Competition, Choice and Pupil Achievement

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Abstract

Competition and choice in education have found growing support from both policy makers and academics over the past decades. Yet, evidence on the actual benefits of market-oriented reforms is at best mixed. Moreover, while the economic rationale for choice and competition is clear, there is rarely an attempt to distinguish between the two concepts. In this paper, we study whether primary schools in England facing more competition perform better than those in a more monopolistic situation, and whether pupils with wider range of choices achieve more than those whose choice is more limited. In simple least squares regression models, we find little evidence of a link between choice and attainment, but find a small positive association between competition and school performance. Yet, this could be related to endogenous school location or pupil sorting. In fact, our instrumental variable strategy, based on discontinuities generated by admissions district boundaries, suggests that the performance gains from greater pupil choice and school competition are limited. Only when we restrict our attention to religious schools and their competitive position in relation to other faith schools do we find evidence of a causal link between competition and pupil achievement.

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1. Introduction

Choice has been the big policy idea in education for quite some time, and it is an idea that is increasingly being pushed hard in the UK. Choice may be a good thing in itself because people value their freedom; but most proponents argue that it leads educational providers to compete for pupils by improving their technology and raising educational standards. The issue has been widely researched in the US, with an extensive literature in the education and economics of education fields (Hoxby, 2003, 2004a). However, it seems only fair to say that the existing evidence is mixed, and at best offers a shaky foundation for policy.

Despite this, a quasi-market in education has political currency.[1] In this paper we study school choice and competition, with the aim of trying to uncover empirical evidence for the hypothesised performance advantages that advocates of choice and competition say underpin these policy ideas. We build on methods used before in the US literature to measure the effects of choice availability and competitive pressures on primary school achievement in the South East of England. Our data allows us to improve on the existing literature since it contains detailed information on pupil and school addresses, from which we can construct separate choice and competition indices.

We also make use of the fact that only a small percentage of pupils in England attend primary schools outside their home Local Education Authority (LEA) because

[1] See Le Grand (1991, 1993) and the more recent discussion in Machin and Vignoles (2005). In the recent 2005 UK government election, the two leading parties both supported it in their manifestos. Labour's pledged was that 'good schools will be able to expand their size and also their influence – by taking over less successful schools' (Labour Party, 2005a). The Conservatives pledged a right to choose that 'will give real autonomy to all schools, and real choice to parents', with the claim that 'choice drives up standards in every field of human endeavour [and]… put pressure on underperforming schools to raise their standards' (Conservative Party, 2005).

there are institutional barriers to doing so. This allows us to derive credible instrumental variables for the competition and choice indices, based on the boundary discontinuity these barriers generate. We use this empirical strategy to solve the difficult issues of reverse causation that are inextricably associated with studying connections between pupil performance and choice/competition.

In the empirical analysis, simple least squares regressions show there to be a positive, but small, association between pupil performance and competition indices. Yet, this seems to be related to endogenous school location or pupil sorting since the instrumental variables estimates show few gains to be had from improving pupil choice and school competition. Indeed, it is only in faith schools that competition seems to be positively and causally linked to performance, and even then only in terms of their competitive position in relation to other faith schools.

The next section of the paper outlines the ideas surrounding debates on choice and competition, explains how these relate to the current admissions system in England, and provides a short guide to the (vast) empirical evidence from the US and the (scant) empirical evidence from elsewhere. Following that, in Section 3 we explain our empirical methods, Section 4 describes the data and Section 5 presents our results. Section 6 concludes.

2. School competition and choice: Theoretical background, previous research and the case of English primary schools

2.1 The costs and benefits of school choice

Theoretical discussions of the benefits of school choice and competition, and on its less desirable consequences, are wide ranging and often highly politicised. Although broad philosophical issues are often involved, we will here attend to the narrower

claims about potential productivity and performance benefits, and consequences in terms of between-school segregation. These issues have been the prime focus of applied work in the education field. The arguments are fairly well rehearsed, and there are many theoretical expositions that focus on different aspects[2], but here we present a brief summary to motivate our empirical work.

The starting point is two 'ideal' modes of school provision:

1) The *community-school* model, in which schools serve local communities only, and only those who live nearby or within the relevant jurisdiction are allowed in.

2) The *parental-choice* model, in which schools admit pupils regardless of where they live, and parental preference is the deciding factor.

Broadly speaking, (1) has traditionally been the most dominant form of provision in most parts of the world. However, comparison of the relatively weak performance of state-sector schools operating under mode (1), with respect to schools in the private sector which operate largely on mode (2), has led many (following on from Friedman, 1962) to advocate expansion of choice as the road to better schooling. Various efficiency and equity arguments impinge on discussions on the relative merits of each model.

i) *Efficiency arguments*

Advocates of mode (2) tend to base their claims on standard efficiency arguments from economic theory. These fall into two categories: those based on market discipline incentives, and those based on better matching of pupil needs and school provision. The main claims are predicated on the assumption that Tiebout choice, in which families

[2] See, *inter alia*, Epple and Romano (1998), Epple, Newlon and Romano (2002), McMillan (2004) and Nechyba (2000, 2003).

vote with their feet and make residential and schooling choices simultaneously, has not led to an efficient allocation of resources under the community-based model (1).

Indeed, community-based schools serving single neighbourhoods work in a relatively monopolistic market, and the incentives for improvement or adoption of new teaching technologies may be weak. Incentives need to come from good governance, supported by strong institutional arrangements including training, monitoring, mechanisms for self-evaluation and performance-related pay (or finance must be linked to housing demand); yet, these institutional arrangements may not be effective. Allowing parents free choice, instead, and linking school finance to school popularity, creates a direct market incentive mechanism: unpopular schools lose pupils and money; popular schools gain pupils additional funding; head-teachers/principals and staff are rewarded accordingly; schools must adapt to meet parental demands – which may include provision of high educational standards – or fail.

Gains also arise through reallocation of pupils to schools according to personal preferences. Pupils find schools that better suit their tastes and pedagogic needs. Consider a move from a community-based to choice based system. If every pupil can find a school that they prefer at least as much as what was available under the old system, the new system must be welfare improving. If every pupil can find a school that offers a teaching technology that educates them at least as effectively as under the community-based system, then academic achievements improve.

Finally, greater choice could offer benefits particularly to people living in poorer communities, where children end up at schools that do not appear to offer educational standards or social environment that they find acceptable.

In defence of mode (1) it is arguable that teaching proceeds better in a stable environment, where teachers are not under undue competitive pressures. Also, classes in a choice-based system may suffer higher pupil turnover linked to search, which can further disrupt teaching (Hanushek, Kain and Rivkin, 2004). Schools facing demand from families with heterogeneous preferences over school quality may even respond to an increase in competition by reducing costly effort and going down-market to serve those with weak preferences for school performance (McMillan, 2004). Finally, a further disadvantage of the choice based system is that on aggregate, pupil travel distances must be greater than (or equal to) those under the community school model. This may have direct effect on attainments because of lateness or stress, but alongside also come higher environmental costs from more car journeys and greater road congestion.

ii) *Equity arguments*

By tradition, critics of mode (2) have argued that it leads to segregation in schools, and inequitable outcomes. Yet, under mode (1), differences in community composition lead directly to disparities in terms of abilities and attitudes of their pupils, and resources at their disposal (in the widest sense, including funding and 'social capital'). Under such conditions, the outcomes of community-based systems can be highly inequitable, since pupils in poor areas have a higher likelihood of attending schools with poor educational outcomes and harsh social environments, than pupils living in wealthier areas. Furthermore, parents who cannot exit unpopular schools via the admission system can exit the community by moving home, leading to further community stratification through house prices (Black, 1999; Gibbons and Machin, 2003, 2004).

Greater choice (conditional on residential location) could break the link between school and community segregation and replace it with sorting across schools along those dimensions of family background which are correlated with more effective exercise of choice. Whether the outcome of a move from community-based to choice-based is better or worse in terms of equity is thus an empirical question, and depends on how segregated communities initially are.

Supporters of the community model (1) would argue that it is better to keep the admission system linked to residential location, and to 'level the playing field' by appropriate resource based policy. Unfortunately, the search for evidence on resource impacts has not unearthed many treasures in terms of effective policy (see Hanushek, 2003).

An overarching concern about wider school choice (model (2)) is, then, that even if choice itself, or the competition it engenders, have the potential to boost pupil achievements, these gains may not be equally distributed. Indeed, whether there are improvements on average depends whether the gains to the winners outweigh the costs to those who lose out. Hoxby (2003) argues that school competition is a 'tide to lift all boats', but as we next discuss the general weight of evidence in the literature (and the evidence we present below) suggests this to be rather bold a claim.

2.2 Previous research

A lot has been written about school choice and competition in the past few decades. Over the years, various countries have adapted their institutional arrangements to accommodate greater freedom of choice for families, and, implicitly at least, greater competition between schools. The literature is rich in descriptions of these institutional arrangements and, sometimes, changes in aggregate achievements that accompanied

them (e.g. Plank and Sykes, 2003; Gorard, Taylor and Fitz, 2003). The topic has also fostered considerable illuminating philosophical discussion (Brighouse, 2000) and political debate. In fact, following different approaches, a substantial volume of quantitative evidence on the effects of school choice on pupil outcomes has been produced (particularly for the US setting); Belfield and Levin (2003) provide a broad survey.

The first and most common approach is to explore the effects of implicit variation in the level of choice available in different school markets (e.g. some of the work reviewed in Belfield and Levin, 2003, Hoxby, 2000, and Rothstein, 2004, for recent examples). These studies start by categorizing schools according to some indicator of market competitiveness, and then measure to what extent this indicator is associated with pupil outcomes in the cross-section. The first empirical problem, and one to which we will return later, is the definition of the competition indicator. In most research, the market in which a school is located is defined by the admissions district in which it is located, whilst the level of competition is based on the number of schools that seem to be available to any pupil in that district. Studies adopting this approach are mixed in their findings. Belfield and Levin (2003) suggest 'the gains from competition are modest in scope with respect to realistic changes in levels of competition' and that many results are statistically insignificant. Hoxby (2000) does find that pupils perform better in metropolitan areas where there seem to be more schooling choices, though only once the number of school districts is predicted from information on the number of natural boundaries (rivers and streams) whereas least squares estimates are near zero and insignificant. Also, the validity of these instruments and the robustness of Hoxby's results have been contested (Rothstein, 2005).

A second approach evaluates the effects of private schooling; this has two strands. One body of work looks at the outcome of private sector pupils relative to public (state) schooling, or more specifically at whether pupils offered vouchers for access to the private sector perform better (Rouse, 1998; Mizala and Romaguera, 2005). In reality, this strand is not directly assessing whether increased choice or competition itself is effective at raising standards; the question is whether schooling in the private sector offers advantages over schooling in the state sector.[3] If it does, then giving families more freedom to choose private schools (by vouchers or similar schemes) could lead to aggregate improvements in educational standards.[4] A second strand looks at the competition effects directly by measuring the effects of private school enrolment on state school performance, on the basis that private schools provide competition for state schools (Hoxby, 1994, 2004a). This strategy is fraught with difficulty since the location of private schools is endogenous to neighbourhood status, and such schools are likely to skim off the higher-achievement pupils from the state sector (Epple and Romano, 1998).

Finally, another body of research evaluates the impact of policy changes introducing greater competition or choice into geographically localised educational markets. In some cases, policies allow constructing research designs that directly exploit random assignment to choice programs: Cullen et al (2003) find that students randomized into supposedly better high-schools experience little academic benefit. On the other hand, Hoxby's work (Hoxby and Rockoff, 2004; Hoxby; 2003) invariably

[3] See some of the arguments in Nechyba (2005), who provides a theoretical overview of issues related to bringing aspects of the private sector to the state sector.
[4] The assumption is that private schools are competitive, and that this is the source of their technological advantage.

finds benefits from choice-increasing programs, as do Holmes et al (2003) on school choice in North Carolina, and Lavy (2005) on choice in school districts in Tel Aviv. The findings from this strand of literature are often difficult to generalize, given the highly localized and peculiar settings under analysis.

All in all, then, it has to be said that the evidence from the US is voluminous but 'mixed'; in contrast, evidence for Britain is almost non-existent. On the one hand, Levacic (2004) finds that secondary school head-teachers' of self-reports of perceived competition are linked to school performance indicators. This probably means that the best headteachers are more aware of their competitors, since her structural measures of competition are unrelated to academic performance. Similarly, Bradley et al. (2000) show a number of 'market' type effects in secondary education following admissions reforms in the late 1980s – for example, schools that performed better than their neighbours attracted more pupils. Finally, Bradley et al (2001) find further that schools with close neighbours are more efficient in their use of resources. On the other hand, Clark (2005) reports that reforms that handed more power to schools (in late 1980s) only exerted modest efficiency gains through competition effects. Otherwise, most research effort has been directed at the effects on segregation (e.g. Gorard, Taylor and Fitz, 2003, Goldstein and Noden, 2003, and Burgess et al, 2004), which we do not pursue here.

The empirical work we present below is, then, to our knowledge the first pupil-level analysis of the effects of *choice* and *competition* on academic achievement in primary schools in England, and the first anywhere that distinguishes these two concepts empirically. Also, our analysis is based on a large pupil census for a wide portion of South-England, and is therefore generally representative. Finally, exploiting

some institutional features of school admissions across school district boundaries, we devise a solid instrumental variable (IV) strategy; this helps us solving some of the problems associated with previous IV studies and contested in Rothstein (2005).

2.3 Primary school choice in the English context

The current state-school system in England is something of a hybrid of a community-based model and a parental-choice setting (i.e., models (1) and (2) discussed above). Traditionally neighbourhood-based, the principle of choice has been extended to a greater or lesser extent in different areas, since the Education Reform Act of 1988 (see e.g. Glennester, 1991). The trend has continued, with further expansion of choice being advocated in many quarters.

Although choice in *secondary* education tend to dominate the political rhetoric and policy discussion, in this paper we will consider the effects of choice at the *primary* phase.[5] The reasons for this are two-fold. Firstly, we believe that choices made at primary age are critical for later educational success (see evidence in Heckman, 2000, and Dearden et al., 2004), and that parents are very active in exercising choice at the primary level (as evidenced by our other research on the house price effects of primary school performance in Gibbons and Machin, 2003, 2004). For this reason, empirical analysis of the impacts of choice and competition on the performance of under-11s is a valuable goal. Next, travel distances have a greater role to play in primary school choice because children of this age are not independent travellers. This means that geographical criteria are likely to be much more relevant in deciding which school to

[5] The UK Labour party, for example, has proposals to make all secondary schools 'Specialist' schools with their own curriculum specialisations and to allow popular schools to expand in response to demand (Labour Party 2005b).

attend, so that the availability of schools can be more confidently inferred from geographical measures of accessibility.

As to the actual extent of actual competition faced by primary schools (or the dimensions over which families can exercise choice), it is important to notice that primary schools are universally non-selective, do not have explicit curriculum specialisations, and are mixed gender; yet, primary institutions are funded according to pupil numbers, like secondary schools, and face therefore similar incentives in terms of their drives to attract pupils by improving educational standards. Moreover, from the perspective of choice and competition, important differences between schools arise, because of the way schools are governed and pupil admissions are controlled.

There are three main groups of schools as follows:

i) 'Community' schools: Most of the 14500 (or so) primary schools in England are classified as 'Community' schools; these are funded through the Local Education Authority (LEA) and admissions arrangements are administered centrally by LEAs. This type of school has no designated religious affiliation, and comprises around 60% of the total number of primary schools.

ii) 'Voluntary Controlled' schools: A further 15% are 'Voluntary Controlled'; these are predominantly faith schools, usually linked to local churches (mostly Church of England, 96%), but staff are employed by the LEA, which also controls admissions arrangements.

iii) 'Voluntary Aided' (23%) and 'Foundation' schools (2%): these have more autonomy and are run by religious or other charitable foundations, which own the school buildings. Their governing bodies include members of the foundation, employ the school staff and control school admissions. Although there are minor distinctions in

funding arrangements between 'Voluntary Aided' and 'Foundation' schools, the main difference is that the foundations that run most 'Foundation' schools (86%) are not connected to a church or other faith; this contrasts with figures for 'Voluntary Aided': 50% of these are linked to the Church of England, and around 47% to the Catholic Church.[6]

Overall, all LEAs and schools must organise their admissions arrangements in accordance with the current Department of Education and Skills School Admissions Code of Practice, which is a statutory document under the 1998 Schools Standards and Framework Act. The Code of Practice reflects the requirements of this Act and the subsequent changes introduced by the Education Reform Act 2002. The guiding principle of this document is that parental choice should be the first consideration when ranking applications to a primary school; yet, if the number of applicants exceeds the number of available places, almost any criterion – which is not discriminatory, does not involve selection by ability and can be clearly assessed by parents – can be used to prioritise applicants. LEAs now publish their admissions policy, complete with information on historical patterns of admission in each school in their jurisdiction (for example Barnet, 2005; Enfield, 2005); these admissions policies vary in detail, but preference is usually given first to children with special educational needs, next to children with siblings in the school and to those children who live closest, and possibly within some designated attendance zone. For faith-schools, instead, regular attendance at one or more designated local churches or other expression of religious commitment is

[6] In the geographical zone we study in this paper, there are slightly more Community schools (66%) and Voluntary Aided schools (27%), but the latter are split between Church of England and Catholic in the same proportion as they are nationally.

foremost; how near or far away a pupil lives becomes important if there are too many applicants fulfilling the faith-related criteria.

Finally, families are allowed to apply to schools in LEAs other than their LEA of residence. However, whereas at secondary school (post age-11) this process is formalised through a common application form to schools within and without the home LEA, at primary level parents must make separate applications to other LEAs; moreover, although LEAs are not allowed by law to prioritise residents of the authorities own administrative area over other applicants, LEAs do not have a statutory requirement to find a school for pupils from other LEAs and the law only require that they provide enough schools for pupils in their area.[7] As a result, banking on admission to a popular school in another LEA is a high-risk strategy, so cross-LEA attendance is not commonplace in 'Community' primary schools. In our study area in and around London only 4.7% of 'Community' school pupils, 3% of 'Voluntary Controlled' pupils and 6% of 'Foundation' school pupils attend outside their home LEA. For 'Voluntary Aided' schools that deal with their own admissions, LEA crossing is a little bit more common – at around 10% of pupils.

In summary, exercise of choice takes place in three ways, and along the dimensions highlighted above. First, given residential location, a family can apply to local or more distant (secular primary) schools, but with a greater probability of admission to those close-by, and within the LEA of residence. Second, a family can, given their place of residence and religion commit to regular church attendance and

[7] The Education Act 1996 section 14 reads: "(1)A local education authority shall secure that sufficient schools for providing (a) primary education, and (b) education that is secondary education by virtue of section 2(2)(a), are available for their area. (2) The schools available for an area shall not be regarded as sufficient for the purposes of subsection (1) unless they are sufficient in number, character and equipment to provide for all pupils the opportunity of appropriate education"

apply to Church schools (rather than non-faith schools) almost anywhere within convenient travel distance, but again there is usually more chance of admission to local schools (and within LEA of residence). Otherwise, they can exercise Tiebout choice and move home, both within and across LEA boundaries.

3 Empirical methods

3.1 Defining competition and choice competition

The concept of competition we will invoke in this study is – like other work in the area – one of spatial competition. Schools compete with other schools for pupils in a community in order to maximise their revenues and minimise the costs associated with disruptive and hard-to-teach pupils.[8] However, a family's choice of school is constrained by the distance between home and school, in part because of commuting costs, but more importantly because school admission rules have historically favoured residents who live nearby. Because of this, residential locations differ in terms of the number and accessibility of alternative schools, which in turn means that some schools face greater competition from alternatives than do others. Since state schools cannot easily change location or vary their price, they can only increase their market share by offering a higher quality product. These are the competition effects we seek out in this paper.

Yet, the purpose of this empirical work is also to measure separate effects of greater freedom of school choice, and greater inter-school competition, on pupil performance. Though these two ideas are conceptually distinct, they can be difficult to

[8] Schools in England are funded on a per-pupil basis (with adjustments for special needs and economic deprivation) but the marginal costs of teaching extra children within a class group are self-evidently small in purely financial terms. Schools are also evaluated on the basis of pupil pass rates in national tests (the league tables), which are heavily dependent on pupils' initial attainments. For these reasons it is not hard to believe that these incentives are real.

separate. At the school level, these things go hand in hand. Markets in which parents have a wider choice of schools are markets in which schools face greater competition from other schools. But for the family, the two concepts of choice and school competition are distinct. Our definitions are as follows: *Choice* is a property of residential location, and is dependent on the number of alternative schools from which a family can choose. *Competition* is a property of school location, and depends on the number of alternatives available to potential pupils.

One thing is clear at the outset: there must be variation in the competitive structure of school markets for either of these ideas to be meaningful empirically. Our empirical work considers a large metropolitan area in which there are few explicit differences in institutional arrangements that could give rise to different competitive structures; all LEAs offer broadly similar admissions arrangements, in line with the legal requirements of the 1988 Education Reform Act, the 1998 Schools Standard and Framework Act, the 2002 Education Act and the DfES codes of practice on schools admissions.[9] Our claim is that it is the spatial arrangement of schools in relation to each other, and in relation to residential housing, to give rise to *de-facto* variation in market structure, because some families will find their homes geographically positioned to take advantage of a wider range of schools, whilst others will be much more constrained. For sure, this spatial arrangement may be endogenous to pupil performance and this is something we consider in our empirical work.

[9] This is unlike the markets studied by Hoxby (2000), who considers the number of school attendance zones in a jurisdiction.

3.2 Measuring choice and competition

Our measurements of parental *choice* are based on the number of schools that, according to our data, are available to families living in a given location. Similarly, our measurements of *competition* are based on the range of alternatives that are available to pupils attending each school. Both of these measurements are based on the spatial configuration of schools and pupil residences.

These kinds of competition/choice indices suffer from a number of problems. Firstly they can capture urban density and school size effects, rather than competition and choice; we try and carefully design the indices to avoid this. Secondly, different market configurations can arise through processes of parental choice and through endogenous school location. If school places are rationed by place of residence, then parents have good reason to move close to popular schools. These schools may appear monopolistic, even though it is parental choice that has compressed the geographical spread of their intake. Conversely, if motivated families with high-achieving children are more successful at exercising choice (conditional on residence), then successful schools may appear competitive, even though it is parental/pupil choice that has spread their geographical intake. Finally, although new school opening and school closures are quite rare, it is not implausible that the current spatial distribution of schools is related to the socioeconomic characteristics of an area, and consequently, its pupil attainments. In particular, we suspect that faith schools may operate in places where economic and educational conditions are more favourable.[10] We address the endogeneity of the

[10] Yet, we have some mixed evidence on this point. For example, religious schools tend to locate in neighbourhoods where a lower fraction of individuals has low educational achievements; yet, they are also more likely to be in areas where a higher fraction of the population is on social rents.

competition and choice indices induced by these factors using an instrumental variables approach based upon a boundary discontinuity, as described below (in Section 3.4)

The indices we use are best described diagrammatically as in Figure 1 (although we define them more precisely below). Our data contains information on school location and pupil residential location, identified by 6 digit (1 metre) coordinates derived from full address postcodes. For each school s we define its *travel zone* to encompass all residential postcode units that are: a) within the same LEA as school s *and* b) contained within the perimeter of a circle drawn around school s at the median of the distribution of the home-school distances for pupils who attend school s.[11]

Our index of school *choice* availability is derived using our knowledge of a pupil's residential postcode and the travel zones of nearby schools. This index is defined as: <u>the number of schools accessible to a pupil</u> - the number of school travel zones that encompass the pupil's residential postcode, excluding the school the pupil actually attends.

The *competition index* is school-based and assesses the extent to which pupils attending school *s*, have or had the option of attending other schools. This information is obtained as: <u>the average number of schools accessible to pupils in the school</u> - the average of our school choice index across pupils *attending* school s.

In all cases, when we consider pupil numbers, we count all pupils in the age 10-11 cohort who are finishing primary school and taking their Key Stage 2 tests.

Notice that we have experimented with a number of alternative competition measures, including number of schools accessible to pupils living in the travel zone,

[11] Using the median means that we are focussing on competition amongst the pupils who live nearest to schools. Our results are similar if we use a wider or narrower travel zone, e.g. the 25th or 75th percentiles.

number of schools located within the travel zone, and number of schools within a *fixed radius* from the school; also, another commonly used measure is based on the Herfindahl index of pupil shares in alternative schools. These alternative indices all gave qualitatively similar result; yet, we think our number-of-school indices are conceptually better and easier to interpret.

Importantly, the way we define the travel-zones used to construct these indices means that they are not purely dependent on school density, and hence on urbanisation effects. Even rural areas can (in principle) appear competitive, since our definition of school accessibility is based on *observed pupil travel behaviour*. Rural areas may exhibit low school density, but may still be competitive because rural pupils travel further to school. In a sense, our travel zones are defined by "revealed preferences", as they are based on actual travel distances. This allows us to directly account for urban-rural differentials, heterogeneous travel time, and other features of parental choice that would otherwise be obscured by imposing some homogeneous structure.[12]

3.3 Modelling school performance

Our focus is on the influence of these competition indices on pupil achievements, where these are measured in terms of standard test results. One can think of this as the effects of choice and/or competition on school productivity (Hoxby, 2003), though we make no attempt to evaluate achievements per pound spent.[13] As discussed above, more competition with other schools, and greater exercise of choice amongst its potential clients, may raise a school's productivity because it forces schools to use a more

[12] Notice that our approach is almost identical to fixing a maximum time that parents/children spend travelling from home to school, and computing the number of available schools within this range. In fact, for a similar amount of time, we expect parents to cover more mileage in rural areas, and less in densely populated urban areas; this is precisely the kind of differences our indices are designed to solve.

[13] Expenditure information at school level is not available to us.

efficient teaching technology, or because reallocation of pupils to schools results in more efficient pupil-school matches. From the pupil perspective, an extended choice set can only increase their personal achievements – conditional on the level of competition faced by the school they actually attend – if the availability of choice means that they were able to make a better choice of school.

We look for these types of influence by estimating pupil-level educational production functions that use information for the London metropolitan area (described below). The data available to us is rich in geographical detail, with information on pupil residential addresses, which makes computation of these competition indices feasible. However, it is only available for two years to date, leaving us with little useful time-series variation in the competition indices and forcing us to adopt an essentially cross-sectional approach.

The inputs into the education production functions include the choice and competition indices, alongside a wide range of pupil, school and/or neighbourhood characteristics. The full details of each specification are described in the Results section below. The outputs of the production function are measures of pupil attainment relating to standard tests taken at the end of the primary phase in English education, at age 10/11. There is little doubt the outputs of a good education amount to more then good results in academic tests; but tests remain the simplest metric on which to judge pupil abilities, and average attainments in schools are the most common, if the most basic, means by which school performance is assessed. So, we use test scores as the main measure of pupil attainments, focussing on the *gain* in pupil attainments from age 6/7 to age 10/11: what is referred to as Key Stage 2 in the English National Curriculum.

Summing up, all our empirical models are more or less restricted versions of the following specification:

$$KS2_{irst} = \alpha KS1_{irst} + \beta_1 c_{rt} + \beta_2 c_{st} + \mathbf{x}'_{\mathbf{irst}}\boldsymbol{\gamma} + \varepsilon_{irst} \qquad (1)$$

where $KS2_{irst}$ is the age-10/11 test score for pupil *i*, who lives in postcode *r* and attends school *s* in year *t*; $KS1_{irst}$ is the age-6/7 test score for pupil *i*, who lives in postcode *r* and attends school *s* in year *t*; c_{st} is a competition index for school s in year t; c_{rt} is a choice index for residents of postcode r in year t; and finally $\mathbf{x}'_{\mathbf{irst}}$ is a vector of pupil, school, neighbourhood characteristics (and a year dummy).

3.4 Accounting for residential sorting: instrumental variables strategy

Families choose where to live, and schools are one thing they certainly consider when making that choice. As a consequence, the market structures we observe in our data – which are based on the spatial configuration of school and pupil residential locations – may be endogenous in the production of pupil achievements. This would be true if, for example, families crowd around a high-performing school, reducing its apparent competitiveness. It would also be true if competitive structure is indicative of market penetration by a specific type of school which tends to be high-performing. For example, faith schools are often considered high performers, and may induce competitive market structure. In fact, it is rare (and would suggest very inefficient planning) if non-denominational primary schools were located in close proximity; yet, it is common to find faith schools near non-denominational schools. Because of these concerns, we need to adopt and instrumental variable strategy and look for credible instruments for our competition and choice indices.

In fact, our indices all assume that residence-school distance is an important factor in school choice because of travel costs. The general assumption is that the probability of family i attending school j is decreasing in the distance to the school d_{ij}. Given this, families are, under most conditions, more likely to choose their nearest school, as the average distance to alternatives increases (other things equal). To see this, consider the following simple exposition. Suppose family utility from attending school j depends on distance d_{ij} and the school quality q_j, with $u_{ij} = aq_j - bd_{ij}$. Family i attends the nearest school k if $aq_j - bd_{ij} < aq_k - bd_{ik}$ for all j, or $a(q_j - q_k) < b(d_{ij} - d_{ik})$. Clearly, for given values of q_j, q_k and d_{ik}, the probability of i attending k increases as d_{ij} increases, for any j. An increase in d_{ik} for any j implies an increase in the average distance to all alternatives to k (assuming the choice set is finite).

Our instrumentation strategy uses this intuition, using the notion that families living near LEA boundaries face longer journeys to schools other than the nearest, than families living in locations interior to the LEA. The idea is best illustrated in Figure 3. The figure shows a linear district with 5 schools k, m, n, p, q spaced at equal intervals. Schools k and q are located at the district boundaries at the left and right ends of the district respectively. The dashed lines show the cost of reaching each school, from each point i along the linear district. The bold line shows the average cost of reaching schools other than the nearest school, at any point i along the linear district. As can be seen, the average costs of travel to schools other than the nearest is higher for residents near the edge than the centre. This means that residents near boundaries are more likely to attend their local school, i.e. travel costs restrict choice for residents near the district boundary relative to those in the centre. A further implication is that probability that school j recruits from the set of families who have j as the nearest school decreases with the

distance of *j* from the LEA boundary. From these arguments, we propose to use the distance between a pupil's home and the LEA boundary as an instrument for school *choice*, and the distance between a school and the LEA boundary as an instrument for its level of *competitiveness*.

These predictions clearly depend on the distribution of schools and families. They would not hold, for example, if schools and households were more densely distributed around the LEA perimeters than the centre. This is an empirical issue, which we investigate below, when we assess the validity of our instruments. A further assumption in using these LEA-boundary-distance instruments is that (as usual) they have no direct influence on school or pupil performance other than through their effects on the choice set available to families.[14]

4 The Data

4.1 Data Sources

The empirical analysis employs a number of large and complex data sets, which we now describe. The central sources of data for the empirical analysis are the combined National Pupil Database (NPD) for 1996-2003, the Annual School Census (ASC) from 1996 to 2003, and the Pupil Level Annual Census (PLASC) for 2002 and 2003. These are administrative datasets made available by the Department of Education and Skills (DfES) of the UK Government.

[14] Similarly, we are assuming that families do not decide to move away from LEA boundaries just because they value competition in itself (they just want a good school). Hence, from the parental perspective, there is no reason to reside far from LEA boundaries, unless this has a direct impact on pupils' performance. This is however empirically rejected in our data (see the section on the instrument validity).

The first (NPD) is a pupil-level dataset that records the test results obtained by pupils at various stages in their school careers. The first set of assessments is administered at age 6/7, at the end of what is called Key Stage 1 in the National Curriculum. The assessment comprises Reading, English and Maths tests and tasks. Pupils are awarded a 'Level' of 0,1,2,3 in each subject (with +/- subcategories), and these Levels can be translated into point scores according to some predetermined DfES rules. We refer to these as *KS1 Point Scores*. The second set of assessments takes place at age 10/11, at the end of 'Key Stage 2'. The assessment comprises English, Maths and Science tests and pupils are awarded percentage marks in each of these (we call these the *KS2 Test Marks*). These marks translate into Key Stage 2 Levels 2,3,4,5 (with some +/- subcategories), which in turn translate into point scores, using standard DfES rules. We refer to these as *KS2 Point Scores*.[15] The basis for our composite dataset are pupils in PLASC who can be matched to pupils in the NPD taking Key Stage 2 tests in the census years 2001/2002-2002/2003, and to their prior test results at Key Stage 1 in 1997/1998 and 1998/1999.

The second data set (ASC) collects information on pupil and teacher characteristics at school-level and is used for resource allocation and other administrative purposes by central government. It was augmented from 2002 on by PLASC, which collects characteristics of pupils individually, and provides a head-count of every pupil in schools on the census day (mid January). These pupil characteristics can be linked to the pupil test results in the NPD and to school characteristics in the ASC. Importantly for our work, we have access to the residential postcodes of pupils.

[15] There are further post-primary education tests at age 13/14 (Key Stage 3), and General Certificate of Secondary Education academic qualifications at age 15/16 (Key Stage 4) but we do not use these since, as we have already noted, our spatial focus is much better suited to primary rather than secondary schools.

All these pupil and school characteristics can be linked to additional school information, in particular school addresses and institution types using the DfES Record of Educational Establishments ('REE') and 'Edubase' files. Moreover, since we are going to compute measures of spatial competition using Euclidian distances, we need geographic coordinates for both schools and pupils; these are derived from the full address postcodes using Ordnance Survey Codepoint data, which provides 1 metre grid references for postcode unit centroids. For some of our analyses we also include information on pupil residential neighbourhood and family background. This is obtained by matching the residential address to GB Census data for 2001. Finally, we derive LEA boundaries from the County and District boundaries obtainable from the 'UK Borders' service for Geographical Information Systems. We shall exploit these in our instrumental variables approach.

4.2 Sample restrictions

As stated above, the pupil data we use relates to age-10/11 pupils sitting Key Stage 2 tests in 2001/2-2002/3. The sample is further restricted to pupils living in a geographical zone within a 45km radius of central London, defined here as Bank tube station in the City of London, and to schools within the same radius.[16] Our purpose in restricting the data is to focus on primarily urban school markets. In very rural areas choice is often very limited, and we do not want to confuse urban-rural effects with those related to choice and competition. Reducing the sample also reduces the computational burden substantially. One further restriction is to eliminate partial LEAs

[16] We start with a sample within 50km in order to construct our choice and competition indices, but base estimation on the sub-sample within 45 km. This avoids us mistakenly inferring lack of competition, at the boundaries of our geographical zone.

(Luton, Bracknell) at the margins of our geographical zone, and in the City of London (which has a very low pupil population).

5 Results

5.1 Sample description

Table 1 summarises the most important variables in the dataset, namely the pupil achievement indicators and competition/choice measures. The competition measures are defined above. Key Stage 2 Marks refer to test-specific percentage marks; Key Stage1-Key Stage 2 Value Added refers to the difference between the total Key Stage 2 and Key Stage 1 point scores, and measures the pupil-specific gain in achievement in all subjects between age 6/7 and age 10/11.

A key question at the outset concerns the amount of variation in our competition measures. Clearly if all schools serve only the local community, or if any school within an LEA is easily accessible from any residence within an LEA, then there is no variation in the level of competition. In the first case, all schools are monopolistic for given spatial distribution of pupil residences. Our methods assume that a mix of neighbourhood-school and parental-choice structures exists, and that this will be reflected in our competition indices. Table 1 tabulates the summary statistics for our indices, Figure 3 graphs their distributions and Figures 4 to 6 provide maps (for part of our study area). These all show there to be substantial variation in the indices we have at hand.

Row 1 of Table 1 shows that, on average, every 10 pupils could quite easily reach 14 schools from their home address – in addition to the school they actually attend. Remember that this index is based on whether the *median* travel distance of pupils in neighbouring schools encompasses each home address, so that the feasible choice set

could be quite a lot larger. This is our main measure of school choice availability. Averaging this choice index at the level of the school in which pupils are enrolled, we derive our competition index (Row 4, Table 1). The difference between the pupil and unweighted school mean implies that pupils in larger schools tend to be those with more choices. Looking at Figure 3, we see that around 1 in 4 pupils have no school (other than the one they attend) within a short travel distance, but only 1 in 10 schools have all pupils with no local alternatives. It is also worth noting that only 48% of 'Community' school pupils and 27% of faith school pupils in our study area actually attend their nearest school within their LEA, so there is clearly considerable exercise of choice (see also Burgess et al, 2004). However, distance is still an important factor: 56% of 'Community' school pupils attend their nearest 'Community' school and 54% of faith school pupils attend their nearest faith school.

From the maps of Figure 4-6 we can also deduce that the competition indices are only partly related to urban centrality and density: Some of the highest values of our index occur in suburban districts such as Barnet and Brent, whilst inner city zones like south Hackney or Southwark exhibit low levels of competition. Moreover, the patterns of competition induced by faith and non-faith schools are distinctly different.

Further down Table 1 are other figures of interest. The median travel distance of primary school pupils in our study area is 743 metres, and this travel zone is home to an average of 80 pupils, though the number ranges widely from 2 up to 1015 metres. The average distance between a school and other schools in its travel zone is 203 metres, ranging from zero (i.e. two or more schools are in the same postcode) up to 3.5 km. We have also computed a cohort density measure centred on each pupil residential postcode, using a count of the number of pupils aged 10-11 within a 564m radius of

each pupil address (a 1km^2 circle). The mean pupil density is 64.1km^{-2}, but ranges between 1 and 256. These two inter-school distance and population density variables do not feature in our competition or choice indices, but are used as controls for more general urban density factors in our regression models.

In the next section we describe the results of these models. Note that we include a number of variables in these regressions, at four levels of aggregation: pupil level, school level, residential postcode and LEA level, in addition to the choice and competition variables in which we are interested. These variables are described in Table A1 in Appendix A.

5.2 Choice competition and performance: OLS results

Our first results are ordinary least squares (OLS) estimates of the model in Equation (1) and appear in Table 2. This shows the coefficients of interest only, and is divided into four panels. The top panel shows estimates of the association between choice availability and pupil attainments, unconditional on the index of competition at the pupil's school (β_1 in Equation 1, with β_2 restricted to zero). The next panel shows the association between school competition and pupil attainments (β_2 in Equation 1, with β_1 restricted to zero). The third panel reports the coefficients with both choice and competition indices included together (β_1 and β_2 unrestricted). The bottom panel reports auxiliary information in common to each of these three models.

We consider three measures of pupil attainment: Column 1 reports results with percentiles of Key Stage 2 English test marks as the dependent variable, conditional on

point scores in Key Stage 1 assessments but without any other control variables.[17] Column 2 reports the same, but with the full set of controls described in Appendix A, Column 3 reports instrumental variables estimates which we discuss below. Columns 4-6 repeat this sequence for Key Stage 2 Maths test marks, conditional on Key Stage 1 point scores.[18] In Columns 7-9 the dependent variable is the pupil's change in points in all subjects between Key Stage 1 and Key Stage 2, and is a direct measure of progress through the National Curriculum stages.

Looking at the OLS results in the first panel of Table 2, it seems clear that there is an association between the number of choices a pupil has available locally and their attainments at school between age 7 and 11. This is true, regardless of which attainment measure we use – though we find no statistically significant association with Maths until we properly control for pupil, school and area characteristics. However, the association is very small in magnitude: one extra school in the pupil choice set relates to a 0.2 percentile improvement in English and Maths, and a 0.1 value-added point. The results are qualitatively similar when we look at the school competition index on its own in the next panel. This is unsurprising, since the choice and competition indices are positively correlated.

When the choice and competition indices are included together the picture is more mixed. According to the OLS estimates, pupils in schools facing more competition seem to do marginally better, unambiguously, but the impacts of pupil's choice

[17] Controlling for prior achievements, or using achievement growth, risks underestimating the effect of fixed school characteristics, because prior achievement is determined by school characteristics too. Unfortunately the coefficient on prior achievement is also endogenous (see Todd and Wolpin, 2003) and downward biased. Nevertheless such specifications are commonplace and we follow tradition. Since we have no instruments for prior achievement which would allow us to correct the specification we simply note here that the coefficients on our competition and choice indices are almost unchanged if we use age-11 test scores unconditional on age-7 test scores.

[18] We cannot repeat this exercise for KS2 test scores in Science as we lack prior KS1 controls since children are not tested in Science at age 6/7.

availability are more varied. Choice is not associated with better pupil performance for either Maths or Total Value Added, though pupils with more choices seem to do slightly better in English tests.[19]

5.3 Instrumental variables estimates

Taken at face value, these estimates suggest small but significant gains to pupils in schools facing more competitive markets. However, although the approach has similarities with previous cross-sectional research, we find it hard trust these as estimates of the causal effects on attainments of pupil choice availability and the competitive pressures faced by primary schools. As discussed in Section 5.4, the choice and competition indices we use are quite likely to be endogenous to pupil and school performance. Firstly, the pupil travel patterns we use to calculate our indices of choice and competition may respond to differences in school quality that arise for reasons unrelated to competition and choice. Secondly, pupils with more choices available may concentrate in better-performing schools. Thirdly, pupil attainments may be correlated with competition structures because of unobserved family background characteristics, if for example, wealthy neighbourhoods contain a higher concentration and diversity of schools.

To address these issues, we employ the Instrumental Variables strategy described in Section 3.4, using the residential distance from LEA admission district boundary as an instrument for choice, and the school distance from the LEA boundary as an instrument for competition. The coefficient estimates from this approach are in

[19] We also assessed whether the impact of competition/choice mainly comes from under- or over-capacity schools. Our results suggest that: a - Competition always matters more than choice; b - Most of the action comes from schools that have a potential for expansion (under-capacity). This “threat effect” is in line with predictions from the empirical IO literature.

Columns (3), (6) and (9) of Table 2, and tell a very different story. The signs on all the coefficients become negative, but statistically insignificant: There is no evidence here to suggest that an increase in the number of schools available near a pupil's home (as we move away from an LEA boundary) improves pupil attainments. Neither is there any evidence that attendance at a school that faces more competition further away from an LEA boundary improves attainments. These point estimates suggest that these changes could have small adverse effects on attainments, though they are imprecisely measured.

5.4 Assessing the instrumental variables strategy

It is reasonable to ask whether, given these results, LEA boundary distance is really related to choice and competition. An important assumption for the instrument to determine choice and competition is that cross-LEA school attendance is not wide-spread. In fact from Pupil Census data we have established that the proportion of entry-age children (age-4) attending schools in an LEA outside their home LEA is only around 5.5%. This figure will include pupils whose family used to live within the school LEA and who have retained admissions rights through sibling rules. For Community schools, the figure is slightly lower at 4.7%.[20]

Ultimately, the deciding factor is whether first stages in the IV regressions are effective. These are tabulated in Table 3. The instrument – the log of boundary distance – is always very powerful (a glance at the map of Figure 4 supports this). A 10% increase in the distance from LEA boundary to pupil residence increases the number of schools in the pupil's choice set by 0.027, or about 2% relative to the mean

[20] Moreover, well over 80% of the closest 10% of pupils to the LEA boundaries attend primary schools within their own LEA. This is particularly reassuring, as these pupils are typically in postcodes that are immediately adjacent to the boundary. LEA border crossing is a very unlikely event even in the closest proximity of an LEA boundary.

(0.027/1.404). A 10% increase in LEA boundary-school distance increases the average number of alternative schools for pupils in that school by about 0.02. The instruments are individually significant and the F-statistic for the joint test of the instruments is always high (Staiger and Stock, 1997). In a nutshell, the instruments are indeed highly statistically significant predictors of choice availability and school competition.

Further results (not tabulated) show that the instrument for choice also works in line with the theoretical reasoning we used to justify its use. Firstly, for each 1% increase in distance between a pupil's residence and the nearest LEA boundary there is a 1.4 percentage point decrease in the probability that the pupil attends the nearest school (controlling for the average pupil-boundary distance within the LEA). Secondly, the average distance between a pupil's residence and the nearest 4 schools (other than the one he or she actually attends) decreases by 0.06% for each 1% increase in the distance between their home and the boundary. In other words pupils near admissions district boundaries seem to be more constrained in their choice of school.

Finally, we performed two sets of additional checks on our instrumental variable strategy. First, we dropped the restriction of no LEA crossing to compute our indices, and re-performed the IV analysis. First stage results show that distances to LEA boundaries are still strong predictor of competition and choice (results not tabulated); yet, we still find no causal impact of competition/choice on pupils' outcomes. Next, we addressed the question of whether school or residence distance from LEA boundaries has a direct impact on pupil characteristics, and hence possibly on achievements. To do so, we regress the instruments against the exogenous variables in our models plus various population characteristics that we have not included in the main equations (from the 2001 British census or from our pupil data) and then test these for significance. The

proportion of full-time employed, average pupil KS1 achievements, and most other local demographic measures are unrelated to LEA boundary distance (again we do not tabulate these).

Everything here indicates that choice and competition in primary schooling (as we define them) increase as pupils and schools move away from LEA boundaries. However, from the results in Table 2 this has *no* systematic impact on pupil performance. The natural interpretation of this is that the positive, but small, association between pupil performance and competition indices seen in the least squares estimates is attributable to endogenous school location or pupil sorting.

5.5 Faith schools and non-faith schools

The difference between the OLS and IV estimates in Table 2 clearly warrants further exploration, and it is to this that we now turn. An important contributor to choice in primary school markets in England is the availability of faith schools – mostly Church of England (12.3% of pupils in our study area) and Catholic schools (11.1% of pupils in our study area) – which provide alternatives to the standard LEA 'Community' schools. Although these are still LEA funded schools, many have greater autonomy in terms of governance and admissions procedures and are a popular choice amongst families seeking high academic standards, good peer groups and a Christian (or other religious) ethos. Also, although the standard LEA 'Community' schools tend to be fairly regularly distributed over space, it is not uncommon for faith schools to be sited quite close to 'Community' schools or close to other denominational schools. Faith schools increase the inequality in inter-school distances. As a simple illustration of this, consider the distribution of distances between nearest neighbour schools: the 90/10

percentile ratio for distances between LEA Community schools in our study area is 4.3, whilst the ratio goes up to 6.5 once faith schools are included.

The importance of faith schools in our competition index is evident in Figure 6, which maps the mean number of faith schools accessible to pupils in each school (smoothed to give a local average suitable for mapping). The pattern is very similar to that in Figure 4, but quite dissimilar to the pattern of competition induced by non-faith Community schools in Figure 5.

Given this, it seems quite plausible that we obtain positive and significant OLS estimates on our competition index, either because faith schools tend to be located in neighbourhoods with more motivated pupils and more favourable family backgrounds, or because pupils with a number of accessible faith schools near their homes become concentrated in those that offer better performance. Results in Table 4 are supportive of this interpretation. Here we split choice and competition indices to measure the number of faith and non-faith schools, and estimate pupil attainment regressions as before. It becomes quite clear, in Columns (1), (4) and (7) that it is the competition driven by neighbouring faith schools that generates the OLS results in Table 2. In fact we can eliminate the competition indices relating to the availability of non-faith schools without much influence on the results (Columns (2), (5) and (8)). Yet again, once we instrument faith school induced competition measures with distance-to-LEA-boundaries, we find negative, insignificant effects from competition.

Delving deeper into the faith school issue, we next show that it is only for pupils in faith schools that there is an association between attainment and our competition index (either faith school or all-school based). Table 5 and 6 break down the results on the impact of faith school competition for the samples of pupils attending non-faith and

faith schools respectively. In Table 5 (non-faith pupils) OLS coefficients are positive but statistically weak; the IV results are also statistically insignificant, but negative. It is for pupils in faith schools (Table 6) that OLS coefficients are positive and, for the competition index, statistically significant. And it is for these pupils that we find our first indication that exogenous changes in competition may matter for pupil attainments. The IV coefficients in Columns (2), (4), and (6) are large and positive, though still statistically weak. There is some indication here that pupils in faith schools benefit from competition with other faith schools within their LEA. Placing one more faith school in competition with a faith school raises pupil attainments by about 6 percentiles in English, by just over 2 percentiles in Maths and by 2 value added points overall.

Importantly, these gains are concentrated on pupils in schools with higher-proportions of children from poorer backgrounds and entitled to Free-School-Meals. Table 7 reports the results on Value Added points, split by High/Low Free-School Meal intake (above and below median proportions). The positive and significant coefficients on competition are concentrated in the poor-school group. The IV results too are significant, indicating that pupils perform better in high-competition faith schools further away from LEA boundaries. These results are consistent with US findings on Catholic schools reported in Neal (1997), Grogger and Neal (2000) and Altonji, Elder and Taber (2005). These authors suggest that urban disadvantaged pupils may benefit more from faith schools primarily, because their local communities offer poor state school alternatives.

It is possible to further unpack these estimates of religious school competition by considering denominational differences – principally Catholic versus Church of England, since these are the main categories in our data. Table 8 presents some

estimates that show how achievements of pupils in Church of England Schools and Catholic Schools varies in relation to the competition these schools face from other Church of England and Catholic Schools. In the OLS estimates, in Columns (1) and (4) we find that pupils in schools with higher competition indices show greater progress from Key Stage 1 to Key Stage 2. If these were truly competition effects, we would expect there to be little relationship between the 'competition' induced by Catholic schools for pupils of Church of England schools – and vice-versa – since these are unlikely to be substitutes, unless pupils are prepared to convert from one Christian denomination to the other. However, this is not the case: pupils in a Church of England school appear to do better if its pupils face a wider choice of Catholic schools, and Catholic schools too seem to be more effective if facing competition from Church of England schools. Once more, OLS results do not seem very credible and we turn to an instrumental variables approach.

Yet, it now becomes impossible to predict Catholic school competition from the school's distance to LEA boundaries. In fact, it turns out that Catholic pupils tend to travel more widely across LEA boundaries; in all, 10.6% of age-4 pupils in Catholic schools attend schools outside their home LEA. Nevertheless, our IV strategy still works for Church of England schools; we therefore take a more limited view and only consider IV estimates for the impact of choice and competition from Church of England Schools (in Columns 3 and 4). The comparison OLS estimates are in Columns 2 and 5.[21] The IV results now indicate that pupils in Church of England schools that face more competition from other Church of England have higher attainments relative to those in

[21] The estimates are consistent even if the variables for competition from and choice amongst Catholic schools rightly belongs in the equations, since both omitted variables are uncorrelated with the instruments.

more isolated schools (which are closer to LEA boundaries). The impact is quite substantial: an additional school in the choice set of the pupil-intake adds 7 value-added points (nearly 1 standard deviation) to the change in pupil attainments between age 7 and age 11. In comparison – as we would expect – the effect of Church of England schools on Catholic schools is small and statistically insignificant. These findings lend some support to a causal effect of competition on pupil achievement in this setting.

6 Concluding remarks

In this paper we have attempted to identify the causal links between choice and competition and the academic achievement of primary school pupils. To do so we have carefully constructed measures of the choices of primary school available to a pupil, based on the equilibrium accessibility of schools to their homes. From this, we also derived competition measures for the schools at which these pupils are enrolled. Choice and competition indices were related to pupil achievements in primary schools, first in a simple least squares setting and second using an instrumental variables approach based on a boundary discontinuity affecting school attendance.

The results we report show a (small) least squares association that pupils tend to do better if they are enrolled in schools that serve more competitive markets. Yet, we found little evidence that it is competition that drives the gain in attainment; pupil sorting and endogenous school location provide more likely explanations for these findings. Once endogeneity issues are controlled for, attainments for pupils at Community schools – the standard state primary in the English system – are unrelated to the choices available to pupils or to the competitive pressures a school faces.

It is only in faith schools – Church of England, and Catholic schools – that competition seems linked to performance, and then only in terms of their competitive

position in relation to other faith schools. In terms of interpretation, we therefore do not rule out the possibility that faith schools respond to more to competition; in particular, Church of England schools seem to respond to competition from other Church of England Schools, but are insensitive to alternative Catholic choices. Given the evidence at hand, we can only speculate that this is attributable to religious fervour or more proactive governance.

These findings matter for the often heated debate about whether choice and competition are good things for pupil performance. There is some comfort here for advocates of choice and competition as a pathway to higher educational standards: we have found some evidence to suggest that competition may improve schooling for some of the 1 in 5 or so of the school population who attend religious primary schools. For the most part though, our results cast some doubt on general effectiveness of choice and competition in the school context. The results point to such pressures only operating in a specific sub-set of the primary school market. There are, of course, a number of other issues that could usefully be studied here. For example, we do not consider competition from private schools (largely for data reasons). Nor can we study parental preferences in any direct way. Building these factors into future work (theoretical and applied) would seem to be a useful direction in which to go.

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7 Figures

Number of schools accessible to pupils:

Numbers 0,1,2,3 indicate the choice index that would be assigned to pupils living in each area (assuming they attend school s)

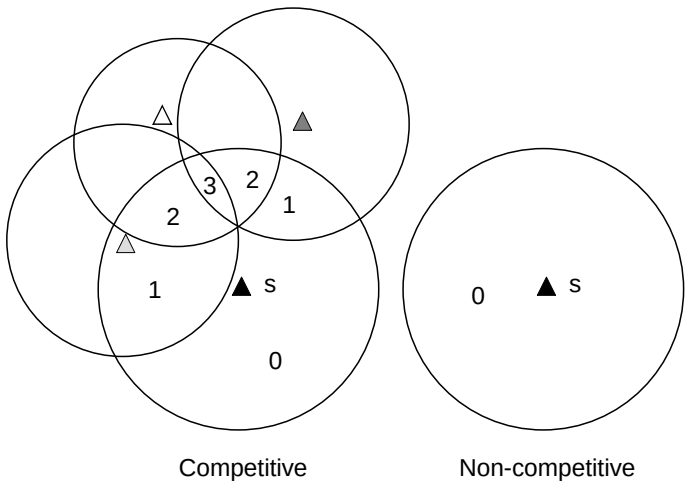


Figure 1: Schematic presentation of the choice and competition measures

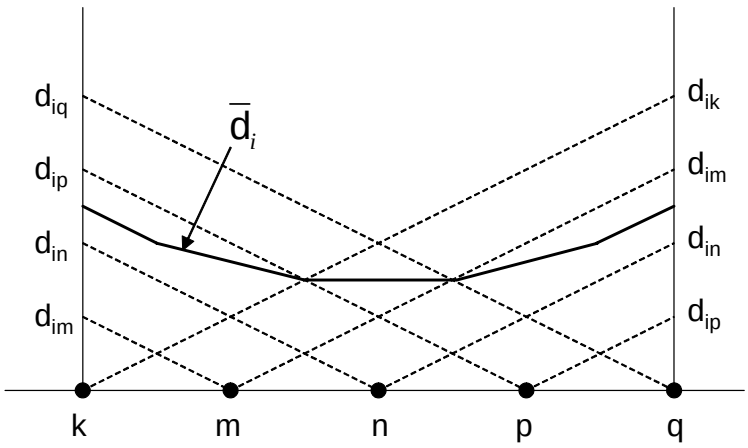
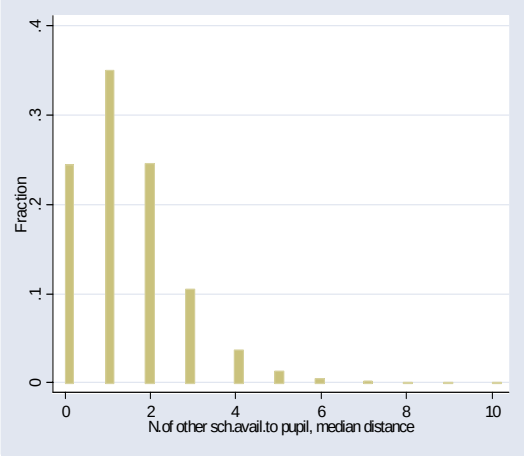


Figure 2**:** Illustration of the instrumentation strategy
Figure shows a linear district with 5 schools, k,m,n,p,q; d_{ij} is the distance to each school; $\bar{d}_i$ is the average distance to schools *other than* the nearest

Pupil choice index: Number of schools accessible to pupil's home



School competition index: Number of schools accessible to pupils, average in school attended

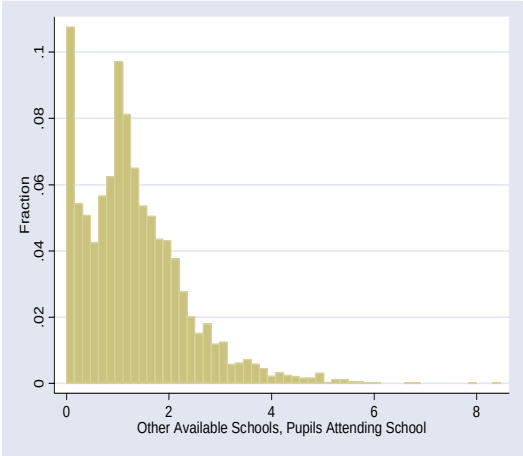


Figure 3: Distributions of the choice and competition indices

Figure 4: Primary School Competition in the Greater London Area
Figure shows local averages of the school-level competition index (Inverse Distance Weighted means of the nearest 6 schools on a 250m raster). Each shading class corresponds to intervals [0,1], (1,2], …(6,7] from lighter to darker.

Figure 5: Non-Faith Primary School Competition in the Greater London Area
Figure shows local averages of the school-level competition index (Inverse Distance Weighted means of the nearest 6 schools on a 250m raster). Each shading class corresponds to intervals [0,0.5], (0.5,2], …(3.5,4] from lighter to darker.

Figure 6: Faith Primary School Competition in the Greater London Area

Figure shows local averages of the school-level faith-school competition index (Inverse Distance Weighted means of the nearest 6 schools on a 250m raster). Each shading class corresponds to intervals [0,1], (1,2], …(5,6] from lighter to darker.

8 Tables

Table 1: Competition and attainments, summary statistics

Variable	Observations	Mean	Std. Dev.	Min , Max
Number of schools accessible to pupil	201034	1.40	1.21	0, 10
Number of religious schools accessible to pupil	201034	0.78	0.88	0, 7
Number of non-religious schools accessible to pupil	201034	0.62	0.74	0, 5
Average number of schools accessible to pupils in school	201034	1.31	0.99	0, 8.31
Average number of religious schools accessible to pupils in school	201034	0.79	0.77	0, 6.88
Average number of non-religious schools accessible to pupils in school	201034	0.52	0.53	0, 4
Median travel distance all schools	201034	743.71	455.37	102, 6157
Median travel distance, faith schools	48405	1084.24	612.25	146, 6157
Median travel distance, non-faith schools	152629	635.72	325.28	102,5491
Number of pupils in the travel area	201034	79.81	71.83	2, 1015
Average school distance from competitors	201034	203.21	299.79	0, 3525
Pupil Density (Number of pupils per hectare)	201034	0.64	0.37	0.01, 2.56
KS2 test marks, English	196706	59.67	28.89	1, 100
KS2 test marks, Maths	197829	50.64	28.89	1, 100
KS2-1 Value Added	201034	38.61	8.17	-4, 90

Table 2: Primary School Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3

	KS2 English percentile conditional on KS1			KS2 Maths percentile, conditional on KS1			Total Value Added Points		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV
Choice index entered separately									
Number of schools accessible to pupil's home	0.260	0.183	-0.348	0.046	0.203	-0.457	0.103	0.104	-0.357
	(3.00)	(4.32)	(-1.48)	(0.48)	(3.27)	(-1.38)	(2.70)	(2.88)	(-1.82)
Competition index entered separately									
Average number of schools accessible to pupils in the school	0.489	0.280	-0.522	0.340	0.414	-0.731	0.194	0.185	-0.517
	(3.28)	(3.33)	(-1.29)	(2.00)	(3.34)	(-1.26)	(2.97)	(2.57)	(-1.50)
Competition and choice together									
Number of schools accessible to pupil's home	0.028	0.093	-0.092	-0.187	0.043	-0.082	0.011	0.038	-0.115
	(0.47)	(3.05)	(-0.46)	(-2.88)	(1.00)	(-0.29)	(0.44)	(1.56)	(-0.66)
Average number of schools accessible to pupils in the school	0.470	0.214	-0.465	0.475	0.384	-0.680	0.186	0.158	-0.442
	(3.10)	(2.52)	(-1.07)	(2.77)	(3.08)	(-1.08)	(2.84)	(2.19)	(-1.18)
Other controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
KS1 controls	Writing Reading	Writing Reading	Writing Reading	Maths	Maths	Maths	None	None	None
Number of schools	2412	2412	2412	2412	2412	2412	2412	2412	2412
Observations	196706	196706	196706	197829	197829	197829	201034	201034	201034

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses.

Other controls are listed in Appendix A. Instruments in Columns (3) (6) and (9) are the log of the distance between school and LEA boundary and pupil home and LEA boundary

Table 3: First Stage Results; Primary School Choice and Competition, and Distance to LEA Boundaries.

	(1) English	(2) Maths	(2) Value Added
Choice index entered separately			
Logarithm of Pupil Residence-LEA boundary distance	0.246	0.246	0.246
	(22.97)	(23.01)	(23.11)
F-Test for the validity of excluded instrument	527.64	529.58	534.16
	[F(1,2382)]	[F(1,2383)]	[F(1,2384)]
Competition indices entered separately			
Logarithm of School-LEA boundary distance	0.201	0.201	0.202
	(10.00)	(10.04)	(10.08)
F-Test for the validity of excluded instrument	100.05	100.82	101.65
	[F(1,2382)]	[F(1,2383)]	[F(1,2384)]
Competition and choice together			
Logarithm of School-LEA boundary distance (Own)	0.187	0.188	0.189
	(8.54)	(8.59)	(8.62)
Logarithm of Pupil Residence-LEA boundary distance (Own)	0.270	0.270	0.271
	(28.45)	(28.46)	(28.66)
Logarithm of School-LEA boundary distance (Cross)	-0.041	-0.040	-0.040
	(-2.98)	(-2.93)	(-2.93)
Logarithm of Pupil Residence-LEA boundary distance (Cross)	0.022	0.022	0.022
	(2.08)	(2.05)	(2.14)
F-Test for the validity of excluded instruments	60.59; 414.55	60.87; 415.07	61.52; 420.81
	[F(2,2380)]	[F(2,2381)]	[F(2,2382)]
Other controls	Yes	Yes	Yes
KS1 controls	Writing Reading	Maths	None
Number of schools	2412	2412	2412
Observations	196706	197829	201034

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses.

Table 4: Primary School Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3

	KS2 English percentile conditional on KS1			KS2 Maths percentile, conditional on KS1			Total Value Added Points		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	OLS	OLS	IV	OLS	OLS	IV	OLS	OLS	IV
N. of non-religious schools accessible to pupil's home	0.061	-	-	-0.021	-	-	0.016	-	-
	(1.49)			(-0.35)			(0.49)		
Av. N. of non-religious schools accessible to pupils in the school	-0.025	-	-	0.152	-	-	0.063	-	-
	(-0.16)			(0.65)			(0.47)		
N. of religious schools accessible to pupil's home	0.089	0.092	-0.081	0.066	0.065	-0.092	0.042	0.043	-0.163
	(1.98)	(2.05)	(-0.25)	(1.04)	(1.01)	(-0.19)	(1.14)	(1.16)	(-0.56)
Av. N. of religious schools accessible to pupils in school	0.223	0.222	-0.720	0.427	0.432	-0.992	0.191	0.194	-0.626
	(2.06)	(2.06)	(-1.08)	(2.71)	(2.75)	(-1.01)	(2.07)	(2.10)	(-1.07)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KS1 controls	Writing Reading	Writing Reading	Writing Reading	Maths	Maths	Maths	None	None	None
Number of schools	2412	2412	2412	2412	2412	2412	2412	2412	2412
Observations	196706	196706	196706	197829	197829	197829	201034	201034	201034

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses.

Other controls are listed in Appendix A. Instruments in Columns (3) (6) and (9) are the log of the distance between school and LEA boundary and pupil home and LEA boundary

Table 5: Primary School Choice, Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3; Pupils in Non-Faith Schools

	KS2 English percentile conditional on KS1		KS2 Maths percentile, conditional on KS1		Total Value Added Points	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
N. of faith schools accessible to pupil	0.094	0.217	0.063	-0.121	0.058	-0.131
	(1.70)	(0.52)	(0.81)	(-0.22)	(1.27)	(-0.38)
Av. N. of faith schools accessible to pupils in school	0.101	-1.587	0.232	-1.100	0.058	-0.979
	(0.80)	(-1.94)	(1.27)	(-1.01)	(0.53)	(-1.47)
Other controls	Yes	Yes	Yes	Yes	No	No
KS1 controls	Writing Reading	Writing Reading	Maths	Maths	None	None
Number of schools	1689	1689	1689	1689	1689	1689
Observations	148844	148844	149897	149897	152629	152629

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%.; t statistics in parenthesis. The instrument for non-religious schools competition (or choice) measure is log of the distance between school (or pupil home) and LEA boundary, controlling for the average school-LEA boundary (or pupil home-LEA boundary) distance. The number of churches within 2km from school, and within 1.5km from pupil home, are also added as an additional controls.

Table 6: Primary School Choice, Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3; Pupils in Faith Schools Only

	KS2 English percentile conditional on KS1		KS2 Maths percentile, conditional on KS1		Total Value Added Points	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
Faith schools accessible to pupil	0.105	-1.017	0.081	-0.452	0.013	-0.351
	(1.46)	(-1.04)	(0.82)	(-0.59)	(0.22)	(-0.78)
Av. N. of faith schools accessible to pupils in school	<u>0.711</u>	6.039	<u>1.118</u>	2.103	<u>0.625</u>	2.256
	(3.45)	(1.79)	(3.86)	(0.76)	(4.00)	(1.39)
Other controls	Yes	Yes	Yes	Yes	No	No
KS1 controls	Writing Reading	Writing Reading	Maths	Maths	None	None
Number of schools	723	723	723	723	723	723
Observations	47862	47862	47932	47932	48405	48405

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%.; t statistics in parentheses. The instrument for non-religious schools competition (or choice) measure is log of the distance between school (or pupil home) and LEA boundary, controlling for the average school-LEA boundary (or pupil home-LEA boundary) distance. The number of churches within 2km from school, and within 1.5km from pupil home, are also added as an additional controls.

Table 7: Primary School Choice, Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3; Religious Schools by Intake Income

	High free school meal entitlement		Low Free-school-meal entitlement	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
N. of religious schools accessible to pupil	-0.140	-0.105	0.110	0.223
	(-1.38)	(-0.23)	(1.71)	(0.23)
Av. N. of religious schools accessible to pupils in school	0.893	2.459	0.341	-0.922
	(3.45)	(2.45)	(1.78)	(-0.22)
Other controls	Yes	Yes	Yes	Yes
Number of schools	272	273	486	486
Observations	15024	15024	33381	33381

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses. The instrument for non-religious schools competition (or choice) measure is log of the distance between school (or pupil home) and LEA boundary, controlling for the average school-LEA boundary (or pupil home-LEA boundary) distance. The number of churches within 2km from school, and within 1.5km from pupil home, are also added as an additional controls.

Table 8: Primary School Choice, Competition and Pupil Attainments, Key Stage 2, 2001/2-2002/3; Faith Schools and Church of England Competition

	C of E			Catholic		
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	IV	OLS	OLS	IV
N. of C of E schools accessible to pupil	-0.218	-0.223	-0.505	0.115	0.115	-0.556
	(-1.62)	(-1.68)	(-0.27)	(0.88)	(0.88)	(-0.48)
Av. N. of C of E schools accessible to pupils in school	0.851	0.906	7.670	1.065	1.065	0.186
	(2.35)	(2.47)	(1.99)	(2.70)	(2.70)	(0.07)
N. of Catholic schools accessible to pupil	0.175	-	-	0.181	-	-
	(1.57)			(1.22)		
Av. N. of Catholic schools accessible to pupils in school	0.693	-	-	1.177	-	-
	(2.10)			(2.17)		
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of schools	397	397	397	306	306	306
Observations	24791	24791	24791	22274	22274	22274

Regression at the pupil level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%.; t statistics in parentheses. The instrument for non-religious schools competition (or choice) measure is log of the distance between school (or pupil home) and LEA boundary, controlling for the average school-LEA boundary (or pupil home-LEA boundary) distance. The number of churches within 2km from school, and within 1.5km from pupil home, is also added as an additional control, respectively in the competition and choice regressions (jointly when all indexes are simultaneously included).

9 Appendix A

Table A1: Controls, summary statistics

Variable	Observations	Mean	Std. Dev.	Min , Max
Pupil Level Variables				
English as First Language	201034	0.795	0.403	0, 1
Female	201034	0.497	0.500	0, 1
Pupil with Special Needs, with and without statements (SEN)	201034	0.245	0.430	0, 1
Free School Meal Eligible (FSME)	201034	0.198	0.399	0, 1
School Level Variables				
Pupil/Qualified Teacher Ratio	201034	23.641	3.936	11.2, 108.3
Total School Size	201034	367.055	138.207	52, 1373
Fraction of Pupils with SEN	201034	0.209	0.090	0, 0.652
Fraction of Pupils with FSME	201034	0.163	0.135	0, 0.620
Postcode Level Variables				
Fraction of Lone Parents	198688	0.274	0.174	0, 1
Fraction of Unemployed	198688	0.039	0.026	0, 0.257
Fraction With no School Qualifications	198688	0.272	0.106	0, 0.724
Fraction with Black Ethnicity	198688	0.083	0.112	0, 0.725
Fraction with Chinese Ethnicity	198688	0.018	0.023	0, 0.527
Fraction with Other Asian Ethnicities	198688	0.099	0.148	0, 0.907
LEA Level Controls				
Total LEA Expenditure in 2000 (in £1000)	201034	2170.823	1691.547	493 , 5983
LEA Area (in 1,000,000 squared metres)	201034	680.349	1076.473	12, 3451

Competition and Accessibility in School Markets: Empirical Analysis Using Boundary Discontinuities*

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Abstract

Advocates of market-based reforms in the public sector argue that competition between providers drives up performance. But in the context of schooling, the concern is that any improvements in efficiency may come at the cost of increased stratification of schools along lines of pupil ability and attainments. In this chapter, we discuss our empirical work on competition and parental choice in English primary schools and present a methodology for identifying competition effects that exploits discontinuities in market access close to education district boundaries.

Keywords: Competition; Primary Schools; Segregation, Attainments.
JEL Classifications: I20, H70, R5.

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1. Introduction

Government education policies in England, as in the US, have increasingly favoured competition among schools. Supporters of market-based reforms argue that autonomy and competition among education providers are effective tools to raise student achievements. These gains are assumed to accrue from market discipline incentives and better matching of pupil needs to school provision. Yet, critics of these ideas point to increased demographic stratification of schools as the most likely outcome, with high-ability children of highly-motivated, high-income, parents securing admission to the best schools.

Despite a growing literature on the topic, evidence on the effects of quasi-markets in education remains rather mixed. One reason for this is that it is difficult to find truly exogenous variation in the competitiveness of school markets with which to identify the effects of competition on pupil attainments and stratification. In this chapter, we discuss evidence from primary-phase schooling in England, which, we argue, succeeds in isolating very localised variation in school accessibility close to attendance district boundaries. The chapter highlights the potential for the use of data with detailed geographical information in the identification of market effects, and in empirical analysis more generally.

The starting point for the empirical methods and results we present is a large and detailed pupil census that includes precise information on pupil and school addresses. This allows us to: (i) use the *de-facto* pupil travel-to-school patterns to construct choice indices from the number of alternative schools available to a pupil at their place of residence; (ii) construct measures of competition faced by a school based on the number of choices available to the pupils it enrols. We argue that these are meaningful measures

of choice and competition, which offer a conceptually attractive alternative to more traditional indices. Indeed, the same idea could be extended to analyse competition in any markets, when data is available on the location of service providers (such as health care facilities, retail outlets, entertainment centres) and the location potential consumers. The drawback of our suggested indices is that they are potentially endogenous to the quality of service provided – particularly in the case of schooling, where it is well known that families engage in Tiebout-type residential sorting to secure access to schools of their choice. We suggest that this problem can be overcome when market areas have clearly defined boundaries – as is often the case in public sector services – because these introduce discontinuities in market access from which the effects of choice and competition can be identified.

The short summary of our empirical work on English schools is that competition – measured as the number of alternative school choices that pupils attending a school have – has no effect on the performance of schools; although there are significant correlations between school competition and mean pupil attainments, these relationships are not *causal*. On the other hand, school competition seems to exacerbate polarization of schools by student attainment; while not statistically significant, our estimates hint at fairly large impact of school-market competitiveness on stratification. As such, our results cast additional doubt on there being any real performance benefits from policy to promote competition in schooling markets; they also suggest there could some cost in terms of increased stratification to be expected from quasi-market reforms.

The remainder of this chapter is organised as follows. In the next section, Section 2, we discuss some of the key empirical literature on competition in school markets. In Section 3 we outline our methodology, discuss the merits of our indices in comparison

with alternatives, and show how our approach to identification relates to some other works exploiting geographical discontinuities. Section 4 explains why our methods are appropriate in the context of English primary schools, summarises our previous work on competition and pupil achievement, and presents new results on the effects of competition on school stratification. Concluding remarks follow, in Section 5.

2. Theoretical issues and general empirical approach

2.1. Background and literature

While broadly heterogeneous in their details, public school admissions systems can be broadly organized around two 'ideal' models of school provision: a) *neighbourhood* based systems; and b) *choice* based systems. In *neighbourhood* based models, admission is determined purely by where a pupil lives, typically with rigidly defined catchment zones. *Choice*-based systems, instead, are intended to give parents a wider choice set that is not limited to neighbouring schools.

Traditionally, public schooling systems have been neighbourhood-based, but this tends to tie school quality to the socioeconomic status of local areas and has become – in many public and policy makers' imaginations at least – linked to poor standards. Since attempts to find appropriate ways to raise standards using resource-based interventions have met with mixed success (Hanushek (2003)), attention has turned to interventions that change the incentives for school leaders and teachers; among these, market-oriented reforms of public education have found growing support. At the most basic level, this involves changing the school admissions system to increase parental choice and adjusting the system of funding to reward schools that attract pupils and

penalise those that do not. This creates direct market incentive mechanisms, with popular schools gaining pupils and additional funding, and unpopular schools failing to do so, and eventually closing. Additional benefits may come in the form of allocative efficiency gains, if pupils can find schools that are better matched to their educational needs and preferences.

Despite policy enthusiasm for these reforms, evidence of their performance-related benefits remains very mixed. Much of this comes from a wide range of studies analyzing the US experience. Some of these explore the effects of implicit variation in the level of choice available in different school markets on pupil achievements (e.g. some of the work reviewed in Belfield and Levin (2003), Hoxby (2000) and Rothstein (2004)). A second approach evaluates the effects of the competition threat imposed on state schools by private institutions (see Hoxby (1994) and (2004)). Finally, another body of research evaluates the impact of policy changes introducing greater competition into geographically localised educational markets (Cullen et al (2003), Hoxby and Rockoff (2004) and Hoxby (2003)). These studies are mixed in their findings, and Belfield and Levin (2003) suggest 'the gains from competition are modest in scope with respect to realistic changes in levels of competition' and that many results are statistically insignificant.

Evidence for Britain is more limited, but similarly mixed. On the one hand, Levacic (2004) finds that secondary school head-teachers' of self-reports of perceived competition are linked to school performance indicators. Similarly, Bradley et al. (2000) show a number of 'market' type effects in secondary education following admissions reforms in the late 1980s – for example, schools that performed better than their neighbours attracted more pupils. On the other hand, Clark (2004) reports that reforms

that handed more power to schools (in late 1980s) only exerted modest efficiency gains through competition effects. Finally, Gibbons et al. (2005) – with results related to those we report later – find little evidence of a positive impact of competition and choice on primary school pupil achievements.

Critics of choice-based reforms point to their potential costs in terms of increased stratification of schools along socioeconomic lines, although the theoretical foundation for this claim is not entirely sound. The idea is that higher socio-economic status parents benefit more from choice-based interventions, as they are better equipped at making good decisions about school quality and getting what they want from the admissions authorities, as well as less constrained by transport costs. However, school choice under a neighbourhood-based school admissions system can be exercised by residential choice, which can just as easily lead to stratification through the housing market. There is, for example, ample evidence that school quality influences local housing prices in neighbourhood-based systems (Black (1999), Gibbons and Machin (2003) and (2004), and Kaine, Staiger and Reig (2004)), which suggests stratification by income.

Evidence that looks more directly at the stratification effects of choice availability is more limited, but again mixed in its conclusions. For the US, Hoxby (2000) suggests that the effects of choice on productivity are more likely caused by competitive pressure, rather than sorting. To stronger conclusions comes Hoxby (2004): enhanced school choice (mainly voucher systems and charter schools) is *not* associated with more cream-skimming and segregation. Yet, findings in Rothstein (2004) and Smith and Meier (1995) provide ground for opposite conclusions: parents value peers more than effective schools; most choice based policies produce their effects via sorting.

UK based evidence has also been produced on this issue. On the one hand, Bradley et al. (2000), Bradley and Taylor (2002), Goldstein and Noden (2003), and Burgess et al. (2004), among the others, suggest that increased competition and greater parental choice are associated with more polarization in English *secondary* schools. On the other hand, Gorard, Taylor and Fitz (2003), summarizing the results of a large-scale research program assessing the impact of competition on segregation in English *secondary* schools, show that these became *less* socially segregated in the 1990s after the introduction of the market-oriented reforms during the late 1980s. Yet, to the best of our knowledge, no in-depth analysis of the impact of school competition on the polarization (and performance) of *primary* institutions exists; moreover, our methods are unique in finding credibly exogenous variation in school accessibility, with which to identify the effects of competition on pupil stratification and achievements.

2.2. Defining and measuring competition

Our modelling strategy is motivated by the following conceptual points: *choice* availability is a property of residential location and depends on the accessibility of alternative service providers; c*ompetition* is a property of the location of service providers and depends on the number of alternatives available to users of the service.

A starting point for the development of indices that measure choice and competition in public-sector schooling is the assumption that residential locations differ in terms of the accessibility of alternative schools (or service providers in the general market context). This means that choice amongst schools is more constrained in some places than others, in part because of the transport costs involved, but also because of institutional barriers to access that may apply even if a school is geographically within

easy reach. The level of competition that a school faces in the market is in turn dependent on the number of alternative choices that were available to its pupils.

The existing literature that measures the effects of competition in public sector markets has largely inherited techniques from work in industrial organisation and takes one of two approaches. Firstly, competitiveness of a market may be defined in terms of an index of market concentration, such the Herfindahl index, using the share of pupils in different schools (or the share of pupils in different admissions districts) in some pre-defined school market area. The market area can be an education authority's zone of jurisdiction (Bradley et al. (2000)), an entire metropolitan area (Hoxby (2000)), or some other geographical area. A drawback of this approach is that low market concentration cannot really be equated with more choice and greater competition unless all operators in the market are equally accessible to all customers. Geographical restrictions on school admission mean that this criterion is unlikely to be met, unless the notion of choice under consideration includes Tiebout choice that is exercised by residential re-location (as in Hoxby (2000)). This seems however a contradictory way to define competition when the idea of relaxing constraints on choice is usually to offer more alternatives *conditional* on where a person lives.

A second approach is based on the reasoning implicit in spatial competition theories (Hotelling (1929)), where what really matters is the number of providers that can be reached within a given travel cost, time or distance. The simplest way to operationalise this is to define a provider's market area as the area encompassed by a circle of fixed radius, then to consider all people living within this area as potential consumers and all other providers within the circle as competitors. A first drawback of this approach is that the number of providers (and consumers) within a fixed radius is

dependent on their areal density, so it becomes difficult to disentangle competition from general urban density effects. Another drawback is that a fixed distance represents very different travel times in urban, suburban and rural environments, so it is hard to see that a fixed radius circular region is meaningful as a market definition in all of these cases. Furthermore, geographical barriers that may obstruct access (rivers, railways, ravines etc.) are easily ignored. More sophisticated analyses try to model market areas on likely journey times. These methods take account of urban-suburban-rural differences and geographical barriers by measuring distances along transport networks, and by adjusting the distance limits of the market area to take account of travel speeds along different classes of road and different types of built environment. A major limitation of this approach is that it requires geographical data on transport networks and is very dependent on the assumptions made about travel mode and travel speeds. For example, a market area defined for schools in terms of car drive times (Burgess et al. (2004)) may not be appropriate if school-travel is usually on foot or by bus.

The indices of competition and choice we develop here are grounded in this second approach, but circumvent some of its problems by inferring a school's *catchment area* from the actual travel patterns of its pupils. This allows us to construct an index of choice availability at a residential location based on the number of schools that could easily be reached from that location – ease of access being inferred from the actual travel behaviour of neighbouring pupils. As a first step in developing these indices, we find the spatial coordinate pairs of each school j and each pupil i 's home address, and use a geographical information system[3] to compute the straight line distances d_{ij}^{j} between a pupil's home address and the school he or she attends. We then

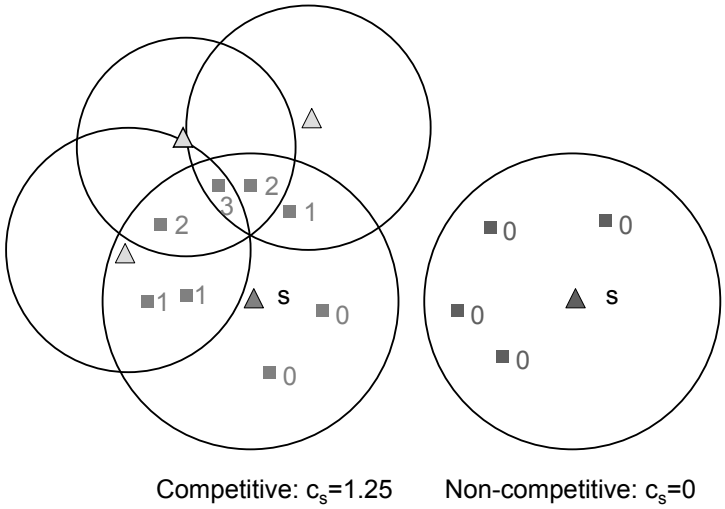
[3] We use the industry-standard ESRI *ArcGIS* software.

take the median of distances d_{ij}^{j} for each school and define this distance $\bar{d}_j$ as the radius of the *catchment area* for school *j*.[4] Finally, we compute the distances d_{ik} between a pupil's home and the other schools in the local area (within some limiting distance, e.g. 10km). A school *k* is then classified as within the feasible set of choices for pupil *i* if the distance between pupil *i* and school *k* is less than the radius of the market area for school *k*, that is if $d_{ik} \leq \bar{d}_k$. The *choice index* for pupil *i* is defined as the number of schools that fall in this set of feasible choices. The choice index thus depends on place of residence and the travel patterns of pupils in neighbouring schools.

The next step is to infer a measure of the competitive pressures faced by each school in our study area, from this choice index. For a given school, the competition it faces depends on the number of feasible alternatives its pupils had available; hence a natural *competition index* is the average number of choices available to pupils in that school. This is easily derived as the mean of the choices indices of the pupils on the school role. The derivation of the competition index is illustrated in Figure 1, where the triangles represent schools, squares represent pupils, and the circles represent their market areas.

[4] For the results that follow, we also experimented using the 25th and 75th percentiles of the pupil home-school distance distribution, rather than the median. Our conclusions are robust to these experiments.

Figure 1: Schematic presentation of the choice and competition measures



Number of schools accessible to pupils: Numbers 0,1,2,3 indicate the choice index that would be assigned to pupils living in each area (assuming they attend school *s*) and the number c_s is the average of these choice indices.

2.3. Measuring performance and stratification

As outlined above, the debate about the effects of expansion of competition and choice in public services centres on the influence this has on performance and stratification across institutions. The type of competition we have in mind in this chapter is one of spatial competition: state schools compete with others for pupils in a community in order to maximise their revenues and minimise the costs associated with disruptive and challenging pupils. Since state schools cannot easily change location or vary their price, they can only increase their market share by offering a higher quality product. This is one reason why we might expect schools in more competitive environments to offer their pupils higher educational standards.[5]

[5] Although there are arguments that would lead in the opposite direction, such as competition leading to more stressful teaching environments or higher pupil turnover; see for example Hanushek et al. (2005).

In the context of schools, better performance is usually taken to imply higher pupil attainments. Therefore it has become standard to measure pupil attainments in terms of test scores and to assess the effectiveness of a school in terms of the gain in attainments of pupils enrolled there over a number of years. In the empirical wok described below, we follow this approach and consider the gain in pupil attainments between age 7 and age 11 as the main 'output' of primary-phase schooling (i.e. what is called pupil 'value-added').

Stratification, on the other hand, is a more complex issue, since it is not obvious along what demographic or educational lines this should be measured, or how it should be measured. Indeed, whether stratification is considered a problem depends on the interaction between stratification and performance – if, for example, peer group quality influences pupil attainments – or on social preferences over the degree of integration of pupils of different abilities and social backgrounds. In our view, the key concern regarding school stratification is the mix of pupils in terms of their abilities and attainments; therefore, we focus our empirical work on this.

Competition could be causally linked to stratification in abilities and attainments in two ways. Firstly, if schools can choose which pupils they admit, then competition may increase the incentives for schools to try to select pupils who are easier to teach and are likely to boost their performance indicators; some schools may win out over others in this game. [6] More importantly, the degree of competition in a school market is, by our definition, related to the number of choices that pupils and their parents have available to them. Increased stratification will therefore be a by-product of increased competition

[6] In the English primary school system, this is unlikely to be a major issue since only a small proportion of schools run their own admissions.

if expansion of choice leads to greater sorting of pupils across schools along lines of ability or other demographic characteristics that are correlated with ability.

Measurement of stratification also poses some conceptual and empirical problems. It is possible to approach this in two ways, either in terms of the between-group inequality in school means, or within-school inequality in pupil characteristic. Stronger sorting of pupils into schools by some characteristic will be evident in a decrease in the within-school dispersion and an increase in between-school dispersion. A common way to look for stratification in some characteristic x is to look at a measure of the dispersion x *between* schools in a market area, using segregation indices such as the *dissimilarity index*, or inequality measures such as the *Gini coefficient*, or standard statistical moments.[7]

We adopt a different approach that takes advantage of pupil level micro data, and explicitly model the inequality in x across pupils within a school. We define stratified schools as those characterized by a more homogenous pupil enrolment (e.g., either predominantly *good* or predominantly *bad* pupils), whilst less-stratified schools are more mixed in terms of student attainment. An advantage of this approach is that it allows us to model the effects of competition on stratification at school level, rather than at the level of some predefined market. However, we can also compare the effects of competition on within-school pupil inequality, with the inequality in attainments within the school's catchment area (as defined in section 2.2).

We will focus on stratification in attainments of two cohorts at two times in the school career: early on in primary schooling at age 7 – the earliest point at which we can measure pupil attainments; and at age 11 when pupils leave the primary school system

[7] For an interesting discussion about the properties of segregation and stratification measures see Massey and Denton (1988).

and move on to secondary school. The first measure is an indication of stratification in terms of the schools' pupil intake; the second measure is an indication of the stratification that exists as a result of these intake differences, plus any influences over the intervening years up to the time pupils leave primary school. In both cases we adopt the Gini coefficient as an index of inequality. We use the Gini coefficient as a measure of *dissimilarity* between pupils in a school (not between schools); this approaches zero when all pupils at a school are similar in terms of their attainments and tends towards one when pupils are more heterogeneous. To state it differently, a school in a highly stratified system will have a small Gini coefficient, while school in a less stratified system will have a high value for the measure[8]

2.4. Competition and choice near administrative boundaries

We argue that the choice and competition indices defined in Section 2.3 offer an improvement over existing methods, in that they are based on observed pupil travel patterns. This means we can be more confident about inferring which schools are accessible from any residential location; but this in turn brings some disadvantages, because pupil travel patterns are the joint outcome of residential location and school attendance decisions, meaning that the indices are potentially endogenous in models of school quality and stratification.

As a first example of this kind of problem, note that it is well known from the literature on the effect of school quality on housing prices that schools have an influence on local housing demand (*op. cit.*). This has a bearing on our choice and competition measures, because any tendency for residential crowding of similar families around

[8] We have experimented with alternative measures of polarization, such as: the 90th-10th percentile ratio; the 75th-25th percentile ratio; and the coefficient of variation. Our main conclusions were fully confirmed.

good schools would tend to shrink the travel area of these schools, making them seem less competitive and more segregated. Conversely, if motivated families with high-achieving children are more successful at exercising choice (conditional on residence), then more popular, higher performing and potentially more segregated schools may appear competitive, even though it is parental choice that has spread their geographical intake and increased their polarization. Moreover, the diversity of pupil attainments within a school must also be tied to diversity in pupil attainments in the neighbouring area, which in turn could be related to fragmentation in terms of housing and environmental characteristics and so to school accessibility. Finally, although school opening and closures are quite rare, it is not implausible that the current spatial distribution of schools is related to the socioeconomic characteristics of an area, and consequently, via housing markets and family background, to its pupil characteristics and polarization. In particular, we suspect that faith schools may operate in places where economic and educational conditions are more favourable.

So, identification of the causal effects of choice and competition on pupil attainments and stratification poses a serious challenge. To succeed, we require variation in accessibility that may determine school quality and the within-school distribution of pupil attainments (through competition and choice), but is not itself determined by pupil or parental preferences or otherwise related to neighbourhood characteristics. As a starting point, we argue that such variation exists because different residential locations that provide access to a particular school can be very different in terms of the number of *alternative* schools that are available. Importantly, and plausibly, we assume that is the quality of a particular school that is the object of choice and not the range of alternatives available. Nevertheless, we need some specific sources of

variation that we can use as instruments for school choice and competition in our school quality and stratification regression models.

One possibility that arises out of earlier literature is to exploit discontinuities in accessibility that occur around geographical barriers such as rivers, roads and railways, which obstruct access to schools in one or more directions; similar ideas have been used in the past in the analysis of school competition (Hoxby (2000)), neighbourhood stratification (Cutler and Glaeser (1997)), and other areas. But these tangible geographical features are unsuitable when we are worried about the interaction between residential choice and school quality, because these features tend to divide up neighbourhoods along socioeconomic strata and are linked to environmental amenities that are in themselves factors in household location decisions. For instance, finding that attainments are lower for pupils living in homes with poor school accessibility close to railway lines could easily be explained by the fact that these pupils come from poorer families living in low-cost housing, rather than any causal impact from reduced choice.

Instead, we propose to identify competition effects by variation in accessibility that occurs close to the *boundaries of the administrative authorities* that are responsible for school admissions – namely Local Education Authorities (LEAs) in the English school system. Pupils living close to these boundaries, relative to other pupils in the same education authority, face a restricted choice set because institutional barriers make it harder to access schools on the opposite side of the boundary; this implies they are more likely to attend their closest school, than are pupils living in more central locations, because the average cost to the alternatives is higher.[9]

[9] The underlying assumption is that the probability of family i attending school j is decreasing in the distance to the school d_{ij}, due to transport costs.

To see this, consider Figure 2: this shows a linear district with 5 schools *k*, *m*, *n*, *p*, *q* spaced at equal intervals. Schools *k* and *q* are located at the district boundaries at the left and right ends of the district respectively. The dashed lines show the cost of reaching each school, from each point *i* along the linear district. The bold line shows the average cost of reaching schools other than the nearest school, at any point *i* along the linear district. As can be seen, the average costs of travel to schools other than the nearest is higher for residents near the edge, than in the centre. As a result, residents near boundaries will be more likely to attend their local school, and schools nearby LEA boundaries will mainly enrol pupils from of local families, who have that school as the nearest choice.

In conclusions, schools in locations close to LEA boundaries face less competition because: a) the catchment area shrinks in radius and land area, closer to catchment area boundaries; b) the catchment area may be partially truncated on one side, which is a restriction we can impose by excluding the few pupils who do cross LEA boundaries in the calculation of our competition index. This means that we can use distance of a school from a boundary as a predictor of the competition it faces in the local school market. As it turns out, a) is most important in terms of driving variation in our competition index.

Figure 2**:** Illustration of the instrumentation strategy

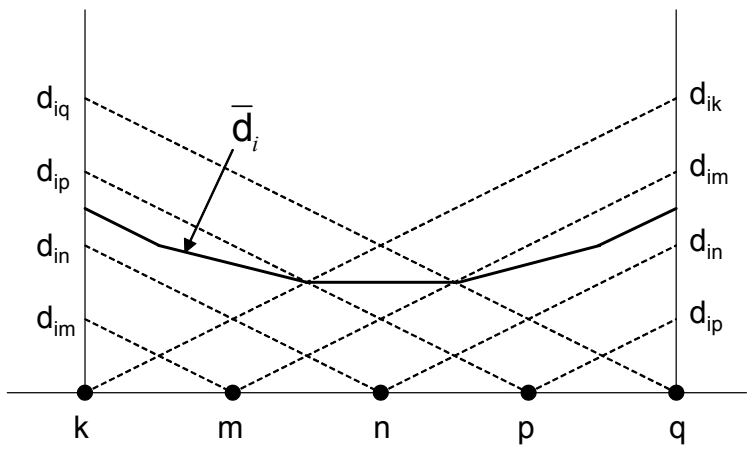


Figure shows a linear district with 5 schools, k,m,n,p,q; d_{ij} is the distance to each school; $\bar{d}_i$ is the average distance to schools *other than* the nearest.

In general, the distance of a place from an administrative boundary will provide a valid instrument for choice availability and the level of market competition at that place if: a) the administrative boundary increases the costs associated with access to services on the opposite side of the boundary; b) distance from the boundary is otherwise uncorrelated with the outcomes that are being analysed. The extent to which such barriers exist and are impervious depends on the particular institutional context, but we argue below (and demonstrate in our estimates) that LEA boundaries act as real impediments to access in the English primary school system. Moreover, there are no strong reasons for believing that households have any preference about how close they live to boundaries relative to other households in the LEA, or that household characteristics are correlated with this distance, or that teaching quality and other factors that drive school effectiveness are directly linked to it.[10]

[10] In fact, evidence discussed in Gibbons et al. (2005) suggests this is not the case.

A similar strategy might be appropriate in the analysis of competition effects in public health and other services, when access is allocated according to zone of residence and discontinuities in accessibility occur close to administrative boundaries. For example, access to general practitioners or hospital medical services provided by a local health authority may be limited to those living within the health authority's jurisdiction. In these cases, distance to health authority boundaries may provide appropriate instruments for the level of competition measured amongst neighbouring hospitals, when there is unobserved area heterogeneity which may be correlated with competition and performance measures (a problem that is often only partially addressed, e.g. Propper et al. (2004), Mobley (2003)).

Closely related thinking lies behind studies which investigate the effects of market access when there are changes in national borders or their permeability. Examples include changes that occurred during German division and re-unification (Redding and Sturm (2005)) or close to the Mexican border as a result of the North American Free Trade Agreement (Hanson (2003)). Our strategy has similarities with these approaches, in that competition, like market access, declines as one moves closer to the boundary on either side. However, because we have observations on both sides of multiple boundaries, we are able to distinguish competition effects from more general monotonic changes that may occur in one direction over the study area. Our approach is, however, distinctly different to the type of empirical analysis that exploits the discontinuities in the *level* of some variable of interest that occurs as one moves from one side of a boundary to the other – for example the boundary fixed effects strategy used by Black (1999) and Kaine, Staiger and Reig (2004) in the analysis of school quality effects on house prices, and Bayer and McMillan (2005) in the context of school choice.

3. Measuring the effects of competition in primary schools in the London metropolitan area

3.1. Data and context

If our proposed methods are to work, we need a setting where there is some freedom of school choice, given where a family lives, but where there are constraints that mean that some places offer greater accessibility to schools than others. We argue here that the primary school system in and around London provides such a context.

The current state-school system in England is a hybrid of a neighbourhood-based and a choice-based system. Since the Education Reform act of 1988, the principle of choice has been extended to a greater or lesser extent in different districts, (see e.g. Glennester (1991)); the trend continues in more recent legislation (e.g. school Standards and Framework Act 1998 and the Education Reform Act 2002). Although competition in *secondary* (post-11) education tends to dominate the political landscape, we consider the effects of competition at the *primary* (pre-11) phase. The reasons for this are partly methodological: travel distances have a greater role to play in primary school choice (than for secondary schools), because children of this age are not independent travellers and need to live much closer to the school they attend. This means it is much easier to infer which schools are accessible from a particular residential location. Moreover, admissions arrangements make it much easier for pupils in secondary schools to cross LEA boundaries – which would undermine the identification strategy we described above. At primary level, there are institutional barriers hindering admission of pupils to

schools outside their home LEA and only a very small number do so. [11] Aside from this, there are good theoretical reasons for focussing on primary-age attainments, because educational and behavioural development at primary age is critical for life-time success (Heckman (2000), and Dearden et al. (2004)).

Although primary school pupils tend to live quite close to their schools, there is still a great deal of scope for parents to choose between alternative schools in the state sector. All primary schools are non-selective, but there is variety in terms of the way schools are governed and admissions organised, and schools differ in terms of aims, ethos and religious character. The basic division is between institutions which are affiliated with a church and "Community" schools which are not. Roughly 60% of schools are Community schools, 26% Church of England, 11% Catholic and the remaining 3% affiliated to other churches or charitable organisations. In most cases (75%), the LEA administers school admissions. The LEA also funds the schools, mostly through central government grant, and provides administrative and managerial support. Importantly for the empirical work we carry out here, the law states that parental choice must be the guiding principle in prioritising admissions (although local differences exist in the way applications are prioritised when schools are over-subscribed). Indeed there is clear evidence in our data that admissions are not tied to place of residence since neighbouring pupils attend many different schools and only 48% of pupils attend their nearest school.

Our empirical analysis of the primary school system requires micro data on pupil attainments, linked to information on pupil background and residential addresses. This

[11] 4.7% overall for Community school pupils in our sample. 85% of residents living right on the LEA boundary attend a school in their home LEA

is available through the Department of Education and Skills' (DfES) National Pupil Database (NPD) for 1996-2003, linked to the Pupil Level Annual Census (PLASC) for 2002 and 2003. These are administrative survey datasets that cover the entire school population, and record pupil scores in standard tests at age 7 and age 11 (and higher ages in secondary school). Our focus is on the tests at age 7 and 11, the start and end dates of what is called Key Stage 2 in the UK National Curriculum. To construct measures of school-mean value-added between age 7 and 11, we work with standard DfES "point scores" which provide a summary measure of pupil achievement based on levels of attainment in maths, and English tests. The school value-added point score is simply the difference between age-11 and age-7 point scores, averaged at school level. To measure within school attainment dispersion at age 7 we convert the point scores into percentiles (in the whole sample) and then calculate the within-school Gini coefficient on these percentiles. To measure dispersion at age 11, we use the Gini on the percentiles of the actual test scores in these subjects (which are not available at age 7).

Pupil and school addresses are geo-coded to British National Grid coordinates using Ordnance Survey "Codepoint" data, which provides grid references for postcode unit (usually street) centroids. Finally – for our instrumental variables strategy – we derive LEA boundaries from the County and District boundaries obtainable from the 'UK Borders' service for Geographical Information Systems data. The sample is then restricted to a geographical zone within a 50km radius of central London, in order to focus on primarily urban school markets.

3.2. Results

Table 1 summarises the most important variables in the data we analyse, namely competition, performance and segregation measures.[12] All variables are defined at the school level of aggregation. A key question regards the amount of variation in the competition and segregation measures. If all schools serve only the local community, or if any school within an LEA is easily accessible from any residence within an LEA, then there is no variation in the level of competition. Similarly, if all schools are populated by similarly heterogeneous pupils, or if all neighbourhoods are characterized by diversified students, with school implementing no differential admission policies, then our polarization measures would display no variation. Table 1, and Figures 3 and 4 below, show that that our data display some interesting features.

Table 1: Competition, stratification (Gini Coefficient) and value added; summary statistics

Variable	Obs.	Mean	Std. Dev.	Min , Max
Competition Measures				
Average number of schools accessible to pupils in school	4707	1.39	1.06	0, 8.31
Stratification Measures				
Gini Coefficient, Pupils in School, Age-7	4707	0.33	0.08	0.06, 0.63
Gini Coefficient, Pupils in School, Age-11	4703	0.31	0.08	0, 0.60
Gini Coefficient, Catchment Area	4707	0.34	0.08	0.06, 0.58
Performance Measures				
KS2-1 Value Added	4707	38.72	3.70	23.16, 55.18

Note: The 5 km radius is chosen so that most schools have at least five other schools competing with them.

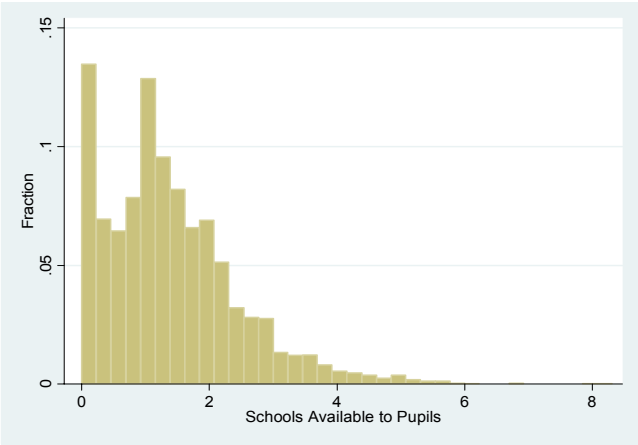
Looking first at the competition index, the first row of Table 1 tabulates summary statistics, while Figure 1 graphs the distribution of the competition index for all schools,

[12] Descriptive statistics for a set of controls used in our analysis are reported in Table A1.

and Figure 2 (taken from Gibbons el al. (2005)) maps of the spatial distribution of school competition in London (part of our study area); these all show there is substantial variation in the competition indices we have at hand.[13] Around 1 in 4 pupils have no school (other than the one they attend) within a short travel distance, but only 1 in 10 schools have all pupils with no local alternatives. Finally, from the map in Figure 2 we can also deduce that the competition indices are only partly related to urban centrality and density.

The central panel of Table 1, instead, reports summary statistics for our measures of segregation. The Gini coefficient at the school level varies between 0.06 and 0.63 (with a standard deviation of 0.08): this suggests that the most segregated schools are ten times more homogeneous, in terms of their pupil ability, than the least polarized ones. The Gini index on the catchment areas we construct around schools shows a very similar pattern.

Figure 3: Distribution of the competition index



[13] Additional details can be found in Gibbons et al. (2005).

Figure 4: Primary School Competition in the Greater London Area

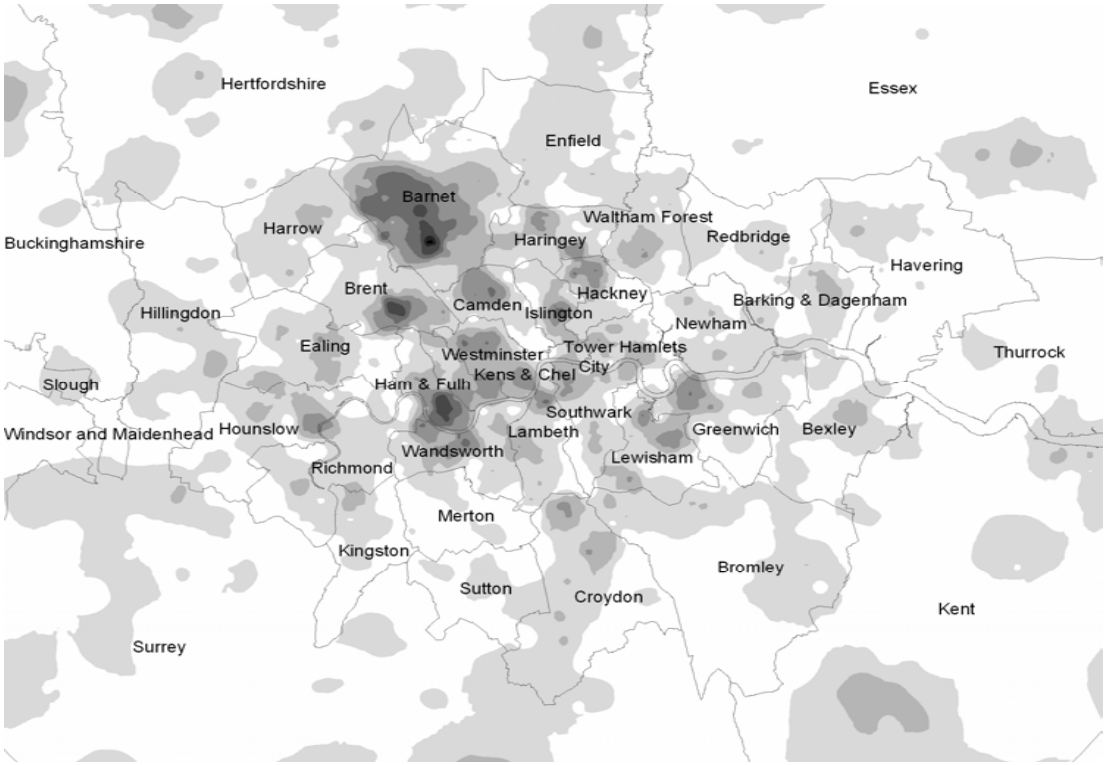


Figure shows local averages of the school-level competition index (Inverse Distance Weighted means of the nearest 6 schools on a 250m raster). Each shading class corresponds to intervals [0,1], (1,2], …(6,7] from lighter to darker.

Next, the panels of Figure 5 present a simple graphical analysis of the raw relationship between the competition a school faces and: a) its performance; and b) the mix of attainments of its pupils at age 7. These plots are smoothed over the competition index range using running means, with 95% confidence intervals. Both the value-added measure and the dispersion in pupil attainments (Gini) show an increasing pattern: more competition is associated with higher-value-added, less stratified schools and. Yet, as already mentioned, this result could simply be the result of unobserved neighbourhood factors, residential choice patterns and strategic school location.

Figure 5a: Association between competition and school performance

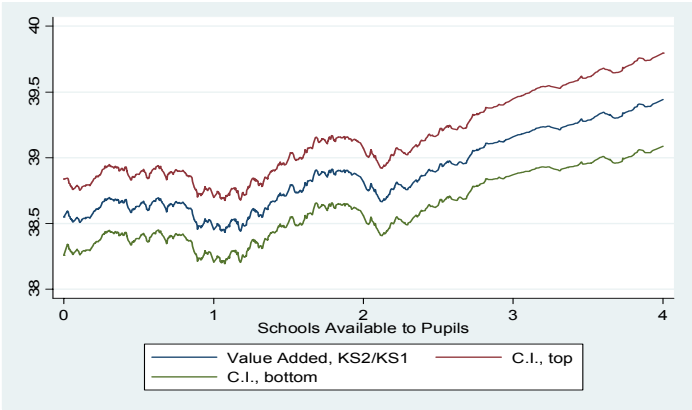
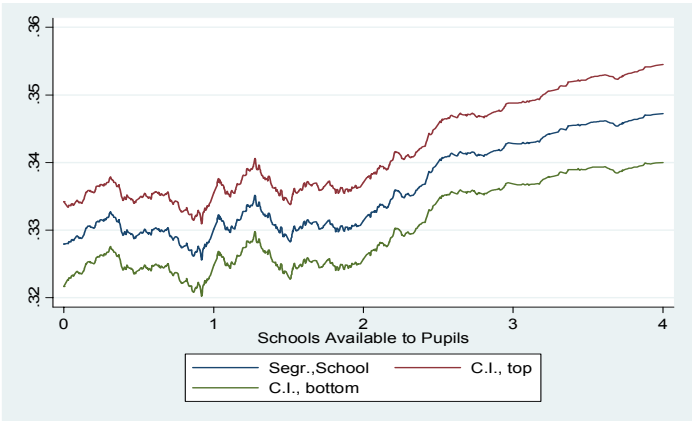


Figure 5b: Association between competition and within-school dispersion in attainment (Gini)



To go further, and estimate a causal impact of competition on either performance or stratification, we need to implement the strategy described in Section 2.4, that makes use of variation in competition near LEA boundaries. First, however, we start our analysis with simple ordinary least squares regression estimates, which model the relationships observed in Figure 3, with some additional control variables.

Columns 1 and 2 of Table 2 presents the first set of these regression results based on ordinary least squares (OLS) estimates of a regression of age-7 to age-11 pupil achievement progression (value added). Column 1 has no controls; Column 2, instead, includes a set of controls for school and neighbourhood characteristics (listed in Table A1). In both cases the coefficient on our competition index is strongly significant and the sign suggests that schools facing more competitive markets have a performance advantage. The order of magnitude is fairly small though, with a one standard deviation increase in our performance index – roughly one alternative school available to its pupils – associated with a 5% of a standard deviation increase in performance[14]. In Columns 3 and 4, we introduce our instrumental variables methodology, using the (logarithm of) distance to LEA boundaries as an instrument for school competition.[15] The results of this are striking: with our without additional controls, our point estimates suggest that competition is really linked to marginally lower school performance, though the coefficients are not statistically significant. Yet, examination of the first stage coefficient and standard error, reported in the second row of Table 2, suggests that our instrument is quite powerful. Our interpretation is that exogenous changes in

[14] These results are similar to those reported using pupil level regressions in Gibbons et al. (2005), though the school-level results here pick up the effects of both technological efficiency and sorting on school performance.

[15] While controlling for the average logarithm of the distance of schools to LEA boundaries in each LEA; this ensures that we are comparing like with like, taking into account the relative size and density of each LEA.

competition do not have a positive effect on school performance, and the OLS results simply pick up unobserved neighbourhood heterogeneity or the fact that pupils with a large number of alternative schools tend to choose the ones that perform best.

Table 2: Primary school competition and school performance 2001/2-2002/3

	Age-7 to Age-11 value added points, pupils age 11 in 2001/2-2002/3			
	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
Competition index: number of schools	0.222	0.197	-0.261	-0.294
	(0.064)	(0.073)	(0.309)	(0.316)
First Stage Regression				
Ln of school-LEA boundary distance	--	--	0.232	0.224
			(0.020)	(0.018)
Controls	No	Yes	No	Yes

Regression at the school level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses. Controls are listed in Appendix A Instrument is the log of the distance between school and LEA boundary, controlling for the log average school-LEA boundary. Number of schools: 2412; number of observations 4707.

Even if competition has weak effects on mean attainments, there may be effects on pupil sorting which lead schools to become more stratified with some competitive schools attracting low-ability pupils and others attracting high-ability pupils. Or perhaps competition breaks the link between residential sorting and school stratification, leading to greater mixing of abilities in competitive schools. We investigate these issues in Table 3, which reports the results of regressions that model the within-school dispersion of age-7 and age-11 attainments using the Gini index. All the figures in the first row are multiplied by 100, so they show the effect of a unit change in our competition index in percentage points.

Column 1-2 are simple OLS results without controls. Column 1 indicates that dispersion in attainment at age 7 is higher in schools that are located in what appear to be competitive markets; yet, this is not true for age 11 achievements where there the association is small in magnitude and statistically insignificant. Moving right across the table we first add some basic neighbourhood controls to account for neighbourhood heterogeneity. Now, the evidence for more dispersion of age-7 attainments in competitive schools is much weaker, and the age-11 attainments appear less dispersed in these schools. This suggests, perhaps, that unobserved neighbourhood attributes may be driving the first OLS results. Yet, one might argue that this method is inappropriate, because some of the effects of competition are absorbed by changes in neighbourhood composition. Turning to our IV methodology, however, gives us bigger *negative* point estimates (Columns 5-8), implying lower ability dispersion, or more school stratification, in competitive markets. The effect is similar whether we measure attainment at age-7 or at age-11.

Although none of these IV coefficients is precisely estimated, they all suggest increased competition may have an economically meaningful impact on stratification by attainment. In fact, an increase of one in the number of alternatives with which a school has to compete (1 standard deviation in our index) reduces the Gini dispersion of attainments at age 7 by just under percentage point, i.e. 12.5% of a standard deviation. Then again, this means quite a substantial change if we move over the full range of the data: expanding the number of alternative schools from 0 to 8 would reduce within-school dispersion Gini from 0.41 to 0.25.

Table 3: Primary school competition and school stratification								
	Gini index of within-school attainments, pupils age 11 in 2001/2-2002/3 scaled 0-100							
	OLS				IV			
	Age-7	Age-11	Age-7	Age-11	Age-7	Age-11	Age-7	Age-11
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Competition index: number of schools	0.423	-0.040	0.219	-0.199	-0.962	-0.657	-0.367	-0.261
	(0.137)	(0.145)	(0.133)	(0.148)	(0.689)	(0.674)	(0.696)	(0.678)
First Stage Regression								
Ln school-LEA boundary Distance	--		--		0.232	0.232	0.213	0.214
					(0.020)	(0.020)	(0.019)	(0.019)
Controls	No	No	Yes	Yes	No	No	Yes	Yes

Regression at the school level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses. Controls are listed in Appendix A, excluding: fraction of females, of FSM students and SEN students at school, and postcode level controls. Instrument is the log of the distance between school and LEA boundary, controlling for the log average school-LEA boundary. Number of schools: 2412; number of observations 4707 (4703 in age-11 models).

Our results so far suggest there may be small adverse effects from competition on pupil performance, and somewhat larger impacts on school stratification. However, our estimates are imprecisely measured. One possibility is that competition has stronger impacts on neighbourhoods, even if the school stratification effects are quite weak. For example, an expansion of school choice, conditional on place of residence, may lessen residential sorting because it is no longer necessary to live close to a particular school in order to get in. We explore this hypothesis in Table 4, in an identical manner to Table 3 – but this time the Gini index is computed on the attainments of *all* pupils who live in the catchment area of a school, not just those who attend it. We define the catchment area using the area we construct for our *competition measure.* What we might expect to see is that neighbourhoods around schools that have many competitors are quite diverse,

whilst those neighbourhoods which are served by just one school are more segregated. Looking across the Columns of Table, we see that this appears to be the case in the basic OLS estimates without controls (Columns (1) and (5)). But, again once controls are included in the age-7 models, or we use our LEA-boundary distance IV strategy, the coefficients become negative and insignificant. In fact, the pattern for the age-7 attainment mix in the neighbourhood is much the same as in the school models of Table 3, though weaker. The pattern of results for age-11 attainments is more indicative of greater school competition (more parental choice) leading to reduced residential sorting; but again the estimates are imprecise. Interpretation of the age-11 results is also clouded by the fact that the mix of age-11 attainments in the neighbourhood will be depend on the effectiveness of the schools that serve the neighbourhood, and not just residential sorting.

Table 4: Primary School Competition and neighbourhood stratification, 2001/2-2002/3.

	Stratification in Catchment Area							
	OLS				IV			
	Age-7	Age-11	Age-7	Age-11	Age-7	Age-11	Age-7	Age-11
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Competition index: number of schools	<u>0.902</u> (0.104)	<u>0.416</u> (0.103)	0.193 (0.104)	-0.171 (0.103)	-0.060 (0.511)	0.552 (0.510)	-0.451 (0.537)	0.075 (0.543)
First Stage Regression								
Ln school-LEA boundary distance	--	--	--	--	<u>0.232</u> (0.020)	<u>0.232</u> (0.020)	<u>0.213</u> (0.018)	<u>0.213</u> (0.018)
Controls	No	No	Yes	Yes	No	No	Yes	Yes

Regression at the school level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses. Controls are listed in Appendix A. Instrument is the log of the distance between school and LEA boundary, controlling for the log average school-LEA boundary. Number of schools: 2412; number of observations 4707.

Ultimately, the plausibility of our IV strategy depends on whether the first stages in the instrumented regressions are effective, and on whether the underlying assumptions are supported by the data.

Looking at the first stage coefficients reported in Tables 2 and 3, we see that a 10% increase in the distance from LEA boundary to a school increases the number of schools in the competition index by about 0.023, or about 1.7% relative to the mean (0.023/1.390). This instrument is significant, with t-statistics or around 10. This is not an artefact of the fact that we impose the constraint the pupils do not cross LEA boundaries in the construction of our competition index. We can form the index without this restriction and get nearly identical results (see Table A2). In this case, identification comes from the fact that catchment areas shrink near LEA boundaries, because, according to our theoretical reasoning, pupils are more likely to attend their nearest schools given they have fewer schools within feasible travel distance.

Further results from pupil-level regressions show that the instrument works in line with this theoretical reasoning: the probability that a pupil attends their nearest school decreases with distance of their home from the nearest LEA boundary, and the average distance between a pupil's residence and the nearest 4 schools (other than the one he or she actually attends) decreases. In other words pupils near admissions district boundaries seem to be more constrained in their choice of school.

Finally, we addressed the question of whether school or residence distance from LEA boundaries has a direct impact on pupil characteristics, and hence possibly on achievements and stratification. Yet again, we found this is not the case, lending further support to our IV strategy.

To conclude, our evidence using credible and powerful instrumental variables suggests that competition in primary schooling does not drive up school performance; if anything, policy that promotes competition through greater access in schooling markets may come at the cost of increased polarization in pupil achievements, and marginally *worse* performance.

4. Concluding remarks

Government education policies in England, as well as in the US and other countries, have increasingly expanded the role of parental choice, and competition among public schools, with the aim of improving educational outcomes. Critics of market-oriented reforms have however warned that these may come at the cost of increased stratification by pupil ability and attainments.

While a growing body of literature has been produced on the topic, evidence of the effects of competition on pupil achievements and segregation remains controversial, and a weak foundation for policy conclusions. In fact, most research has been confronted with the difficult challenge of finding credible exogenous variation to identify the effects of competition on pupil outcome.

In this chapter, we have presented a methodology to identify the impact of school competition and choice on pupil outcomes, using discontinuities in market access generated by proximity to administrative boundaries; this allows isolation of exogenous variation in the competitive pressure faced schools, which can be used to identify the impact of competition on pupil achievements and stratification by attainments.

Using a large pupil census with detailed information on pupil and school address, we have first constructed measures of school competition based on the number of

alternative schools that pupils enrolled at a given institutions had, given their residence, the geographical location of schools, and the *de-facto* pupil travel-to-school patterns. This is an intuitive measure of competition, which can be easily extended to the analysis of other markets: competition pressures faced by a service provide are simply captured by the number of alternative that its users had within convenient travel distance. A drawback of these indices, shared with most of the alternatives used in previous analysis, is however that they may be endogenous to the quality of the service provided.

Our solution to this problem has exploited discontinuities in market access generated by clearly defined administrative boundaries. In fact, families near-by school admission district boundaries face a restricted choice, with respect to other in more central location, because institutional barriers make it difficult for them to access schools on the other side of the boundaries, and it is costly to travel to alternatives further away towards the centre of the district. As a result, schools in the proximity of boundaries will enrol the vast majority of local students, and face little competition from other provides. We have argued that this methodology can be easily extended to similar contexts in the public service provision, such as public health, where access is ruled by zone of residence.

Our findings for English primary schools suggest that competition has no *causal* effect on the performance of schools. Most of the observed positive correlation between the number of competing schools and pupil attainments is driven by unobserved neighbourhood characteristics or endogenous selection of pupils with choice into better quality schools. Yet, we uncovered evidence that school competition may exacerbate stratification of schools by student attainment. Although our results are imprecisely estimated, they hint at a potentially large impact from expansion of competition on

polarization of schools by pupil abilities. All in all, our analysis suggests that further expansion of quasi-market discipline in the public education sector *may* come at some costs, and with few evident benefits.

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Appendix

Appendix Table A1: Controls, summary statistics

Variable	Observations	Mean	Std. Dev.	Min , Max
School Level Variables				
Fraction of Female in Schools	4707	0.477	0.042	0, 1
Pupil/Qualified Teacher Ratio	4707	23.25	4.27	11.2, 108.3
Total School Size	4707	324.3	132.02	52, 1373
Fraction of Pupils with SEN	4707	0.211	0.091	0, 0.65
Fraction of Pupils with FSME	4707	0.210	0.167	0, 0.77
Median travel distance all schools	4707	755.99	520.51	102, 6157
Number of pupils in the travel area	4707	75.59	74.93	2,1015
Average school distance from competitors	4707	217.50	328.37	0,3525
Postcode Level Variables				
Fraction of Lone Parents	4707	0.282	0.127	0, 0.617
Fraction of Unemployed	4707	0.040	0.020	0, 0.104
Fraction With no School Qualifications	4707	0.267	0.075	0, 0.576
Fraction with Black Ethnicity	4707	0.088	0.101	0, 0.557
Fraction with Chinese Ethnicity	4707	0.019	0.015	0, 0.128
Fraction with Other Asian Ethnicities	4707	0.090	0.120	0, 0.766
LEA Level Controls				
Total LEA Expenditure in 2000 (in £1000)	4707	2258.39	1747.31	493.5, 5982.7
LEA Area (in 1,000,000 squared metres)	4707	719.31	1100.18	12.4, 3450.8

Appendix Table A2: Primary School Competition, school performance and school stratification, 2001/2-2002/3; without no-LEA boundary crossing restriction

	Age-7 to Age-11 value added points		School stratification Age-7 (KS1)	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Competition index: number of schools	0.205	-0.635	-0.150	-0.423
	(0.069)	(0.701)	(0.121)	(1.543)
First Stage Regression				
Logarithm of School-LEA boundary Distance	--	0.103	--	0.093
		(0.019)		(0.020)
Controls	Yes	Yes	Yes	Yes

Regression at the school level. Standard errors clustered on school: underline significant at 5%; bold underline significant at 1%; t statistics in parentheses. Controls are listed in Appendix A; controls in columns 6, 8 and 10 *do not* include: fraction of females, of FSM students and SEN students at school, and postcode level controls. Instrument is the log of the distance between school and LEA boundary, controlling for the log average school-LEA boundary. Number of schools: 2412; number of observations 4707.