Sheffield Economic Research Paper Series.

**Neighbourhood Effects on Educational Attainment:
Does Family Background Influence the Relationship?**

Emily McDool

Neighbourhood Effects on Educational Attainment: Does Family Background Influence the Relationship?

Emily McDool

Department of Economics, University of Sheffield

January 2017

Abstract

Evidence of the existence of neighbourhood effects upon educational attainment remains inconclusive, though recently receiving increased attention. This study adds to the existing literature to identify whether neighbourhood deprivation impacts upon the educational outcomes of 16 year olds, adopting Longitudinal Survey of Young People in England (LSYPE) data. Using propensity score matching methods, the main results indicate that individuals living in a deprived neighbourhood are 4 - 6 percentage points less likely to obtain the expected age 16 educational outcomes relative to characteristically similar individuals living in non-deprived neighbourhoods. Additionally, significant differential neighbourhood effects are identified for individuals with parents educated to at least post-16 level, relative to individuals with below post-16 level educated parents. Findings suggest that individuals with educated parents are disadvantaged by living in a deprived neighbourhood to a greater extent than individuals with less educated parents.

1 Introduction

To what extent does the neighbourhood that an individual lives in influence their outcomes? Empirically, this question has been addressed when considering outcomes such as school dropout (Overman, 2002; Harding 2003), employment prospects and income (Oreopoulos, 2003; Bolster et al. 2007, Manley and Ham, 2010) and teenage pregnancy (Harding, 2003; Lupton and Kneale 2010). One additional outcome of recent interest within the neighbourhood effects literature, and providing the focus of this paper, is educational attainment.

The Department for Education (2014) reported a 29.5 percentage point gap in the attainment of five GCSEs A*-C including English and mathematics in 2012/13[1] between children from deprived and non-deprived areas. Concurrently, it is well documented that children from deprived backgrounds generally complete school with substantially lower levels of educational attainment (Chowdry, 2010).

The neighbourhood in which an individual lives and the characteristics of that neighbourhood, are likely to induce a multiplicity of effects upon the individual and their outcomes. The peers, social norms, experiences with violence and crime and physical neighbourhood resources provided by the neighbourhood are likely to differ vastly between deprived and non-deprived neighbourhoods (Hastings, 2009; Galster, 2012). Whilst the existing literature provides mixed evidence on the magnitude of the neighbourhood effects, a number of studies have identified that neighbourhood characteristics that are correlated or associated with deprivation, do matter in determining educational outcomes (Gibbons 2002; Nicoletti and Rabe 2010; Solon et al. 2000; Harding 2003; Lindahl 2011; Goux and Maurin 2007; Owens 2010).

In attempting to identify the impact of neighbourhoods upon individual outcomes, researchers are confronted with the issues of a selection bias which arises since an individual's selection into a neighbourhood may relate to their observable or unobservable characteristics, alongside the additional evaluation problem of only one outcome per individual being observable. To overcome these issues, a number of approaches have been adopted within the neighbourhood effects literature including the observation of correlations in the outcomes of siblings and neighbours (Lindahl,2011; Nicoletti and Rabe, 2010; Solon et al., 2000), the exploitation of the timing of a neighbourhood move (Weinhardt, 2013) and the observation of a change in neighbourhood composition (Gibbons, 2002; Gibbons et al. 2012) alongside propensity score matching techniques (Harding, 2003), instrumental variable methods (Goux and Maurin, 2007; Cutler and Glaeser, 1997) and the analysis

---

[1] GCSEs (General Certificates of Secondary Education) refer to qualifications that are obtained in individual subjects, typically by students in secondary school aged between 14 and 16 across the UK, except in Scotland.

of experimental approaches, such as the Moving To Opportunity programme (Sanbonmatsu,2006; Gennetian et al. 2012, Ludwig et al. 2008). Whereas research within the US provides more clear-cut evidence of neighbourhood effects, studies from Europe and more specifically the UK, reflect much greater variance (Brattbakk and Wessel, 2012); despite the extensive research, a consensus fails to be reached regarding the magnitude or even the existence of a role of neighbourhood quality in determining educational attainment in the UK; the probable cause of this conflict in evidence may be the difference in the adopted definition of a neighbourhood and the measure of deprivation across studies.

In an ideal setting, the educational outcome of one individual living in a deprived neighbourhood would be compared to their outcome when concurrently living in a non-deprived neighbourhood, though this is not possible and is termed the evaluation problem. In an attempt to simulate such an experiment and to overcome the surrounding econometric issues, this study will adopt propensity score matching methods, allowing for the outcomes of individuals from deprived neighbourhoods to be estimated should they have lived in a non-deprived neighbourhood by matching characteristically similar individuals. In doing so, the study identifies the impact of neighbourhood deprivation, measured by Income Deprivation Affecting Children Index (IDACI) scores, upon the GCSE attainment of English pupils, utilising data from the Longitudinal Survey of Young People in England (LSYPE). Specifically, the study is interested in the attainment of five GCSEs graded A* - C and five GCSEs A*-C including English and maths, often termed the gold standard of GCSE results. Additionally, the study seeks to identify whether the differential in the outcomes of pupils from deprived and non-deprived neighbourhoods with educated parents is greater than the differential in outcomes for those with less educated parents, without post-16 education; this would be consistent with the hypothesis that the attainments of children with educated parents are improved to a greater extent by living in a non-deprived neighbourhood, relative to individuals with less educated parents. Limited evidence suggests that the extent to which neighbourhood quality influences educational attainment is dependent upon parental education (Pattacchini & Zenou, 2011); factors associated with parental education, for instance parenting, may also mediate the influence the impact of poverty upon child outcomes (Katz et al. 2007). This research is of interest from a policy perspective since the findings may signal the characteristics that increase vulnerability to neighbourhood effects.

This paper will contribute to the existing neighbourhood effects literature by providing an analysis of the impact of neighbourhood deprivation upon educational attainment using the method of propensity score matching to overcome the issues surrounding the measurement of neighbourhood effects. To my knowledge, propensity score matching has not previously been adopted as a method

to analyse neighbourhood effects upon educational attainment, though used within studies of neighbourhood effects on school drop-out (Harding, 2003). Whilst adopting an alternative approach to neighbourhood effects measurement, this paper will examine the impact upon educational attainment at GCSE level, specifically, on the attainment of headline measures: five GCSEs A*-C and five GCSEs A*-C including English and maths, thus contributing to the UK neighbourhood effects literature, where few studies have examined the effect upon these important education outcomes. Furthermore, the analysis of the differential impact of neighbourhood deprivation by parental education is an innovative addition to the existing literature, especially for the UK where few studies have attempted to identify how family background, which signals socio-economic status, impacts upon susceptibility to neighbourhood effects.

The paper will be structured as follows; a description of the data and the adopted methodology will be discussed in sections 2 and 3 respectively, with section 4 presenting the results from the different models analysed. Section 5 will close with a summary of the study aims, methods, results and conclusions.

2 Data

The Longitudinal Survey of Young People in England (LSYPE) is adopted within this study, providing a representative sample from a particular cohort of young people in England. This dataset encompasses approximately 15,000 individuals who are followed on an annual basis beginning in 2003/2004 when aged 13-14 and in year 9 of the UK schooling system. The most recent wave from 2009/2010 corresponds to when respondents were aged 19-20. Waves one to three will be utilized within this study in order to observe GCSE outcomes corresponding with the year 2005/2006 from wave three when respondents were aged 15-16 and in the final year of lower secondary schooling.

The LSYPE is matched to the National Pupil Database (NPD) which is a longitudinal administrative dataset that tracks all school and college pupils in England throughout their schooling years. Matching the LSYPE to the NPD allows for student past attainments, including Key Stage 2 and 3 test scores[2], geographical indicators and school level data to be obtained.

The LSYPE dataset also provides information on neighbourhood deprivation through the IDACI[3], providing a rank alongside a score, which indicates the percentage of children aged under 16 within

---

[2] Key Stage 2 refers to the four years of schooling in England and Wales when children and are aged between 7 and 11 and are in the year group 3 to year 6. Key stage 3 refers to the initial three years of secondary schooling when students are aged between 11 and 14 and are in year 7 to year 9.

[3] IDACI gives the percentage of children under 16 in each lower layer super Output Area (LSOA) who are living with families that are income deprived i.e. their families are in receipt of Income Support, Income based Jobseeker's Allowance, Working Families Tax Credit or Disabled Person's Tax Credit below a given threshold.

each lower layer super output area (LSOA) who live within income deprived households; a higher score therefore represents a higher degree of deprivation (Department for Communities and Local Government, 2008).The IDACI index is a suitable measure for this study since it represents the proportion of children directly affected by deprivation within the neighbourhood thereby indicating the deprivation amongst neighbourhood peers and the children observed themselves. The index is still likely to reflect the characteristics of the adults and the over-16 population within the neighbourhoods, given that these individuals determine whether the household is characterised as low income. In addition, since the index is based upon deprivation within the LSOA and around 1,500 individuals are contained in each LSOA, the index provides a suitable measure of deprivation within a small enough area to be defined as a neighbourhood. Deprivation is defined according to IDACI deciles, with the top 30% of deprivation scores characterising a deprived neighbourhood as with the remainder classified as non-deprived. The definition of neighbourhood deprivation is later adapted to the top 20% for comparative and robustness purposes.

The characteristic controls and deprivation information used within this study correspond with the time period 2003/4-2005/6 due to the availability of data; the neighbourhood effect presented will consequently indicate the impact of neighbourhood deprivation when exposure duration is at least three years, from year 9 to 11 in the UK schooling system. Kunz et al. (2001) recognise that short-term neighbourhood characteristics are likely to be highly correlated with long-term characteristics thus short-term neighbourhoods observed at a point in time may proxy longer term neighbourhood exposure. The neighbourhood effect estimations may therefore correlate with the impact of longer-term neighbourhood deprivation exposure.

Individuals are observed if they move within deprived or non-deprived neighbourhoods but are dropped from the sample if they move between neighbourhoods differing by deprivation status as defined by the IDACI deciles. These individuals are dropped in order to achieve a sample in which individuals have consistently experienced either deprived or non-deprived neighbourhoods for the time period observed, allowing for definitive assignment to the treatment or control group. In addition to dropping movers and non-respondents in any of the three observed waves, the loss of individuals with missing values for the control variables leads to an initial sample size for analysis of 9,555 individuals.

Weighting adjustment is applied to account for the survey design of the LSYPE which involved oversampling deprived schools alongside pupils from ethnic minority groups to achieve acceptable sample sizes across deprivation levels and ethnic groups. Applying the weights provided within the dataset therefore allows for the panel to be restored, giving representative proportions of

respondents from all deprivation levels and ethnic groups (Anders, 2012). The sampling weights have not been controlled for within the propensity score matching analysis since it is recommended that sampling weights are ignored with the use of the 'psmatch2' command in STATA (Leuven, 2014); this is because sample weights are associated with the characteristics of individuals, which may be directly used in the estimation of the propensity score or may be highly correlated with these characteristics.

The primary analysis involves identifying the overall neighbourhood effect when defining a deprived neighbourhood as an area within the top 30% deprived according to IDACI scores. An 'educated' parent is initially defined as at least one parent being educated to at least post-16 level. Subsequent analysis and robustness checks will consist of adopting a stricter definition of a deprived neighbourhood with focus on only neighbourhoods with IDACI scores within the top 20%. Additionally, the definition of an educated parent will be varied by defining parents with only a degree or higher as educated as opposed to post-16 education.

3 Methodology

There are a number of methodological challenges that must be overcome in order to identify the impact of neighbourhood deprivation; one such issue is the evaluation problem which arises since an individual may only be observed in one state; therefore, we can only observe an individual's outcomes when living in a deprived neighbourhood for example, we cannot observe the counterfactual outcome for the same individual should they have lived in a non-deprived neighbourhood. Additionally, there is a selection problem since individuals are not likely to randomly select a neighbourhood in which to live; Cheshire (2007) argues that poor individuals select into poor neighbourhoods, thus factors associated with family background are likely to determine neighbourhood residence. The choice of neighbourhood is likely to be related to an individual's observable or unobservable characteristics which may in turn influence outcomes such as educational attainment. This selection problem causes difficulties in establishing causality; when observing an individual's outcomes from a deprived neighbourhood, poor outcomes may be attributed to the neighbourhood. However, since individual characteristics are likely to partly determine neighbourhood selection, these characteristics may inevitably lead to poor outcomes despite the characteristics of the neighbourhood of residence.

With non-experimental methods, random assignment does not take place, hence when observing whether individuals were treated or not, self-selection and therefore differences in characteristics between the two groups must be taken into account. The treatment effect may be identified through the procedure and technique of matching as a substitute for randomised experiments (Heckman et

al. 1998)[4]. The matching procedure, which involves treating the individuals who live in a deprived neighbourhood as treated and individuals living in a non-deprived neighbourhood as the control group, allows for the control group outcomes to be used as a counterfactual outcome for treated individuals. This relies upon the assumption of conditional independence (CIA), also termed 'unconfoundedness' (Rosenbaum and Rubin, 1983)[5].

Matching methods may take into account the potential self-selection bias on observable characteristics by matching those who receive treatment to individuals in the control group, based upon them having comparable observable characteristics before the treatment is undertaken (Calavrezo and Sari, 2012). Since individuals share characteristics but differ in their neighbourhood deprivation status, the issue of causality may be relieved. Furthermore, matching methods may assist in overcoming the evaluation problem should similar individuals be matched allowing the counterfactual outcome to be observed.

A propensity score matching methodology is adopted since exact matching on a vector of characteristics may produce a sample in which many individuals are not matched (Rosenbaum and Rubin, 1983). The propensity score reflects the propensity to be treated and therefore the propensity to live in a deprived neighbourhood. The estimation of the propensity score involves modelling a logit model of treatment; the covariates included within the model should determine or relate with living in a deprived neighbourhood whilst influencing the GCSE attainment of the young person[6]. Descriptive statistics are provided in Table 1 for the control variables used in this paper. Individuals are then matched based upon their score; the commonly employed nearest neighbour (NN) matching method will be predominantly adopted within this study with caliper matching[7] additionally employed to check the robustness of NN estimates.

To enforce common support or overlap, which ensures that for treated observations there are comparison observations which are close in the propensity score distribution, treatment observations whose score is higher than the maximum or lower than the minimum of the score of

---

[4] When referring to the treatment effect, the average treatment effect on the treated (ATT) is specifically the parameter of interest. The ATT indicates the impact of treatment upon those who are actually treated and varies from the average treatment effect (ATE) which indicates the effect of treatment on a randomly selected member of the population.

[5] CIA states that controlling for observable characteristic differences between the treatment and control groups, where these observable covariates X are unaffected by treatment, possible outcomes, Y, are independent of treatment assignment, that is, the outcome that would result should treatment not be applied would be the same for both groups.

[6] The covariates within the model reflect characteristics which span the three years. For example a parent is defined as professional should they report holding a professional position for all three waves but unprofessional if they do not hold a professional position in any one of the observed waves; the rationale for this approach is that any changes in characteristics over the time period observed may influence pupil attainment. A propensity score to be calculated which is reflective of the full period observed.

[7] A caliper equal to 0.005 is specified for this matching method since the caliper is reduced to the smallest width before the sample size begins to deteriorate.

the controls are dropped[8]. Balancing tests check whether there is equality in the average propensity score and the mean of observable characteristics (Khandker et al. 2010). A number of tests of balance are utilized to check that there is sufficient overlap in the distribution of treated and untreated individuals. This check of common support or overlap therefore ensures that for treated observations there are comparison observations which are close in the propensity score distribution. Figures A.1 and A.2 within the appendix present the propensity score kernel density plots before and after matching; after matching, an overlap in the distribution is evident where this was not apparent before matching. Additional balance tests are carried out and presented in Table 2. Firstly, the pseudo R^2 is assessed to evaluate how well the covariates X explain the probability of participation. The R^2 should be low after matching since this signals that no systematic differences exist between the distribution of covariates in the treatment and control groups (Caliendo and Kopeinig, 2008). Additionally, the standardised bias check is carried out; this gives the percentage difference in the sample means in the treated and control group samples as a percentage of the square root of the average of the sample variances in both groups. There is consensus that a standardised bias reduction to below 5% after matching is considered sufficient. Furthermore, the Hotelling test of equal covariate means checks for the joint significance of covariates; since indicating insignificance, the test indicates that balance is achieved in all three samples. Further to these tests, balancing checks are carried out on the individual covariates; the results of these tests are provided for the full sample, alongside the educated and less educated parent samples within the appendix (Tables A.3, A.4 and A.5). These checks for individual covariates include a t-test for the equality of means between the treated and control group, before and after matching, alongside the standardised bias check for individual covariates. The percentage reduction in absolute bias is also presented.

The results of the balancing tests predominantly indicate that balance was achieved by the matching procedure. The results of the t-test balance check within the full sample signal a p-value of 0.007 for the school interaction term, indicating significance where we would expect insignificance. However, this is a small matter given that all other balance tests are passed. In addition, whilst the balance is tested and deemed important, emphasis is placed upon the use of a common specification across all three samples; the consistency of the controls and the model provide a good basis for analysis and comparability across all three samples (pooled, educated parents, less educated parents) where the specification managed to achieve balance in each individual sample.

---

[8] Imposing this common support condition leads to no observations being dropped within the matched sample encompassing both educated and uneducated parents; fewer than ten observations fail to satisfy the common support condition and are subsequently dropped within each of the educated parent and uneducated parent samples.

The standard errors obtained and presented within this analysis were acquired by bootstrapping since the estimation of propensity scores is likely to involve some variance which should therefore be included within the variance of the estimated treatment effect. Variation is likely to exceed the normal sampling variation so that the standard errors are likely to be undervalued. Bootstrapping provides a resolution to this issue (Lechner, 2002).

Initially, propensity score matching is used to match an individual from a deprived neighbourhood to a comparable individual from a non-deprived neighbourhood. The study then addresses whether children with less educated parents, whose highest level of education is below post-16 level, are more susceptible to neighbourhood effects than the children of educated families. Propensity score matching techniques continue to be adopted, with the procedure explained following an identical arrangement. However, before estimating an individual's propensity score and matching individuals based on this score, the sample is split according to parental education. Propensity score analysis will be carried out on the two separate groups to identify the neighbourhood effect for individuals with an educated family background (or at least one educated parent) alongside the neighbourhood effect for those individuals with parent/s without post-16 education. In doing so, individuals with educated parents are matched to others with educated backgrounds, differing on their neighbourhood deprivation; education will therefore be over-weighted so that individuals are matched exactly on this characteristic whilst the remaining covariates are treated unequally relative to family education; the remaining previously matched characteristics continue to be accounted for within the propensity score.

The neighbourhood effect will be calculated as before with GCSE outcomes of those in a deprived neighbourhood compared with the outcomes of those living in a non-deprived neighbourhood; this will be calculated separately for individuals with post-16 educated parents and for those without. The average treatment effect on the treated (ATT) will be compared between sub groups. From this strategy, a higher treatment, or neighbourhood effect identified from the individuals with educated families may be concluded to indicate a greater differential influence of neighbourhoods upon those from educated backgrounds. An equal effect and therefore zero difference between educated and less educated parents' children's outcomes would imply that family background, in terms of education, does not alter the impact of neighbourhood deprivation upon young people's outcomes.

4 Results

4.1 Descriptive Statistics

The impact of neighbourhood deprivation upon educational attainment is investigated when observing two GCSE attainment outcomes; firstly, the achievement of five GCSEs graded A* to C

alongside the attainment of the gold standard, that is five GCSEs A*-C including English and mathematics. The treatment refers to living within a deprived neighbourhood defined in the top 30% by the IDACI score for all three years observed between 2003-2006. This section discusses the raw data before providing a formal analysis of the propensity score matching results.

The raw percentages of individuals attaining the GCSE outcomes of interest within deprived and non-deprived neighbourhoods are provided in Table 3. The attainment of both outcomes is higher in non-deprived neighbourhoods relative to deprived, for example, 41.9% of residents in deprived neighbourhoods obtain five GCSEs A*-C relative to 66.7% in non-deprived neighbourhoods. The achievement of the gold standard is lower within both deprived and non-deprived neighbourhoods at 28.7% and 55.7% respectively.

This is also evident when observing attainment by neighbourhood and by parental education (Table 4). Within deprived neighbourhoods 56.1% of individuals with educated parents attain five GCSEs A*-C, relative to 76.7% of children of educated parents in non-deprived neighbourhoods. Attainment is similarly greater within non-deprived amongst the children of less educated parents, with 40.3% obtaining five GCSEs A*-C including English and maths, compared to just 22.8% within deprived neighbourhood. The raw gaps in attainment between children in deprived and non-deprived neighbourhoods are greater amongst children of educated parents both in the attainment of five GCSEs A*-C and the gold standard. These raw attainment gaps are greatest when observing the attainment of five GCSEs A*-C including English and maths; this gap between deprived and non-deprived neighbourhood equals 23.8 percentage points for individuals with educated parents, comparable to a 17.5 percentage point gap for individuals with less educated parents. As expected, the attainment of the GCSE measures is greater amongst children of educated parents.

The raw data also indicate that within the deprived neighbourhoods, only 30.2% of the young people observed have parents who are educated to at least post-16 level, whilst 69.8% have parents with lower than post-16 education (Table 5). The reverse is identified in non-deprived neighbourhoods where 59% of young people have educated parents and only 41% have parents with a lower level of education.

4.2 Results – neighbourhood effect

The main results are presented in Table 6. The neighbourhood effect for the full sample, given in the first row, presents the overall effect of residing within a deprived neighbourhood. Nearest neighbour results will be discussed since the caliper matching procedure provides very similar results, indicating that results are robust to a change in the matching procedure.

The first panel looks at the impact of neighbourhood deprivation upon the attainment of five GCSEs graded A* to C. The results indicate that individuals within a deprived neighbourhood are 4 percentage points less likely to achieve these GCSE grades than comparable individuals within the control group who live in a non-deprived neighbourhood, ceteris paribus. Given that 66.7% of non-deprived neighbourhood residents achieve five GCSEs A*-C, comparable with 41.9% of deprived neighbourhood residents, the estimated neighbourhood effect may explain 16.1% of the raw gap in attainment of five GCSEs A*-C between deprived and non-deprived neighbourhood residents. When observing the outcome of five GCSEs A*-C including English and maths, results indicate that young people living in deprived neighbourhoods are 6 percentage points less likely to attain the gold standard of GCSE results relative to a similar young person who lives in a non-deprived neighbourhood, ceteris paribus. This significant effect suggests that neighbourhoods partly determine the GCSE outcomes of young people when we additionally consider whether good grades in both English and maths were attained. Considering that 28.7% of individuals living in deprived neighbourhoods within the sample attain at least five A*-C grades including English and mathematics, relative to the 55.7% in non-deprived neighbourhoods, neighbourhood deprivation explains approximately 22.2% of the gap in the attainment of the gold standard between deprived and non-deprived neighbourhood residents, presenting a sizeable effect.

The findings suggest that neighbourhoods play a greater role in determining whether an individual attains five GCSEs A*-C including English and mathematics, than in influencing the achievement of any five GCSEs with good grades; this may be since individuals whose educational attainments may be suffering from the mechanisms and effects of neighbourhood deprivation could possibly fail a number of GCSEs, yet they may still obtain five, thus entering the five A*-C category. However, attaining good grades in at least five subjects including the core subjects may be more difficult to achieve. Additionally, greater emphasis is placed upon gaining good grades in core subjects, thus it may be expected that students exert effort to achieve good grades yet it may be that underlying characteristics and other factors, such as neighbourhood effects, continue to influence this outcome. For these reasons, the results are as expected: neighbourhood deprivation has a larger influence on the attainment of an arguably more difficult set of GCSE results with greater importance for future prospects.

4.3 Results - Neighbourhood effects by parental education
The analysis of neighbourhood effects by parental education seeks to identify whether individuals with educated parents incur a differential neighbourhood effect relative to those with less educated parents who completed education below post-16 level. A neighbourhood effect equal to zero for any estimate would imply that when living in a deprived neighbourhood, the likelihood of obtaining the

GCSE outcomes is not different to the likelihood of those living in non-deprived neighbourhoods achieving these outcomes. When observing the distinct neighbourhood effects by parental education, a difference that is insignificantly different from zero would imply that parental education does not alter the influence of neighbourhood deprivation upon the child's attainment at GCSE level.

Results from Table 6 indicate that individuals with educated parents living within a deprived neighbourhood are 7.4 percentage points less likely to attain five GCSEs graded A*-C than similar individuals with educated parents living within a non-deprived neighbourhood. This is a sizeable effect if we consider the raw data; 76.7% of individuals living in a non-deprived neighbourhood with parents educated to at least post-16 level attain five GCSEs A*-C; this is comparable with 56.1% who attain these grades in deprived neighbourhoods. The true neighbourhood effect therefore equals 35.9% of the raw attainment differential between deprived and non-deprived neighbourhoods.

Correspondingly, this effect is calculated for individuals with less educated parents who did not complete post-16 education; ceteris paribus, estimates reveal that young people living within deprived neighbourhoods are 1.7 percentage points less likely to attain five GCSEs graded A*-C than similar individuals who live within a non-deprived neighbourhood. Neighbourhood deprivation does not significantly influence the attainment of five A*-C for individuals who have parents without post-16 education.

A comparison of the results for pupils with educated and less educated parents indicates that there is a 5.7 percentage point difference between the estimated neighbourhood effects for the two groups. This insignificant difference suggests that there is not a significant difference in the impact of neighbourhood deprivation upon the attainment of five GCSEs A*-C by parental education.

When estimating the neighbourhood effect on the gold standard GCSE outcome by parental education, findings indicate that individuals with educated parents living within a deprived neighbourhood are 12.3 percentage points less likely to attain at least five GCSEs A*-C including English and maths relative to similar individuals in the sample with educated parents who live in non-deprived neighbourhoods. This highly significant impact of neighbourhood deprivation indicates that children of educated parents could do much better should they have lived in a non-deprived area; neighbourhood deprivation explains 51.7% of the raw gap in the attainment of the gold standard GCSE results of children with educated parents from deprived and non-deprived neighbourhoods.

Similarly, the estimate of the neighbourhood effect upon children of less educated parents indicates that those living in deprived neighbourhoods are 5.7 percentage points less likely to attain the gold standard GCSE result relative to people from non-deprived neighbourhoods, ceteris paribus. This effect is also significant at the five percent significance level, explaining 32.6% of the raw gap in the gold standard attainment between children with less educated parents living in deprived and non-deprived neighbourhoods.

Individually, each of these effects is greater than the impact identified when observing the five A*-C outcome, suggesting that neighbourhoods influence the probability of attainment of good GCSE grades including English and maths to a greater extent than the probability of gaining any five GCSE graded A*-C, as expected given the results of the initial analysis.

When observing the difference in results for pupils of educated and less educated parents, it is clear that neighbourhoods influence the outcomes of the educated group to a greater extent. The impact of neighbourhood deprivation is 6.7 percentage points greater for those with educated parents relative to those with less educated parents. This significant finding suggests that the losses, in terms of educational outcomes, from living in a deprived neighbourhood are greater for those with educated parents relative to those with less educated parents. To rephrase, the difference between what individuals with educated parents attain in deprived neighbourhoods and what they could have attained should they have lived in a non-deprived neighbourhood is significantly greater than the difference between actual achievement in deprived areas and potential attainment in non-deprived areas for individuals with less educated parents.

From these results, it is not true that children from educated parents do worse than those with less educated parents, in fact the attainment of children with educated parents is likely to be greater than children with less educated parents (Black et al. 2009; Dickson et al. 2016). Raw statistics from Table 4 indicate greater proportions of individuals with educated parents attaining the two GCSE outcomes relative to those with less educated parents; this is true within both deprived and non-deprived neighbourhoods. What the results do suggest is that the educated group in deprived neighbourhoods could have had a better chance at attaining the gold standard if they had lived in a non-deprived neighbourhood. The potential gain from living in a non-deprived neighbourhood in the likelihood of gaining the gold standard is significantly lower for children who have parents educated to below post-16 level.

The explanations behind these results are based on speculation alone. The results may correspond somewhat with Owens (2010) who identifies low socio-economic status (SES) neighbourhood children as being worse off when attending schools with a high composition of high SES children,

whilst high SES pupils do better by attending such schools. Whilst Owens essentially observes simply the effect of moving school between a deprived and non-deprived neighbourhood, the results of this study reflect a number of additional effects associated with this movement, which, from the results, positively influence outcomes. Thus, whilst low SES children, or children of uneducated parents, experience a negative effect of moving school but positive effect overall, high SES children experience the two effects which work in the same direction, providing a larger overall positive effect of the non-deprived neighbourhood.

Alternatively, since research suggests that higher ability students are more sensitive to school composition (Opdenakker and Van Damme, 2001), it could be argued that children of educated parents who have a higher level of innate ability, are worse off in deprived neighbourhoods and schools, where peers, such as friendship groups, classmates or school peers are more likely to be of lower ability; children of uneducated parents may conversely be less sensitive since being more likely to be lower ability themselves.

Peer aspirations and attitudes rather than, or in addition to, peer ability could also possibly explain the identified effect. A young person's aspirations to complete post-16 or higher education may be correlated with the aspirations of their friends or close peers (Alexander and Campbell, 1964), whilst aspirations are found to impact upon educational outcomes (Ryan and Homel, 2014). Since lower socio-economic backgrounds and low income influence lower aspirations of young people relative to more advantaged peers (Schoon, 2006), it is likely that the average aspirations to continue in education or to do well in education are lower amongst peers in deprived neighbourhoods, where a higher proportion of low SES families reside. Moving from a deprived neighbourhood, where educational aspirations to stay on or achieve good results for example may be low, to non-deprived neighbourhoods where aspirations among peers may be higher, may therefore increase aspirations and attainment of all children. However, for those with uneducated parents, from low SES backgrounds, this effect of peer aspirations may be bounded by SES.

One further possible explanation, again based purely on conjecture, may be the lifestyle differences between residents of deprived and non-deprived neighbourhoods. Lupton (2003) argues that the social relations of individuals will vary between isolated and well-connected areas; within non-deprived neighbourhoods, educated parents and their children alike may have a greater opportunity to expand and build social networks with other educated individuals and families therefore possibly increasing the exposure to potential educated role models. Children may be more likely to associate with peers and individuals with similar characteristics, though children of educated parents may have less opportunity to do so in a deprived neighbourhood where educated individuals are

underrepresented. Children of uneducated parents may on the other hand continue to associate with individuals of similar backgrounds and socio-economic status in a non-deprived neighbourhood as they may have done when living in a deprived neighbourhood, thus reducing the possibility of benefitting from such social networks.

Relatedly, characteristically similar individuals in non-deprived areas may lead differential lifestyles to those in deprived neighbourhoods, thus impacting upon educational attainment. For example, extracurricular activities are found to enhance educational and occupational aspirations (Gutman and Akerman, 2008). Xu et al. (2009) identify a negative influence of neighbourhood disadvantage upon the participation in extra-curricular activities whilst those with educated parents are more likely to participate. There may therefore be little difference in the participation in such activities between deprived and non-deprived residents with uneducated parents, whereas the participation of those with educated parents in non-deprived areas may be greater than the participation of individuals with educated parents in deprived neighbourhoods.

5 Robustness checks

5.1 Defining deprivation

There is no clear, accepted definition of neighbourhood deprivation when measuring deprivation by the IDACI score; initially neighbourhoods were defined as deprived if their scores were within the top 30% of the score distribution. Deprived neighbourhoods will now be defined as those with an IDACI score in the top 20%. Table 7 presents the results from re-estimating the neighbourhood effect.

The results for the overall neighbourhood effect indicate that the five A*-C GCSE outcome is now insignificant; hence, living within a neighbourhood that has an IDACI score ranked in the top 20% nationally, does not significantly influence the likelihood of obtaining five GCSEs A*-C relative to living in non-deprived neighbourhoods.

The neighbourhood effect upon the gold standard outcome is smaller than that calculated when the 30% level definition of deprivation is adopted; individuals living in a deprived neighbourhood are 3.6 percentage points less likely to attain five GCSEs A*-C including English and maths relative to characteristically similar individuals living in a non-deprived neighbourhood. This is a significant effect only at the 10% level.

When estimating the influence of neighbourhood deprivation upon GCSE outcomes by parental education, all individual estimates are insignificant for both those with educated and less educated

parents, equally for the five A*-C and the five A*-C including English and maths outcomes. Living within a neighbourhood with a deprivation rate in the top 20% according to IDACI scores therefore does not influence the likelihood of obtaining the GCSE outcomes of interest, regardless of parental education. These results differ substantially from those presented when a 30% deprivation rate was adopted.

It could be argued that these results may reflect that defining only neighbourhoods with a higher level of deprivation as deprived may capture largely neighbourhoods which are targeted by programmes or schemes that focus on the most deprived or very poor areas within England. Such schemes may assist in improving GCSE attainment within poor neighbourhoods thus offsetting the previously identified negative neighbourhood effect so that individuals in deprived areas are equally likely to obtain the observed GCSE outcomes as if they had lived in a non-deprived neighbourhood. Examples of these schemes may include the Neighbourhood renewal fund [9], the SureStart children's centres initiative [10] and teach first [11] .

It is possible that the negative neighbourhood effect is of equal magnitude for the top 20% and top 30% deprived neighbourhoods, thus, the insignificance of neighbourhood deprivation following the redefinition of deprivation may be due to the inclusion of previously defined deprived neighbourhoods, within the top 20-30% deprived neighbourhoods, within the control group. Whilst the observed GCSE attainment within the deprived neighbourhoods remains consistent with the attainment when observing all deprived neighbourhoods at the 30% level, the observed attainment within the non-deprived neighbourhoods may be reduced relative to the main results since neighbourhoods inflicting negative effects are now included within the control group. Furthermore, it is likely that these newly defined control individuals may be matched to treated individuals due to similar characteristics. The raw data provides some evidence for this; the change in definition of deprivation from 30% to 20% causes the proportion of individuals attaining the gold standard within non-deprived neighbourhoods to fall from 55.7% to 52.7%; this is comparable to a change from 28.7% to 27% within deprived neighbourhoods.

5.2 *Defining educated parents*

As with the definition of a deprived neighbourhood, there is no clear consensus of what level of education should be deemed 'educated'. Initially parents with post-16 education were defined as educated; for comparative purposes a degree will now define an educated parent. The ratio of

---

[9] https://www.communities-ni.gov.uk/articles/introduction-neighbourhood-renewal
[10] https://www.instituteforgovernment.org.uk/sites/default/files/publications/Implementing%20Sure%20Start%20Childrens%20Centres%20-%20final_0.pdf
[11] https://www.ifs.org.uk/comms/r79.pdf

educated parents to less educated parents becomes much smaller with 15.4% of the sample educated parents relative to 49.8% when adopting the post-16 definition. When matching individuals with educated parents within deprived and non-deprived neighbourhoods, only 260 treated individuals could be matched therefore a change in sample size may influence the results. The nearest neighbour matching estimates will be discussed here with results presented in Table 8.

The overall neighbourhood effect is slightly higher than the initial results; ceteris paribus, those living in deprived neighbourhoods are 5.3 percentage points significantly less likely to attain five GCSEs A*-C relative to those in non-deprived neighbourhoods, and 8.7 percentage points significantly less likely to obtain the gold standard outcome. These estimated effects are highly significant and support the results of the main analysis to a certain extent. The results suggest that 21.4% of the raw gap in attainment of five GCSEs A*-C and 32% of the raw gap in the attainment of the gold standard between residents of deprived and non-deprived neighbourhoods may be explained by the neighbourhood effect.

As in the main sample, the neighbourhood effect for children of less educated parents remains consistent with the main results; the neighbourhood effect explains 27.7% of the raw gap in the attainment of five GCSEs A*-C between children living in deprived and non-derived neighbourhoods.

Dissimilarities arise with the main results in the estimates of the neighbourhood effect for those with degree educated parents. Living in a deprived neighbourhood does not significantly influence the likelihood of attaining both five GCSEs A*-C and five GCSEs A*-C including English and maths. These individuals are therefore just as likely to obtain the GCSE outcomes of interest whilst living in a deprived area as if they had lived in a non-deprived neighbourhood.

One explanation for this dissimilarity with the main results, could be that degree educated parents are more able to compensate for negative neighbourhood influences, thus, regardless of the neighbourhood deprivation, the child is equally likely to obtain the GCSE benchmarks. For example, highly educated parents may provide a higher quality of assistance with school work and exam preparation relative to parents with post-16 education only.

Alternatively, the young person may be more likely to aspire to attend university should their parent/s have done so, thus such aspirations may induce higher levels of effort in school which may influence attainment.

Relatedly, children with degree educated parents may be higher ability pupils, relative to children of parents with post-16 education, and may therefore be more able to obtain the GCSE outcomes of

interest. Neighbourhood deprivation may still influence their outcomes for example by achieving a B grade rather than an A*, though this negative effect is not observed since they may continue to gain the five GCSEs A* -C and the gold standard.

All results presented throughout the paper are robust to a change in the matching method, from nearest neighbour to caliper matching.

6 Discussion

This study has investigated whether neighbourhood effects exist in determining educational outcomes at GCSE level, specifically observing the impact of neighbourhood deprivation upon the attainment of five GCSEs graded A* to C and five GCSEs A* to C including English and mathematics, also termed the gold standard. Using LSYPE data from 2003 to 2006, the differential effect of neighbourhood deprivation upon individuals with educated parents, with post-16 or above education, and less educated parents, with below post-16 level education, was also examined in an attempt to answer the question: Are young people from uneducated families more susceptible to neighbourhood effects than the children of educated families?

The study adopts a propensity score matching procedure to estimate the impact of neighbourhood characteristics upon individual outcomes since the matching procedure alleviates the main issues surrounding the measurement of neighbourhood effects namely the issues of a selection bias, causality and the evaluation problem. The overall neighbourhood effect is estimated using PSM techniques and subsequently the neighbourhood effects by parental education, by estimating the effect for two samples according to parental education.

When investigating the influence of living in a deprived neighbourhood with an IDACI score within the top 30%, the results indicated that individuals living in deprived neighbourhoods are around 4 percentage points less likely to obtain five GCSEs A*-C, relative to individuals living in non-deprived neighbourhoods and are around 6 percentage points less likely to obtain the gold standard GCSE outcome. The neighbourhood effect may therefore explain 16.1% of the raw gap in the attainment of five GCSEs A*-C, and 22.2% of the raw gap in the attainment of the gold standard between deprived and non-deprived residents. The results reflect the common finding that neighbourhood deprivation has a greater influence on the attainment of the 5 GCSEs A*-C including English and maths than the standard 5 GCSEs A*-C outcome.

Robustness checks are carried out to identify whether redefining deprivation and parental education influence these results. A stricter definition of a deprived neighbourhood is firstly adopted as neighbourhoods within the top two deciles of the IDACI. Findings suggest a smaller neighbourhood

effect with a significant impact of neighbourhood deprivation upon the gold standard outcome only. Returning to a 30% deprivation definition but varying the definition of an educated parent from a parent with at least post-16 education to at least a degree, the overall neighbourhood estimates differ little from the main analysis though presenting slightly larger estimates of the neighbourhood effect.

The impact of neighbourhood deprivation is then estimated separately for individuals with educated parents, defined as those with at least post-16 education, and for individuals with below post-16 level educated parents, to identify whether the neighbourhood deprivation has a heterogeneous effect upon outcomes according to parental education. Negative and significant neighbourhood effects are identified for individuals with educated parents with at least post-16 education; ceteris paribus, individuals with educated parents living in deprived neighbourhoods are around 7 percentage points less likely to obtain five GCSEs A*-C, and around 12 percentage points less likely to gain the gold standard, relative to characteristically similar individuals with educated parents from non-deprived neighbourhoods, based upon nearest neighbour matching estimations. Neighbourhood effects therefore explain 35.9% of the raw gap in the attainment of five GCSEs A*-C and 51.7% of the raw gap in the attainment of five GCSEs A*-C including English and maths between deprived and non-deprived residents with educated parents.

Neighbourhood deprivation is found to influence individuals with less educated parents to a lesser extent; whilst insignificantly impacting upon the attainment of five GCSEs A*-C, the likelihood of obtaining the gold standard is reduced by around 6 percentage points by living in a deprived neighbourhood for young people with less educated parents. The estimated neighbourhood effect is significantly larger for individuals with educated parents signalling that the penalty associated with neighbourhood deprivation imposed upon the educational attainment of residents is greater for individuals with educated parents who would benefit to a greater extent by living in a non-deprived neighbourhood, relative to individuals of less educated parents.

The robustness checks are additionally applied to the estimation of neighbourhood effects by parental education. When the stricter definition of deprivation is adopted, all neighbourhood effects both upon the attainment of five GCSEs A*-C and upon the gold standard are insignificant; this is so for both parental education groups. Defining parents as educated when holding a degree and subsequently estimating the neighbourhood effect gives similar results as in the main analysis for individuals with less educated parents. However, variation from the estimates within the main analysis is evident within the estimates of the neighbourhood effect for individuals with educated parents, since neighbourhood deprivation is found to insignificantly influence both observed GCSE

outcomes. It is suggested that neighbourhood deprivation may remain to impede upon education but this is uncaptured within this analysis which focuses on broad headline measures.

The results of the robustness checks highlight the relevance of the methodology and sample employed; should a 20% level of neighbourhood deprivation have been examined within the main analysis, the main results would differ drastically and would fall in line with many studies within the existing literature that suggest an insignificant role of neighbourhoods in determining educational outcomes Gibbons, 2012; Weinhardt, 2013; Sanbonmatsu, 2006; Lindahl, 2008; McCulloch and Joshi, 2001). The cut off at which a deprived neighbourhood is defined is therefore of great importance. It is argued that the insignificant impact of neighbourhood deprivation is identified when neighbourhoods in the top 20% of deprived areas are examined, since within the analysis, neighbourhoods in the top 30% deprived areas that were previously deemed treated, are included within the control group; deprived neighbourhoods are therefore used as a comparison, though a negative impact of these control neighbourhoods is evident from the main results.

The main analysis within this paper reveals an interesting finding; neighbourhood effects are found to be negative and significant, thus contrasting with the findings of other neighbourhood effects studies (Gibbons, 2012; Weinhardt, 2013; Sanbonmatsu, 2006; Lindahl, 2008; McCulloch and Joshi, 2001). A possible explanation for the differential results both between this study and other neighbourhood effects papers and amongst the neighbourhood literature is the variation in methods across studies; there is not a clear single method which has been adopted or identified as being the most suitable in estimating the impact of neighbourhoods upon outcomes such as education. In addition, the data adopted the definition of a neighbourhood, the deprivation measure or index and the outcome of interest varies between studies thus explaining the range of findings within the neighbourhood effects literature.

This empirical analysis would benefit from the availability of past residence data in order to identify the duration of exposure to neighbourhood deprivation, allowing for the relative impacts of long-term and short-term exposure to be investigated. The finding of insignificant neighbourhood effects for children of degree level educated parents may of course be due to data restrictions and sample size since only a small number of individuals with degree educated parents within deprived neighbourhoods were successfully matched. A larger sample size and dataset may therefore have benefitted this part of the analysis.

This paper adds to the existing neighbourhood effects literature by presenting an alternative approach to measuring the impact of neighbourhood deprivation upon educational attainment, this study additionally presents further analysis of neighbourhood effects by identifying the family

background characteristics of individuals who may be more susceptible to the negative influences; at present, few studies consider the heterogeneity of neighbourhood effects due to family background. This may be important for policy since the results indicate that targeting children based upon their socio-economic status alone may fail to aid those with educated parents whose educational attainment may suffer due to deprived surroundings. It is not only children from deprived and uneducated families who fail to reach their potential within deprived neighbourhoods, it is more so the children of educated parents whose may potentially be more able but suffer educational losses due to the neighbourhood in which they live.

TABLE 1: Characteristic controls descriptive statistics

VARIABLE	VARIABLE TYPE	MEAN	STANDARD DEVIATION
Household employed	Binary	0.775	0.418
Parental education (post-16 educated)	Binary	0.483	0.362
Professional parent	Binary	0.312	0.463
KS2 ability	Continuous	27.27	3.920
KS2 ability squared	Continuous	757.39	202.975
Born in UK & white	Binary	0.698	0.459
Household deprivation	Binary	0.196	0.397
Parental interest: homework*parents evening*intentions for educ.	Binary	0.441	0.497
School below average A*-C	Binary	0.826	0.379
School interaction: below A*-C average, class size abv av. Mainstream school	Binary	0.641	0.480

N = 9,555

Controls include: **Household employment** (dummy equals one if at least one parent is employed), **Professional parent** (dummy equals one if at least one parent is in professional employment based on NSSEC), **Educated parent** (dummy equals one if at least one parent has post-16 education), **KS2 average point score, School A*-C record** (dummy equals one if school attended has a 2004 A*-C achievement rate below average), **Interaction UK born and white, Parent involvement** (interaction equals one when main parent / partner attends parents evening, reports intentions for the child to continue in education and reports helping with homework), **School interaction** (equals one when School A*-C rate below average, class size above average and mainstream school).**Household deprivation** (dummy equals one when at least two types of household deprivation are experienced throughout the time observed: no internet access, no computer, no mobile phone, in receipt of free school meals, the household reports financial difficulty)

TABLE 2: Balancing checks

	30% FULL SAMPLE	EDUCATED PARENTS	UNEDUCATED PARENTS
Pseudo R2	0.001	0.002	0.001
Standardized bias (%)	1.844	3.297	1.749
Hotelling p-values	0.253	0.634	0.829
T-stat for individual covariates	All insignificant at 1% level except 1 covariate	All insignificant at 5% level	All insignificant at 1% level
Absolute bias (highest)	6	8	3

P-value = 0.007 on one covariate - the School interaction: School A*-C rate below average, class size above average and mainstream school

TABLE 3: Proportion of individuals within deprived/ non-deprived neighbourhoods attaining GCSE outcomes (30% deprivation)

	DEPRIVED NEIGHBOURHOOD	NON-DEPRIVED NEIGHBOURHOOD
5 GCSEs A*-C	41.9%	66.7%
5 GCSEs A*-C inc. English and maths	28.7%	55.7%

TABLE 4: Proportion on individuals within deprived/ non-deprived neighbourhoods attaining GCSE outcomes, by parental education (30% deprivation)

ATTAINMENT	SAMPLE	DEPRIVED NEIGHBOURHOOD	NON-DEPRIVED NEIGHBOURHOOD
5 A*-C	**Educated parents Post-16**	56.1%	76.7%
	Below post-16 educated parents	35.7%	52.2%
5 A*-C inc. English and maths	**Educated parents Post-16**	42.5%	66.3%
	Below post-16 educated parents	22.8%	40.3%

TABLE 5: Proportion of educated and uneducated parents within deprived and non-deprived neighbourhoods (30% deprivation)

	DEPRIVED NEIGHBOURHOOD	NON-DEPRIVED NEIGHBOURHOOD
% with educated parents Post-16 education	30.2%	59%
% with below post-16 educated parents	69.8%	41%
Total	100%	100%

TABLE 6: Propensity score matching: 30% deprivation Post-16 education definition

	Educated: Post-16 Education / Deprivation: Top 30% deprived IDACI								
	Outcome: 5 GCSE A*-C				*Outcome: 5 GCSE A*-C including Eng & Mat.(gold standard)*				
	(1) Propensity score Nearest neighbour	(2) Difference: uneducated and educated	(3) Propensity score Caliper matching	(4) Difference: uneducated and educated	(5) Propensity score Nearest neighbour	(6) Difference: uneducated and educated	(7) Propensity score Caliper matching	(8) Difference: uneducated and educated	N (Treated)
Neighbourhood effect (full sample)	-0.040* (0.018)		-0.041* (0.018)		-0.060*** (0.016)		-0.061*** (0.016)		3352
Neighbourhood effect educated parents	-0.074** (0.027)	-0.057 (0.035)	-0.079** (0.027)	-0.063 (0.034)	-0.123*** (0.028)	-0.067* (0.033)	-0.128*** (0.026)	-0.071** (0.032)	1309
Neighbourhood effect uneducated parents	-0.017 (0.022)		-0.017 (0.022)		-0.057** (0.019)		-0.057** (0.019)		2512

Significance: *** 1% level   **5% level   *10% level

TABLE 7: Propensity score matching: 20% deprivation Post-16 education definition

	Educated: Post-16 Education / Deprivation: Top 20% deprived IDACI								
	Outcome: 5 GCSE A*-C				*Outcome: 5 GCSE A*-C including Eng & Mat.(gold standard)*				
	(1) Propensity score Nearest neighbour	(2) Difference: uneducated and educated	(3) Propensity score Caliper matching	(4) Difference: uneducated and educated	(5) Propensity score Nearest neighbour	(6) Difference: uneducated and educated	(7) Propensity score Caliper matching	(8) Difference: uneducated and educated	N (Treated)
Neighbourhood effect (full sample)	-0.014 (0.017)		-0.014 (0.017)		-0.036* (0.017)		-0.036* (0.017)		2507
Neighbourhood effect educated parents	-0.021 (0.030)	-0.036 (0.038)	-0.021 (0.029)	-0.038 (0.037)	-0.056 (0.033)	-0.033 (0.040)	-0.060 (0.031)	-0.038 (0.039)	662
Neighbourhood effect uneducated parents	0.015 (0.022)		0.016 (0.022)		-0.023 (0.023)		-0.022 (0.024)		1845

Significance: *** 1% level   **5% level   *10% level

TABLE 8: Propensity score matching: 30% deprivation, degree education definition

	Educated: Degree Education / Deprivation: Top 30% deprived IDACI								
	Outcome: 5 GCSEs A*-C				Outcome: 5 GCSE A*-C including Eng & Mat.(gold standard)				
	(1) Propensity score Nearest neighbour	(2) Difference: uneducated and educated	(3) Propensity score Caliper matching	(4) Difference: uneducated and educated	(5) Propensity score Nearest neighbour	(6) Difference: uneducated and educated	(7) Propensity score Caliper matching	(8) Difference: uneducated and educated	N (Treated)
Neighbourhood effect (full sample)	-0.053*** (0.015)		-0.053*** (0.015)		-0.087*** (0.017)		-0.087*** (0.017)		3352
Neighbourhood effect educated parents	-0.023 (0.043)	0.0045 (0.047)	-0.045 (0.038)	-0.017 (0.042)	-0.035 (0.050)	-0.030 (0.053)	-0.045 (0.049)	0.019 (0.052)	260
Neighbourhood effect uneducated parents	-0.028 (0.020)		-0.028 (0.019)		-0.064*** (0.019)		-0.064*** (0.018)		3282

Significance: *** 1% level   **5% level   *10% level

References

Alexander, N., and Campbell, E. (1964). Peer influence on adolescent educational aspirations and attainments. *American Sociological Review, 29(4), 568-575*

Black, S., Devereux, P. & Salvanes, K. (2009) Like father like son? A note on the intergenerational transmission of IQ scores. *Economic letters* 105(1): 138-140

Bolster, A., Burgess, S., Johnston, R., Jobes, K. Propper, C and Sarker, R. (2007) Neighbourhoods, households and income dynamics: a semi-parametric investigation of neighbourhood effects. *Journal of Economic Geography 7: 1-38*

Brattbak, I. and Wessel, T. (2012) Long-term Neighbourhood Effects on Education, Income and Employment among Adolescents in Oslo. *Urban Studies* 1, 1-16

Caliendo, M, and Kopeinig, S. (2008) Some practical guidance for the implementation of propensity score matching *Journal of economic* survey 22: 31-72.

Cheshire, P. (2007) *Segregated Neighbourhoods and Mixed Communities: A critical analysis* Joseph Rowntree Foundation. York.

Chetty, R., Stepner, M.,Abraham, S., Lin, S., Scuderi, B., Turner, N. Bergeron, A. and Cutler, D. (2016) The Association Between Income and Life Expectancy in the United States, 2001-2014. *Journal of the American Medical Association* 315(16)1750-1766

Chowdry, H. Crawford, C. and Goodman, A. (2010) *The roles of attitudes and behaviours in explaining socio-economic differences in attainment at age 16.* Institute for Fiscal Studies working paper 10/15

Cutler, D. and Glaeser, E. (1997) Are ghettos good or bad? *The Quarterly Journal of Economics 112(3): 827-72*

Department for Education (2014) *GCSE and equivalent attainment by pupil characteristics in England, 2012/13.* Retrieved 7th May 2014 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/280689/sfr05_2014_text_final.pdf

Dickson, M., Gregg, P. & Robinson, H. (2016) Early, late or never: when does parental education impact child outcomes? *The Economic Journal* 126(596): 184-231

Galster, G. (2012) The mechanism(s) of neighbourhood effects: theory, evidence, and policy implications. Cited in van Ham M., Manley D., Bailey N., Simpson L. and Maclennan, D. (2012) Neighbourhood Effects Research: New Perspectives, pp. 1–22. Springer

Gennetian. L., Sciandra, M., Sanbonmatsu, L., Ludwig, J., Katz. LF., Duncan, GJ., Kling, JR. and Kessler, RC (2012). The Long-Term Effects of Moving to Opportunity on Youth Outcomes. *Cityscape 14(2):137-68.*

Gibbons, S. (2002) *Neighbourhood effects on educational achievement: evidence from the census and national child development study.* Discussion Paper LSE18, Centre for the Economics of Education, London School of Economics

Gibbons, S., Silva, O. Weinhardt, F. (2012) Everybody needs good neighbours? Evidence from students' outcomes in England. *The Economic Journal 123(571): 831-874*

Gutman, L. and Akerman, R. (2008) *Determinants of aspirations.* Centre for Research on the Wider Benefits of Learning. Research report 27

Goux, D. and Maurin, E. (2006) Close neighbours matter: Neighbourhood effects on Early performance at school. *Economic Journal, Royal Economic Society 117(523): 1193-1215.*

Harding, D. (2003) Counterfactual models of neighbourhood effects: the effect of neighbourhood poverty on dropping out and teenage pregnancy. *American Journal of Sociology* 109(3): 676-719

Harding , D. Gennetian, L. winship, C. Sanbonmatsu, L. and Kling, J. (2010) *Unpacking neighbourhood influences on educational outcomes: setting the stage for future research.* NBER Working Paper No. 16055.

Hastings, A. (2009) Poor Neighbourhoods and Poor Services: Evidence on the 'Rationing' of Environmental Service Provision to Deprived Neighbourhoods. *Urban Studies 46(13) 2907–2927.*

Heckman, J., Ichimura, H. and Todd, P. (1998) Matching as an econometric evaluation estimator. *Review of Economic Studies 65 261-294*

Katz, I., Corlyon, J., La Placa, V. and Hunter, S. (2007) *The relationship between parenting and poverty.* Joseph Rowntree Foundation.

Khandker, S., Koowal, G. and Samad, H. (2010) *Handbook on impact evaluation: quantitative methods and practises.* World bank, Washington.

Kunz, J. Page, M. and Solon, G. (2001) Are Single-Year Measures of Neighborhood Characteristics Useful Proxies for Children's Long-Run Neighborhood Environment? *Economic Letters 79(2):231–37*

Lechner, M. (2002) Some practical issues in the evaluation of heterogenous labour market programmes by matching methods. *Journal of the Royal Statistical Society,* 165, 59–82.

Leuven, E. (2014) *Help for psmatch2.* Retrieved 6th Jan 2015 from http://repec.org/bocode/p/psmatch2.html

Lupton, R. (2003) *Neighbourhood effects can we measure them and does it matter?* CASE paper, 73. Centre for Analysis of Social Exclusion, London School of Economics and Political Science, London, UK.

Lupton, R. and Kneale, D. (2010) *Are there neighbourhood effects on teenage parenthood in the UK, and does it matter for policy? A review of theory and evidence.* Centre for Analysis of Social Exclusion CASE paper 141

Lindahl, L. (2011) A comparison of family and neighbourhood effects on grades, test scores, educational attainment and income- evidence from Sweden. *The Journal of Economic Inequality 9: 207-226*

Ludwig, J. Kling, J. katz, L. sanbonmatsu, L. Liebman,J. Duncan,G. and Kessler, R. (2008) What can we learn about neighbourhood effects from the moving to opportunity experiment. *American Journal of Sociology 114(1) 144-188*

Manley, D. and Van ham, M. (2010) *Neighbourhood effects housing tenure and individual employment outcomes.* IZA discussion paper no.5271

McCulloch, A. and Joshi, H. (2001) Neighbourhood and family influences on the cognitive ability of children in the British national child development study. *Social Science and Medicine 53(5):579-91.*

Nicoletti, C. and Rabe, B. (2010) *Inequality in pupil's educational attainment: how much do family, sibling type and neighbourhood matter*? ISER Working Paper Series: 2010-26

Calvrezo, O. and Sari, F. (2012) Neighbourhood effects and unemployment outcomes: empirical evidence from french priority neighbourhoods. *Urban Public Economics Review 17 12-55*

Opdenakker, M. and Van Damme, J. (2001). Relationship between school composition and characteristics of school process and their effect on Mathematics achievement. *British Educational Research Journal, 27(4), 407–432*

Oreopolous, P. (2003) The long run consequences of living in in a poor neighbourhood. *Quarterly Journal of Economics* 118(4) 1533-75

Overman, H. (2002) Neighbourhood effects in large and small neighbourhoods. *Urban Studies 39(1) 117-130*

Owens, A. (2010) Neighborhoods and Schools as Competing and Reinforcing Contexts for Educational Attainment. *Sociology of Education 83(4) 287-311*

Patacchini, E. and Zenou, Y. (2011) Neighbourhood effects and parental involvement in the intergenerational transmission of education. *Journal of regional science* 51(5) 987-1013

Rosenbaum P. and Rubin, D. (1983) The central role of the propensity score in observational studies for causal effects. *Biometrika 70(1):41–55.*

Ryan, C. and Homel, J. (2014) *Educational outcomes: the impact of aspirations and the role of student background characteristics.* Research report no.65 LSAY

Sanbonmatsu, L., Kling, J. Duncan, G and brooks-Gunn, J. (2006) *Neighbourhoods and academic achievement: results from the moving to opportunity experiment.* The National Bureau of Economic Research working paper no. 11909

Schoon, I. (2006) *Risk and Resilience: Adaptations in Changing Times*. Cambridge: Cambridge University Press.

Solon, G. Page, M. and Duncan, G. (2000) Correlations between neighbouring children in their subsequent educational attainment. *The Review of Economics and Statistics 82(3): 383-392*

Weinhardt, A. (2013) *Neighbourhood quality and student performance*. IZA discussion paper 7139

Xu, L., Gauthier, A. and Strohschien, L. (2009) Why are some Children Left Out? Factors Barring Canadian Children from Participating in Extracurricular Activities. *Canadian Studies in Population 36(3-4)325-345*

Figure A.1 Propensity score plot: before matching
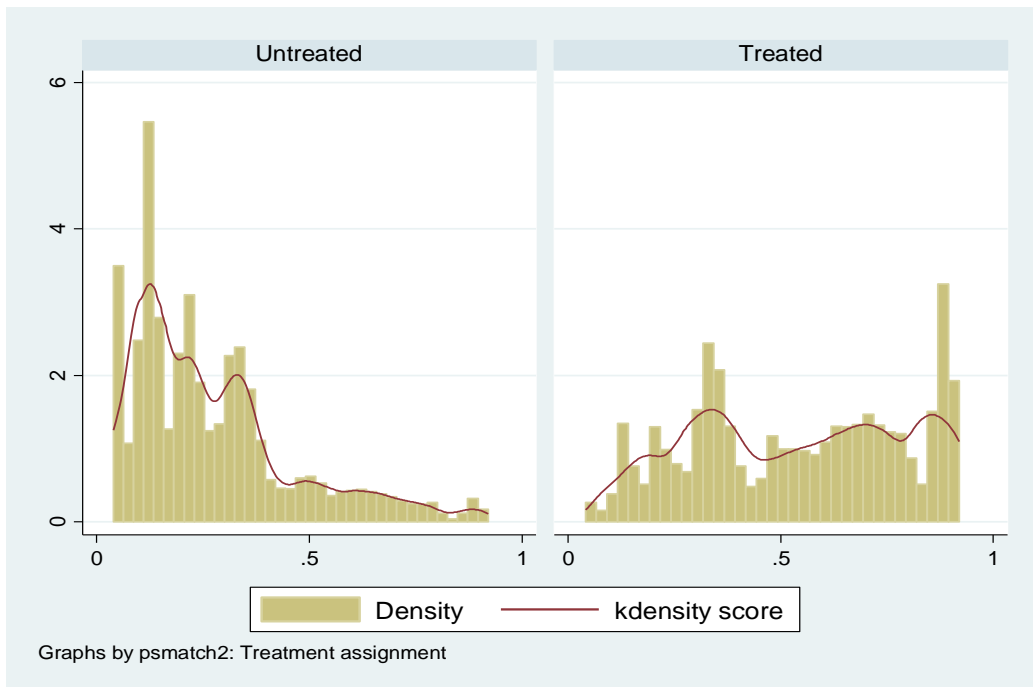
Figure A.2 Propensity score plot after matching

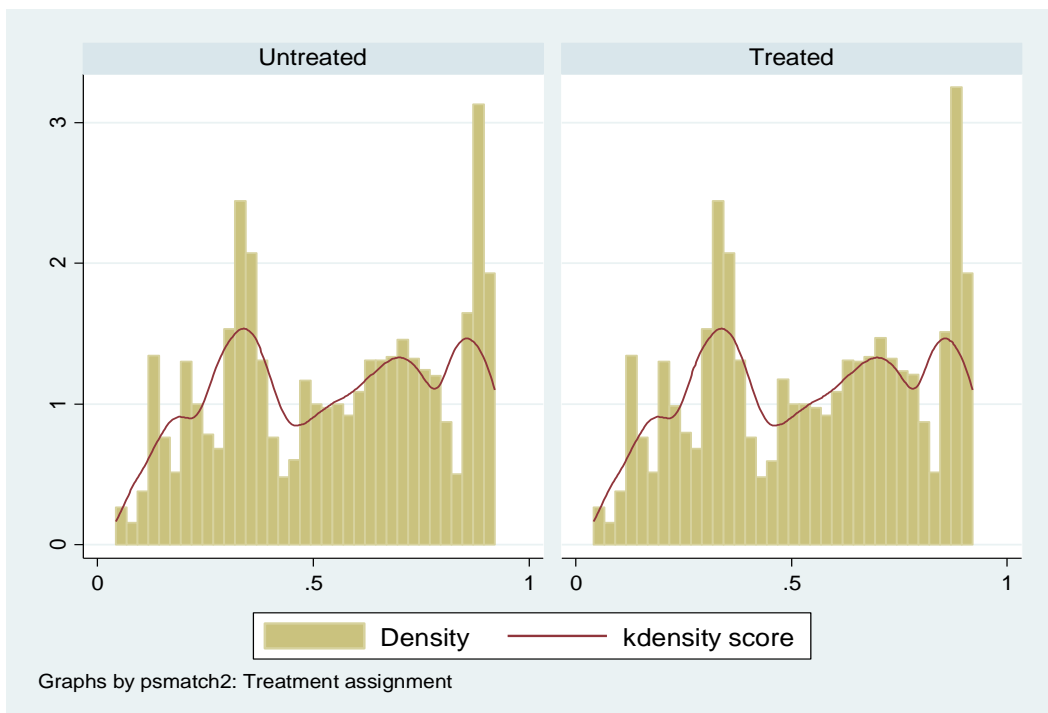**Table A.3: Balancing checks for individual covariates - Full sample (educated and uneducated parents)**

Variable	Sample	Mean		%bias	%reduct |bias|	t-test	
		Treated	Control			t	p>|t|
Household employment	Unmatched	0.581	0.891	-75.3	95.4	-37.71	0.000
	Matched	0.581	0.595	-3.5		-1.23	0.219
Parental education	Unmatched	0.293	0.597	-64.3	99.3	-30.08	0.000
	Matched	0.293	0.295	-0.5		-0.21	0.835
Professional parent	Unmatched	0.135	0.419	-66.7	97.5	-30.20	0.000
	Matched	0.135	0.128	1.7		0.88	0.381
KS2 ability	Unmatched	26.045	27.977	-50.1	98.1	-24.07	0.000
	Matched	26.045	26.009	0.9		0.38	0.704
KS2 ability squared	Unmatched	695.07	795.73	-50.8	97.5	-24.18	0.000
	Matched	695.07	692.59	1.3		0.52	0.604
Born in in UK & white	Unmatched	0.503	0.813	-69.2	99.8	-33.78	0.000
	Matched	0.503	0.503	0.1		0.05	0.962
Household deprivation	Unmatched	0.384	0.085	75.2	97.5	38.06	0.000
	Matched	0.384	0.376	1.8		0.64	0.525
Parent interest	Unmatched	0.380	0.478	-20.1	96.9	-9.44	0.000
	Matched	0.380	0.383	-0.6		-0.27	0.788
School below average A*-C	Unmatched	0.925	0.765	45.5	95.4	20.37	0.000
	Matched	0.925	0.933	-2.1		-1.20	0.230
School interaction	Unmatched	0.735	0.584	32.3	81.6	15.04	0.000
	Matched	0.735	0.763	-6.0		-2.71	0.007

Table A.4: Balancing checks for individual covariates - uneducated parents

Variable	Sample	Mean		%bias	%reduct |bias|	t-test	
		Treated	**Control**			**t**	**p>|t|**
Household employment	Unmatched	0.492	0.823	-74.5	99.5	-26.10	0.000
	Matched	0.492	0.490	0.4		0.11	0.910
Professional parent	Unmatched	0.044	0.200	-48.9	96.9	-17.26	0.000
	Matched	0.044	0.039	1.5		0.85	0.396
KS2 ability	Unmatched	25.518	26.819	-33.3	95.5	-11.67	0.000
	Matched	25.515	25.456	1.5		0.50	0.615
KS2 ability squared	Unmatched	668.24	732.77	-32.9	94.7	-11.54	0.000
	Matched	668.06	664.67	1.7		0.60	0.550
Born in in UK & white	Unmatched	0.486	0.793	-67.4	96.8	-23.63	0.000
	Matched	0.486	0.496	-2.2		-0.71	0.481
Household deprivation	Unmatched	0.466	0.155	71.5	97.8	25.02	0.000
	Matched	0.467	0.460	1.6		0.48	0.631
Parent interest	Unmatched	0.329	0.356	-5.6	46	-1.97	0.049
	Matched	0.329	0.314	3		1.09	0.277
School below average A*-C	Unmatched	0.945	0.845	33	90.8	11.64	0.000
	Matched	0.945	0.954	-3		-1.48	0.138
School interaction	Unmatched	0.753	0.643	24.3	96.4	8.53	0.000
	Matched	0.754	0.758	-0.9		-0.33	0.743

Table A.5: Balancing checks for individual covariates - educated parents

Variable	Sample	Mean		%bias	%reduct |bias|	t-test	
		Treated	Control			t	p>|t|
Household employment	Unmatched	0.795	0.937	-42.7	100	-14.07	0.00
	Matched	0.797	0.797	0.0		0.000	1
Professional parent	Unmatched	0.356	0.567	-43.3	94.1	-12.17	0.000
	Matched	0.357	0.344	2.6		0.6	0.550
KS2 ability	Unmatched	27.321	28.76	-41	93.6	-11.95	0.000
	Matched	27.339	27.432	-2.6		-0.57	0.566
KS2 ability squared	Unmatched	759.97	838.28	-41.9	93.3	-12.05	0.000
	Matched	760.82	766.06	-2.8		-0.62	0.533
Born in in UK & white	Unmatched	0.544	0.827	-64.1	98	-19.7	0.000
	Matched	0.545	0.539	1.3		0.26	0.792
Household deprivation	Unmatched	0.184	0.039	47.5	89.4	16.5	0.001
	Matched	0.182	0.167	5		0.93	0.355
Parent interest	Unmatched	0.501	0.561	-12.0	32.2	-3.41	0.000
	Matched	0.502	0.543	-8.1		-1.85	0.065
School below average A*-C	Unmatched	0.879	0.711	42.5	92.5	11.13	0.000
	Matched	0.879	0.891	-3.2		-0.89	0.372
School interaction	Unmatched	0.690	0.544	30.4	89.5	8.46	0.000
	Matched	0.689	0.705	-3.2		-0.76	0.445