Healthy school meals and Educational Outcomes

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This paper provides quasi-experimental evidence on the effects of diet on educational outcomes, exploiting a campaign lead in the UK in 2004, which introduced drastic changes in the meals offered in the schools of one Borough – Greenwich, shifting from low-budget processed meals towards healthier options. We evaluate the effect of the campaign on educational outcomes in primary schools using a difference in differences approach; comparing educational outcomes in primary schools (key stage 2 outcomes more specifically) before and after the reform, using the neighbouring Local Education Authorities as a control group. We find evidence that educational outcomes did improve significantly in English and Science. We also find that the campaign lead to a 15% fall in authorised absences – which are most likely linked to illness and health.

Keywords: Child nutrition, Child health, School meals, Education, Natural Experiment, Placebo effect
JEL-codes: J13, I18, I28, H51, H52

"Mens Sana in Corpore Sano"

(A Sound Mind in a Sound Body)

Juvenal (Satire 10.356)

Introduction

Children's diet has deteriorated tremendously over the last decades, and has become a major source of preoccupation in developed countries, in particular in view of the rising rates of obesity among young children, observed across almost all developed countries.[1] In the UK, a large and fierce debate arose on the quality of food served at school when the British Chef Jamie Oliver publicly denounced the poor nutritional contents of school lunches – which were found to be high in saturated fat, salt and sugar – and embarked in a high profile campaign aimed at improving the nutritional standards at school. His campaign – Feed Me Better – resulted in a large-scale field experiment. The 80 schools of one borough – Greenwich - would serve as a pilot for the rest of the country. The Chef designed a set of new menus, shifting away from low-budget processed meals towards healthier options and arranged all junk food to be banned from those schools. Because it was literally designed and implemented as an experiment, this campaign offers a unique opportunity to assess the causal effects of diet on educational outcomes.

Nutrition is an obvious input of the "learning production function". A poor diet is likely to result in important deficiencies in those nutrients playing a direct role in the ability to learn. Indeed, a number of studies point at the significant and *immediate* effect of diet on behaviour, concentration and cognitive ability; as well as on the immune system, and therefore the ability to attend school (see Sorhaindo and Feinstein (2006) for a review). School meals from that point of view possibly play a crucial role in learning and educational performance. They are of major importance in British schools, with about 45% of school kids in primary and secondary schools eating school lunches every day, and are therefore an obvious instrument for policy

[1] For example, in the UK, 15% of children aged 2 to 10 were classified as "obese" in 2006, compared to 10% only 10 years ago (Health Survey for England)

intervention in children's diet. School meals seem also to be more important now than in the past, because children rely more on food provided at school now than three decades ago. For example, Anderson, Butcher and Levine (2003) show that increases in maternal employment rates in the US have been associated with an increase in obesity rates, which they attribute partly to the decrease in the consumption of home cooked meals.

A number of studies provide quasi-experimental evidence of a causal relationship between diet and obesity (Whitmore (2005), Anderson and Butcher (2006a, 2006b)), and in particular between the availability of junk food at school on children's obesity. Little is known though on the effect of poor diet on other outcomes, and in particular, on learning and cognitive ability. There are a number of studies documenting correlations between *malnutrition* and educational outcomes (see Pollitt (1990), Behrman (1996), Alderman et al. (2001), Glewwe et al. (2001)), but most of this literature concentrates on developing countries (and therefore on malnourishment rather than poor eating habits), and few of them are able to establish a *causal* effect, i.e. they do not have a source of exogenous variation in nutritional habits.

Using pupil and school-level data from the National Pupil Database (NPD) and from the School census covering the period 2002-2007, we evaluate the effect of the campaign on educational outcomes and on absenteeism in primary schools using a difference in differences (DD) approach; comparing educational outcomes (key stage 2 outcomes more specifically) before and after the reform, using the neighbouring Local Education Authorities as a control group. We find that the campaign improved educational achievements. Our estimates show that the campaign increased the percentage of pupils reaching level 4 by 4.5 percentage points in English, and the percentage of pupils reaching level 5 by 6 percentage points in Science. However, the estimates are not very precise, such that we cannot exclude small positive effects. Nevertheless, it is noteworthy to find *any* significant effect, because the campaign was not directly targeted at improving educational outcomes and, also, we are looking at improvements within a relatively short horizon (2 years). One could have expected that changing diet habits is a long and difficult process, which would possibly only have effects after a long time, effects that would be hard to measure. Next to these

educational outcomes, we find clear evidence that *authorised* absences (which are more likely to be linked to sickness) drop by 15% on average in Greenwich relatively to other LEAs. Interestingly, we find no such effect on *unauthorised* absences (less likely to be linked to sickness).

The campaign also provides an interesting and unique opportunity to shed some light on a possible *placebo* effect, which is usually hard to assess in social sciences. We investigate how test scores changed in the schools that were mentioned explicitly in the television program, with the hypothesis that maybe these schools were more vulnerable to a possible placebo effect than other schools. We do not find a stronger effect among those schools, the DD estimates even turn negative for some of the specifications. Thus, we do not find convincing evidence that the positive effects we documented earlier are driven by a placebo effect.

The paper is structured as follows. Section 1 describes the background of the "Feed me Better Campaign". Section 2 discusses the existing evidence in the literature on the effects of nutrition on health and educational outcomes. Section 3 describes the sample and data we use in our empirical analysis. Section 4 presents our identification strategy and the results. Section 5 concludes.

1. Background: School Meals and the "Feed Me Better" Campaign

The British Chef Oliver started the campaign "Feed me Better" in 2004, drawing attention to the poor quality of meals offered in schools. The campaign has been publicised through a TV documentary broadcast in February 2005 on one of UK channels (Channel 4). The programme featured mainly one school in Greenwich (Kidbrooke secondary school), the first school where the changes were implemented. The idea of the campaign was to drastically change the school meal menus in all schools of the borough of Greenwich, as an "experiment" that would serve as an example for the rest of the country.

Typically, the Local Education Authories are in charge of allocating a budget to schools. Schools have contractual agreements with catering companies – the largest one in the UK at the time was Scholarest. These contracts are long-term contracts and short-term changes to menus are very difficult to implement. Oliver obtained the agreement of the Council of Greenwich to change the menus (provided the menus would stay within budget). The large majority of schools in the Greenwich area switched from their old menus to the new menus in the school year of 2004-2005. Before the campaign, school meals were mainly based on low-budget processed food. In the Appendix, we provide an example of menus as they were before and after the Jamie Oliver campaign.

The campaign mobilised a lot of resources, involved retraining the cooks (most cooks participated to a three-day boot camp organised by the Chef) and equipping the schools with the appropriate equipment. Clearly, the implementation has not been straightforward and it would have been very difficult for schools in other LEAs to have made these changes on such a large scale.

In September 2004 at the start of the autumn term Jamie hosted an evening for all the head teachers in which they were invited to take part in the experiment. 81 of the 88 head teachers signed up. The aim was to roll the scheme, which completely replaced the junk food with healthy alternatives, out in 6 weeks, so it commenced just after the half term-October 2004. The scheme was rolled out gradually across the borough, five schools at a time. By February 2005 more than 25 schools had removed all processed foods and implemented the new menus.[2] The roll out had taken place fully by September 2005 with 81 of the 88 schools taking part in the scheme.

As part of the experiment the council has increased the investment into school meals: an initial increase in the school food budget by £628,850 was agreed in the February 2005 budget going to cover the cost of the extra staff hours that were needed in

[2] In the pilot school of Kidbrooke, the healthy meals were initially being put along side the original junk food. In most cases children preferred to stick to the junk food rather than opting for the healthy meals. This was not the case when the scheme was rolled out across the borough.

preparation of the meal, equipment costs and promotion to the parents. By September 2007 a total £1.2 million had been invested in school meals[3].

Despite the initial difficulties of implementation, the evaluation of the campaign has been quite positive. The website of the "Heath Education Trust"[4] for example mentions the following reactions: The Head teacher of Kidbrooke School said, "Because the children aren't being stuffed with additives they're much less hyper in the afternoons now. It hasn't been an easy transition as getting older children to embrace change takes time."; One classroom teacher commented, "Children enjoy the food and talk about it more than they did in the past. They seem to have more energy and can concentrate for longer."

Nutritional analysis

We have some information on the nutritional content of the meals offered to the children before the changes, although only through the TV programme. The Jamie Oliver team asked a nutrionist to analyse a sample of the pre-reform meals. The meals were lacking fruit and vegetables, and the meat/fish was reconstituted, rather than fresh. Overall, the meals were lacking in basic nutrients, such as iron and vitamin C. Furthermore, the reform included removing all junk food.

2. Related literature

Despite the importance of the subject in the public and policy arenas, there is only a limited number of studies on the causal effect of children's diet on health on the one hand, and educational outcomes on the other.

The medical literature has carried out a number of studies on the relationship between diet and behaviour, concentration and educational outcomes. Sorhaindo and Feinstein (2006) provide a review of this literature. They mention four different channels through which nutrition may affect educational outcomes. The first channel is through physical development. A poor diet leaves children susceptible to. Greater illness

[3] Source: www.greenwich.gov.uk

[4] Source: http://www.healthedtrust.com/

results in more days absent and further a decrease in teacher contact hours which may result in a decrease in performance. The second channel is through cognition and ability to concentrate. Numerous studies have found that there is a link between diet and the ability of children to think and concentrate. In particular deficiencies in iron can have an impact on the development of the central nervous system and also cognition in later life. Sorhaindo and Feinstein (2006) point out two crucial findings in the existing studies. Firstly, good nutrition in early childhood is important in the cognitive development for both school-aged and adolescent children. Secondly, children's academic performance is altered by diet on an *instant* basis. The third channel mentioned in their review is behaviour. There is a causal link between a deficiency in vitamin B and behavioural problems; particularly this is related to aggressive behaviour. The research in this area is more limited. There could also be social interaction effects through peer effects within the classroom if it is the case that healthy food has an impact on behaviour. Healthy school meals could generate positive externalities on all children, through their positive effect on behaviour in the classroom. Finally, the last channel mentioned is through school life and in particular difficult school inclusion due to obesity.

Overall, the conclusion one can draw from the medical literature (see also Bellisle (2004)) is that a well balanced diet is the best way to enable good cognitive and behavioural performance at all times.

Economists have recently devoted more attention to the determinants and effects of obesity, and child obesity in particular. Anderson and Butcher (2006a) review the literature investigating the possible reasons underlying the rise in child obesity. They conclude that there does not seem to be one single determining factor of the rise, rather a combination of factors. Interestingly, they do point at the important changes in the school environment, such as the availability of vending machines in schools, as a possible factor triggering calories intake and thereby obesity. One study they have carried out (Anderson and Butcher (2006b)) link school financial pressures to the availability of junk food in middle and high schools, and estimate that a 10 percentage point increase in the provision of junk food at school produces an average increase in BMI of 1 percent, while for adolescents with an overweight parent the effect is

double. Effects of this size can explain about a quarter of the increase in average BMI of adolescents over the 1990's. Whitmore (2005) evaluates the effects of eating school lunches (from the US based National School Lunch Program) on childhood obesity. She uses two sources of variations to identify the effect of eating school lunches on children's obesity. First, she exploits within-individual time variation in school lunch participation, and second, she exploits the discontinuity in eligibility for reduced-price lunch – available to children from families earning less than 185 percent of the poverty rate – and compares children just above and just below the eligibility cut-off. She finds that students who eat school lunch are more likely to be obese. She attributes this effect to the poor nutritional content of lunches and concludes that healthier school meals could reduce child obesity.

There is a limited number of studies studying the effect of diet on educational performance, based on interventions in the US. Kleinman et al. (2002) and Murphy et al. (1998) study the effects of an intervention providing free school breakfasts and found evidence of a positive effect on school performance. However, the evidence is limited to small-scale interventions. Glewwe et al. (2001)

A recent study by Figlio and Winicki (2005) find that schools tend to change the nutritional content of their lunches on test days. They present this as evidence of strategic behaviour of schools, which seem to exploit the relationship between food and performance as a way of gaming the accountability system. Using disaggregate data from schools in the state of Virginia, they find that those schools who are most at risk of receiving a sanction for not meeting proficiency goals, increase the number of calories of school lunches on test days. This strategy seems to be somewhat effective, with significant improvements in test scores in mathematics and to a lesser extent in History/Social Sciences. However, they argue that these changes are targeted at immediate and short-lived improvements in performance, based on an increase of the number of calories and glucose intake, rather than a long-term strategy aimed at providing a healthier and balanced diet to children.

3. Data, sample and descriptive statistics

3.1 Data and Sample

We investigate the effect of the campaign on three outcome variables: Educational outcomes, absenteeism and take-up rates.

For educational outcomes, we chose to concentrate on performance in primary schools for two main reasons: 1) The recent economic literature has pointed to the importance of interventions in early childhood[5], 2) primary school children are typically not allowed to leave the school during lunch time, while secondary children are. Therefore, primary school children are less likely to have been able to substitute for school meals by alternative food (such as buying junk food in neighbouring outlets). Since the number of junk outlets per secondary school is 36.7 on average in the Inner London area[6], it is harder to identify with certainty the treated group.

We use detailed individual data from the National Pupil Database (NPD), which matches information collected through the Pupil Level Annual Schools Census (PLASC) to other data sources such as Key Stage attainment.

The NPD contains information on key pupil characteristics. These include several variables such as ethnicity, a low-income marker and information on Special Education Needs (SEN), that we have matched with Keystage 2 attainment records. Key Stage 2 corresponds to the grades 3 to 6 in England; and all pupils take a standardized test at the end of the Key Stage (in year 6, typically at the age of 11). The Key Stage 2 test has three main components: English, Maths and Sciences. We will consider these three components separately.

Our empirical analysis follows closely Machin and McNally (2008). We conduct two levels of analysis. We have school level data, this is aggregated data from the levels that the pupils attained in order to examine the percentage of pupils in a school that achieved above levels 3, 4 and 5; where level 4 is the national standard target as set by

[5] See Heckman et al. (2006) who stresses the importance of interventions even before the children enter school.

[6] Source: School Food Trust; Inner London includes: Hammersmith and Fulham, Kensington and Chelsea, Westminster, Camden, Islington, City, Hackney, Tower Hamlets, Soutwark, Lambeth, Wandsworth, Lewisham and Greenwich; the number is calculated by dividing the total number of outlets in the area by the number of secondary schools in that area.

the government. We also use individual pupil data. In this case we have the test scores, however rather than use the raw scores, given the examinations change from year to year, we create a percentile rank score (as in Machin and McNally (2008)).. This prevents any mark scheme changes from driving the results.

Our second outcome measure is absenteeism at the school level, measured by the percentage of half days missed (the data was taken from the DCSF publication tables)[7]. We have two levels of absenteeism, authorised and unauthorised. For authorised absence then the pupil has been given permission to miss the time from school this is typically, although not exclusively, for illness. Unauthorised absence includes absence without permission, this would in most cases include no illness bases absence. Hence although we do not have any direct measures of health, authorised absenteeism is our closest proxy.

Finally, we investigate the effect of the campaign on take-up rates of school meals, for children who are eligible for free school meals (provided by the DCSF). There is no public information available on the take-up rate for all children, so this measure is the closest indicator we have to assess the effect of the campaign on take-up.

We concentrate the analysis on the school years from 2002 to 2007, and exclude the year 2005 to avoid misclassification problems (since menus were effectively changed in the course of the school year 2004-2005)

We use five neighbouring Local Education Countries as controls for the analysis. The campaign was implemented in one borough only, the idea being to use this as an experiment for the whole country. Of course, Greenwich has specific characteristics, it is in the neighbourhood of London and is a relatively poor area. There are potentially a large number of possible controls though and we chose to use as controls LEAs that resemble Greenwich most in terms of health indicators (obesity rates), socio-economic characteristics, such as the proportion of whites, proportion of households living in social housing and the unemployment rate. Figure 1 shows the

[7] Source: http://www.dcsf.gov.uk/performancetables/

geographical location of these LEAs and Table 1 presents summary neighbourhood statistics of these LEAs.

3.2 Descriptive statistics

Table 2 compares control and treatment schools on a number of observable characteristics, as well as educational outcomes, before and after the campaign. Although we have chosen the control LEAs for their similarities with Greenwich, there are a number of notable differences worth pointing out. The percentage of white pupils is higher in Greenwich than in the control areas. The reverse is true for the percentage of pupils speaking English as their first language. On the other hand, indicators of social deprivation, such as the Income Deprivation Affecting Children Index and the percentage of pupils eligible for free school meals are comparable in the treatment and control groups. Importantly for our analysis, these indicators are quite similar before and after the campaign.

Turning to educational outcomes, we find that most indicators do increase between 2004 and 2006, both in the treatment schools and in Greenwich. There is a slight relative improvement in performance in Greenwich in comparison to other LEAs.
We now turn to a more detailed empirical analysis.

4. Analysis

4.1 Empirical strategy

As in Machin and McNally (2008), we estimate a difference-in-differences model on school level outcomes and individual outcomes.

School-level outcomes:

$Y_{slt} = a + ß\ Greenwich_l + \gamma\ Greenwich_l * Post\text{-}2005_t + \varphi\ Z_{st} + ?\ Z_s + + p_t\ T_t + \rho_l t + e_{ist}$

Where Y_{slt} denotes the outcome variable for school *s* in LEA *l* in year *t*; Greenwich is a dummy variable equal to 1 for the LEA of Greenwich and 0 for the five neighbouring LEAs; Post-2005 is a dummy variable equal to 1 for school years 2004-05, 2005-06 and 2006-07 and 0 for school years 2002-03, 2003-04, *Z* is a vector of

school characteristics; T is a set of yearly dummies; and ε_{ist} is an error term. In addition to the Machin and McNally (2008) specification, we also allow for LEA specific trends (captured by the parameters ρ_l).

γ is our main coefficient of interest. It shows how pupil performance changed in Greenwich schools in comparison to other LEAs. If the campaign had a positive effect on diet and performance, we should find a positive coefficient.

Individual outcomes:

$Y_{islt} = a + ß\ Greenwich_l + \gamma\ Greenwich_l * Post\text{-}2005_t + X_{ist}'\delta + ?Z_{st} + p_t\ T_t + \rho_l t + e_{ist}$

Where Y_{islt} denotes the outcome variable for pupil *i* in school *s* and LEA *l*; and *X* is a vector of pupil characteristics. Again, γ is our main coefficient of interest.

4.2 Results

a) Effect on educational outcomes

We first study the effect of the campaign on school-level outcomes, more precisely, on the percentage of pupils reaching (1) level 3 or more, (2) level 4 or more or (3) level 5 in english, maths and science respectively.

We present two sets of results. First, we present results based on school-level data, that is, where we aggregated test scores at the school level, and introduce controls for school characteristics and school fixed effects. Second, we present results using individual pupil data, controlling for individual pupil characteristics and school characteristics.

The results for the different specifications are presented in Table 3. We find that Key stage 2 results are significantly improved, specifically in English and Science. We find a significant effect of the interaction dummy on the percentage of pupils reaching level 4 in English and on the percentage of people reaching level 5 in Science. The effects are quite substantial: We find that the percentage of pupils reaching level 4 or more in English increased by 4.5 percentage points and the percentage of pupils reaching level 5 for science increased by 6 percentage points. We should point out

that the coefficients are close to zero for the percentage of pupils reaching level 3 and above, and positive for levels 4 and 5. However, the standard errors are quite large, and we cannot rule out small (or even negative) effects, as we can also not rule out relatively large effects.

The bottom of Table 3 reports the results of DD estimates based on pupil level data. We find that the results significantly improved in English. Again, the coefficients are positive for test scores in Maths and Science as well, but we cannot reject that they have not been affected. Note that the dependent variable here is the test score result, thus the picture suggests that even though we cannot reject that the Science test scores did not change on average, it seems that they have improved at the top of the distribution, which enabled some pupils to reach level 5 instead of level 4.

Overall the results so far show that there is evidence that educational outcomes improved in the Greenwhich area relatively to other neighbouring LEAs. The estimated coefficients are relatively high, but so are the standard errors. Thus, a careful conclusion is to note that there is some evidence pointing in the direction of a positive effect. This is quite noteworthy though, given that these effects are within a relatively short horizon and given that the campaign was not directly targeted at improving educational outcomes.

Heterogenous effects

So far we have included all pupils in the analysis. However, only part of them has been truly treated, those who actually eat school meals and experienced a change in diet because of the campaign. We do not have individual information about who is eating school meals and who is not. We only know whether the pupil is eligible for free school meals[8]. As we mentioned earlier, 45% of the children eat school meals at school and about a third of them receive them for free. We investigate whether we find any differences in effects across FSM children versus non NFS children. Table 4

8 Free school meals eligibility criteria: Parents do not have to pay for school lunches if they receive any of the following: Income support, income-based Jobseeker's Allowance, support under Part VI of the Immigration and Asylum Act 1999, Child Tax Credit, provided they are not entitled to working tax credit and have an Annual income (as assessed by HM Revenue & Customs) that does not exceed £15,575, the Guarantee element of State Pension Credit.

presents DD estimates when we split the sample according to the free school meal status. We find that most of the positive significant effects decrease or disappear entirely for the FSM children. Thus, we fail to find evidence that the campaign specifically helped those children who benefit from free school meals. One possible story is that FSM children tend to be more represented at the bottom of the distribution of scores than the non FSM children. It could be that improvements are harder to achieve for those at the bottom than from those in the middle. This is important to point out though, in the context of using this policy as a possible mechanism to reduce disparities across children.

We investigate further whether we find evidence of heterogeneous effects according to gender, race and "special educational needs" status (remaining of Table 4). We have a priori no clear reasons to expect some groups to be more affected than others, in particular because we do not know the distribution of school meal consumption across these groups. We actually find no clear evidence of heterogeneous effects. Girls seem to have been more affected, but we cannot reject that the effect of the reform was identical across gender. Thus, we cannot conclude that the reform affected some students more than others, except according to their free school meal status.

b) Effects on absenteeism

We now turn to the effects of campaign on absenteeism. We have information at the school level on the percentage of authorised and unauthorised absences. Authorised absences are those that are formally pre-authorised by the school, thus likely to be linked with sickness. Table 5 shows the results of the DD analysis, both on the percentage of authorised an unauthorised absences. We find a substantial negative effect on authorised absences; the rate of absenteeism drops by about .80 percentage points, which corresponds to 15% of the average rate of absenteeism. On the other hand, we do not find a significant effect on unauthorised absences.

The relative fall in absenteeism could in itself drive part of the improvement in educational outcomes, although obviously only a small part of the population of pupils has presumably been affected by this fall. In Table 6, we compare the results we have presented earlier (in Tables 3, based on the school level data) with results controlling for authorised absenteeism at the school level. We find that the

coefficients reported earlier remain very similar. Thus, the effects on educational achievements are not due to the change in absenteeism. However, it could be that for those children for whom absenteeism does change, the improvement in educational achievements is more substantial than for the others. Unfortunately, we are unable to identify those children in the pupil-level data.

c) Effect on take-up rates

We now examine the effect of the campaign on the take-up rates of free school meals. We do not have information on whether children did indeed eat the food or not (the anecdotal information we have points that, indeed, children were far from enthusiastic at the beginning but did adjust relatively quickly to the new menus), nor do we have information on the overall take-up rates of school lunches. We do have, however, detailed information at the school level on the percentage of children taking up free school meals (conditional on eligibility).

Changes in take-up rates are important to look at because, obviously, falling take-up rates would jeopardise the success of the campaign. On the other hand, it could be that improvements in the quality of the food encourage take-up.

We report the results in Table 6. We find no evidence of a change in take-up rates. Obviously, this does not mean that there has been no change in the actual consumption of school meals. As we discussed earlier, the change in menus had not been implemented easily and some children were reluctant to accept the new menus. At least, these results show that there was no change in the recorded take-up rates.

d) Placebo effect

One concern is that the campaign affected educational outcomes not through the improvement in diet, but simply through a "placebo-effect". Indeed, the schools were very well aware they were part of a pilot experiment and the campaign received a lot of media attention. Thus, we should worry that the effect we measure is a placebo effect rather than an actual effect of the campaign.

We should note that any reform of this kind, that is, where one group of people is treated and another is not, is potentially subject to this placebo effect. In contrast to experiments in pure sciences, it is virtually impossible to think of a way of administering a placebo treatment to a control group. Any change in policy could affect outcomes simply because those who are treated know they are treated. There is usually no way researchers can be sure that the effect they estimate is truly due to the change in policy rather than a placebo effect.

In this particular case, it is not clear whether the effects we find could be driven by such a placebo effect. On the one hand, this campaign has received attention from the media, which possibly could trigger a placebo effect. On the other hand, the attention was very much focused on the health benefits, and in particular on tackling the problem of obesity, rather than improving school performance. Also, we are looking at outcomes more than a year after the campaign.

Our setting, nonetheless, gives us some scope to investigate the placebo effect to some extent. As the campaign was part of a programme broadcast on one of the major channels in the UK, we have good reasons to believe that some schools were probably more subject to a possible placebo effect than others. Some of the treated schools were explicitly mentioned in the program, such that one could expect that for those schools, the "placebo-effect" could be stronger than others. However, there were only 7 schools explicitly mentioned in the programme, so we should be careful in interpreting the results, as idiosyncratic changes in one of these schools will weigh more on the estimates.

We have extended the empirical analysis by adding an interaction term for those schools that were explicitly mentioned during the programme (note that some of them were just very briefly mentioned, there was no filming on location). We present the results in Table 7 for English, Maths and Science respectively. The evidence points in the direction of a "disruption effect" rather than a positive placebo effect. In the case of maths, we find that the interaction coefficient is significant and negative, while we find no positive effect of the campaign overall. For English and Science, the interaction dummy is in most cases negative but is not significant. Additional

evidence on this disruption is that there were many initial problems in the schools that took on the scheme early on. Further, as the programme was rolled out a food week was introduced, hence those later schools would have had this and the early schools were treated with just a change in the menus with little additional support. Further, there were tasting sessions for the parents that did not occur in the earlier schools.

Since there are only few of these schools, we do not wish to draw too much attention to these estimates, but we conclude that, at least, there is little evidence of a positive placebo effect.

e) Robustness

To make sure that the effects we have identified are not a statistical coincidence, we run a number of alternative specifications, successively comparing the results in each LEA to the other LEAs; thus running a DD regression (such as in Table 4) but attributing the role of "treated" to each other LEA successively. We report the results in the Appendix. The results we find are much less consistent. More precisely we only find systematically and consistently positive coefficients for Greenwich; we find no such pattern in any of the other LEAs. These results provide some additional evidence that the effects we find are likely to be due to the Jamie Oliver campaign.

f) Spill-over effects

One legitimate concern regarding the analysis and the results is whether school meals did remain similar in the control LEAs after the campaign. As we mentioned earlier, the campaign was public and thus could have spilled over to the schools not directly involved in the campaign. This seems very unlikely for two reasons: First, the campaign proved to be quite resource-intensive and not straightforward to implement, it involved the re-training of kitchen staff and the improvement of kitchen equipment. Other schools could not realistically have implemented similar changes at the same time. Second, schools are involved in long-term contracts with catering services and thus could not directly renegotiate menus and food provision. Nevertheless, it could be that the campaign raised public awareness and this may have affected parental behaviour, possibly even at home. We have no information that such changes have

taken place but, in any case, this would imply that our results provide a lower bound on the effects of diet on educational achievements.

g) Costs and benefits

The last exercise we propose is a back-of-the-envelope cost and benefit analysis. Note that since we do not detailed information about health outcomes, our estimates probably provide also a lower bound on the *overall* benefits of the program. As indicated by the relative fall in absenteeism, it is likely that children's health improved as well, which could also have long-lasting consequences for the children involved not only through improved educational achievements, but also in terms of their life expectancy, quality of life, and productive capacity on the labour market. We can only provide an estimate of the long-term benefits accrued through better learning and better educational achievements. The effects we have identified are comparable in magnitude to those estimates by Machin and McNally (2008) for the "Literacy Hour". The "Literacy Hour" was a reform implemented in the nineties in the UK to raise standards of literacy in schools by improving the quality of teaching through more focused literacy instruction and effective classroom management. They found that the reform increased the proportion of pupils reaching level 4 or more in reading increased by 3.2 percentage points, an effect very similar to the effect we have estimated.

They calculated the overall benefit in terms of future labour market earnings using the British Cohort Study, that includes information on wages at age 30 and reading scores at age 10. They estimate the overall benefit of the reform to be between £75.40 and £196.32 (depending on the specification) per annum, and assuming a discount rate of 3% and a labour market participation of 45 years (between 20 and 65) implies an overall lifetime benefit between £2,103 and £5,476.

It is worthwhile discussing not only the benefits of the programs, but also the costs. As we have mentioned earlier, the campaign lead to substantial increases in costs in terms of retraining the cooking staff, refurbishing kitchens, and even the food costs have increased slightly as well. By September 2007, the council of Greenwich alone had invested £1.2 million in the campaign. About 28,000 school children in the

county benefited from the healthy school meals, thus, the cost per pupil was around £43. The largest proportion of these costs was one-off costs (refurbishing kitchens, retraining staff), such that in the long-term, the long-term cost per pupil should be substantially lower. There is therefore no doubt that the campaign provides large benefits in comparison to its costs per pupil.

5. Conclusion

This paper exploits the unique features of the "Jamie Oliver Feed Me Better" campaign, lead in 2004 in the UK, to evaluate the impact of healthy school meals on educational outcomes. The campaign introduced drastic changes in the menus of meals served in schools of one borough – Greenwich – and banned junk food in those schools. Since the meals were introduced in one Local Education Area only at first, we can use a difference in differences approach to identify the *causal* effect of healthy meals on educational performance.

Using pupil and school level data, we evaluate the effect of the reform on educational performance in primary schools, more precisely, we compare Key stage 2 test scores results before and after the campaign, using neighbouring local education areas as a control group. We identify positive effects of the "Feed me Better Campaign" on Key Stage 2 test scores in English and Sciences. The effects are quite large: Our estimates show that the campaign increased the percentage of pupils reaching level 4 by 4.5 percentage points in English, and the percentage of pupils reaching level 5 by 6 percentage points in Science. We also find that authorised absences (which are likely to be linked to sickness) drop by 15% on average. These effects are particularly noteworthy since they only capture direct and relatively short-term effects of improvement in children's diet on educational achievements. One could have expected that changing diet habits is a long and difficult process, which would possibly only have effects after a long time, effects that would be hard to measure.
It is worth pointing out that the campaign did not particularly affect the children from the "free school meal" children. Indeed, we do not find significant changes in the performance of those children, despite the fact that we find no significant changes in take-up rates. One explanation could be that changes in diet are harder to implement

for these children, or that their performance is harder to improve, since they tend to be more represented at the bottom of the performance distribution. Nevertheless, this is a source of concern, in particular in the light of using school meals as a way of reducing disparities in diet across children.

References

Alderman, H., Behrman, J., Lavy, V., and Menon, R. (2001) Child health and school enrollment: a longitudinal analysis, *Journal of Human Resources*, 36, 185–205.

Anderson P.M. and K.F. Butcher (2006a), Childhood Obesity: Trends and Potential Causes, *The Future of Children* 16(1), 19-45.

Anderson P.M. and K.F. Butcher (2006b), Reading, Writing, and Refreshments: Are School Finances Contributing to Children's Obesity? *Journal of Human Resources*, 41, 467-494.

Anderson, P.M., K.F. Butcher and P.B. Levine (2003), Maternal employment and overweight children, *Journal of Health Economics* 22(3), 477-504.

Behrman, J. (1996) The impact of health and nutrition on education. World Bank Research Observer, 11, 23–37.

Bellisle, F. (2004) 'Effects of diet on behaviour and cognition in children', *British Journal of Nutrition*, suppl. 2: S227-S232.

Bryan, J., Osendarp, S., Hughes, D., Calvaresi, E., Baghurst, K. and van Klinken, J. (2004), Nutrients for cognitive development in school-aged children, *Nutrition Reviews* 62(8), 295-306.

Delange F. (2000), The role of iodine in brain development. *Proceedings of the Nutrition Society* 59, 75-79.

Figlio, D.N. and J. Winicki (2005), Food for thought: the effects of school accountability plans on school nutrition, *Journal of Public Economics*, 89, 381-94.

Glewwe, P., Jacoby, H., and King, E. (2001) Early childhood nutrition and academic achievement: a longitudinal analysis, Journal of Public Economics, 81, 345–68.

Heckman, J. (2006), Skill Formation and the Economics of Investing in Disadvantaged Children, *Science* 30, vol. 312, no. 5782, 1900-1902

Kleinman R.E.., S. Hall, H. Green, D. Korzec-Ramirez, K. Patton, M.E. Pagano J.M. Murphy (2002), Diet, Breakfast, and Academic Performance in Children, *Annales of Nutrition and Metabolism* 46(suppl 1), 24–30

Lambert, J., Agostoni, C., Elmadfa, I., Hulsof, K., Krause, E., Livingstone, B., Socha, P., Pannemans, D. and Samartins, S. (2004) 'Dietary intake and nutritional status of children and adolescents in Europe', *British Journal of Nutrition*, 92(suppl 2): S147-211.

Machin, S. and S. Mcnally (2008), The Literacy Hour, *Journal of Public Economics* 92 (5-6), 1441-62.

Murphy, J.M., M.E. Pagano, J. Nachmani, P. Sperling; S. Kane and R.E. Kleinman (1998), The Relationship of School Breakfast to Psychosocial and Academic Functioning Cross-sectional and Longitudinal Observations in an Inner-city School Sample, *Archives of Pediatrics & Adolescent Medicine* 152, 899-907.

Pollitt, E. (1990). Malnutrition and Infection in the Classroom. Paris: UNESCO.

Pollitt, E. and Gorman, K.S. (1994) 'Nutritional deficiencies as developmental risk factors'. In Nelson, C.A. (ed.) Threats to optimal development: integrating biological,psychological and social risk factors, New Jersey, US: Lawrence Erlbaum Associates

Sorhaindo, A. and L. Feinstein (2006), What is the Relationship Between Child Nutrition and School Outcomes, *Wider Benefits of Learning Research Report* No.18, Centre for Research on the Wider Benefits of Learning.

Whitmore, D. (2005), Do School Lunches Contribute to Childhood Obesity, *Harris School Working Paper Series* 05.13.

TABLES AND FIGURES

Figure 1: Local education authorities in the London area

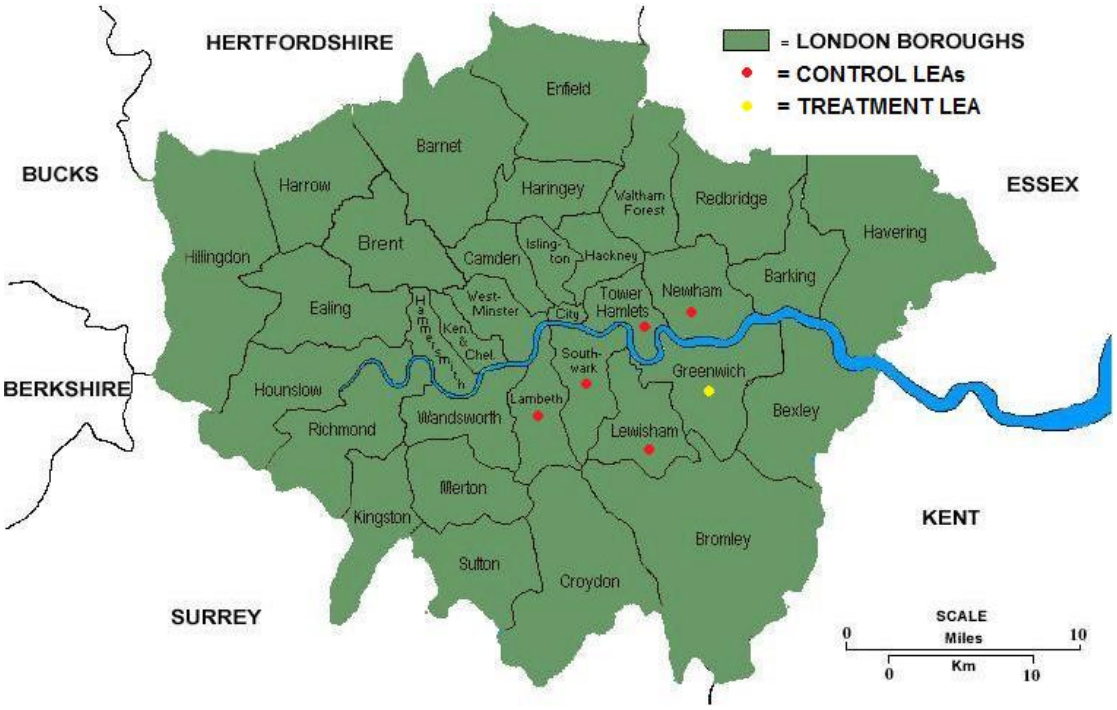

Table 1 - Neighbourhood statistics

	Greenwich	Lambeth	Southwark	Lewisham	Newham	Tower Hamlets
Proportion of whites	77.1%	62.4%	63.0%	65.9%	39.4%	51.4%
Long-term unemployment rate[1]	1.9%	2.0%	2.1%	1.9%	2.1%	2.2%
Social housing[2]	39.5%	41.4%	53.4%	35.6%	36.5%	52.5%
Rate of obesity[3]	20.2%	16.8%	19.7%	19.2%	21.2%	11.9%
Free School meals Eligility[4]	36.4%	39.0%	37.8%	29.2%	37.9%	55.0%
Price of a school meal[5]	£1.30	-	£1.15	£1.10	£1.25	£1.50

Source: Office for National Statistics (Neighbourhood statistics) [1] Obesity rates among adults (obesity is such that body mass index > 20), survey from 2003-2005, [3] People aged 16-74: Economically active: Unemployed (Persons, census April 2001), [4] Percentage of households living in housing rented to the Local area council (Census 2001), [4] Percentage of pupils eligible for free school meals (School Census 2004)

Table 2 - Control and treatment schools – Summary statistics
(Standard deviations in parentheses)

	Non-Greenwich		Greenwich	
	2004	2006	2004	2006
Average no. of pupils	341.43	302.6	308.4	278.74
	(156.75)	(134.51)	(115.65)	(107.33)
% of pupils eligible for Free School Meals	39.84	40.44	36.44	35.59
	(15.54)	(15.58)	(16.5)	(15.66)
% of pupils female	48.2	47.95	47.56	47.25
	(7.14)	(7.72)	(9.4)	(9.29)
% of pupils with some special need	25.42	27.92	27.88	30.93
	(20.13)	(19.81)	(20.02)	(20.02)
% of pupils with statement of special need	7.4	7.36	6.16	6.88
	(22.48)	(22.18)	(20.34)	(20.45)
% of pupils non-white	68.74	70.66	40.07	44.08
	(18.23)	(17.75)	(19.48)	(20.71)
& of pupils who have English as a first Language	51.11	49.42	75.21	70.42
	(26.56)	(26.46)	(16.74)	(18.31)
Average IDACI[9] score	45.15	45	39.67	38.94
	(10.65)	(10.67)	(10.49)	(9.92)
% Faith School	26.21	26.21	23.94	23.94
	(44.04)	(44.04)	(42.98)	(42.98)
English: Proportion attaining level 3 and above	87.11	89.43	86.93	89.71
	(18.09)	(17.58)	(18.13)	(15.12)
English: Proportion attaining level 4 and above	70.48	73.88	68.72	73.61
	(20.16)	(19.85)	(19.76)	(16.64)
English: Proportion attaining level 5 and above	21.71	26.16	20.88	26.51
	(14.94)	(16.41)	(15.1)	(14.24)
Maths: Proportion attaining level 3 and above	87.3	89.33	87.39	89.75
	(18.16)	(17.47)	(17.76)	(15.17)
Maths: Proportion attaining level 4 and above	68.53	71.06	68.3	72.13
	(19.16)	(19.2)	(17.83)	(17.83)

[9] **Income Deprivation Affecting Children Index shows the percentage of children in each SOA (Super Output Area) that live in families that are income deprived (ie, in receipt of Income Support, Income based Jobseeker's Allowance, Working Families' Tax Credit or Disabled Person's Tax Credit below a given threshold), DCSF)**

Maths: Proportion attaining level 5 and above	26.44	27.59	25.88	29.59
	(13.43)	(13.76)	(13.73)	(14.2)
Science: Proportion attaining level 3 and above	87.83	89.76	88.24	90.64
	(18.22)	(17.56)	(17.7)	(14.98)
Science: Proportion attaining level 4 and above	77.18	78.93	76.54	80
	(19.83)	(19.89)	(19.33)	(17.16)
Science: Proportion attaining level 5 and above	32.99	35.5	31.63	37.86
	(18.53)	(17.98)	(17.63)	(18.91)
Pupil Teacher Ratio	21.87	20.38	21.43	20.5
	(6.05)	(5.26)	(5.44)	(4.98)
Pupil Staff Ratio	10.83	9.81	12.29	11
	(3.03)	(2.68)	(3.34)	(2.92)
Authorised Absence (% half days missed)	4.79	5.06	5.42	5.31
	(1.13)	(1.13)	(1.08)	(1.15)
Unauthorised Absence (% half days missed)	1.05	1.08	1.24	1.27
	(1.04)	(0.92)	(1.13)	(0.96)

Table 3 - Difference-in-difference estimates - Key stage 2 results

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Greenwich*Post 2005	0.350	0.325	-0.197
	(1.659)	(1.725)	(1.580)
% Level 4 and above			
Greenwich*Post 2005	4.533*	2.467	3.000
	(2.541)	(2.926)	(2.852)
% Level 5 and above			
Greenwich*Post 2005	2.717	2.196	6.067*
	(3.288)	(2.826)	(3.666)
Number of observations	1991	1991	1991
Number of schools	415	415	415
Number of pupils	67,805	69,073	69,824
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Greenwich*Post 2005	4.713**	1.697	3.582
	(2.271)	(2.235)	(2.578)
Number of schools	403	404	405
Number of pupils	78,665	79,761	80.801
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p <0.1. Individual controls include: free school meal eligibility, gender, some special needs requirement, special needs statement, ethnicity, English as a first language, Income Deprivation Affecting Children Index score (idaci), month of birth dummies. School controls include: % with free school meal eligibility; % girls; % require special needs, with and with-out statement, % of different ethnicities , % English as a first language, average Income Deprivation Affecting Children Index (idaci), faith school indicator. All regressions contain specific LEA trends and year dummies. Control LEAs include: Southwark, Lewisham, Tower Hamlets, Newham and Lambeth.

Table 4 - Difference-in-differences estimates – Key stage 2 results
Heterogeneous effects (pupil level data)

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Free school meal status			
Greenwich*Post 2005*NFSM	6.688***	3.822*	5.788**
	(2.481)	(2.254)	(2.561)
Greenwich*Post 2005*FSM	1.239	-1.824	0.0812
	(3.212)	(3.102)	(3.323)
P Value of test of no difference	0.009	0.109	0.200
Gender			
Greenwich*Post 2005*Boys	3.371	0.319	1.829
	(2.881)	(2.595)	(3.047)
Greenwich*Post 2005*Girls	5.711**	2.751	5.142*
	(2.373)	(2.524)	(2.812)
P Value of test of no difference	0.421	0.622	0.321
Race			
Greenwich*Post 2005*white	3.308	3.639	5.399**
	(2.609)	(2.499)	(2.602)
Greenwich*Post 2005*non-white	5.634**	-0.762	1.741
	(2.803)	(3.024)	(3.704)
P Value of test of no difference	0.026	0.645	0.024
Special educational need			
Greenwich*Post 2005*no statement	4.898**	1.883	3.365
	(2.276)	(2.262)	(2.598)
Greenwich*Post 2005*statement	-9.855	-4.768	11.54
	(10.63)	(8.783)	(8.699)
P Value of test of no difference	0.990	0.957	0.570
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table 5 - Difference-in-differences estimates – Absenteeism (school level data)

	Authorised Absenteeism	***Unauthorised Absenteeism***	***Total absenteeism***
Greenwich*Post 2005	-0.782***	-0.404	-1.201***
	(0.273)	(0.261)	(0.365)
Number of observations	1853	1777	1777
Number of schools	380	379	379
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

See notes to table 3.

Table 6 – Difference-in-differences estimates – Key stage 2 results
With and without controls for absenteeism
(School level data)

	English		Maths		Science	
	No controls for absenteeism rate	Controlling for authorised absenteeism	No controls for absenteeism rate	Controlling for authorised absenteeism	No controls for absenteeism rate	Controlling for authorised absenteeism
% Level 3 and above	0.350	0.369	0.325	0.432	-0.197	-0.174
Greenwich*Post 2005	(1.659)	(1.693)	(1.725)	(1.640)	(1.580)	(1.524)
% Level 4 and above	4.533*	4.597*	2.467	3.247	3.000	4.135
Greenwich*Post 2005	(2.541)	(2.706)	(2.926)	(2.953)	(2.852)	(2.964)
% Level 5 and above	2.717	2.722	2.196	2.715	6.067*	6.881*
Greenwich*Post 2005	(3.288)	(3.566)	(2.826)	(3.062)	(3.666)	(3.950)
Number of observations	1991	1848	1991	1848	1991	1848
Number of Schools	415	380	415	380	415	380
School Controls	Yes	Yes	Yes	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

See notes to table 3.

Table 7: Difference-in-differences estimates – Take up rates and eligibility (school level data)

	(1)	(2)
	% FSM Take up rate	***% FSM Eligibility***
Greenwich*Post 2005	-0.379	-0.217
	(1.146)	(0.436)
Number of observations	2033	2039
Number of schools	421	421
School Controls	Yes	Yes
School Fixed Effects	Yes	Yes

See notes to table 3.

Table 8: Difference-in-differences estimates - Placebo effect (School level data)

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Greenwich*Post 2005	0.277	0.300	-0.205
	(1.686)	(1.752)	(1.607)
TV*Post 2005	0.733	0.250	0.0810
	(1.806)	(1.826)	(1.420)
% Level 4 and above			
Greenwich*Post 2005	4.636*	3.109	3.085
	(2.603)	(3.014)	(2.939)
TV*Post 2005	-1.038	-6.440*	-0.843
	(3.093)	(3.854)	(2.606)
% Level 5 and above			
Greenwich*Post 2005	2.651	3.293	6.615*
	(3.331)	(2.845)	(3.864)
TV*Post 2005	0.659	-11.00***	-5.502
	(2.135)	(3.841)	(5.772)
Observations	1991	1991	1991
Number of Schools	415	415	415
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

See notes to table 3.

APPENDIX: Sample of menus

Before the Jamie Oliver Campaign

Mains: burgers and chips; sausage rolls; fish fingers; turkey drummers; chicken dinosaurs

Desserts: sponge pudding and custard; milk shake and home made biscuit; fruit salad

Example of weekly menus introduced with the Jamie Oliver campaign

* = Meat Option ** = Fish Option V = Vegetarian Option

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK 1 Bread & Salad Bar Everyday	* Proper Sausages Creamy Mash Peas & Sweetcorn • Mexican Bean Wrap (v) Cheesy Leek Pasta (v) Peas & Sweetcorn Salad • Vanilla Sponge & Custard	* Chicken & Mushroom Casserole * Chilli Con Carne Savoury Rice & Salad • Vegetable Chow Mein (v) Salad • Fruit Crumble & Custard	* Roast Beef Roast Potatoes, Green Beans & Gravy • Mushroom & Lentil Bake (v) Roast Potatoes & Green Beans • ** Tuna Jacket Potato Green Beans • Fresh Fruit Platter & Custard	* Lamb & Vegetable Pie Veggie Mince Pie (v) ** Creamy Coconut Fish New Potatoes Broccoli • Creamed Rice Pudding	* BBQ Chicken Cheese Flan (v) Jacket Wedges Salad • * Cottage Pie Seasonal Vegetable • Fresh Fruit & Custard

source: www.greenwich.gov.uk

Table A1: Difference-in-difference estimates – Lambeth

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Lambeth*Post 2005	-0.0124	-0.847	-0.250
	(2.092)	(2.310)	(2.243)
% Level 4 and above			
Lambeth *Post 2005	-4.873	-0.645	0.339
	(3.415)	(3.297)	(3.004)
% Level 5 and above			
Lambeth *Post 2005	6.379	7.340**	-0.387
	(4.299)	(2.838)	(3.639)
Observations	1659	1659	1659
Number of Schools	346	346	346
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Lambeth *Post 2005	1.244	1.089	0.476
	(2.584)	(2.231)	(2.628)
Observations	66298	67176	68017
Number of Schools	336	336	338
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table A2: Difference-in-difference estimates – Lewisham

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Lewisham*Post 2005	2.306	2.325	1.239
	(2.058)	(2.145)	(2.055)
% Level 4 and above			
Lewisham *Post 2005	5.154*	-0.195	0.955
	(3.070)	(3.180)	(2.929)
% Level 5 and above			
Lewisham*Post 2005	5.217	-0.218	7.597**
	(3.735)	(3.194)	(3.861)
Observations	1659	1659	1659
Number of Schools	346	346	346
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Lewisham *Post 2005	3.293	-0.648	2.567
	(2.866)	(2.718)	(3.088)
Observations	66298	67176	68017
Number of Schools	336	336	338
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table A3: Difference-in-difference estimates – Southwark

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Southwark*Post 2005	-1.955	-1.021	-1.962
	(1.949)	(1.956)	(1.834)
% Level 4 and above			
Southwark *Post 2005	0.110	1.895	-0.514
	(3.338)	(3.083)	(2.513)
% Level 5 and above			
Southwark *Post 2005	1.870	-2.757	-1.664
	(3.478)	(2.944)	(3.729)
Observations	1659	1659	1659
Number of Schools	346	346	346
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Southwark *Post 2005	2.792	1.124	-0.339
	(2.769)	(2.167)	(2.516)
Observations	66298	67176	68017
Number of Schools	336	336	338
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table A4: Difference-in-difference estimates – Tower Hamlets

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Tower Hamlets*Post 2005	-0.533	-0.512	0.588
	(2.212)	(2.278)	(2.235)
% Level 4 and above			
Tower Hamlets *Post 2005	-0.883	-4.103	-1.070
	(3.185)	(2.927)	(2.996)
% Level 5 and above			
Tower Hamlets *Post 2005	-6.012	0.0352	-3.501
	(4.289)	(3.313)	(3.851)
Observations	1659	1659	1659
Number of Schools	346	346	346
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Tower Hamlets *Post 2005	-2.895	-2.550	-2.231
	(2.946)	(2.466)	(2.931)
Observations	66298	67176	68017
Number of Schools	336	336	338
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table A5: Difference-in-difference estimates – Newham

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Newham*Post 2005	0.505	0.170	0.649
	(2.174)	(2.075)	(2.032)
% Level 4 and above			
Newham *Post 2005	0.235	3.085	0.445
	(3.379)	(3.152)	(2.884)
% Level 5 and above			
Newham *Post 2005	-7.532**	-3.813	-1.816
	(3.627)	(2.864)	(4.024)
Observations	1659	1659	1659
Number of Schools	346	346	346
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Newham *Post 2005	-3.759	0.731	-0.352
	(2.704)	(2.295)	(2.851)
Observations	66298	67176	68017
Number of Schools	336	336	338
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes