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Modifying school choice for more equitable access in England

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Executive Summary

Motivation:

- Education inequality is a major precursor to income inequality.
- While the average quality of English secondary schools is relatively high, there are differences in effectiveness across schools, and there are persistent and wide gaps in attainment between more and less advantaged pupils. We define and measure school effectiveness by the progress a school's pupils make; specifically we use Progress 8, a value-added measure based on GCSE scores.
- The attainment gaps is driven in part by differences in school effectiveness. Pupils not eligible for Free School Meals (FSM) are 43% more likely to be assigned to a highly effective secondary school (defined as in the top 25% of effectiveness) than those eligible for FSM, for example.
- Access to popular and effective schools is commonly rationed by geographic over-subscription criteria, creating demand for housing in the favoured areas, increasing property prices, and so leading to access inequality.
- Our central focus is describing the role of the school admissions system in generating educational inequality, and analysing options for reform.

Our Approach:

- Our methodology combines national administrative data on families' secondary school choices, location and pupil characteristics (over 550k pupils) with bespoke national data on school over-subscription criteria (152 Local Authorities, and 3,248 secondary schools).
  - First, we document the patterns of school choices, residential moves and access to effective schools across families. We can straightforwardly use the location of school and home to define schools that are 'commutable' for a pupil - simply defined as those within roughly 10km of home. Using our unique data on each school's catchment area and 'de-facto' catchment area, we can go a step further and locate each pupil precisely relative to those catchment area boundaries. We define the 'geographic' choice set as all schools for which the pupil has priority due to geographic over-subscription criteria (catchment area, de-facto catchment area, feeder primary school).
  - Second, we simulate the likely effects of reforms to school over-subscription criteria in England. Versions of each reform are already used by some secondary schools in England. These reforms are:
    - **FSM quota:** a fraction of seats are reserved for pupils eligible for FSM. Other seats are assigned using each school's current over-subscription criteria. This reform aims to widen the set of schools accessible to FSM-eligible pupils, and

to increase the probability that FSM-eligible pupils gain access to their most preferred school.

  - **Marginal ballots:** a fraction of seats are reserved for pupils outside the catchment/'de-facto' catchment area of the school, allocated by lottery if over-subscribed. Other seats are assigned using each school's current over-subscription criteria. This reform widens the set of schools which become potentially accessible for all pupils, but with a relatively low probability.

  - **Banding:** each school has a quota for four ability bands, together taking up all the spaces in a school, moving towards a 'comprehensive' intake by ability, but existing over-subscription criteria are otherwise maintained to rank pupils within each band.

- For the first two reforms, we report a central scenario (where the quota seats are 15% of available seats) in the main text, and alternative scenarios are reported in the Appendix.

Summary of findings:

- Families have, on average, 19 secondary schools within commutable distance from their homes. This average varies by location - much higher in dense urban environments. Some of these schools are inaccessible in practice, however, due to geographic over-subscription criteria. Excluding these schools reduces the number and effectiveness of 'feasible' schools to around 12, on average. We find geographic over-subscription criteria restrict the set of 'feasible' schools more for disadvantaged pupils, which we call the 'effectiveness gap'.

- This 'effectiveness gap' between commutable and feasible schools is larger for pupils living in poorer neighbourhoods; in fact, the effectiveness gap for the top third poorest neighbourhoods is more than double that of the richest third of neighbourhoods. That is, the imposition of geographic over-subscription criteria costs disadvantaged pupils more in terms of the effectiveness of available schools. This suggests that geographic over-subscription criteria are a channel through which inequality of access operates. We find that Local Authorities with a higher fraction of over-subscribed schools using geographic or test-based over-subscription criteria tend to have more unequal assignment of disadvantaged pupils to effective schools.

- Families make residential moves and school choices with the current school over-subscription criteria in mind. Non-FSM-eligible pupils are more likely to make a school 'choice' through moving into the catchment area of a popular and effective secondary school during their primary school years. Families just outside the catchment area of a popular and effective school are less likely to choose that school as their first choice than families living just inside the catchment area. This suggests that some families know school over-subscription criteria and fear 'wasting' one of their school choices.

- All three reforms improve equity of access for disadvantaged pupils to effective schools, to varying degrees. The targeted nature of FSM quota leads to the most pupils eligible for

FSM accessing effective schools. In our simulations, we model many policy reforms, varying the parameters for FSM quota and marginal ballots. Reviewing these, our preferred policy is FSM quota, with a quota of 15% (our central scenario). In that case, almost all FSM-eligible pupils are assigned to their most preferred school, typically a more effective school.

- These results show that the current unequal distribution of FSM-eligible pupils across school effectiveness levels is at least partly driven by admissions arrangements and constraints on access, rather than purely reflecting families' preferences or schools' locations.
- Marginal ballots and banding expand potential access to effective schools, but for an untargeted group. As both more and less disadvantaged pupils can apply to and gain access to effective schools, these reforms reduce inequality less than FSM quota.
- The reforms redistribute school seats at over-subscribed schools and thus necessarily create winners and losers. However, under all the reforms (using 15% quotas for FSM quota and marginal ballots), the vast majority of pupils (around 90%) are unaffected by the reform, and attend the same school as at baseline. This happens for two reasons: because the school assigned at baseline is the pupil's most preferred school and the pupil is not reallocated to a less preferred school. Second, the school assigned at baseline is not the pupil's most preferred school, but the reform does yield an offer to a more preferred school.
- Consequently, the distances pupils travel between home and school are barely affected for most pupils: the increase in median distance is 24 meters, and the increase even at the 90th percentile is only 113 meters.

Overall recommendation:

- This report makes the case for modifying the current school admissions system with its pervasive use of geographic over-subscription criteria. Based on detailed empirical modelling, our preferred policy is giving priority to FSM-eligible pupils, up to a quota of 15% of places in each school. This policy provides a strong positive impact for FSM-eligible pupils on access to highly effective schools, whilst minimising the degree of overall disruption.

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1 Introduction

Inequality is one of the major issues of our time, generating and strengthening divisions in society (Satz and White, 2024). Inequality in educational outcomes contributes strongly to income inequality, implying a clear direct link between attainment gaps in school and later inequality (Blanden et al., 2023).[1] While the average quality of English secondary schools is relatively high, there are wide differences in effectiveness across schools, and there are persistent and wide gaps in attainment between more and less advantaged pupils. For example, Farquharson et al. (2022) document the 'huge differences in educational attainment between children and young people from different backgrounds': in 2019, around 60% of pupils not eligible for Free School Meals (FSMs) achieved the benchmark performance in GCSEs, compared to 30% of pupils eligible for FSM (Farquharson et al., 2022).[2]

This disadvantage gap derives in part from differential access to more effective secondary schools (Epple et al., 2016; Cheng et al., 2017; Cohodes and Parham, 2021). We define and measure school effectiveness by the progress a school's pupils make; specifically we use Progress 8, a value-added measure based on GCSE scores. In our cohort of pupils who are making the transition into secondary school, we find a substantial difference in the probability of enrolment in a highly effective school (defined as a school in the top 25% of effectiveness). Higher-income pupils are around 43% more likely to be enrolled in a highly effective school than lower-income pupils: around 18% of pupils eligible for FSM are enrolled in a highly effective school, compared to around 25% of pupils not eligible for FSM.[3]

We study how school over-subscription criteria contribute to inequality in access to effective schools. Our focus on geographic criteria is motivated by the consistent and strong evidence, in England and worldwide, that property prices increase around popular and high-performing schools, wherever access is partly determined by geography.[4] These property premiums can price lower-income families out of the area, reducing access to popular schools (Fitz et al., 2002, 2003; Fletcher-Campbell et al., 2007; Feintuck and Stevens, 2013; Burgess et al., 2023).[5]

[1] For example, Deming (2022) estimates around 30% of wage variation (inequality) in the US arises from education inequality.

[2] Around 24% of secondary school pupils in England (in our sample of schools in the 2018-2019 academic year) have ever been eligible for FSMs. FSM eligibility is one widely used indicator of socio-economic disadvantage.

[3] This derives from a simple regression where the independent variable is an indicator for enrolment in a highly effective school (in the top 25% of Progress 8). The explanatory variable is a binary indicator for not being eligible for FSMs. The results are essentially the same whether we control for Local Authority or not. These simple statistics do not have a causal interpretation, since reverse causality may be at play (a higher share of disadvantaged pupils could lower school effectiveness). Using the incoming cohort of pupils removes the direct reverse causality - that disadvantaged pupils reduce school effectiveness - but does not wholly solve it. Previous generations of disadvantaged pupils from the same neighbourhoods likely went to those same schools, and may in part account for the lower scores observed today. However, our focus on a value-added measure of school effectiveness mitigates the problem, as there is a low correlation between school-level composition and value-added.

[4] The consensus is that a one-standard deviation increase in school quality increases property prices by around 3-4% (Black and Machin, 2011). Since the abolition of selective (grammar) schools in the 1970s, school assignment in England has been largely based on where pupils live, with priority given through catchment areas, distance tie-breakers, and attending feeder schools (Gorard et al., 2002a; West and Hind, 2003; Coldron et al., 2008; Noden et al., 2014; West and Hind, 2016; Burgess et al., 2023).

[5] Van den Brande et al. (2019) note that catchment areas could be designed to draw from diverse neighbourhoods. This process could be politically charged and difficult to achieve, however, as evident from the first

We make a number of contributions to these debates. First, we establish some facts about geographic over-subscription criteria and inequality in access to effective schools. Second, using a structural model of families' preferences and schools' over-subscription criteria, we simulate the outcomes of three different reforms to over-subscription criteria. This is our main contribution to policy-making, and we describe in detail the reform we find to be most effective in terms of increased equity in access for minimal overall disruption to school allocations.

Our methodology combines national administrative data on families' school choices (their submitted rank-ordered lists, ROLs), locations, and pupil characteristics, with bespoke national data on school over-subscription criteria (covering 152 Local Authorities (LAs) and 3,248 schools)[6]. Using these data, we first document the patterns of school and residential choices and access to effective schools across families. By precisely geolocating pupils within schools' catchment area and 'de-facto' catchment area (defined by the distance cut-off), we compare the set of schools which are 'commutable' with those that are feasible considering geographic criteria.

Taking our main findings in turn, first, we study the association between geographic over-subscription criteria and educational inequality across LAs in England. The measure of educational inequality is a Gini coefficient capturing the disparity in assignment to more and less effective schools of pupils that are or are not eligible for FSM. The measure of schools' over-subscription criteria is created at the LA-level by taking the average percentage of schools using each criteria in their first three criteria (excluding the two mandatory criteria). The use of geographic criteria is associated with substantially higher inequality. Faith criteria and particularly test-based criteria are also very strongly associated with higher inequality.

Second, we consider how geographic over-subscription criteria change the nature of pupils' choice set of schools. We define these criteria as being based on pupils' location, including defined catchment areas, 'de facto' catchment areas or feeder schools. For each pupil, we take the median effectiveness for schools which are simply within a reasonable commute distance of home, and also the median effectiveness of schools where the pupil has priority due to geographic over-subscription criteria. We take the gap between these as the effect of imposing geographic over-subscription criteria, which we call the 'effectiveness gap'. The data show that this gap is strongly increasing with neighbourhood poverty, and with FSM status. That is, geographic criteria bite much more (restrict access to effective schools) for disadvantaged pupils.

Third, we provide empirical descriptive evidence to support the hypothesis that property price premiums around effective schools are (at least in part) driven by demand from families with school-aged children. At the school-level, more effective schools are more likely to attract pupils into their catchment areas over time, on average. For example, on average, the number of pupils living in the catchment area of a school in the top 10% of effectiveness increases by around 15%

introduction of catchment areas in Brighton & Hove (Boyle, 2010). From 2008, Brighton & Hove replaced a straight-line distance tie-breaking rule with catchment areas combined with a lottery to break ties. Two of these catchment areas were/are 'dual', containing two schools each. Allen et al. (2013) find that school composition changed in response to the change in over-subscription criteria, probably reflecting the change in the composition of the areas given priority to each school.

[6]See Burgess et al. (2023) for details of how we collected this data, plus analysis.

during their primary school years. This is compared to around 3.5% for catchment areas of schools in the bottom 10% of effectiveness. This is driven by non-FSM-eligible pupils, which suggests FSM-eligible pupils do not (or are unable to) make their school 'choices' through the housing market.

Fourth, we find evidence that some families make overly 'ambitious' or naive school choices that result in not being assigned to any of their chosen schools. Other families are more strategic, and actively remove popular schools with a low probability of admission from their ROL. We find that families living just outside the catchment area of a popular school are less likely to choose that school as first choice than families living just inside the catchment area. This is consistent with families 'skipping the impossible' when making their school choices (Fack et al., 2019), which implies that families' rank-ordered lists are not accurate reflections of their *true* preferences.[7]

Fifth, schools with 'open' (less geographic) over-subscription criteria widen access.[8] By comparing schools with 'open' criteria to their closest competitor school, we find that pupils apply and are admitted to schools with 'open' criteria from 0.4km and 1km further away, respectively. This is because when schools widen the opportunity for admission, fewer families view choosing the school as a wasted choice. Intakes to schools with 'open' criteria are also slightly more diverse, with higher percentages of FSM-eligible pupils and with EAL, on average.

Our second major contribution in this report is to model three potential reforms to school over-subscription criteria. The reforms we model are: priority in admissions for FSM-eligible pupils, up to a quota (called 'FSM Quota' below); a random ballot for a minority of places in a school, up to a quota ('marginal ballots') (see Burgess et al., 2020); and a test-based allocation, assigning to each school equal numbers of pupils from quartiles of the test score distribution ('banding') (see Gorard et al., 2002b). All these options are currently used by some schools in England.

Our modelling combines our estimates of pupils' true preferences for school characteristics (which depends on each pupil's feasible choice set of schools based on our detailed data on schools' over-subscription criteria), schools' current over-subscription criteria, and the algorithm used by each LA in England to assign pupils to schools. The estimated preferences are used to reconstruct each family's ROL of schools. We then replicate the LA algorithm to assign pupils to schools, based on the simulated ROLs and the reformed school over-subscription criteria. This analysis necessarily requires some simplifying assumptions, which we discuss throughout the report. The simulated reforms involve detailed policy design considerations, such as the size of the quota and the precedence order of allocating the quota seats.[9] Both of these policy choices matter, and for FSM quota and marginal ballots we report a central scenario (15% quota) and a full set of variations.

[7] As explained below, we take account of this in our modelling of potential reforms.

[8] 'Open' criteria are defined as random allocation of the available places to some applicants without reference to distance, test-based entry to assure a mixed-ability intake ('Banding'), unconditional FSM/Pupil Premium criterion, reserving places for pupils out of the catchment area or in an outer catchment area.

[9] Whether the quota is allocated before or after seats allocated according to the school's existing criteria matters Dur et al. (2018).

Reforms to school admissions are about reallocation: the reallocation of access to effective schools. The reforms do not change the levels of effectiveness available, but rather attempt to change which groups of pupils have access to highly effective schools and which groups do not.

This means that the focus of evaluating such reforms should not be on a measure of overall change in school effectiveness, because this will necessarily be very close to zero. A true sense of the impact of the policy will come from assessing which groups of pupils are more likely to be 'winners' (assigned to a higher-ranked school) and 'losers' (assigned to a lower-ranked school). Winners and losers are inherent to these sort of reforms: we want to increase the chances of some pupils in gaining access to highly effective schools and this unavoidably reduces the chances for others.

In this case, the key issue for comparing reforms is which social groups gain access to effective schools. We focus mainly on FSM-eligible pupils, as the standard measure of pupil-level income disadvantage, and a wider measure of poverty based on living in the poorest decile of neighbourhoods. Needless to say, since one of our reforms explicitly prioritises FSM-eligible pupils, this is by far the most effective of the three in enhancing access for that group. The other two reforms generate more changes from school assignments at baseline, but the 'winners' in these moves are much less focussed on FSM-eligible pupils.

There is little existing evidence about the effect of reforming school over-subscription criteria in England, although a recent reform in Brighton and Hove offers an excellent case study to validate our simulation findings in the future. For the overall effect of school over-subscription criteria, Allen et al. (2012a) find that strengthening the School Admissions Code (in 2003 and 2007) to ban some criteria (such as ranking by family interviews) slightly influenced the pupil composition of affected schools.

It is straightforward to see how the reforms we simulate might affect the attainment gap between more and less disadvantaged pupils: attending a more effective school will give a greater boost to the pupil's test scores. There is rich, robust, and worldwide evidence that the quality of a school affects pupils' educational outcomes, and beyond into the labour market. In the US, researchers are able to calculate the causal effect of schools by comparing the outcomes of pupils that randomly 'win' a place to those that randomly 'lose'. In a meta-analysis of studies of this design, Cheng et al. (2017) find that 'No Excuses' Charter schools (in the US) increase attainment in maths by 0.25 standard deviations and 0.17 standard deviations in literacy, for each year of attendance.[10]

There are other potential effects in the few schools where school composition changes significantly (see below), such as peer effects or ranking effects among pupils, and possible re-sorting of teachers across schools (Jackson, 2009; Karbownik, 2020).[11]

[10] See also Epple et al. (2016) and Cohodes and Parham (2021) for review articles for Charter schools more generally.

[11] Estimating peer group effects is notoriously difficult (Manski, 1993) but there are methods to overcome some of these challenges. Worldwide, there is inconclusive evidence that studying with higher ability peers improves educational attainment, but stronger evidence on social outcomes (such as drinking) and longer-term outcomes such as employment (Sacerdote, 2014). For England, Gibbons and Telhaj (2016) study peer effects resulting from cohort-to-cohort variations in peer quality on entry to secondary school. For example, due to natural variation,

There are potential disadvantages of school admissions reform to incumbent pupils at schools which receive more disadvantaged pupils after the reform. In addition, there could be negative consequences for pupils who are assigned to a less preferred school than at baseline. Unfortunately, there is no existing evidence about the latter channel. For the former channel, incumbent pupils in various settings appear to be largely unaffected by incoming pupils (Rao, 2019; Angrist and Lang, 2004; Imberman et al., 2012).

We anticipate a number of objections to the reform of school over-subscription criteria. First, reducing inequalities in pupils' home environments could have a bigger effect on educational inequality than changing school assignments. It would also be much harder to achieve, however, as long political experience has shown. Second, one popular response to inequities in school choice is to instead 'make all schools effective'. There is now a large evidence base which suggests this is difficult to achieve, however, particularly on a large scale (Deming, 2022). Reducing the imbalance in access to high-performing schools is therefore a feasible potential policy that might have meaningful effects on inequality.

More specific critiques of the particular reforms we propose are considered below, such as increasing travel times, disrupting the housing market, and displacing pupils from their local school. In brief, we find that the distribution of distance between home and school is only marginally increased even under the most radical reforms. This suggests that most pupils have a nearby alternative school to attend if they are reallocated to a less preferred school compared to baseline, although there will be specific cases where this is not so. There are typically few pupils reallocated to a less preferred school compared to baseline at the school-level, and over 90% of pupils attend the same school as at baseline. A minority of schools have around 10% of pupils who 'lose' their place at the school at baseline (and are reallocated to a less preferred school).[12] For the housing market, it is likely that prices would fall around the boundary of the catchment/de-facto catchment of popular schools, where many families currently strategically move to access the school but might lose access. Prices could rise very close to these schools, as certain access becomes even more dependent on proximity. We do not expect premiums to change dramatically in most areas, however, as admission probabilities will change marginally. In current work, Greaves and Venturin (2025) estimate the price premiums paid around secondary schools in England by comparing neighbouring properties which differ only in location on either side of a catchment area, finding that there are significant price premiums only where the difference in school quality on either side of the catchment area is very large. This suggests that the housing market will be disrupted only around a minority of schools.

the prior ability (measured in primary school) of year 7 pupils might be higher or lower. Using this variation, Gibbons and Telhaj (2016) find that the effect of exposure to higher ability peers is positive and statistically significant, but relatively small. A one standard deviation increase in peer quality leads to a 0.02 standard deviation increase in attainment at Key Stage 3. Any effect of reforming school over-subscription criteria on education outcomes through exposure to higher ability peers is therefore likely to be positive, but relatively small.

[12] For FSM quota, the 90th percentile pupils reallocated to a less preferred school than at baseline is 8.7%, for marginal ballots it is 14%, and for banding it is 13%.

2 Background

In this Section we briefly describe the set up of the school system and school choice process in England, which provides context necessary to understand our analysis and modelling choices.

2.1 The structure of the school system in England

The compulsory school system in England is organised around three stages: early years, primary education and secondary education. Secondary education, which is the focus of this report, covers ages 10/11, up to when the pupils are 15/16 years old.[13] The academic year runs from September to July. After compulsory schooling, pupils are required to be in some form of education or training until the age of 18. For pupils continuing in the academic track, this will be A-level qualifications, which are the typical route to university.

2.2 Qualifications in England

The exams at the end of secondary education (known as General Certificate of Secondary Education or GCSEs) are high-stakes for the pupil, as they are a gateway to the academic A-level qualifications, have a strong influence on the chance of continuing through to higher education, and also on job prospects. For example, Machin et al. (2020) find narrowly missing the Grade C threshold for GCSE English Language (equivalent to level 5 in GCSE results today) reduces the probability of remaining in education until age 18 by around 6 percentage points, and increases the probability of being NEET (not in employment, education or training) at age 18 by around 3 percentage points. Expanding around this threshold, comparing all pupils that achieved a Grade C compared to a Grade D in English Language, double science and mathematics, Jerrim (2023) finds consistent evidence that meeting the threshold increases the probability of progression to higher education by around 6% and employment later in life (for English and maths exams, between 1% and 4% at age 26). Using a different methodology, Hodge et al. (2021) find higher earnings are associated with higher GCSE grades.[14]

2.3 Secondary school admissions in England

This paper focuses on the transition into secondary school, specifically the process by which pupils are allocated to one particular secondary school. This Section provides some necessary institutional background on admissions arrangements for secondary schools in England.

In England, families have had the right to 'express a preference' for the school they would like their child to attend since the 1988 Education Reform Act. In practice today, the School Admissions Code governs many aspects of the process, for example, the number of 'choices'

[13] The minority of schools that do not follow this timing are either 'middle' or 'all-through' schools. There are around 100 middle schools in England, concentrated in 6 LAs, where pupils enter at around age 9 and leave at around age 13. There are also around 100 'all-through' schools that educate pupils from compulsory school starting to leaving age. Middle and all-through schools are included in our sample where the school or relevant admissions authority provides admissions arrangements for the secondary school phase.

[14] The authors find that, for the cohort taking GCSE exams between 2001 and 2004, "A one-grade improvement in overall GCSE attainment is associated with an average increase in the present value of lifetime earnings of £8,500".

families can express and the type of over-subscription criteria that schools can adopt. Families submit a ROL of schools they would like their child to attend, in order of preference, to their LA of residence. The LA then coordinates the process by running an assignment algorithm to place each pupil into school. This algorithm takes into account families' preferences, schools' capacities, and schools' over-subscription criteria. Each of these aspects is summarised in more detail below.

2.3.1 Rank-ordered lists (ROLs)

The School Admissions Code states that LAs must provide families with a common application form, with a minimum of three choices for state-funded schools. There is no maximum number of choices specified, but in practice the maximum number of choices permitted in England is six. This is relatively low in the international context, and the average number of schools pupils have within commuting distance, and may lead to sub-optimal matches between pupils and schools (Walker and Weldon, 2020). For example, around 10% of countries around the world have a maximum list length of 7-9, around 25% have a maximum of 10 or more (Neilson, 2024). In addition, the coordinated secondary school admissions process in Chile, Hungary, and Romania allows families to list as many schools as they wish, through an unlimited ROL (Neilson, 2024).

Families must submit their ROL to their LA of residence, although they can list schools in different LAs. Private schools are not included in the coordinated admissions process, but all types of state-funded schools are, including partially selective schools, selective schools and religious schools.

For secondary schools, the deadline to submit school choices is 31st October, in the academic year before the pupil begins secondary school in September. Families and pupils find out which school they have been assigned to on National Offer Day, which is the 1st March (roughly four months after school choices were submitted) or the next working day after the 1st March.

To inform their choice, families have access to a vast amount of publicly available information about secondary schools. This includes school performance tables provided by the Department for Education (including information on staffing, funding, and pupil composition in addition to attainment and pupil progress measures) and school inspection grades from Ofsted. Families are able to compare this information for all schools within a certain radius of their home (or other schools of interest to them) on one central website. Many LAs also produce information booklets for families which contain the details of all secondary schools in the area.

Burgess et al. (2019) describe the nature of secondary school preferences submitted by all the families in England in 2014, in relation to school and family characteristics. Key insights from this work, based on national administrative data, are that first, many families make active school choices, with more than 60% of families by-passing their nearest secondary school for their first-choice. 27% of families make the maximum possible number of school choices, and this percentage rises in dense urban areas, and when the nearest school has low effectiveness. Second, families with and without eligibility for FSM have similar patterns of school choice, defined by 'the number of choices made, the proximity of first-choice, and admission to first

choice school'. Despite this, Burgess et al. (2019) conclude that 'non-FSM households still access better schools due to their proximity to higher performing schools'. Finally, families with EAL make school choices consistent with high educational aspirations and engagement with the school choice process. This is consistent with Walker and Weldon (2020) who find that families from minority ethnic groups are willing to travel further for higher quality schools than white families.

The preferences that families submit are in many cases decisive. Indeed, on average, around 85% of families are offered a place at their first-choice secondary school (Burgess et al., 2019). The School Admissions Code states that, apart from selective schools, all state-funded schools must offer a place to each pupil that has applied for one if they have enough places. Where there are more applicants than places, however, schools must use over-subscription criteria to determine who receives an offer at each school.

2.3.2 Schools' over-subscription criteria

Every state school in England is required to publish their over-subscription criteria in advance of the school choice process, stating which pupils have priority if there are more applications than places. This Section documents the legal background for schools' admissions arrangements, while Section 3.1 summarises our evidence on the over-subscription criteria schools adopt in practice.

In England, the School Admissions Code regulates admissions, with the aim of ensuring that all state school places "are allocated and offered in an open and fair way" (Department for Education, 2021).[15] The School Admissions Code has the force of law, and its provisions are mandatory requirements (paragraph 12).[16]

The School Admissions Code identifies two categories of pupils that must be given top priority in admissions, which we refer to as 'mandatory' criteria: children with an Education Health Care Plan (referred to as 'EHCP' in the following) and 'Looked After' children. Beyond these, the School Admissions Code does not specify what criteria are allowed; it does not "give a definitive list of acceptable admissions arrangements" (p. 12). Instead, "It is for Admissions Authorities to decide which criteria would be most suitable to the school according to the local circumstances." (p. 12). In practice, the School Admissions Code describes a long list of over-subscription criteria that are *not* allowed. Schools are not allowed to select pupils based on their family's income, occupation or wealth ("they must not ... give priority to children according to the occupational, marital, financial, or educational status of parents applying.").[17]

[15]This applies to mainstream schools only, where the term 'mainstream' excludes schools designated as solely for pupils with Special Educational Needs. These schools are known as 'Special' or 'Specialist' schools in England.

[16]The School Admissions Code was introduced following The School Standards and Framework Act 1998, and has been amended (typically strengthened) over time (in 1999, 2003, 2007, 2009, 2010, 2012, 2014 and 2021). Studying changes across the 2003 and 2007 School Admissions Codes, Allen et al. (2012b) show that regulating admissions arrangements in this way appears to affect the differentiation of school intakes. See Allen et al. (2012b) for an excellent description of the introduction and revisions of the School Admissions Code until 2009.

[17]The School Admissions Code also bans other criteria that might reasonably be interpreted as schools attempting to estimate the family circumstances or the child's ability, such as listing the child or family's hobbies, conducting interviews, requesting photographs of the child, or requesting donations to the school.

Table 1: Types of school and Admissions Authorities in England

School type	Admissions Authority	Percentage of secondary schools (2019)
Academy	Academy Trust	71.00
Free	Academy Trust or Governing Body	6.74
Foundation	Governing Body	5.14
Voluntary Aided	Governing Body	6.74
Voluntary Controlled	Local Authority	0.74
Community	Local Authority	9.64

Source: Department for Education, 2021 (p. 6.) and Department for Education, 2014 (p. 11.)
Note: Foundation schools are also state-funded schools with more autonomy. Voluntary Aided and Voluntary Controlled schools have degrees of more autonomy than community schools, and typically have a religious character. 'Free' includes studio schools (6) and university technical colleges (11). 'Academy' includes 'converter' and 'sponsor-led' academies. 'Converter' academies are schools that were previously community and that converted to academy status. 'Sponsor-led' academies were previously under-performing community schools that were required to convert to academy status, with sponsorship to contribute to new school buildings and/or capital investment. 67.09% of academy secondary schools (47.63% of all secondary schools in England) are 'converter' academies, and the remainder are 'sponsor-led' academies.

An important exception is the priority for 'disadvantaged' pupils, for example eligibility for FSM and/or the Pupil Premium (PP), which has been allowed since the 2014 version of the School Admissions Code.

Schools are not allowed to select pupils by ability and behaviour ("take account of reports from previous schools about children's past behaviour, attendance, attitude, or achievement" p. 12). Exceptions are the 163 explicitly selective schools, 40 partially selective schools, and 136 schools with an aptitude quota granted by the school's specialism, for example in music or languages.

Within these rules, over-subscription criteria are set by the Admissions Authority of the school. School type determines the Admissions Authority. For community and voluntary controlled schools, the Admissions Authority is the LA. For the other school types, the Admissions Authority is the Governing Body of the school if it is a singleton, or the Academy Trust if the school is in a multi-school group (Table 1).[18] In our data overall, around 90% of schools are their own Admissions Authority and around 10% are controlled by the LA (Table 1).

2.3.3 Local Authority algorithm

LAs have an important role in the school choice process. LAs are responsible for ensuring sufficient school capacity in their area, coordinating the school admissions process and providing home-to-school transport for eligible pupils. LAs are also responsible for setting over-

[18]Other differences across school types include whether the per-pupil funding is received through the LA or directly from central government. All these types of schools are funded according to a National Funding Formula, which allocates per-pupil funding, with higher funding for certain groups of pupils, for example pupils with Special Educational Needs, EAL, and eligible for FSM. Community, foundation, and voluntary aided/controlled schools receive this funding through their LA, while academy and free schools receive this funding directly from the Department for Education. Free schools and academies receive an equivalent level of funding per pupil as a community school in the same area. In addition, they receive funding equivalent to services previously provided by the LA (West and Bailey, 2013).

subscription criteria for community and Voluntary Controlled schools in their area. There are 152 LAs in England, which vary enormously in the number of schools, population density, and physical area. Urban LAs tend to be geographically smaller, and rural LAs tend to be geographically larger.

Coordinating the school admissions process means assigning pupils to schools, based on schools' capacities and over-subscription criteria and pupils' submitted preferences (ROLs).

There are multiple ways that the LA could assign pupils to schools, based on submitted ROLs and schools' over-subscription criteria. In England, the process is known as the 'equal preferences' algorithm, and is equivalent to what is known in the scientific literature as the 'school-proposing deferred acceptance algorithm'. The result of this algorithm is that all pupils are assigned to their most preferred school, unless there is excess demand for that school. Whenever there are more pupils who would like to attend the school than available places, the LA assigns places to pupils in order of priority defined by each school's over-subscription criteria.

In practice, families receive only one offer at the end of the algorithm, but we detail the internal steps of the algorithm for clarity:[19][20]

Round 1:

> [**Offer stage**] Each school offers a seat to the pupils who applied to them, using their criteria and tie-breaking rules in case of excess demand.
>
> [**Acceptance stage**] Pupils who have received more than one offer keep only the one they prefer (based on their ROLs) and reject the others. Schools' remaining capacities are updated accordingly.

Round $k \geq 2$:

> [**Offer stage**] Schools with remaining seats offer them to pupils who applied to them and who are next in the school's ranking.
>
> [**Acceptance stage**] Pupils who have received a new offer (or more) compare them with the offer they have kept from the previous round, if any, and only keep the one they prefer. Schools' remaining capacities are updated accordingly.

Round k is repeated until no more pupils are on schools' lists to which they have not made an offer or until schools no longer have remaining capacity. Note that pupils' assignments weakly improve over the course of the process. At each stage, they only keep the best offer so far, so their situation can only improve.

[19] For real-life examples, some descriptions from LAs in England are Brighton and Hove LA and West Northamptonshire Council. There is a clear description by a website focusing on 11+ exams, which determines access to selective schools.

[20] These rounds are typically performed by a computer with no need for human intervention. Pupils are only informed about their final assignment, and not the outcome of the intermediary steps.

3 Data

As described in the previous Section, the school admissions system in England involves families submitting a list of their preferred schools, schools (or Admissions Authorities) publishing their over-subscription criteria, and a centralised algorithm (at LA-level) bringing these together. We now describe our data on all of these aspects, along with our data on pupils and on schools. Specific details on our data harmonisation and construction procedures are in Appendix B.

3.1 School over-subscription criteria

As described in Section 2.3.2, when a school is over-subscribed, over-subscription criteria are used to determine in which order pupils are admitted, up to capacity. In other words, criteria can determine whether a pupil will be admitted to the school of their choice, and are therefore of first-order importance.

We have recorded and coded this information for all public secondary schools in England (3,248 schools) using, as primary source, the information published in guidance booklets published by the LAs and individual schools. Based on an extensive data collection, Burgess et al. (2023) provide a representative snapshot of how over-subscribed schools allocate seats, for the cohort entering secondary school in 2020-2021. These data are representative because the data collection covered almost all state secondary school in England, with no systematically missing schools. The data have unparalleled detail, including the order of precise criteria, the order of tie-breaking rules, school identifiers for all feeder primary schools, and geo-located catchment areas. The context for our data collection is a period of widespread 'academisation' of the secondary school sector.

We now briefly summarise the results from our previous report to give context to this one.

- **Geographic criteria** are used by almost all schools. In addition, geographic criteria are most often near the top of schools' over-subscription criteria, meaning they are likely to determine which pupils are admitted. This is likely to have consequences for equality of access in the education system, as there is much evidence that property prices rise around popular schools (see Leech and Campos (2003), Cheshire and Sheppard (2004), Gibbons and Machin (2008) and Gibbons et al. (2013) for evidence from England) which is likely to exclude lower-income families.

- **Selection** by ability occurs in 163 selective schools still operating in England. In addition, there are 40 secondary schools are permitted to be partially selective, and in practice admit up to 43.5% of pupils according to ability or aptitude.[21] Also, there are around 130 secondary schools with a specialism that are permitted by the School Admissions Code to admit up to 10% of pupils according to aptitude in this specialism. The effect of aptitude or specialism quotas on equality of access for lower social-economic groups is expected to be negative, as "high relative attainment in any of the subjects (even sport) will involve

[21] There is variation across partially selective schools in the percentage of pupils admitted according to ability of aptitude, from 10% to 43.5%. Source: correspondence with the Department for Education.

expense of resources of time and money for travelling, equipment and training" (Coldron et al., 2008). Selection according to test-score or aptitude is typically decided by a bespoke assessment conducted by the school or group of schools. For example, pupils applying to a selective school will need to sit the '11-plus' examination in the Autumn when they are in year 6, and register some months before this.

- In contrast, prevalence of the **FSM/PP** criterion is less common than would perhaps be expected, given the often progressive ethos of many schools, and the explicit aim that the introduction of the PP policy would facilitate access for disadvantaged pupils (Gorard, 2022). Only a handful of non-selective secondary schools currently give priority according to FSM/PP status. Schools are given additional funding for each pupil eligible for the PP, which varies by stage of education (primary vs secondary) and pupil background (pupils eligible for FSM, at any time during the last six years vs pupils ever looked after by a LA or other state care). For example, the funding per pupil ever eligible for FSM for secondary schools is £1,050 for the 2024-2025 academic year (Department for Education, 2025).

- A few schools are currently using **'innovative'** or **'open'** over-subscription criteria, including the FSM/PP, discussed above. These schools are showing that other approaches to admissions are possible and may serve as exemplars for other schools to follow. 'Innovative' or 'open' criteria include:

  - random allocation of the available places to some applicants without reference to distance (104 schools)
  - test-based entry to assure a mixed-ability intake ('Banding') (103 schools)
  - unconditional FSM/PP criterion (42 schools)[22]
  - reserving places for pupils out of the catchment area (23 schools)
  - reserving places for pupils in outer catchment areas (35 schools)

- Free schools are disproportionately likely to have 'innovative' or 'open' criteria, which may suggest that it is easier to implement non-geographic criteria from day one, rather than through reform.[23]

3.2 Schools' characteristics

As briefly described in Section 2.3.1, families have access to a wide range of data about schools to inform their school choices. We use the following variables to estimate families' preferences for school characteristics.

- Distance between home and school, calculated as a straight-line measurement (source: National Pupil Database and Get Information About Schools)

[22] 'Unconditional' refers to the criterion not being conditional on other pupil characteristics, such as location.
[23] Higham et al. (2024) find that new free schools are associated with increasing segregation at the primary school-level, but not overall at the secondary school-level.

- Religious denomination (source: Get Information About Schools). This source records the precise religious denomination and ethos of each school, for example Catholic, Church of England, Hindu, Jewish, Muslim and Sikh.
- Progress 8 score (source: School Performance Tables). Progress 8 is a national school performance measure produced by the Department for Education. The measure is standardised such that zero represents average school effectiveness, a positive number represents better than average effectiveness, and a negative number represents worse than average school effectiveness. The school-level measure is the average of all pupil-level progress measures, which in turn come from the difference in each pupil's progress from the end of primary school to the end of secondary school. 'Progress' is defined relative to the group of pupils with the same attainment at the end of primary school. We use the measure of performance from summer 2017, the most recent published before our cohort of interest made school choices, in Autumn 2018. To minimise the problem of missing observations in our dataset, we impute with attainment in adjacent years where school performance in 2017 is missing. In a minority of cases (fewer than 40 'new' schools) where school performance is not available for any years, we impute with the average performance in the LA.
- Percentage of pupils with English as an Additional Language (source: Get Information About Schools). This is the school-level percentage, from 2017.
- Percentage of pupils ever eligible for Free School Meals (source: Get Information About Schools). This is the school-level percentage, from 2017.
- Percentage of pupils with any Special Educational Need (source: Get Information About Schools). This is the school-level percentage, from 2017.

We use the following school characteristics to define the set of schools which are feasible for each pupil to access. For example, single sex schools of the opposite gender are not accessible. This 'feasible choice set' is defined in Appendix B and described briefly in Section 3.5.

- Catchment area (source: Authors' data collection)
- De-facto catchment area (source: National Pupil Database and authors' data collection). The de-facto catchment area refers to the cut-off at which pupils living closer are admitted under the distance tie-breaking rule.
- Feeder primary schools (source: Authors' data collection)
- Single sex (source: Get Information About Schools)
- Selective (source: Get Information About Schools)

3.3 National Pupil Database

We use the National Pupil Database (NPD) to provide data on pupils and their families. This is a large administrative dataset, covering all pupils in all state schools in England. It is managed

and owned by the Department for Education (DfE). Access to the data was provided by the DfE, through the NPD application process and the Secure Research Service run by the Office for National Statistics. The data provides a census of all pupils in state schools, taken in the Spring of each year. We use variables measuring pupil characteristics, pupil location, and pupil test-score history. We include the following pupil characteristics: a measure of family poverty, eligibility for FSM;[24] a measure of neighbourhood poverty, the Income Deprivation Affecting Children Index (IDACI) index and rank; gender; aggregated ethnic groups, and whether a pupil's parents/guardians speak a language other than English at home (English as an Additional Language, or EAL), and whether the pupil is White British or an ethnic minority. We also know for some cohorts the birth order within the family and whether the focus child is first-born or not.

Regarding the pupil's location, we were granted secure access to the full postcode. This locates the pupil very precisely, with the typical urban postcode including 8 - 12 addresses.[25] To give some context, in the UK as a whole there are around 1.7m postcodes.

Finally, the NPD provides a full record of Keystage test scores (and also early-years tests). The most relevant ones for this study are the Keystage 2 tests (KS2) taken at age 10 - 11 in the final year of primary school. These tests are national curriculum tests, and play no formal role in school admissions.[26] We use these results as a proxy for pupil ability, however, which will affect entry into partially selective and selective schools.

Our main sample from the NPD takes all pupils in year 7, the first year of secondary school, in the 2019-2020 academic year, who stated a preference for at least one school in the admissions process. This yields 578,809 pupils. This necessarily excludes pupils who made no submission, and around 23,000 pupils that submitted an ROL but do not attend a state school in year 7. Note that this cohort of pupils enters secondary school the academic year before our data collection of secondary school over-subscription criteria. This is unfortunate, but necessary, as the corresponding cohort finished primary school during the COVID-19 pandemic, and so have no measure of prior attainment (KS2 test scores).[27]

3.4 Families' school choices - submitted ROLs

As described in Section 2.3.1, families in the English state education system have the right to express a preference for the school that they would like their child to attend. We have access to administrative data which contains the universe of secondary school choices in England. We focus on the cohort of pupils submitting their school choices in October 2018, for entry to secondary school in September 2019 (the 2019-2020 academic year).

[24] As Campbell et al. (2025) make clear, using the FSM threshold in analysis and policy as the measure of disadvantage has problems, not least in creating sharp discontinuities in benefits. But this is the standard measure of disadvantage in use, and is already available data.

[25] Postcodes are typically larger in rural areas, but still typically locate a pupil precisely within school catchment areas.

[26] Indeed, the test results are not available when school assignments are made.

[27] These test scores are essential for two reasons. First, to have a proxy for academic ability that would determine entry to a selective school. Second, to explore the heterogeneity in school choices and offers across different ability groups.

The school choice data contain for each pupil: an anonymous pupil identifier; the school identifier for each nominated school, in order; the school identifier for the assigned school and the school the pupil goes on to attend.

This pupil-level data on choices links to the National Pupil Database, described above, via the pupil's unique anonymous identifier, and links to the schools data, discussed above, via the school identifier. Families that submit an ROL but do not enter the state-sector are included in these data, but in practice are excluded from the analysis as we do not observe pupil characteristics and household location in the NPD.

3.5 Assembling the pupil-school dataset

Our final dataset we use for analysis is at the pupil-school-level.[28] We create different samples depending on the choice set. The 'commutable' choice set for each pupil is all schools within a reasonable distance from their home and which accepts pupils of the same gender. The 'geographic' choice set removes all schools the pupil would have priority at given their location from the commutable choice set. For example, if the pupil lives outside the catchment area and the de-facto catchment area of a school, this school would be excluded from the 'geographic' choice set. Finally, the 'feasible' choice set additionally excludes with other criteria which means the pupil would not be admitted, such as selective schools for low-ability pupils, and all those they are, or would be, rejected from. Appendix B contains details for the construction of these pupil-specific choice sets, and provide a brief summary here:

Commutable choice set: All schools within a certain radius from the pupil's home, plus any schools chosen outside this radius, or distant schools where the pupil is in the catchment or feeder primary school. The radius is specific for the urban/rural classification of the pupil's home postcode. The distance cut-off for rural schools is 14.2km, for schools in towns is 10.3km, schools in London is 6.3km, and schools in other urban areas is 6.4km. These distances correspond to the 95th percentile of distance between home and school offered in our dataset, by urban/rural status. Single sex schools are excluded for pupils of the opposite gender. For example, a boys only school would be excluded from a girl's choice sets.

Geographic choice set: All schools where the pupil lives in the catchment or de-facto catchment area, or attends a feeder primary school. Schools that the pupil chooses are also included in the geographic choice set.

Feasible choice set: All schools in the geographic choice set, minus any that are inaccessible for the pupil based on pupil characteristics. This excludes selective schools for pupils who didn't choose a selective school and have low prior attainment (proxied by KS2 test scores). This set also excludes schools where the pupil applied but was rejected. Also, schools where the pupil would be rejected, on the basis of feeder school, catchment/de facto catchment areas and home-school distance. We choose not to restrict by religion as we only have an imperfect measure for the pupil's religion, and many religious schools have 'community places' for non-religious pupils.

[28] This means that each row in the dataset contains a unique pupil and school pair.

Table 2: Number of schools per choice set

Sample	Mean	Median	Standard deviation	25th percentile	75th percentile
All pupils:					
Commutable	19.11	16	13.72	9	25
Geographic	11.88	10	7.28	7	15
Feasible	11.04	10	6.94	6	14
FSM pupils:					
Commutable	21.95	19	15.19	11	28
Geographic	13.19	12	7.82	8	17
Feasible	12.29	11	7.52	7	16
IDACI-1 pupils:					
Commutable	22.8	20	13.51	14	28
Geographic	13.39	12	6.84	9	16
Feasible	12.55	11	6.58	8	15

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.

Note: 'FSM' refers to Free School Meals. 'IDACI-1' refers to neighbourhoods in the poorest IDACI decile. 'IDACI' refers to the Income Deprivation Affecting Children Index.

Table 2 reports the number of schools for each choice set, for all pupils, FSM-eligible pupils, and pupils living in the poorest 10% of neighbourhoods (IDACI-1).The largest reduction in the number of schools in the choice set is the imposition of geographic criteria. For example, for all pupils, the average number of schools in the commutable choice set is 19, compared to around 12 in the geographic choice set. FSM eligible pupils and IDACI-1 pupils have slightly more schools in their choice sets, perhaps due to their more urban location, but the reduction due to geographic and other over-subscription criteria is similar.

For each pupil, we create indicators for pupil characteristics, as outlined in Section 3.3.

For each pupil-school pair, the dataset contains information on pupil's school choices (see Section 3.4). For example, the main independent variable is equal to one if the pupil chose the school as first choice, and equal to zero if not. Other variables are binary variables for choosing the school in any position in the ROL, and assigned a place and attend the school. We also know precise home to school distance, measured in a straight line, which is the relevant tie-breaker for most secondary schools in England, and is also a relevant school characteristic that families value (Hastings et al., 2009; Borghans et al., 2015; Burgess et al., 2015; Denice and Gross, 2016; Glazerman and Dotter, 2017; Akyol and Krishna, 2017; Beuermann et al., 2022; Fack et al., 2019; Harris and Larsen, 2019; Ruijs and Oosterbeek, 2019; Abdulkadiroğlu et al., 2020; Bertoni et al., 2020; Walker and Weldon, 2020).

For each school, the dataset contains information on school composition and school performance, and school over-subscription criteria (see Section 3.1). For example, we create indicators for whether the pupil lives within the catchment and/or de-facto catchment for each school, and attended a feeder primary school, if relevant.

At the end of this process we have a dataset with 3,248 schools and 578,809 pupils. There are 11,062,379 pupil-school observations in the commutable choice set, and 6,873,626 pupil-school observations in the geographic choice set. In the feasible choice set there are 6,389,800 pupil-school observations. On average pupils have 19 schools in their commutable choice set, with a median of 16. This declines to an average of 12 in the geographic choice set, with a median of 10. The median remains 10 for the feasible choice set, with an average of 11.

We use the pupil-school feasible choice set to estimate families' preferences for school characteristics. Some of our analyses rely on a measure of over-subscription, which we define as follows. A school is classified as over-subscribed if the number of pupils offered a place is lower than the number of pupils who would like to attend the school.[29] In practice, we define a school as over-subscribed if we observe at least one pupil who listed the school in their ROL but got admitted to a school lower in their ROL.

4 Admissions arrangements and educational inequality

This Section describes the relationship between schools' admissions arrangements (over-subscription criteria and tie-breaking rules) and educational inequality. We show inequality in the effectiveness of schools that, respectively, advantaged and disadvantaged pupils attend. Furthermore, we show that this inequality is related to schools' admissions arrangements.

We first create a measure of inequality of educational access at the LA-level and show that it covaries with the over-subscription criteria most commonly used in the LA. In particular, the use of geographic over-subscription criteria is associated with higher levels of inequality in educational access.

Consequently, in a second step we explore the imposition of geographic criteria on the schools available to the pupils. Geographic criteria reduce the set of schools that are feasible for pupils. This changes the median (and mean) effectiveness of the schools available to pupils, relative to a situation without geographic over-subscription criteria. We show that this change in average available effectiveness is more negative for disadvantaged pupils, further establishing the detrimental impact of geographic over-subscription criteria on educational equity.

Finally, we explore whether geographic criteria are associated with excess residential moves, although we are limited to observing this from when pupils enter primary school.[30] We find that pupils are significantly more likely to move into the catchment areas of more effective schools, and that this is driven by non-FSM-eligible pupils. This corroborates the argument that geographic criteria systematically block access for lower-income households to more effective schools.

[29] This includes pupils who name the school as first choice, and pupils who name the school second choice (or lower), but were not accepted at the first choice (or lower) and would therefore like to attend the school.

[30] Many households may instead make residential choices related to secondary schooling prior to this point, given the high cost of relocation in England. This means that our results will underestimate the full extent of residential moves made to access secondary schools in England.

4.1 Over-subscription criteria and educational equity at the LA-level

To measure educational inequality, or more precisely, inequality in educational access, we construct, at LA-level, a Gini coefficient for the access of disadvantaged pupils to effective schools. While the Gini coefficient is commonly known for measuring income inequality, in this context it has a related but different interpretation: it measures the extent to which non-disadvantaged pupils are disproportionately sorted into more effective schools. A Gini of 0 means that disadvantaged pupils are distributed across schools of different effectiveness levels in exactly the same way as non-disadvantaged pupils; a Gini of 1 means perfect segregation - all non-disadvantaged pupils attend more effective schools than any school attended by disadvantaged pupils.

Specifically, we measure disadvantage by a pupil's eligibility for FSM, and we measure school effectiveness using a value-added measure, Progress 8 (P8). For each pupil, we take the P8 value of the school they were assigned to. We then construct, for each LA, the Gini coefficient of the distribution of FSM-eligible pupils across school effectiveness levels.

In our data, the Gini coefficient has a mean of 0.293, and a standard deviation 0.079; the overall distribution is unimodal and has a normal distribution shape.[31]

To explore to what extent inequality of educational access is related to admissions arrangements, we regress the LA-level Gini coefficient on LA-level summary measures of the over-subscription criteria used in these LAs, and other LA-level characteristics that may drive inequality of access.

Specifically, for each criterion (e.g. "applicant has an older sibling in the school") and for each of the schools in our dataset, we record whether this criterion was in the top 3 for this school, ignoring the top two legally binding criteria.[32]

For each criterion, we then compute the mean fraction of schools in each LA that have that criterion in their top 3. We do the same for tie-breakers.

Table 3 describes the frequencies of these criteria in our dataset.[33] Aside from the sibling criterion, the most commonly used criteria are geographic: either explicit catchment areas, distance tie-breaking, and feeder schools. Since these criteria all give priority to families in specific areas, albeit indirectly so for feeder schools, we have combined them into a single indicator equal to one if any are used.

Another special case is the FSM/PP criterion. Burgess et al. (2023) find that the FSM/PP criterion is mostly used by selective schools, though is typically rendered impotent by applying this after the criterion of passing the test. To avoid strange results driven by this correlation, we distinguish schools that use the FSM/PP criterion, according to whether they also use tests among their over-subscription criteria.[34]

[31]The Gini coefficient is produced using the ROCTAB command in Stata.

[32]These are EHCP and LAC, see Section 2.3.2 for more details. We also ignore two criteria which are very rare at school-level: Child of Armed Forces (1% of schools) and random tie-breaking (0.1% of schools).

[33]See Burgess et al. (2023) for further discussion on the distribution of school over-subscription criteria, and Section 2.3.2 for an overview.

[34]Specifically, we define: (1) Test criterion used, FSM/PP criterion used; (2) Test criterion used, FSM/PP criterion not used; (3) Test criterion not used, FSM/PP criterion used; The fourth category (neither criterion

Table 3: Schools' top three criteria

Criterion	% of schools
Sibling	92.6
Geographic - Catchment area	53.1
Geographic - Distance	19.7
Geographic - Feeder school	25.2
Child of staff	30.2
Faith	14.1
Test	10.8
FSM/PP	4.7
Child of Armed Forces Personnel	1.3

Source: Authors' dataset of secondary school admissions arrangements. Secondary school admissions arrangements collected from LA and school websites for entry to the 2020-2021 academic year. These numbers from Table A10, p. 80, in Burgess et al. (2023).
Note: These are percentages of 3,248 schools; criteria for entry in 2020-2021. Numbers add to more than 100% as each school can have up to three criteria in its top 3. These are school criteria; tie-break rules are not included in this table. Note the "top 3" are defined after the two mandatory top criteria. 'FSM' refers to Free School Meals and 'PP' refers to Pupil Premium.

Criteria and tie-breakers only matter if a school is over-subscribed, so we take account of that. We use the measure of whether a school is over-subscribed described in Section 3.5. At school-level, for each criterion and tie-breaker, we interact this binary measure of over-subscription with the binary measure of whether school s has criterion X in its top 3 criteria. Finally, we average this measure over the schools in the LA to produce an LA-level variable.

Educational inequality at the LA-level may also be driven by other LA-specific factors. These include (i) how rural or urban is the LA: rural; town (omitted category), urban-London; urban non-London; (ii) how many school choices families can make on their ROLs, which varies as discussed in Section 3; and (iii) the overall level of inequality in raw (rather than value-added) educational attainment from a previous cohort.[35] We control for these variables in the regressions. We also include the LA-level fraction of over-subscribed schools, as we use it as an interaction.

Table 4 describes the result of our regression of LA-level Gini coefficients on LA-level criteria averages and these other control variables (estimates not reported). Column (1) has one observation per LA, and this represents our main results. Because LAs differ dramatically in size, column (2) shows the results weighting each LA by the number of pupils; this produces little difference.

The coefficients indicate a relationship between variables, which may not be causal. This is because over-subscription criteria are chosen by schools' admission authorities (the Academy Trust, the Governing Body or the LA). We cannot rule out that these choices depend on LA's situation beyond those we control for. For example, LAs with poor public transportation may

used) is the reference category.

[35]This measure is included as a control variable to account for underlying inequalities at the LA-level which are unrelated to school effectiveness.

Table 4: Inequality of allocation to effective schools (Gini) and school over-subscription criteria

Criteria	Unweighted	Weighted
Siblings	0.152+	0.158*
	(0.079)	(0.073)
Faith-based criteria	0.152*	0.141*
	(0.071)	(0.065)
Geographic criteria	0.146*	0.150*
	(0.070)	(0.065)
Test and FSM/Pupil Premium	0.466**	0.419**
	(0.126)	(0.108)
FSM/Pupil Premium and not Test	0.083	0.145
	(0.214)	(0.224)
Test and not FSM/Pupil Premium	-0.022	-0.014
	(0.077)	(0.071)
Special Circumstances	0.037	0.041
	(0.036)	(0.034)
Child of Staff	-0.009	-0.006
	(0.049)	(0.049)
Random tie-break	-0.063*	-0.049*
	(0.026)	(0.024)
Distance tie-break	0.053	0.041
	(0.034)	(0.030)
Test-based tie-break	0.038	0.021
	(0.129)	(0.119)
Banding	-0.105	-0.105
	(0.076)	(0.068)
Constant	0.244**	0.229**
	(0.040)	(0.036)
N LAs	147	147
Adjusted R^2	0.286	0.369

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: The unit of observation is an LA. The dependent variable is the value of the Gini index for the allocation of disadvantaged pupils to effective schools relative to non-disadvantaged pupils. Column (1) has one observation per LA, column (2) is weighted by the number of pupils in the LA. The right-hand side variables are LA averages over school-level data. For each school, a binary variable indicating whether it has that over-subscription criteria in its top 3 (excluding the legally required two), interacted with an indicator variable for whether the school was over-subscribed. The LA-level variable is simply the average of this across its schools. Omitted criteria: Child of Armed Forces' parent; Random criterion (because very low fractions of schools have these). Also included in the regression (but not reported in the Table) are LA structural factors (urban-rural markers, whether the LA permits families a maximum of 3 or 6 choices on their ROLs, and a measure of overall attainment inequality) plus the LA fraction of over-subscribed schools. Standard errors in parentheses. ** p<0.01; * p<0.05; + p<0.1

be characterised by housing segregation and schools that prioritise geography, not because the geographic criterion *causes* inequality of access, but because the lack of public transport leads schools to prioritise pupils living nearby. As a result, we should be cautious when interpreting the coefficients as indicative of a causal relationship.

This said, the results do align with our expectations regarding the channels through which over-subscription criteria affect inequality of access. Consider first our main focus variable, geographic criteria. Use of a geographic criterion by over-subscribed schools is associated with higher inequality at the LA-level, and is statistically significant. To get a sense of scale, we can compare two otherwise identical LAs (based on the controls included in the regression) with the prevalence of geographic criteria at the lower and upper quartiles, as a standard way of comparing a high-but-not-very high value with a low-but-not-very-low value. Using the regression coefficient of 0.151, and the inter-quartile range of 4.19, the difference in the Gini is 0.036. This difference corresponds to 45 percent of the Gini standard deviation, or 12 percent of the Gini mean, which is sizeable.

Second, as expected from other studies, the presence of over-subscribed selective schools with test-based criteria is associated with higher levels educational inequality. This is despite them also typically employing the FSM/PP criterion in their top 3 over-subscription criteria, because most FSM/PP-eligible applicants do not score highly enough in the test to be considered under the FSM/PP criterion.

The only other criterion achieving modest statistical significance is the use of faith-based criteria. It is also associated with higher levels of inequality.

4.2 Geographic criteria and feasible choice sets for more and less disadvantaged families

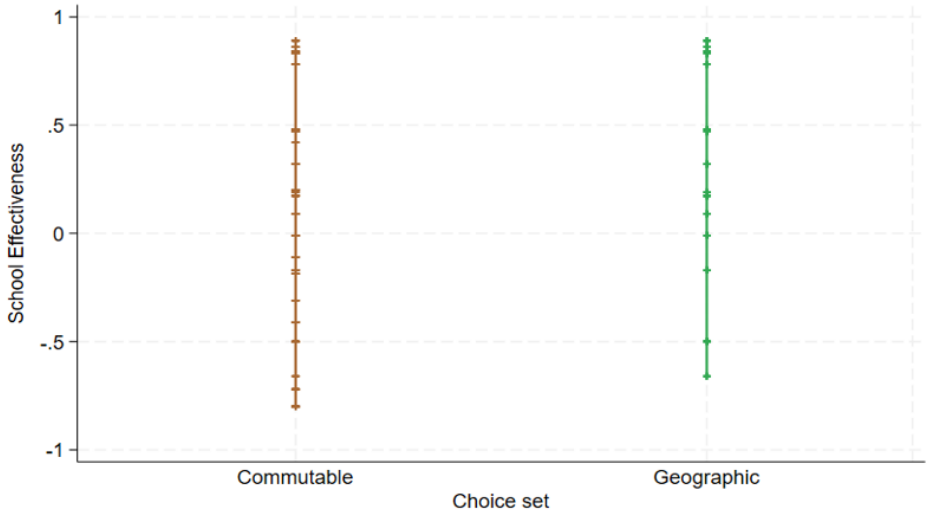
Given these results, we further explore the role of school over-subscription criteria defined by geography, namely the use of explicit catchment areas (for example, lists of postcodes), de-facto catchment areas, and feeder schools.

Over-subscription criteria remove certain schools from a pupil's choice set, where the pupil does not have high enough priority, given their characteristics and/or location. In the case of geographic criteria, these choice set deletions are defined by geography: pupils living in some places will not have access. Because real estate in the favoured areas attracts a price premium, geography-based criteria will tend to have different effects based on pupils' family income.

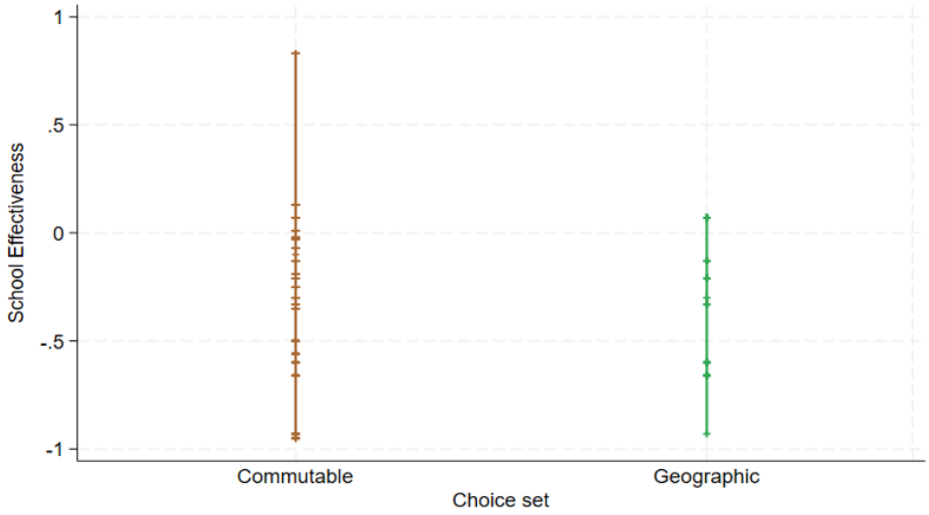
To illustrate this, we select two micro-neighbourhoods in our data, one advantaged and one disadvantaged.[36] We use the IDACI poverty index described in Section 3.3 to capture advantage.

We take the view of a group of pupils living in a neighbourhood, thinking about which secondary schools to apply for. Consider first the set of all secondary schools within the commutable set,

[36]Ideally, we would illustrate this process using just one pupil in a disadvantaged neighbourhood, relative to one in a wealthier place. But to ensure pupil anonymity, data security regulations require a minimum of ten pupils be used.



(a) Affluent Neighbourhood



(b) Disadvantaged Neighbourhood

Figure 1: Change in choice set after imposing geographic criteria

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Notes: The graph illustrates the change in available schools from the imposition of schools' geographic criteria. The vertical axis shows the school effectiveness (Progress 8) measure for each school in the choice set for the group of 26 pupils living in an affluent neighbourhood (panel a) and 24 pupils living in a poor neighbourhood (panel b). The horizontal axis is non-numeric and shows the situation for two school choice sets. The left-hand line shows the set of available schools in a choice set defined only by distance from the pupils' homes (the 'commutable' choice set); the right hand line shows the set of available schools in a choice set defined by the schools' geographic criteria (the 'geographic' choice set). See Section 3.5 for definitions of these choice sets.

simply considering the feasibility of the home-school commute. Each of those commutable schools has a set of characteristics, for example, pupil composition, school effectiveness, and distance. Figure 1 focuses on the schools' effectiveness, as measured by Progress 8.[37] The left-hand vertical line on each panel shows the set of those schools and their effectiveness scores represented by a + plotted. The line represents the choice set of effectiveness available to the pupils based on feasible commuting distance alone.

How does the imposition of geographic criteria change this? Many schools are over-subscribed and, as shown above, for many schools, a pupil's priority depends on distance between home and school. The right-hand vertical line in each Panel illustrates the choice set when we account for these over-subscription criteria: we only retain in the choice set the schools to which these focus pupils would have priority due to geographic criteria. In panel (a) of Figure 1, representing an affluent neighbourhood, few schools are lost from the choice set. There is a strong contrast here to panel (b) of Figure 1, drawn for a few pupils from a very disadvantaged neighbourhood: here, all the highly effective schools are removed from the choice set once we impose the geographic criteria.

Together, Figure 1 illustrates how geographic over-subscription criteria can harm poor neighbourhoods more than affluent neighbourhoods, contributing to educational inequality.

To investigate this issue more systematically, we return to the full dataset of over 550,000 pupils to examine whether this is a general phenomenon. The key comparison is between school effectiveness in commutable choice sets and geographic choice sets, the 'effectiveness gap', and how the difference varies across relatively affluent and disadvantaged neighbourhoods.

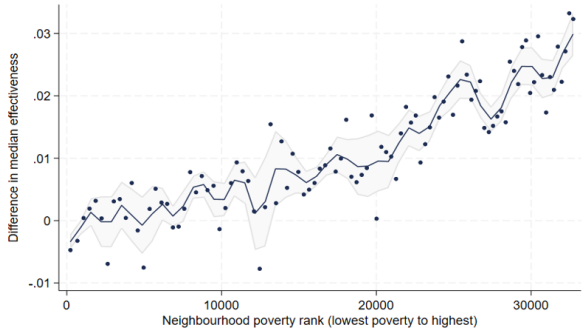
We calculate the 'effectiveness gap' for each pupil using the median school effectiveness in the commutable and geographic choice sets.[38] The difference between the median value of school effectiveness in the two sets summarises the extent to which the geographic choice set restricts access to effective schools. A higher value means that the geographic over-subscription criteria restricts access to effective schools more. We repeat this process to create alternative measures, by using the mean and maximum value of effectiveness, rather than the median, in the two sets.

The 'effectiveness gap' is larger in poorer neighbourhoods (defined by IDACI), which means that pupils from more disadvantaged areas can access less effective schools once geographic criteria are applied. Panel (a) of Figure 2 shows the relationship between the median effectiveness gap against centiles of neighbourhood poverty. It shows a strong positive slope throughout the range. The same pattern is evident in panel (b) of Figure 2, which shows the mean effectiveness gap.

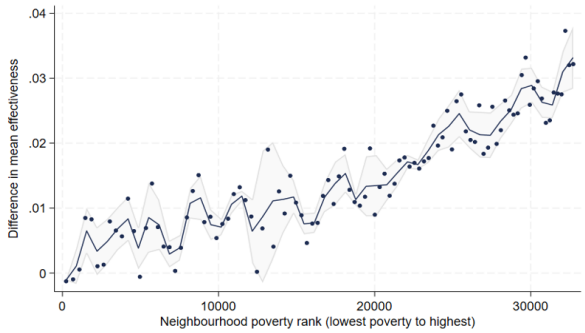
The corresponding graph for the maximum effectiveness gap is in panel (c) of Figure 2. The pattern is slightly different. The effectiveness gap is roughly constant for around two-thirds of the distribution and then increases sharply for the poorest third of neighbourhoods. In both cases, the use of geographic criteria affects disadvantaged families more than advantaged ones.

[37] For reference, recall that school effectiveness (Progress 8) has a mean of 0 and a standard deviation of 0.45.
[38] The median is the value of the middle school, if all schools were ordered from lowest to highest effectiveness.

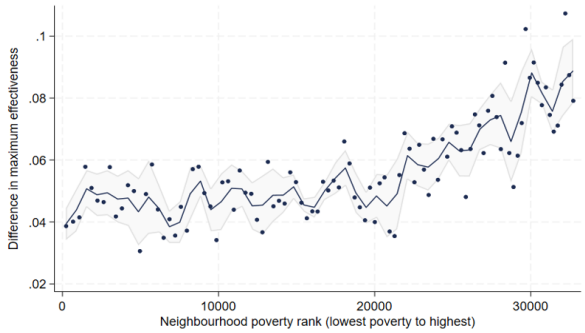
Figure 2: Neighbourhood poverty and the effectiveness gap in school quality between commutable and feasible choice sets



(a) Median gap



(b) Mean gap



(c) Maximum gap

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Each graph plots features of pupils' school choice sets against area poverty rates. Each plotted point represents a centile of the pupil-level data. The horizontal axis measures the IDACI rank of neighbourhood poverty. The vertical axis is based on, for each pupil, the difference in median/mean/maximum school value-added they can access between their 'commutable' and 'geographic' school choice set (see Section 3.5).

We can compare these numbers to standard intervention effect sizes. The variation (SD) in effectiveness, P8, over schools is 0.45. Among pupils living in disadvantaged neighbourhoods, the difference in P8 terms between the most effective school reachable in the commutable choice set and the most effective in the geographic choice set is around 0.07, or approximately 15 percent of the overall P8 standard error. This would be considered a strong outcome in an educational intervention. Obviously, our re-assignment intervention has pupils who move to lower P8 schools, and a full overview would evaluate the change in educational inequality.

We summarise these relationships with regression analysis, presented in Appendix Table A1. In all cases, the pattern is the same: the effectiveness gap increases with disadvantage.

In summary, geographic over-subscription criteria disproportionally negatively affect access to effective schools for less advantaged pupils. This is the first such systematic evidence using rich and complete data on the over-subscription criteria of some 3,200 secondary schools with a full cohort of pupils across the jurisdiction, for over 550,000 pupils in one cohort.

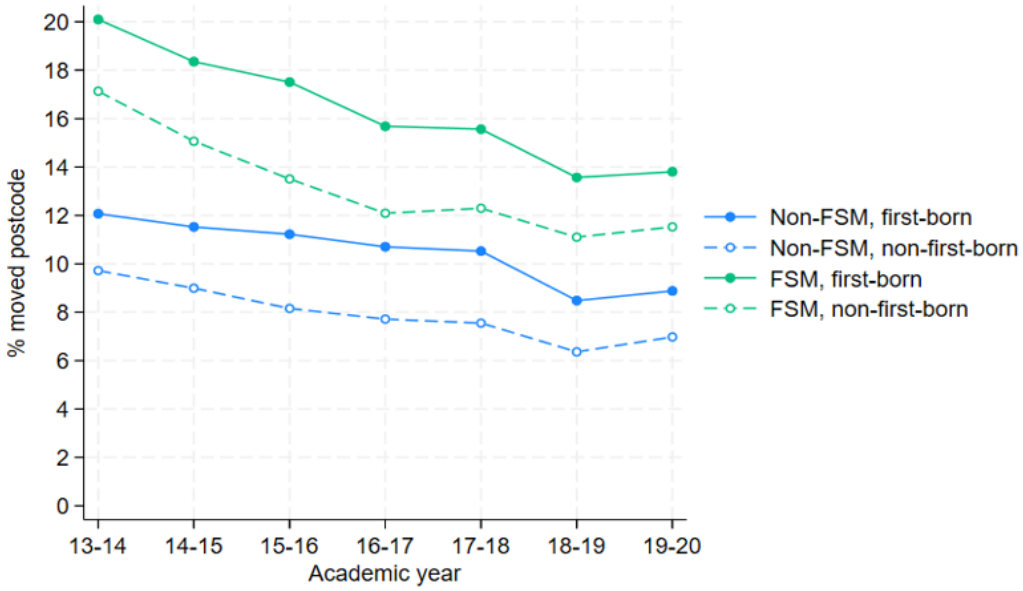
4.3 Catchment areas and pupil residential mobility

There is a long-standing empirical relationship between school quality and local property prices (see Black and Machin (2011) for a review). This is hypothesised to be driven by increased demand by families for properties around 'good' schools, which pushes up prices. For this study, we are interested in how much this process would be reversed if school admissions became less geographic. Evidence from other countries suggests that school admissions reform will affect the residential market. For example, Machin and Salvanes (2016) find that the property price premium halved around 'good' schools in Oslo after school admissions became based on test score rather than residential location. In the US, Charter schools are associated with lower neighbourhood segregation, as they have random rather than neighbourhood assignment (Rich et al., 2021; Monarrez et al., 2022). Similarly, Boterman (2021) finds that free school choice in Amsterdam has encouraged neighbourhood integration, as breaking the link between home location and school removes "some of the anxieties and perceived necessity of moving away from socially and ethnically mixed areas".

To explore this process in England, we use the data available to us to track pupils' residential mobility across academic years, for one cohort, from the year they entered primary school (Reception) to the year they entered Secondary school. Note that we do not have access to residential location prior to Reception, and residential decisions could be made before this time for many families.[39] Each Figure uses one cohort of pupils, those entering secondary school in the 2019-2020 academic year. For this one cohort, we can track their residential location over time, and calculate the percentage of families that move between academic years, and live in particular catchment areas over time.

[39]For example, Gambaro et al. (2022) finds that around 40% of households in urban areas of England moved between the time their child was 9 months and 5 years old.

Figure 3: Percentage of pupils in one cohort who move across academic years



Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: This Figure shows the percentage of pupils in one cohort that move postcode between two academic years. The cohort entered primary school in 2012-2013, which is the first time we can observe their postcode. '13/14' therefore shows the percentage of pupils that moved postcode between 2012-2013 and 2013-2014 (equivalent to between Reception and Year 1 of primary school). Moving postcode is defined as a different full postcode across adjacent academic years, excluding missing postcodes. This definition does not account for post reorganisation, which would change the postcode without a pupil having moved. This would affect the level of lines, but not the trend, as we would not expect postcode reorganisations to happen more frequently in some years. 'FSM' is 'Free School Meals'. 'First-Born' is equal to one if the pupil is the oldest child in the family, and zero if the pupil has at least one older sibling.

First, we plot some general trends in the percentage of pupils in this cohort moving residential location across academic years. Second, we consider the percentage of pupils in this cohort living in catchment areas of 'good' and 'bad' schools over time. Finally, we calculate the percentage change in the number of first-born pupils in this cohort living within the catchment area of each school, from Reception to Secondary school entry. We take this measure as a proxy for sorting in response to demand for the school, and find that it is correlated with school quality. Better performing schools have a larger percentage change in the number of pupils living inside the catchment area, on average.[40]

Figure 3 shows that, overall, families are less likely to move home across academic years as their child ages. There is some variation between pupil types. First-born children are more likely to move home than later-born children. FSM-eligible pupils are more likely to move home than non-FSM-eligible pupils. This pattern is similar for alternative definitions of moving home (not shown). Both of these alternative definitions reduce the chance that the family is moving for work rather than school related reasons.

[40]These second two analyses necessarily focus on schools with pre-defined catchment areas. Similar patterns may exist for schools with distance tie-breaking rules, but this is more difficult to analyse given the unpredictability of the precise distance threshold.

These aggregate patterns could mask variation across different types of schools, however. Figure 4 explores this variation by showing the percentage of all pupils in our selected cohort that live within different catchment area 'types'. The 'types' are groups of schools which are either 'good' or 'bad' in terms of effectiveness. 'Top over-subscribed' schools are defined as schools that are over-subscribed (rejected at least one applicant) and are in the top 25% of school effectiveness. 'Bottom under-subscribed' schools are defined as schools that are under-subscribed (did not reject any applicants) and are in the bottom 25% of school effectiveness.

Focusing first on the levels, Figure 4 shows there is a similar percentage of FSM-eligible pupils in our selected cohort living in the catchment areas of 'good' and 'bad' schools. Non-FSM-eligible pupils are more likely to live in the catchment area of 'good' schools, however. Around 12% live in the catchment area of a 'top over-subscribed' while 8% live in the catchment area of a 'bottom under-subscribed' school.

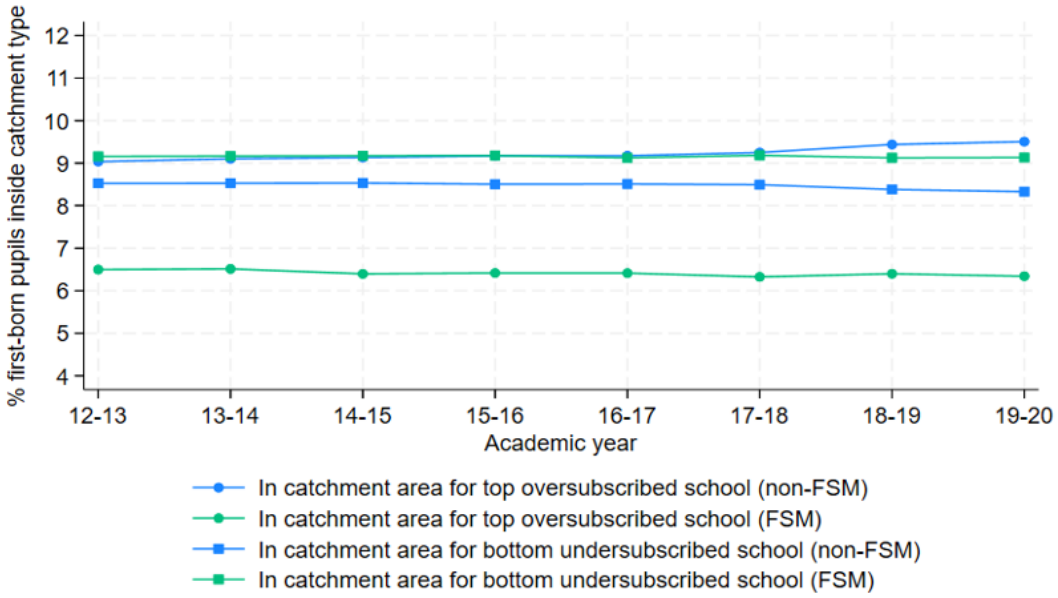
This pattern for non-FSM-eligible pupils in our selected cohort has widened as the cohort aged. As pupils get closer to the secondary school choice process, the percentage of pupils living in the catchment area of a 'good' school increases, albeit marginally. The percentage living in the catchment area of a 'bad' school decreases slightly. Overall, this pattern is consistent with some richer households systematically moving close to gain priority at high-performing over-subscribed schools. The pattern is muted, however, which suggests either that residential sorting for secondary schools is not as strong as commonly supposed, or that residential sorting happens before the pupil starts primary school.[41][42]

Within the overall percentage in Figure 4, there are likely to be some schools which attract many more entrants to the catchment area. To explore the differences across schools, Figure 5 is based on a school-level measure of the percentage change in the number of pupils in our selected cohort living inside the catchment area, from when they entered primary school to when they entered secondary school. To preserve anonymity, Figure 5 shows the results, on average, for groups of schools, grouped by school effectiveness. The grouping is at national-level, into 50 equally sized groups. Not all schools have catchment areas, however, and so the number within each group in Figure 5 varies.

[41] Greaves and Turon (2023) construct a dynamic model of families' school and residential choices, and show that families are forward-looking, given the cost of moving home. Greaves (2023) shows that the patterns of movement are similar for families that ever have children in areas with stronger and weaker incentives to sort into neighbourhoods for schools, relative to families that never have children.

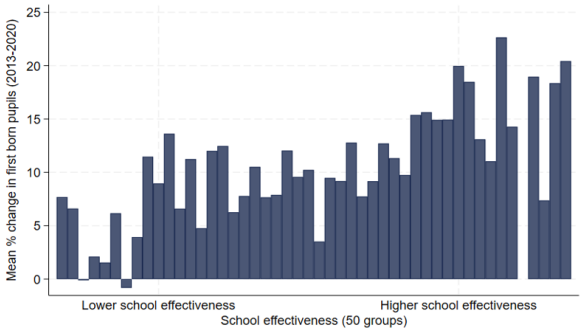
[42] This pattern is similar when defining 'good' and 'bad' schools as the top and bottom 10% of school-effectiveness (not shown).

Figure 4: Percentage of pupils in one cohort who live in catchment areas of 'good' and 'bad' schools across academic years

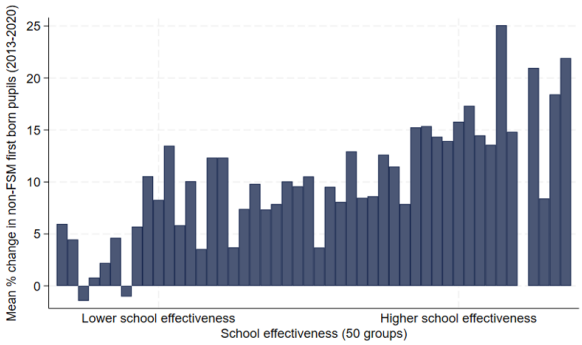


Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: This Figure shows the percentage of all first-born pupils in one cohort that live in a catchment area of two groups of schools. The percentage is calculated separately for pupils with and without eligibility for FSM. The definition of 'top over-subscribed school' is a non-selective, non-faith school with a catchment area, in the top 25% of Progress 8 in 2018 and which was over-subscribed in 2019. The definition of 'bottom undersubscribed school' is a non-selective, non-faith school with a catchment area, in the bottom 25% of Progress 8 in 2018 and which was under-subscribed in 2019. The definition of catchment area is a pre-defined geographic area, which gives pupils who live inside it priority at the school. This excludes 'de-facto' catchment areas defined by distance cut-offs from tie-breaking rules.

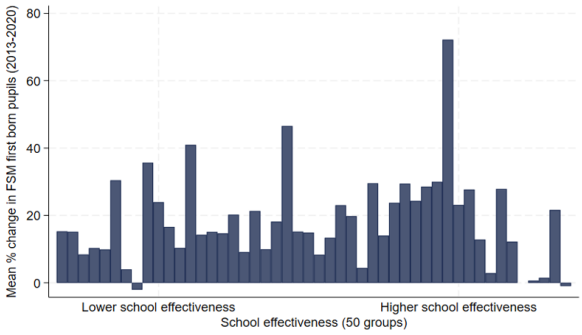
Figure 5: The percentage change in number of first-born pupils in one cohort living inside the catchment area, between entering primary school and secondary school



(a) All pupils



(b) Non-FSM-eligible pupils



(c) FSM-eligible pupils

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: These Figures are based on calculations at the school-level, for the percentage change in the number of first-born pupils living in the catchment area of the school, between 2012-2013 and 2019-2020. First-born pupils are those without an older sibling, as identified in the National Pupil Database. There are 50 groups of school-effectiveness, based on the national distribution of school effectiveness, with an equal number of schools in each group, nationally. As this Figure contains only non-selective schools with a catchment area, actual group size is unbalanced. Groups 48, 49 and 50 are combined due to low sample sizes, as schools at the top of the distribution are more likely to be selective schools which are less likely to have a catchment area. Panel (a) shows the percentage change for all pupils. Pupil (b) shows the percentage change for all pupils not eligible for Free School Meals (FSM), while Panel (c) shows the percentage for all FSM-eligible pupils. The definition of catchment area is a pre-defined geographic area, which gives pupils who live inside it priority to the school. This excludes 'de-facto' catchment areas defined by distance cut-offs from tie-breaking rules.

Panel (a) and panel (b) show as school effectiveness increases the percentage change in pupils in our selected cohort living inside the catchment area also typically increases. This is confirmed by a regression, which finds a statistically significant correlation of around 0.3 in each case. This means that as a school goes to one attainment group higher (for example, from being in the 30th highest attainment group to the 31st highest attainment group, out of 50) it increases the percentage of pupils moving into the catchment area by 0.3 percentage points. Moving ten attainment groups higher (for example, from 30th highest to 40th highest) increases the percentage of pupils moving in by 3 percentage points. This pattern is not evident for FSM-eligible pupils, suggesting that these families do not contribute to residential demand around popular schools. This is consistent with the theory that lower-income families are priced out of the market as prices rise.

Overall, this Section has shown that although patterns of systematic moving close to the school choice deadline are not observed overall, richer families are more likely to move into catchment areas of effective schools during their child's primary school years. This option appears not to be available for families with FSM. This supports the hypothesis that geographic over-subscription criteria for effective schools, and the consequent property price increases, increase the share of more affluent families at the school at the expense of disadvantaged families.

5 Families' school choices

The optimal strategy for families making school choices in England is to submit their ROL of their most preferred schools in order of their true preference, making sure to include at least one 'safe' school, i.e., a school within their feasible choice set (described in Section 3.5), to avoid the risk of not being assigned to any chosen school.

This Section explores the patterns of families' school choices with two aims. First, to inform policy debates, we explore to what extent families are left unassigned to any chosen school, and why. This helps inform whether more information should be provided to families about the school choice process. Second, to inform our modelling, we explore whether there is evidence of 'skipping the impossible' (as coined by Fack et al. (2019)) in ROLs. We conclude that there is evidence of strategic selection of school choices, as families are less likely to choose a popular school as 'first-choice' just outside compared to just inside the catchment area.

5.1 Unsuccessful school choices

Given the LA algorithm used in England, pupils are unassigned when the schools they listed on their ROL are at capacity and they do not have priority for these schools, given the existing over-subscription criteria. This suggests those families misjudged how ambitious their choices were, or were unlucky.

Table 5: Characteristics of unassigned pupils and their choices

		For those unassigned			
			Share of 'ambitious' schools chosen		
	% unassigned	% blank choice on ROL	None	Some	All
# choices permitted by LA					
3	3.73	48.24	11.25	2.32	86.43
4	5.10	56.06	11.09	1.4	87.51
5	5.72	67.41	8.71	2.35	88.95
6	5.46	65.58	8.21	6.06	85.73
Pupil characteristics					
Non-FSM	4.52	56.57	9.75	4.18	86.08
FSM	5.92	68.46	9.27	2.26	88.46
Non-EAL	3.96	60.54	10.28	3.62	86.10
EAL	6.87	55.97	8.66	4.13	87.20
Non-SEN	4.68	57.72	9.32	3.80	86.88
SEN	4.79	66.77	11.37	3.35	85.27
KS2 decile 1	4.80	70.51	10.72	2.20	87.08
KS2 decile 2	4.75	67.85	9.85	2.20	87.95
KS2 decile 5	5.24	58.14	9.7	3.58	86.72
KS2 decile 6	5.02	58.46	9.22	4.30	86.48
KS2 decile 9	4.50	50.89	9.24	5.47	85.29
KS2 decile 10	3.81	46.79	9.60	6.95	83.45

Source: Department for Education (school choices linked to National Pupil Database); Authors: data collection of school over-subscription criteria.
Note: This Table shows statistics for the percentage of pupils unassigned to one of their ranked schools (column 1), and the characteristics of pupils left unassigned (columns 2 to 5). 'Unassigned' means that the pupil submitted a rank-ordered list containing at least one school, but was not assigned to any of their ranked schools at the end of the algorithm run by their Local Authority.
The Table shows the statistics separately for pupils living in LAs that permit 3, 4, 5 or 6 choices. For example, 3.82% of pupils living in LAs that permit 3 choices are unassigned to any of their ranked schools at the end of the algorithm. Column 2 shows the percentage of unassigned pupils that left at least one school choice blank on their rank-ordered list, for example listing 2 schools when the maximum permitted is 3. For example, 40.58% of the pupils left unassigned at least one school choice blank. Columns 3 to 5 show the percentage of schools on the rank-ordered list that are defined as 'ambitious', for pupils left unassigned. An 'ambitious' school choice is defined as a school outside the pupil's feasible choice set (see Section 3.5).
'FSM' is 'Free School Meals'. 'EAL' is 'English as an Additional Language'. 'SEN' is special education need. 'KS2 decile' is the broad level of attainment at the end of primary school in KS2 assessments. Deciles group pupils into ten equally sized groups, according to their performance. KS1 decile 1 contains the 10% of pupils with the lowest performance, while KS1 decile 10 contains the 10% of pupils with the highest performance.

Table 5 quantifies the extent to which misjudgment by families drives unsuccessful school choices and suggests two measures that LAs could take to reduce it. First, families should be encouraged to use all available school choices. Column 2 of Table 5 shows that around 40% of those

unassigned left at least one choice blank on their ROL. Although some LAs give very clear guidance to families about the value of using all school choices, this could be emphasised more, and common myths dispelled, such as 'making only one choice will improve the chance you get it'.

Second, families should be encouraged to name at least one 'safe' school. Columns 3 to 5 of Table 5 show that more than 80% of all school choices on the ROL of those pupils left unassigned were 'ambitious', i.e. outside of their feasible choice set, rather than 'safe'. This suggests that some families have not understood the risk of being unassigned to any of their school 'choices'. Again, there is room for clearer guidance from LAs to families. The need for families to replace a truly preferred school with a safe school would be reduced by LAs allowing more school choices.

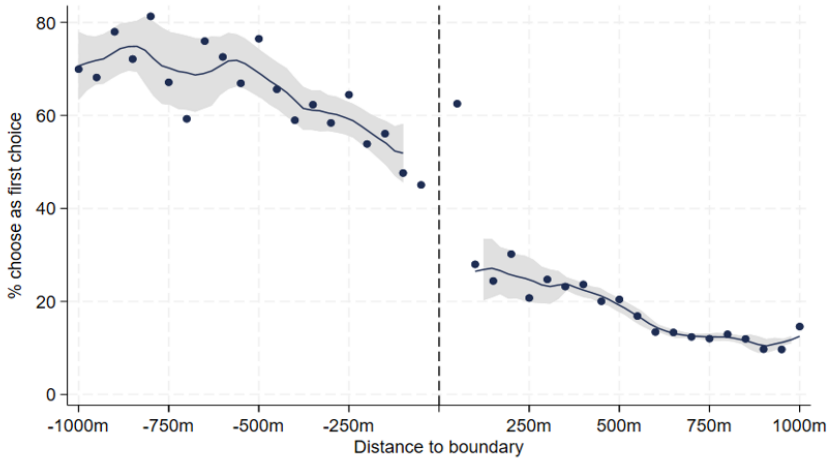
This guidance could be especially useful for families with EAL, who may be less familiar with the school choice system in England, or have more difficulty understanding (often complex) school over-subscription criteria. Table 5 shows that families with EAL are much more likely to be unassigned (6.9% compared to 4% with English as a first language). Aside from this difference, the overall pattern of Table 5 is a similar propensity for different pupil types to be unassigned at the end of the process. For example, around 4.5% of non-FSM-eligible pupils are unassigned, which is similar to the 5.9% of FSM-eligible pupils. Comparing across prior attainment groups, only pupils with the highest level of prior attainment (KS2 decile 10) are noticeably less likely to be unassigned (3.8% compared to over 4.5% in other deciles of attainment).

5.2 School over-subscription criteria and pupil applications

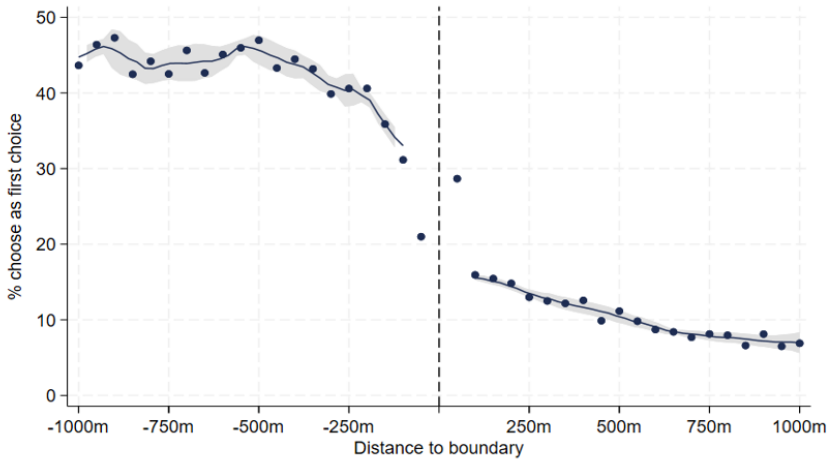
Section 5.1 showed that a minority of families are left unassigned at the end of the admission process and that part of the reason is that these families misjudged the probabilities of getting admitted to one of their listed schools. For most families, however, the school choices they make will be a careful balance of preference for the school and the probability of admission.

This Section explores the relationship between over-subscription criteria and the school choices families make in two dimensions. First, we present evidence that living just inside (versus just outside) a catchment area of a popular school noticeably increases the probability of applying to it. This is likely to reflect the lower probability of admission to the school from outside the catchment, resulting in families considering it a 'wasted' school choice, coined 'skipping the impossible' in the theoretical literature (Fack et al., 2019). Second, we show that schools with 'open' (to be defined precisely below) as opposed to strictly geographic over-subscription criteria draw and admit applicants from further afield, relative to their closest competitor school. These applicants are more likely to be eligible for FSM and have EAL, so 'open' admissions seem to increase diversity of the pupil intake.

Figure 6: The probability of applying to the popular school as first choice for first-born children, by proximity to the catchment area boundary



(a) Popular defined by movement into catchment



(b) Popular defined by effectiveness

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: This Figure shows the percentage of first-born pupils that apply to a popular, non-selective, and non-faith school with a catchment area, by varying distances to the catchment area boundary. Each dot on the Figure represents the average percentage of pupils living a certain distance from the boundary, grouped into 50m bands. The dotted line represents the catchment area boundary. Dots to the left of the boundary are inside the catchment area of the popular school. Dots to the right are outside. The lines are local polynomial smooth plots, and the shaded area represents the confidence interval around the local polynomial smooth plot. In panel (a) a 'popular' school is defined as an effective school (in the top 40% of the distribution of Progress 8) which has one of the most marked increases in the percentage of pupils living in the catchment area over time (above the 90th percentile, see Figure 5.) In panel (b) a 'popular' school is defined as an over-subscribed school in the top 25% of Progress 8 scores. First-born pupils are those without an older sibling, as identified in the National Pupil Database.

Living outside the catchment area of a popular school reduces the likelihood of choosing it. Figure 6 shows the probability of applying to a popular catchment school as first choice, according to distance from the catchment area boundary. Panel (a) uses a definition of 'popular' based on schools with catchment areas where many pupils move in during primary school, whereas panel

(b) uses a definition based on effectiveness. In both panels, there is a general negative trend in the probability of choosing the popular school as first choice. This could reflect distance from the school, which affects commuting time and the probability of admission where distance is used as a tie-breaker. In both panels, however, there is a discontinuity in the probability of choosing the popular school as first choice just inside and just outside the catchment boundary. In panel (a) further than 50m inside the boundary, the probability of naming the school as first choice is above 45%. Further than 50m outside the boundary, the probability is lower than 30%. This suggests that the lower probability of admission outside the catchment area reduces the likelihood of application. This pattern is replicated for the whole sample of pupils (first and later born pupils) and using distance bands of 20m rather than 50m. The same pattern is also present in panel (b), where the probability drops from over 30% just inside the catchment boundary, to below 20% outside it.

Do schools with 'open' admissions encourage applications from further afield? Table 6 compares the pupil composition of non-selective schools with 'open' over-subscription criteria with the school's closest competitor school without 'open' over-subscription criteria. 'Open' over-subscription criteria are defined as the presence of any of the following criteria: a quota for pupils outside a catchment area; an unconditional quota for pupils eligible for FSM/PP; random allocation. In addition, schools with no geographic criteria or tie-breaking rule are defined as having 'open' over-subscription criteria. The closest competitor school is defined as the school with the biggest overlap on families' school choice lists.[43] These two schools are likely to be similar in geographic location and ethos, given that many families list both schools on their ROLs. Differences in pupil composition could therefore plausibly be related to the over-subscription criteria. There is no causal interpretation for this descriptive analysis, however, as these two schools could have other differences besides their over-subscription criteria, despite being close competitors.

With this in mind, Table 6 presents the summary statistics for schools with 'open' over-subscription criteria, and their closest competitors without 'open' over-subscription criteria. The Table shows that schools with 'open' criteria have 14.9% of FSM-eligible pupils on average, compared with 14% for their competitor schools. Taking the difference between each pair of schools, the average difference is 0.91 percentage points. At the median, the difference is 0.44 percentage points.

Schools with 'open' criteria also have a higher percentage of pupils with EAL than their closest competitor school, on average. Differences by pupil prior test scores (KS2 decile) are typically small, although schools with 'open' criteria have a lower percentage of pupils in the highest KS2 decile by 0.8 percentage points. Most notably, schools with 'open' criteria have pupils that travel more than one kilometer further to school than their closest competitor school, on

[43]Specifically, we define a 'closest' competitor for each secondary school in England, based on the share of families that name each pair of schools on their ROL. For each school pair (the target school and potential competitor), we calculate the share of families who choose both schools, relative to the number of families who choose the target school. The 'closest competitor' is defined as the school among all possible school pairs with the highest share of common appearances on ROLs. To be a 'closest competitor', at least 10% of families who choose the target school must choose the competitor school, and vice versa.

average. This evidence is consistent with schools with 'open' criteria admitting pupils from a wider geographic radius, and with a more diverse intake.

Table 6: Pupil characteristics of those admitted to schools with 'open' over-subscription criteria and the school's closest competitor

Pupil characteristics	School with open criteria	Closest competitor	Difference			
			Mean	25th percentile	50th percentile	75th percentile
% FSM	14.88	13.99	0.89	-3.91	0.44	5.46
% EAL	28.81	25.84	2.97	-4.14	2.18	10.76
KS2 decile = lowest	8.81	8.67	0.14	-3.33	0.18	3.64
KS2 decile = 2	9.85	9.79	0.06	-3.27	0.29	3.11
KS2 decile = 3	9.97	9.43	0.54	-2.55	0.75	3.19
KS2 decile = 4	10.77	10.72	0.05	-2.16	0.33	2.14
KS2 decile = 5	9.12	8.94	0.19	-2.38	0.01	2.28
KS2 decile = 6	9.77	9.5	0.27	-2.18	0.21	2.59
KS2 decile = 7	11.93	12.3	-0.37	-2.97	-0.55	1.96
KS2 decile = 8	10.84	10.52	0.31	-2.1	0.51	2.96
KS2 decile = 9	10.10	10.51	-0.41	-2.76	-0.37	2.41
KS2 decile = Highest	8.86	9.62	-0.77	-4.13	-0.22	2.54
Distance to school (km)	3.45	2.36	1.09	-0.12	0.73	2.00

Source: Department for Education (National Pupil Database); Authors: data collection of school over-subscription criteria.
Note: 'Open' over-subscription criteria are defined as the presence of any of the following criteria: a quota for pupils outside a catchment area; an unconditional quota for pupils eligible for FSM/PP; FSM/PP (without conditioning on test score); random allocation. In addition, schools with no geographic criteria or tie-breaking rule as defined as having 'open' over-subscription criteria. 'Closest competitor' is defined as the school that most pupils who choose the school with 'open' over-subscription criteria also choose on their rank-ordered list. This school must not have 'open' over-subscription criteria for this comparison exercise.
School composition variables are: '% FSM' - the percentage of pupils offered a place at the school that are eligible for Free School Meals (FSM). '% EAL' is the percentage of pupils offered a place with 'English as an Additional Language'. '% KS2 decile' is the percentage of pupils offered a place within a broad level of attainment at the end of primary school in KS2 assessments. Deciles group pupils into ten equally sized groups, according to their performance. KS1 decile 1 contains the 10% of pupils with the lowest performance, while KS1 decile 10 contains the 10% of pupils with the highest performance. Distance (home to school) is the straight-line distance between the pupil's home postcode and postcode of the offered school, in kilometres.
Column 1 shows the school composition of pupils offered a place at non-selective schools with 'open' over-subscription criteria. Column 2 shows school composition for the 'closest competitor'. Columns 3 to 6 show summary statistics for the difference between the school with 'open' over-subscription criteria and the closest competitor, on average. Column 3 shows the mean (average) difference. Column 4 shows the difference at the 25th percentile, Column 5 shows the difference at the 50th percentile (or median), and Column 6 shows the difference at the 75th percentile. These percentiles are interpreted as the value if all school-pair differences were ordered, and the value 25%, 50% and 75% from the bottom were taken.

Appendix Table A2 shows these general patterns are also present for the pupil composition of all those that apply (rather than are admitted) to the school. The differences are more muted, however. This implies that 'open' over-subscription criteria affect the composition of

applicants to some extent (pupils are more likely to apply from further afield) but affects the pupil composition of those admitted more (pupils are more likely to be accepted from further afield).

This evidence suggests multiple policy implications for LAs to improve the matching between pupils and schools. These are:

1. Provide clear guidance to families about how to submit school choices to minimise the risk of unassignment to any of their preferred schools, while at the same time choosing some truly preferred schools. There is evidence that some families misunderstand how the school choice system works. There would be fewer families unassigned to any of their school choices if families did not leave choices blank and named at least one 'safe' school.

2. Target information at families with English as an Additional Language or new to England. Families with EAL more likely to be unassigned any of their choices at the end of the process.

3. Increase the maximum number of school choices families are permitted to make. This is low cost to LAs, and allows families to name their truly preferred schools without compromising the chance of being assigned to a chosen school. The number of choices permitted in England is relatively low compared to internationally (Neilson, 2024).

6 Modelling framework for evaluating reforms

This Section describes our approach to simulating the outcome of alternative admissions arrangements.

6.1 Overview

Simulating alternative over-subscription criteria requires two building blocks. First, we need a model of how school admissions work. School admissions take as inputs families' submitted preferences (ROLs), the number of seats available at each school (school capacities) and the way these are allocated. Section 6.2 describes in detail how we reproduce this process in our data.

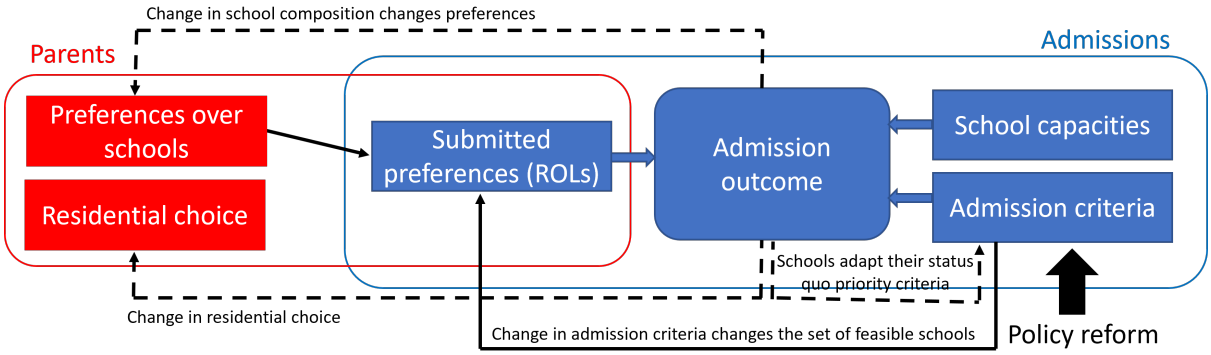
Second, we need a description of the channels through which the reform changes the behaviour of the actors of the admissions process, and therefore their inputs to the process.

Our analysis focuses on the way the reform changes the application behaviour of families. The current admissions system in England, with short ROLs, encourages families to apply to schools where their child benefits from some priority (feasible schools). Given that the reforms we examine change the set of feasible schools that families face, typically enlarging it (especially for pupils of less advantaged backgrounds), we can expect families to change their submitted choices.

To account for this change in application behaviour, we need to know families' preferences and how these map into submitted ROLs, under the new policy. Section 6.3 describes how

we estimate these preferences on the basis of the observed submitted preferences (ROLs) and existing admissions arrangements. Section 6.4 describes how we take these into account to generate the admissions outcome under the new policy.

Figure 7: Policy feedback mechanisms included in the policy analysis



Source: The authors.
Notes: The solid lines correspond to the channels included in the policy simulations. The dotted lines correspond to the channels not accounted for the main policy simulations.

Figure 7 summarises our modelling framework. The reform changes the over-subscription criteria. Holding everything else (including submitted preferences) equal would already change the admission outcome, since we have changed one of the inputs. This is the direct effect of the policy change. Additionally, our modelling framework explicitly accounts for how the change in over-subscription criteria affects ROLs, as it alters which schools are feasible and therefore worth applying to.

There are other likely indirect effects. First, the change in admission outcomes induced by the policy change, specifically the resulting change in school socio-economic composition, may change families' preferences over schools if families care about socio-econonomic composition. This effect is represented by the dotted line from 'Admission outcome' to 'Preferences over schools' in Figure 7. Our main analysis excludes this channel, but we explore the effect of including this channel in Section 7.3.1.

Second, reform may affect families' residential choices. Section 4.3 provided suggestive evidence that residential choice is related to school choice: residential moves before secondary school are more frequent for first-born pupils than for second and later children (Figure 3), and these moves are more frequent in the direction of catchment areas of effective schools (Figure 5). To the extent that the reforms reduce the role of geography, we may expect incentives to move to be reduced.

Third, schools may choose to adapt their 'status quo' over-subscription criteria - those not affected by the reforms we consider - or adjust capacity in response to the policy change. Criteria are not neutral: they favour one group of pupils over the other. If the policy leads to a change in intake that a school views as undesirable for whatever reason, that school may want to change some of the criteria not subject to the reform.

These indirect effects, if they happen, are likely to play out in the longer term. Our main modelling framework does not account for them explicitly. Instead, we discuss, when presenting and interpreting the results, the likelihood and magnitude of each channel. For example, for the first channel, if we find that families place little emphasis on socio-economic composition in their preferences over school, or if the reform has a small impact on pupil composition, then we would infer that families' preferences over schools are unlikely to change dramatically after the reform. Instead, if the reform has a large effect on pupil composition and families care about pupil composition, the policy is likely to also change preferences over schools. Section 7.3.1 provides an illustrative exercise quantifying this.

For the second channel, and anticipating the discussion later on, we note that all the reforms that we consider *reduce* the role of geography for access. Therefore, we suspect that the polices will weaken, if anything, the link between the 'school market' and the residential market. Nevertheless, we will pay attention to how the reform impacts access for different socio-economic groups, given the evidence in Section 4.3 of a higher mobility among richer families.

The last channel - where a change in school intakes leads schools to revise their 'status quo' criteria - will only materialise if two conditions are met. First, the reform does indeed affect the school intake, and, second, a change in criteria or tie-breaking can undo it.

Our proposed reforms will create losers and winners, since they are essentially about deciding how to allocate a fixed set of school seats. A remaining question, therefore, is whether they may increase exit to the private sector if 'losers' are unhappy with their assigned state school. Looking at the distribution of school assignment outcomes of non-FSM-eligible pupils and pupils from advantaged postcodes, for example the share assigned to their first-choice school, will provide us with some indication of whether this is a realistic scenario. To the extent that the reforms increase the number of families opting for the private sector: exit by some will improve access to the remaining pupils. In other words, the measures of access to effective schools for disadvantaged pupils that we provide for the different policy options can be seen as lower bounds.[44]

To sum up, these indirect effects are more likely to materialise if some groups of pupils or some schools are significantly affected by the reform. For this reason, when analysing the overall effects of the reform, we pay attention to the effects for all types of schools and pupils. Not only on the target group of our analysis, the disadvantaged pupils, but also on pupils from socio-economically advantaged postcodes (since they are the most likely to be able to afford to move), and on the schools themselves (changes in their school intakes). Large changes in access for advantaged pupils are likely to lead to changes in residential choices to adapt to the new reality, or exit from the state sector. Conversely, limited changes in access for advantaged pupils suggest that this indirect effect is likely to be small.

[44]We do not expect the reforms to reduce the current level of exit because they are all designed to increase access opportunities for disadvantaged pupils, a population less likely to exit the state sector anyway.

6.2 Modelling existing admissions arrangements

School admissions arrangements take as inputs families' submitted preferences (ROLs), the number of seats available at each school (school capacities) and the way these are allocated. A challenging aspect of replicating existing admissions arrangements is that we do not observe all the relevant characteristics of pupils that are used for determining their priority at each school. In this Section, we describe our data and how we work around this challenge.

Rank-ordered lists: For our analysis, we use the ROLs submitted for admission for the academic year 2019-2020. If a pupil was assigned to a school not listed in their ROL, we assume that this pupil was administratively assigned to another school at the end of the process. We add this school at the end of their ROLs. We drop the pupils who did not end up in the state-funded sector since we do not observe any information about them and therefore cannot infer their priority at each school. The final number of pupils in our dataset is 578,809, which is the number of pupils submitting a school choice for entry in the academic year 2019-2020 and entering the state secondary sector in the academic year 2020-2021.[45]

School capacities: We use the 2019-2020 published admission numbers (PANs) by the schools as a starting point to determine school capacities. When data are missing, we impute them from year 2020-2021 or later, if necessary. If the school is over-subscribed (namely, it rejects at least one pupil) we use the number of pupils offered a place as the school's capacity. If instead the school is under-subscribed, we use the recorded PAN.

Admissions arrangements: As described in Section 3.1, we have recorded and coded the admissions arrangements for all public secondary schools in England (3,248 schools) using the information in guidance booklets published by the LAs and schools as the primary source. Admissions arrangements consist of over-subscription criteria and tie-breaking rules.

Over-subscription criteria are conditions that applicants need to meet to benefit from a priority. For example, a 'sibling' criterion means that all applicants with a sibling in the school have priority over (namely, they will be admitted before) applicants with no sibling in the school. A priority can be absolute, meaning applicants who meet a criterion benefit from the priority with no restriction, or it can be conditional (up to a percentage of seats, for example). In that case, we refer to the proportion of seats as the quota.

One challenge for replicating the existing admissions process is that some pupil characteristics, which are relevant for their priority, are not observed (for example, whether the pupil is the child of a staff member or is religious). As a result, we cannot perfectly predict the way over-subscribed schools will rank the pupils who apply. We used proxies for the unobserved pupil characteristics affecting large groups of pupils, and ignored the remaining unobserved characteristics. Among the unobserved criteria, most are found in very few schools or concern very few pupils. There are two that affect all schools, EHCP and LAC, which we can do nothing about. But for most schools, only a few pupils will be admitted through these two mandatory criteria.

[45] We estimate around 23,000 pupils submit a school choice but do not enter the state secondary sector, and so are not in our dataset.

Table 7 describes all over-subscription criteria present in our data, how we proxied for them where needed, and the percentage of schools using them.[46][47]

When two pupils have equal priority under a given criterion, but there is only one seat left, schools use a tie-breaking rule. Ties can be broken based on the distance between the pupil's home and the school, the result of a test, or randomly. Only distance is observed. We proxied test-based tie-breaking rules with the available KS2 score. We apply a random tie-breaking rule after all recorded tie-breakers for each school. This ensures that our results are replicable.

Assignment process: We implemented the school admissions process using the school-proposing deferred acceptance algorithm, which corresponds to the computerised version of the "equal preferences" scheme used by English LAs (see Section 2.3.3 for details).

To account for quotas (i.e., conditional priorities), we created "mini-schools" before using the algorithm. Specifically, every school with a quota is replaced by two "mini-schools" with capacities commensurate to the quotas (so if 10% of seats are reserved for a certain group of pupils, the corresponding mini-school has a capacity of 10% of the seats).[48] Seats in each mini-school inherit the original school's criteria, except for the mini-school associated with the quota, where the target pupil group is placed first. In families' ROLs, the original school is replaced by two mini-schools, with the mini-school corresponding to the quota appearing first (this ensures, through the algorithm's work, that quota seats are allocated first).

We have made some pragmatic simplifications of schools' use of quotas and banding under the baseline.

- Test: For non-selective schools with a test quota, we have coded the quota at 10%, which is the permitted share of seats for all schools with a specialism. In practice, a minority of partially selective schools have a quota larger than 10%, but we have not accounted for this.
- FSM/PP: For the small number of schools which already have a quota, we have coded the FSM/PP quota to be equal to the share of seats recorded by the school in their admissions policy. This varies from around 2% of seats to 37.5% of seats (with a median of around 10%). We have ignored any conditions attached to this quota, for example living in the catchment area, apart from being above the test score threshold for selective schools.
- Religion: We have coded the religious quota as the total share of seats reserved for pupils with any religion, which varies between around 4% and 100% (with a median of 50%). This ignores more subtle quotas for 'own' and 'other' religions, which we have combined.[49]

[46] Our proxy for religion could be an underestimate of the number of pupils with priority due to religion, as families could practice a religion without attending a religious primary. It could also be an overestimate, however, as not all pupils who attend a religious primary school would meet the criteria for a religious secondary school.

[47] 'Resource base' is relevant to eight schools, six of which are in Norfolk. These places are allocated by the LA to dedicated Resource bases for pupils with special educational needs.

[48] Schools with banding or more than one quota would have more than two "mini-schools".

[49] This explains why some 'quotas' are 100% of seats. These schools could have a 50% quota for their own religion and 50% for other religions, for example.

Table 7: Availability and proxies for over-subscription criteria

Criterion	Data availability	Proxy used (when applicable)	Freq. of criterion
Catchment	Observed		55.39%
Distance	Observed		52.31%
Feeder	Observed		37.35%
Nearest School	Observed		4.46%
First Born	Observed		0.46%
Sibling	Proxied	For each child with an older sibling, priority to the first school ranked by the child on their true rank-ordered list.	95.54%
Religion	Proxied	Religious denomination of child's primary school. The pupil is classified as having the same religion if the primary and secondary school have the same religious ethos (for example, both Catholic). The pupil is classified has having 'Other Denomination' if the primary and secondary school both have a Christian ethos, but different denomination (for example, a Catholic primary school and Church of England secondary school). The pupil is classified as having 'Other Faith' if the primary and secondary school both have a religious ethos, but from a different world faith (for example, a Catholic primary school and Muslim secondary school).	15.12%
Test Score	Proxied	KS2 test (Reading and Maths score).	10.81%
Pupil Premium	Proxied	Free school meal eligibility.	5.23%
Random	Proxied	One random draws for each student generated from a uniform distribution.	1.02%
EHCP	Ignored		99.91%
Looked After	Ignored		99.85%
Child of Staff	Ignored		43.72%
Special Circumstances	Ignored		40.09%
Medical Need	Ignored		8.59%
Child of Army	Ignored		2.00%
Year 6	Ignored		1.02%
LA Quota	Ignored		0.34%
Resource Base	Ignored		0.25%
Multiple Births	Ignored		0.22%
Alumni	Ignored		0.12%
Autism or Hear Impairment	Ignored		0.12%
Boarding Need	Ignored		0.06%
Carer	Ignored		0.03%
Domestic Circumstances	Ignored		0.03%
International	Ignored		0.03%
Rural	Ignored		0.03%

Source: Authors' dataset of secondary school admissions arrangements (3,248 schools).
Notes: The last column reports the percentage of schools adopting the named criterion. Criteria listed in the order of frequency in the data (any place in the admission arrangements).

Table 8: Replication of LA algorithm under current over-subscription criteria, by LA type

	Mean	Min.	25th percentile	Median	75th percentile	Max.	N LAs
All LAs	80.93	61.04	73.53	82.6	87.66	97.1	149
Rural LAs	87.11	70.7	83.88	89	90.33	94.11	18
Urban LAs	80.08	61.04	73.03	81.55	86.67	97.1	131
LAs > 50% oversubscribed	78.66	61.04	71.58	78.66	84.95	93.12	75
LAs < 50% oversubscribed	83.23	63.68	78.91	84.39	88.91	97.1	74
LAs > median religious	77.74	61.04	70.02	78.43	84.96	91.97	74
LAs < median religious	84.07	66.68	79.77	84.5	89.87	97.1	75

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: The table describes the fraction of pupils assigned by our model to exactly the same school as in the data. The unit of observation is a Local Authority. The table provides information about the minimum and maximum fraction of pupils, as well as the quartiles of the distribution. Low and high fractions of religious schools refer to LAs with below and above median fractions of religious schools (16.67% of schools).

- Banding: We have imposed that each school using banding applies four bands. In reality, this varies between 3 and 9 bands, with 31% of schools using four and 33% of schools using five bands. We proxy the test score by the KS2 average points score (Reading and Maths score). This is the same proxy we use to rank pupils for selective schools and partially selective schools. Pupils are divided into four equally sized groups (quartiles) according to the national distribution of test scores.

For selective schools, we impose a minimum test score threshold to be considered at the school, which corresponds to around the 75th percentile of the national test score distribution. This is to proxy for the '11-plus' pass mark, below which no pupils are considered. The threshold was chosen to minimise those below who are admitted to a selective school, and maximise those above who are admitted. Below this threshold, for pupils in selective areas, 76% did not apply to selective schools, 13% applied but did not get in, and 11% applied and were admitted. Above this threshold, only around 23% did not apply, 11% applied but did not get in, and 66% applied are were admitted.

Table 8 provides descriptive statistics of the fraction of pupils that we are assigning to exactly the same school as in our data, when we use the submitted ROLs and our coded over-subscription criteria and tie-breaking as described above. These numbers provide an assessment of our ability to reproduce the existing admissions arrangements (criteria and tie-breaking) despite the lack of observability of some of the pupils' characteristics.

Overall, our replication matches a high share of pupils to the schools they were indeed assigned to in the NPD data. Across all LAs, the median percentage of matched pupils is 83%, where 'matched' means that the school assigned in reality matches the school assigned in our replica-

tion. There is variation across LAs, however, with a minimum percentage matched of 61% and a maximum of 97%. In general, our replication matches a higher percentage of pupils in rural than in urban areas. This likely reflects the dominance of distance between home and potential schools and geographic over-subscription criteria (which we observe) or the lower levels of over-subscription of schools or number of feasible options in rural LAs. The next two rows confirm that we match fewer pupils in LAs with a large fraction of over-subscribed schools, as this is where over-subscription criteria make the most difference, than in LAs with few over-subscribed schools. The performance remains reasonable, however, with just under 80% of pupils matches in the median LA in the group of highly over-subscribed LAs. The performance of our replication is slightly lower in LAs with a higher percentage of religious schools than the median LA (relative to below the median). This is not surprising given that we do not observe religiosity and only infer it from the religious character of the pupil's primary school. Overall, Table 8 provides reassuring statistics that in most LAs we can reasonably replicate the assignment of pupils to schools.

At the pupil-level, a similar percentage of FSM-eligible and non-FSM-eligible pupils are matched to the same school (around 85%). A slightly lower percentage of pupils in the top ability quintile are matched to the same school (82% compared to 85% in the lower ability quintiles). The largest discrepancy is between those with and without EAL (79% compared to 89%). This could reflect the more urban sample, or there may be more relevant religious criteria, which we proxy imperfectly, for this group.

6.3 Estimating families' preferences for schools

Families in the English school admissions process need to be strategic. There are two reasons why they may not want to submit their truthful preferences on their ROL.

First, the number of schools they can list is limited, typically to 3 or 6 schools. If the top school for a family is very popular and their child does not have priority under any criteria, it may be best to drop it from the list, instead of 'wasting' one of the limited choices on the form (Haeringer and Klijn, 2009). This is a phenomenon referred to 'skipping the impossible' (Fack et al., 2019), which has been documented in the scientific literature (Calsamiglia et al., 2010; Chen and Pereyra, 2019; Larroucau and Rios, 2020; Artemov et al., 2021). As a result:

Implication 1: We cannot conclude, without further analysis, that all the schools listed on the form are preferred over the schools *not listed* on the form.

The second theoretical reason why families may want to be strategic is more subtle and comes from the school assignment algorithm used in England.[50] In this algorithm, each pupil is ranked by each school they apply to (according to each school's over-subscription criteria). The algorithm works by provisionally assigning pupils to schools, starting from pupils with a high priority at those schools. At each stage of the algorithm, each pupil only keeps one offer - the one they prefer among those received so far. Spots free up when pupils decline offers for better

[50]Such effect is not present in the student-proposing deferred algorithm, see Abdulkadiroğlu and Sönmez (2003).

ones.[51] This process means that the situation can arise where the algorithm ends and two pupils are assigned to a (different) school ranked low in their ROL while a switch between them would make both better off. The reason the algorithm ends is that the first pupil does not free their slot until they get a better one (but where they benefit from a lower priority), which the second does not free because they do not get a better one either.

Roth and Rothblum (1999) have studied this situation and concluded that the optimal strategy for families in this situation can take the form of truncating (removing the bottom schools from) their ROLs. Truncation avoids a pupil's application being considered in a school where s/he is highly ranked but which is low on his/her preferences. But they also note that this type of strategy is informationally demanding. Families need to be able to assess that the truncation will indeed lead, through a chain of offers and rejections, to them getting a better offer. In other words, they should not truncate their ROLs if they are not sure they can get a better assignment ('safe school'). For this reason, we suspect that very few pupils in our dataset actually strategically truncate their ROLs.

If strategic truncation nevertheless happens, the implication is that:

Implication 2: One cannot conclude from ROLs shorter than the allowed length of 3 or 6 schools that all other schools are unacceptable to these pupils. These families may just want to avoid clogging the admissions lists of less preferred schools.

Several approaches have been proposed to infer preferences from submitted ROLs in school admissions when ROLs may be strategic. They differ mostly in their assumptions on the informational context and behaviour of families, and in their data requirements (see Agarwal and Somaini (2020) for a review).

Here, we follow the approach first proposed by Fack et al. (2019). This method exploits the fact that equilibrium admissions outcomes (how pupils are assigned to schools) in high information environments (where pupils would have good knowledge of their priority) can be considered, using a technical term, 'stable'. 'Stable' means that there is no school a pupil prefers to their assigned school and that the pupil would be accepted to. The school each pupil is assigned to can therefore be considered as the most preferred school available to the family which is feasible for them to access.

This argument requires that families are sufficiently well informed about which schools are feasible or not. Families have access to a wide range of information about school performance and composition through the Department for Education, but less comprehensive information about school admissions statistics or birth cohort sizes (which can affect the number of sibling places). In an earlier report for the Nuffield Foundation, we described the information that LAs provide to families regarding schools' admissions arrangements and over-subscription status and noted that it was often dispersed and not always formatted in a useful way for decisions (Burgess et al., 2023). Our descriptive analysis in Section 5.1 shows that few pupils are left unassigned

[51] Remember that this is all automated. Pupils do not actually see what offers they received over the course of the algorithm. They only see their final offer.

to any of their preferred schools, however, suggesting that most families can identify at least one 'safe' school.

Practically, Fack et al. (2019)'s approach comes down to determining the feasible set of schools for each pupil, given their characteristics and the schools' over-subscription criteria, and then inferring preferences based on the argument that their allocated school is their preferred choice among the schools in their feasible set (if not, it means that they should have submitted a different ROL). Section 5.1 provides validation for our construction of feasible choice sets. We observe that when pupils choose a school inside the feasible choice set they have a high probability of admission, and a low probability of admission when they choose a school outside the feasible choice set.

We model preferences using a discrete multinomial choice framework over these feasible sets. Each pupil-school pair is associated with a utility number u_{is}, where i denotes the pupil and s the school, which depends on the pupil's characteristics, on the school's characteristics and on their interactions, and on some random idiosyncratic term ϵ_{is}:

$$u_{is} = \beta X_{is} + \epsilon_{is} \tag{1}$$

where X_{is} is a vector of pupil, school and pupil-school characteristics of interest (see below) and ϵ_{is} is assumed to be identically independently distributed extreme value type-I.

Let F_i denote the constructed feasible set of schools for pupil i. Observing that pupil i is assigned to school s at the end of the admissions process leads us to conclude that school s is preferred by pupil i over all other schools in F_i. Formally,

$$u_{is} = \beta X_{is} + \epsilon_{is} > u_{is'} = \beta X_{is'} + \epsilon_{is'} \text{ , for all } s' \neq s \text{ in } F_i \tag{2}$$

The estimation maximises the likelihood of the observed allocation, given equations (1) and (2).

We run this specification for all families making school choices for their first-born child. Theoretically, this is the best estimation of families' preferences, because school choices for later-born children are likely to follow the school assignment of the first child, regardless of changes in the school characteristics over time (for example, composition and effectiveness).

Construction of pupils' choice sets: A central element in the estimation is the determination of each pupil's feasible choice set. Making the feasible choice set too large will lead to biased estimates of the coefficients of equation (1) because we would wrongly conclude that a school is preferred to another one, even though that other school was actually not feasible for this pupil.

By contrast, reducing the set of alternatives can still yield correct inference, provided that the reduction is done through proper resampling methods (McFadden, 1978). In these cases, the inference we make about preferences remains correct, even though we ignore that the allocated school is preferred to some feasible schools wrongly excluded from the feasible set. Ignoring information reduces the precision of our estimates, but given that our dataset is very large, this

is not too costly in our setting.

We use the 'feasible choice set' described in Section 3.5 and Appendix B.

Explanatory variables: Another key decision is the set of variables to include in the preference specification (equation 1). Our preferred specification includes both pupil-school variables, such as distance to school and interaction terms between the pupil's school type in primary school and the target school's type, and school-specific variables such as the school type or the fraction of FSM-eligible pupils. Note that we include 'Decile of prior attainment (KS2)' as a proxy for family characteristics, which potentially affect preferences for schools, for example, educational aspirations and level of income.

The complete list of explanatory variables is described in Table 9. The full list of coefficients is long and is relegated to the Appendix Table A3. The size of these coefficients does not have an intuitive interpretation and can not be easily presented as the predicted probability of choosing a particular school within the choice set. The interpretation is limited to a positive coefficient increasing the utility of a school with this characteristic and so increasing the probability of this school being chosen from the choice set. A negative value would have the opposite implication. Across explanatory variables, we can meaningfully compare the coefficients on interaction variables. For example, a higher (positive) coefficient on school effectiveness for pupils in a low compared to high decile of prior attainment means pupils with low prior attainment value school effectiveness *relatively* more than pupils with high prior attainment.

The main insights from Table A3 are the following:

- Everything else equal, families dislike longer distances to schools. This effect is muted for pupils in the top 50% of the (KS2) prior attainment score distribution. Conversely, this effect is exacerbated for families from an ethnic minority background.[52] The interaction term with the FSM status is small and not significant, which means that we cannot rule out that FSM families dislike distance the same way as non-FSM families, once the other factors (prior attainment and ethnicity) are taken into account.
- All families value school effectiveness positively. Families with higher prior attainment value school effectiveness more.
- Everything else equal, FSM-eligible pupils value school effectiveness less than non-FSM-eligible pupils.
- Everything else equal, EAL pupils value schools with a high percentage of EAL pupils more.
- Everything else equal, families value schools with a higher percentage of FSM-eligible pupils less. That effect is weaker for FSM families.

[52]This is in contrast to previous literature which finds that families from an ethnic minority are less likely to choose their closest school (Burgess et al., 2019) and are more willing to travel further for a higher-performing school (Walker and Weldon, 2020). These differences could be driven by the measure of school performance (Progress 8 rather than the % meeting threshold attainment levels).

Table 9: Family and school characteristics included in the estimation of families' preferences for school characteristics

School characteristic	Interaction with family characteristic
Log distance (home-school)	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
School effectiveness (P8)	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
% English as an Additional Language	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
% Free School Meals	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
% Any Special Educational Need	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
Faith (any)	Decile of prior attainment (KS2)
	Free School Meals
	English as an Additional Language
	Non-white British
Catholic	Catholic primary
	Church of England primary
	Christian primary
Church of England	Catholic primary
	Church of England primary
	Christian primary primary
Christian	Catholic primary
	Church of England primary
	Christian primary
Muslim	Muslim primary
Sikh	Sikh primary
Jewish	Jewish primary

Source: Department for Education (National Pupil Database); Department for Education (Get Information About Schools); Department for Education (School Performance Tables); Authors: data collection of school over-subscription criteria.
Note: All school characteristics are entered as continuous variables, aside from faith school and indicators, which are entered as binary variables. All pupils' characteristics are entered as binary variables. Reference categories are KS2 prior attainment decile = 1; Free School Meals eligibility = 0; English as an Additional Language = 0; Non-white British = 0; Faith status of primary school = 0.

- Families' faith (as inferred by their primary school choices) has an influence on their preferences over faith schools. Catholics prefer a Catholic school, everything else equal. Similarly, Muslims, Sikhs, and Jews prefer, respectively, Muslim, Sikh, and Jewish schools. No such effects are found for Church of England or other Christian schools.

6.4 Policy simulations

To assess the outcome of reforms to schools' over-subscription criteria, we use our estimates of families' preferences over school characteristics to simulate the way families would rank schools if their feasible choice sets changed following changes in admissions arrangements, and use the new criteria to determine admission outcomes.

For every reform, we run 100 rounds of simulations. One round corresponds to a draw of a preference list for each pupil in our database, using the estimated utility parameters from Section 6.3, $u_{is} = \hat{\beta} X_{is} + \epsilon_{is}$, and drawing an extreme-value type-1 error for each pupil-school pair. This is done for each school within the commutable choice set. Once we have replicated the admission algorithm to match pupils to schools (given the preference draw of this round) we record the final assignment of pupils to schools. As a baseline, we do the same (with the same draws of preferences) for the current admissions arrangement.

As argued previously, the 'equal preferences' algorithm with a limit on the number of choices that families can list creates incentives for families to misreport their true preferences by both skipping unfeasible choices and truncating their submitted ROLs. This means that, in principle, we should compute the strategic school choices made by each family. We circumvent this problem by removing the 3-school or 6-school constraint on the length of the submitted choices in our simulations. This eliminates the 'skipping-the-impossible' consideration, as families are not concerned about wasting a choice on a school with a low probability of admission. This simplifies the computations considerably without affecting the result. This 'trick' does not remove the 'truncation' incentive, however, but as argued above, we think this incentive is negligible in our setting, given its informational demand.

The data does not include pupils who submitted a ROL but left the state-funded sector. These represent about 4% of pupils. These pupils may have decided to go to a private school or left the country altogether. Because we have very little data on these pupils beyond where they live, we exclude them from the simulations. This is equivalent to considering that they would make exactly the same choice and get the same outcome under the reform. This is reasonable if we think that these pupils left the country. It is also reasonable if pupils that left for the private sector before any reform continue to do so. We would expect the reforms to increase rather than decrease the share exiting to the private sector, as these families are typically more affluent and more likely to 'lose' rather than 'win' from any reform.

Appendix C provides more detail on each step of the policy simulation.

7 Analysis of reforms

7.1 Options for reform

We consider three options for reforming school over-subscription criteria in England. All these options are already implemented in secondary schools in England or elsewhere, therefore indicating practical feasibility. They are also fully compliant with the current School Admissions Code.

7.1.1 FSM quota

The 2014 revision of the School Admissions Code gave admissions authorities the "option to give priority to disadvantaged children in their admissions arrangements" (Department for Education, 2014). This was the first time schools were explicitly allowed to include eligibility for FSM or the PP as a criterion in their admissions arrangements. This remains the case in the 2021 School Admissions Code (Department for Education, 2021).

This was a major reform - explicitly giving schools the option to favour disadvantaged pupils in admission. But our data show that almost ten years after the reform, almost no schools chose to introduce this criterion. In our data for entry to the 2020-2021 academic year, only 170 schools (5 percent of the total) use FSM/PP in their over-subscription criteria (see Table 7). Among those few schools, three-quarters are selective schools and typically require pupils to be above the test score threshold to benefit from the criterion. Among selective schools, 79 percent use the FSM/PP criterion in their admissions arrangements; among non-selective schools, only 1.4 percent (42 schools) do so (see Table A12 in Burgess et al. (2023)). Recently, a high-profile reform in Brighton and Hove has led to an increase in this number. From the 2025/26 academic year, the city's six community schools give priority to FSM-eligible pupils, up to a quota equal to the LA average percentage of FSM-eligible pupils.

'FSM quota' refers to a mandatory quota of seats for which FSM-eligible pupils have priority. The exact fraction of seats is a policy parameter which we vary between 10% and 20%, and the LA average, but our central scenario is a quota of 15% of places.[53] FSM-eligible pupils have priority for those seats. There is no change to the criteria that apply to the remaining ('status quo') seats. If not enough pupils apply to a school to fill their FSM quota, the remaining seats are allocated using the criteria that prevail for the 'status quo' seats. This is referred to as a 'soft quota' in the scientific literature.

One question that arises when introducing a quota is the order in which to allocate the seats to applicants: those of the quota first, or those of the quota last? In England, non-selective schools with a test quota typically allocate those seats first to the highest performers among their applicant pool, independently of other criteria. Allocating the quota seats first means that some pupils may be admitted under the test quota, even though they would have been admitted to the school anyway, given the other over-subscription criteria. For these pupils, the quota makes no difference to them. Dur et al. (2018) have shown that allocating quota seats last

[53] As a benchmark, the proportion of FSM-eligible pupils in our data is 15.8%.

is more effective in increasing admissions of the targeted population than allocating those seats first, and that the effect is sizable. For this reason, for each quota size, we simulate the effect of the policy if the quota seats are allocated first (first precedence), and if they are allocated last (last precedence).

The main text presents the results of the central scenario (the 15% quota, allocated last). All other policy variants are presented in the Appendix.

7.1.2 Marginal Ballots

One conceptually straightforward way to separate school assignment from family circumstances is to randomise assignment, conditional on families' school choices. That is, to hold a ballot for all the places in a school among all those who apply (separately assigning only the LAC and EHCP pupils). Although a 'lottery' has negative connotations in England (the 'postcode lottery' in healthcare, for example), ballots are viewed as equitable in other contexts. For example, over-subscribed U.S. Charter schools must admit pupils according to 'public random drawing' by law (Justia US Law). In New Zealand, where the school choice system has changed over time, the random ballot is viewed as 'formally fair', 'unlikely to be subject to corrupting practices', and to 'prevent schools cream-skimming top students' (Pearce and Gordon, 2005).

The advantage of giving priority by random number is that it increases access to everyone, including pupils who do not qualify for FSM status but are nevertheless disadvantaged. One potential disadvantage, however, is that it could fragment communities and increase commuting distance between home and school.

The alternative we consider is a marginal lottery (marginal ballots), where most seats are awarded according to the 'status quo' and some are reserved to be assigned by lottery. This is 'marginal' in two senses. First, it applies to only a minority of seats in a school. Second, the school's existing criteria (typically geographic) apply to the remaining seats. This means the lottery will apply to the places previously filled by families living at the margins of the catchment (or de facto catchment) areas. This compromise would preserve much of the sense of a school in its community that a geographic admissions system brings, whilst also offering some inclusivity by opening some places to pupils beyond the catchment area.[54]

The key policy parameter is the size of the quota: what fraction of seats are allocated by the school's standard admissions arrangements, the remainder by the marginal lottery. Like for FSM quota, we choose 15% as the central scenario for marginal ballots, but vary the parameter between 10% and 20%. As for FSM quota, we simulate the effect of assigning the quota first and last to evaluate the effect of the order of allocation, presenting the central scenario (the case where the quota seats for marginal ballots are allocated last) in the main text.

[54] Where a distance tie-breaking rule is used, this option also preserves priority in admissions for those living closest to the school, and so avoids displacing pupils very close to their catchment school.

7.1.3 Banding

Banding is a test-based over-subscription criterion, but with an important difference to selective schools, as it is designed to admit a representative set of pupils according to ability. All pupils in the admissions pool take a test, and the school fills seats for each ability 'band'. For example, a school might have 25% of seats for each of four equally sized ability bands. This system is used in a few schools in England, mostly in London.

Seats within each band are allocated according to the school's existing over-subscription criteria, for example siblings and/or catchment area.

Concerns have been raised about the manipulability of the system, with schools attempting to 'cream-skim' through banding (West et al., 2003). Instituting banding on a large scale would reduce the strategic incentives for individual schools to cream-skim through banding, but would require more complicated logistics for pupils taking the test. In LAs in London where banding is common, these tests are taken in primary schools to ensure inclusivity. In the policy studied here, there would have to be a new system of national testing and marking.

To model banding, we create four 'mini-schools', matching the four quartiles of the test results, and in each band the relevant group of pupils is given priority over the others. The remaining places in each school are filled according to the original criteria, using pupils from adjacent bands.[55]

7.2 Results

This Section describes the results from the policy simulations under the central scenario for the reforms discussed in the previous section. Appendix A provides the results for the other scenarios.

In a school choice context, over-subscription criteria have an effect only if some schools are over-subscribed (when there is spare capacity at all schools, every pupil can go wherever he or she wants). This does not mean that a change in the over-subscription criteria only affects those schools that are over-subscribed (around 64% in our data). Under-subscribed schools can also be affected through ripple effects. This is because pupils reallocated to a less preferred school under the reform than at baseline may have different preferences to pupils who 'took their seats' following the reform.

As an introduction to our results, Table 10 shows, for each reform and for the central scenario (15% quota for FSM quota and marginal ballots, with the quota and marginal ballots seats assigned last), the average number of pupils assigned to the same schools in the baseline and under the reform, and the average number of pupils assigned to a different school.[56]

[55] Many schools currently using banding give priority to pupils in adjacent bands in the event of under-subscription. For example, the admissions policy for Camden School for Girls states that "[i]n the unlikely event that there are fewer than 30 applicants in any band, the unused places will be offered to applicants in the adjacent bands, taken equally from the bands above and below where this is possible.". For the coordinated system in Hackney, "[i]f places still remain within a band, these will then be allocated from the equivalent zone in the nearest band, looking first at remaining applicants in the band above (where applicable)."

[56] A small number of pupils are not assigned under either the baseline or the policy. A pupil may be left

As explained in Section 6.4, we run 100 rounds of simulations. This provides us with the equivalent of a confidence interval to infer whether differences between outcomes at baseline and under the reform are statistically significant. Using these, and given our large sample size, almost all of the changes we report are statistically significant. We therefore do not clutter the results tables with stars and confidence intervals.

On average, FSM quota leads to a different assignment for 5.6% of the pupils. This number is much higher, despite the size of the quota being the same, for marginal ballots, which leads to 11.5% of the pupils getting a different assignment under the policy compared to the baseline. The number of pupils receiving a different assignment under banding is 10.6%.

Table 10: Pupils with different (movers) or identical (non-movers) assignments under the new policy and the baseline

	FSM quota	Marginal ballots	Banding
Movers	32,102	66,337	61,263
Non-movers	543,917	509,351	513,211
Unassigned	2,790	3,121	4,335
Total	578,809	578,809	578,809
Percentage of movers	5.6%	11.5%	10.6%

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Notes: Results for the central scenarios (15% quota) for FSM quota and marginal ballots, with the quota assigned last (last precedence). 'Movers' refers to pupils assigned to a different school at baseline and reform. 'Non-moves' refers to pupils assigned to the same school at baseline and reform. 'Unassigned' refers to those left unassigned to any school in their commutable choice set after the LA algorithm.

These numbers provide the background against which we can assess the effect of reforms on different outcomes that matter for policy, and which we analyse in the next subsections. We begin by examining the school effectiveness of the assigned school for different groups of pupils under the different reforms and the baseline (assuming unchanged school effectiveness), in Section 7.2.1. Access to effective schools is a key consideration for policy-makers. The results show that all three reforms under consideration improve access to effective schools for disadvantaged pupils, but to varying degrees. Specifically, FSM quota is most effective in increasing access of FSM-eligible pupils to effective schools.

We next consider families' preferences, in Section 7.2.2. Our reforms change who gets priority in different schools and therefore inevitably create 'winners', i.e. pupils who get a higher choice on their ROL following the reform, and 'losers', i.e. pupils who get a lower choice in their ROL following the reform. We find that the FSM quota clearly benefits the FSM-eligible pupils,

unassigned at the end of the process if all schools in their commutable set are at capacity or have gender restrictions for which they do not qualify. Pupils in this situation are assigned administratively under the School Admissions Code.

whereas most non-FSM movers lose. The other reforms create winners and losers in both groups.

We also analyse the effect of the reforms on segregation at the LA-level. For the central scenario, more LAs experience an increase in segregation under FSM quota than LAs experiencing a decrease (this effect is muted or even disappears for lower quota sizes or when FSM quota seats are allocated first); we discuss this finding in more depth below. Segregation is not noticeably affected by the other two reforms.

As additional measures of side effects of the reforms, and their potential disruptive impact, we also look at distance to school and the change in pupil intake at the school-level, in Section 7.2.4.

7.2.1 Access to an effective school

Table 11 describes school effectiveness of the allocated school for the median pupil, at baseline and under the three reforms. For reference, recall that school effectiveness (Progress 8) has a mean of 0 and a standard deviation of 0.45.[57]

[57]'Above average' schools have a Progress 8 score above 0 but below 0.5, and the entire confidence interval is above 0. 'Well above average' schools have a Progress 8 score of at least 0.5, and the entire confidence interval is above 0 DfE, 2025.

Table 11: Median school effectiveness, by FSM status, of the assigned school at baseline and under reform - FSM quota and marginal ballots (15% quota, last precedence) and banding

Panel (a)			
FSM quota (15% quota, last precedence)	All	FSM	Non-FSM
Median school effectiveness (baseline)	-0.0102	-0.1056	0.0070
Median school effectiveness (reform)	-0.0105	-0.0888	0.0047
Difference (reform - baseline)	-0.0003	0.0168	-0.0023
Panel (b)			
Marginal ballots (15% quota, last precedence)	All	FSM	Non-FSM
Median school effectiveness (baseline)	-0.0102	-0.1056	0.0070
Median school effectiveness (reform)	-0.0103	-0.1055	0.0066
Difference (reform - baseline)	-0.0001	0.0001	-0.0004
Panel (c)			
Banding	All	FSM	Non-FSM
Median school effectiveness (baseline)	-0.0102	-0.1056	0.0070
Median school effectiveness (reform)	-0.0120	-0.1026	0.0043
Difference (reform - baseline)	-0.0018	0.0030	-0.0027

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: 'Median school effectiveness (baseline)' records the median Progress 8 score across pupils of the assigned school at baseline. 'Median school effectiveness (reform)' records the median Progress 8 score across pupils of the assigned school under the reform (FSM quota, marginal ballots, or banding). 'Difference (reform - baseline)' reports the difference in the medians under the baseline and reform assignments (row two minus row one). '% change in average school effectiveness' reports the percentage change in average school effectiveness, relative to the baseline (row three divided by row one, multiplied by 100). '% change in school effectiveness between FSM and non-FSM' reports the percentage change in the difference between Non-FSM-eligible and FSM-eligible pupils (row two for Non-FSM minus row two for FSM - difference one, minus row one for Non-FSM minus row one for FSM - difference two, divided by difference two, multiplied by 100.

Key to the interpretation of this table is the fact that the three reforms reallocate school places. The levels of school effectiveness available remain the same, and the outcomes differ only in which pupils are assigned seats in the highly effective schools. In this reallocation, there are winners and losers, some attending a more effective school and others attending a less effective school. This implies that the overall average effectiveness, averaging over winners and losers, cannot change by much (simply some second order change in differential school size). The calculations we present in table 11 that average over winners and losers will necessarily produce an overall average change close to zero.

The average change in school effectiveness can vary by subgroup, however, as some groups of

pupils have priority or become more likely to gain access after the reform. For example, for FSM quota the group of winners is more or less synonymous with FSM-eligible pupils, so averaging by FSM status is close to averaging separately by winners and lowers. Once we fully separate out winners and losers, those calculations of average change in school effectiveness attended give a better representation of the impact of the reforms. We present those numbers below in Table 14.

In table 11, in the baseline, the median school effectiveness of the schools attended by FSM-eligible pupils is -0.1056, and the median school effectiveness of the schools attended by non-FSM-eligible pupils is 0.0070, indicating a difference of 0.1126 to the disadvantage of FSM-eligible pupils. FSM quota increases the median effectiveness of schools attended by FSM-eligible pupils by 0.0168, 15.9% (0.0168/0.1056), and decreases the median effectiveness of the schools attended by non-FSM-eligible pupils by 0.0023. This amounts to a reduction of 17% of the gap in median school effectiveness between FSM-eligible and non-FSM-eligible pupils at baseline ((0.0168+0.0023)/0.1126). The pattern is similar for all variants of this reform, with the effect increasing with larger quotas (Appendix Table A4).

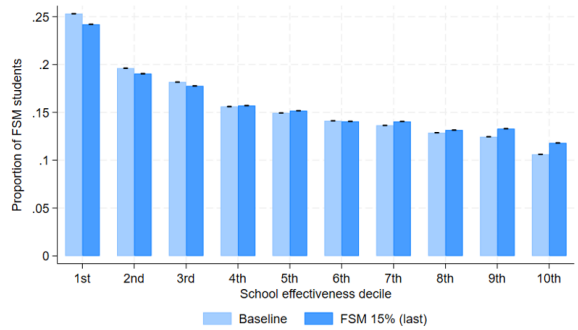
Marginal ballots also increase the median effectiveness of the schools attended by FSM-eligible pupils and decrease the median effectiveness of the schools attended by non-FSM-eligible pupils in the central scenario, but the effect is quantitatively much smaller than for FSM quota. This reflects the fact that the groups of winners and losers from this reform are not closely aligned with FSM status, so the average change for FSM-eligible pupils combines some winners and some losers.

Banding leads to the largest overall decrease in median school effectiveness, but the decrease is small (0.0018). This implies that, overall, pupils very slightly shift from more to less effective schools under banding. Banding increases the median effectiveness of the schools attended by FSM-eligible pupils and decreases the median effectiveness of the schools attended by non-FSM, with the size of the effects between FSM quota and marginal ballots.

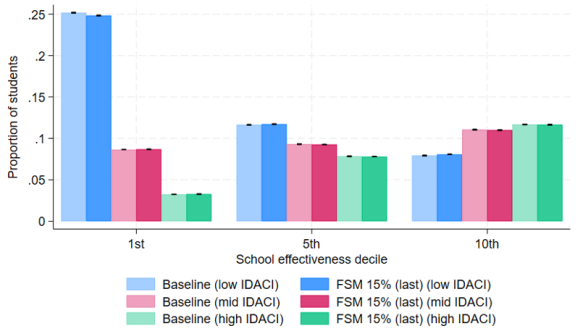
Figure 8 shows how these gains for FSM-eligible pupils are distributed across deciles of school effectiveness. Panel (a) shows the percentage of FSM-eligible pupils in each decile of school effectiveness, under the baseline (lighter blue bars) and FSM quota (darker blue bars). It is clear that the reform has effects along the distribution, but is concentrated at the extremes: fewer FSM-eligible pupils attend the least effective schools and more FSM-eligible pupils attend the most effective schools. In fact, the fraction of FSM-eligible pupils in the top two deciles of school effectiveness increases from 12.5% to 13.3% (9th decile) and from 10.6% to 11.8% (top decile).[58] Overall, the movements of pupils across schools in different effectiveness deciles lead to the 17% reduction in the gap in median school effectiveness between FSM-eligible and non-FSM-eligible pupils at baseline, discussed above.

[58] Appendix Figure A1 shows how this varies depending on the size of the quota and the precedence order of the quota. A 20% quota and an LA average quota generate the largest gains in the percentage of FSM-eligible pupils that access the most effective schools, to just over 13%.

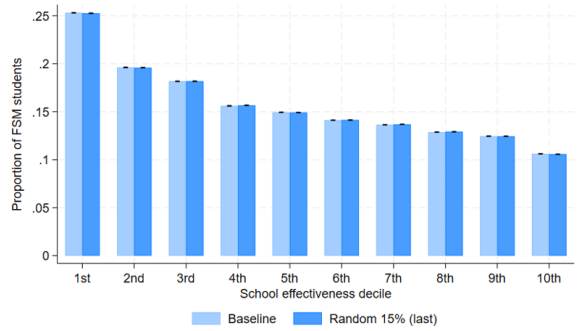
Figure 8: Average percentage of FSM-eligible pupils or living in high/mid/low poverty neighbourhoods, by school effectiveness decile, for FSM quota and marginal ballots (15% quota, last precedence) and banding



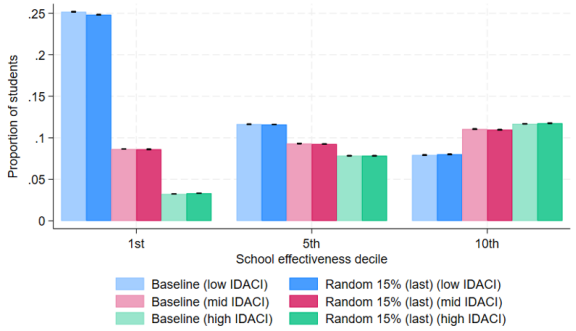
(a) FSM: FSM 15%, last precedence



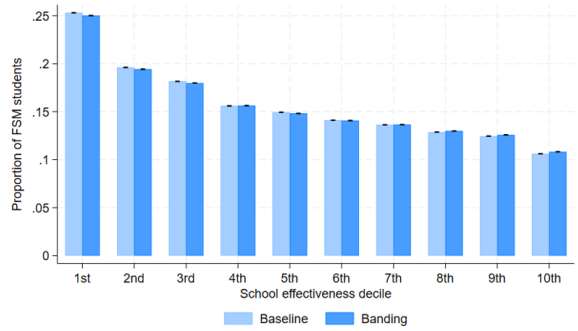
(b) IDACI: FSM 15%, last precedence



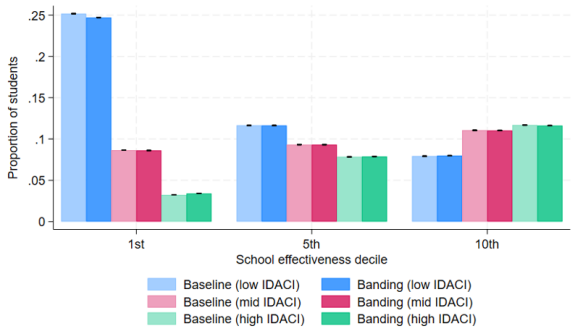
(c) FSM: Marginal ballots 15%, last precedence



(d) IDACI: Marginal ballots 15%, last precedence



(e) FSM: Banding



(f) IDACI: Banding

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'FSM' refers to eligibility for Free School Meals. 'IDACI' refers to the Income Deprivation Affecting Children Index.

The changes in the proportion of FSM-eligible pupils across the different deciles are barely discernible for marginal ballots (panel (c)) and banding (panel (e)), which is consistent with the smaller change in the median school effectiveness for FSM-eligible pupils for these reforms.[59]

[59]This result is robust across quota sizes and precedence order, see Figure A2 in the Appendix.

Because FSM status does not perfectly capture socio-economic disadvantage, we also look at the change in school effectiveness for pupils living in richer and poorer neighbourhoods, as measured by IDACI deciles. Across reform options, panels (b), (d) and (f) show that the allocation of pupils from richer and poorer neighbourhoods is not markedly affected by the reforms. This is because the reforms either expand access to families in all areas (marginal ballots and banding) or a targeted group of pupils which is not perfectly correlated with area disadvantage (FSM quota).[60]

7.2.2 Access to a preferred school

While policy-makers care about access to effective schools, families value other school attributes beyond school effectiveness (see Section 6.3). Given that, in our simulations, pupils are assumed to submit their ROL truthfully (since we removed the length constraint on ROLs), we can use the rank of the school assigned to pupils as a measure of the extent to which the system is able to satisfy families' preferences.

Table 12: Percentage of pupils by rank of assigned school under baseline and each reform (FSM, marginal ballots, and banding)

		Assigned school			Rank relative to baseline		
Reform	Group	1st	2nd	3rd +	Better	Same	Worse
Baseline	Non-FSM	88.00	9.75	2.25			
	FSM	91.06	7.20	1.74			
FSM	Non-FSM	85.48	11.67	2.85	0.22	96.15	3.63
(15%, last precedence)	FSM	98.57	1.40	0.04	8.25	91.75	0.00
Marginal ballots	Non-FSM	87.29	10.06	2.65	3.15	92.97	3.88
(15%, last precedence)	FSM	90.08	7.76	2.17	2.74	93.69	3.57
Banding	Non-FSM	87.90	9.41	2.68	3.87	91.71	4.42
	FSM	89.14	8.05	2.81	3.15	90.85	6.00

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. 'Assigned school' refers to the school assigned by the LA algorithm. 'Rank relative to baseline' refers to the rank of the assigned school in the ROL under the reform relative to baseline.

Table 12 shows, by pupil group (FSM-eligible and non-FSM-eligible), the percentage of those

[60] In the poorest IDACI decile, around 34% of pupils are FSM-eligible. In the middle deciles, this is around 10%, and in the richest decile, less than 3%.

getting their first choice school, second choice school and third choice school and lower. Under the current system (baseline), most pupils get their first or second choice school. Specifically, 88% of non-FSM-eligible pupils get their first choice school and more than 95% get their first or second choice school. Those numbers are even higher for FSM-eligible pupils: 91% of them get their first choice and more than 98% get their first or second choices.

FSM quota prioritises FSM-eligible pupils for some fraction of the seats. It is therefore not surprising that the probability that they get their first or second choice increases. Table 12 confirms this intuition. Under FSM quota, 98.57% of FSM-eligible pupils get their first choices and virtually all get their first or second choices. 8.25% FSM-eligible pupils are assigned to schools they prefer more than under the baseline. Almost none are assigned to less preferred schools. The figures for non-FSM-eligible pupils naturally reflect the opposite tendency, with a higher percentage assigned to a less preferred school.[61]

In contrast, fewer pupils, FSM-eligible and non-FSM-eligible alike, get their first choices (or their first and second choices) under marginal ballots and banding. While the fraction of unaffected pupils remains high under both reforms (they get the same school assignment), slightly more pupils get a lower-ranked school assignment under both reforms. This effect is especially salient for banding under which 6% of FSM-eligible pupils get a lower-ranked school.

Table 13 breaks pupils down by whether they are winners or losers from each reform. Pupils either benefit from the change in over-subscription criteria because they get a more preferred school (the 'winners'), or they get a less preferred school (the 'losers'), or they get the same school as baseline and so are unaffected. Table 13 confirms that the winners from FSM quota are predominantly FSM-eligible pupils and the losers are predominantly non-FSM-eligible pupils. This contrasts with the results for marginal ballots and banding, in which winners and losers are not so strongly correlated with FSM status. Marginal ballots shows more movement overall - 66,337 pupils are assigned to different schools than baseline, about double the number under FSM quota. Banding also produces more movement, with 61,263 not in baseline schools.

Table 13 shows that FSM quota also creates more winners than losers in the group of pupils who live in the lowest decile of the neighbourhoods (IDACI-1). Of the 16,916 pupils assigned to a preferred school under FSM quota, 27.6% live in IDACI-1 neighbourhoods, compared to 12.9% of pupils living there overall. This shows that pupils living in IDACI-1 neighbourhoods are over-represented among the 'winners'. The other reforms create more or less as many losers as winners among that group of pupils.

[61] Appendix Table A5 reports the equivalent results for the other variations of this reform. All of them provide a higher percentage of FSM-eligible pupils assigned to preferred schools, with the effect increasing with the size of the quota.

Table 13: The number of pupils 'moving' assigned school between baseline under reform (FSM quota and marginal ballots (15% quota, last precedence) and banding

			Pupil eligible for Free School Meals (FSM)		Bottom IDACI decile (IDACI-1)	
		All	Yes	No	Yes	No
Panel (a) FSM quota (15% quota, last precedence)						
Movers	Winners	16,916	15,631	1,285	4,667	12,237
	Losers	15,186	0	15,186	2,373	12,824
Non-movers		543,917	75,464	468,453	67,117	476,787
All		576,019	91,095	484,924	74,157	501,848
Panel (b) Marginal ballots (15% quota, last precedence)						
Movers	Winners	32,145	5,172	26,973	4,884	27,258
	Losers	34,192	5,568	28,624	5,176	29,015
Non-movers		509,351	80,225	429,126	64,033	445,308
All		575,688	90,965	484,723	74,093	501,581
Panel (c) Banding						
Movers	Winners	33,165	4,850	28,315	5,031	28,132
	Losers	28,098	5,707	22,391	5,000	23,097
Non-movers		513,211	80,109	433,102	63,823	449,377
All		574,474	90,666	483,808	73,854	500,606

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: A pupil is defined as a 'mover' if they are assigned to a different school under the reform compared to the baseline case. 'Winner' refers to a pupil that was assigned to a more preferred school under the reform than at baseline. 'Loser' refers to a pupil that was assigned to a less preferred school under the reform than at baseline. The 'Loser' group for FSM-eligible pupils under FSM quota has been suppressed due to low sample sizes, as few FSM-eligible pupils are reallocated to a less preferred school than at baseline under this reform. The results show the number and percentage of pupils in each group, by pupil characteristic (eligibility for FSM and living in the lowest - most disadvantaged IDACI decile - IDACI-1). 'IDACI' refers to the Income Deprivation Affecting Children Index.

As argued above, families' preferences may take many other school attributes into account beyond academic excellence. Table 14 provides insights into the extent to which school choice, in which families' preferences are a key input, is compatible with policy-makers' desire for equal access to effective schools. The Table reports the change in school effectiveness (P8) for winners and losers under each reform. Across all reform options and pupil groups (first column), winners, i.e. pupils who get a higher-ranked school in their preferences, also end up in a more effective school, whereas losers end up in a less effective school, on average. This is an important result

because it shows that school choice, which gives families a voice on their educational choice is compatible with access to effective schools, a policy objective.

Table 14: The change in school effectiveness (P8) for pupils 'moving' assigned school between baseline and reform (FSM quota and marginal ballots, 15% quota, last precedence) and banding

			Pupil eligible for Free School Meals (FSM)		Bottom IDACI decile (IDACI-1)	
		All	Yes	No	Yes	No
Panel (a) FSM quota (15% quota, last precedence)						
Movers	Winner	0.097	0.110	-0.065	0.130	-0.087
	Loser	-0.077	0.000	-0.077	-0.087	-0.075
Non-movers		0.000	0.000	0.000	0.000	0.000
All		0.001	0.023	-0.003	0.006	-0.004
Panel (b) Marginal ballots (15% quota, last precedence)						
Movers	Winner	0.050	0.032	0.054	0.100	0.041
	Loser	-0.042	-0.041	-0.042	-0.050	-0.041
Non-movers		0.000	0.000	0.000	0.000	0.000
All		0.000	-0.001	0.001	0.004	0.000
Panel (c) Banding						
Movers	Winner	0.007	0.023	0.004	0.056	-0.002
	Loser	-0.040	0.005	-0.051	-0.023	-0.043
Non-movers		0.000	0.000	0.000	0.000	0.000
All		-0.002	0.002	-0.002	0.003	-0.002

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: A pupil is defined as a 'mover' if they are assigned to a different school under the reform compared to the baseline case. 'Winner' refers to a pupil that was assigned to a more preferred school under the reform than at baseline. 'Loser' refers to a pupil that was assigned to a less preferred school under the reform than at baseline. The 'Loser' group for FSM-eligible pupils under FSM quota has been suppressed due to low sample sizes, as few FSM-eligible pupils are reallocated to a less preferred school than at baseline under this reform. The results show the number and percentage of pupils in each group, by pupil characteristic (eligibility for FSM and living in the lowest - most disadvantaged IDACI decile - IDACI-1). 'IDACI' refers to the Income Deprivation Affecting Children Index.

The picture is different once we compare winners and losers, depending on whether they are FSM-eligible or live in a bottom decile IDACI neighbourhood. Under FSM quota, FSM-eligible pupils end up in a more effective school if they are winners (0.110 improvement in P8), whereas non-FSM-eligible pupils end up in less effective schools, on average, even when they are winners (-0.065 decrease). This is because school preferences are not determined solely by school effectiveness. The pattern is also the same when our measure of disadvantage is IDACI-1 rather than FSM.

In contrast, under marginal ballots, winners get a more effective school on average, independent of their socio-economic circumstances, and losers get to a less effective school. Under banding, this is the case too, except when socio-economic status is measured by the IDACI index. Here, winners that do not live in a poor (bottom decile) neighbourhood get a seat in a slightly less effective school.

Finally, under banding, FSM-eligible pupils are assigned to a more effective school, on average. This is true whether they are 'winners' or 'losers', although losers from a bottom decile neighbourhood do also get to a less effective school, on average.

7.2.3 Segregation at the Local Authority level

How do these movements of pupils across schools affect segregation of FSM-eligible and non-FSM-eligible pupils at the local level? We measure socioeconomic segregation at the LA-level, using the Dissimilarity Index, which measures the evenness of the distribution of two demographic groups (here FSM-eligible and non-FSM-eligible pupils) across geographic units (here: schools).[62] A Dissimilarity Index of zero indicates that the proportion of FSM-eligible pupils is exactly the same across schools in the LA. A value of one indicates full segregation.

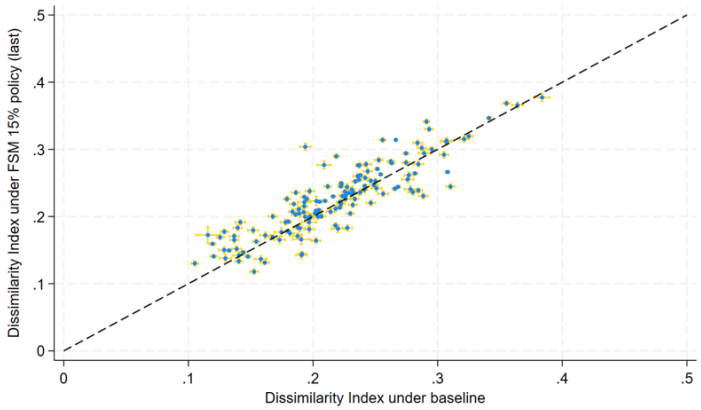
Figure 9 plots, for each reform and for each LA, the Dissimilarity Index of the LA under baseline (x-axis) and the Dissimilarity Index under the central scenario of the reform (y-axis). Figure A3 and Figure A4 in the Appendix present the results for the other reform parameters. Points on the 45-degree line indicate LAs with no change in segregation following the introduction of the reform. Points above the 45-degree line indicate LAs where segregation increases following the reform.

Most points lie on or close to the 45-degree line. This is not surprising since over 90% of the pupils are assigned to the same school under each reform and at baseline. Figure 9(b) shows a barely discernible decrease in segregation under marginal ballots (and the same holds for other quota sizes). Banding (panel (c)) reduces segregation in more LAs than marginal ballots, which suggests that creating a more comprehensive intake according to prior attainment also creates a more balanced intake by FSM eligibility.

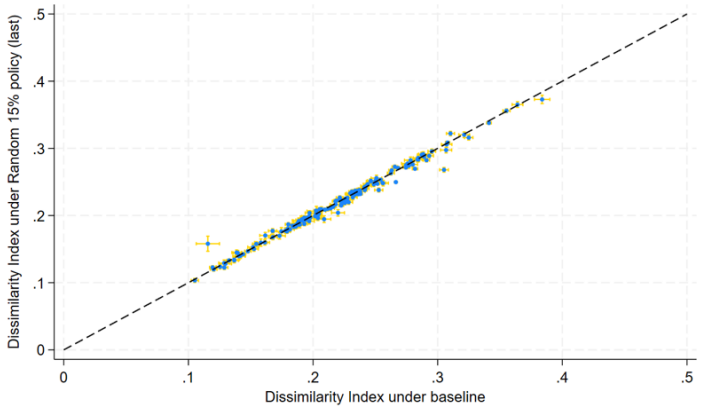
The change in segregation is considerably more pronounced under FSM quota (panel (a)), despite the fact that fewer pupils change schools under this reform than under the other two reforms (Table 10). Panel (a) also shows that, under FSM quota, segregation increases in more LAs than decreases. This may appear counterintuitive at first, as the movement of FSM-eligible pupils is, on average, towards more effective schools, which typically have lower shares of FSM-eligible pupils at baseline.

[62] Formally, the Dissimilarity Index for LA i is given by $D_i = \frac{1}{2}\sum_s \left|\frac{\text{Nb FSM}_s}{\text{Nb FSM}_i} - \frac{\text{Nb non FSM}_s}{\text{Nb non FSM}_i}\right|$, where the summation is taken over all schools s in LA i, and 'Nb FSM' and 'Nb non FSM' refer to the number of FSM-eligible and non FSM-eligible pupils in school s or LA i. See Duncan and Duncan (1955).

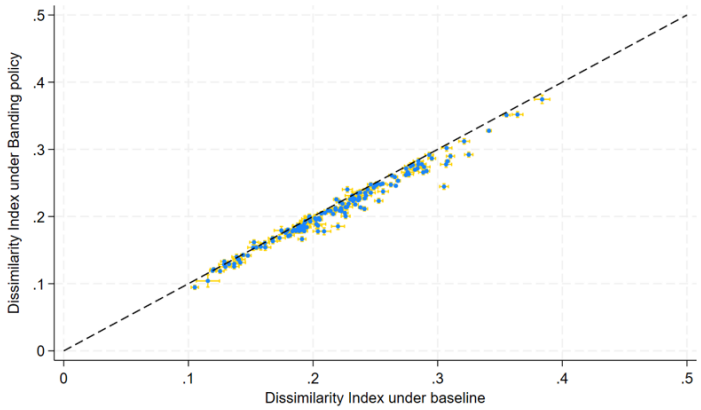
Figure 9: Segregation at LA-level for FSM quota and marginal ballots (15% quota, last precedence) and banding



(a) FSM 15%, last precedence



(b) Marginal ballots 15%, last precedence



(c) Banding

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. Blue dots represent the point estimate, and yellow bars represent the confidence interval. Segregation is computed using the Index of Dissimilarity (Duncan and Duncan, 1955).

The reason lies with the specificities of LAs. Some effective schools will not gain FSM-eligible pupils, simply because they are too far or have other characteristics that do not make them attractive for FSM-eligible pupils. On the other hand, some very effective schools happen to have high shares of FSM-eligible pupils and are located in areas easily accessible for FSM-eligible pupils. The increase in segregation in panel (a) can be explained by clustering of FSM-eligible pupils in high-FSM and highly effective schools. For example, in the LA with the largest increase in segregation, Merton in Greater London, FSM-eligible pupils move towards schools in the 9th and 10th deciles of school effectiveness, with already high shares of FSM-eligible pupils at baseline.

Note, however, that this is not a general pattern. There are also LAs where the improved access of FSM-eligible pupils to effective schools works towards desegregation as expected. Which effect dominates overall depends on the size of the quota and whether quota seats are allocated first (first precedence) or last. Figure A3 in the Appendix shows that segregation decreases in more LAs when the FSM quota is allocated first, whereas it increases in more LAs when the FSM quota is allocated last, and this pattern strengthens with the quota size.

Recall that the precedence order affects how many 'new' FSM-eligible pupils who would not otherwise be admitted gain priority at their preferred school. When the quota has first precedence, pupils assigned quota seats include those who would otherwise have been assigned a seat. This means that pupil composition shifts less, and school segregation is less affected (it is 'as if' the quota size were smaller, as shown by Dur et al. (2018)).

In sum, the results suggest that, overall, the first and expected effect (desegregation through improved access of FSM-eligible pupils to low FSM highly effective school) dominates for smaller sizes of the quota (or a quota allocated first) and that the second effect (increased segregation following an increase in the number of FSM in high FSM highly effective schools) dominates for larger quota sizes.

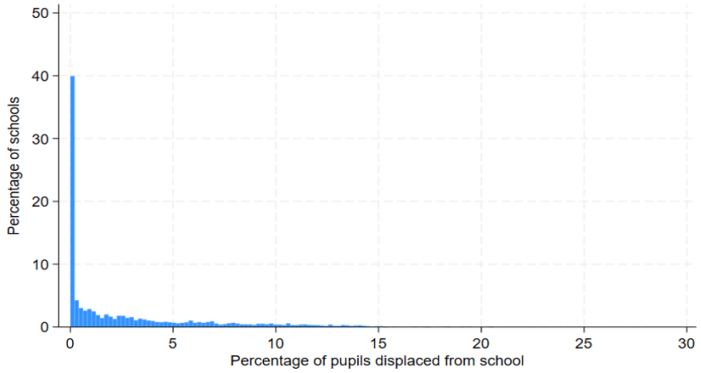
7.2.4 Pupil reallocation to a less preferred school than at baseline and commuting distance

Finally, we present results for two other important outcomes of interest to families and schools, namely the number of pupils reallocated to a less preferred school, and the distance travelled to school. Changes in both outcomes might be common objections to reforming school oversubscription criteria.

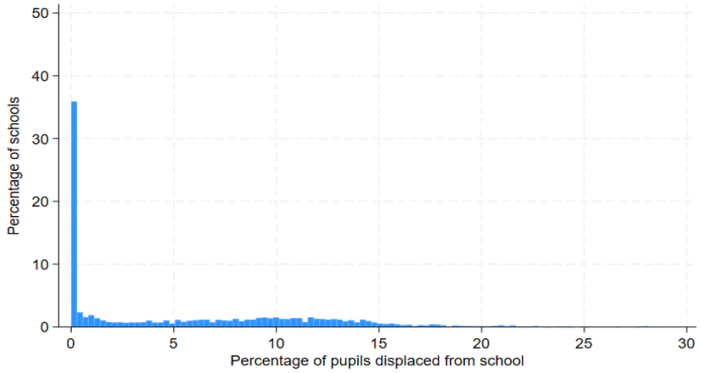
As a metric for the potential disruption to schools, Figure 10 plots, for each reform, the distribution of the percentage of pupils who would be allocated to the school at baseline being reallocated to a less preferred school under the reform (in this section referred to as 'reallocated' for simplicity).[63]

[63]The denominator for this school-level outcome measure is all pupils allocated to the school at baseline. The numerator is all pupils allocated to the school at baseline who are reallocated to a less preferred school under the reform, as another pupil has priority above them.

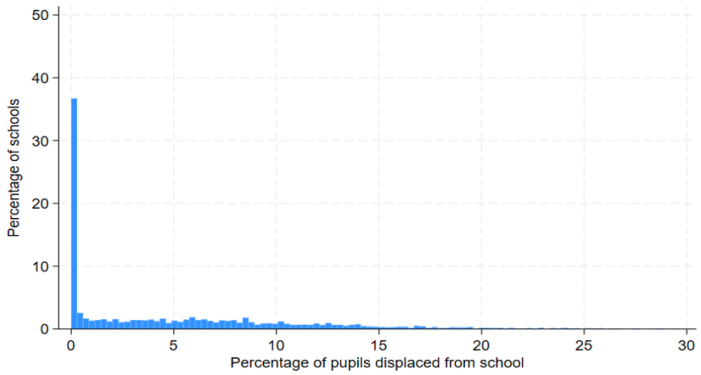
Figure 10: The percentage of pupils reallocated to a less preferred school than at baseline for the FSM quota and marginal ballots (15% quota, last precedence) and banding



(a) FSM 15%, last precedence



(b) Marginal ballots 15%, last precedence



(c) Banding

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'Percentage of pupils displaced from school' refers to the percentage of pupils at the school reallocated to a less preferred school than at baseline.

Figure 10 shows that between 36% and 40% of schools have no reallocated pupils following the introduction of the reform. There is a long-tail for each reform, however, with a minority of

schools seeing more reallocated pupils.[64] This is particularly the case for marginal ballots and banding, consistent with our earlier finding that these two reform options also lead to a higher proportion of pupils being reallocated (Table 10).

Overall, however, the percentage of reallocated pupils for each school is low. For the median school, the FSM quota leads to 0.85% of pupils being reallocated. This means that for the median school, fewer than 1% of pupils assigned to the school at baseline are replaced by other pupils. The 75th percentile is also low, at 4.1%. At the 90th percentile (very near the top of the distribution, with only 10% of schools with a higher change), the change in pupil intake is 8.7%, which is much lower than the quota size of 15%.

Marginal ballots leads to a larger percentage of reallocated pupils, but the 90th percentile is still lower than the quota size (14% compared to 15%). The median is 3.9% and the 75th percentile is 10%. Banding leads to similar percentages of reallocated pupils as marginal ballots, with a median of 2.8%, 75th percentile of 8.1%, and 90th percentile of 13%.

As a second metric for potential disruption, we look at the distance between the assigned school and home. Figure 11 shows the cumulative distribution of distance to school for the FSM-eligible and non-FSM-eligible pupils, under baseline (full blue and green lines) and the reform under consideration (blue and green dotted lines). Figures for all the other parameter options for FSM quota and marginal ballots are in Appendix (Figure A5 and Figure A6).

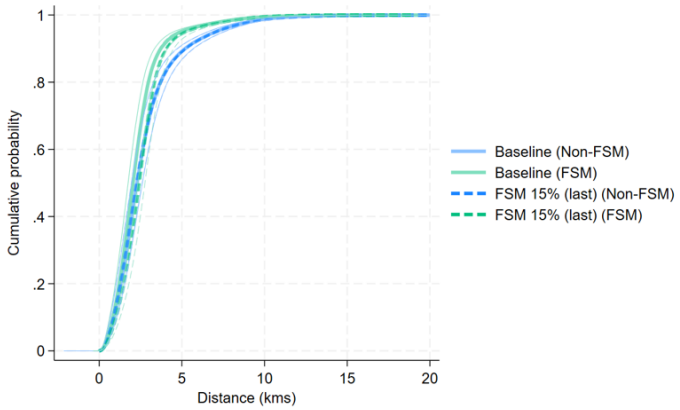
At baseline, Figure 11 shows that distances are generally short, and that non-FSM-eligible pupils travel slightly further than FSM-eligible pupils. Close to 90% of non-FSM-eligible pupils travel less than five kilometres to go to secondary school. For FSM-eligible pupils, that number is around 95%. The median distance across all pupils is 1.725km; the mean is 2.689 km.

FSM quota increases commuting distance, but marginally: the median distance under FSM quota is 1.749km (with a mean of 2.734km). Across the cumulative distribution shown in Figure 11, the change for non-FSM-eligible pupils is not visible and not significant, suggesting that pupils reallocated to a less preferred school than at baseline from this group attend relatively close alternative schools. For FSM-eligible pupils the change is just visible but again not significant, as the confidence intervals overlap. The local transportation context will matter, however, and the effects on commuting time may be larger in contexts with sparser school markets.

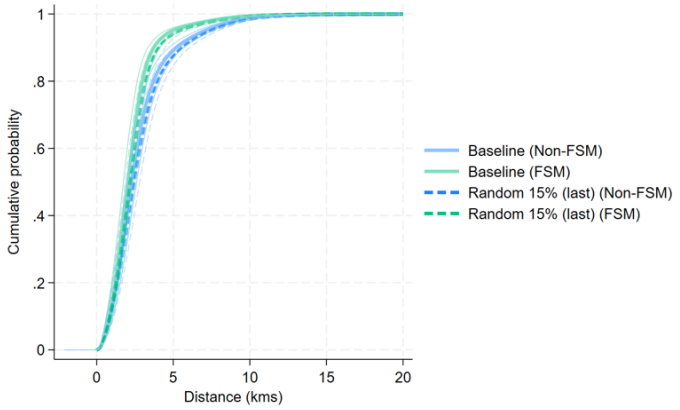
The average change in distance travelled from the marginal ballots and banding reforms is also very small. Compared to the baseline median of 1.725km, the marginal ballots and banding reforms lead to a median of 1.78km. The percentage increase is slightly larger for FSM-eligible pupils (1.55km to 1.59km, or 4.6%) than non-FSM-eligible pupils (1.76km to 1.82km, or 3.4%). The change in the cumulative distribution functions in panels (b) and (c) is not significant, however.

[64] Despite a quota size of 15% of seats, the number of reallocated pupils can be higher than 15% because pupils gaining access to one school thanks to the reform displace pupils who can, in turn, through the work of the criteria, lead to changes in pupil intake at another school.

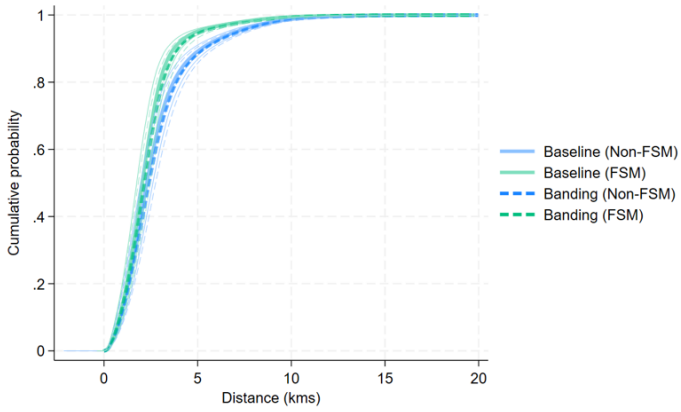
Figure 11: Home-school distance for FSM quota and marginal ballots (15% quota, last precedence) and banding



(a) FSM 15%, last precedence



(b) Marginal ballots 15%, last precedence



(c) Banding

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'Cumulative probability' refers to the total probability that a pupil lives at or below the home-school distance. Almost all pupils live less than 10km from their assigned school.

7.3 Possible behavioural responses to reform

This Section summarises the evidence we can gather about likely behavioural responses to our proposed reforms. This is structured around the behavioural responses detailed in Section 6 and Figure 7. We first describe how pupil composition changes across schools, and the results of an exercise to show how families' school choices change in response to this. Second, we consider whether residential choices are likely to dramatically alter due to the reforms. Finally, we provide some qualitative arguments for the extent to which schools would adjust their own over-subscription criteria to limit the overall effect of the reforms.

7.3.1 Potential change in preferences following a change in school composition

The percentage of FSM-eligible pupils at each school is not dramatically affected for most schools, for any reform. At baseline, the average school has 16% pupils eligible for FSM. Figure 12 shows that for marginal ballots and banding, most schools have less than a 5 percentage point change in the percentage of pupils eligible for FSM, and there are roughly equal numbers of schools gaining and losing FSM-eligible pupils.

FSM quota has the biggest effect on school composition, as it gives priority to FSM-eligible pupils to attend their preferred school, which often results in more clustering of FSM-eligible pupils. Panel (a) of Figure 12 shows that some schools gain or lose more than 5 percentage points, and there are more schools gaining than losing relatively large numbers. Many schools see little change, however, and for the median school, the percentage of FSM-eligible pupils declines by 0.4 percentage points.[65]

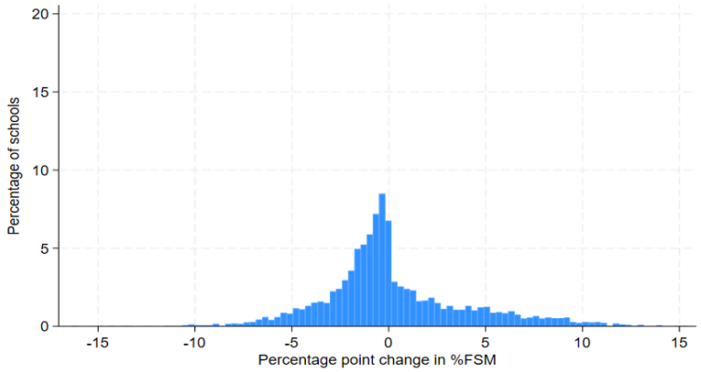
How do these compositional changes affect families' school choices? The pertinent question is whether moves in the percentage eligible for FSM, for example from 16% to 22%, affect the ordering of schools in families' ROLs. The coefficients presented in Appendix Table A3 show that an increasing percentage of FSM-eligible pupils at the school means non-FSM-eligible pupils are less likely to choose the school, but FSM-eligible pupils are more likely to choose the school. This could reflect homophily ('own-group' preference).

To assess this comprehensively, we enhance our modelling exercise to allow families' school choices to change in response to shifts in school composition for schools in their feasible choice sets. In practice, we allow school choices to update in response to school composition, and then school composition to update in response to school choices, up to ten times. This modelling method is equivalent to assuming that families can accurately forecast the eventual school composition under the reform.

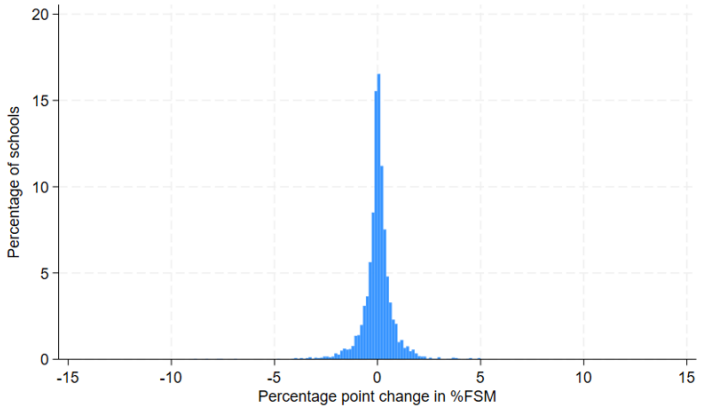
Overall, the effects of FSM quota on access to effective schools are larger when we allow families' school choices to respond to changes in school composition (Figure 13). For example, the share of FSM-eligible pupils assigned to schools with the highest effectiveness increases. In the ninth decile of school effectiveness, the share of FSM-eligible pupils increases from 13.3% to 13.6%. In the top decile, from 11.8% to 12.4%. This suggests that FSM-eligible pupils are more likely

[65] At the 10th percentile, the decline is 3.7 percentage points, and at the 90th percentile, the increase is 5.7 percentage points.

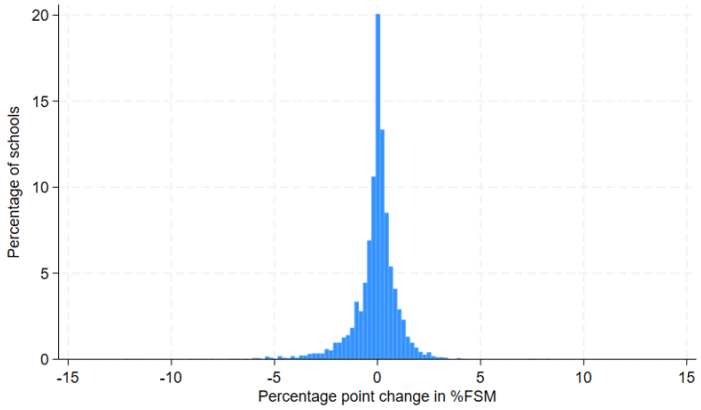
Figure 12: School composition at school-level for FSM quota and marginal ballots (15% quota, last precedence) and banding



(a) FSM 15%, last precedence



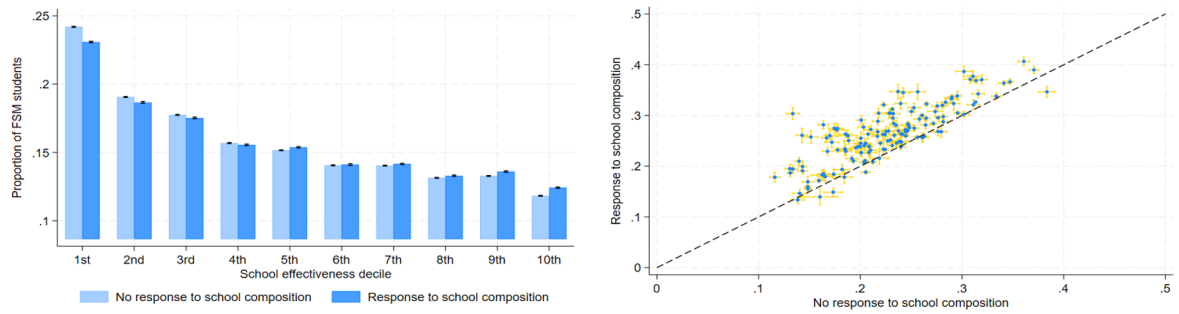
(b) Marginal ballots 15%, last precedence



(c) Banding

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'Percentage point change in %FSM' refers to the percentage point change in the percentage of pupils eligible for Free School Meals at the school-level, between baseline and the reform. For example, a change from 5% to 7% would be a 2 percentage point increase.

Figure 13: Results for FSM quota (15% quota, last precedence) with and without allowing families to respond to changes in school composition



(a) School access

(b) Segregation

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the reformed over-subscription criteria in two scenarios. 'No response to school composition' means that families' school choices do not change once they predict/observe changes in the percentage of FSM-eligible pupils in their school choice set. 'Response to school composition' means that families' school choices can change. Typically, families with FSM-eligible pupils would be more likely to choose a school with an increasing share of FSM-eligible pupils, while families with non-FSM children would be less likely to (see Appendix Table A3).

to choose effective schools when these schools have higher shares of FSM-eligible pupils, or that more spaces become available as non-FSM-eligible pupils choose alternative schools.

Panel (b) of Figure 13 shows that the overall effect of allowing families' school choices to respond to changes in school composition increases segregation in most LAs. FSM-eligible pupils become more clustered in more effective schools with higher FSM intake.

7.3.2 Potential changes in residential choice

Evidence from property prices around 'good' schools suggests that families compete for properties when location heavily influences school admission (Black and Machin, 2011; Leech and Campos, 2003). Illustrating part of the picture, Section 4.3 showed that families are more likely to move into the catchment areas of more effective schools than less effective schools during their child's primary school years.[66] Also, that these moves are driven by families without children eligible for FSM, suggesting that lower-income families are priced out of gaining school access through location.

Would these patterns of residential sorting change dramatically in response to the reforms? This will depend on two factors. First, how responsive the probability of admission is to reform. Second, how responsive residential decisions are to the probability of admission.

Turning to the first point, Section 7.2 showed that around 90% of pupils attend the same school, under any reform, as at baseline. This suggests that for most families, in most neighbourhoods,

[66] As mentioned in Section 4.3, many moves could take place before the child starts primary school, or even before the child is born.

the probability of admission to their preferred school does not change. Indeed, in around 40% of schools, no pupils are reallocated to a less preferred school than at baseline due to a reform.

The effects of a reform on the probability of admission will be concentrated in certain neighbourhoods. For most schools, which retain the distance tie-breaking rule, the probability would change in neighbourhoods relatively far from the school. This is because pupils gaining access through the quota (either FSM quota or marginal ballots) would displace those just inside the distance cut-off at baseline. The probability will therefore change the most in neighbourhoods on the boundary of the catchment or 'de-facto' catchment area of popular schools, where many pupils from outside the traditional catchment area wish to attend.

The probability of admission in some neighbourhoods will fall from one (certain to be admitted) to zero (definitely not admitted). In reality, families may not be able to perfectly predict this change in probability, as the probability fluctuates annually due to random factors, such as the number of pupils with sibling priority. The perceived change may be from 0.9 to 0.8, for example, rather than from one to zero.

The next question is how responsive residential decisions would be to perceived changes in admission, which depends on the short or longer-term horizon. In the short-term, the high costs of moving home in England could dampen any changes. Incumbent households could accept the risk from the small change in the probability of admission to avoid Stamp Duty, for example. In the longer-term, families yet to buy a property could re-optimise, and either choose to live much closer to their preferred school (to guarantee admission), or much further away (hoping to benefit from the reform).

These are ultimately empirical questions, but our assessment is that the housing market would see minimal disruption from reforms which tweak rather than overhaul school over-subscription criteria.

7.3.3 Potential changes in 'status quo' over-subscription criteria

Although schools could undo some effects of the reform through altering other aspects of their over-subscription criteria, we believe that this would be limited. Most schools in England are now Academies, and are able to set their own over-subscription criteria, within the School Admissions Code. Burgess et al. (2023) find that very few Academies have chosen to do this, however, suggesting inertia in this domain. The predicted changes in pupil composition and reallocated to a less preferred school than at baseline are also small, for most schools, creating weak incentives to reform existing criteria.

Finally, even if they wanted to change their over-subscription criteria to undo the effects, schools would find it difficult to do so. First, the School Admissions Code does not allow criteria based on the socio-economic characteristics of the pupils (the FSM/PP criterion is the only exception) and one of the take-aways of our study is that less targeted criteria are not as effective as driving change for FSM/non FSM-eligible pupils. Second, our research shows that a 15% FSM quota is sufficient to give virtually all FSM-eligible pupils their first choice, reducing the role of the

'status quo' criteria for affecting socio-economic composition of the schools' intake.

8 Concluding remarks

The attainment gap between advantaged and disadvantaged pupils in England is large and persistent, despite decades of initiatives and additional funding to close it. Whilst the most important single factor for attainment is the home environment, the school and teachers that pupils are assigned to also matter. Disadvantaged pupils are less likely to attend effective schools (defined by a value-added measure, Progress 8), and this will affect their educational outcomes. In this project, we have focused on the role of school assignment, accounting for differences between affluent and disadvantaged pupils in preferences, spatial location, and characteristics.

We show that there are barriers to school choice which disproportionately affect disadvantaged pupils, arising from school over-subscription criteria prioritising pupils based on where they live. These include pre-defined catchment areas and distance tie-breaking rules, which rank pupils in order of priority based on home to school distance. We show that disadvantaged pupils' feasible set of schools to choose from shrinks due to these geographic over-subscription criteria, disproportionately excluding more effective schools. We also show that disadvantaged families are less likely to move into catchment areas of effective secondary schools during their primary school years, and that they are more likely to be outside the catchment and de-facto catchment areas of effective schools.

Geographic over-subscription criteria generate inequality in access to effective schools. And yet, places in popular, high-performing schools do need to be rationed somehow. The main contribution of this report to policy-making is to use a model of preferences and over-subscription criteria to simulate the effects of three potential reforms to over-subscription criteria.

We focus on three cases: (a) admissions priority for FSM-eligible pupils, up to a quota ('FSM quota'), which expands the feasible set of schools for a targeted group of pupils; (b) a quota of places to which the school's criteria do not apply, reserved for those outside the catchment/de-facto catchment area, and which are filled by random draw if over-subscribed ('marginal ballots'). To expand the potential set of pupils who gain, marginal ballots increases the feasible set of schools for all pupils. This means that all pupils have a positive chance of admission to any school, although the probability can be low, as many pupils can compete for few seats; (c) a test-based approach, in which all pupils take a test and each school is assigned pupils with equal weights across ability bands ('banding'). Banding is equivalent to each school having four quotas, one reserved for pupils in the lowest 25% of ability, one reserved for pupils in the second lowest 25% of ability, and so on. Our central scenario for FSM quota and marginal ballots is a 15% quota, which is assigned in second precedence. Second precedence means that quota places are assigned after 'status quo' places (assigned by the school's normal over-subscription criteria). In general, this acts to increase the share of pupils with priority under the quota, as some are admitted in 'status quo' seats, and the maximum number are admitted in quota seats.

Table 15: Overall comparison of reforms (central scenario for FSM quota and marginal ballots, and banding)

	FSM quota	Marginal ballots	Banding	Baseline
Pupil-level				
Fraction of pupils with a different assignment relative to baseline	5.6%	11.5%	10.6%	-
Fraction of pupils with a less preferred school	2.6%	5.9%	4.9%	-
% Non-FSM with top 2 choice	97.15%	97.35%	97.31%	97.75%
% FSM with top 2 choice	99.97%	97.84%	97.19%	98.26%
Change in school effectiveness among all reform winners (level)	0.097	0.050	0.007	-
Change in school effectiveness gap between FSM and non-FSM	-16.96%	-0.44%	-5.06%	-
Change in distance to school (median)	24 m	55 m	55 m	-
School-level				
% pupils reallocated to less preferred school (median)	0.85%	3.9%	2.8%	
LA-level				
Segregation	increase	little change	slight decrease	-

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'FSM' refers to eligibility for Free School Meals. 'Fraction of pupils with a different assignment relative to baseline' refers to pupils with a different allocated school at baseline and under the reform. 'Fraction of pupils with a less preferred school' refers to those reallocated to a less preferred school under the reform than at baseline. '% Non-FSM with top 2 choice' and '% FSM with top 2 choice' refer to the percentage of Non-FSM-eligible and FSM-eligible pupils, respectively, allocated to their first or second choice on their rank-ordered list. 'Change in school effectiveness among all reform winners (level)' refers to the difference in Progress 8 score between the assigned school at baseline and reform, for all pupils allocated to a more preferred school under the reform. 'Change in school effectiveness gap between FSM and non-FSM' refers to the overall change in Progress 8 scores of schools allocated to FSM-eligible and non-FSM-eligible pupils from baseline to under the reform. 'Change in distance to school (median)' refers to the change in home-school distance for the median (middle) pupil, from baseline to reform. '% pupils reallocated to less preferred school (median)' refers to the school-level percentage of pupils reallocated to a less preferred school from the baseline school, for the median (middle) school. 'LA segregation' refers to the Index of Dissimilarity (Duncan and Duncan (1955)).

Table 15 collects our main findings for the central scenario for FSM quota and marginal ballots, and banding. FSM quota is the most effective reform of the three: it achieves the greatest reduction in the gap in school effectiveness between FSM-eligible and non-FSM-eligible pupils, while limiting the number of pupils assigned to a different school than at baseline (5.6%), the number of pupils assigned to a less preferred school (2.6%), the percentage of pupils of a school

reallocated to a less preferred school (0.85% for the median school), and the extra distance travelled.

Table 15 highlights the key outcomes for each reform option. Within each reform, there remains the choice of the quota level. The results reported in the Appendix show the sensitivity of the different outcomes of interest (change in school effectiveness, fraction of reallocated pupils, etc) to this policy parameter.

We note that a 15% quota for FSM quota, as in our central scenario, ensures that virtually all FSM-eligible pupils get one of their top 2 choices (Table 15). This means that increasing the size of the quota is unlikely to generate very different results: the observed reduction in school effectiveness between FSM-eligible and non-FSM-eligible pupils in Table 15 is more or less the maximum that can be achieved in the presence of school choice by changing school over-subscription criteria. Remaining differences in access are likely driven by families' preferences, for example a preference for closer schools or schools with a certain pupil demographic, and families' and schools' locations. A 15% quota is also close to the fraction of FSM-eligible pupils in our data (15.8%). An obvious variant is to set the level of the quota equal to the fraction of FSM-eligible pupils in the LA. The results in the Appendix indicate that this would further improve access of FSM-eligible pupils to effective schools and decrease the effectiveness gap (Table A4 and Figure A1). The LA-specific quota size adjusts the quota upwards where there are many FSM-eligible pupils, ensuring virtually all get their first choices, while reducing it where it is not useful. It also involves more pupils reallocated to schools other than their school assigned at baseline, and greater changes in segregation (both increases and decreases) at the LA-level (Figure A3).

We have modelled each reform as affecting all schools at the same time, for example, being imposed by a revised School Admissions Code. The overall effects of individual or small groups of schools implementing any of the reforms would be different, as pupils might flow disproportionately to or from these schools. For example, if only one effective school implemented FSM quota, then a higher share of FSM-eligible pupils might choose this school, rather than being spread across many schools. Piecemeal implementation at a local level is likely to lead to greater changes in pupil intakes for the school(s) changing their over-subscription criteria and their closest 'competitor' schools. For these reasons, we recommend that any reform of over-subscription criteria be implemented nationally via revising the statutory School Admissions Code, or by groups of neighbouring schools.

Reducing educational inequalities in England is a challenge for our school system that has long proved elusive to address (Farquharson et al., 2024). We propose and analyse reforms to improve the access of disadvantaged pupils to more effective schools. Our results suggest that our preferred reform, priority for FSM-eligible pupils up to a quota, can make a substantial difference to this societal challenge and, beyond school, to subsequent life chances.

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A Additional results

This appendix collects further results referred to in the main text. Tables are placed first, followed by figures.

Table A1: The median school effectiveness gap as a function of pupils' individual and neighbourhood disadvantage

	FSM 1	IDACI 2	FSM & IDACI 3	+LA FE 4	First born 5	+ Xs 6
Pupil eligible for FSM	0.009**		0.003**	0.001**	0.003**	0.002*
	(0.002)		(0.001)	(0.000)	(0.001)	(0.001)
2nd Decile		0.001	0.001	0.001	0.001	0.001
		(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
3rd Decile		0.006+	0.005+	0.005*	0.006+	0.005+
		(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
4th Decile		0.006+	0.006+	0.006**	0.006+	0.006+
		(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
5th Decile		0.009*	0.008*	0.007**	0.009*	0.008*
		(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
6th Decile		0.009*	0.009*	0.006*	0.009*	0.009*
		(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
7th Decile		0.017**	0.016**	0.011**	0.016**	0.016**
		(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
8th Decile		0.020**	0.019**	0.010**	0.019**	0.019**
		(0.005)	(0.005)	(0.003)	(0.005)	(0.004)
9th Decile		0.022**	0.022**	0.011**	0.022**	0.021**
		(0.005)	(0.005)	(0.003)	(0.005)	(0.004)
10th (highest) Decile		0.026**	0.025**	0.016**	0.025**	0.024**
		(0.005)	(0.005)	(0.003)	(0.005)	(0.005)
N	578,784	578,770	578,770	578,770	281,904	567,352

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: The unit of observation is a pupil, and the metric is school effectiveness (Progress 8). The dependent variable is the difference between the median Progress 8 score in each pupil's commutable and geographic choice sets (see Section 3.5). 'FSM' refers to eligibility for Free School Meals. 'IDACI' refers to the Income Deprivation Affecting Children Index. Column 1 includes the deciles of neighbourhood poverty (IDACI); Column 2 includes individual poverty (FSM eligibility); column 3 includes both these; column 4 adds a full set of LA dummies (not reported); column 5 estimates just on first-born pupils; and column 6 adds other individual characteristics: gender, ethnicity, special educational needs status and KS2 test score. Standard errors clustered at LA-level. + p<0.1, * p<0.05, ** p<0.01

Table A2: Pupil characteristics of those who applied to schools with 'open' over-subscription criteria and the school's closest competitor

Pupil characteristic	School with open criteria	Closest competitor	Difference			
			Mean	25th percentile	50th percentile	75th percentile
% FSM	14.77	14.46	0.36	-2.43	-0.28	2.7
% EAL	29.91	28.05	1.98	-2.34	1.23	6.02
KS2 decile = lowest	8.76	8.49	0.26	-1.51	0.01	1.96
KS2 decile = 2	9.49	9.6	-0.13	-1.83	0.05	1.41
KS2 decile = 3	9.58	9.58	0.01	-1.29	-0.07	0.99
KS2 decile = 4	10.74	10.68	0.07	-1.11	0.16	1.35
KS2 decile = 5	9.14	9.07	0.07	-1.19	-0.25	1.26
KS2 decile = 6	9.56	9.41	0.15	-0.97	0.03	1.29
KS2 decile = 7	12.42	12.16	0.27	-0.78	0.02	1.27
KS2 decile = 8	10.48	10.62	-0.15	-1.36	0.05	1.04
KS2 decile = 9	10.35	10.6	-0.26	-1.68	-0.03	1.1
KS2 decile = Highest	9.48	9.77	-0.28	-1.76	-0.12	1.49
Distance, km (home to school)	3.95	3.55	0.41	-0.42	0.30	1.42

Source: Department for Education (National Pupil Database); Authors: data collection of school over-subscription criteria.
Note: 'Open' over-subscription criteria are defined as the presence of any of the following criteria: a quota for pupils outside a catchment area; an unconditional quota for pupils eligible for Free School Meals/Pupil Premium; Pupil Premium (without conditioning on test score); random allocation. In addition, schools with no geographic criteria or tie-breaking rule as defined as having 'open' over-subscription criteria. 'Closest competitor' is defined as the school for which most pupils who choose the school with 'open' over-subscription criteria also choose on their rank-ordered list. This school must not have 'open' over-subscription criteria for this comparison exercise. School composition variables are: '% FSM' - the percentage of pupils offered a place at the school that are eligible for Free School Meals (FSM). '% EAL' is the percentage of pupils offered a place with 'English as an Additional Language'. '% KS2 decile' is the percentage of pupils offered a place within a broad level of attainment at the end of primary school in KS2 assessments. Deciles group pupils into ten equally-sized groups, according to their performance. KS1 decile 1 contains the 10% of pupils with the lowest performance, while KS1 decile 10 contains the 10% of pupils with the highest performance. Distance (home to school) is the straight-line distance between the pupil's home postcode and postcode of the offered school, in kilometres.
Column 1 shows the school composition of pupils offered a place at non-selective schools with 'open' over-subscription criteria. Column 2 shows school composition for the 'closest competitor'. Columns 3 to 6 show summary statistics for the difference between the school with 'open' over-subscription criteria and the closest competitor, on average. Column 3 shows the mean (average) difference. Column 4 shows the difference at the 25th percentile, Column 5 shows the difference at the 50th percentile (or median), and Column 6 shows the difference at the 75th percentile. These percentiles are interpreted as the value if all school-pair differences were ordered, and the value 25%, 50% and 75% from the bottom were taken.

Table A3: Coefficients from the final specification to estimate families' preferences for school characteristics

	Log Distance	Faith (Any)	Effectiveness (Progress 8)	% EAL	% FSM	% SEN	Catholic	Church of England	Christian	Muslim	Sikh	Jewish
Main effect	-1.539**	-0.117	0.144*	-0.002	-0.013**	-0.004	-0.719**	0.129	-0.459*	-0.658**	-1.726**	-2.918**
	(0.027)	(0.076)	(0.060)	(0.001)	(0.002)	(0.003)	(0.184)	(0.193)	(0.194)	(0.255)	(0.263)	(0.527)
Interaction with pupil characteristic												
KS2 decile 2	0.009	0.031	0.086*	-0.001+	-0.004**	0.000						
	(0.020)	(0.039)	(0.035)	(0.001)	(0.001)	(0.002)						
KS2 decile 3	0.063**	0.002	0.164**	-0.003**	-0.006**	0.001						
	(0.021)	(0.042)	(0.036)	(0.001)	(0.001)	(0.002)						
KS2 decile 4	0.046*	-0.009	0.237**	-0.002**	-0.008**	-0.002						
	(0.020)	(0.032)	(0.039)	(0.001)	(0.001)	(0.003)						
KS2 decile 5	0.117**	0.062+	0.214**	-0.002	-0.008**	-0.002						
	(0.021)	(0.036)	(0.040)	(0.001)	(0.001)	(0.002)						
KS2 decile 6	0.099**	0.004	0.247**	-0.002+	-0.013**	-0.002						
	(0.024)	(0.040)	(0.036)	(0.001)	(0.001)	(0.003)						
KS2 decile 7	0.111**	-0.042	0.375**	-0.001	-0.017**	-0.002						
	(0.024)	(0.040)	(0.041)	(0.001)	(0.002)	(0.002)						
KS2 decile 8	0.187**	-0.019	0.359**	-0.002	-0.017**	-0.006*						
	(0.026)	(0.048)	(0.044)	(0.001)	(0.002)	(0.003)						
KS2 decile 9	0.270**	-0.068	0.467**	-0.002	-0.019**	-0.005						
	(0.030)	(0.050)	(0.050)	(0.002)	(0.002)	(0.003)						
KS2 decile 10	0.454**	-0.259**	0.749**	0.001	-0.031**	-0.024**						
	(0.033)	(0.065)	(0.062)	(0.002)	(0.003)	(0.004)						
FSM	-0.019	-0.021	-0.219**	0.001	0.026**	0.002						
	(0.017)	(0.032)	(0.028)	(0.001)	(0.001)	(0.002)						
EAL	-0.016	0.039	0.054+	0.011**	0.005**	-0.008**						
	(0.024)	(0.032)	(0.032)	(0.001)	(0.001)	(0.003)						
Ethnic minority	-0.294**	-0.261**	-0.063	-0.019**	-0.002	0.001						
	(0.032)	(0.047)	(0.048)	(0.001)	(0.002)	(0.003)						
Primary school:												
Catholic							2.683*	0.348	0.196			
							(1.156)	(1.401)	(1.139)			
Church of England							0.110	1.52	-1.016			
							(1.213)	(1.489)	(1.211)			
Christian							-0.245	-1.135	1.594			
							(1.128)	(1.429)	(1.145)			
Muslim										4.477**		
										(1.530)		
Sikh											4.438**	
											(0.576)	
Hindu												6.345**
												(0.731)

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.

Note: 'FSM' refers to eligibility for Free School Meals. 'EAL' refers to English as an additional language. 'SEN' refers to special educational need. 'Ethnic minority' refers to non-White British. Standard errors in parentheses. ** p<0.01; * p<0.05; + p<0.1. The sample size is 2,987,765.

Table A4: Median school effectiveness of the assigned school, by FSM status, under the baseline and all other reforms

	All	FSM	Non-FSM	FSM difference to baseline
Baseline	-0.0102	-0.1056	0.0070	
FSM (10% quota, first precedence)	-0.0101	-0.0977	0.0059	0.0079
FSM (15% quota, first precedence)	-0.0104	-0.0917	0.0051	0.0060
FSM (20% quota, first precedence)	-0.0106	-0.0898	0.0048	0.0019
FSM (LA% quota, first precedence)	-0.0104	-0.0879	0.0044	0.0019
FSM (10% quota, last precedence)	-0.0106	-0.0909	0.0052	-0.0030
FSM (15% quota, last precedence)	-0.0105	-0.0888	0.0047	0.0021
FSM (20% quota, last precedence)	-0.0106	-0.0875	0.0044	0.0013
FSM (LA% quota, last precedence)	-0.0106	-0.0864	0.0042	0.0011
Marginal ballots (10% quota, first precedence)	-0.0102	-0.1051	0.0067	-0.0187
Marginal ballots (15% quota, first precedence)	-0.0103	-0.1055	0.0066	-0.0004
Marginal ballots (20% quota, first precedence)	-0.0105	-0.1057	0.0064	-0.0002
Marginal ballots (10% quota, last precedence)	-0.0103	-0.1051	0.0065	0.0006
Marginal ballots (15% quota, last precedence)	-0.0103	-0.1052	0.0066	-0.0001
Marginal ballots (20% quota, last precedence)	-0.0104	-0.1053	0.0065	-0.0001
Banding	-0.0120	-0.1026	0.0043	0.0027

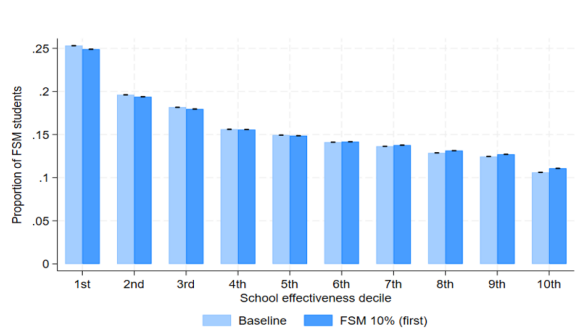
Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. This table shows the median school effectiveness (Progress 8) of the assigned school. 'FSM' refers to eligibility for Free School Meals. 'FSM difference to baseline' reports the difference in school effectiveness for only the FSM group of pupils.

Table A5: Rank of assigned school under baseline and each reform (FSM quota, marginal ballots, and banding) and variant (10%, 15%, 20%, LA% quota, and first and last precedence)

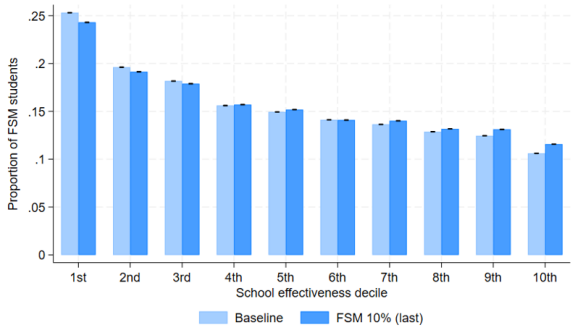
		Assigned school			Rank relative to baseline		
Reform	Group	1st	2nd	3rd +	Better	Same	Worse
Baseline	Non-FSM	88.00	9.75	2.25			
	FSM	91.06	7.20	1.74			
FSM (10%, first precedence)	Non-FSM	87.68	10.06	2.27	0.35	98.92	0.73
	FSM	92.21	6.29	1.50	1.95	97.83	0.22
FSM (15%, first precedence)	Non-FSM	87.17	10.47	2.36	0.40	98.12	1.48
	FSM	93.98	4.84	1.18	4.21	95.65	0.14
FSM (20%, first precedence)	Non-FSM	86.58	10.91	2.51	0.38	97.33	2.29
	FSM	95.91	3.40	0.69	6.22	93.73	0.06
FSM (LA%, first precedence)	Non-FSM	86.92	10.68	2.40	0.36	97.96	1.69
	FSM	94.83	3.97	1.20	5.03	94.86	0.10
FSM (10%, last precedence)	Non-FSM	85.79	11.47	2.74	0.21	96.56	3.23
	FSM	98.05	1.83	0.12	8.00	92.00	0.00
FSM (15%, last precedence)	Non-FSM	85.48	11.67	2.85	0.22	96.15	3.63
	FSM	98.57	1.40	0.04	8.25	91.75	0.00
FSM (20%, last precedence)	Non-FSM	85.30	11.79	2.91	0.22	95.92	3.85
	FSM	98.75	1.23	0.02	8.32	91.68	0.00
FSM (LA%, last precedence)	Non-FSM	85.33	11.78	2.89	0.21	95.96	3.83
	FSM	98.53	1.40	0.06	8.24	91.76	0.00
Random (10%, first precedence)	Non-FSM	87.67	9.90	2.43	2.12	95.42	2.46
	FSM	90.65	7.36	1.99	1.93	95.85	2.23
Random (15%, first precedence)	Non-FSM	87.21	10.04	2.75	2.73	93.95	3.32
	FSM	90.05	7.68	2.26	2.46	94.54	3.01
Random (20%, first precedence)	Non-FSM	87.52	9.99	2.49	3.26	92.62	4.12
	FSM	90.42	7.57	2.01	2.92	93.30	3.78
Random (10%, last precedence)	Non-FSM	87.29	10.06	2.65	2.48	94.56	2.96
	FSM	90.08	7.76	2.17	2.19	95.14	2.67
Random (15%, last precedence)	Non-FSM	87.29	10.06	2.65	3.15	92.97	3.88
	FSM	90.08	7.76	2.17	2.74	93.69	3.57
Random (20%, last precedence)	Non-FSM	87.00	10.19	2.80	3.69	91.58	4.74
	FSM	89.85	7.85	2.30	3.21	92.51	4.28
Banding	Non-FSM	87.90	9.41	2.68	3.87	91.71	4.42
	FSM	89.14	8.05	2.81	3.15	90.85	6.00

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. 'Assigned school' refers to the school assigned by the LA algorithm. 'Rank relative to baseline' refers to the rank of the assigned school in the ROL under the reform relative to baseline.

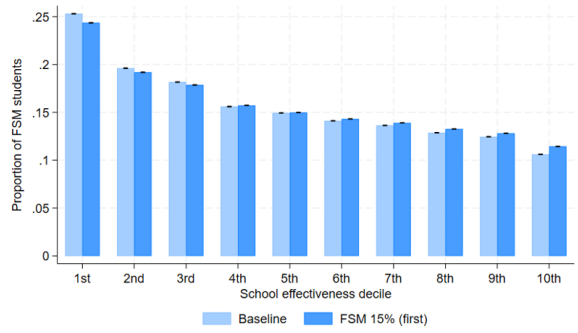
Figure A1: Results for FSM quota across specifications (quota size and precedence order): Access to effective schools



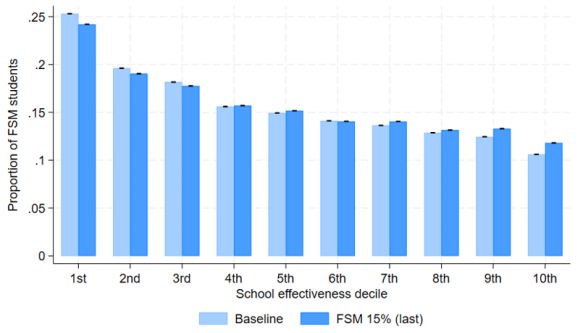
(a) FSM 10%, first precedence



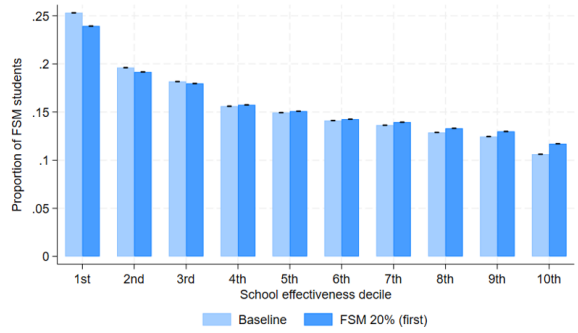
(b) FSM 10%, last precedence



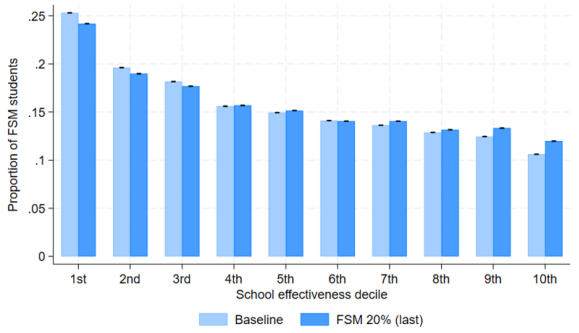
(c) FSM 15%, first precedence



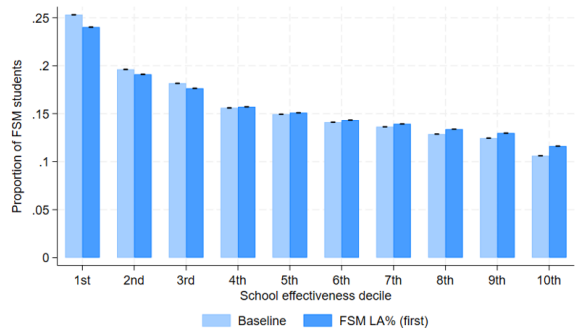
(d) FSM 15%, last precedence



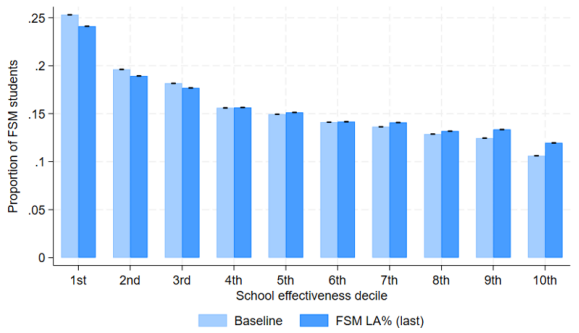
(e) FSM 20%, first precedence



(f) FSM 20%, last precedence



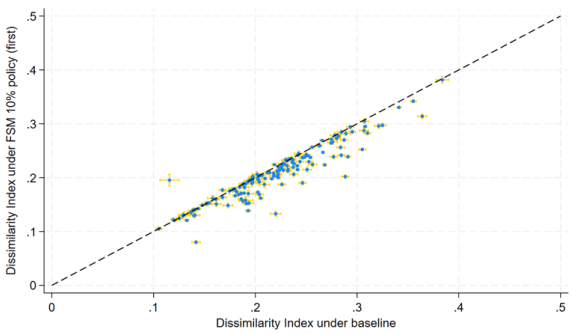
(g) FSM LA%, first precedence



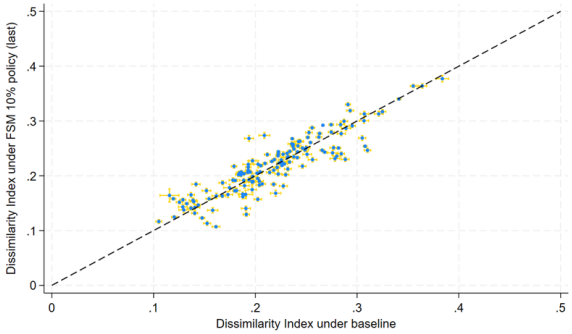
(h) FSM LA%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'FSM' refers to eligibility for Free School Meals. 'IDACI' refers to the Income Deprivation Affecting Children Index.

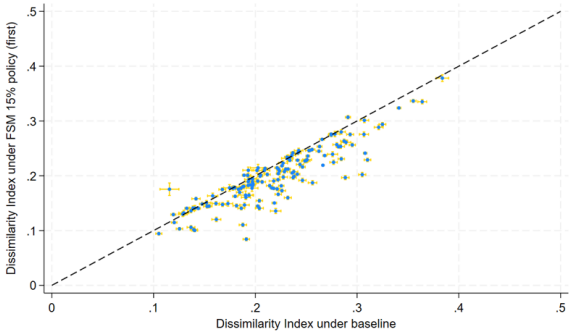
Figure A3: Results for FSM quota across specifications (quota size and precedence order): Segregation at LA-level



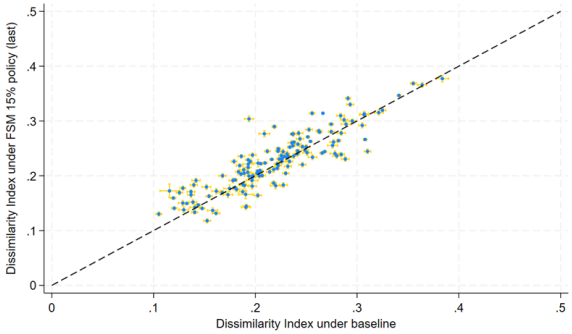
(a) FSM 10%, first precedence



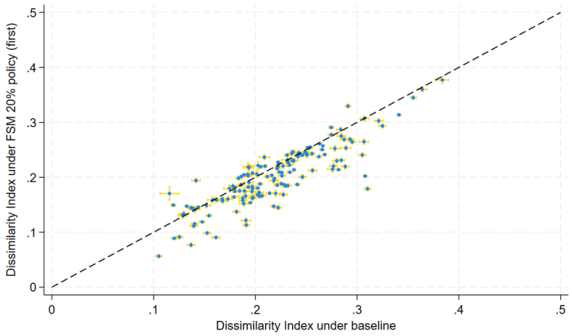
(b) FSM 10%, last precedence



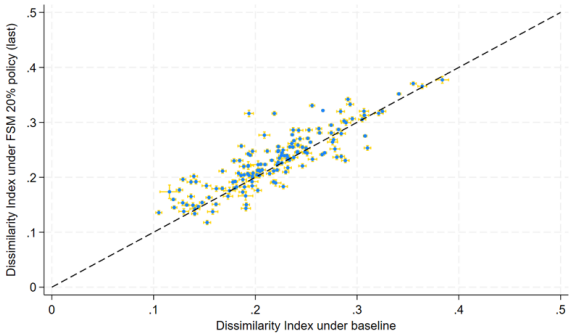
(c) FSM 15%, first precedence



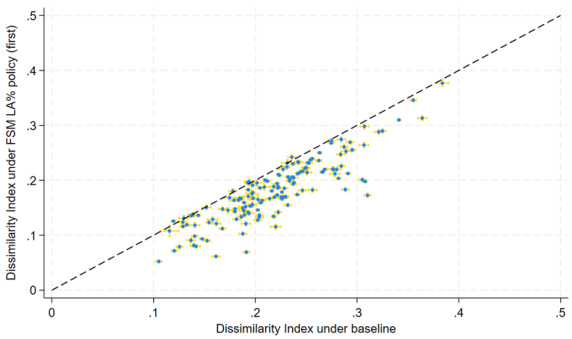
(d) FSM 15%, last precedence



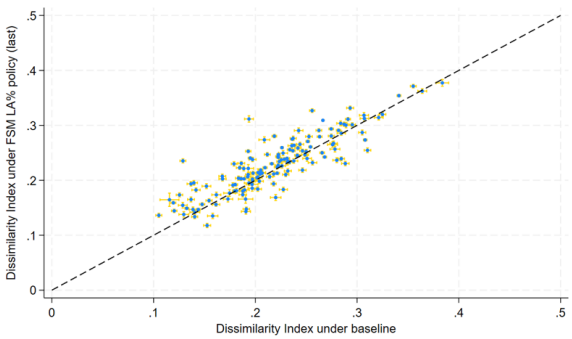
(e) FSM 20%, first precedence



(f) FSM 20%, last precedence



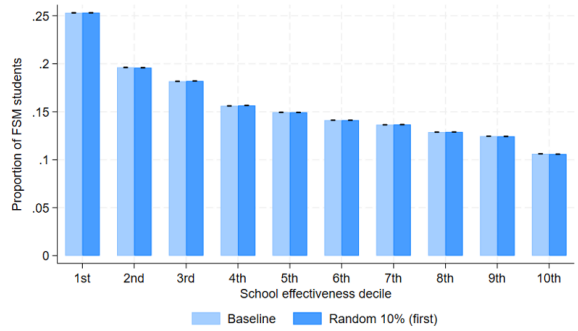
(g) FSM LA%, first precedence



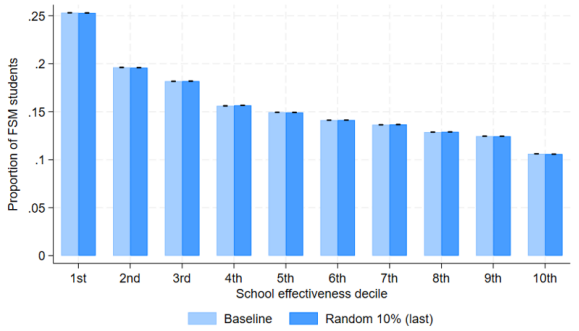
(h) FSM LA%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. Blue dots represent the point estimate, and yellow bars represent the confidence interval. Segregation is computed using the Index of Dissimilarity (Duncan and Duncan (1955)).

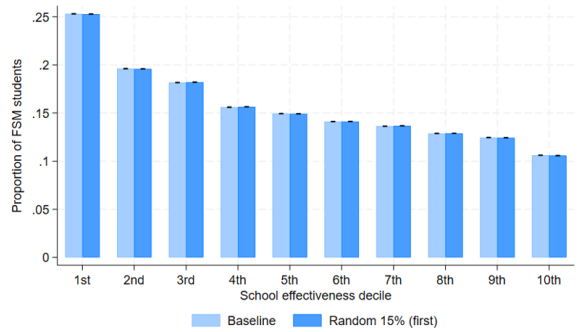
Figure A2: Results for marginal ballots across specifications (quota size and precedence order): Access to effective schools



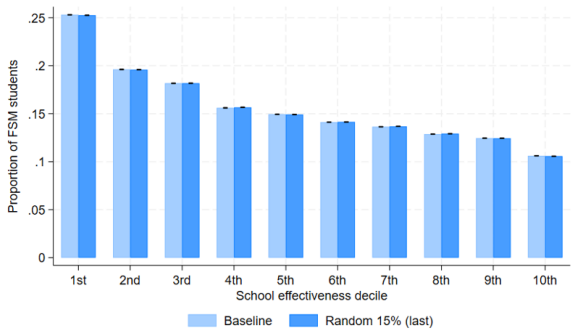
(a) Marginal ballots 10%, first precedence



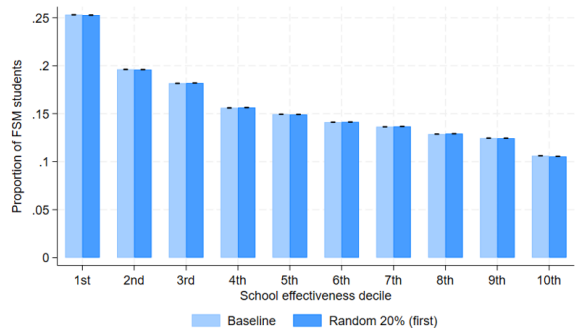
(b) Marginal ballots 10%, last precedence



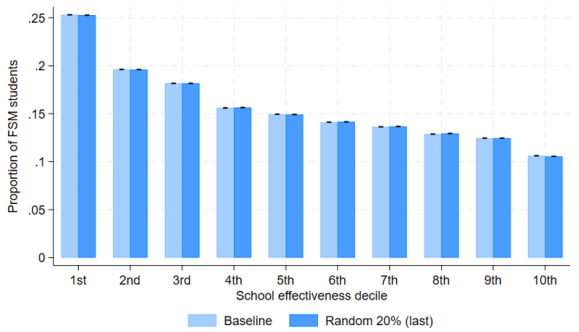
(c) Marginal ballots 15%, first precedence



(d) Marginal ballots 15%, last precedence



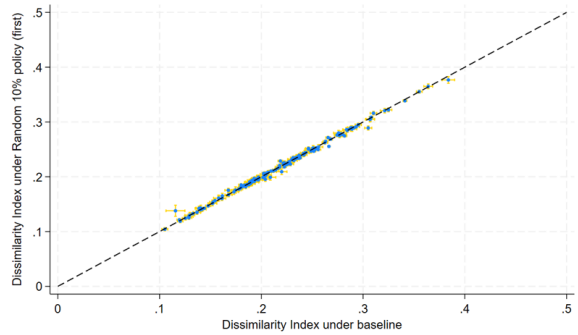
(e) Marginal ballots 20%, first precedence



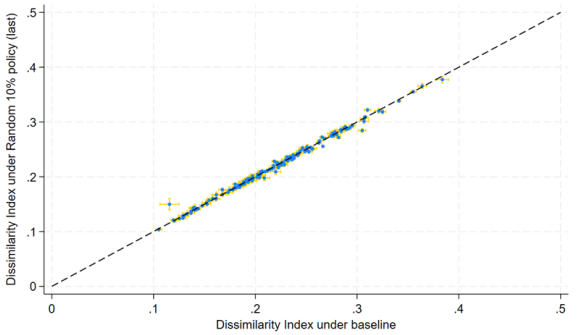
(f) Marginal ballots 20%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'FSM' refers to eligibility for Free School Meals. 'IDACI' refers to the Income Deprivation Affecting Children Index.

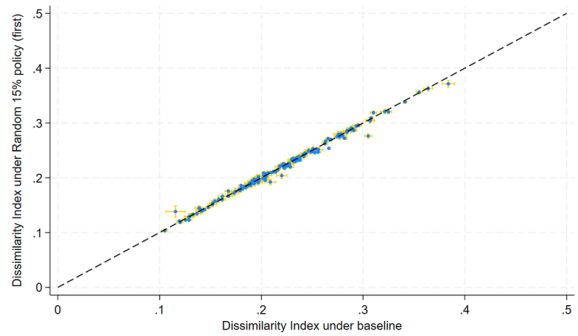
Figure A4: Results for marginal ballots across specifications (quota size and precedence order): Segregation at LA-level



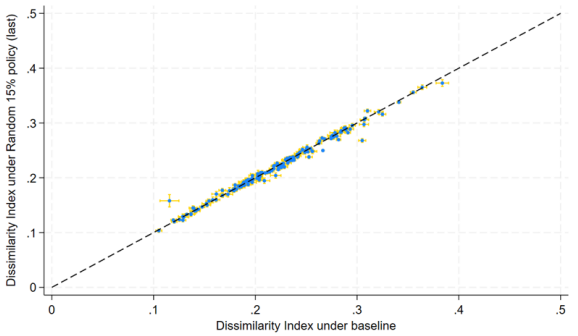
(a) Marginal ballots 10%, first precedence



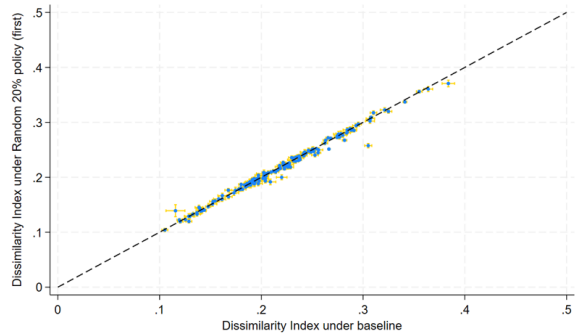
(b) Marginal ballots 10%, last precedence



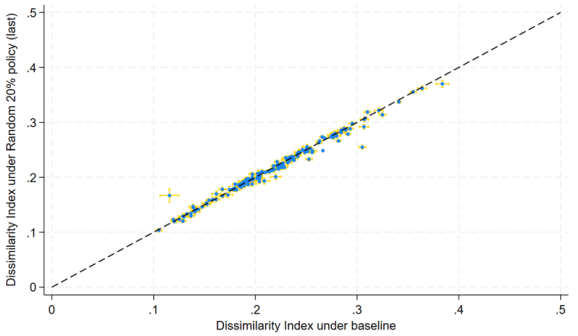
(c) Marginal ballots 15%, first precedence



(d) Marginal ballots 15%, last precedence



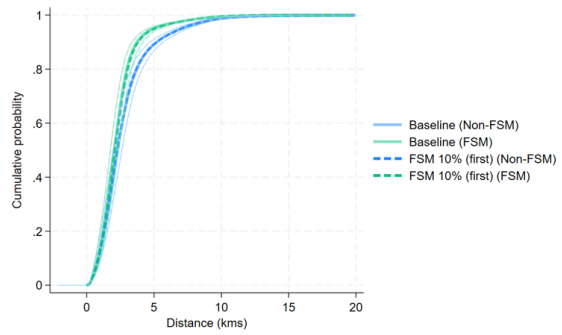
(e) Marginal ballots 20%, first precedence



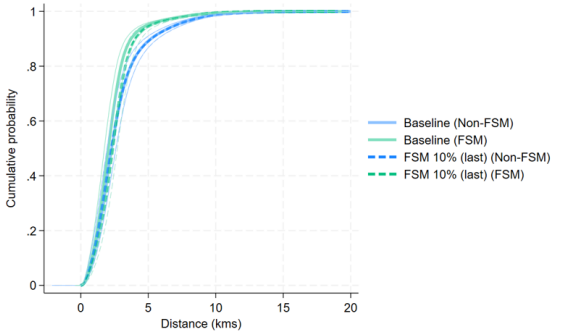
(f) Marginal ballots 20%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. Blue dots represent the point estimate, and yellow bars represent the confidence interval. Segregation is computed using the Index of Dissimilarity (Duncan and Duncan, 1955).

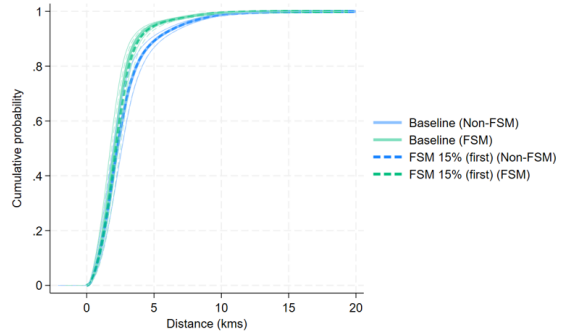
Figure A5: Results for FSM quota across specifications (quota size and precedence order): Home-school distance



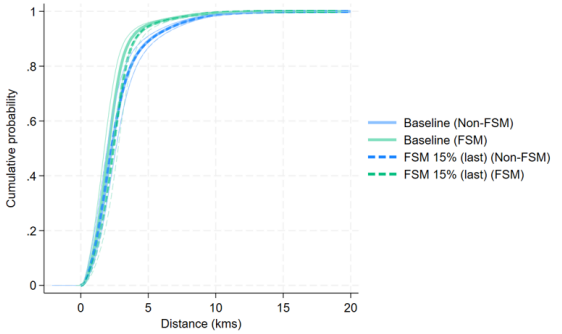
(a) FSM 10%, first precedence



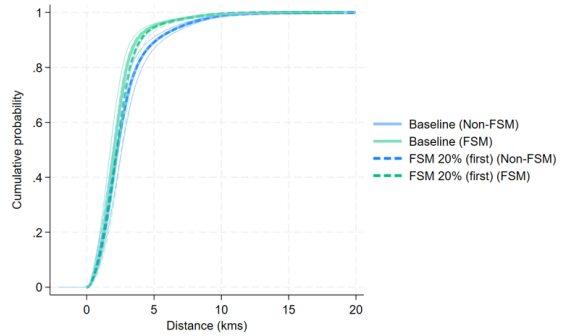
(b) FSM 10%, last precedence



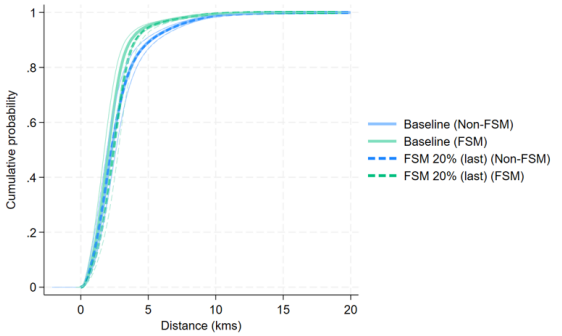
(c) FSM 15%, first precedence



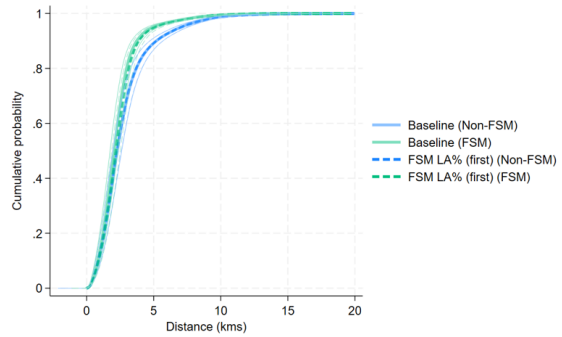
(d) FSM 15%, last precedence



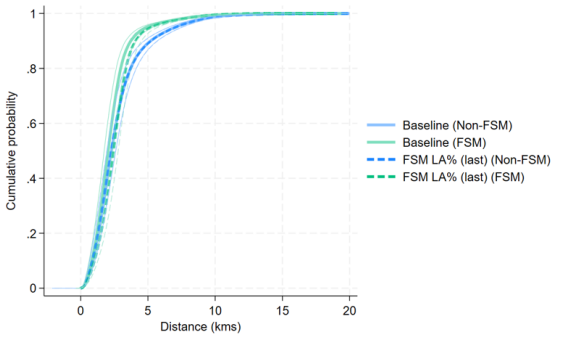
(e) FSM 20%, first precedence



(f) FSM 20%, last precedence



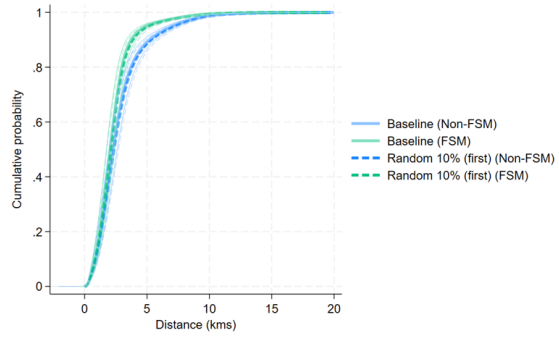
(g) FSM LA%, first precedence



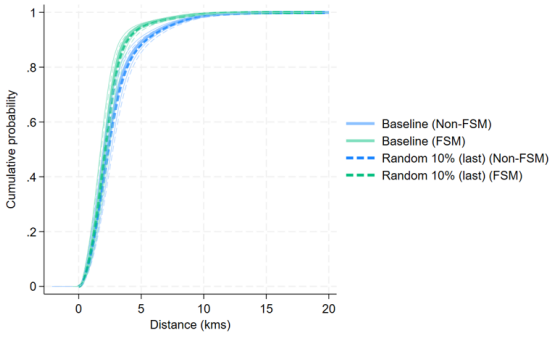
(h) FSM LA%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'Cumulative probability' refers to the total probability that a pupil lives at or below the home-school distance. Almost all pupils live less than 10km from their assigned school.

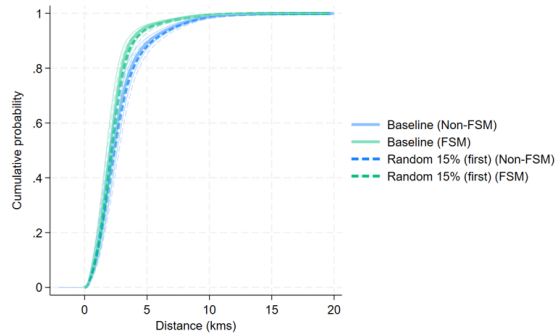
Figure A6: Results for marginal ballots across specifications (quota size and precedence order): Segregation at LA-level



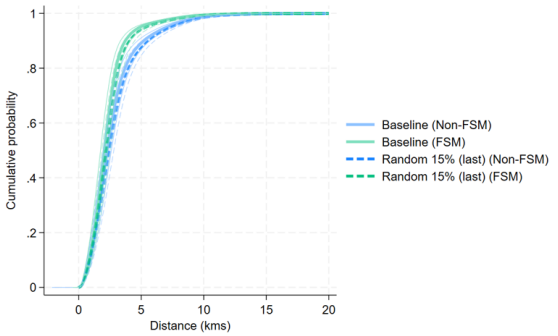
(a) Marginal ballots 10%, first precedence



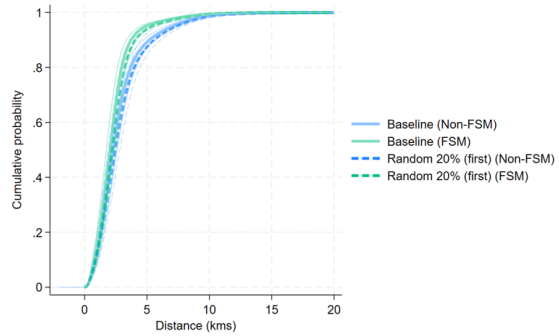
(b) Marginal ballots 10%, last precedence



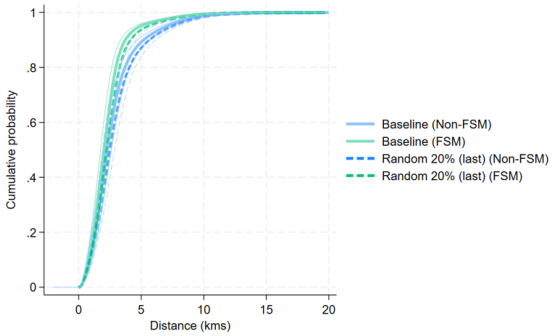
(c) Marginal ballots 15%, first precedence



(d) Marginal ballots 15%, last precedence



(e) Marginal ballots 20%, first precedence



(f) Marginal ballots 20%, last precedence

Source: Department for Education (National Pupil Database); Office for National Statistics (Postcode Directory); Authors: data collection of school over-subscription criteria.
Note: Results are based on 100 simulations. Simulations differ by a random taste shock which affects families' utility from each school, and therefore their rank-ordered list. The results compare the assignment to school under the baseline school over-subscription criteria and the criteria under the reform. 'Cumulative probability' refers to the total probability that a pupil lives at or below the home-school distance. Almost all pupils live less than 10km from their assigned school.

B Methodology: Constructing pupil-specific feasible choice sets

The methodology described in Fack et al. (2019) relies on knowing the ex-post feasible choice set of schools for each pupil. Preferences are estimated by comparing the school characteristics of each pupil's allocated school to other feasible schools for that pupil.

We construct a feasible choice set of schools using observed outcomes from the coordinated process of assigning pupils to schools (the algorithm run by LAs) and information gleaned from school admissions arrangements. For example, from each pupil's assigned school, we can observe with certainty whether they were rejected from another (higher-ranked) school.

The starting point for each pupil's choice set of secondary schools is each school within a 20km radius of the pupil's home postcode. (We use the location of the postcode centroid.) This list of schools was created at the postcode level, taking each postcode observed in the pupil-level dataset and each school location observed in the school over-subscription criteria file. The data is a long list of pupil identifiers, with one row per pupil and school.

In this file, we record whether each school in each pupil's list is:

- A school where the pupil has priority due to living in the pre-defined catchment area
- A school where the pupil has priority due to attending a feeder primary school
- A school where the pupil has priority due to living within the 'de-facto' catchment area defined by the straight-line distance between home postcode and school which would be admitted under a distance tie-breaking rule. For each school, the 'de-facto' catchment area is the 95th percentile of the distance between home postcode and school for the population of pupils that were offered a place. This distance is differentiated by whether the pupil offered a place lived within or outside the pre-defined catchment area of the school, if present.

The list of schools is refined as follows. Steps 6 to 7 are to make the data construction consistent with Fack et al. (2019), in that each school in the choice set should be feasible in equilibrium for the pupil.

1. Any other school mentioned on the pupil's application form is **added** to the list (as it is considered feasible by the pupil by definition).
2. Furthest schools are **deleted** from the list. Any school which is beyond the urban-rural status distance cut-off, is not a catchment school, a chosen school or a feeder school is **deleted** from the list. The urban-rural status distance cut-off is defined as the 95th percentile distance between the home postcode and the offered school, varying with the urban/rural status of the offered school. To be precise, the 95th percentile for rural schools is 14.2km, for schools in towns is 10.3km, schools in London is 6.3km, and schools in other urban areas is 6.4km.
3. Any school which is single sex is **deleted** from the list for pupils of the opposite sex. The set at this stage corresponds to the 'commutable' choice set described in Section 3.5.

4. Any school where the pupil is not inside the catchment area or de-facto catchment area or feeder school is **deleted** from the list, unless the pupil chose the school. The set at this stage corresponds to the 'geographic' choice set described in Section 3.5.

5. Any school which is fully selective is **deleted** from the list for pupils with low prior ability and who didn't choose a selective school. This is defined as the 25th percentile of KS2 average test scores for pupils that applied to and were admitted to a selective school, in a LA where at least 20% of schools are fully selective.

6. Any school the pupil chose but was rejected from is **deleted** from the list.

7. For any school we don't know whether the pupil would be rejected from in equilibrium (because the pupil didn't choose it or because they were assigned to a higher-ranked school) the school is deleted if:

   (a) The pupil would have priority through the catchment criterion but not the feeder criterion, the school rejected at least one pupil from within the catchment area, and the pupil lives further from the school than the distance tie-breaking rule. The distance tie-breaking rule is defined as the 99th percentile of the distance between home postcode and school for all pupils offered a place from within the catchment area.

   (b) The pupil would have priority through the feeder criterion but not the catchment criterion, the school rejected at least one pupil with priority through the feeder criterion, and the pupil lives further from the school than the distance tie-breaking rule. The distance tie-breaking rule is defined as the 99th percentile of the distance between home postcode and school for all pupils offered a place with priority from the feeder criterion.

   (c) The pupil would have priority through the feeder and catchment criterion, the school rejected at least one pupil with priority from the catchment or feeder criterion, and the pupil lives further from the school than the distance tie-breaking rule. In this case, the distance tie-breaking rule is defined as the maximum of the 99th percentiles of the distance between home postcode and school for pupils with priority from the feeder and catchment criterion.

The set at this stage corresponds to the 'feasible' choice set described in Section 3.5.

Table 5 shows the number and percentage of families that make 'ambitious' school choices, by the position in the ROL. We define 'ambitious' as outside the feasible choice set. For example, outside the catchment area and/or de-facto catchment area. Table 5 validates our definition of the feasible choice set, as of all choices 'considered' at a school, above 85% of 'ambitious' choices were rejected.[67] In contrast, above 80% of choices made inside the feasible choice set were accepted (99% of first choices.)

[67] The number of choices 'considered' is the total number minus all those assigned to a preferred school.

C Methodology: Implementation details for the reform simulations

To assess the outcomes of reforms to schools' over-subscription criteria, we use our estimates of families' preferences over school characteristics to simulate how families would rank schools, and we use the new over-subscription criteria to determine admission outcomes based on these preferences.

In this Section, we summarise the procedure we follow to simulate the outcomes under each reform. This procedure consists of five main steps: (i) construction of pupils' feasible choice set, (ii) definition of schools' over-subscription criteria under each reform, (iii) creation of pupils' ROLs, (iv) implementation of the LA algorithm, and (v) computation of the outputs of interest.

Step 1: Construction of pupil-specific choice sets

For each pupil, we construct their feasible choice set (Section 3.5), i.e. the set of schools within a specific radius of their postcode, corrected for gender restriction if any, and any other accessibility restriction based on pupil's characteristics and schools' over-subscription criteria (see Appendix B).

Step 2: Construction of schools' over-subscription criteria

Baseline

We construct school over-subscription criteria under the baseline based on (i) the existing criteria and (ii) the existing quotas. However, we do not observe all the current over-subscription criteria.

The criteria directly observable are catchment, distance, nearest school, feeder, and whether the child is first born, which we can easily identify. For the remaining criteria, we develop proxies based on available information (Table 7). Sibling priority is proxied by assigning priority to the first school ranked by the child if the child has an older sibling. This assumes that younger siblings typically attend the same school has an older sibling. Religious priority is proxied using the denomination of the child's primary school. If the primary and secondary schools have the same religious ethos, the pupil is classified as having religious priority at the secondary school. If the primary and secondary schools both have a Christian ethos, but a different denomination (for example, Catholic and Church of England), the pupil is given priority through 'Other Denomination' criterium. If the primary and secondary schools both have a religious ethos, but from a different faith, the pupil is given priority through 'Other Faith' criterium. Test score and aptitude criteria are proxied by the average KS2 test score in Reading and Maths. PP eligibility is proxied by whether the pupil is eligible for FSM. Finally, random tie-breaking is modelled by drawing one random number for each pupil from a uniform distribution. All other residual criteria, such as EHCP, Looked After, Child of Staff, and various special circumstances, are not observed in our data and are therefore ignored. These special circumstances apply to only a small fraction of pupils.

Finally, we observe existing quotas for schools currently implementing them, which are provided by religion, PP, test and banding. We code these existing quotas accordingly, with some simplifications.

We have coded the religious quota as the total share of seats reserved for pupils with any religion, which can vary between around 4% and 100%, where we have combined quotas for 'own' and 'other' religions. We have coded the PP quota to be the share of seats recorded by the school in their over-subscription criteria. This varies in practice from around 2% of seats to 37.5% of seats. Any further conditions attached to this quota, apart from being above the test score threshold for selective schools, is ignored. For simplicity, we set the test quota for partially selective schools to 10%, even though a minority have a larger quota. Finally, we code banding as consisting of four bands, even though in practice they may vary between 3 and 9.

We implement quotas by creating "mini-schools", each endowed with the corresponding fraction of seats and its specific priority ordering of pupils.

FSM quota

To code FSM quota we assume that each school reserves a quota of the seats to FSM-eligible pupils, with the quota varying between 10%, 15%, 20%, and the LA average percentage of FSM-eligible pupils (LA%) across the different reform variants. Each school is split into two mini-schools: one ranks FSM-eligible pupils first (and the remaining pupils according to the existing criteria), while the other ranks all pupils according to the existing criteria.

One question that arises involves whether these reserved seats are allocated first (first precedence) or after the remaining seats are allocated under the existing criteria (last precedence). We implement each of these possibilities as different reform variants.

Marginal Ballots

Operationally, the coding of marginal ballots is isomorphic to FSM quota, except that one mini-school ranks pupils randomly first, while the other mini-school ranks all pupils according to the existing criteria. The quota seats are reserved for pupils outside the catchment area or de-facto catchment area (as applicable to the school).

Banding

The coding of banding is similar in structure to FSM quota and marginal ballots, except that we now map each existing school into four mini-schools. Each mini-school gives priority to pupils from the corresponding band first, ranking pupils according to the school's existing criteria. To determine each pupil's band, we use their average KS2 test score in Reading and Maths. We first construct the distribution of scores for all pupils and divide it into four equal-sized groups (quartiles), which define the four bands. We then assign each pupil to a band according to the quartile in which their individual score falls.

Table A6: Ordering of mini-schools, by school admissions environment

Baseline	FSM quota, first precedence	FSM quota, last precedence	Marginal ballots, first precedence	Marginal ballots, last precedence	Banding: band 1	Banding: band 1	Banding: band 1	Banding: band 1
Test	Test	Test	Test	Test	Band 1	Band 2	Band 3	Band 4
FSM	FSM	Religious	FSM	FSM	Band 2	Band 1	Band 2	Band 3
Religious	Religious	Main	Random	Religious	Band 3	Band 3	Band 4	Band 2
Band 1	Main	FSM	Religious	Main	Band 4	Band 4	Band 1	Band 1
Band 2			Main	Random				
Band 3								
Band 4								
Main								

Source: Authors: data collection of school over-subscription criteria.
Note: This table shows the ordering of mini-schools in the ROL under baseline and each reform.

Step 3: Construction of families' preferences

For each reform and the baseline, we run 100 simulations. Each simulation corresponds to one draw of preferences over schools for every pupil in the dataset. Preferences are modelled according to the random utility specification in equation 1, where the representative utility is determined by the estimated parameters (Table A3) and the error term is drawn independently for each pupil-school pair from a Gumbel distribution (identically independently distributed extreme value type-I). This produces a simulated utility value for every feasible pupil-school pair. Then, we sort the schools in the pupil's choice set by these simulated utilities to construct a preference ranking over the schools (ROL).

Once we have obtained each pupil's ROL over the original schools, we map these lists into the corresponding mini-schools for each counterfactual reform. This procedure is equivalent to splitting each school into several sub-units (e.g. quota seats for FSM-eligible pupils, quota seats allocated by the marginal lottery, ability-based banding seats, religion/test quotas, and non-quota seats), which differ in their over-subscription criteria.

Table A6 shows the ordering of mini-schools for the baseline case and each variant of a reform. Using this ordering, we expand, for each reform, the pupil's ROL of schools into an ROL of the relevant mini-schools, which then is used as an input in the LA algorithm.

Step 4: Running the LA algorithm

Once we have all the necessary inputs (i.e., school ordering of pupils based on the over-subscription criteria, families' preferences over schools and mini-schools, and school capacities), we run the LA algorithm.[68]

The algorithm generates the assigned mini-school as output. By mapping the mini-schools to their corresponding initial school, we get each pupil's assigned school and rank of assigned school under each reform.

[68] For school capacities, we use the 2019-2020 published admission numbers (PANs) by the schools as a starting point. When data are missing, we impute them from year 2020-2021 or later, if necessary. If the school is over-subscribed (namely, it rejects at least one pupil) we use the number of pupils offered a place as the school's capacity. If instead the school is under-subscribed, we use the recorded PAN.

Accounting for changing ROLs following a change in school composition

We develop a slightly different procedure for the iterative computation of school assignment when accounting for the endogenous change in families' preferences (ROLs) over schools due to the change in socio-economic composition (Section 7.3.1).

For each reform, we run 50 rounds of simulations. In each iteration, we initialise each school's composition variables as the current percentages of pupils with English as an Additional Language (EAL), Free School Meals (FSM), and Special Educational Needs (SEN). Then we run the LA algorithm and recompute each school's composition based on the resulting matches.

We define convergence when the maximum absolute change across schools in any of the three composition measures falls below 1 percentage point; otherwise, we update the composition variables and continue until convergence or a maximum number of iterations that, for simplicity, we fix at 10.

Step 5: Computation of the desired outcomes

Finally, for each simulation run, we compute the following outcomes:

- the effectiveness (measured by P8) of the assigned school
- the rank of the assigned school in families' preferences
- LA-level segregation measured by the Dissimilarity Index (Duncan and Duncan, 1955)
- the distribution of the percentage of pupils in each baseline school reallocated to a less preferred school
- the distance travelled by pupils

C.1 Steps for implementing reform simulations

In this section, we provide further details for implementing the simulation procedure. We distinguish three building blocks: (i) Setup and Input Building; (ii) the School-Proposing Deferred Acceptance Algorithm; and (iii) the Main Simulation Loop.

Algorithm 1 Setup and Input Building

Inputs:
    Data files: `VacanciesData`, `SchoolOrderingsData`
Outputs:
    schools to mini-schools mapping, mini-school vacancies, school over-subscription criteria, mini-school over-subscription criteria.

Start
For each policy:
    For each mini-school:
        assign to each mini-school a capacity as defined by the policy

For each policy:
    For each school:
        retrieve the ordered list of pupils from `SchoolOrderingsData`

For each policy:
    assign to each school its list of mini-schools

For each policy:
    For each school:
        sort mini-schools according to the specified quota order

For each policy:
    For each mini-school:
        retrieve the ordered list of pupils from `SchoolOrderingsData`
End program

Algorithm 2 School-Proposing Deferred Acceptance

Inputs:
    `mini-school vacancies`, `mini-school over-subscription criteria`, `pupil preferences over mini-schools`
Output:
    assignment of mini-school to list of matched pupils

Start
For each mini-school:
    initialize an (empty) list of proposals (containing pupils to whom they propose to)

For each pupil:
    initialize (as None) their tentative accepted assigned mini-school

For each mini-school:
    initialize (to zero) the index of the next proposal

Repeat
    initialize `MatchChanged` to **false**
    For each mini-school:
        while capacity is not filled and there remain pupils in its priority list:
            the mini-school makes a proposal to the next pupil in its priority list
            If the pupil is unmatched **or** prefers this mini-school to their current tentative assignment:
                If the pupil is already tentatively assigned to another mini-school:
                    remove the pupil from that mini-school's list of current proposals
                tentatively assign the pupil to this mini-school
                add the pupil to this mini-school's list of current proposals
                set `MatchChanged` to **true**
Until not `MatchChanged`

For each mini-school:
    return the list of assigned pupils
End program

Algorithm 3 Main Simulation Loop

Inputs:
  Data: `StudentSchoolsData`
Outputs:
  pupil to school assignments; *assignment ranks*

Start
For each simulation from 1 to N: // We set N equal to 100
  For each pupil-school pair (i, s):
    draw an error term $\varepsilon_{i,s} \sim \text{Gumbel}(0, 1)$
    compute the deterministic component of utility $V_{i,s} = X'_{i,s}\beta$
    compute total utility $U_{i,s} = V_{i,s} + \varepsilon_{i,s}$
  For each pupil:
    create rank-ordered lists of schools in their choice set by sorting utilities
  For each policy:
    For each pupil:
      create rank-ordered lists of mini-schools
  For each policy:
    determine the assignment of pupils to mini-schools by executing the
    `School-Proposing Deferred Acceptance` matching function (Algorithm 2)
    determine the assignment of pupils to schools
    calculate rank assignment
End program

C.2 Steps for implementing the composition change

In this section, we provide further details for implementing the simulations procedure while accounting for the endogenous change in families' preferences due to the schools' change in the socio-economic composition (namely, the change in the percentages of FSM, SEN, and EAL pupils). For simplicity, we report only the Main Simulation Loop, which is the part of the procedure that differs from the one described in Section C.1.

Algorithm 4 Main Simulation Loop

Inputs:
  Data: `StudentSchoolsData`
Outputs:
  pupil to school assignments; *assignment ranks*

Start
For each simulation from 1 to N: // We set N equal to 100
  Repeat until convergence or until reaching the maximum number of iterations K:
    // For simplicity, we set K equal to 10
    For each pupil-school pair (i, s):
      draw an error term $\varepsilon_{i,s} \sim \text{Gumbel}(0, 1)$
      compute the deterministic component of utility $V_{i,s} = X'_{i,s}\beta$
      compute total utility $U_{i,s} = V_{i,s} + \varepsilon_{i,s}$
    For each pupil:
      create rank-ordered lists of schools in their choice set by sorting utilities
    For each policy:
      For each pupil:
        create rank-ordered lists of mini-schools
    For each policy:
      determine the assignment of pupils to mini-schools by executing the
      `School-Proposing Deferred Acceptance` matching function (Algorithm 2)
      determine the assignment of pupils to schools
      calculate rank assignment
    For each policy:
      For each school:
        compute the percentages of FSM, SEN, EAL pupils
      store percentages for the current iteration
      compare new and previous percentages to assess convergence
End program

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