all the between-school variance without the need to specify the variables on which this variance may occur, in other words, everything that is different between the schools in the model is accounted for by that dummy variable.

[23] Common practice is to use eligibility in the six years preceding the point of interest; however, FSM data only began to be collected in 2002, five years before the LSYPE1 cohort sat GCSEs. Therefore five years of data, instead of the usual six, are relied upon here.

4.4.3 Household employment

Two separate variables make up the household employment candidate proxy:

- the employment status of the household, whereby a measure was created that coded for whether at least one of the parents was in full-time employment; the reference category is therefore households where neither parent was in full-time employment
- lone-parent households, to account for the distinct profile of households that cannot have more than one person in employment

4.4.4 Household occupational class

Occupational class is defined using ONS criteria and is a variable derived during the initial stages of LSYPE1 data management, whereby a missing data imputation protocol is applied. From this imputed variable a series of dummy variables identifying the highest occupational class in the household were derived, giving equal weight to the mother and the father. The reference category is represented by the “Higher managerial” category.

4.4.5 Household qualifications

Household qualifications underwent a treatment similar to that of the household occupational class proxy. Using the original LSYPE1 variable, a series of dummy variables identifying the highest qualifications obtained by either of the parents in the household was computed, regardless of who had achieved it. The reference category was households where the higher qualification was “Degree or above”.

4.4.6 Household income

The LSYPE1 questionnaire contained an item that asked parents to report their household income. Missing data was, as expected, a major issue, and the variable underwent an imputation procedure before it was made publicly available. Income was coded in two series of bands, ranging from very low absolute sums and small ranges (e.g. £520 to £1,040 per annum) for the first one, to wider ranges at the higher end of the continuum (e.g. more than £400,000 per annum) in the case of the second one.

The Institute for Fiscal Studies provided a data handling procedure that allowed for the creation of one single continuous variable that identified the mid-points of the previously-defined income bands. This derived variable, alongside its imputation flag, was included in all analyses that include household income as a potential proxy for socio-economic background.

The research team would like to note that the collection of self-reported economic data is notoriously difficult (see e.g. Moore et al., 2000; Hobbs and Vignoles, 2009), and income

data in particular are likely to suffer from non-response bias and mis-estimation by respondents.

4.4.7 Household objective characteristics

The last of the household-related potential SES proxies consisted of a combination of factors present in the LSYPE1 questionnaire that reflected aspects of the household not previously captured above. The variables included in this set were:

- mother's age
- whether the mother was of working age[24]
- a series of dummy variables identifying the type of housing tenure: owned; privately-rented; rented from a local authority; rent-free; or other housing arrangement
- household size

4.4.8 Neighbourhood characteristics

The aim of this research was to explore the possibility that socio-economic proxies may refer to the neighbourhood in which a pupil lived, and not just their household characteristics. Therefore, the analysis also included a neighbourhood occupations measure. Using data from the 2001 Census (to match with the LSYPE1 data collection time frame), the research team derived a variable that identified the proportion of people in the neighbourhood who, at the time of the Census, were in one of the two top occupational classes (or top-level occupations, thereafter).

Alongside this measure, a similar measure relating to neighbourhood qualifications (the proportion of people in the neighbourhood with degree-level qualifications) was also tested. The results were very similar to the ones using the occupations-focused variable. Therefore, the results for the neighbourhood qualifications variable are not presented here.

4.4.9 Income Deprivation Affecting Children Index (IDACI)

Another neighbourhood-level variable is represented by IDACI. It is an ONS-derived index that also relies on Census data and that identifies neighbourhoods where children are more or less affected by income deprivation, by ranking neighbourhoods according to the proportion of children living in low-income households. To allow for easier interpretation of results, the original index was rescaled to range from 0 to 100.

[24] Since LSYPE1 includes carers under the mother/father denomination, this variable captures those who are at the extremes of the age distribution, as well as a majority of step families.

IMD was initially considered as a candidate proxy. The initial OLS and school-fixed effects models yielded results very similar to IDACI in terms of explained variance and the relationship of the index with attainment once all other factors had been controlled for. Although the government uses IMD for 16-19 deprivation-driven funding allocations instead of IDACI, IDACI was considered it to be more appropriate as it refers explicitly to children living in neighbourhoods, as does LSYPE. Therefore, only results based on IDACI are reported in what follows.

4.4.10 Parental practices, expectations and aspirations

The last set of variables making up a potential proxy for SES combines parental practices, parents' expectations and pupils' own aspirations for their educational progress after age 16. Despite the abundance of literature that attempts to establish a correlation between aspirations and achievement (see e.g. Field, 2010: 17), there is widespread agreement that this is very difficult to achieve given the possibility of a reverse-causation relationship, whereby current attitudes and aspirations are often a *response* to prior levels of attainment (i.e. the variables are endogenous).[25]

This set of variables was, nonetheless, retained for the purposes of a later iteration of the models, which served as a means to illustrate the predictive power of a model that includes attitudinal measures not available from administrative data sources.

4.5 Prior attainment at key stage 2

A wealth of prior research (e.g. Chowdry et al., 2012) suggests that prior attainment would be a good predictor of future attainment, as past behaviour is a good (but not perfect) predictor of future behaviour. For the purposes of this research, prior attainment was not treated as a candidate proxy for SES. It was, however, included in the sensitivity analyses; the purpose of these was to assess whether FSM eligibility histories and any of the potential proxies were still related to key stage 4 attainment when variation in past attainment had been accounted for. To measure prior attainment, the total key stage 2 points score on English, maths and science was used.[26] Many variables behave quite differently in the model if prior attainment is included. This is because in models without prior attainment, the coefficient measures the association between the variable and the level of pupil achievement; in models with prior attainment, the coefficient measures the association between the variable and *changes* in pupil achievement. It is important to note that this report focuses on achievement in secondary school and it is not clear the extent to which findings could be extrapolated to primary education.

[25] In a review of interventions aimed at affecting aspirations and attitudes (and thereby attainment), the authors found "no evidence that impact on attainment is mediated by change in any of these attitudes" (Cummings et al., 2012: 1).

[26] In preliminary work the average points score was also used, but this produces very similar results.

5. Analysis approach and results

The analyses presented here refer to the first research question and aim to describe the pupils eligible for FSM on all dimensions addressed by the LSYPE1 survey, as well as on achievement at key stage 2 and key stage 4.

5.1 What characterises FSM eligible children in LSYPE1?

The first aim was to use the available data to describe FSM eligible pupils in LSYPE1 when compared to pupils not eligible for FSM. Appendix III lists the proportion of cases (or the mean statistic, depending on the type of variable) of each of the basic controls and candidate proxies for FSM and non-FSM pupils.

In the LSYPE1 sample, 27.5% of pupils were eligible for FSM for at least one year in the five years prior to them sitting GCSE exams. As compared to non-FSM eligible pupils, eligible pupils are more likely to come from households with lower qualifications. Parents of FSM children are 14 percentage points less likely to have a degree and 34 percentage points more likely to have no qualifications at the time of the survey. Parents of FSM pupils were 21 percentage points more likely to be in long-term unemployment and 14 percentage points less likely to be in a higher-managerial occupation category. Additionally, FSM eligible children were more likely to be in single-parent households: 50% of FSM-children lived in lone-parent households, while only 16% of non-FSM pupils did so.

The relationship between FSM eligibility and household income was also evident, with non-FSM children's households earning on average £30,000 per annum, while FSM households around £14,000 per annum. The ethnic make-up of FSM and non-FSM pupils was also different. Approximately 45% of FSM pupils were White, compared to 72% of non-FSM pupils. In terms of the schools attended, FSM pupils were enrolled in schools with, on average, double the rate of FSM eligible pupils (31% vs. 14%); and where the per-school proportion of White pupils was 20 percentage points lower (80% vs. 60% for non-FSM pupils).

FSM children expressed similar expectations to non-FSM children regarding their education progress beyond age 16: both groups were equally likely to report wanting to continue in full-time education (87% and 84%, respectively). This was also true for parents, who had similar expectations about whether their child was likely to go to university (69% and 67% for non-FSM pupils and FSM eligible pupils, respectively).

5.2 Analysis approach: Multi-level models

As a result of the decisions made during preparatory work, the following models were run in a multi-level framework.[27] Multi-level models allow for pupils' residual clustering by school, pupil characteristics and school-level measures to be included, and a more detailed understanding of the variation in outcomes.[28] Table 1 below sets out the results from these models – each column represents a new model specification with a different proxy measure. Proxies were substituted in and out in this way because the purpose of the project was to assess the relationship between a specific proxy and attainment, on the assumption that only one such proxy might be available. All analyses were conducted using the `mixed` command in Stata 13.1 (StataCorp, 2014).

5.3 Results from SES proxy models

The first two models represent the so-called 'empty model' (Model 1) and a model with basic control variables (Model 2; see description above of basic control variables). The next two models include measures of FSM eligibility. Model 3 is 'ever been eligible for FSM in the previous five years' (similar to the 'ever six' measure used by DfE) and Model 4 is 'number of years been eligible for FSM in previous five years'. These offer a 'baseline' of current practice against which proxy models (Model 5-Model 11) can be compared in terms of the model fit of measures being used. A summary of the models is given in Box 1 below, after which the results presented in Table 1 are discussed.

In the preparatory work for this report, the authors used the overall amount of variance explained (model R^2) as the measure of model fit to allow for comparison. In the models presented here, the proportion of within-school (between pupil) variation accounted for was the approach used. This was motivated in part by the fact that between school differences in key stage 4 outcomes are very small (0.5-2%) when different measures of deprivation are included.

Assessing explained variance is difficult in multi-level models given that the variance is split between the two levels, as are the predictors included in the models, and some (Kreft and De Leeuw, 1998) suggest not using measures of explained variance at all. Instead of relying on the traditionally-used (Recchia, 2010) proportional reduction in variance indicator, the Snijders-Bosker measure uses the "proportional reduction in mean

[27] A general formalisation of the models used here – random intercepts multi-level models – is:

$$Y_{ij} = \alpha_0 + b_1 x_{1ij} + b_2 z_{2j} + \mu_{0j} + \varepsilon_{ij}$$

Where *Yij* is a continuous outcome measure for individual *i* in school *j*. α_0 is the overall intercept (average), $b_{ij}x_{1ij}$ is an individual level measure for person *i* in school *j* and z_{2j} is a school level variable. ε_{ij} and μ_{0j} are, respectively, the pupil and school level error terms (residuals).

[28] Specifically, the extent that the outcome varied between schools and within schools (between pupils). Both of these sources of variation are of interest; the former relates to the extent to which clustering 'matters' for the analyses, whilst the latter is of how much difference between pupils within schools is evident.

squared prediction error" (Snijders and Bosker, 1994, p.342) to assess the effectiveness of models at both level1 (individual-level in the present analysis) and level 2 (school-level here). Given that a wide range of school-level predictors were used, a significant proportion of the variance between schools can be controlled for. Additionally, the differences between individuals identified by various proxies as most likely to be of low socio-economic standing are also of interest. Therefore, when comparing models, the Snijders-Bosker R^2 for level 1 was used (i.e. for individual-level, within-school variance).

Box 1: Summary of proxy models

Model 1: Null model (no controls)
Model 2: Basic controls
Model 3: Basic controls and FSM eligibility ever in the five years prior to GSCE exams (ever5FSM)
Model 4: Basic controls and years of FSM eligibility in the five years prior to GCSE exams
Model 5: Basic controls and IDACI
Model 6: Basic controls and household employment status
Model 7: Basic controls and the proportion in young person's neighbourhood with top occupations
Model 8: Basic controls and highest household education
Model 9: Basic controls and parental occupations
Model 10: Basic controls and household income
Model 11: Basic controls and other household characteristics

Table 1. Results for FSM and FSM-proxy models (Level 1 n = 12,678; Level 2 n = 358) Outcome: GCSE capped total points score

Proxy indicator (regression coefficient)	Model 1 (empty)	Model 2 Basic	Model 3 Ever5FSM	Model 4 FSM_year	Model 5 NH_IDACI	Model 6 HH_emp	Model 7 NH_occ	Model 8 HH_ed	Model 9 HH_oc	Model 10 HH_inc	Model 11 HH_other
Residual between school variation (ICC)	9.50%	1.44%	1.33%	1.38%	1.48%	1.46%	1.13%	0.92%	1.01%	1.06%	1.42%
Proportion of individual-level explained variance	N/A	18.66%	23.31%	23.44%	20.83%	22.54%	21.07%	25.77%	25.62%	20.61%	24.41%
Ever FSM eligible			-56.543*								
1 year of FSM eligibility				-44.172*							
2 years of FSM eligibility				-50.655*							
3 years of FSM eligibility				-65.351*							
4 years of FSM eligibility				-66.687*							
5 years of FSM eligibility				-56.683*							
IDACI score					-1.059*						
At least one parent full-time employed						41.445*					
Single-parent household						-22.654*					
Proportion higher occupations							1.738*				
HE, below degree-level								-29.118*			
A-level or equivalent								-38.227*			
GCSE-level or equivalent								-55.312*			
Other qualification								-67.857*			
Level1 qualification								-80.742*			
No qualification								-91.690*			
Imputation flag								-14.135*			
Lower-managerial									-23.486*		
Intermediate occupation									-34.342*		
Small employers									-54.538*		
Lower supervisory									-66.056*		
Semi-routine									-70.477*		
Routine									-91.434*		
Never worked/unemployed									-95.777*		
Imputation flag									-3.816		
Income (£1000s)										.547*	
Imputation flag										-.390	
Age of mother											1.552*
Mother of working age											57.979*
House tenure: private rent											-34.732*
Housing tenure: LA rent											-53.183*
Housing tenure: other											-32.358*
Household size (persons)											-2.199*

Notes: *p≤.05. Results for basic controls omitted from this table. Reference categories for proxy variables: Models 1 & 2: none; Models 3 & 4: never eligible for FSM; Model 5: none (IDACI=continuous variable); Model 6: No parent employed full-time, household with both parents; Model 7: none (proportion higher occupations = continuous variable); Models 8: degree-level qualification; Model 9: higher-managerial occupation; Model 10: none (income – continuous variable); Model 11: house tenure: owner-occupier; mother not of working age, all other variables continuous.

Firstly, the results from the so-called 'empty model' – that is the model with only the outcome included – are presented. This model (Model 1 in Table 1) is used simply to consider the extent to which variation across pupils is largely between- or within-schools. Before adjusting for pupil/school composition effects, 9.5% of the variation in key stage 4 attainment is between-schools, meaning that 90.5% of variation occurs within-schools.

Model 2 includes the basic controls discussed above. Basic controls consist of individual demographic measures such as sex and ethnicity; area measures relating to region of residence and urban/rural; and school level characteristics such as school size, the proportion of pupils with SEN statements. A fuller description of controls is given in section 4.2 of this report. The inclusion of these measures reduces the between-school variation to less than 2%. Adding in basic controls explains 18.7% of the within-school variance. All subsequent models include these basic control variables.

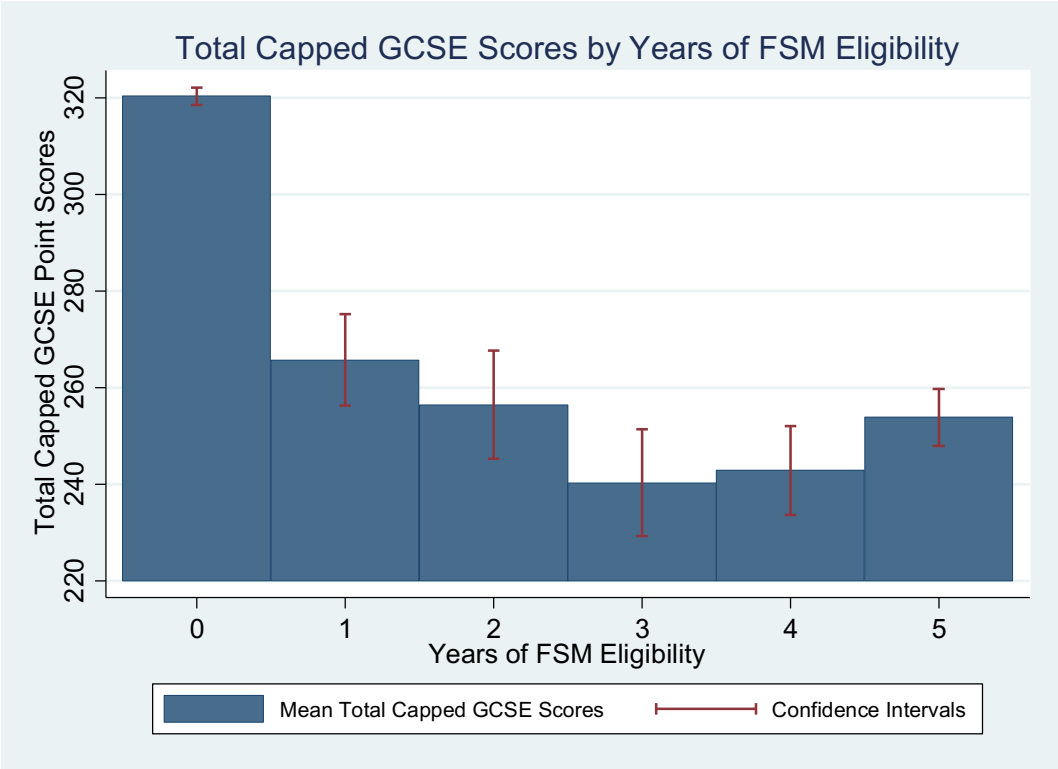
In Model 3, the ever5FSM measure is introduced. This model (including basic controls) explains 23.3% of within-school variation in key stage 4 marks. In practical terms, there is a 56 point[29] difference between pupils who have ever been FSM eligible in the last five years and those who have not, equating to the difference between a pupil gaining one grade better across seven GCSEs (e.g. moving from a C to a B) and two grades better on an eighth GCSE (nine letter grades in total), a substantial difference.

The number of years a pupil had been FSM eligible in the last five years was also assessed, to see if this produced different results. In Model 4 there is a non-linear relationship between years FSM and attainment, with the effects increasing from 1-3 years, levelling off for 3-4 years then decreasing for five years, as can be seen in Figure 4 below. The reason for this u-shaped relationship is unclear. The magnitude of the effect is slightly larger for those who were FSM eligible for four years versus non-FSM eligible pupils, than for five years versus non-FSM eligible pupils. The overall model fit is, as might be expected, comparable to that of the ever5FSM measure at around 23.4% of within-school variance explained.[30] Both these models fare better than the one including current eligibility for FSM: alongside the controls, the variable explains 20.7% of the within-school variance in key stage 4 outcomes and being eligible for FSM in the final GCSE year is associated with a 44 point reduction in the capped GCSE score.

[29] As set out above, when interpreting the results presented in this report, a difference of six GCSE points equates to one grade better on a single GCSE. A difference of 12 points would mean either one grade better on two GCSEs or two grades better on one GCSE and so on.

[30] It is worth noting that the difference between ever5FSM and being FSM for one year and for five years is similar to findings from a recent Fisher Family Trust report (Treadaway, 2014), with the difference being that the FFT research consisted of unadjusted associations between FSM status and attainment.

Figure 4 Total Capped GCSE Scores by Years of FSM Eligibility



The next model, Model 5, reports the results from the first proxy measure – neighbourhood IDACI score. The overall model fit is slightly lower than for the FSM measures, explaining 20.8% of within-school variance. Each additional point on the IDACI scale (i.e. as deprivation worsens) is associated with one less GCSE point. Given that the re-scaled measure of IDACI ranges from .31 to 99.30, there is a wide gap between those at the top and bottom of the scale in terms of GCSE attainment (equivalent to approximately two full GCSEs less for pupils in the lowest-scoring neighbourhood compared to the highest).

Model 6 explored the relationship between attainment and household employment characteristics (whether one parent is full-time employed / whether a single parent household). Model 6 explains 22.5% of the within-school variance in key stage 4 capped total scores. Both of the measures included in the proxy are again binary – therefore the coefficients are the difference in means between groups of pupils that do and do not have the characteristics. There is a strong positive association between pupils with one parent in full-time employment and educational attainment. Compared to a two-parent household where neither parent is working, there is an average 22 point difference in attainment when at least one parent is working.

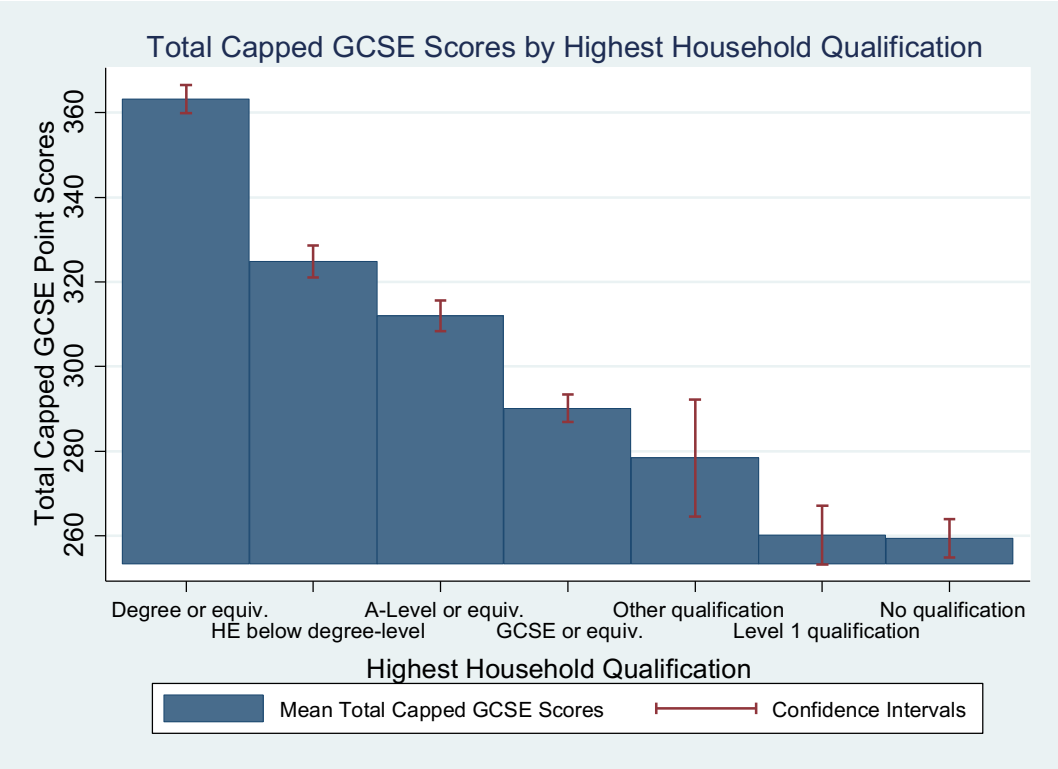
Model 7 reports on the relationship between attainment and the proportion of working-age adults in the neighbourhood in higher-managerial and lower-managerial/professional

occupational class categories. For every additional percentage point increase in the number of individuals in higher occupations in a child's neighbourhood, there was an associated increase in attainment of 1.73 points: however, it should be reiterated here that this is not a causal association, and that this relationship reflects a range of other factors (e.g. selective sorting into neighbourhoods on the basis of income, educational levels and so on – see Allen et al., 2010; Gorard and Cheng, 2011).

For Model 8, household educational level was operationalised as the highest educational level of either parent, with each category entered as a dummy variable (with degree level being the reference category). There is a strong linear association between household educational level and attainment, namely that as household educational level decreases, so does the attainment level, as can be seen in Figure 5 below.[31] At the extremes, children from households with a qualification at level 1 or no qualifications, achieve, on average, 80-91 fewer points at key stage 4 than children from households where at least one parent holds a degree level or equivalent qualification, equating to a near two grade difference across the 'Best 8' measure. As above, one should be conscious that this result is not necessarily causal since parental education may proxy a host of other factors that are unmeasured. For example, parental education may act as a proxy for innate intelligence, the home learning environment and other factors not captured by the model. The 'imputation flag' for highest household education level is also significant, which indicates that pupils missing this information tended to fare slightly worse than the reference category of degree-educated households.

[31] It is unclear what qualifications make up the 'other qualifications' category, but whichever qualifications are included appear higher than 'level one' qualifications.

Figure 5 Total Capped GCSE Scores by Highest Household Qualification



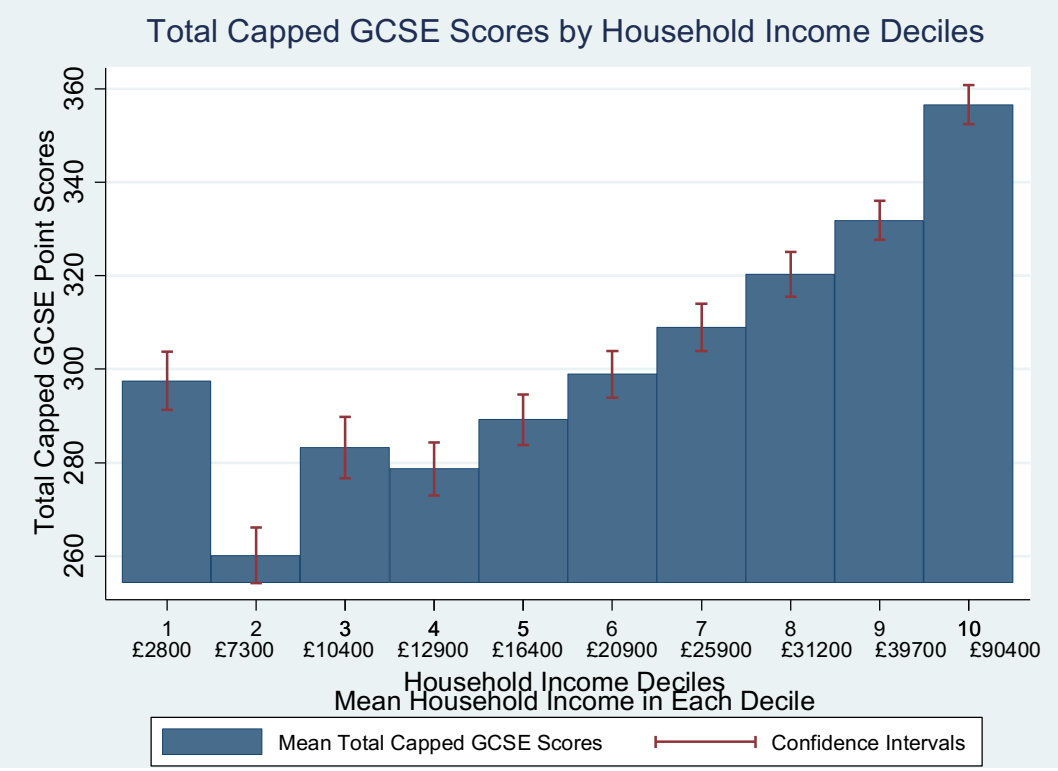
There is a similar linear relationship in Model 9 for household occupational class, and with both the household educational and occupation models, the within-school variance explained is slightly higher than for the FSM models, suggesting that these measures could act as 'better' proxies for deprivation than FSM. However, the additional explanatory power of Model 9, when compared to Models 3 and 4, is not sufficiently large to warrant a definitive conclusion that household occupational class should replace FSM eligibility. One point to note is the difference between children from semi-routine, routine and unemployed households and those from the highest occupational classes. Individuals in these former groups, on average, score between 70 and 95 fewer points at key stage 4 than children from professional households. This is equivalent to a pupil with only seven GCSEs gaining an additional A* GSCE and increasing, by one grade, six of their other GCSEs.

It must be stressed that by substituting proxy measures in and out of models, the results noted for a given proxy represent both the direct relationship with that measure and attainment, *as well as* any variation from other proxies that overlap with it. For example, highest household occupational class is strongly correlated with household income because households with higher occupational classes tend to have higher incomes. It is also correlated with household educational level. This means, for instance, that when occupational class is included in the model, it absorbs part of the variation associated with household income and household education.

The final two models relate to household income (Model 10) and more general household characteristics (Model 11). The coefficient for household income is very small in comparison to other proxies (*b* = .547*) as this represents the association between a £1,000 increase in household income and key stage 4 attainment. This means that an increase of £10,000 in household income is associated with a five point increase in key stage 4 attainment, i.e. less than the difference between a B and an A on a single GCSE. In short, the relationship between household income and attainment is quite weak when accounting for all of the basic controls. The most likely reason for these results, the research team believe, is the fact that this variable is measured with error and this is likely to reduce the magnitude of the coefficient on the income variable.

Figure 6 below illustrates the relationship between the measure of income used for this analysis (presented here as deciles of the outcome variable). The figure represents the relationship between self-reported household income and GCSE points score, unadjusted for other covariates, so as to allow an assessment of whether this relationship is linear or not. It is clear that apart from the lowest income group the relationship is strongly linear, but to assess whether a non-linear income variable would yield better explanatory power, a model using a quadratic term was also estimated. The results did not indicate any benefit to using the quadratic term over the linear one. Therefore, for sake of simplicity, the outcomes of the linear model are those discussed when comparing income with the other candidate proxies.

Figure 6 Total Capped GCSE Scores by Income Decile (lowest to highest)



Model 11 contains results for variables relating to housing tenure, household size and mother's age. The reference category for housing tenure is 'owner occupier'. Pupils from 'owner occupier' households record higher key stage 4 outcomes than pupils in all other housing types.

In summary, using multi-level models estimated on the same LSYPE1 sample, this analysis explored the relative predictive power of several sets of potential proxies for SES for explaining variation in key stage 4 outcome.

From amongst the considered candidate proxies, the best performing ones, **but only by a small additional proportion of explained variance**, were parental education and parental qualifications (both explaining around 25.6% of variance in the total GCSE point score when entered in the models alongside the basic controls, compared to 23.3% for ever eligible for FSM in the previous five years); these were followed closely by household characteristics (such as housing tenure), at 24.4% of variance. It must be noted, however, that these proxies come with the same major disadvantage: they require the systematic collection of individual level data. Such data is difficult and expensive to collect, and if it is of poor quality can result in problems of measurement error, as observed in relation to household income. Despite research literature indicating a strong association between income and attainment, in this analysis the model containing all basic controls and income only explained around 20.6% of the variance, the lowest of all the considered proxies. The research team attribute this to the way the variable was measured and the unavoidable difficulties of collecting self-reported earnings data.

Neighbourhood-level proxies performed marginally better than household income: IDACI explained 20.8% of variance, while the proportion of the neighbourhood with top-level occupations explained 21.1% of variance. While the data collection required for deriving these two measures is already embedded in the Census, the timeline of its collection would mean that the further away in time from each Census, the more these variables would be measured with error and potentially lose their predictive power. Additionally, they both explain less variation in GCSE points than FSM eligibility.

Being ever eligible for FSM in the previous five years is the fourth-best candidate proxy, at 23.3% of explained variance. This proxy has clear advantages over the alternatives proposed; it is available in current data and has been established as a key metric for a long time, with substantial long-term research investigating its use**. Taking all this into account, at this stage, FSM eligibility histories – measured either using the 'Ever 5 FSM' or the number of years FSM – represents the most appropriate proxy for SES.**

Before turning to the exploration of the potential of a combination of proxies delivering more explanatory power, as well as testing the robustness of the above models to different specifications and different parts of the LSYPE1 sample, an important observation must be made.

In statistical terms, the best predictor of future achievement is the pupil's level of prior achievement; key stage 2 total point scores accounted for the largest proportion of explained variance at the individual level. When entered alone in the model (without the basic controls) it explains 44.2% of the within-school variance in key stage 4 capped scores. When entered in the models in a similar fashion to the above proxies, alongside the same set of basic controls, the proportion of explained within-school variance increases to 51.7%. The increase in explanatory power is not large because the prior attainment measure already captures some of the SES-driven variation between individuals. Although associated with SES, it cannot, however, be considered a proxy for SES, because it is not a direct or indirect measure of any of its aspects. Additionally, using only key stage 2 attainment as a predictor for key stage 4 attainment may conceivably lead to the under-representation of disadvantaged pupils at the higher ends of the achievement distribution. While the measure will soak up some of the deprivation-linked variation, it may miss the 'lost potential' of more able disadvantaged pupils who are still falling short of their full potential. Therefore, although its explanatory power is greater, it does not fit the purposes and rationale of this research and cannot, as such, be considered a potential replacement for FSM eligibility histories. However, combining the FSM and key stage 2 attainment measures might overcome this issue – a point returned to in the discussion.

6. Robustness checks

In this section, results from a series of robustness checks are set out. The purpose of such analyses is to assess the sensitivity of previous results by using different model specifications. The approach here was to include all potential proxies in a single model to assess the independent effect of each proxy, net of other associations. This is not a realistic scenario because it is unlikely that much of the rich survey data from LSYPE1 would be available, but it is a worthwhile exercise because it allows one to demonstrate whether a particular measure is still associated with the outcome net of the overlap with other measures. In addition to including all proxies together, later models also include key stage 2 attainment and (subsequently) measures relating to parenting practice, and then attitudes towards education that both LSYPE1 participants and their parents had.

6.1 What results are observed when all proxies, prior attainment and attitudinal measures are in a single model?

Table 2 presents the results from three separate models, with these models summarised in Box 2 below. In each model, results are estimated based on those individuals who have complete information for all the variables being used. Model 12 is the 'best case scenario' where significant amounts of rich survey and administrative data are available. Model 13 includes all the measures from Model 12 and includes prior attainment at key stage 2. In Model 14 parenting practices and attitudinal measures as collected in LSYPE1 are added, though it should be recognised that these variables are potentially endogenous (as discussed above) and therefore the relationship between them and final key stage 4 outcomes is very difficult to interpret. An important point to note is that the sample changes between Model 13 and 14 because of additional missing data (a loss of roughly 1,300 observations). Although approximately 1,300 observations are lost, estimating Models 12 and 13 on the same sample as Model 14 does not lead to significantly different conclusions.[32] Therefore, the results using the largest possible samples are reported.

Box 2: Summary of robustness check models

Model 12: Basic controls and all candidate proxies
Model 13: Basic controls, all candidate proxies, and prior attainment
Model 14: Basic controls, all candidate proxies, prior attainment, parenting practices, and young persons' and parents' attitudes towards education

Table 2. Results from multiple proxy variable models including prior attainment

[32] Estimating Models 12 and 13 on the sample for Model 14 yields the following results: Model 12: 30.3% explained within-school variance and ICC=1.35%; Model 12: 55.94% explained within-school variance and ICC=0.65%.

Outcome: GCSE points score Proxy indicator (regression coefficient)	Model 12	Model 13	Model 14
Ever FSM eligible	-18.075*	-9.802*	-10.347*
IDACI score	-.078	-.123*	-.094
Proportion higher occupations	.623*	.341*	.192*
At least one parent full-time employed	5.540	4.453	2.993
Single-parent household	-11.568*	-16.244*	-12.900*
HE, below degree-level	-19.397*	-7.484*	-6.346*
A-level or equivalent	-21.909*	-9.288*	-5.728*
GCSE-level or equivalent	-29.516*	-11.593*	-5.663*
Other qualification	-33.847*	-10.608	-6.424
Level1 qualification	-42.405*	-16.092*	-11.702*
No qualification	-49.554*	-19.930*	-12.310*
Imputation flag	-14.953*	-13.662*	-7.738*
Lower-managerial	-10.918	-1.968	-.280
Intermediate occupation	-8.310*	1.073	3.490
Small employers	-25.020*	-5.708*	-2.555
Lower supervisory	-31.514*	-8.778*	-4.810
Semi-routine	-24.356*	-4.921	-2.282
Routine	-34.433*	-10.426*	-7.379*
Never worked/unemployed	-30.609*	-8.409*	-5.564
Imputation flag	.159	.140	-2.366
Income	.065*	-.029	-.037
Imputation flag	-2.111	-.098	1.588
Age of mother	1.128*	.673*	.743*
Mother of working age	29.655*	11.124	21.882
House tenure: private rent	-11.710*	-5.186	-3.850
Housing tenure: LA rent	-20.346*	-12.384*	-10.706*
Housing tenure: other	-21.820*	-9.981	-9.063
Household size (persons)	-3.563*	-1.715*	-.881
Key stage 2 scores		1.259*	1.106*
Parents have meals with family weekly			13.361*
Parents know of child's whereabouts when out			27.125*
Child does not go out			8.553*
Child has extra tuition, school subject			3.480
Child has extra tuition, non-school subject			4.328*
Child expects to continue education post 16			26.085*
Parents expect child to attend HE			26.067*
Individual sample size	12,678	11,666	10,352
School sample size	365	358	350
Residual between school variation (ICC)	0.931%	0.871%	0.486%
Proportion of individual-level explained variance	31.33%	55.30%	59.30%

Note: *p≤0.05. Basic control variable results (in Appendix IV & V) are omitted from this table. Reference categories for categorical variables are discussed in Section 4.

As before, the between-school variation in attainment is very low (<1%) when control and proxy measures are included, so the focus is instead on the individual level variance explained and the substantive results for each proxy measure. In all three models, even with rich survey and comprehensive administrative data included alongside prior attainment, ***FSM eligibility is still statistically and substantively associated with lower key stage 4 attainment.*** In Model 12, there is an average 18 point difference between FSM and non-FSM eligible children, which remains as high as 10 points in Models 13 and 14. This is equivalent to increasing (up to) three GCSES by one grade (if an 18 point difference). This comes in contrast with the 56 point reduction associated

with being eligible for FSM at any point in the five years prior to GCSE (Table 1, Model 3); this suggests that the prior attainment measure already captures some of the SES-driven variance in attainment scores, which is to be expected.

This section details the performance of the various candidate proxy measures across the three models (Model 12, 13, and 14). For the IDACI score, this measure is not significant (at the p≤.05 level)[33] in Models 12 and 14, suggesting that net of the other factors in the model, the relationship between IDACI and attainment is quite weak.[34] Similarly, whether or not one parent is full-time employed is not significant at the 5% level in any model. However, children from single-parent households score lower than children in other types of households in all three versions of the models, with the greatest difference noted in Model 13 when prior attainment is included.[35] In these richer models, the effect of neighbourhood occupational class is substantially attenuated. In the previous model with neighbourhood occupational class on its own (Table 1, Model 7), a one percentage point increase in the proportion of households from higher occupations was associated with a 1.73 increase in key stage 4 points score. Here, the relationship was reduced by 65%, 80%, and 89% for Models 12-14 respectively.[36]

As with neighbourhood occupation, the relationship between parental education and attainment is strongly attenuated in these models once prior attainment is included, but the relationship appears to remain consistent and nearly all of the differences remain statistically significant at the 5% level. For household occupation level, the results differ quite markedly from the previous table. Notably, the previously strong linear relationship between household occupation level and attainment only holds for Model 12 in Table 2. With the addition of prior attainment (Model 13) there is an inconsistent relationship, with many differences no longer being significant at the 5% level. Including these measures might artificially inflate the relationships within the model because of the strong relationship between prior performance, current attitudes and future performance Household income was no longer significant (at p≤.05) in Models 13 and 14.

Prior attainment was included in Models 13 and 14. Key stage 2 attainment is statistically and substantively linked to key stage 4 attainment. For every additional key stage 2 point, pupils achieved an additional 1.0-1.2 key stage 4 point – given that the key stage 2 measure ranges from 12 to 272 points, this is a strong relationship. As with previous

[33] In the model containing all proxies and prior attainment (Model 13), IDACI is significantly correlated with attainment at the p≤.05 level.

[34] Concerns emerged about potential collinearity between IDACI and other neighbourhood measures such as the proportion in higher occupations. The correlation between IDACI and this measure is -.50, p≤.05, indicating a moderately-strong association, but not perfect collinearity.

[35] It is worth noting that the status of 'single parent household' is measured only in wave 1 of LSYPE1. It is therefore unknown whether the pupil was always in a single-parent household or whether this was a recent occurrence prior to wave 1. This means that the effect noted here is a mixture of all prior scenarios where at the point of measurement the pupil was in a single-parent household.

[36] E.g. the coefficient for neighbourhood occupation for Model 12 in Table 2 (0.623) is roughly one-third that of Model 7 in Table 1 (1.738), meaning a reduction of nearly two-thirds.

discussions, this should not be confused with a causal effect – both scores could be determined by unmeasured factors and in essence, future behaviour is being predicted from past behaviour so it is unsurprising that this is a strong relationship between these measures. However, this strong relationship, and the fact that the individual R^2 increases by 20 percentage points with the addition of prior attainment, does demonstrate that the best predictor of future attainment is past attainment.

6.2 Do results differ by gender?

This section details the results of another set of robustness checks. The same proxy models reported in Table 1 were run using different sub-samples of the LSYPE1 full sample. For example, in Table 3, results of separate analyses for boys and girls are presented side-by-side.

Since by definition the analyses are using different subgroups, the results (explained variance/effect sizes) should not be interpreted as evidence of definitive differences in the predictive power of the different proxies. The aim of these analyses is to test whether the conclusions emerging from running the models on the whole sample still hold when the data are split in various sub-groups of interest.

Confirming the robustness of the results, the overall pattern of associations is the same, but the strength of relationship is weaker for girls or stronger for boys such that there is a stronger relationship between measures of SES and boys' achievement. For example, FSM are associated with a 60 point difference in key stage 4 outcomes for boys, but 53 points for girls. One exception is the association between attainment and whether the pupil's mother is of working age – this effect is stronger for girls than for boys.

Table 3.Sub-group analysis by gender

Outcome: GCSE points score	Boys N=6,367		Girls N=6,311	
	Residual intra-class correlation	**Individual R^2** Coefficient	**Residual intra-class correlation**	**Individual R^2** Coefficient
Model 3	**1.68%**	**23.57%**	**0.85%**	**19.13%**
Ever FSM eligible		-59.995*		-52.964*
Model 4	**1.73%**	**23.71%**	**0.90%**	**19.29%**
1 year of FSM eligibility		-45.170*		-42.407*
2 years of FSM eligibility		-57.901*		-42.602*
3 years of FSM eligibility		-70.862*		-59.383*
4 years of FSM eligibility		-68.998*		-64.425*
5 years of FSM eligibility		-59.812*		-53.836*
Model 5	**2.16%**	**20.45%**	**1.10%**	**17.24%**
IDACI score		-1.035*		-1.094*
Model 6	**2.03%**	**22.53%**	**0.77%**	**18.70%**
At least one parent full-time		40.015*		42.776*
Single-parent household		-27.126*		-18.232*
Model 7	**2.00%**	**20.63%**	**0.73%**	**17.45%**
Proportion occupations		1.664*		1.815*
Model 8	**1.55%**	**25.83%**	**0.56%**	**22.03%**
HE, below degree-level		-33.761*		-24.756*
A-level or equivalent		-42.881*		-33.738*
GCSE-level or equivalent		-57.453*		-53.895*
Other qualification		-74.234*		-62.024*
Level1 qualification		-83.630*		-78.703*
No qualification		-97.631*		-86.359*
Imputation flag		-5.886		-20.916*
Model 9	**1.74%**	**25.54%**	**0.57%**	**22.08%**
Lower-managerial		-25.611*		-21.737*
Intermediate occupation		-34.107*		-35.441*
Small employers		-55.661*		-53.688*
Lower supervisory		-68.977*		-63.399*
Semi-routine		-73.768*		-68.475*
Routine		-90.969*		-92.846*
Never worked/unemployed		-106.541*		-87.223*
Imputation flag		1.759		-9.664*
Model 10	**1.88%**	**20.39%**	**0.59%**	**16.67%**
Income		.547*		.551*
Imputation flag		.271		.942
Model 11	**1.86%**	**24.18%**	**1.01%**	**20.94%**
Age of mother		1.862*		1.257*
Mother of working age		52.389*		68.195*
House tenure: private rent		-34.867*		-35.417*
Housing tenure: LA rent		-52.464*		-53.798*
Housing tenure: other		-27.839*		-38.034*
Household size (persons)		-1.979*		-2.562*

Note: *p≤.05. Basic control variable results are omitted from this table. Reference categories for categorical variables are discussed in Section 4.

6.3 Do results differ by urban-rural locations?

The same approach was used here as above, splitting the sample by urban/rural and comparing results from the two models to assess whether the relationships noted in earlier models hold for these specific sub-samples. It should be noted that definitions of “urban” and “rural” are problematic as they are changeable. In this case, the division between urban and rural was defined as follows: the urban indicator captured densely-

populated cities, while rural captured every other category, including sparsely-populated cities and all types of villages and towns. Table 4 shows that the relationship between ever being eligible for FSM and attainment differs somewhat depending on whether pupils are in urban or rural locations (56 and 62 points respectively), though the broad patterns across the different proxies remain similar to that described earlier.

Table 4 Sub-group analysis by urban/rural

Outcome: GCSE points score	Urban N=10,643		Rural N=2,035	
	Residual intra-class correlation	**Individual R^2** Coefficient	**Residual intra-class correlation**	**Individual R^2** Coefficient
Model 3	**1.12%**	**22.93%**	**4.22 %**	**19.71%**
Ever FSM eligible		-56.184*		-62.342*
Model 4	**1.14%**	**23.04%**	**4.02%**	**20.71%**
1 year of FSM eligibility		-44.762*		-39.935*
2 years of FSM eligibility		-51.110*		-45.410*
3 years of FSM eligibility		-64.937*		-69.631*
4 years of FSM eligibility		-63.459*		-121.032*
5 years of FSM eligibility		-56.815*		-52.872*
Model 5	**1.26%**	**20.49%**	**4.70%**	**16.51%**
IDACI score		-1.051*		-1.334*
Model 6	**1.23%**	**22.27%**	**4.63%**	**18.02%**
At least one parent full-time		41.692*		40.208*
Single-parent household		-22.746*		-22.627*
Model 7	**1.05%**	**20.57%**	**4.88%**	**17.46%**
NH proportion top occupations		1.756*		1.871*
Model 8	**0.81%**	**24.72%**	**2.66%**	**27.45%**
HE, below degree-level		-29.138*		-29.191*
A-level or equivalent		-36.171*		-46.267*
GCSE-level or equivalent		-52.988*		-64.817*
Other qualification		-69.442*		-54.735*
Level1 qualification		-78.242*		-91.125*
No qualification		-88.982*		-118.024*
Imputation flag		-13.365*		-16.884*
Model 9	**0.87%**	**24.79%**	**3.77%**	**25.53%**
Lower-managerial		-26.891*		-10.425*
Intermediate occupation		-35.375*		-32.029*
Small employers		-56.806*		-46.141*
Lower supervisory		-67.245*		-61.922*
Semi-routine		-72.120*		-64.654*
Routine		-92.015*		-97.486*
Never worked/unemployed		-96.693*		-126.235*
Imputation flag		-3.936		-3.672
Model 10	**0.88%**	**20.04%**	**4.25%**	**17.79%**
Income		.573*		.454*
Imputation flag		.215		-1.539
Model 11	**1.18%**	**23.69%**	**4.07%**	**23.67%**
Age of mother		1.378*		2.437*
Mother of working age		54.321*		Omitted
House tenure: private rent		-33.900*		-38.871*
Housing tenure: LA rent		-53.117*		-55.622*
Housing tenure: other		-39.418*		-17.424
Household size (persons)		-2.324*		-.888

Note: *p≤.05. Basic control variable results are omitted from this table. Reference categories for categorical variables are discussed in Section 4.

6.4 Are SES-attainment relationships consistent across the Key Stage 4 pupil attainment distribution?

The relationship between proxy measures and key stage 4 attainment at different points in the attainment distribution was assessed using quantile regression models.[37] By using this procedure, the analysis can reveal whether the different candidate proxies are better at predicting key stage 4 attainment at either the lower- or the upper-extremes. As Table 5 illustrates, differences in the association with final outcome measures, when comparing low- and high-achieving pupils, can be observed for several proxy variables, including FSM eligibility, the lower end of parental qualifications and occupations, IDACI, and household tenure.

Being ever eligible for FSM is associated with a 73 point reduction in the total GCSE score for low-achieving pupils (the 25th quantile); whilst only with a 35 point reduction for the high achievers (the 75th quantile). The same pattern is evident when FSM is entered in the model as years of eligibility, with a smaller impact of being FSM eligible at the higher end of the attainment distribution. IDACI, despite the relatively small overall effect size, still shows a sizeable difference between its association with GCSE scores at the 25th and 75th quantile, respectively. Living in the most deprived neighbourhood, as compared to living in the least deprived neighbourhood, is associated with a 144 point reduction in GCSE points for the low achievers, and only a 74 point reduction for the high achievers.

Parental occupation and qualifications also seem to be differently related to key stage 4 outcomes, particularly with regard to the 'Long-term unemployed' and 'No qualifications' categories. Membership of these groups is associated with a reduction in GCSE point scores compared to the respective reference categories that is nearly twice as large for those at the lower end of the achievement scale.

[37] Quantile regression models use different intercepts (constants), allowing researchers to determine whether factors result in movement above or below these differing intercepts. The key point is to use different quantiles (e.g. 25th and 75th) and compare coefficients between models.

Table 5. Quantile regression results for 25th and 75th quantiles

	25% Quantile N=12678	75% Quantile N=12678
Model 3	Proxy indicator (regression coefficient)	Proxy indicator (regression coefficient)
Ever FSM eligible	-72.606*	-35.232
Model 4		
1 year of FSM eligibility	-61.449*	-25.322*
2 years of FSM eligibility	-66.178*	-32.087*
3 years of FSM eligibility	-91.012*	-40.661*
4 years of FSM eligibility	-92.427*	-37.823*
5 years of FSM eligibility	-70.530*	-39.091*
Model 5		
IDACI score	-1.447*	-.745*
Model 6		
At least one parent full-time	53.521*	24.677
Single-parent household	-29.764*	-14.871*
Model 7		
Proportion occupations	1.892*	1.418*
Model 8		
HE, below degree-level	-24.832*	-28.565*
A-level or equivalent	-40.043*	-38.939*
GCSE-level or equivalent	-59.650*	-46.876*
Level1 qualification	-71.716*	-68.857*
Other qualification	-92.610*	-68.751*
No qualification	-108.677*	-67.718*
Imputation flag	-23.358*	-5.708*
Model 9		
Lower-managerial	-17.928*	-23.507*
Intermediate occupation	-32.910*	-33.777*
Small employers	-55.936*	-47.767*
Lower supervisory	-74.052*	-57.133*
Semi-routine	-78.892*	-55.795*
Routine	-106.374*	-66.771*
Never worked/unemployed	-114.629*	-68.235*
Imputation flag	-4.855	-.936
Model 10		
Income	.572*	.445*
Imputation flag	-2.125	.640
Model 11		
Age of mother	1.804*	1.653*
Mother of working age	94.251	49.563*
House tenure: private rent	-46.228*	-20.379*
Housing tenure: LA rent	-68.307*	-35.438*
Housing tenure: other	-46.012*	-12.868*
Household size (persons)	-2.571*	-1.912*

Note: *p≤.05. Basic control variable results are omitted from this table. Reference categories for categorical variables are discussed in Section 4.

By contrast, some proxy measures have a similar relationship to achievement at different parts of the achievement distribution, specifically the proportion in the neighbourhood with top-level occupations and parental income. In the case of the latter, it has already been suggested that the parental income measure has considerable measurement error. This will tend to attenuate the relationship between income and achievement at all parts of the achievement distribution.

Lastly, household characteristics also seem to be more strongly related to key stage 4 results for those at the lower end of the GCSE distribution. For instance, living in a

household that rents from a local authority is associated with a 68 point reduction in the GCSE score at the 25th quantile, but only with a 35 point reduction at the 75th quantile.

Two important conclusions emerge from this exercise. Firstly, the pattern of association is different for the two extremes of the achievement scale, with circumstances indicative of socio-economic deprivation being more strongly associated with attainment for low-achieving pupils. Secondly, regardless of which part of the distribution of achievement focused on (e.g. the 25th or 75th quantile), the relative strength of each proxy compared to the other proxies is consistent with earlier results from the multi-level models. This would suggest that the results, in terms of the adequacy of the various proxies for capturing socio-economic deprivation, still stand. What these results also suggest, however, is that most of the proxy indicators are more strongly related to achievement for those at the lower end of the achievement distribution, potentially because lower achieving pupils are more susceptible to the effects of socio-economic disadvantage, though this needs further investigation before results can be interpreted in this causal way.[38]

[38] An alternative explanation might be that these results are a statistical artifact arising from a reduction in variance as one moves up the SES scale.

7. Other points of interest

There is typically a great deal of interest in specific results for any statistical modelling relating to attainment. In anticipation of such interest, some specific results are discussed below, but readers should note that these were not the focus of this research and, just to repeat, the analysis is not causal. Full results relating to the points discussed below are included in Appendix IV and V. As a general observation, many of the questions addressed would be better answered through analyses of data from the National Pupil Database – a point reiterated below.

7.1 Date of birth

Based on the analyses undertaken above, the division of school years in September results in residual attainment differences between pupils within the same school year. When prior attainment is not controlled for, children born in the first quarter of the school year (September-November) perform, all other things being equal, better than younger pupils in their academic cohort. This is consistent with previous literature (Crawford et al. 2011). However, once key stage 2 outcomes are included in the multi-level model containing all potential proxies, the differences between the birth quarters are reversed. This indicates that younger pupils may start with a lower level of achievement compared to older pupils in their cohort, but over time, they catch up. Therefore, when their prior levels of achievement are taken into account, younger children in the cohort make relatively more progress between key stage 2 and key stage 4 than their older peers, which is reflected in the reversal of results. This is consistent with previous literature that found larger gaps by month of birth in earlier years when the age differences are a greater proportion of a child's life, with gaps in achievement by month of birth narrowing over time as pupils' progress through to A level and into university (Crawford et al., 2011).

7.2 Ethnicity

Previous research (e.g. Plewis, 2011; Burgess, 2014) has demonstrated differences between ethnic groups in terms of educational attainment, and the interplay between ethnicity and deprivation. Plewis (2011) found when looking at NPD data on 570,000 pupils that, compared to White British pupils, Chinese pupils achieved higher grades (key stage 4 points), but children from Black Caribbean, Black African and 'Black other' backgrounds performed less well, particularly in maths. Plewis also notes that deprivation

(as measured by FSM) had less of an impact on children from ethnic minority backgrounds compared to White British pupils.[39]

As with Plewis (2011), there were residual differences when comparing ethnic minorities to the reference category of White British children, but some estimates are limited by small sample sizes. When pupils' prior attainment is not controlled for it was found, for instance, that Chinese pupils attained on average GCSE scores 66 points higher than White British pupils, the reference category; this estimate is, however, limited by the fact that there were only 44 Chinese pupils in the LSYPE1 dataset. There was also a negative difference of 6.5 GCSE points for Black Caribbean pupils, but this was not statistically significant. When the fact that different ethnic groups start at different levels of key stage 2 achievement is accounted for, and then make different amounts of progress by controlling for prior attainment in the model, it was found that, as in the case of date of birth, ethnic-minority pupils catch up with White British pupils. Full results for both models are given in Appendix IV and V.

7.3 Regions

Dummy variables were included to assess whether there were residual differences between regions. Compared to the reference category of Yorkshire and the Humber, there were no significant differences between regions if pupils' prior attainment was allowed for. The South-East was the only exception, whereby a residual difference of approximately seven GCSE points in favour of the South-East was observed. Further to the earlier conclusion that prior attainment captures some of the variation between individual characteristics such as date of birth and ethnicity, prior attainment also appears to drive results referring to the residual differences between regions. More precisely, in a model *without* prior attainment, pupils in all regions except the East of England and the South West did better than the reference region, with London leading by a difference of 15 GCSE points compared to Yorkshire and the Humber. However, once prior attainment is included these differences disappeared, which is in keeping with previous research on this topic:

> '…a large part of the higher GCSE results for disadvantaged pupils in London and other big cities compared with the rest of England is accounted for by differences in prior attainment between pupils in these areas' (Greaves et al., 2014: 25).

Again, readers are reminded that this was not the focus of the research. By including dummy variables to indicate region, anything that is unique about the region relating to educational performance, but is not included in the model, is being captured by these

[39] For more on the issue of the attainment of White children in particular see the recent Education Select Committee report *Underachievement in Education by White Working Class Children* (House of Commons Education Committee, 2014).

measures. Given that the research used a sample, it is recommended that this analysis be run using NPD data so that population differences can be determined.[40]

[40] Research using NPD has attempted to explain the 'London effect' in terms of the ethnic composition of London's neighbourhoods (Burgess, 2014). The exact causes of London's success are unclear but prior attainment appears to be a strong driver of such differences (Greaves et al., 2014; see also Leckie, 2009).

8. Discussion and conclusion

8.1 Summary of results

The aim of this project was to determine whether or not one of the current measures of social deprivation used by DfE, namely the history of eligibility for FSM, is an appropriate proxy indicator for socio-economic disadvantage, or whether it can be improved upon with better data. Specifically, the research considered what other proxy measures may be available that could better predict pupil achievement at GCSE, as compared to FSM eligibility. A wide range of proxy measures, including individual, neighbourhood and geographic indicators was considered.

The main findings are as follows:

- a measure of whether the pupil was ever eligible for FSM in the last five years explains about 23% of the variation in pupil achievement at GCSE when entered in a model alongside a set of basic controls. A variable measuring whether a pupil has ever been eligible for FSM in the last five years performs better, in terms of predictive power, than simply using current (2006) FSM eligibility;
- parental qualifications, parental occupations and household characteristics are slightly better predictors of pupil achievement than FSM eligibility (current or 'ever five' FSM). However, these proxies have the problem that at-scale collection of this information is likely to be impractical and difficult;
- other individual neighbourhood based proxy measures do not perform as well as FSM eligibility in terms of their predictive power. In combination, such neighbourhood based measures can provide more predictive power than FSM eligibility. These proxies are more practical in terms of data collection than individual measures but they have the twin problems of being difficult to interpret and not providing data on the individual child. Using neighbourhood based measures would not allow DfE to monitor the attainment or progress of disadvantaged children within a school or area, which is a significant weakness of such measures.

Accordingly, **the conclusion is that if it is not possible to collect rich data on pupils' family background, such as their parents' education level or occupation, then using eligibility for FSM is a better proxy for socio-economic disadvantage than a number of different neighbourhood based measures of socio-economic deprivation.**

It is also worth noting that the parental income measures used in the model were not very predictive of pupil achievement, however, this is most likely due to the fact that the measures of income in the data set were of low quality due to being self-reported. The research literature suggests that better quality measures of parental income are likely to

be more predictive. In particular, if DfE were able to use administrative sources of data on parental income, such as tax records, this is likely to be a higher quality alternative proxy to FSM eligibility. However, if this proves not to be possible for practical or legal reasons, poor quality measures of family income do not offer a superior alternative to FSM eligibility as a feasible and adequate indicator of family background.

Some commentators have suggested that there may be implications from the recent DfE policy to provide FSM to all primary school children up to year 2. It is unclear what the effect of this will be on FSM uptake beyond year 2. Parents may be more likely to register their children as eligible for FSM if they have already been receiving the benefit of free schools meals and do not want to suddenly start paying for them in year 3. Alternatively it may make it more difficult if parents have a weaker incentive to register their low income/benefit status because they are going to get FSM for their children in the earlier years anyway. This research cannot determine which of these scenarios is more likely. However, if at any point it became infeasible to continue with the FSM eligibility measure, a combination of neighbourhood based proxy measures performed nearly as well as FSM eligibility, despite being neighbourhood rather than individual measures of socio-economic deprivation.

The other issue that has been raised by the Education Select Committee (2014) is the fact that even though those pupils eligible for FSM are from the poorest fifth of households, there are other pupils who are not eligible for FSM who are nevertheless relatively poor. The ever FSM proxy of course simply divides the population of pupils into those eligible and those not, and fails to distinguish between the wealthy and less wealthy in both the eligible and non-eligible groups.[41] Combining FSM and neighbourhood proxy measures might have the advantage of both greater predictive power and being able to identify pupils from different backgrounds. It comes at a cost however, namely that the measures combine neighbourhood and individual based measures making interpretation quite problematic. Further, there is now a great deal of evidence on FSM eligibility and its relationship with pupil achievement. This is a measure that has been tracked for a long period of time. Any future change will lose continuity with measures of the socio-economic achievement gap that relied on FSM eligibility. The combination of individual and neighbourhood measures may also create difficulties for using these data for accountability purposes and indeed assessing value for money if it becomes unclear whether one can only measure the progress of deprived schools as distinct from deprived pupils.

As a final and crucially important policy point, it should be borne in mind that the true relationship between pupils' socio-economic status and attainment is likely to be stronger than the results here would suggest. This is because there is, and has been for many years, a redistributive and compensatory approach towards schools serving high

[41] This also holds for the FSM eligible group, due to distinctions between Working Tax Credit and Child Tax Credit.

proportions of FSM eligible children. That is, schools receive more funding if they have more deprived pupils i.e. based on the proportion of FSM eligible children on the school roll, with this money being used to try and ameliorate the educational difficulties faced by children from impoverished backgrounds. Without this additional effort, it seems likely that FSM eligibility would be an even stronger (negative) predictor of pupil achievement and that there would be even larger gaps in attainment between FSM and non-FSM eligible children.

In summary (see Box 3), the analysis has suggested that FSM eligibility can be improved upon as a proxy for social deprivation, but only by using proxies for which it is impractical to collect data. Alternative neighbourhood measures can be used but unless they are combined with FSM, they do not predict achievement as well as just using FSM eligibility. In conclusion, FSM eligibility, for all of its limitations, performs as well, if not better, than most proxy measures proposed and assessed here.

Box 3. Summary of findings

Q1. Can FSM be improved on as a proxy for social deprivation?

A1. Yes, but only by using proxies for which it may be impractical to collect data

Q2. What alternative (practical) proxy measures can be used?

A2. Neighbourhood measures (IDACI, neighbourhood occupation level)

Q3. Do alternative proxy measures better enable us to identify pupils at risk of low achievement?

A3. No, unless they are combined with FSM. Combinations of proxy variables may be problematic to interpret

Do alternative proxy measures better enable us to identify pupils at risk of low achievement?

It is worth returning to this in a little more detail, primarily to point out that it is not possible to pick one measure that ‘does a better job’. The purpose of this research has been to assess other proxy measures of SES and compare them to the FSM measure in terms of pupil attainment. As noted above and in other research (e.g. Gorard, 2012) the FSM measure picks up primarily low-income families, but does so imperfectly. Each of the proxy measures also picks up different groups; for example the neighbourhood measures may be better at picking up the ‘working poor’ than FSM eligibility histories. Each of these measures on their own will – by virtue of what they are measuring – perform differently to the FSM measure but not necessarily ‘better’ (limitations of how ‘better’ is assessed notwithstanding). The conclusion given in box 3 above reflects this point – combining instead of substituting different proxy measures with FSM would help to better identify pupils at risk of low achievement.

However, the clearest result from this work was on the relationship between key stage 2 attainment and key stage 4 attainment. In many cases, at least using the sample data from LSYPE1, accounting for key stage 2 scores appears to explain away (mediate) relationships such as attainment differences between regions, and is a much stronger predictor of key stage 4 attainment than any other measure. Prior research makes clear that poor, low achieving children may do disproportionately worse than either their 'just poor' or 'just low achieving' peers (see e.g. Jerrim and Vignoles, 2012). As such it seems that combining an early testing regime with measures of deprivation such as FSM would capture those 'most at risk of underachievement'.

8.2 Areas for further research

There are some issues stemming from this project that require further investigation:

- first, it seems clear that the relationship between income and attainment might change if there were better measures of parental income. This could be explored using administrative data on parental income or survey data with better measures of family income
- second, there are many questions relating to attainment that would be better answered using NPD data – in particular relating to the effects of region, ethnicity, urban/rural divides, and month of birth
- third, the influence of early years and primary education on later attainment and life-chances has been repeatedly emphasised (e.g. Heckman, 2006; Leckie, 2009; Connelly et al., 2014); it is important to determine whether the findings presented here hold for primary school achievement since only the relationship between socio-economic indicators and achievement at GCSE has been considered. This could be achieved through analysis of the second LSYPE cohort and other data such as the Millennium Cohort Study
- fourth, there are well-known limitations with the FSM measure – particularly in relation to it inconsistently capturing 'the working poor' (Hobbs and Vignoles, 2009). More work on how best to capture this group – perhaps focusing on earnings thresholds – would be beneficial. One might also usefully consider the advantage of using cumulative years of FSM eligibility in cohorts where there are far more years of data on FSM eligibility and can start to construct lifetime profiles of FSM status
- fifth, a clearer understanding of the relationship between different levels of SES and achievement is also needed. The quantile regression models presented here are a first step at bridging this gap, but raise questions about possible different relationships between SES and achievement depending on pupils' achievement

Appendix I: Variable construction and coding

Variable	Derived from	Coding
FSM eligibility for no years	Free school meal NPD extract file	1 if pupil never eligible for free school meals between 2002 and 2006
FSM eligibility for 1 year		For each variable: 1 if pupil eligible for the respective number of years, at any point between 2002 and 2006. 0 if not eligible Missing values retained
FSM eligibility for 2 years		
FSM eligibility for 3 years		
FSM eligibility for 4 years		
FSM eligibility for 5 years		
FSM eligibility ever in the 2002-2006 period		1 if child FSM eligible in any year from 2002 to 2006 0 otherwise Missing values retained
Single parent family	W1famtyp	1 if W1famtyp=lone mum or W1famtyp=lone dad Missing retained
Household employment status	W1empsmum, W1empsdad	1 if either of the parents are in full-time employment 0 if both parents part-time employed, unemployed, ill, in training, and all other categories except full-time employment Missing if both parents are missing data
Highest occupation in household: Higher Managerial Occupation	W1nssecdad_IMP, W1nssecmum_IMP	1 if the highest occupation in household (from either parent) is Higher Managerial 0 if otherwise Missing if both parents are missing
Highest occupation in household: Lower Managerial Occupation		1 if the highest occupation in household (from either parent) is Lower Managerial 0 if otherwise Missing if both parents are missing
Highest occupation in household: Intermediate Occupation		1 if the highest occupation in household (from either parent) is Intermediate Occupations 0 if otherwise Missing if both parents are missing
Highest occupation in household: Small Employers		1 if the highest occupation in household (from either parent) is Small Employers 0 if otherwise Missing if both parents are missing
Highest occupation in household: Lower supervisory		1 if the highest occupation in household (from either parent) is Lower supervisory 0 if otherwise Missing if both parents are missing
Highest occupation in household: Semi-routine		1 if the highest occupation in household (from either parent) is Semi-routine 0 if otherwise Missing if both parents are missing
Highest occupation in household: Routine		1 if the highest occupation in household (from either parent) is Routine 0 if otherwise Missing if both parents are missing
Variable	**Derived from**	**Coding**

Highest occupation in household: Never worked/ Long-term unemployed		1 if the highest occupation in household (from either parent) is Never worked/long-term unemployed 0 if otherwise Missing if both parents are missing
Highest occupation in household: Highest occupation imputed	W1nssecdad_flag, W1nssecmum_flag	1 if either W1nssecdad_flag=1 or W1nssecmum_flag=1 0 otherwise Missing if both imputation flags are missing
Highest qualification in household: Degree or above	Hiqualgfam2_IMP	1 if Hiqualgfam2_IMP=1 (Degree or above) 0 otherwise
Highest qualification in household: HE below degree		1 if Hiqualgfam2_IMP=2 (HE, below degree level) 0 otherwise
Highest qualification in household: A Level (or equivalents)		1 if Hiqualgfam2_IMP=3 (A Level or equivalents) 0 otherwise
Highest qualification in household: GCSE A-C (or equivalents)		1 if Hiqualgfam2_IMP=4 (GCSE A-C or equivalents) 0 otherwise
Highest qualification in household: Level 1 and below		1 if Hiqualgfam2_IMP=2 (Level 1 and below) 0 otherwise
Highest qualification in household: Other qualification		1 if Hiqualgfam2_IMP=2 (Other qualification) 0 otherwise
Highest qualification in household: No qualification		1 if Hiqualgfam2_IMP=2 (No qualification) 0 otherwise
Highest qualification in household: Highest qualification imputed	Hiqualgfam2_Flag	1 if Hiqualgfam2_Flag=1 0 if Hiqualgfam2_Flag=0 Missing values retained
Proportion of persons in neighbourhood with degrees	2001 CENSUS	Continuous variable Missing values as resulting from merge on LSOA
Proportion of persons in neighbourhood with top-level occupations	2001 CENSUS	Continuous variable Missing values as resulting from merge on LSOA
IMD_score	imd_s	Continuous variable Missing values retained
IDACI_score	newk4_idaci	Continuous variable, multiplied by 100. Missing values retained
Child expects to stay on in full-time education at age 16	W1plann16YP	1 if YP reports they want to stay on in full-time education 0 otherwise Missing values retained
Parents expect child will attend HE	W1hepossMP	1 if main parent report that child is “very likely” or “fairly likely” to attend HE 0 otherwise Missing values retained
Parents meals with family at least once a week	W1fammealMP	1 if main parent reports any parent having a meal with family “every night”, “most nights”, “once or twice a week” 0 otherwise Missing values retained
Variable	**Derived from**	**Coding**

Parents at least sometimes aware of child whereabouts	W1paroutMP	1 if main parent reports any parent aware of where child is when YP goes out in the evening “Always” “Usually” or “Sometimes” as well as when parents report that child does not go out 0 otherwise Missing values retained
Child does not go out evenings	W1paroutMP	1 if main parent reports that child does not go out 0 otherwise Missing values retained
Either parent attended parents’ evening	W1pareveMP	1 if main parent reports any parent has attended a parent’s evening or similar event at school in the previous year 0 otherwise Missing values retained
Parents paid extra tuition in school subject	W1extrtu1MP	1 if main parent reports that any parent has paid for extra tuition in subjects that the child studies at school 0 if otherwise Missing values retained
Parents paid extra tuition other subject	W1ethincYP (DV)	1 if main parent reports that any parent has paid for extra tuition in a supplemental subject to those the child studies at school 0 if otherwise Missing values retained

Appendix II: Descriptive statistics for all measures

Panel A: Basic control variables	Mean [a]	Median	Std. Dev.	Min.	Max.	Valid cases
Quarter of birth: September-November	0.24		0.43	0	1	15386
Quarter of birth: December-February	0.24		0.43	0	1	15386
Quarter of birth: March-May	0.25		0.43	0	1	15386
Quarter of birth: June-August	0.26		0.44	0	1	15386
Gender: female	0.49		0.50	0	1	15035
Ethnicity: White	0.65		0.48	0	1	15390
Ethnicity: White Irish	0.00		0.04	0	1	15390
Ethnicity: White Other	0.01		0.11	0	1	15390
Ethnicity: White and Black Caribbean	0.03		0.16	0	1	15390
Ethnicity: White and Black African	0.01		0.08	0	1	15390
Ethnicity: White and Asian	0.01		0.11	0	1	15390
Ethnicity: Any other mixed	0.01		0.09	0	1	15390
Ethnicity: Indian	0.07		0.25	0	1	15390
Ethnicity: Pakistani	0.06		0.24	0	1	15390
Ethnicity: Bangladeshi	0.05		0.21	0	1	15390
Ethnicity: Asian Other	0.01		0.10	0	1	15390
Ethnicity: Black Caribbean	0.04		0.19	0	1	15390
Ethnicity: Black African	0.04		0.19	0	1	15390
Ethnicity: Black Other	0.01		0.08	0	1	15390
Ethnicity: Chinese	0.00		0.05	0	1	15390
Ethnicity: Any Other	0.01		0.09	0	1	15390
English as additional language	0.07		0.25	0	1	15075
Pupil has disability that affects schooling	0.06		0.23	0	1	14883
Panel B: Geographical measures						
North East	0.04		0.21	0	1	15390
North West	0.14		0.35	0	1	15390
Yorkshire and the Humber	0.10		0.31	0	1	15390
East Midlands	0.09		0.28	0	1	15390
West Midlands	0.12		0.33	0	1	15390
East of England	0.10		0.30	0	1	15390
London	0.19		0.39	0	1	15390
South East	0.14		0.35	0	1	15390
South West	0.08		0.26	0	1	15390
Environment: urban	0.85		0.36	0	1	15386
Panel C: School characteristics						
School type: Voluntary Aided	0.11		0.32	0	1	15034
School type: Voluntary Controlled	0.03		0.16	0	1	15034
School type: Foundation	0.15		0.36	0	1	15034
School type: Other Independent	0.03		0.17	0	1	15034
School type: City Technical College	0.01		0.08	0	1	15034
School type: Sponsor-led Academy	0.01		0.09	0	1	15034
School size (pupils)	1010.51	999	285.05	52	2124	15049
Proportion pupils eligible for FSM	18.41	12.7	16.41	0	83.3	15182
Proportion SEN pupils with statements	2.52	2.1	1.95	0	13.4	15109
Proportion SEN pupils without statements	13.14	11.2	9.97	0	66.2	15109
School CVA score (KS2-KS4)	988.07	989.5	27.85	904.7	1071.2	14945
Proportion of pupils classed as White	72.35	87.04	30.62	0	100	15182
Panel D: Outcome measure						
Total capped GCSE point score	300.34	320	103.30	0	502	15035

Note: [a] For all the dummy variables in the model, the mean represents the proportion of participants in the sample for whom the respective dummy variable takes a value of 1. E.g. in the case of month of birth (December to February), 24% of the sample had birthdays that fell within that interval.

Appendix III: Table on descriptive characteristics for FSM/non-FSM

	Ever eligible for FSM		Total sample size
	No	Yes	
Basic controls: individual level			
Quarter of birth: September-November	24.04%	24.49%	14973
Quarter of birth: December-February	24.29%	24.71%	14973
Quarter of birth: March-May	25.44%	24.71%	14973
Quarter of birth: June-August	26.23%	26.09%	14973
Gender=female	49.05%	50.31%	14638
Ethnicity=White British	72.24%	44.56%	14977
Ethnicity=White Irish	0.15%	0.34%	14977
Ethnicity=White Other	1.21%	1.51%	14777
Ethnicity=White and Black Caribbean	2.12%	4.11%	14977
Ethnicity=White and Black African	0.50%	0.90%	14977
Ethnicity=White and Asian	1.09%	1.29%	14977
Ethnicity=Any other mixed	0.84%	0.80%	14977
Ethnicity=Indian	7.36%	4.86%	14977
Ethnicity=Pakistani	4.24%	11.71%	14977
Ethnicity=Bangladeshi	1.87%	12.88%	14977
Ethnicity=Asian Other	0.87%	1.34%	14977
Ethnicity=Black Caribbean	3.34%	5.25%	14977
Ethnicity=Black African	2.72%	7.56%	14977
Ethnicity=Black Other	0.51%	0.92%	14977
Ethnicity=Chinese	0.33%	0.12%	14977
Ethnicity=Any Other	0.55%	1.48%	14977
English as additional language	3.85%	15.55%	14666
Disability affecting school	4.99%	7.60%	14487
Young person: care responsibilities at home	3.77%	9.32%	14647
Young person: first-born	41.81%	34.90%	14466
Basic controls: school level			
School size (in pupils)	1029.76	1009.94	14636
Proportion of pupils eligible for FSM	14.31%	31.10%	14773
Proportion of SEN pupils with statements	2.45%	2.87%	14696
Proportion of SEN pupils without statements	11.99%	16.60%	14696
School KS2-KS4 CVA score (points)	989.12	982.14	14664
Proportion of White pupils in school	79.57%	60.20%	14773
School type: Community	65.28%	75.81%	14637
School type: Voluntary Aided	12.35%	9.85%	14637
School type: Voluntary Controlled	3.18%	1.51%	14637
School type: Foundation	17.54%	10.53%	14637
School type: Other Independent	0.39%	0.18%	14637
School type: Further Education /City Technical College	0.66%	0.63%	14637
School type: Academy (Sponsor-Led)	0.60%	1.49%	14637
Neighbourhood: IDACI			
IDACI (score*100)	19.05	38.44	14455
Neighbourhood: occupations			
Proportion with top-level occupations	25.24%	20.22%	14965
	Ever eligible for FSM		Total sample size

	No	Yes	
Employment			
At least one parent in full-time employment	96.52%	36.58%	14660
Single parent family	16.35%	49.84%	14853
Highest qualification in household (imputed)			
Degree or above	19.36%	4.91%	14977
HE below degree	18.00%	6.41%	14977
A Level (or equivalents)	19.58%	9.14%	14977
GCSE A-C (or equivalents)	26.43%	23.52%	14977
Level 1 and below	5.33%	9.06%	14977
Other qualification	1.17%	2.45%	14977
No qualification	10.08%	44.51%	14977
Highest qualification imputed	6.66%	7.43%	14977
Highest occupation in household (imputed)			
Higher Managerial Occupation	16.10%	1.88%	14707
Lower Managerial Occupation	34.25%	10.77%	14707
Intermediate Occupation	12.12%	6.74%	14707
Small Employers	12.25%	8.59%	14707
Lower supervisory	10.42%	10.52%	14707
Semi-routine	9.97%	20.66%	14707
Routine	3.98%	18.78%	14707
Never worked/ Long-term unemployed	0.92%	22.05%	14707
Highest occupation imputed	12.45%	13.56%	14975
Income			
Income, mid-point (£)	29854.34	13617.90	14973
Income imputed	26.04%	27.43%	14973
Household characteristics			
Mother's age (in years) (at time of survey)	41.71	39.92	14300
Mother of working age (at time of survey)	99.83%	99.37%	14300
Housing tenure: Own	81.52%	28.26%	14977
Housing tenure: Private rent	4.09%	10.40%	14977
Housing tenure: LA rent	12.27%	58.55%	14977
Housing tenure: Other	1.03%	1.34%	14977
Household size (in persons)	4.41	4.80	14879
Parenting practices and attitudes			
Young person expects to continue in full-time education age 16	87.31%	84.06%	13854
Parents expect young person to attend HE	69.16%	66.53%	13791
Parents meals with family at least once a week	95.91%	95.21%	14708
Parents at least sometimes aware of young person whereabouts	98.76%	97.06%	14714
Young person does not go out evenings	11.50%	17.97%	14714
Either parent attended parents' evening	92.83%	80.04%	14691
Parents paid extra tuition in school subject	14.28%	6.70%	14719
Parents paid extra tuition other subject	19.36%	6.33%	14717
Prior attainment			
Key stage 2 total point score	184.97	160.05	13552
Achievement outcome			
Key stage 4: total capped GCSE and equivalents point score	316.70	246.54	14638

Appendix IV: Multi-level linear model for key stage 4 attainment with all SES proxy measures, without a measure of prior attainment

Outcome: GCSE points score Variables	Coef.	Std.Err	z	P>z	95% CI	
Dob_schoolQ_2DecFeb	-2.78	2.12	-1.31	0.19	-6.93	1.37
Dob_schoolQ_3MarMay	-5.92	2.10	-2.82	0.01	-10.04	-1.81
Dob_schoolQ_4JunAug	-5.13	2.08	-2.47	0.01	-9.21	-1.05
Gender=Female	23.24	1.50	15.52	0.00	20.31	26.17
Ethnicity=White Irish	22.50	18.20	1.24	0.22	-13.18	58.18
Ethnicity=White Other	24.40	7.21	3.38	0.00	10.26	38.54
Ethnicity=White and Black Caribbean	9.11	4.90	1.86	0.06	-0.50	18.73
Ethnicity=White and Black African	15.47	9.53	1.62	0.10	-3.20	34.14
Ethnicity=White and Asian	16.83	7.09	2.37	0.02	2.94	30.71
Ethnicity=Any other mixed	13.18	8.20	1.61	0.11	-2.89	29.26
Ethnicity=Indian	39.51	3.50	11.29	0.00	32.65	46.37
Ethnicity=Pakistani	30.05	3.98	7.55	0.00	22.25	37.84
Ethnicity=Bangladeshi	59.09	4.74	12.47	0.00	49.80	68.38
Ethnicity=Asian Other	39.05	7.95	4.91	0.00	23.47	54.64
Ethnicity=Black Caribbean	-6.50	4.43	-1.47	0.14	-15.19	2.19
Ethnicity=Black African	27.18	4.60	5.91	0.00	18.17	36.19
Ethnicity=Black Other	8.44	9.46	0.89	0.37	-10.11	26.98
Ethnicity=Chinese	66.27	15.21	4.36	0.00	36.46	96.08
Ethnicity=Any Other	31.66	8.74	3.62	0.00	14.53	48.80
English_YP_additional	-7.43	3.47	-2.14	0.03	-14.22	-0.64
disability_affecting_school	-57.85	3.29	-17.59	0.00	-64.29	-51.40
Region: North East	11.80	4.44	2.66	0.01	3.11	20.49
Region: North West	11.38	3.30	3.44	0.00	4.90	17.85
Region: East Midlands	7.35	3.87	1.90	0.06	-0.23	14.93
Region: West Midlands	4.27	3.38	1.26	0.21	-2.36	10.89
Region: East of England	1.23	3.62	0.34	0.73	-5.87	8.33
Region: London	14.97	3.57	4.19	0.00	7.97	21.96
Region: South East	4.36	3.40	1.28	0.20	-2.30	11.02
Region: South West	3.41	3.81	0.90	0.37	-4.06	10.88
Urban	-6.24	2.36	-2.64	0.01	-10.87	-1.60
School type: Voluntary-Aided	10.98	2.88	3.81	0.00	5.33	16.63
School type: Voluntary-Controlled	19.71	5.41	3.65	0.00	9.12	30.31
School type: Foundation	6.58	2.77	2.38	0.02	1.16	12.00
School type: Other Independent	85.56	48.14	1.78	0.08	-8.80	179.92
School type: College (FE, Tech)	39.46	13.03	3.03	0.00	13.92	65.00
School type: Sponsored Academy	16.03	16.19	0.99	0.32	-15.70	47.75
School size	0.00	0.00	-0.41	0.68	-0.01	0.00
School proportion of FSM-elig. pupils	0.04	0.09	0.44	0.66	-0.14	0.23
School proportion SEN with statements	-2.57	0.45	-5.77	0.00	-3.45	-1.70
School proportion SEN without statements	0.04	0.10	0.37	0.71	-0.16	0.23
School KS2KS4 CVA score	0.53	0.04	13.94	0.00	0.46	0.61
School proportion of White pupils	0.14	0.05	2.64	0.01	0.04	0.24
fsm_ever5	-18.08	2.59	-6.97	0.00	-23.16	-12.99
IDACI_score	-0.08	0.06	-1.23	0.22	-0.20	0.05
neighbourhood_prop_topoccup	0.62	0.10	6.27	0.00	0.43	0.82

employment_household	5.54	2.96	1.87	0.06	-0.27	11.35
single_parent_family	-11.57	2.29	-5.05	0.00	-16.06	-7.08
HE below degree	-19.40	2.74	-7.09	0.00	-24.76	-14.04
A Level (or equivalents)	-21.91	2.76	-7.93	0.00	-27.33	-16.49
GCSE A-C (or equivalents)	-29.52	2.72	-10.86	0.00	-34.84	-24.19
Level 1 and below	-42.41	3.84	-11.04	0.00	-49.93	-34.88
Other qualification	-33.85	6.57	-5.15	0.00	-46.72	-20.98
No qualification	-49.56	3.29	-15.08	0.00	-56.00	-43.12
Highest qualification imputed	-14.95	4.32	-3.46	0.00	-23.42	-6.49
Lower Managerial Occupation	-10.92	2.58	-4.23	0.00	-15.98	-5.86
Intermediate Occupation	-8.31	3.32	-2.51	0.01	-14.81	-1.81
Small Employers	-25.02	3.36	-7.45	0.00	-31.60	-18.44
Lower supervisory	-31.51	3.47	-9.07	0.00	-38.32	-24.71
Semi-routine	-24.36	3.46	-7.04	0.00	-31.14	-17.58
Routine	-34.43	4.05	-8.51	0.00	-42.37	-26.50
Never worked/ Long-term unemployed	-30.60	4.74	-6.46	0.00	-39.88	-21.32
Highest occupation imputed	0.16	3.27	0.05	0.96	-6.25	6.57
income_midpoint	0.07	0.03	2.00	0.05	0.00	0.13
income_imputed_flag	-2.11	1.78	-1.19	0.24	-5.59	1.37
age_mother	1.13	0.15	7.68	0.00	0.84	1.42
workage_mother	29.66	14.52	2.04	0.04	1.19	58.12
house_tenure_priv_rent	-11.71	3.46	-3.38	0.00	-18.50	-4.92
house_tenure_LA_rent	-20.35	2.34	-8.70	0.00	-24.93	-15.76
house_tenure_other	-21.82	7.24	-3.01	0.00	-36.01	-7.63
household_size	-3.56	0.64	-5.57	0.00	-4.82	-2.31
Intercept	-265.42	44.10	-6.02	0.00	-351.85	-178.99
Random-effects Parameters	**Estimate**	**Std. Err.**			**95% CI**	
var(_cons)	64.18	21.48			33.30	123.68
var(Residual)	6823.29	86.82			6655.23	6995.59
LR test vs. linear regression:	Chi2(01)	27.87	Prob >= chibar2 = 0.0000			
Residual intra-class correlation	**ICC**	**Std. Err.**			**95% CI**	
	0.009	0.003			0.005	0.018
Explained variance						
Level 1	31.33%					
Level 2	51.01%					

Appendix V: Multi-level linear model for key stage 4 attainment with all SES proxy measures, and key stage 2 attainment

The table below presents the full statistical results from Model 2 in Table 2 (p.31 of this report). The discussions relating to date of birth, ethnicity and region are based on the results in this table.

Outcome: GCSE points score Variables	Coef.	Std.Err	z	P>z	95% CI	
Key stage 2 total score	1.26	0.02	80.88	0.00	1.23	1.29
Dob_schoolQ_2DecFeb	3.00	1.68	1.78	0.08	-0.30	6.30
Dob_schoolQ_3MarMay	6.63	1.67	3.96	0.00	3.35	9.91
Dob_schoolQ_4JunAug	10.56	1.66	6.35	0.00	7.30	13.82
Gender=Female	19.70	1.19	16.58	0.00	17.37	22.03
Ethnicity=White Irish	8.05	14.58	0.55	0.58	-20.53	36.64
Ethnicity=White Other	24.51	6.09	4.03	0.00	12.58	36.44
Ethnicity=White and Black Caribbean	9.43	3.86	2.44	0.02	1.86	17.00
Ethnicity=White and Black African	11.83	7.76	1.52	0.13	-3.39	27.04
Ethnicity=White and Asian	16.61	5.62	2.96	0.00	5.60	27.63
Ethnicity=Any other mixed	7.80	6.50	1.20	0.23	-4.95	20.54
Ethnicity=Indian	37.13	2.76	13.44	0.00	31.72	42.55
Ethnicity=Pakistani	39.63	3.23	12.28	0.00	33.30	45.95
Ethnicity=Bangladeshi	47.80	3.86	12.37	0.00	40.22	55.37
Ethnicity=Asian Other	43.09	6.61	6.52	0.00	30.14	56.04
Ethnicity=Black Caribbean	12.62	3.58	3.53	0.00	5.61	19.63
Ethnicity=Black African	39.27	4.06	9.67	0.00	31.32	47.23
Ethnicity=Black Other	19.80	7.70	2.57	0.01	4.71	34.89
Ethnicity=Chinese	44.19	12.22	3.62	0.00	20.23	68.15
Ethnicity=Any Other	32.82	7.63	4.30	0.00	17.87	47.76
English_YP_additional	10.65	3.00	3.55	0.00	4.78	16.53
disability_affecting_school	-22.79	2.76	-8.27	0.00	-28.20	-17.39
Region: North East	5.59	3.51	1.60	0.11	-1.28	12.46
Region: North West	4.23	2.60	1.63	0.10	-0.87	9.34
Region: East Midlands	5.39	3.07	1.76	0.08	-0.62	11.40
Region: West Midlands	1.40	2.67	0.52	0.60	-3.83	6.63
Region: East of England	4.78	2.85	1.68	0.09	-0.81	10.37
Region: London	3.92	2.86	1.37	0.17	-1.68	9.53
Region: South East	6.72	2.68	2.50	0.01	1.46	11.98
Region: South West	5.04	3.00	1.68	0.09	-0.84	10.92
Urban	-4.54	1.85	-2.46	0.01	-8.16	-0.92
School type: Voluntary-Aided	6.21	2.25	2.76	0.01	1.80	10.62
School type: Voluntary-Controlled	11.54	4.21	2.75	0.01	3.30	19.79
School type: Foundation	1.79	2.14	0.83	0.40	-2.41	5.98
School type: Other Independent	57.75	44.88	1.29	0.20	-30.21	145.71
School type: College (FE, Tech)	14.13	9.87	1.43	0.15	-5.22	33.48
School type: Sponsored Academy	37.49	12.97	2.89	0.00	12.06	62.92
School size	0.00	0.00	1.40	0.16	0.00	0.01
School proportion of FSM-elig. pupils	0.17	0.08	2.24	0.03	0.02	0.32
School proportion SEN with statements	-0.62	0.36	-1.74	0.08	-1.31	0.08
School proportion SEN without statements	0.19	0.08	2.39	0.02	0.03	0.34
School KS2KS4 CVA score	0.43	0.03	14.26	0.00	0.37	0.49

School proportion of white pupils	0.13	0.04	3.20	0.00	0.05	0.22
fsm_ever5	-9.80	2.09	-4.69	0.00	-13.90	-5.70
IDACI_score	-0.12	0.05	-2.42	0.02	-0.22	-0.02
neighbourhood_prop_topoccup	0.34	0.08	4.29	0.00	0.19	0.50
employment_household	4.45	2.40	1.85	0.06	-0.25	9.16
single_parent_family	-16.24	1.83	-8.86	0.00	-19.84	-12.65
HE below degree	-7.48	2.16	-3.47	0.00	-11.72	-3.25
A Level (or equivalents)	-9.29	2.18	-4.26	0.00	-13.57	-5.01
GCSE A-C (or equivalents)	-11.59	2.16	-5.37	0.00	-15.82	-7.37
Level 1 and below	-16.09	3.07	-5.24	0.00	-22.11	-10.07
Other qualification	-10.61	5.34	-1.99	0.05	-21.08	-0.14
No qualification	-19.93	2.67	-7.47	0.00	-25.16	-14.70
Highest qualification imputed	-13.66	3.41	-4.00	0.00	-20.35	-6.98
Lower Managerial Occupation	-1.97	2.03	-0.97	0.33	-5.94	2.01
Intermediate Occupation	1.07	2.60	0.41	0.68	-4.03	6.18
Small Employers	-5.71	2.67	-2.14	0.03	-10.94	-0.48
Lower supervisory	-8.78	2.76	-3.18	0.00	-14.19	-3.37
Semi-routine	-4.92	2.75	-1.79	0.07	-10.32	0.47
Routine	-10.43	3.25	-3.21	0.00	-16.80	-4.05
Never worked/ Long-term unemployed	-8.41	3.89	-2.16	0.03	-16.04	-0.78
Highest occupation imputed	0.14	2.58	0.05	0.96	-4.92	5.20
income_midpoint	-0.03	0.03	-1.13	0.26	-0.08	0.02
income_imputed_flag	-0.10	1.42	-0.07	0.94	-2.88	2.68
age_mother	0.67	0.12	5.70	0.00	0.44	0.91
workage_mother	11.12	12.12	0.92	0.36	-12.64	34.89
house_tenure_priv_rent	-5.19	2.88	-1.80	0.07	-10.83	0.46
house_tenure_LA_rent	-12.38	1.88	-6.57	0.00	-16.08	-8.69
house_tenure_other	-9.98	6.39	-1.56	0.12	-22.51	2.54
household_size	-1.72	0.52	-3.29	0.00	-2.74	-0.69
Intercept	-404.78	35.48	-11.41	0.00	-474.32	-335.25
Random-effects Parameters	**Estimate**	**Std. Err.**			**95% CI**	
var(_cons)	34.84	12.57			17.18	70.66
var(Residual)	3961.45	52.56			3859.77	4065.81
LR test vs. linear regression:	$chi^2(01)$	16	Prob >= chibar2 = 0.0000			
Residual intra-class correlation	**ICC**	**Std. Err.**			**95% CI**	
	0.009	0.003			0.004	0.018
Explained variance						
Level 1	55.30%					
Level 2	68.97%					

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