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The early impact of Brighton and Hove's school admission reforms

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How should we treat under-performing schools? A regression discontinuity analysis of school inspections in England

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Abstract. We analyse the initial impact of a major school admission reform in Brighton and Hove. The new system incorporated a lottery for over-subscribed places and new catchment areas. We examine the post-reform changes in school composition. We locate the major winners and losers in terms of the quality of school attended. We match similar cities and conduct a difference-in-difference analysis of the policy change. We see no significant change in student sorting: if anything, the point estimates suggest a rise in socio-economic segregation. We do see a significant weakening of the dependence of school attended on student's prior attainment.

JEL classification: I20, I28.

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1. Introduction

In February 2007, the city of Brighton and Hove announced plans for a complete reform of their secondary school admissions system. The newly proposed system was unique in England because it incorporated widespread use of a lottery, or random allocation, as a tie-breaker for oversubscribed places instead of using the distance from home to school. This lottery was introduced alongside the drawing of new catchment areas (or priority zones), and also a national reform from a First Preference First (or priority) matching mechanism to an equal preferences system. These reforms are likely to influence school composition, residential sorting, house prices, and pupil movements to private schooling and other Local Authorities (LAs). Some of these are likely to be processes taking a number of years, and some are likely to be more immediate. In this paper, we analyse the initial impact of the reforms on the distribution of pupils to schools; in subsequent papers we plan to address the other issues.

These reforms in Brighton and Hove have taken place in the context of long-standing concerns by policy-makers about the levels of social segregation across schools. In England there has actually been little change in levels of free school meal segregation over the past two decades, despite policies to facilitate greater parental choice and several major changes in the school admissions code (Gorard et al., 2003; Allen and Vignoles, 2007; Gibbons and Telhaj, 2007). This persistent segregation makes it clear that there are unequal opportunities for poor and rich families to access high quality schools. Residential segregation is the most important contributor to secondary school segregation, and the process of school admissions usually serves to increase inequalities in access to secondary schools (Burgess et al., 2008; Burgess and Briggs, 2010; Allen, 2007).

By itself, we would expect the abandonment of proximity as a tie-breaker for admission to the most popular school to lead to lower student sorting. A lottery provides equal chances of admission and removes the link with immediate neighbourhood and the dependence on income via house prices. But the new admission system in Brighton and Hove does not give equal chances to all pupils in the city because it prioritises those who live within catchment areas. This means that the design of the catchment areas is crucial to the outcome, and so overall the reform may increase or decrease the degree of school segregation. It is the interaction between the lottery and the boundaries of the catchment areas that is key to the outcome of this admissions reform.

We carry out three analyses. First, we simply examine the post-reform changes in school composition in Brighton relative to pre-reform trends. These changes are well explained by the interaction of the use of the lottery and the detail of the catchment area boundaries. Second, we

locate the neighbourhoods of the major winners and losers in terms of the quality of school attended; again most of these derive clearly from the reforms. Third, we identify a small number of LAs similar to Brighton and Hove and use these to conduct a difference-in-difference analysis of the policy change, using the long spell of data in the before period and the first two years after. We see no significant change in student sorting: if anything, the point estimates suggest a rise in socio-economic segregation, but very imprecisely measured. We do see a significant weakening of the dependence of school attended on student's prior attainment. This derives from dependence on neighbourhood, and is concentrated at the top of the distribution. Specifically, some students living in the wealthier neighbourhoods of Brighton and Hove, with high prior tests scores, gain admission to schools of lower quality after the reform than they might have expected to. These are the primary group losing out from the reform, identified in our spatial analysis, and balanced by a more diffuse group of winners who did gain access to the higher performing schools.

In the following section we describe the nature of the policy change, and provide an overview of the characteristics of the schools and neighbourhoods pre-reform. In section 3, we sketch out the economic framework of our analysis and the empirical approach. Section 4 describes the data, section 5 presents the results and we offer some conclusions in Section 6.

2. Nature of the reform

Brighton and Hove is a relatively small but densely populated unitary authority of about a quarter of a million residents on the south coast of England. Like many areas of England, places at secondary schools were previously allocated giving priority to pupils living closest to schools. Social segregation between schools across the city was significantly lower in the city than across the rest of England, though there have been modest rises in socio-economic segregation in schools from 2005/6 onwards with the dissimilarity index rising from 0.18 to 0.23 by 2007/8. The large differences in attainment of pupils in the best and worst performing schools can largely be explained by the clustering of deprived neighbourhoods in the east and the far west of the city. For example, in 2007/8 64% of pupils who attended the top performing school achieved 5 or more good GCSEs at grades A* to C (including English and Maths) compared to just 19% in the lowest performing school. There were perceived to be specific problems relating to variation in the amount of choice that parents had across the city, which result from the clustered location of schools in particular residential areas, particularly in the northern part of Brighton (illustrated in the map in Figure 1). This meant that some parents had a guaranteed place at more than one school, while other parents had no *de facto* neighbourhood school. The closure of one secondary school – the East Brighton

College of Media and Arts (COMART) – in 2007 exacerbated problems of the supply of places in the east of the city (see Figure 2 for a timeline of events affecting secondary education in Brighton and Hove).

a) Changes in the admissions process

Secondary school admissions follow a similar process in all LAs across England. Parents are able to express preferences for any state maintained school and schools must admit pupils up to a published capacity. Under the old regime in Brighton and Hove, parents were invited to list up to three schools in order and these preferences were considered using a First Preference First or priority matching mechanism (see Roth, 1984 for details of alternative algorithms, and Abdulkadiroğlu et al. (2005) for examples of algorithm reforms in the US). First Preference First considered only the parent's first choice of school and attempted to meet these preferences using oversubscription criteria to rank pupils where necessary. This was a problem to the extent that it required strategic action on the part of parents because second and third choice schools would often be filled by other pupils who ranked it as their first choice. The move to Equal Preferences (technically this is a Gale-Shapley school-deferring mechanism as described in Gale and Shapely, 1962) where all listed preferences were simultaneously considered, was mandatorily introduced in Brighton and Hove and other LAs in 2008 as part of the 2007 Admissions Code.

The move from a proximity oversubscription criterion to catchment area priorities (marked in Figure 1) represents a significant change in the probability of households achieving a place at a particular school. The catchment zones are unusual because there are two dual catchment zones. The large zone in Hove gives all parents inside the zone equal opportunity of access to Hove Park and Blatchington Mill schools, with an 'almost' guarantee of a place at one of the two schools.[1] The large zone in central Brighton works in the same manner for Dorothy Stringer and Varndean schools.

A random allocation, or lottery, tie-breaker is applied twice in the new system: firstly, to rank applicants who live within the catchment zones and secondly, in the event of spare remaining places, to rank any applicants who are applying from outside the zone. This process is seen as being more equitable and removes the long-standing creation of 'golden halos' of expensive housing that guaranteed school access around popular schools.

[1] Secondary School Admissions in Brighton and Hove 2010/11 booklet (page 22, accessed May 2010): "if a school is oversubscribed with applicants who live within the catchment area, we will negotiate with the school in question to try to secure additional places." "If your child's home address is within a catchment area which applies to two schools (i.e. Varndean and Dorothy Stringer or Hove Park and Blatchington Mill) we will do our best to ensure that you are offered a place at one of these schools, as long as you list preferences for both of the schools in your catchment area."

As a voluntary aided school, Cardinal Newman is responsible for its own admissions procedures and chose not to change them as part of the reforms. As with most state-maintained Roman Catholic schools, Cardinal Newman gives priority to Catholic families, followed by other Christian, then other non-Catholic Christian families followed by any other applicants.[2]

b) Characteristics of the catchment areas and schools

Under the reforms two dual catchment areas and four single school catchment areas were introduced across Brighton and Hove. As we shall refer to the catchment areas and schools by name in this paper it is important to have an understanding of the recent attainment and composition of the schools. Table 2 gives a summary of the schools composition in 2008 for the final year 7 cohort to enter the schools prior to the reforms, and shows significant differences in socio-economic composition, for example from Dorothy Stringer with 8% students eligible for Free School Meals (FSM) to Falmer High with 48%.

Whilst the reforms will have implications for all the schools in Brighton and Hove, some schools will be more noticeably affected than others. The use of random allocations in the dual catchment areas will inevitably alter the composition of the schools. The Varndean/Dorothy Stringer (V/DS) catchment area in the centre of the city is a relatively affluent area with a strip of more deprived housing along its far eastern edge. Both schools in this catchment are high performing with above average attainment at GCSE,[3] confirmed by the fact that both schools were oversubscribed prior to the reforms. The Hove Park/Blatchington Mill (BM/HP) area in central Hove differs from the V/DS area in that only one of its schools has a pass rate above the national average. Whilst Blatchington Mill was the city's best performing state school in 2008; Hove Park performed significantly worse, with a pass rate over 10 percentage points below the national average. The two schools differ compositionally with Hove Park having a larger proportion of students who are eligible for free schools meals (FSM) and a smaller proportion of high-ability students entering the school from primary school.

Schools outside these dual catchment areas in the centre of the city are less likely to experience significant changes in pupil intake following the reforms because they have been assigned distinct catchment zones: Falmer High has always served the north east catchment area with Longhill serving the south east; Portslade will still be the school most pupils living on the western edge of the city attend. Because these three schools traditionally serve more deprived housing areas, they are

[2] Secondary School Admissions in Brighton and Hove 2009/10 (page 34, accessed April 2010)

[3] In 2008 48.1% of year 11 pupils achieved 5 A*-C grades including English and Maths nationally.

unlikely to attract large numbers of applicants from other areas. By contrast, however, Patcham High is likely to see an increase in academic ability of their pupil intakes because a set of households who were previously guaranteed access to Dorothy Stringer and Varndean have been assigned Patcham High as their catchment area school.

It is worth noting that the disparities between the attainment levels of the schools can largely be explained by the differing qualities of the students they admit. For example, less than 10% of the year 7's who entered Falmer High in September 2007 were in the top quartile of the KS2 score distribution whilst over 40% of those entering Dorothy Stringer were in the top quartile. When the contextual value added[4] (CVA) measure of school quality is used, Falmer scores as highly as Blatchington Mills and Dorothy Stringer. This does not imply top students who attend Falmer High would have the same realised outcome as they would if they attended Dorothy Stringer but that Falmer High cannot be deemed to be failing its students simply because it has the lowest GCSE pass rate in the city.

3. Modelling framework

The Brighton and Hove school admission reforms are still relatively new and so in this paper we are only able to analyse whether the admissions reforms in Brighton and Hove have altered the distribution of pupils across schools over a two-year period. We do expect these reforms to have a significant impact on residential house prices and sorting, and we plan to return to these issues in later work.

a) Economic Model of school and household location

The formation of pupil intakes at schools has been extensively studied in theoretical models and empirical data. A central feature of the models is that peer groups, and thus school quality and the value of housing, are endogenously determined, with most models directly building on hedonic pricing models that match consumers to locations and find prices that separate people based on willingness to pay for locational quality, of which local school quality is one dimension (Tinbergen, 1959; Sattinger, 1980). The general equilibrium models of Epple and Romano (1998) and Nechyba (2000) show location choice where school assignment is decided strictly via a residence requirement restriction and thus households purchase homes and school access as bundles. This is the traditional

[4] CVA attempts to control for personal characteristics such as free school meal status and ethnicity, as well as ability using previous test scores. For more information on what is included in the CVA measure visit http://www.standards.dfes.gov.uk/performance/1316367/CVAinPAT2005/ (accessed July 2010)

means by which parents 'choose' schools in the United States and is similar in nature to catchment areas or proximity oversubscription criterion in the English context.

Econometric studies have consistently shown that parents are willing to pay for school quality through the housing market (Black, 1999; Bogart and Cromwell, 1997, 2000; Goodman and Thibodeau, 1998; Sieg et al., 1999; Gibbons and Machin, 2003; Cheshire and Sheppard, 1995; Leech and Campos, 2003; Rosenthal, 2003). For example, Black (1999) examines the differential house prices for those residences either side of elementary school attendance zone boundaries, in an attempt to resolve the problem of unobservable neighbourhood characteristics. She estimates that families are willing to pay 2.5% higher house prices for a school quality increase of 5%. Bayer et al. (2007) estimate a mean marginal willingness to pay for a standard deviation increase in average test scores of approximately 2 percent of house value in San Francisco, with strong heterogeneity around this mean. Gibbons and Machin (2003) find similar results for English primary schools. The analysis of Rothstein (2006) suggests that this willingness to pay is related to peer, rather than school, characteristics.

There are developments on the basic general equilibrium models of household location that explore the potential impact of different types of school choice programs. Some models adapt scenarios whereby public schools make places available for non-neighbourhood families and these are allocated by lottery, with transportation costs providing an important disutility to travelling outside the neighbourhood (Epple and Romano, 2003; Brunner and Imazeki, 2008). The winners and losers from this type of choice system (relative to strict neighbourhood schooling) are complex, especially where poor families cannot benefit due to high transportation costs. Other choice models introduce a voucher program for private schools into a neighbourhood school system (Epple and Romano, 1998; Nechyba, 1999; Ferreyra, 2007). However, no existing theoretical models currently combine the complexities of a typical English secondary school admissions system, where catchment areas are usually fairly porous and state-funded faith schools do not prioritise proximity.

b) Difference-in-difference approach

i. Empirical Framework

We adopt a simple linear model to summarise the allocation of students to schools. Whilst in principle this allocation has many dimensions, we aim to describe in a straightforward way the relationship between the academic quality of the school attended and the socioeconomic status of the student. Denoting the academic quality of school s as q_s and the characteristic of pupil i as z_i, we summarise the assignment mechanism as $E(q_{s(i)} | z_i)$, interpreted as the likelihood of a student with

characteristic z being assigned to a school of quality q. This is a purely descriptive relationship and has the advantage that it is independent of any specific location; for example, it is not based on the chance of being assigned to a specific named school. We can therefore use it across a number of LAs, allowing us to contrast the experience of Brighton and Hove with other control LAs. Assuming a linear relationship, our model is:

$$q_{s(i)} = \alpha + \beta_a.z_i + \mu_a + \varepsilon_i \quad (1)$$

where subscript a denotes the area, in this case an LA. The outcome of the assignment mechanism is summarised by β_a, varying by LA. The inclusion of LA fixed effects takes out any mean differences in school quality.

Our research question is whether and how β was changed by the admissions reform in Brighton and Hove. To address this we use a difference-in-difference identification strategy, comparing the situation before and after the reform date in Brighton with the same change in a set of matched control LAs.

ii. Matched LAs

We select nine LAs to act as our control group. The key factor in the selection is that the control LAs changed from the First Preference First (FPF) system to the Equal Preferences (EP) system at the same time as Brighton and Hove. This ensures that we match any changes in assignment outcomes deriving from that change. We also rule out of consideration any LAs with a middle school structure (LAs which had more than 10% of year 7 students attending middle schools). We then ranked each LA by its similarity to Brighton and Hove using a range of LA level variables: population density, percentage of students eligible for FSM, percentage of students who are White British, and segregation (using FSM and Ethnicity dissimilarity indices). A summary of these variables across Brighton and Hove and the control LAs is shown in Table 3. We see that Brighton and Hove is slightly poorer and slightly less white than the controls. The distribution of test scores matches very well and also happens to match the national distribution quite closely**.**

The nine LAs which provide the best matches are: North Somerset, North Tyneside, Peterborough, Plymouth, Portsmouth, Southampton, Stoke, Suffolk, Swindon, Telford and Wrekin. We use data from almost all pupils in these LAs, omitting those who attend special schools, a small group of less than 1% who attend middle schools in year 7, and the 3% of students for whom we could not obtain school GCSE pass rates due to schools opening and closing (without acting as parent schools to subsequent schools).

c) Difference-in-difference model

The difference-in-difference approach eliminates observed and unobserved factors which are constant over time in each LA, and also removes common changes that identically affect all our LAs (such as the shift from FPF to EP assignment mechanism). We estimate the following model:

$$q_{ijk} = \alpha + (\beta_1 + \beta_{2j} + \beta_3 (BH*\{year=2009\}) + \beta_4 (BH*\{year=2010\}))Z_{ijk} + \mu_j + T_k \qquad (2)$$

where *i* denotes student, j denotes LA (with Brighton and Hove as the baseline), *BH* specifically denotes Brighton and Hove LA, and *k* denotes year.

The first set of regressions model school quality as the dependent variable to explore whether the reforms in Brighton and Hove have changed the relationship between a pupil's own characteristics and the characteristics of the school they attend. The parameters of interest are β_3 and β_4 which measure the year 1 and year 2 effects of the policy respectively. We allow the policy impact to vary over time as the initial effect is likely to be diluted by the sibling rule for school admission. We also run the model with the school socioeconomic composition as the dependent variable. This second set of regressions will allow us to directly measure whether school segregation changed as a result of the reforms.

We run our analysis using various different specifications for the student characteristic *Z*: a dummy measuring eligibility for Free School Meals (FSM), the IDACI score of the student's home postcode, whether or not the student is in the top/bottom (separately) quartile of the KS2 distribution, and the student's standardized KS2 score. We also run a specification including separate dummies for the top and bottom quartiles of the KS2 distribution and the top and bottom quartiles of the IDACI (within LA). All regressions cluster standard errors at the school level.

4. Data

a) Data on Pupils

The dataset we use in our analysis is the National Pupil Database (NPD), an administrative dataset containing data on all pupils in state-maintained primary and secondary schools in England. We have information about each pupil's previous schools, which enables us to track pupil's transitions from primary to secondary schools and allows us to follow movements between LAs. We also have data on pupils who were in the state school system in year 6 but absent in year 7, enabling us to examine whether Brighton and Hove experienced an increase in pupils entering the private system as a result of the reforms. The NPD includes characteristics such as ethnicity, age, FSM eligibility (an indicator of

poverty, recognising its drawbacks as a proxy for low income (Hobbs and Vignoles, 2010)), indicators of special educational needs, as well as linked histories of all previous key stage test scores. These test scores serve as a proxy for academic success to date, in English, Maths and Science. We aggregate the underlying Key Stage 2 scores in Science, English and Maths and normalize this aggregate to create indicators for those who scored in the top and bottom quartiles of the tests.

Crucially, we have data on pupil's current and past postcodes, which enables us to assign each Brighton and Hove pupil to a catchment area and identify neighbourhood characteristics. We have a postcode for every year the child is at school. It is the postcode of the child in year six that determines their catchment area, and subsequently, schools which they will have priority to attend. However, as we suspect parents may not always keep schools informed of house movements we use the pupils year 7 postcodes to assign catchment areas and neighbourhood characteristics, which we believe is a better indication of the pupils postcode at the time allocations were decided. The postcodes also allow us to assign each pupil to the relevant Lower Layer Super Output Area (LLSOA). This is an administrative geography used for the collection and publication of small area statistics. LLSOAs contain around 1500 residents on average[5]. Based on the LLSOA, we use the Income Deprivation Affecting Children Index (IDACI) to quantify the level of deprivation in pupils' home neighbourhood. A household is defined as being income deprived if it is "receiving Income Support/Income based Job Seekers Allowance/Pension Credits or those not in receipt of these benefits but in receipt of Working Tax Credit/Child Tax Credits with an equivalised income below 60 per cent of the national median before housing costs".[6] This is one of our key variables: using the IDACI score to characterise the level of deprivation in a small area will allow us to investigate how the quality of schools attended by pupils in the most deprived areas has changed relative to those in more affluent areas.

b) Data on Schools

We characterize secondary school quality in various ways in order to see exactly how school composition, segregation and assignments change for various groups. Social profiles are aggregated from the pupil-level data for each cohort. We calculate the proportion of students who are eligible for FSM and the mean IDACI score for each school, two measures of the deprivation in each cohort, with a view to observing how these change for the subgroups after the reforms. To characterize the academic quality of schools we use the widely quoted measure of the proportion of a school's pupils

[5]http://www.neighbourhood.statistics.gov.uk/dissemination/Info.do?page=aboutneighbourhood/geography/superoutputareas/soafaq/soa-faq.htm (Accessed July 2010)

[6] http://www.communities.gov.uk/documents/communities/pdf/733520.pdf

achieving grades A* to C in at least 5 GCSE exams at age 16 including English and Maths (%5A*-C). We use data from the most recent exams at the time the school applications are made. For example, a child who starts school in September 2008 will submit their application in October 2007; we therefore use the May/June 2007 exam pass rate as the indication of school quality. The GCSE exams are important, nationally set, and come at the end of compulsory schooling in the state system. Whilst quality measures such as contextual value added attempt to control for the quality of students schools intake (as measured by prior attainment) and adjust for the social composition of the school, GCSE pass rates are easy to interpret making it easy for parents to compare schools.

5. Results

We first describe the changes in composition schools experience in the first two years of the reform; we also examine how movements to the neighbouring LAs and the private sector were affected. Second, we present a spatial analysis which enables us to locate the 'winners' and 'losers' of the reforms. Third, we use the difference-in-difference approach to test for any changes in the pattern of assignment of students to schools.

a) Composition changes

We present this information graphically, exploiting the long pre-reform period; we show all Brighton and Hove schools, and also highlight the two pairs of schools in the dual-catchment areas. Figure 3 shows how the percentage of FSM-eligible students in the school intake year changes over time. We can see that there is a lot variation from year to year pre-reform, but some schools' changes in the post-reform period stand out. Due to the design of the catchment areas we expected the schools in the dual catchment areas plus Patcham High to be the schools most affected by the reforms and this is supported by Figure 3. Dorothy Stringer had tended to be the school receiving the lowest proportion of FSM students, and also had a declining trend pre-reform. However, by 2009/10 Dorothy Stringer's FSM intake percentage had doubled from the 2007/8 figure of 6% to just over 13%. Similarly, Varndean saw its FSM intake percentage increase from just over 16% to almost 27% - the second highest rate in the city. In the opposite direction we see Patcham High which is just north of Varndean and Dorothy Stringer reduce its FSM intake percentage from 25% to 18%. The BM/HP catchment area also experienced falls; Blatchington Mills FSM intake fell slightly from 14% to 11% while Hove Park's fell by over a third from 22% to 14%. These changes do not simply reflect macro conditions: during this period Brighton and Hove's FSM rate remained constant at 17.6%.

Figure 4 shows the proportion of year 7s in each school who were in the top quartile of the KS2 score distribution (in their cohort). We would expect the proportion of top quartile students attending a school to move in the opposite direction to the proportion of FSM students and this is indeed the case. Dorothy Stringer was not only the school with the lowest FSM intake in 2007/8 but also had the highest proportion of students who were in the top quartile of the KS2 distribution, in the years preceding the reforms it had seen an upwards trend in the proportion of its intake who were in the top quartile peaking at 44% in the year before the reforms were implemented. The two years following the reform saw this fall to 31% in 2009/10. Conversely, Hove Park increased its proportion of top quartile students from just over 20% to just under 30%, almost converging with Blatchington Mill which had consistently (in each of the 7 pre-reform years we have data for) had a much higher proportion of top quartile students. We do not see much of a change in the other schools and perhaps surprisingly Patcham High only experienced small gains. Figure 5 performs the equivalent analysis for the bottom KS2 quartile, and this largely mirrors the upper quartile pattern just described.

One possible outcome of the reforms is that parents who are not guaranteed a place in what they deem a sufficiently good school, may opt out choosing private education or schools in neighbouring LAs. We can investigate this to a degree using our data. Figure 6 displays some changes in the patterns of movements between Brighton and Hove, and its two neighbours East Sussex and West Sussex. We see increased movements to West Sussex from Brighton and Hove, decreased movements from Brighton and Hove to East Sussex and a slight decrease in movements to Brighton and Hove from both neighbours. We do not see any significant increases in the proportion of students who are in the state system in year 6 and are not in the state system in year 7, suggesting there has been no increase in movements to private education.

In summary, this section has shown a degree of homogenisation of FSM shares in Brighton and Hove's schools post reform as we might expect. There appears to be some convergence in composition between the two schools in one dual-catchment area, Blatchington Mill and Hove Park, though less so in the other dual-catchment area with Dorothy Stringer and Varndean.

b) Spatial Analysis

Focussing on a single city allows us to analyse changes in school assignment in some spatial detail. We take all the pupils living in a specific neighbourhood (LLSOA) and compute the average academic quality of school attended by those pupils, measured by the percentage of students gaining at least 5 A* to C grades. We do this for the intake year in the final year before the reform, 2007 intake, and again two years later, 2009 intake, and calculate the change. We then do this for each

neighbourhood in Brighton and Hove, and display the changes on a map in Figure 7a and on a cartogram in Figure 7b, with the spatial scale distorted to reflect relative populations. We use the median change as opposed to mean change to minimise the impact of outliers, and we use the same measure of school quality in both periods (the 2008 %5 A*-C grade GCSEs) to avoid differences caused by grade inflation. The difference between the average quality of school attended is plotted for each LLSOA using a graduated scale with white representing small or no effect, and black representing the largest effects. The striped areas indicate the median change was negative with solid colours representing the areas which experienced positive changes.

Figure 7a shows that the majority of areas in Brighton experienced little change in school quality as a result of the reforms. As noted earlier the Longhill, Falmer and Portslade catchments were largely unaffected by the reforms with only a small number of neighbourhoods in those areas experiencing increases or decreases in the quality of school attended, pupils in the southern part of the Portslade area who were now unable to attend Hove Park experienced the most visible change of these areas[7].

The areas which experienced the biggest median change in the quality of school attended were those in the south of the Patcham catchment area. Pupils in these areas are very close to Dorothy Stringer and Varndean, and attended these high-performing and popular schools. Post-reform, pupils in these areas generally attend Patcham High unless they have a sibling link elsewhere, or are able to get a place in Cardinal Newman. The northern part of the Patcham area, was largely unaffected by the reforms. Conversely, the southern parts of both dual catchment areas appear to be the biggest beneficiaries with majority of the gains experienced in these two areas. The 'almost' guarantee of a place of one of the two catchment schools in the V/DS area means that those pupils in the southern areas who previously would have been unlikely to get into any of the oversubscribed schools are now effectively guaranteed a place a one of the top schools in the city; equally the increased probability of a place in Blatchington Mill for those on the southern coast of HP/BM area mean such gains were not unexpected, however, sample size becomes an issue in the southern coast of the HP/BM area with some of the LLSOAs having as few as 2 children in each cohort. The areas immediately surrounding Blatchington Mill also sees some losers as many living there have seen their almost certain access to that school replaced by a lottery between Blatchington Mill and Hove Park.

[7] The south east of Falmer has two peculiar LLSOAs, one which experiences big gains and one which appears to be a big loser; this can be explained by changes in the number of year 7s in these areas. The 'winner' experienced a decline in the number of year 7s whilst the number attending the top schools increased. The 'loser' experienced an increase in students from 23 to 33 and whilst the number attending schools other than Falmer High remained constant at 19, the median school quality decreased as a result of this. These serve as an example of how our spatial analysis is sensitive to changes in the number of pupils over time.

Table 4 gives an overview of the school destinations of pupils from the various catchment areas both before the catchments were designed and post-reform. Table 4 clearly shows the decline in pupils from the Patcham area attending Varndean and Dorothy Stringer with both schools accepting far fewer students from the area; we expect to see further decreases when the cross catchment sibling links are phased out from 2012. We see a similar story for the Falmer catchment which previously had some of its western edge students relatively close to Varndean. The percentage of students attending their designated catchment school(s) increases in every area.

Summarising this evidence, the distinct winners and losers from the reform relate very strongly to the new catchment areas, and the abolition of proximity as the tie-breaker for over-subscribed schools.

c) Regression Analysis

We now report our findings from the pupil level difference-in-difference regressions in equation (2), presented in tables 5 and 6. The treatment group comprise all pupils who attended a school in Brighton and Hove. In all regressions we include LA level dummies to control for mean differences in school quality, LA-variable interactions to capture differences in the mean allocation patterns and year dummies to control for any macro time trend. The standard errors are clustered at the school level in all regressions.

To measure the expected quality of the assigned school for a student of a given type, we regress a school level characteristic (on the LHS) on an individual characteristic on the right. This provides a summary description of the assignment of students to schools, measuring the expected school characteristic for a student of a given individual type. We use two different school characteristics, academic quality and socioeconomic composition, and the two measures of the student's circumstances. Thus the models with academic quality as the school characteristic are measuring the chances of poor and non-poor students of accessing high quality schools; the models with socioeconomic composition as the school characteristic are measuring segregation, that is, the relative chances of poor and non-poor of attending high-poverty schools. These regressions are run over the treated LA and the controls to implement the difference-in-difference analysis; the model also includes interactions of these with all the LA dummies to allow the structure of the allocation to vary by place. The key terms are the policy variables, which are the interaction of the individual characteristic (FSM or IDACI) and the treatment, namely being in Brighton and Hove after the policy change.

In Table 5 we examine school allocation by students' socioeconomic status, measured by first individual poverty (FSM) and then (very small) neighbourhood poverty (IDACI). Column 1 shows that FSM eligible students attended schools which achieved around 4.5% less 5 A*-C GCSEs on average than non-FSM students, about a quarter of a standard deviation. The coefficients on the policy variables are negative in both of the after periods, increasing the average school quality gap to nearly half of a standard deviation for FSM eligible students in the second year of the policy. However, in this specification neither the FSM nor the policy coefficients are significantly different from zero. Column 3 shows how the relationship between IDACI scores and school quality changes after the reforms. Post-reform this gap increases with the negative coefficient in the second year of the policy indicating students at the median attended schools with pass rates 5.4% (0.29 of a standard deviation) lower than those in the most affluent areas. The IDACI coefficient and the change in the second year are both significant at the 10% level; the first year change was negative but not significantly different from zero.

Turning to the segregation results, column 2 shows that FSM-eligible students on average attend schools with around 3.5% (0.30 of a standard deviation) more FSM students. This is obviously not surprising given socio-economic sorting, and we have shown elsewhere that in this context the OLS regression coefficient is equivalent to the eta-squared measure of segregation. The policy effect is positive (implying schools are became more segregated) in both years but the effect is weaker in the second year than in the first; both coefficients are not significantly different from zero. The IDACI score is a finer measure of the deprivation experienced in a pupil's local area, with a score of 1 indicating 100% of children between 0-15 in the area are deprived and a score of 0 indicating none are deprived. In Brighton and Hove the IDACI scores range between 0.02 and 0.74 in Brighton with a median value of 0.2. Column 4 shows that on average, students from deprived areas attend schools which have more students from deprived areas; this is expected due to the location of schools and clustering of deprivation in Brighton. The policy coefficients are close to zero in both post reform periods; both regressions have policy effects which were not significantly different from zero suggesting the reforms have not had much of an effect in terms of overall segregation.

Table 6 looks at school allocation by students' KS2 scores, using the same measure of school academic quality, the GCSE pass rate (%5 A*-C) of the pupils destination school at the time of applying. Column 1 uses the student's normalised KS2 score, and the estimates show a strong positive relationship between this and the quality of school attended. This reflects neighbourhood clustering, not academic selection; see below. The difference-in-difference variables show that this gradient is reduced, indicating some degree of homogenisation. By the second year, this is quantitatively and statistically significant.

To understand where in the distribution this is happening, Column 2 focusses on the top quartile of KS2. Pre-reform, students in the top quartile of the KS2 distribution attended schools which were an average of over a third of a standard deviation better than other students. The reforms reduced this gap to quarter and then a sixth of a standard deviation in the first and second post reform years respectively. Given the results of our spatial analysis, it seems likely that a significant part of the relative deterioration in school quality for high KS2 students in Brighton and Hove is located in the area that lost access to Dorothy Stringer and Varndean. Column 3 shows a fall for the bottom quartile too, but insignificant. Column 4 includes the two quartiles together and the results are confirmed: the policy variables for both the top and the bottom students remain similar in size - and remain significant for the top quartile - and imply that the policy benefitted the students in the middle of the KS2 distribution the most. Column 5 repeats this analysis for quartiles of neighbourhood deprivation rather than prior scores.

In Figure 8 we display the average school quality by KS2 decile before and after the policy change. This is just for Brighton and Hove and is an unconditional plot, so will not exactly replicate the Table 6 results. It shows a degree of homogenisation: the allocation line is somewhat flatter after the reform, with much of the gap happening at the higher KS2 scores[8].

Summarising the regression results, Table 5 shows there is little significant evidence that the policy changed the allocation of students by socioeconomic characteristics, though all the point estimates suggest that if anything the policy tended to increase socioeconomic segregation and allocate poor children to lower performing schools in Brighton and Hove. Table 6 provides evidence of some significant homogenisation of school allocation by KS2 score: the policy reduced the differential school quality of high KS2 students in Brighton and Hove.

6. Conclusion

The abandonment of proximity as a tie-breaker and the use of lotteries within distinct catchment areas is a major school admissions reform, the first of its kind in England. This study is the first analysis of the early impacts of the reforms in Brighton and Hove. The introduction of a lottery of school places has led to widespread interest across the national media and from policy-makers in other cities. Although it had largely been assumed that the lottery would reduce the dependence of school access on the ability of parents to purchase a house in the correct neighbourhood, thus

[8] The higher school quality for low KS2 students in the Figure does not match the results in table 6, because the latter estimates differential changes in Brighton and Hove relative to the control LAs.

lowering social segregation, we have shown that the re-drawing of catchment areas in the city has considerably complicated the patterns of winners and losers.

Under some conditions we would expect to see some homogenisation of intakes within the dual-catchment areas using lotteries. This is clearly reflected in the data for one of these areas (Blatchington Mill, Hove Park). In the other (Dorothy Stringer, Varndean), there is convergence between the pair of schools and the rest of the city, but no real convergence between the two schools. This is because the boundary drawn around the first area was a lot closer to the de facto pre-existing catchment areas for those schools, and so the major effects were internal to the area, whereas the boundary drawn around the second pair cut right across the pre-existing catchments and so the adjustments involved other schools as well. This degree of homogenisation is also reflected in our difference-in-difference results. We find after the reform a weakening of the dependence of the quality of school attended on the student's prior test score, reflecting a weakening of the dependence on location. However, when we analyse segregation directly we find some hints at increased segregation also arising from the design of the catchment areas, but these results are not statistically significant.

There are clearly winners and losers from these reforms: some students are attending less academically successful secondary schools than they might have expected to; for others the reverse is true. The location of these winners and losers largely derive from the design of the catchment areas rather than the impact of the lottery where it applies. So, the largest group who see a deterioration in academic quality of school they attend are those who lived close enough to access Dorothy Stringer under the old proximity allocation, but are now designated Patcham High as their catchment area school. Similarly, the largest group of winners are those who live on the far east of the newly created Varndean/Dorothy Stringer catchment area that did not live close enough to gain a place at either school under the old allocation. One reason why the impact of the reform has followed catchment area boundaries so closely has been that school capacity is relatively constrained within the city. This means that, although the allocation does provide for a lottery to take place between out-of-catchment applicants, in reality there have been few spaces available at the most popular schools once priority to those living within the catchment zone has been accounted for.

It will be several more years before the long-run impact of the school admission reforms in Brighton and Hove become apparent because we do expect families to relocate and house prices to adjust in response to the re-drawing of the catchment boundaries. Nevertheless, it seems unlikely that the reforms are likely to substantially lower social segregation across schools even in the long-run in this

city where differences in the quality of housing stock across areas are deeply entrenched and the boundaries of the new catchment areas mean that families living in the most deprived neighbourhoods have little chance of accessing the most popular schools in the centre of the city.

References

Abdulkadiroğlu, A. Pathak, P.A., Roth, A.E. and Sönmez, T. (2005) The Boston Public School Match, *The American Economic Review*, 95 (2) pp. 368-371.

Allen, R. (2007) Allocating pupils to their nearest school: the consequences for ability and social stratification, *Urban Studies*, 44(4)751-770.

Allen, R. and Vignoles, A. (2007) What should an index of school segregation measure?, *Oxford Review of Education* 33(5)643-668.

Bayer, P., Ferreira, F. and McMillan, R. (2007) A Unified Framework for Measuring Preferences for Schools and Neighbourhoods, Journal of Political Economy, 115, (4), 588-638.

Black, S. (1999) Do better schools matter? Parental evaluation of elementary education, *Quarterly Journal of Economics*, 114(2), pp. 577-599.

Bogart, W. T. and Cromwell, B. A. (1997) How much more is a good school district worth? *National Tax Journal*, 50:215–232.

Bogart, W. T. and Cromwell, B. A. (2000) How much is a neighbourhood school worth? *Journal of Urban Economics*, 47:280–305.

Brunner, E. J. and Imazeki, J. (2008) Tiebout choice and universal school vouchers, *Journal of Urban Economics*, 63(1)253-279.

Burgess, S. and Briggs, A. (2010). *School assignment, school choice and social mobility*. Forthcoming, *Economics of Education Review*.

Burgess, S., Johnston, R., Key, T., Propper, C. and Wilson, D. (2008) The transition of pupils from primary to secondary school in England, *Transactions of the Institute of British Geographers,* 33(3)388-403.

Cheshire, P. C. and Sheppard, S. C. (1995) On the price of land and the value of amenities, *Economica*, 62:247–267.

Epple, D. and Romano, R. E. (1998) Competition between private and public schools, vouchers and peer-group effects, *American Economic Review*, 88:33–62.

Epple, D. and Romano, R. E. (2003), Neighbourhood schools, choice, and the distribution of educational benefits, in Hoxby, C. M. (ed) *The economics of school choice*, pages 227–286, University of Chicago Press, Chicago.

Ferreyra, M. M. (2007) Estimating the effects of private school vouchers in multidistrict economies, *The American Economic Review,* 97(3) 789-817.

Gale, D. and Shapley, L. S. (1962). College admissions and the stability of marriage. *The American Mathematical Monthly*, 69(1) pp. 9–15.

Gibbons, S. and Machin, S. (2003) Valuing English primary schools, *Journal of Urban Economics*, 53, pp. 197-219.

Gibbons, S. and Telhaj, S. (2007) Are Schools Drifting Apart? Intake Stratification in English Secondary Schools, *Urban Studies*, 44(7) pp. 1281-1305.

Goodman, A. C. and Thibodeau, T. G. (1998) Housing market segmentation, *Journal of Housing Economics*, 7:121–143.

Gorard, S., Taylor, C., and Fitz, J. (2003) *Schools, markets and choice policies,* RoutledgeFalmer, London.

Hobbs, G. and Vignoles, A. (2010) Is children's free school meal 'eligibility' a good proxy for family income? *British Educational Research Journal*, 36(4) pp. 673 – 690.

Leech, D. and Campos, E. (2003) Is comprehensive education really free? A case study in the effect of secondary school admissions policies on house prices in one local area, *Journal of the Royal Statistical Society Series A*, 166:135–154.

Nechyba, T.J. (1999) School Finance-Induced Migration and Stratification Patterns: the Impact of Private School Vouchers, *Journal of Public Economic Theory*, Vol. 1.

Nechyba, T.J. (2000) Mobility, Targeting and Private School Vouchers, *American Economic Review,* 90(1), 130-46.

Rosenthal, L. (2003) The value of secondary schooling, *Oxford Bulletin of Economics and Statistics*, 65:329–355.

Roth, A. E. (1984). The evolution of the labor market for medical interns and residents: A case study in game theory, *Journal of Political Economy*, 92 pp. 991–1016

Rothstein, J. (2003) Good Principals or Good Peers? Parental Valuation of School Characteristics, Tiebout Equilibrium, and the Incentive Effects of Competition Among Jurisdictions, *American Economic Review,* 96(4) 1333-1650.

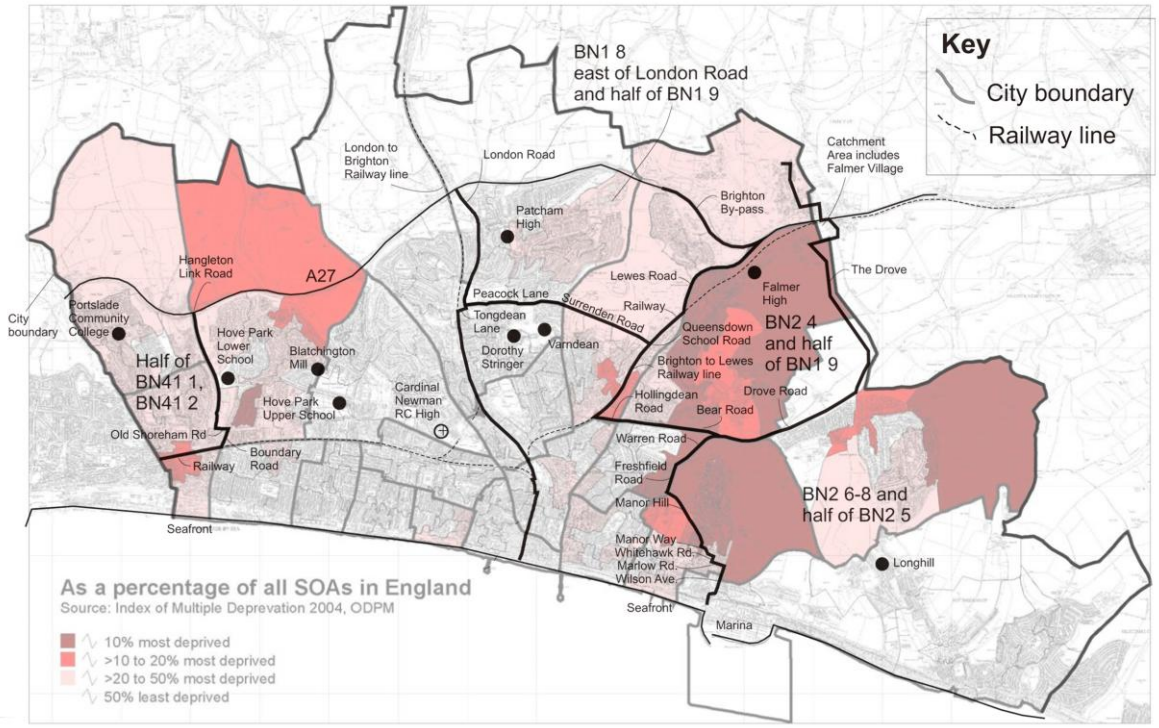
Sattinger, M. (1980). *Capital and the distribution of labor earnings*. North-Holland, Amsterdam.

Sieg, H., Smith, V. K., Banzhof, H. S., and Walsh, R. (1999) The role of optimizing behavior in willingness-to-pay estimates for air quality, *American Journal of Agricultural Economics*, 81:1112–1117.

Tinbergen, J. (1959) On the theory of income distribution, In Klaassen, L. H., Koyck, L. M., and Witteveen, H. J., editors, *Selected papers of Jan Tinbergen*. North-Holland, Amsterdam.

Tables and Figures

Fig 1: Catchment Areas and the 2004 Index of Multiple Deprivation



Source : Brighton and Hove Council

Fig 2: Brighton and Hove Timeline

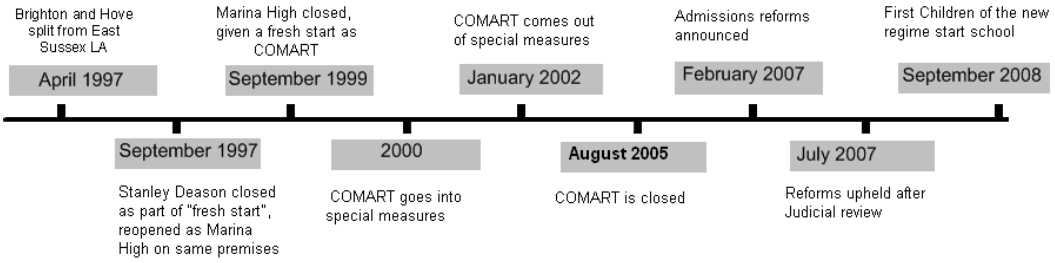


Fig 3a: Pupils eligible for free school meals by year 7 cohort in school (%)

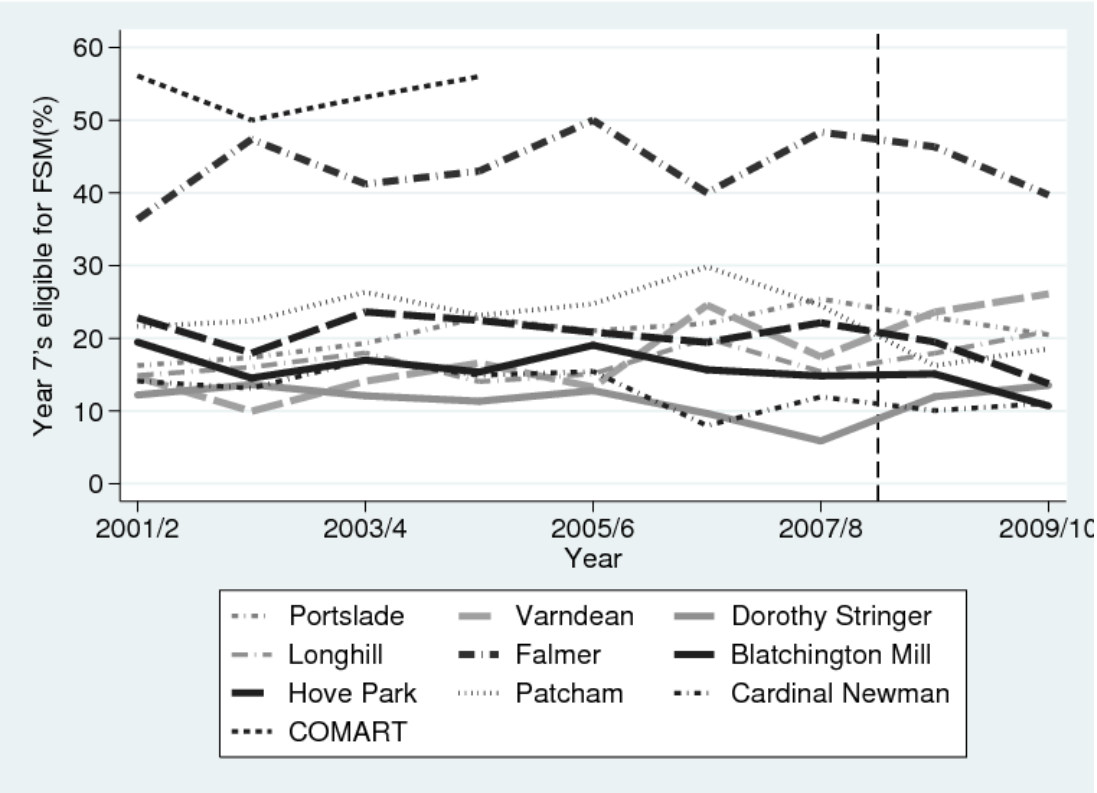


Fig 3b: Pupils eligible for free school meals by year 7 cohort in dual catchment school (%)

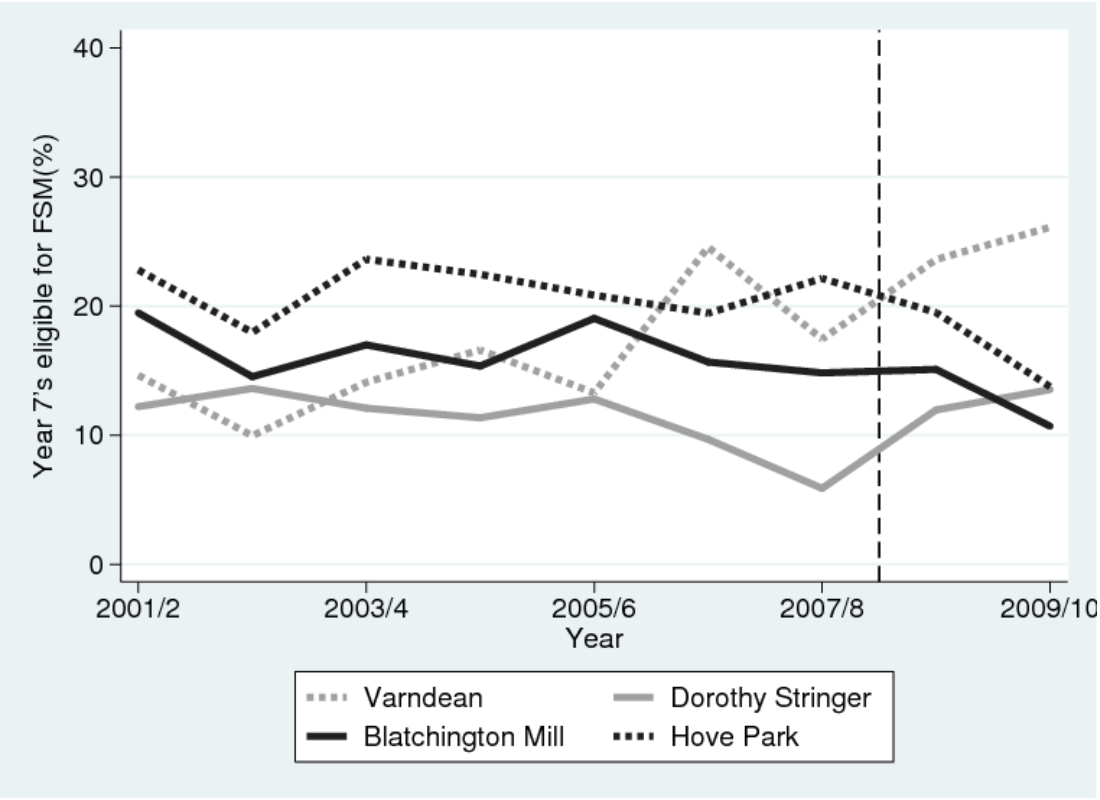


Fig 4a: % of the top quartile of KS2 students in each school

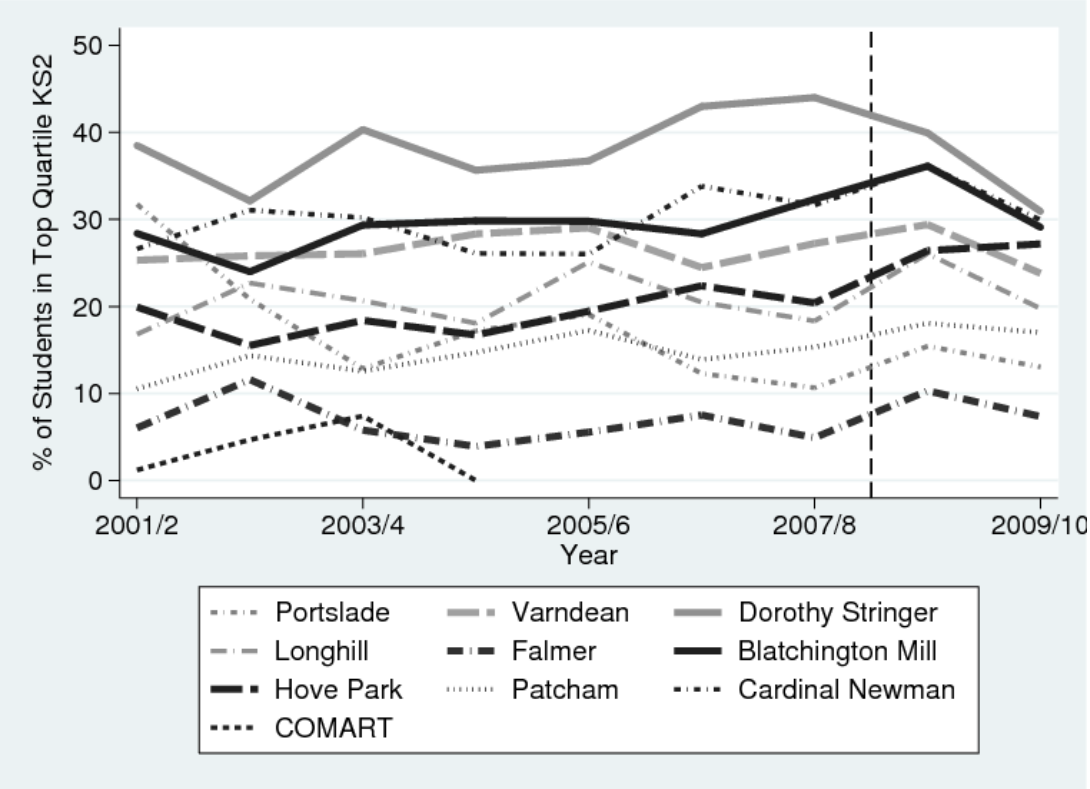


Fig 4b: % of the top quartile of KS2 students in each school - - Selected Schools

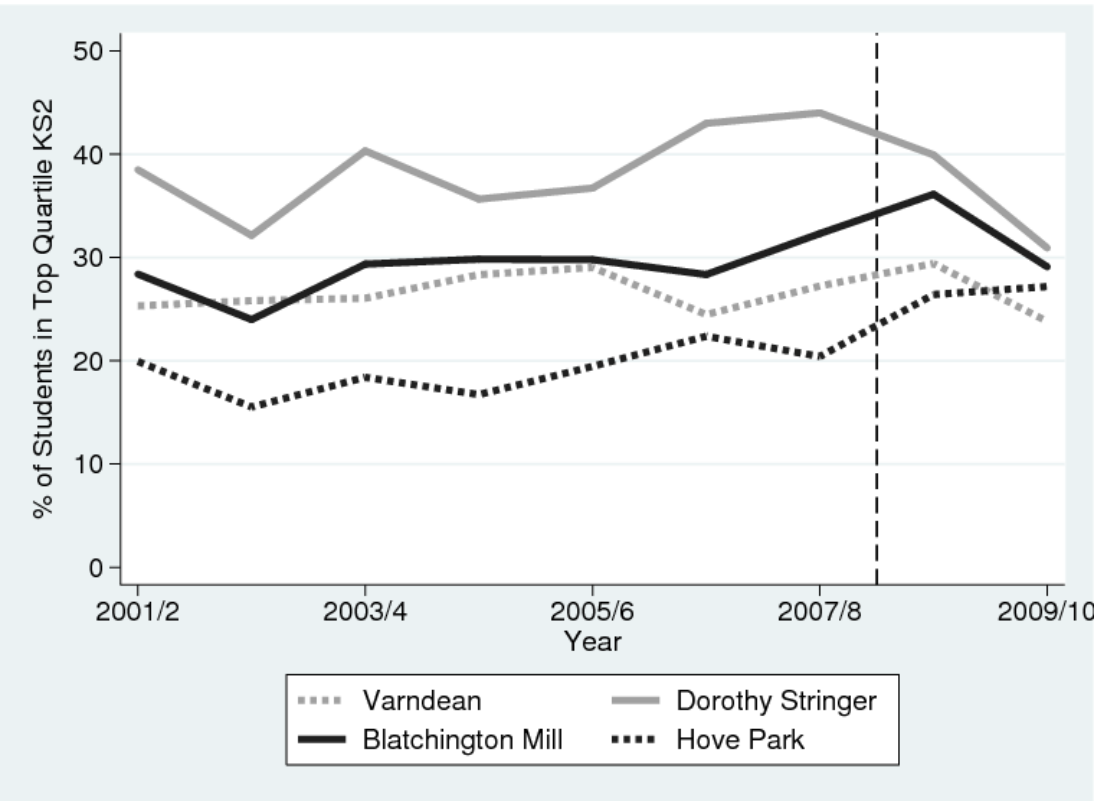


Fig 5a: % of the bottom quartile of KS2 students in each school

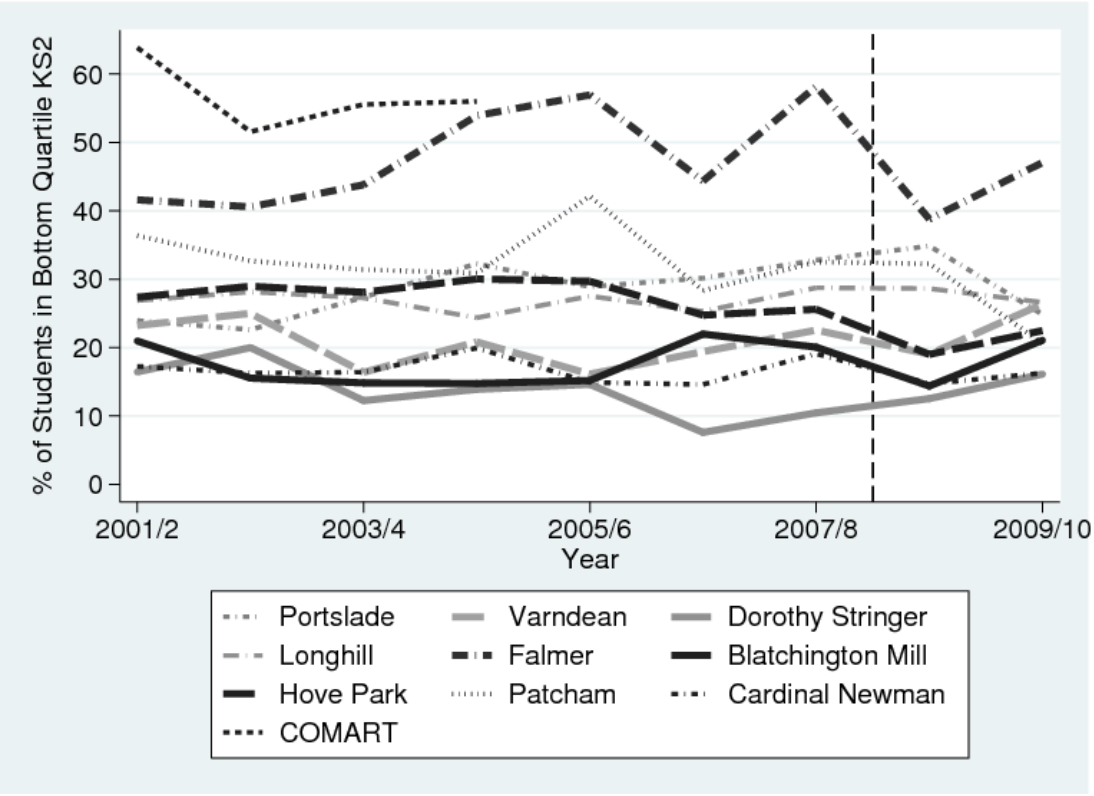


Fig 5b: % of the bottom quartile of KS2 students in each school – selected schools

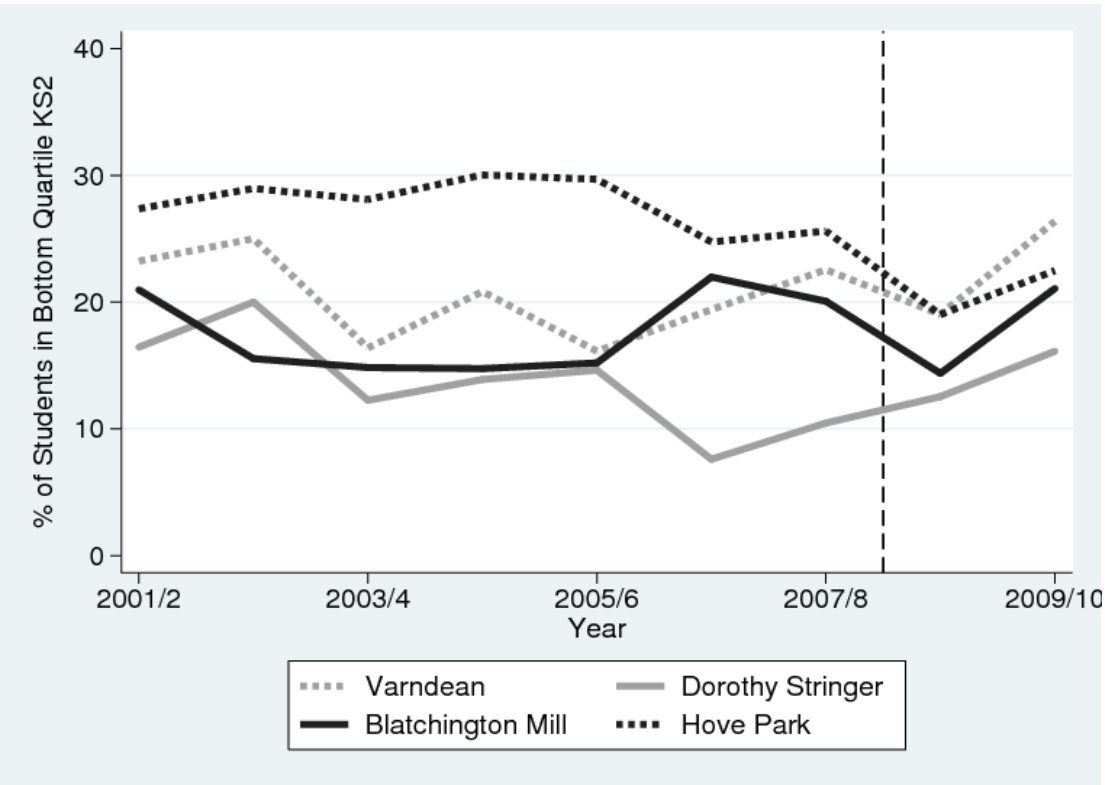


Fig 6: Movements between Brighton and it's neighbouring LAs

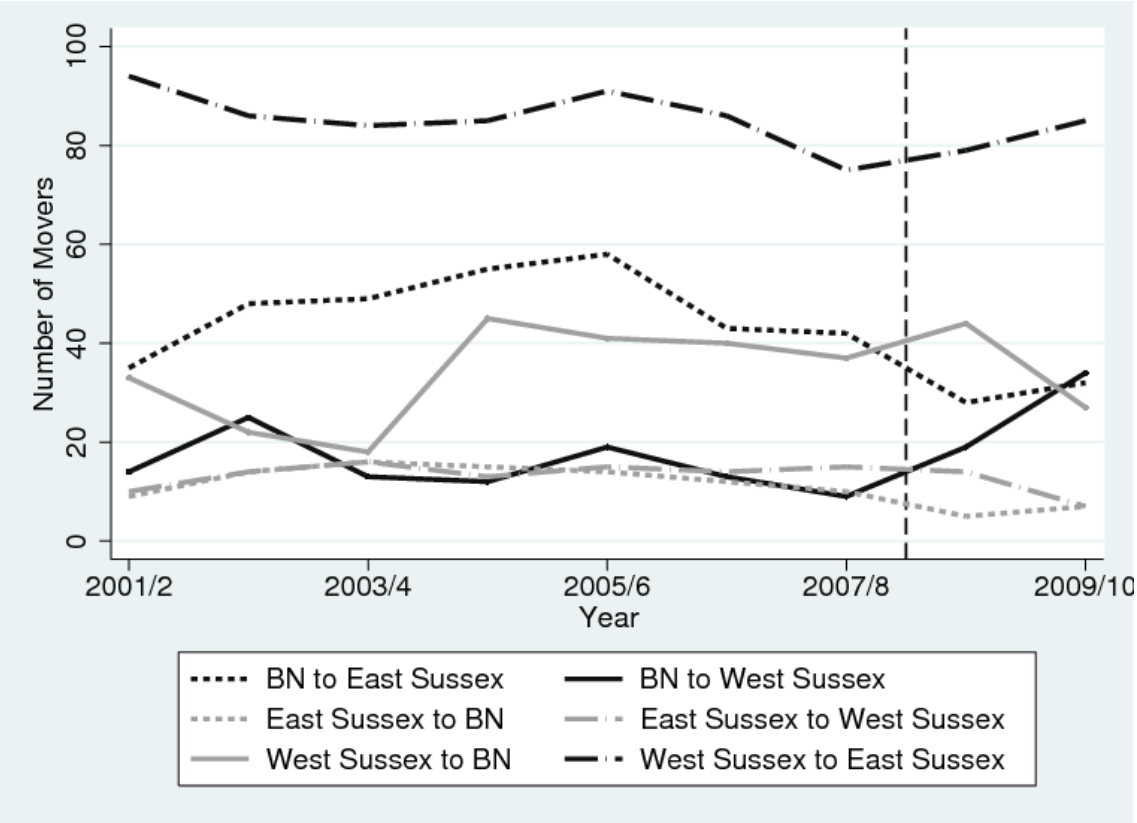


Figure 7a: Graduated quality change by LLSOA

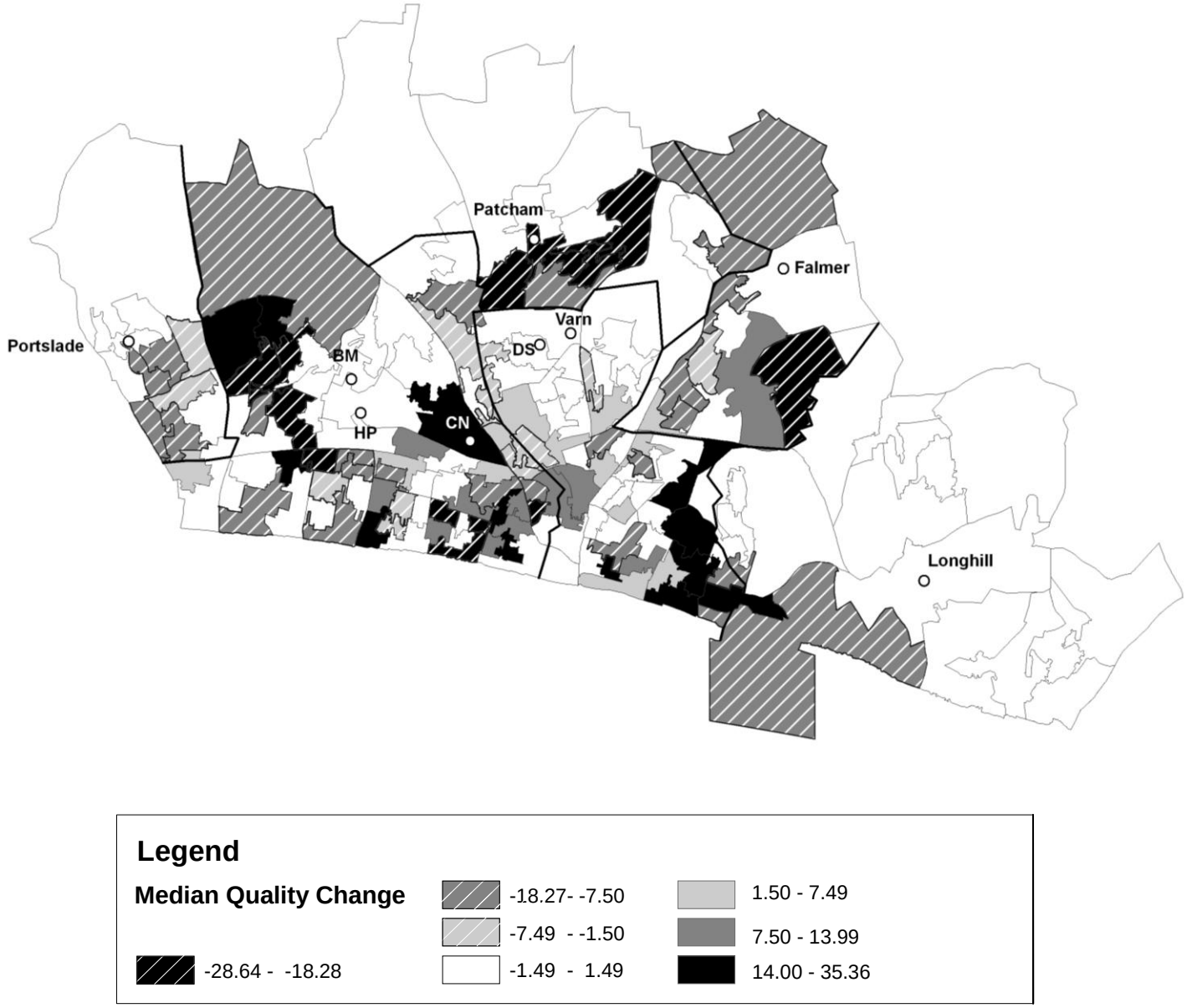
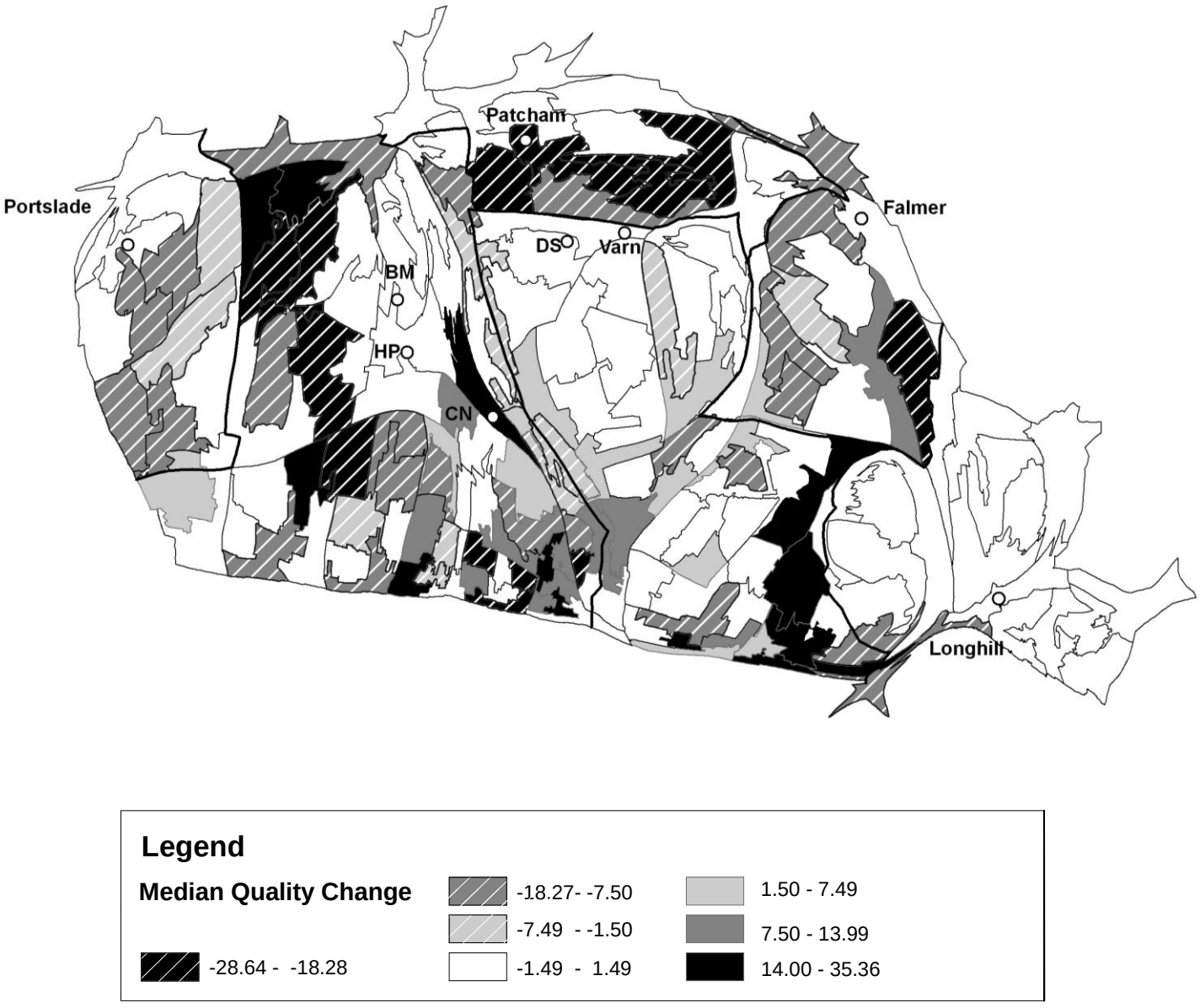


Figure 7b: Graduated quality change by LLSOA - Cartogram



Note: spatial scale is distorted to show area relative to student population.

Fig 8: Academic Quality of School Attended by KS2 Decile in Brighton and Hove

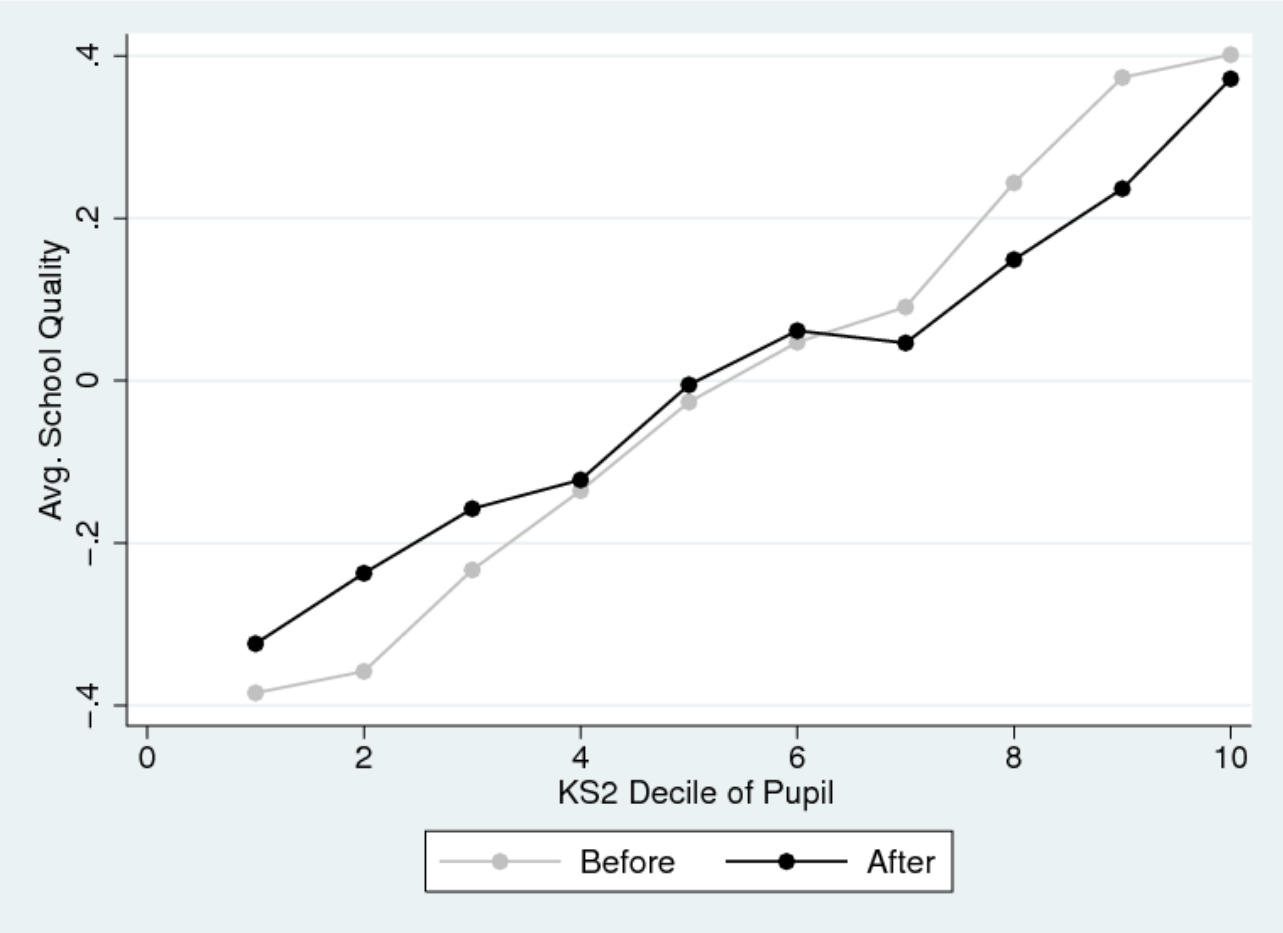


Table 1: Overview of admission reforms in Brighton and Hove

	Pre Sept 2008 entry	**Sept 2008 entry onwards**
Number of preferences	3	3
Matching mechanism	First Preference First (Priority Matching Mechanism)	Equal Preferences (Gale-Shapley school-deferring)
Priority I	Compelling medical or other reasons	Children in care; medical and other reasons
Priority II	Sibling currently at the school	Sibling currently at the school (only for households within catchment from 2012)
Priority III	Home to school distance	Within catchment area, with a random allocation tie-breaker
Priority IV		Outside catchment area, with a random allocation tie-breaker

Table 2: 2007/8 School Characteristics

School	% 5 A*-C GCSEs (Inc. English and Maths)	% FSM Eligible in Year 7	Number of Year 7s	Post Reform Catchment Type
Falmer High	19	48.4	126	Single
Patcham High	28	21.3	168	Single
Portslade CC	29	18.4	126	Single
Longhill High	36	15.8	242	Single
Hove Park	36	18.8	294	Dual (HP/BM)
Cardinal Newman	55	9.38	341	None (Catholic)
Varndean	57	17.4	241	Dual (V/DS)
Dorothy Stringer	63	8.22	331	Dual (V/DS)
Blatchington Mills	64	12.3	304	Dual (HP/BM)
Brighton average	44.5	13.4	250	
England average	47.6	12.6	189	

Table 3: Comparison of Brighton and Hove with control LAs

2007 / 2008	Brighton	Control LAs
% Free School Meals	17.6	16.8
% White British	83.8	87.5
Mean IDACI Score	0.256	0.237
Mean (Normalized) KS2 score	0.051	0.007
% in national top quartile KS2	26.2	24.5
% in national bottom quartile KS2	24.4	24.7

Catchment Name	N	Varndean	Dorothy Stringer	Longhill	Falmer High	Portslade	Blatchington Mill	Hove Park	Patcham	Cardinal Newman	Other
BM / HP2008	637	2.20	8.16	0.32	0.16	2.98	41.92	21.35	0.94	19.15	2.82
BM / HP2010	712	1.54	2.53	0.14	0.14	0.98	40.03	30.90	1.26	20.65	1.83
Falmer2008	205	16.10	4.88	1.95	39.52	0.49	0	2.93	15.61	9.26	9.26
Falmer2010	218	12.84	2.29	0.46	49.08	0.46	0.46	2.29	16.97	8.26	6.89
Longhill2008	331	3.32	1.21	63.75	3.32	0.60	1.21	6.34	3.63	12.08	4.54
Longhill2010	341	4.11	0.88	68.33	2.93	0.59	0.29	1.17	1.76	12.9	7.04
Patcham2008	177	20.90	18.08	0.56	3.95	0	0	0.56	45.2	9.04	1.71
Patcham2010	205	13.66	8.29	0.49	3.41	0	0	0.49	63.41	6.83	3.42
Portslade2008	221	0.45	0	0	0.45	38.46	5.88	37.10	0	11.76	5.90
Portslade2010	236	0	0	0	0.42	59.32	3.39	23.73	0.42	8.05	4.67
Varn / DS2008	503	25.92	42.94	3.68	3.09	0.39	0	2.90	5.61	10.83	4.64
Varn / DS2010	542	34.87	47.97	1.29	1.85	0.18	0.37	0.55	2.03	8.86	2.03
Total2008	**2093**	**10.99**	**15.29**	**11.42**	**5.64**	**5.21**	**13.57**	**12.52**	**7.64**	**13.33**	**4.39**
Total2010	**2260**	**11.99**	**13.45**	**10.80**	**6.02**	**6.68**	**13.14**	**12.83**	**8.58**	**12.92**	**3.6**

Table 4 : Transition Table showing the percentage of Catchment area which attended each School

Table 5: Socioeconomic Characteristics and School Allocation

Outcome	**%5AC**	**%FSM**	**%5AC**	**School Mean Idaci Score**
Specification	**(1) FSM**	**(2) FSM**	**(3) IDACI**	**(4) IDACI**
FSM	-4.360	3.513***	-	-
	(2.890)	(1.260)		
IDACI Score	-	-	-19.49*	0.151**
			(10.36)	(0.0746)
Policy in Year 1	-1.837	3.064	-4.753	0.00120
	(1.652)	(2.973)	(3.998)	(0.0259)
Policy in Year 2	-4.458	0.578	-7.753*	0.00223
	(3.660)	(2.364)	(4.542)	(0.0241)
N	108813	111759	108829	111775
adj. R2	0.121	0.193	0.221	0.442

Notes:
1) Unit is a pupil
2) "Policy in Year 1" means the interaction of: the main variable (FSM in columns 1 and 2), location in Brighton and Hove LA, 'after' year 1.
3)Standard errors in parentheses
4) Significant levels are * p < 0.1, ** p < 0.05, *** p < 0.01
5) All regressions include LA*main variable interactions, LA and year dummies and standard errors are clustered at school level.

Table 6: Prior test score and School Allocation (Outcome is % of students scoring 5 A*-C in destination school)

	Normalized KS2 Score	KS2 Top Quartile	KS2 Bottom Quartile	KS2 Top and Bottom Quartiles	IDACI Top and bottom Quartiles
	(1)	(2)	(3)	(4)	(5)
Level	3.994***	6.684***	-5.474**		
	(1.341)	(1.996)	(2.651)		
Policy in Year 1	-0.500	-2.237*	-1.879		
	(0.502)	(1.308)	(1.912)		
Policy in Year 2	-1.285***	-4.000**	-0.921		
	(0.475)	(1.634)	(1.975)		
Bottom Quartile					
Level				-4.135*	-6.456
				(2.356)	(4.272)
Policy in Year 1				-1.933	0.018
				(1.927)	(1.947)
Policy in Year 2				-1.026	-2.239
				(2.003)	(2.391)
Top Quartile					
Level				5.194***	3.978***
				(1.500)	(1.464)
Policy in Year 1				-2.277*	-2.873*
				(1.334)	(1.661)
Policy in Year 2				-4.010**	-5.461***
				(1.670)	(1.995)
N	107761	107761	107761	107761	108829
adj. R2	0.196	0.187	0.126	0.202	0.205

Notes:
1) Unit is a pupil
2) "Policy in Year 1" means the interaction of: the main variable (KS2 score in column 1), location in Brighton and Hove LA, 'after' year 1.
3) Standard errors in parentheses
4) Significant levels are * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
5) All regressions include LA*main variable interactions, LA and year dummies and standard errors are clustered at school level.