Stephen Gibbons, Stephen Machin, Olmo Silva

Choice, competition and pupil achievement

Article (Accepted version) (Refereed)

Original citation:
Gibbons, Stephen, Machin, Stephen and Silva, Olmo (2008) *Choice, competition and pupil achievement.* Journal of the European Economic Association, 6 (4). pp. 912-947. ISSN 1542-4774

DOI: 10.1162/JEEA.2008.6.4.912

CHOICE, COMPETITION AND PUPIL ACHIEVEMENT

Stephen Gibbons*, Stephen Machin**and Olmo Silva***

July 2007 – Accepted Manuscript

* *Department of Geography and Environment, Centre for the Economics of Education and Centre for Economic Performance, London School of Economics*

** *Department of Economics, University College London, Centre for the Economics of Education and Centre for Economic Performance, London School of Economics*

*** *Centre for the Economics of Education and Centre for Economic Performance, London School of Economics and Department of Economics, European University Institute, Florence*

Abstract

Choice and competition in education have found growing support from both policy makers and academics in the recent past. Yet evidence on the actual benefits of market-orientated reforms is at best mixed. Moreover, while the economic rationale for choice and competition is clear, in existing work there is rarely an attempt to distinguish between the two concepts. In this paper, we study whether pupils in Primary schools in England with a wider range of school choices achieve better academic outcomes than those whose choice is more limited; and whether Primary schools facing more competition perform better than those in a more monopolistic situation. In simple least squares regression models we find little evidence of a link between choice and achievement, but uncover a small positive association between competition and school performance. Yet this could be related to endogenous school location or pupil sorting. In fact, an instrumental variable strategy based on discontinuities generated by admissions district boundaries suggests that the performance gains from greater school competition are limited. Only when we restrict our attention to Voluntary Aided schools, which have more freedom in managing their governance and admission practices, do we find some evidence of a positive causal link between competition and pupil achievement.

Keywords: Choice; Competition; Primary Schools; Pupil Achievement.
JEL Classifications: I20, H70, R5.

Acknowledgements
We would like to thank the Department for Education and Skills for funding this work under the Centre for the Economics of Education work programme and to acknowledge unusually detailed comments from three anonymous referees and the Editor (Roberto Perotti) and suggestions from Tim Besley, Amy Challen, Andrea Ichino, Victor Lavy, Eric Maurin, Robert McMillan and participants at the LSE Research Lab Workshops Day 2005 (London), the Second CEPR-EEEPE Network Meeting (Uppsala), the IZA Research Seminar, the DfES Conference on "The Educational Impact of School Competition and Choice" (London), the STICERD Workshop on Public Organization (London), the WPEG Conference 2006 (University of Kent) and the Harvard Inequality Seminar for useful comments.

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 to choose. Yet, most proponents stress that it leads educational providers to compete for pupils by improving their technology, thus raising educational standards. Additionally, it is argued that gains may directly arise from choice through better matching of pupils with schools according to personal tastes and needs. These issues have been widely researched in the US, with an extensive literature in the education and economics of education fields (Hoxby, 2000, 2003, 2004). 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 uncovering empirical evidence for the hypothesised performance advantages that advocates of choice and competition say underpin these policy ideas. We focus explicitly on two conceptually distinct questions: 1) Do pupils perform better if they have more schools from which to choose, conditional on where they live; 2) Do pupils perform better if they are enrolled in schools that have to compete with many other

[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[s] pressure on underperforming schools to raise their standards" (Conservative Party, 2005).

schools to attract pupils, given where pupils live? We consider these questions to be the most relevant when evaluating the likely impacts of policies designed to expand the choice set available to families, without requiring them to move house. As such, we abstract from the kind of choice that can by exercised by changes in residential location (Tiebout, 1956), which has been studied elsewhere (e.g. Hoxby, 2000).

Our analysis, which use rich administrative data on Primary school pupils in the South East of England, allows us to improve on the existing (largely US-based) literature, since the data contains detailed information on pupil and school addresses, which we will use to 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 of their home Local Education Authority (LEA) because 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 that these barriers generate. We use this empirical strategy to solve the difficult issues of endogeneity that are inextricably associated with studying connections between pupil performance and choice/competition.

In the empirical analysis, simple least squares regressions show no link between choice and achievement, but a small positive association between school competition and performance. However, this seems to be related to endogenous pupil sorting or school location, since instrumental variable estimates show that there are no general benefits to be had from increasing school competition. It is only a minority of schools, namely Voluntary Aided schools with autonomous governance and admission procedures, which seem to respond positively to a greater degree of competition with local schools.

The rest of the paper has the following structure. The next section outlines the ideas surrounding debates on choice and competition and provides a short guide to

the (vast) empirical evidence from the US and the (scant) empirical evidence from the UK. Then, we discuss how choice and competition relate to the current admissions system in England. Following that, in Section 4 we explain our empirical methods. Section 5 describes the data and Section 6 presents our results. Section 7 concludes.

2. Theoretical Background and Previous Research

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 (Brighouse, 2000), here we will mainly attend to the narrower claims about the potential productivity and performance benefits that have been the prime focus of applied work in the field. The arguments are fairly well rehearsed, and there are many theoretical expositions that focus on different aspects of the issue[2], so the purpose of this section is to briefly outline the key themes that motivate and structure our empirical work.

Behind any analysis in this field lie two ideal modes of school provision: (1) the *community-school* model, in which only pupils living nearby the school are allowed in; and (2) the *parental-choice* model, in which schools admit pupils regardless of where they live, and parental preference is the deciding factor. Broadly speaking, mode (1) has traditionally been the most dominant form of state 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

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

better schooling. Alternative systems have begun to be adopted worldwide (Plank and Sykes, 2003).

Advocates of mode (2) tend to base their claims on two standard efficiency arguments from economic theory. According to the first argument, community-based schools serving single neighbourhoods are monopolistic, and the incentives for improvement or adoption of new teaching technologies may be weak. These incentives need to come from good governance, supported by strong institutional arrangements including training, monitoring, mechanisms for self-evaluation and performance-related pay. The alternative is to give parents freedom of choice, to link school finance, management incentives and teacher pay to school popularity, and so create a market incentive mechanism. Under this system, schools must adapt to meet parental demands – presumably to include high educational standards – or fail and close. We refer to this mechanism as a *school competition* effect stemming from greater parental choice in education markets. The second economic argument is that gains arise through the reallocation of pupils to schools according to personal tastes and pedagogic needs. Consider a move from a community-based to choice-based system: if every pupil can find a school that that they enjoy at least as much as the school that was available under the old system, the new system must be welfare improving. Additionally, 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 achievement should improve. We refer to this second mechanism as a *direct choice* effect of school provision operating under mode (2).

In defence of mode (1) it has been claimed that teaching works better in a stable environment, where teachers are not under undue competitive pressures and where there is lower search-based turnover (which may have detrimental effects on achievement; Hanushek, Kain and Rivkin, 2004; Gibbons and Telhaj, 2007a).

Moreover, schools could respond to an increase in competition by reducing costly effort and going down-market in order to serve only those with weak preferences for school performance (McMillan, 2004). Another overarching concern is that even if wider school choice boosts some pupils' achievements, these benefits may come at the cost of increased between-school segregation and the gains may not be equally distributed.[3] In this case, it would be important to know whether the gains to the "winners" outweigh the costs to those who lose out (i.e. whether school competition is a "tide to lift all boats"; Hoxby (2003)). Finally, total pupil travel distances could be greater when pupils do not automatically attend their closest neighbourhood school, with consequent environmental impacts and detrimental effects on achievement because of lateness, absence or stress.

Given all these counterbalancing arguments, solid empirical evidence on the effects of school choice and competition is needed in order to make informed policy decisions. In fact, a substantial volume of quantitative evidence has been produced over the past decades – using various approaches – particularly in the US context. The first and most common empirical framework uses cross-sectional, geographically-based school choice/competition indices to explore the effects of implicit variation in the level of choice available in different school markets (e.g. Belfield and Levin, 2003 for a survey, and Hoxby, 2000, and Rothstein, 2006a for recent examples). Our empirical work adopts this style of approach. One fundamental empirical problem here is the definition of the choice/competition indicator. The general idea is to first define a market area, and then measure the number of choices available within it. However, this depends entirely on prior assumptions about the markets and the appropriate units of choice: for example,

[3] Although the theoretical argument for the link between choice, competition and segregation is not clear, and could point in either direction.

some studies look at the number of schools within a school district, whilst others look at the number of school districts within a metropolitan area. Another difficulty is that the choice/competition indices are potentially correlated with unobserved pupil, family or area characteristics. Hoxby (2000) provides one of the best known solutions to this problem, observing that pupils perform better in US metropolitan areas that are naturally subdivided (by rivers) into a greater number of school admission districts (thus offering a wider variety of schools).[4] Generally, studies adopting this competition index-based approach come to varying conclusions, and Belfield and Levin's (2003) summary is that "the gains from competition are modest in scope with respect to realistic changes in levels of competition", with many results statistically insignificant. Importantly, none of these studies separates the influence of parental or pupil choice from the effect of inter-school competition, although these are quite distinct concepts. In the empirical work we present below, we try to address all these issues: the appropriate definition and endogeneity of the choice-competition index in educational achievement models, and the distinction between choice and competition.

Other methodological approaches appear in the literature, but all have their drawbacks. Some studies evaluate the benefits of institutional systems that widen access to private schooling through voucher systems (Rouse, 1998; Mizala and Romaguera, 2005). Although these studies might say something about the benefits that the private sector offers over schooling in the state sector, they say very little about the expansion of choice or competition in its own right. One extension is to

[4] Note that Hoxby's paper is concerned with choice across school districts, exercised by Tiebout residential moves, not with choice conditional on place of residence. Recently, the validity of the stream-based instruments and the robustness of Hoxby's results have been contested (Rothstein, 2006b; Hoxby, 2006).

measure the effects of private school enrolment on local *state* school performance (Hoxby, 1994, 2004), but this strategy is complicated by the possibility that the location of private schools is endogenous to neighbourhood status, and such schools are likely to skim off higher-achieving pupils from the state sector (Epple and Romano, 1998). Other studies evaluate the impact of policy *changes* that introduce greater choice into geographically localised educational markets, in some cases using research designs that exploit random assignment to choice programmes. Again, some researchers find positive benefits (Holmes et al., 2003; Hoxby, 2003; Hoxby and Rockoff, 2004; Lavy, 2005), whilst others do not (Cullen et al. 2003, 2005). All these findings are difficult to generalize, given the highly localised and peculiar settings under analysis. Moreover, it is difficult to judge whether any benefits occur because choice improves the match of pupils with educational providers or because it increases competitive pressure.

All in all, it has to be said that the international evidence is voluminous, but mixed in its findings. In contrast, evidence specifically for Britain is almost non-existent. A few studies show evidence of positive links between competition and performance, popularity or efficiency (Levacic 2004; Bradley et al. 2000, 2001). On the other hand, Clark (2005) reports that reforms that handed more power to schools (in the late 1980s) only generated modest efficiency gains through competition effects. Otherwise, all the research effort in Britain has been directed at the effects of competition on segregation (e.g. Goldstein and Noden, 2003; Gorard, Taylor and Fitz, 2003; Burgess et al., 2004; Gibbons and Telhaj 2007b), which we do not pursue here.

The empirical work we present in this paper is, therefore, the first pupil-level analysis of the effects of choice and competition on academic achievement in

Primary schools in England, and the first distinguishing these two concepts empirically.[5] Moreover, our analysis is based on a large pupil census for a sizable part of the South of England, which is thus generally representative. Finally, exploiting some institutional features of school admissions across school district boundaries, we devise a solid instrumental variable (IV) strategy, which we describe in more detail below.

3. School Choice and Competition in English Primary Schools

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. Glennerster, 1991). The trend has continued recently, with further expansion of choice being advocated in many quarters.[6]

Although choice at the *Secondary* education phase tends to dominate the political rhetoric and policy discussion, in this paper we will consider the effects of choice and competition among *Primary* state schools only.[7] The reasons for this are two-fold. First, we believe that choices made at Primary age are critical for later educational success (see Heckman, 2000, and Dearden et al., 2004), and that parents are very active in exercising choice at the Primary level (as evidenced by

[5] Bayer and McMillan (2005) is the only other work conceptually distinguishing the two ideas. Yet the authors' structural modelling approach only allows estimating the effect of school competition.

[6] See, for example the UK Government's October 2005 White Paper: "Higher Standards, Better Schools for All: More choice for parents and pupils".

[7] 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).

research on the house price effects of Primary school performance in Gibbons and Machin, 2003, 2006). Secondly, 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 more relevant in deciding which school to attend, so that the availability of schools can be more confidently inferred from geographical measures of accessibility.

All state schools in England are funded largely by central government, through Local Education Authorities (LEA) that are responsible for schools in their geographical domain, and, crucially, funding is linked to the number of pupils enrolled in schools. Primary schools in the state-sector fall into a number of different categories, and differ in terms of the way they are governed, who controls pupil admissions, and their religious affiliation (if any). In addition there is a small private, fee-paying sector, which we do not consider here.[8] The key differences between the various types of state school – Community, Voluntary Controlled, Foundation and Voluntary Aided– are set out in Appendix Table A1. About 60% of the 14500 (or so) Primary schools in England are classified as Community schools, with a further 15% being Voluntary Controlled schools (predominantly Faith schools). Next, Foundation schools account for about 2% (86% of which are not connected to a particular Faith) and Voluntary Aided for about 23% of the state-Primary sector (97% of which are religiously affiliated).

All schools are run by a Governing Body composed of members elected from amongst parents and staff (Parent Governors and Staff Governors), members appointed by the LEA (LEA Governors), members appointed by the church or charitable foundation that owns the school premises (where relevant – Foundation

[8] Private schools educate around 6%-7% of pupils in England as a whole.

Governors), and members appointed from the community (e.g. local businesses) by the Governing Body. The Governing Body sets the strategic direction of the school, draws up school policies, sets targets and monitors performance, although day-to-day running is down to the head teacher (principal) and his or her leadership team. The constitution of the Governing Body is crucial because it determines how much influence various stakeholders have in the way the school is run and, in particular, the balance between control by the LEA and control by the church or charitable foundation associated with the school. For the purpose of our analysis, the most important distinction is the one between Voluntary Aided schools, where the charity or foundation has a controlling majority within the Governing body and so a strong influence on the running of the school, and all other types of schools where governance is shared more equally among LEA representatives, teaching staff and parents. We suspect the arrangement in "majority controlled" Voluntary Aided schools to be more conducive to a focused, competitive ethos in which the setting of targets, drawing up of strategies, adoption of technologies and monitoring of performance will be seen as a way to attract pupils through the promise of excellence. On the other hand, in other "non-majority controlled" school types, there is a greater need to balance the objective of high standards for high-achieving children with appropriate education for children from diverse backgrounds, including those with English as additional language and those with special educational needs. These distinctions are important when considering the different incentives that competition may have for different school types.

Overall, all LEAs and schools must organise their admissions arrangements in accordance with the current (statutory) Department of Education and Skills School Admissions Code of Practice. 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.[9] These 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. For Faith schools, regular attendance at designated local churches (or other expressions of religious commitment) is foremost. Note that less than 50% of pupils attend their closest Community school, which shows that there is not a one-to-one mapping between where a child lives and where they go to school and suggests that parents have some scope to exercise their "right to choose".

However, one important restriction applies. Families are allowed to apply to schools in LEAs other than their LEA of residence, but parents must make separate applications to other LEAs, and, more importantly, LEAs do not have a statutory requirement to find a school for pupils from other LEAs: the law only requires that they provide enough schools for pupils in "their area".[10] As a result, banking on admission to a popular school in another LEA is a high-risk strategy, and cross-LEA attendance is not commonplace in 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 a school located

[9] 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)

[10] 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"

outside their home LEA. For Voluntary Aided schools, the rate of LEA crossing is slightly higher, but is still only about 10%.

As to the actual extent of competition faced by Primary schools, it is important to notice that state Primary schools are universally non-selective by ability, do not have explicit curriculum specialisations, and are mixed gender. Yet there is considerable heterogeneity in terms of their performance, and enrolment rates are likely to be elastic with respect to quality measures, as evidenced by research on the house price effects of Primary school performance in England (Gibbons and Machin, 2003, 2006; Cheshire and Sheppard 2004). Given that Primary institutions are mainly funded according to pupil numbers, schools have strong incentives to attract pupils by improving educational standards:[11] failing schools are under threat of falling enrolment, shrinking funding and reduced personnel and could eventually be closed. Popular schools on the other hand receive growing numbers of applications, more resources and are able to expand. In addition, high-flying schools can receive extra resources and recognition for their excellence (e.g. so called "Beacon schools") and headteacher pay schemes are explicitly linked to performance.

One final remark is worth making: we expect these competition incentives to be stronger in Voluntary Aided schools, where the church or charitable foundation manages the school admission systems *via* the Governing body and so is directly responsible for attracting pupils and funding. On the other hand, numbers in undersubscribed "non-majority controlled" schools, such as Community schools

[11] As already mentioned, schools are funded on a per-pupil basis (with adjustments for special needs and economic deprivation); yet the marginal costs of teaching extra children within a class group are small in purely financial terms. Schools are also evaluated on the basis of pupil pass rates in national tests (the league tables). For these reasons it is not hard to believe that these incentives are real.

for which the Local Education Authority handles admissions centrally, are often topped up with pupils who could not be accommodated in their school(s) of choice. This undoubtedly weakens the potential link between parental choice and school competition.[12]

4. Empirical Methods

4.1. Defining and measuring choice and competition

The concept of competition we will use in this study is one of spatial competition conditional on pupils' residence: schools compete with other schools for students in a community in order to maximise their revenues and minimise the costs associated with disruptive and hard-to-teach pupils. Even under a parental-choice regime of school provision (model (2) above), a family's set of available schools is constrained by the distance between home and school, in part because of commuting costs and in part because school admission rules have historically favoured residents who live nearby. Because of this, residential locations differ in terms of numbers 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; these are the competition effects we seek in this paper.

One thing should be clear from the outset: there must be variation in the structure of school markets for these ideas to be empirically meaningful. Our empirical work considers a large metropolitan area in which there are few explicit differences in institutional arrangements that could give rise to different

[12] Unfortunately, we do not have access to data about how families ranked their school choices.

competitive configurations.[13] However, our claim is that it is the spatial arrangement of schools in relation to each other, and in relation to residential housing, which gives rise to *de facto* variation in school accessibility and market structure.[14]

The purpose of this empirical work is to assess separately the effect of greater school choice and that of greater inter-school competition on pupil academic performance. Though these two ideas are conceptually distinct, they can be difficult to separate. At the school level, these 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. Yet for the family, the two concepts are distinct. Our definitions are then 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 enrolled pupils. So 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. Our measurements of competition are based on the range of alternatives that are available to pupils attending each school.

Competition/choice indices generally suffer from a number of problems. First, they can also capture urban density and school size effects, rather than competition and choice. We try to avoid this by carefully designing our measures. Secondly, different market configurations can arise through processes of parental

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

[14] Of course, this spatial arrangement may be endogenous to pupil performance and this is something we consider in our empirical work.

choice and school location, which may be endogenous to pupil performance. For example, if school places are rationed by place of residence, then parents have good reason to move close to popular schools. Schools may then appear monopolistic, even though it is parental choice that has compressed the geographical spread of their intake. Additionally, although new school openings are rare, it is not implausible that the current spatial distribution of schools is related to the socioeconomic characteristics of an area and, consequently, its level of pupil achievement.[15] We address the endogeneity of the competition and choice indices using an instrumental variables approach based upon a boundary discontinuity, as described below (in Section 4.3).

To construct our indices (which are described diagrammatically in Figure 1), we start by taking advantage of the fact that 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 (a) are within the same LEA as school *s* and (b) are contained within a circle drawn around school *s* at the median of the distribution of the home-school distances for the school's pupils.[16]

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

---

[15] It has to be emphasized though that school opening has not been common in England in recent years and that very few schools were opened in the time window under analysis in our study area. Moreover, the location of schools, as well as the geographical distribution of specific school types (such as Voluntary Aided or other Faith schools), mainly reflect historical factors.

[16] 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.

defined as *the number of schools accessible to a pupil*, i.e. the number of school travel zones that encompass the pupil's residential postcode, excluding the school the pupil actually attends.

Next, the *competition* index is school-based and assesses the extent to which pupils attending school *s*, have the option of attending other schools. This information is obtained as *the average number of schools accessible to pupils in the school*, i.e. the average of our school choice index across pupils actually *attending* school *s*.[17]

Note that we have experimented with a number of alternative choice and competition measures, including the number of alternative schools and number of competitors within a fixed radius, and a Herfindahl index of pupil shares in schools available within travel zones. These alternatives gave qualitatively similar result, but we think our number-of-school indices are conceptually easier to interpret and avoid imposing a priori restrictions on travel patterns.

Finally, 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. For example, semi-rural and low-density suburban areas can (in principle) appear competitive because our definition of school accessibility is based on observed pupil travel behaviour: less dense places may exhibit low school density, but still be competitive school markets because families can travel longer distances more easily. Essentially, the fact that our travel zones are defined by revealed preferences allows us to account for heterogeneous travel modes and time, and other features of choice patterns that would be obscured by more restrictive

[17] 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.

assumptions such as common travel distances or common travel modes in different urban, suburban and semi-rural settings.

4.2. Modelling school performance

Our focus is on the influence of these indices on pupil achievements, where these are measured by 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.[18] As discussed above, more competition with other schools and greater exercise of choice amongst potential pupils may raise a school's productivity, because it forces schools to use a more efficient teaching technology, or because reallocation of pupils to schools results in more efficient pupil-school matches.

We look for these types of influence by estimating pupil-level educational production functions that use information for the extended 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 choice and competition indices feasible. However, at the time of analysis this information was only available for two years, leaving us with little useful time-series variation in the 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 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 achievement relating to standard tests taken at the end of the Primary phase in

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

English education, at age 10/11. There is little doubt that the outputs of a good education amount to more then good results in academic tests. However, tests remain the simplest metric by which to judge pupil abilities, and average achievement in schools is the most common, if the most basic, means by which school performance is assessed. We therefore use test scores as the main measure of pupil achievement, and focus on the *gain* in pupil achievement from age 6/7 to age 10/11: this stage is referred to as Key Stage 2 in the English National Curriculum.

To sum 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_{rt} is a choice index for residents of postcode *r* in year *t*; c_{st} is a competition index for school *s* in year *t*; and finally $\mathbf{x}'_{\mathbf{irst}}$ is a vector of pupil, school, and neighbourhood characteristics, and a year dummy.

4.3. Accounting for residential sorting: instrumental variables strategy

Families choose where to live, and schools are one thing they consider when making that choice. More generally, where families choose to settle in relation to local schools will depend on their own characteristics and preferences, as residential sorting arises from the exercise of choice through residential decisions. 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.[19] This would be true if, for example, families crowded around a high-performing school, reducing its apparent competitiveness. It would also be true if the competitive structure was indicative of market penetration by a specific school type in areas with specific socioeconomic characteristics. Because of these concerns, we need to adopt an instrumental variable strategy and look for credible instruments that generate variation in our competition and choice indices, but are uncorrelated with unobserved school and family characteristics.

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 decreases with 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 being 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).

[19] School choice is also exercised by changing residential location (*à la* Tiebout, 1956), but the aim in our research is to study the effects of school choice and competition taking residential decisions as given. Hence our identification strategy will be based on finding variation in school accessibility and competition that exists after residential decisions have been made and that is plausibly exogenous to family and school characteristics (we will test this assumption). Our estimates of the impact of choice and competition are therefore net of any effect arising through Tiebout-type choice.

Our instrumentation strategy uses this intuition, exploiting the notion that families living near LEA boundaries face longer journeys to schools other than the nearest one, than do families living in locations interior to the LEA. The idea is best illustrated in Figure 2. 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 the 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; so, schools near to LEA boundaries will mainly enrol pupils from local families, who have that school as the nearest choice.

In conclusion, schools in locations close to LEA boundaries face less competition because: (a) the catchment area shrinks in radius and land area closer to LEA boundaries due to local pupils (who face a more restricted choice set) crowding out those who would have travelled from further afield; (b) the catchment area may be partially truncated on one side, which is a restriction we impose by excluding the few pupils who cross LEA boundaries in the calculation of our choice and competition indices.[20] From these arguments, we propose to use the

[20] As it turns out, (a) is most important in terms of driving variation in our indices.

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.

The validity of this strategy rests on a set of assumptions. First, it requires that the administrative boundary increases the costs associated with access to services on the opposite side of the boundary, so that they actually restrict parental choice and school competition.[21] Next, we require that the distributions of schools and school types, as well as of families, do not follow systematic patterns with respect to LEA boundaries; for example, schools (or school types) and households should not be more densely distributed around the LEA perimeters than the centre. A further assumption is that these LEA-boundary distance instruments do not have a direct influence on school or pupil performance other than through their effects on the choice set available to families and that they are otherwise uncorrelated with the outcomes that are being analysed.[22] These are empirical issues regarding the power and balancing properties of our instruments which we will investigate in detail below when we assess the validity of our strategy. In doing so, we will borrow from the methodology used in Cullen *et al.* (2005).

[21] It also assumes that LEA boundaries are exogenously fixed and stable; this seems to be the case, as LEA boundaries were last re-drawn in 1997/1998, and even then very few boundaries in the area we study were affected.

[22] 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.

5. Data Sources and Sample Construction

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 to 2003, the Annual School Census (ASC) from 1996 to 2003, and the Pupil Level Annual School Census (PLASC) for 2002 and 2003. These are administrative datasets made available by the Department for Education and Skills (DfES) of the UK Government.

The first (NPD) is a pupil-level dataset that records 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 (KS1) in the National Curriculum. The assessment comprises Reading, English and Mathematics 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 predetermined DfES rules. The second set of assessments takes place at age 10/11, at the end of Key Stage 2 (KS2). The assessment comprises English, Maths and Science tests and pupils are awarded percentage marks in each of these; marks translate into KS2 Levels 2,3,4,5 (with some +/- subcategories), which in turn translate into point scores, again using standard DfES rules. We will use KS2 and KS1 point score information to compute a value-added measure of educational progress between age 6/7 and 10/11.

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.[23] ASC was augmented from 2002 onwards by PLASC, which collects characteristics of pupils individually, including

[23] School level characteristics are based on census information covering all grades at Primary schools (from age 5 to age 11), so do not relate only to the cohorts in our pupil sample.

their residential postcodes. These can be linked to the pupil test results in the NPD and to school characteristics in the ASC. So the basis for our composite dataset is all pupils in PLASC who took KS2 tests in the school years 2001/2002 and 2002/2003, and sat their KS1 tests in 1997/1998 and 1998/1999.

This information 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, 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 provide one metre grid references for postcode unit centroids. For some of our analyses we also include information on pupil residential neighbourhood and family background, which we obtained by matching the residential address to Census data for 2001.[24] Finally, we derive LEA boundaries from the County and District boundaries obtainable from the UK Borders[25] geographical information service, which we will use in our instrumental variable analysis.

As stated above, the pupil data we use relates to age-10/11 pupils sitting KS2 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.[26] Our

[24] We identify pupil residential neighbourhoods using postcode sectors; these include a handful of postcode tracts and are well designed to represent the community where individuals live.

[25] Available from the Edinburgh University Data Library at www.edina.ac.uk.

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

purpose in restricting the data is to focus on primarily urban school markets, but it also substantially reduces the computational burden. One further restriction is to eliminate partial LEAs (Luton, Bracknell) at the margins of our geographical zone, and in the City of London (which has a very low pupil population).

6. Results

6.1. Sample description

Table 1 summarises the most important variables in the dataset, namely the pupil achievement indicators and competition/choice indices. One key question 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. Our methods assume that a mix of neighbourhood-school and parental-choice structures exists, and that this will be reflected in our measures. Table 1 tabulates the summary statistics for our indices, Figure 3 graphs their distributions and Figure 4 provides a map 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. 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. Obviously, the choice and competition indices are highly correlated (with a pair-wise

correlation of about 0.60); yet they display sufficient independent variation, from which we will separately identify the effects of school availability and competition.[27] 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 exercising of choice (see also Burgess *et al.*, 2004). Finally, from the map of Figure 4, 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.

Further down Table 1 are other interesting features of the data. 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.[28] We have also computed a cohort density measure centred on each pupil's residential postcode, using a count of the number of pupils aged 10/11 within a 564m radius of each pupil's address (a 1km^2 circle). The mean pupil density is 64.1km^{-2}, but ranges between 1 and 256. These 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 addition, we will include a number of controls in these regressions, at

[27] This is because, for example, pupils coming from an area with little available choice may travel long distances and enrol in a school which faces a highly competitive market.

[28] The average distance between a school and other schools in its travel zone is about 600 metres, ranging from zero (i.e. two or more schools are in the same postcode) up to 4.4 km.

four levels of aggregation: pupil, school, residential postcode sector, and LEA level.[29] These are described in Appendix Table A2.

6.2. Choice, competition and performance: regression results

Our first results are ordinary least squares (OLS) estimates of the model in equation 1, which are presented in Table 2. This shows the coefficients of interest only, and is divided into three panels. The top panel shows estimates of the association between choice availability and pupil achievement, 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 achievement (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). All columns report results where the dependent variable is the pupil's change in point scores between KS1 and KS2, a direct measure of value added through the National Curriculum stages. Table A3 in the Appendix reports results for KS2 English and Maths test marks separately. As we did not find different patterns for the two subjects, we decided to focus on the overall value-added measures.[30] Finally, notice that it is difficult to establish a priori at which

[29] Along with school type dummies (Community, Foundation, Voluntary Aided and Voluntary Controlled).

[30] Controlling for prior achievement, 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 potentially 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

level one should cluster standard errors; therefore, we report both standard errors clustered at school and LEA level (in round and square brackets respectively).

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 achievement at school between age 7 and 11. This is true regardless of whether we include the full set of controls described above. However, the association is very small in magnitude: one extra school in the pupil choice set relates to about 0.1 additional value-added points. These 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. Finally, when the choice and competition indices are included together, we find that pupils in schools facing more competition do marginally better; yet we find that choice is not associated with higher pupil performance.[31]

Taken at face value, these estimates suggest small but significant gains for pupils in schools facing more competitive markets. However, we find it hard to trust these findings, because the choice and competition indices we use are likely to be endogenous to pupil and school performance. To address this, we employ the instrumental variables (IV) strategy described above, using the pupil residence-LEA boundary distance as an instrument for choice, and the school-LEA boundary distance as an instrument for competition.

---

almost unchanged if we use age-11 test scores unconditional on age-7 test scores. See Table A2 in the Appendix.

[31] 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 effect comes from schools that have a potential for expansion (under-capacity). This "threat effect" is in line with predictions from the empirical IO literature.

The IV coefficient estimates are presented in columns (3) and (4) of Table 2, and tell a very different story. The signs on all the coefficients become negative, although statistically insignificant.[32] Starting from the top panel, there is now *no* evidence 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 achievement. A Hausman test of the hypothesis that the IV coefficient on the choice index in column (4) is equal to the OLS estimate of column (2) rejects the null with a *p*-value of 0.0363. Notice that this coefficient identifies an average effect of school availability, i.e. both for individuals who exercise choice and opt out of their local schools, and for individuals who are left in the local institution. Without further assumptions, we cannot disentangle a pure pupil-school matching effect from indirect spill-over effects. Similarly, we do not find evidence that attendance at a school that faces more competition further away from an LEA boundary improves achievement (central panel). The IV coefficient for the competition index is always negative, though not significant, and a test that the IV estimate in column (4) is equal to the OLS coefficient in column (2) rejects the null with a *p*-value of 0.0481. Finally, when we include the choice and competition indices together in our regressions (bottom panel), we come to similar conclusions: neither increased choice nor fiercer competition away from LEA boundaries significantly increases pupil achievement. A test on the two IV coefficients in column (4) being jointly equal to the OLS estimates in column (2) speaks against the null with a *p*-value of 0.0869. In conclusion, all these point estimates suggest that moves away from an LEA boundary could have small adverse effects on achievement, though they are imprecisely determined.

[32] Remarkably, our results are similar whether we include the full set of controls or not; this reassures us as to the validity of our instrumental variable approach.

6.3. Assessing the instrumental variables strategy

It is reasonable to ask whether, given these results, LEA boundary distance measures are good instruments for the choice and competition indices. An important assumption for the instrument to determine choice and competition is that cross-LEA Primary school attendance is not widespread. From the 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%, and slightly lower for Community schools at around 4.7%. Moreover, of the 10% of pupils who live closest to the LEA boundaries, well over 80% 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 and might be equally likely to attend a school in the adjacent LEA as in their own LEA if the boundary imposed no barrier.

Whilst this suggests that our distance measures could be good predictors of school choice and competition, the deciding factor on the power of these instruments boils down to whether the first stages of the IV regressions are effective. These are tabulated in Table 3, where we report results for specifications including and excluding controls, and with standard errors clustered at school or LEA level. The instruments – the log of boundary distances – are always very powerful. 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 (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, LEA boundary distance measures are indeed strong predictors of choice availability and school competition.

Further results (not tabulated) also show that the instrument for choice (and indirectly, competition) works in line with the theoretical reasoning we used to justify its use. First, 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, and within the LEA of residence) 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 dropped the restriction of no-LEA-crossing to compute our indices, and reran the IV analysis (presented in Appendix Table A4, columns (1) and (2)). First stage results show that distances to LEA boundaries are still strong predictors of competition and choice. As explained before, we expect the instruments to work if boundaries are effective barriers, even if we include boundary-crossers (very few) in our indices. This is because the composition of the intake in a less-competitive school close to an LEA boundary will be weighted towards restricted-choice pupils living in the immediate vicinity. This shrinks the catchment area radius relative to schools located more centrally within the LEA, and so influences the choice and competition indices in the surrounding area.

One further concern relates to the fact that some of the variation in our choice and competition indices could be generated by differences in how far pupils travel to school, a factor which is plausibly correlated with preferences over schooling and family resources. For instance, looking at Figure 2, if pupils differ in terms of their transport costs (e.g. some have cars and some do not), then those

with the lowest costs per unit of travel distance will be best placed to exercise choice and attend the most competitive schools. In other words, home-school distance is a potentially important omitted variable when we use our boundary-distance IV strategy. However, our instrumental variable strategy does *not* systematically rely on differences in travel distance to identify the causal effect of school competition on pupil achievement. It instead contrasts pupils living in the same neighbourhood but travelling in different directions: towards the centre of the LEA or towards a boundary (for example, looking again at Figure 2, our competition instrument compares pupils who live at, say, *p* and attend a school at *q*, with others who live at *p* but attend a school at *n*). We do not think there is a strong theoretical case for individual unobservable characteristics being related to *direction* of travel. Nevertheless, in order to directly address this issue, in columns (3) and (4) of Appendix Table A4 we replicate our IV analysis controlling for the distance between home and the school a pupil actually attends. The results are essentially unchanged and this set of estimates confirms our previous findings, suggesting that differences in costs or preferences associated with home-school travel distance are not biasing our estimates.

Finally, one crucial assumption behind our strategy is that school or residence distance from LEA boundaries is uncorrelated with unobserved pupil and school characteristics that may influence educational outcomes. This assumption might be violated if, for example, there were geographical differences between places close to LEA boundaries and places further away, and residential sorting led to differences in the distributions of pupil characteristics in these areas. Although this assumption is ultimately untestable, we can provide some evidence in support of it by demonstrating that our instruments are not strongly correlated with observable school and residential neighbourhood characteristics. To do so, we

borrow from the methodology in Cullen et al. (2005) and perform balancing tests for the two instruments separately. Results are reported in Tables 4 and 5.

In the first of the two tables, we investigate the validity of the instrument for school choice. The aim is to test whether the distance between home and the LEA boundary (relative to the mean within the LEA) is correlated with the level and diversity of various neighbourhood attributes that might in turn be linked to family background and hence pupil performance at school. Since we are concerned primarily with factors that are unobserved in our models, we test whether the distance between pupil residence and the LEA boundary (or rather its natural logarithm) is correlated with various neighbourhood characteristics *not* included as controls in our specifications, both conditional on these controls and unconditionally. These are derived from the UK Census 2001, from the UK Land Registry and from our pupil and school datasets. We implement these tests by aggregating all data to the postcode-sector[33] level (about 2500 households), calculating the distance from the LEA boundary to the postcode sector centroid[34] and regressing each neighbourhood characteristic separately on neighbourhood-LEA boundary distance, both with and without controls.

The regression coefficients and standard errors from this analysis are in column (1) and (2) of Table 4. The neighbourhood attributes considered are: the

[33] Full UK postcodes are typically of the form AB# #CD, where # is numeric. Deleting the last two characters generates a *postcode sector* code. At this level we can calculate means and standard deviations of the characteristics recorded in our pupil and school data at the full postcode level (10 or so households), and in the UK Census at the Census Output Area level (around 50-100 households).

[34] The reasons for this aggregation are: (a) we are interested in potential within-neighbourhood heterogeneity in pupil characteristics and housing prices as well as differences in means; and (b) the neighbourhood controls in our regressions are at this geographical level. See footnote 24 above.

dispersion of school achievement of peers in the neighbourhood (standard deviation of KS1 grades);[35] the number of private schools; the average and standard deviation of log house prices; the fractions of adult individuals working and economically active in the neighbourhood; the fractions of adults retired from work and sick or disabled in the neighbourhood; and a measure for the homogeneity of educational attainment of adults in the neighbourhood (a Herfindhal index). Descriptive statistics are reported in column (3), and the number of available observations is reported in column (4) of Table 4; the latter varies between 1133 and 1181 due to some missing values. Whether or not we include the full set of controls in the regression, we find neither significant nor sizable relationships between any these measures and the distance between residential neighbourhood and the LEA boundary.[36]

In Table 5 we repeat this analysis, this time aggregating our data to school level and regressing school level characteristics on school-LEA boundary distance. The aim here is to test the validity of the instrument for our competition index, which varies only across schools, by checking whether the characteristics of

---

[35] We do not report tests that relate age-7 (KS1) pupil achievement to LEA boundary distances, because these are used to construct our value-added measures. Nevertheless, we found no significant evidence that early-age grades are related to school or home distances from school district boundaries.

[36] In line with the analysis so far, we cluster standard errors at the LEA level to take care of potential spatial correlation of observations across different postcode sector within localised areas (LEAs). However, one should also note that the outcomes in each equation are potentially correlated with each other within postcode sectors, suggesting that a Seemingly Unrelated Regressions setup might improve efficiency. In fact, as the set of controls is identical in each equation, SURE does not provide any more information than OLS, even though the SURE and OLS estimates are marginally different because of differing sample sizes in each regression. In any case, we have tried a SURE approach and this led to almost identical conclusions.

schools located close to district boundaries differ systematically from those further away. We consider a number of school characteristics. First, we compute a measure of the dispersion of achievement of peers based on age-7 grades of pupils in the cohort under analysis (standard deviation of KS1 grades within school), averaged over the two years in our sample. Then, using age-7 grades of pupils in the two cohorts immediately adjacent to those in our sample (i.e. pupils aged 7 in 1999/2000 and 2000/2001), we compute school averages of KS1 grades and dispersion of early-stage attainment within school (the standard deviation of KS1 grades); we again average these over the two years.[37] Next, using Annual School Census information, we construct two measures of the ratio of support staff to qualified teachers for the schools across all different stages (i.e. overall, from age 5 to age 11). Finally, we measure distances from schools to main roads and the number of schools within 1km (including those across LEA boundaries). These school-level regression results, with and without controls, are reported in columns (1) and (2) in Table 5. Descriptive statistics and the number of observations for these variables are reported in columns (3) and (4). Once more, we find no evidence for a significant association between these variables and our instrument.[38]

---

[37] Unfortunately, we do not have access to the information required to compute these two indices for cohorts younger than those in our sample.

[38] We have tested explicitly whether students' characteristics are correlated with the boundary-to-school distance of the school that they attend. To do so, we regressed pupil characteristics on the log of the school-to-boundary distance in the pupil-level dataset, both with and without residential postcode fixed effects. In no case could we find any significant association between pupil characteristics and the school-to-boundary distance. This evidence rules out family decisions about direction of travel to school (towards or away from the LEA boundary) as a potential unobserved source of correlation between our instrument and pupil achievement.

Everything here indicates that both choice and competition in Primary schooling increase exogenously as pupils and schools move away from LEA boundaries. In support of the assumption discussed above, we find that our distance measures do not simply capture features of schools next to LEA boundaries, nor do they reflect other neighbourhood characteristics which may have a direct influence on school or pupil performance. However, results in Table 2 show *no* systematic impact of choice and competition on pupil performance. The natural interpretation of this is that the positive, but small, association between pupil performance and competition indices seen in the ordinary least squares estimates is attributable to endogenous pupil sorting.

6.4. Heterogeneous effects: majority vs. non-majority controlled 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. As we discussed in Section 3, there are important institutional differences between state-funded Primary schools in England, particularly in terms of governance and admissions procedures. These distinctions may be important when considering how different school types react to school competition incentives. At one extreme, "majority controlled" Voluntary Aided schools are likely to be highly responsive to competition. The foundation or charitable institution that owns the school premises has majority representation on the Governing body and so has a strong influence over the running of the school. Because Voluntary Aided schools are also directly responsible for their own pupil admissions, and since funding is linked to pupil numbers, strategies promoting excellence, monitoring performance and rewarding outstanding teaching will be promoted as a means to attract pupils. In other school types, governance is shared more equally between LEA representatives, teaching staff and parents, and the school foundation; as a result, less emphasis will be placed on targets and

innovative teaching methods, and more on balancing a range of different objectives. Furthermore, admissions to "non-majority controlled" schools are more tightly controlled by the Local Education Authority (either directly or via the Governing Body), which may have an incentive to reallocate some pupils whose preferred schools are over-subscribed to schools that are under-subscribed. These institutional arrangements clearly have the potential to weaken the link between parental choice, school competition and pupil achievement.

Given these considerations, we now separately examine pupils in "majority controlled" schools and pupils in "non-majority controlled" schools (Community, Voluntary Controlled and Foundations), and study whether choice and competition have different effects for these two subgroups. Results are reported in Table 6. Columns (1) and (3) present OLS results for majority and non-majority controlled institutions respectively. For both school types, we still find that choice is not significantly associated with pupil achievement. More interestingly, we find that competition is positively related to performance in "majority controlled" schools, but that this is not the case for schools where governance is more under LEA control. While this suggests that competition may improve average achievement for pupils in schools that, we have argued, are likely to be more responsive to incentives, it may also be driven by the endogeneity of the choice and competition indices to pupil and school performance.

To address this issue, we reproduce our IV strategy for these two groups; results are presented in column (2) and (4) of Table 6. First stage statistics reported at the bottom of the table show that our instruments based on school and residence distance to LEA boundaries are still effective for the two groups separately. Yet the IV coefficients for the effect of school competition on pupil achievement have opposite signs for majority and non-majority controlled institutions. For the latter we find a small, negative and marginally significant association between

competition and achievement. One additional competitor (about one standard deviation of our competition index) is associated with 0.893 point lower value-added, accounting for about 10% of its standard-deviation. However, we find a sizeable and positive impact of school competition on pupil achievement for majority-controlled schools. While this is only significant at the 10% level, the effect is quite large: the competition threat associated with one extra school available to pupils increases the value-added by 1.6 points, accounting for more than 20% of its standard deviation. A test for the IV coefficients on the choice and competition indices being simultaneously equal across the two sub-groups does not provide strong support for the null, with a *p*-value of 0.0503; more interestingly, when we test only whether the IV estimates of the effect of school competition are the same for the two groups, we strongly reject this hypothesis with a *p*-value of 0.0195.

Overall, these findings support the existence of a beneficial effect of competition on pupil achievement in a setting in which schools combine more responsive governance (mainly via institutional arrangements) with greater autonomy in admission procedures. It should be emphasized that these schools are a relatively important group in the state Primary education system, enrolling more than 20% of the pupils. However, a more conservative interpretation should take into account the possibility that competition may come at the cost of lower pupil attainment in schools that do not benefit from independence and flexibility in their management, potentially increasing school segregation along the lines of pupil attainment. This divergence in results between "majority controlled" and "non-majority controlled" schools suggests that school competition might not be "a rising tide that lifts all boats" (Hoxby, 2003).

7. Concluding Remarks

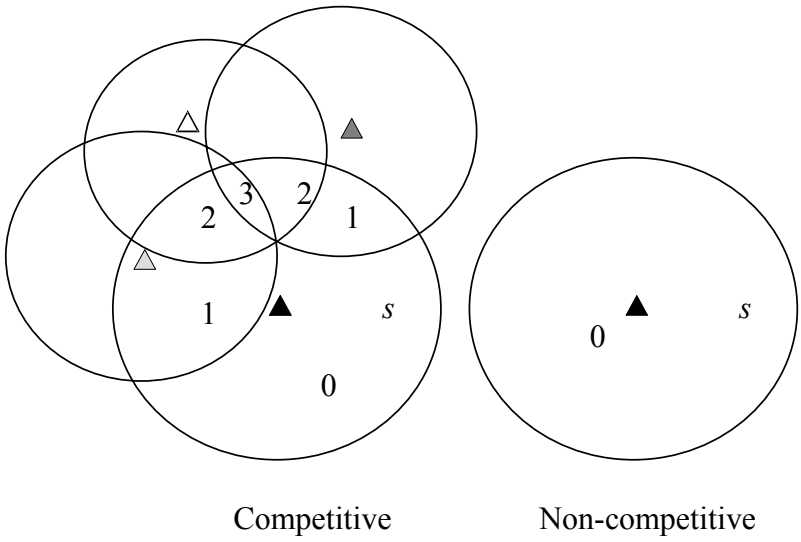
In this paper we have attempted to identify the causal links between choice and competition and the academic achievement of Primary school pupils. To do so we have carefully constructed measures of the Primary school choices available to pupils based on the equilibrium accessibility of schools to their 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 then using an instrumental variables approach based on a boundary discontinuity affecting school attendance.

Simple least squares results show a small positive association between school competition and achievement: 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 achievement; pupil sorting, endogenous travel patterns, and school location provide more plausible explanations for these findings. Once endogeneity issues are controlled for, pupil achievement is generally unrelated to the competitive pressures a school faces. It is only in "majority controlled" schools, which have more freedom in governance and admission practices, that competition appears to be positively linked to performance. This is likely to be attributable to their potentially more responsive institutional arrangements and to factors like proactive governance and religious fervour. However, there is weaker evidence that school competition might be detrimental to pupil learning in schools in which governance is shared more equally among stakeholders and the Local Educational Authority retains more control over school management, teacher recruitment, and admissions.

These findings matter for the often heated debate about whether choice and competition improve pupil performance. There is some comfort here for advocates

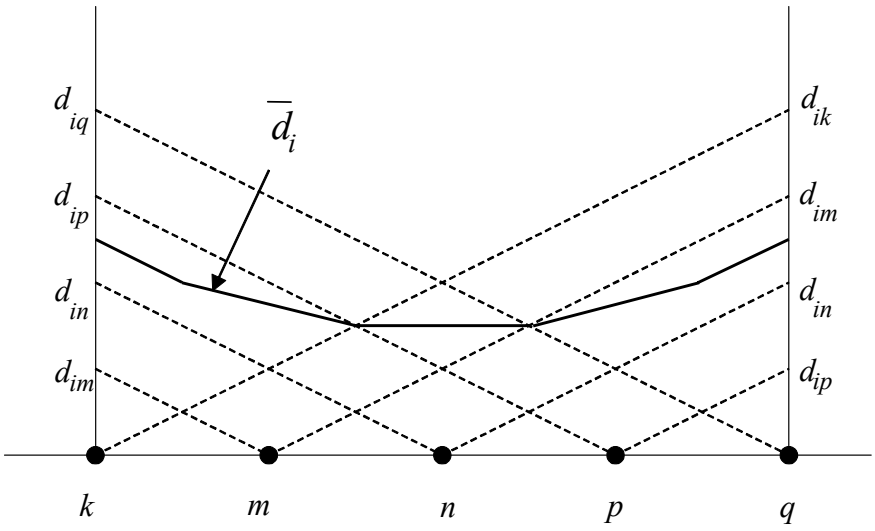
of choice and competition as pathways to higher educational standards: our evidence suggests that competition may improve school performance for some of the one-in-five students who attend Voluntary Aided schools. However, our results cast some doubt on the general effectiveness of choice and competition in the school context: they imply that such pressures only operate in a specific subset of the Primary school market and possibly at the cost of polarisation of schools along the dimension of pupil achievement. 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. Incorporating these factors into future work (both theoretical and applied) would seem to be a useful direction in which to go.

Figure 1: Schematic presentation of the choice and competition measures



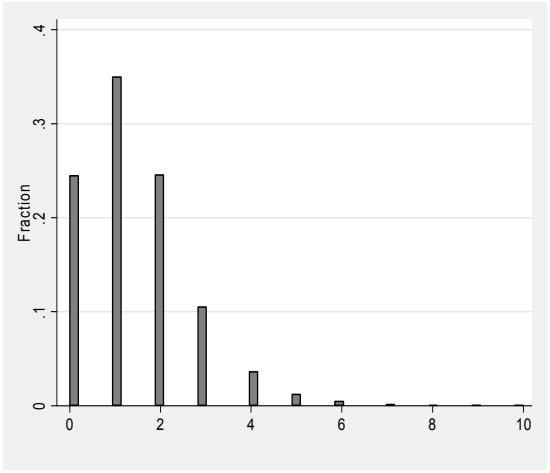
Note: Numbers 0,1,2,3 indicate the choice index that would be assigned to pupils living in each area (assuming they attend school *s*)

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

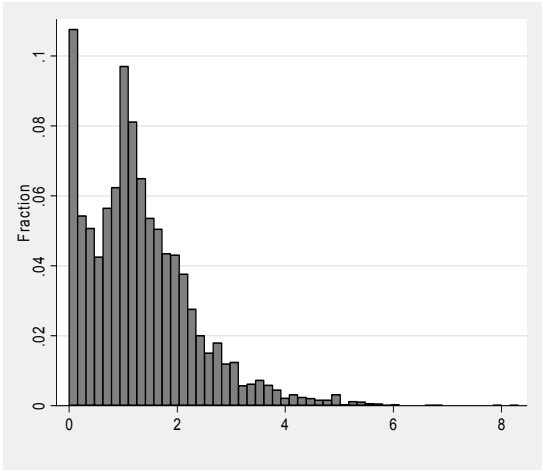


Note: Figure shows a linear district with 5 schools, *k*, *m*, *n*, *p*, *q*; d_{ij} is the distance to each school; $\overline{d}_i$ is the average distance to schools *other than* the nearest.

Figure 3: Distributions of the choice and competition indices

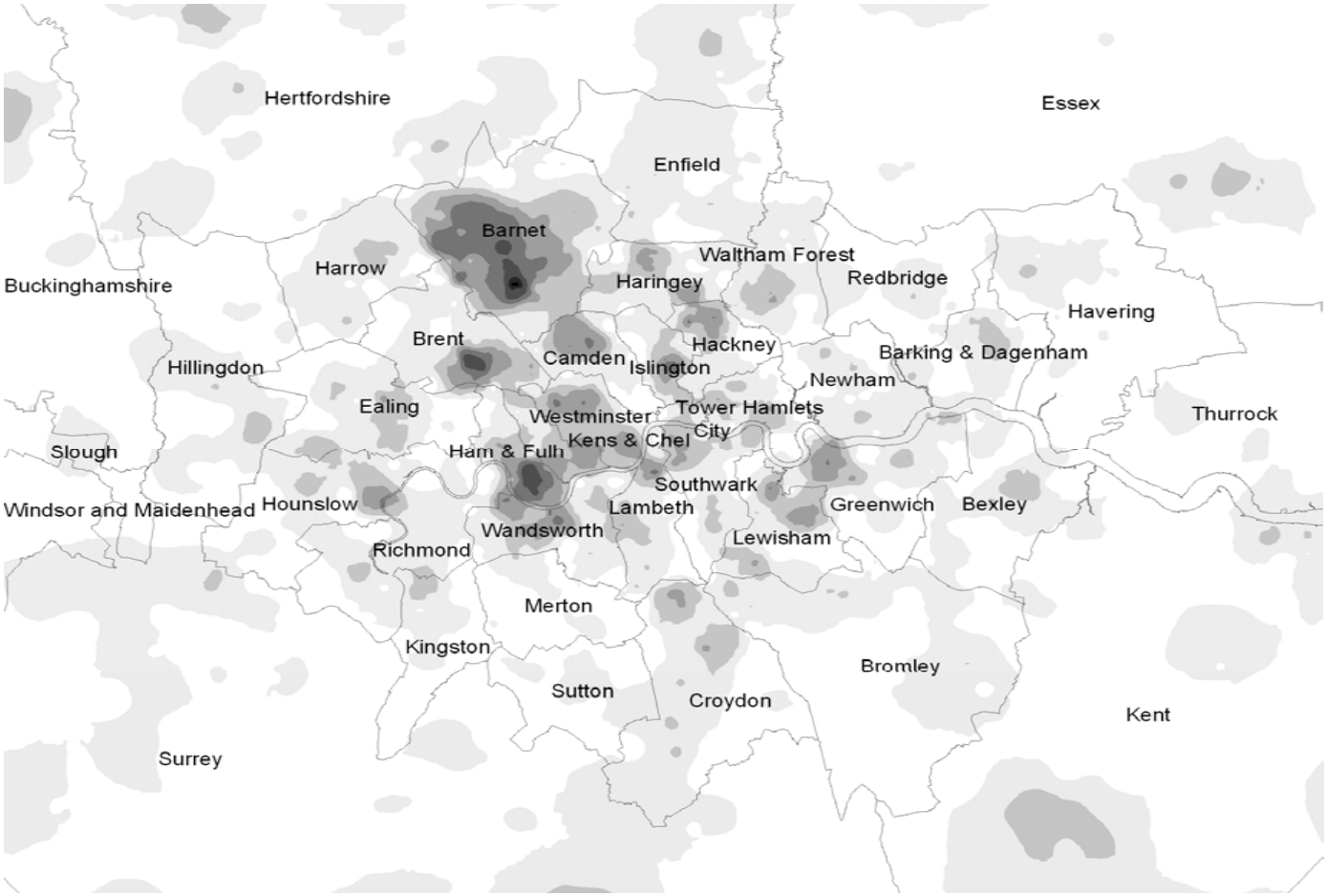


Pupil choice index: Number of schools accessible from pupil's home



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

Figure 4: Primary school competition in the Greater London Area



Note: 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.

Table 1: Choice, competition and pupil achievement: summary statistics

Variable	Observations	Mean	Std. Dev.	Min, Max
Number of schools accessible to pupil	201034	1.40	1.21	0, 10
Number of schools accessible to pupils enrolled in majority controlled schools	42993	1.58	1.29	0, 10
Number of schools accessible to pupils enrolled in non-majority controlled schools	144002	1.35	1.18	0, 10
Average number of schools accessible to pupils in school	201034	1.31	0.99	0, 8.31
Average number of schools accessible to pupils enrolled in majority controlled schools	42993	1.57	1.03	0, 6.73
Average number of schools accessible to pupils enrolled in non-majority controlled schools	144002	1.24	0.97	0, 8.31
Median travel distance all schools	201034	743.71	455.37	102, 6157
Median travel distance, majority controlled schools	42993	1096.59	616.78	146, 6157
Median travel distance, non-majority controlled schools	144002	647.16	341.49	102, 4303
Number of pupils in the travel area	201034	79.81	71.83	2, 1015
Pupil density (Number of pupils per hectare)	201034	0.64	0.37	0.01, 2.56
KS2-1 Value Added	201034	38.61	8.17	-4, 90
KS2-1 Value Added, majority controlled schools	42993	39.14	7.67	2, 84
KS2-1 Value Added, non-majority controlled schools	144002	38.46	8.30	-4, 90

Note: Majority controlled schools are Voluntary Aided schools where the school foundation has at least fifty percent of the votes in the school Governing Body; non-majority controlled schools are Community, Voluntary Controlled and Foundation schools where no single stakeholder has a majority share in the governing body.

Table 2: Primary school choice, competition and pupil achievement; Key Stage 2, 2001/2-2002/3

	Total value-added points			
	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
Choice index entered separately				
Number of schools accessible to pupil's home	0.103	0.098	-0.244	-0.305
	(0.038)**	(0.036)**	(0.195)	(0.196)
	[0.060]	*[0.035]*	*[0.257]*	*[0.266]*
Competition index entered separately				
Average number of schools accessible to pupils in the school	0.195	0.172	-0.386	-0.488
	(0.066)**	(0.070)*	(0.325)	(0.341)
	[0.087]	*[0.066]*	*[0.390]*	*[0.417]*
Choice and competition together				
Number of schools accessible to pupil's home	0.011	0.036	-0.036	-0.065
	(0.025)	(0.024)	(0.168)	(0.176)
	[0.040]	*[0.032]*	*[0.172]*	*[0.187]*
Average number of schools accessible to pupils in the school	0.186	0.147	-0.361	-0.463
	(0.066)**	(0.070)*	(0.350)	(0.373)
	[0.083]	*[0.073]*	*[0.390]*	*[0.417]*
Controls	No	Yes	No	Yes
Number of schools	2412	2412	2412	2412
Observations	201034	201034	201034	201034

Note: Regressions at the pupil level. Standard errors clustered on schools in round parenthesis: *, significant at 5%; **, significant at 1%. Standard errors clustered at the LEA level in square brackets (there are 42 LEAs in the area under analysis). Controls include pupil median travel distance and number of pupils in travel area (Table 1), dummies for school type (Community, Foundation, and Voluntary Aided; Voluntary Controlled as excluded category) and variables listed in Appendix Table A2. Missing Postcode Sector Level and LEA Level variables recoded to zeros; dummies for missing Postcode Sector Level and LEA Level observations included in the specifications. Instruments in columns (3) and (4) are as follows. Top panel, *choice only*: log of distance between pupil home and LEA boundary, controlling for LEA average of log distance between pupil home and LEA boundary. Central panel, *competition only*: log of distance between school and LEA boundary, controlling for LEA average of log distance between school and LEA boundary. Bottom panel, *choice and competition*: log of distance between school and LEA boundary and pupil home and LEA boundary, controlling for LEA average of log distance between school and LEA boundary and LEA average of log distance between pupil home and LEA boundary.

Table 3: First stage results:
Primary school choice and competition, and distance to LEA boundaries

	Models without controls		*Models with controls*	
	(1) School level clustered S.E.	(2) LEA level clustered S.E.	(3) School level clustered S.E.	(4) LEA level clustered S.E.
Choice index entered separately				
Coeff. on log. of pupil residence-LEA boundary distance	0.253 (0.012)**	0.253 (0.036)**	0.249 (0.011)**	0.249 (0.034)**
F-Statistics	426.91	48.55	523.77	54.06
[p-value]	*[0.0000]*	*[0.0000]*	*[0.0000]*	*[0.0000]*
Partial R^2 on excluded instrument	0.0421	0.0421	0.0442	0.0442
Competition index entered separately				
Coeff on log. of school-LEA boundary distance	0.212 (0.022)**	0.212 (0.031)**	0.205 (0.020)**	0.205 (0.032)**
F-Statistics	95.27	46.42	101.20	41.96
[p-value]	*[0.0000]*	*[0.0000]*	*[0.0000]*	*[0.0000]*
Partial R^2 on excluded instrument	0.0411	0.0411	0.0437	0.0440
Competition and choice indices together				
Choice index first stage equation				
Coeff. on log. of pupil residence-LEA boundary distance *(Own)*	0.282 (0.011)**	0.282 (0.030)**	0.270 (0.009)**	0.270 (0.028)**
Coeff. on log. of school-LEA boundary distance *(Cross)*	-0.048 (0.015)**	-0.048 (0.015)**	-0.036 (0.014)*	-0.036 (0.015)*
F-Statistics	350.99	83.53	407.21	72.63
[p-value]	*[0.0000]*	*[0.0000]*	*[0.0000]*	*[0.0000]*
Partial R^2 on excluded instruments	0.0436	0.0436	0.0448	0.0448
Competition index first stage equation				
Coeff. on log. of school-LEA boundary distance *(Own)*	0.198 (0.024)**	0.198 (0.029)**	0.191 (0.022)**	0.191 (0.032)**
Coeff. on log. of pupil residence-LEA boundary distance *(Cross)*	0.023 (0.013)*	0.023 (0.013)	0.021 (0.011)*	0.021 (0.011)
F-Statistics	55.01	23.19	57.47	*21.55*
[p-value]	*[0.0000]*	*[0.0000]*	*[0.0000]*	*[0.0001]*
Partial R^2 on excluded instruments	0.0420	0.0420	0.0439	0.0441

Note: Regressions at the pupil level. Standard errors clustered on schools in round parenthesis in columns (1) and (3); standard errors clustered at the LEA level in round parenthesis in columns (2) and (4). *, significant at 5%; **, significant at 1%. Controls include pupil median travel distance and number of pupils in travel area (Table 1), dummies for school type (Community, Foundation, and Voluntary Aided; Voluntary Controlled as excluded category) and variables listed in Appendix Table A2. Missing Postcode Sector Level and LEA Level variables recoded to zeros; dummies for missing Postcode Sector Level and LEA Level observations included in the specifications. Top panel (*choice only*) also controls for LEA average of log distance between pupil home and LEA boundary. Central panel (*competition only*) also controls for LEA average of log distance between school and LEA boundary. Bottom panel (*choice and competition*) also controls for LEA average of log distance between school and LEA boundary and LEA average of log distance between pupil home and LEA boundary. Number of observations: 201034; number of schools 2412.

Table 4: Pupil home-LEA boundary distance and neighbourhood characteristics

	(1)	(2)	(3)	(4)
Variable List:	Reg.Coefficients, No Controls	Reg.Coefficients, With Controls	Mean (Std.Dev)	N. Obs.
Std.Dev of KS1 grades, within postcode sector	-0.076	-0.099	10.464	1133
	(0.103)	(0.109)	(1.933)	
Number of independent (Private) schools, within postcode sector	0.077	0.045	0.451	1181
	(0.045)	(0.038)	(0.912)	
Average house prices, within postcode sector	-0.002	-0.016	0.202	1152
	(0.027)	(0.013)	(0.357)	
Std.Dev. house prices, within postcode sector	0.011	0.006	0.387	1152
	(0.008)	(0.005)	(0.105)	
Fraction of individuals economically active, within postcode sector	0.001	-0.003	0.686	1144
	(0.003)	(0.003)	(0.686)	
Fraction of individuals working full time, within postcode sector	-0.000	-0.002	0.428	1144
	(0.004)	(0.004)	(0.060)	
Fraction of individuals retired from work, within postcode sector	0.001	0.000	0.111	1140
	(0.002)	(0.001)	(0.035)	
Fraction of sick and disabled individuals, within postcode sector	-0.002	0.000	0.041	1140
	(0.002)	(0.001)	(0.021)	
Educational homogeneity (Herfindhal index), within postcode sector	-0.001	0.000	0.234	1144
	(0.002)	(0.002)	(0.051)	

Note: Regression coefficients obtained from separate regressions of listed variable on log of distance between pupil home and LEA boundary; regressions at the postcode sector level. Standard errors clustered on LEA in round parenthesis; no regression coefficients significant at conventional levels. Controls in column (1) only include year dummies and LEA average of log distance between pupil home and LEA boundary; column (2) additionally includes the usual controls detailed above (see note to Table 2). All controls averaged at the postcode level. Herfindahl Index is constructed over the following 6 categories: missing qualification; no qualification, Level-1 qualifications; Level-2 qualifications; Level-3 qualifications; Level -4 or -5 qualifications.

Table 5: School-LEA boundary distance and school characteristics

	(1)	(2)	(3)	(4)
Variable List:	Reg.Coefficients, No Controls	Reg.Coefficients, With Controls	Mean (Std.Dev)	N. Obs.
Std.Dev. of KS1 grades, within school, sample cohorts	-0.011 (0.034)	0.048 (0.030)	10.346 (1.565)	2412
Average KS1 grades, within school, younger two cohorts	0.105 (0.095)	-0.010 (0.066)	45.162 (4.358)	1946
Std.Dev. of KS1 grades, within school, younger two cohorts	-0.007 (0.040)	0.032 (0.035)	10.560 (1.728)	1946
SEN support teacher to total pupil ratio	0.011 (0.012)	0.011 (0.012)	0.589 (0.602)	2412
Ethnic minorities support teacher to total pupil ratio	-0.001 (0.003)	-0.001 (0.002)	0.059 (0.158)	2412
Log distance to main roads	0.023 (0.025)	0.004 (0.026)	6.596 (1.161)	2412
Number of other schools within 1km, controlling for LEA school density	0.038 (0.044)	0.019 (0.034)	3.389 (3.144)	2412

Note: Regression coefficients obtained from separate regressions of listed variable on log of distance between school and LEA boundary; regressions at the school level. Robust standard errors (equivalent to standard errors clustered on school) in round parenthesis; no regression coefficients significant at conventional levels. Sample cohorts: pupils aged 7 in 1997/1998 and 1998/1999; younger two cohorts: pupils aged 7 in 1999/2000 and 2000/2001. SEN means Special Educational Needs. Controls in column (1) only include year dummies and LEA average of log distance between school and LEA boundary; column (2) additionally includes the usual controls detailed above (see note to Table 2). All controls averaged at the school level.

Table 6: Primary school choice, competition and pupil achievement; Key Stage 2, 2001/2-2002/3: pupils in majority controlled and non-majority controlled schools separately

	Majority controlled schools		*Non-majority controlled schools*	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
Number of schools accessible to pupil's home	0.027	0.045	0.038	-0.029
	(0.040)	(0.250)	(0.030)	(0.220)
	[0.044]	*[0.247]*	*[0.041]*	*[0.209]*
Average number of schools accessible to pupils in the school	0.378	1.625	0.094	-0.893
	(0.120)**	(0.968)	(0.085)	(0.474)
	[0.141]	*[1.073]*	*[0.082]*	*[0.601]*
F-Statistics *[p-value]*				
Choice equation	--	136.28 *[0.0000]*	--	280.70 *[0.0000]*
Competition equation	--	6.06 *[0.0023]*	--	39.57 *[0.0000]*
Partial-R^2				
Choice equation	--	0.0394	--	0.0441
Competition equation	--	0.0185	--	0.0386
Controls	Yes	Yes	Yes	Yes
Number of schools	641	641	1771	1771
Observations	43189	43189	157845	157845

Note: Regressions at the pupil level. Standard errors clustered on school in round parenthesis: *, significant at 5%; **, significant at 1%. Standard errors clustered at the LEA level in square brackets (there are 42 LEAs in the area under analysis). First stage statistics for models with standard errors clustered at the school level. Controls include pupil median travel distance and number of pupils in travel area (Table 1) and variables listed in Appendix Table A2. Columns (3) and (4) also include dummies for school type (Community and Foundation; Voluntary Controlled as excluded category). Missing Postcode Sector Level and LEA Level variables recoded to zeros; dummies for missing Postcode Sector Level and LEA Level observations included in the specifications. Instruments in columns (2) and (4) are log of distance between school and LEA boundary and between pupil home and LEA boundary, controlling for LEA average of log distance between school and LEA boundary and LEA average of log distance between pupil home and LEA boundary. Majority controlled schools include Voluntary Aided schools; non-majority controlled schools include Community, Voluntary Controlled and Foundation schools.

Appendix: Additional Tables

Table A1: Primary school categories in England

Type	Faith	Governors	Admissions authority	Assets owned by	Employer
Non- Majority Controlled Schools					
Community	Secular	Parents >30% LEA 20% Staff <30% Community 20%	LEA	LEA	LEA
Voluntary Controlled	Mostly C. of E., some other faith, some secular	Foundation <25% Parents >30% LEA <20% Staff <30% Community 10%	LEA	LEA	LEA
Foundation	Mostly secular, some C. of E.,	Foundation <25% Parents >30% LEA <20% Staff <30% Community 10%	Governors	Church or charity	Governors
Majority Controlled Schools					
Voluntary Aided	Mostly C. of E. or Catholic, some secular	Foundation >50% Parents >30% LEA <10% Staff (<30%)	Governors	Church or charity	Governors

Note: C. of E. means Church of England. In our sample: 72% of pupils are in Community schools (1613 schools); 3% of pupils are in Voluntary Controlled schools (86 schools); 4% of pupils are in Foundation schools (72 schools) and 21% of pupils are in Voluntary Aided schools (641 schools). Total number of pupils: 201034. Total number of schools: 2412.

Table A2: 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 Educational Needs (SEN)	201034	0.245	0.430	0, 1
Free School Meal Eligible (FSME) pupil	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 eligible for FSM	201034	0.198	0.158	0, 0.771
Postcode sector level variables				
Fraction of lone parents	199693	0.260	0.116	0.035, 0.606
Fraction of unemployed	199693	0.037	0.018	0.007, 0.097
Fraction with no school qualifications	199693	0.259	0.076	0.037, 0.535
Fraction with Black ethnicity	199693	0.077	0.094	0, 0.536
Fraction with Asian ethnicities	199693	0.116	0.134	0.001, 0.795
Fraction of individuals aged 16 or below	199693	0.222	0.032	0.018, 0.431
LEA Level Controls				
Total LEA expenditure in 2000 (in £1000)	201034	2170.823	1691.547	493, 5983
LEA area (in 1,000,000 square metres)	201034	680.349	1076.473	12, 3451
LEA deprivation score in 2000	198770	24.140	13.569	7.5, 61.34

Note: Pupil level information obtained form Pupil Level Annual School Census (PLASC), academic years 2001/2002 and 2002/2003. School level information obtained from Annual School Census (ASC), academic years 2001/2002 and 2002/2003; this refers to all pupils within a Primary school at various grades (from age 5 to age 11). Postcode sector level obtained from the Great Britain Census 2001. LEA level control information provided by the Department for Education and Skills (DfES).

Table A3: Primary school choice, competition and pupil achievement;
Key Stage 2, 2001/2-2002/3: percentiles of English and Mathematics test scores

	KS2 English percentiles				*KS2 Maths percentiles*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	IV	IV	OLS	OLS	IV	IV
Competition and choice together								
Number of schools accessible to pupil's home	0.081	0.115	0.080	-0.086	-0.038	0.024	0.156	0.136
	(0.069)	(0.057)*	(0.435)	(0.380)	(0.071)	(0.060)	(0.414)	(0.402)
Average number of schools accessible to pupils in the school	0.568	0.360	-0.505	-0.753	0.691	0.538	-0.570	-1.067
	(0.166)**	(0.154)*	(0.857)	(0.787)	(0.171)**	(0.168)**	(0.811)	(0.851)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KS1 controls	No	Writing Reading	No	Writing Reading	No	Maths	No	Maths
Number of schools	2412	2412	2412	2412	2412	2412	2412	2412
Observations	196706	196706	196706	197829	197829	197829	201034	201034

Note: Regressions at the pupil level. Standard errors clustered on school in round parenthesis: *, significant at 5%; **, significant at 1%. Controls include pupil median travel distance and number of pupils in travel area (Table 1), dummies for school type (Community, Foundation, and Voluntary Aided; Voluntary Controlled as excluded category) and variables listed in Appendix Table A2. Missing Postcode Sector Level and LEA Level variables recoded to zeros; dummies for missing Postcode Sector Level and LEA Level observations included in the specifications. Instruments in columns (3), (4), (7) and (8) are log of distance between school and LEA boundary and between pupil home and LEA boundary, controlling for LEA average of log distance between school and LEA boundary and LEA average of log distance between pupil home and LEA boundary.

Table A4: Primary school choice, competition and pupil achievement; Key Stage 2, 2001/2-2002/3: instrumental variable regression, robustness checks

	Total value-added points			
	(1)	(2)	(3)	(4)
	Without no-LEA Crossing restriction	Without no-LEA crossing restriction	Control for home to school distance	Control for home to school distance
Number of schools accessible to pupil	-0.090	-0.182	-0.040	-0.064
	(0.457)	(0.518)	(0.168)	(0.177)
Average number of schools accessible to pupils in school	-0.858	-1.016	-0.361	-0.464
	(0.887)	(0.950)	(0.350)	(0.373)
First Stage Statistics				
F-Statistics *[p-values]*				
Choice equation	41.75	44.19	355.17	408.74
	[0.0000]	*[0.0000]*	*[0.0000]*	*[0.0000]*
Competition equation	8.83	10.11	54.90	57.43
	[0.0002]	*[0.0000]*	*[0.0000]*	*[0.0000]*
Partial-R^2				
Choice equation	*0.0061*	*0.0064*	*0.0433*	*0.0449*
Competition equation	*0.0067*	*0.0077*	*0.0420*	*0.0440*
Controls	No	Yes	No	Yes
Number of schools	2412	2412	2412	2412
Observations	201034	201034	201034	201034

Note: Regressions at the pupil level. Standard errors clustered on school in round parenthesis: *, significant at 5%; **, significant at 1%. First stage statistics for models with standard errors clustered at the school level. Controls include pupil median travel distance and number of pupils in travel area (Table 1), dummies for school type (Community, Foundation, and Voluntary Aided; Voluntary Controlled as excluded category) and variables listed in Appendix Table A2. Missing Postcode Sector Level and LEA Level variables recoded to zeros; dummies for missing Postcode Sector Level and LEA Level observations included in the specifications. Instruments are log of distance between school and LEA boundary and pupil home and LEA boundary, controlling for LEA average of log distance between school and LEA boundary and LEA average of log distance between pupil home and LEA boundary. Choice index, without no-LEA crossing restriction, descriptive statistics (Columns (1) and (2)): mean=1.566; std.dev.=1.299. Competition index, without no-LEA crossing restriction, descriptive statistics (Columns (1) and (2)): mean=1.475; std.dev.= 1.084. Home to school distance, descriptive statistics ((Columns (3) and (4)): mean=1210.80; std.dev=1688.43.

References

Barnet (2005). "A Guide to Primary Education in Barnet". London Borough of Barnet.

Bayer, Patrick, and Robert McMillan (2005). "Choice and Competition in Local School Markets." NBER Working Paper 11802.

Belfield, Clive, and Henry Levin (2003). "The Effects of Competition between Schools on Educational Outcomes: A review for the United States." *Review of Educational Research*, 72(2), 279-341.

Black, Sandra (1999). "Do Better Schools Matter? Parental Valuation of Elementary Education." *Quarterly Journal of Economics*, 114, 578-599.

Bradley, Steve, Robert Crouchley, Jim Millington and Jim Taylor (2000). "Testing for Quasi-Market Forces in Secondary Education." *Oxford Bulletin of Economics and Statistics,* 62(3), 357-90.

Bradley, Steve, Geraint Johnes and Jim Millington (2001). "School choice, competition and the efficiency of secondary schools in England." *European Journal of Operational Research*, 135, 545-568.

Brighouse, Harry (2000). *School Choice and Social Justice.* Oxford University Press. Oxford.

Burgess, Simon, Brendon McConnell, Carol Propper and Deborah Wilson (2004). "Sorting and Choice in English Secondary Schools." Centre for Market and Public Organisation Working Paper, 04/111.

Cheshire, Paul, and Stephen Sheppard (2004). "Capitalising the Value of Free Schools: the Impact of Supply Constraints and Uncertainty." *Economic Journal*, 114(499), F397–424.

Clark, Damon (2005). "Politics, Markets and Schools: Quasi-Experimental Evidence on the Impact of Autonomy and Competition from a Truly Revolutionary UK Reform." Mimeo, University of California, Berkeley, US.

Conservative Party (2005). "Educational Manifesto."

Cullen, Julie B., Brian Jacob and Stephen D. Levitt (2003). "The Effect of School Choice On Student Outcomes: Evidence From Randomized Lotteries." NBER Working Paper, 10113.

Cullen, Julie B., Brian Jacob and Stephen D, Levitt (2005). "The Impact of School Choice on Student Outcomes: An Analysis of the Chicago Public Schools." *Journal of Public Economics*, 89(5-6), 729-60.

Dearden, Lorraine, Leslie McGranahan and Barbara Sianesi (2004). "The Role of Credit Constraints in Educational Choices: Evidence from NCDS and BCS70." Centre for the Economics of Education Discussion Paper 48, London School of Economics.

Enfield (2005). "Primary School Admissions 2005." Enfield School Admission Service.

Epple, Dennis, and Richard Romano (1998). "Competition between Public and Private Schools: Vouchers and Peer Effects." *American Economic Review*, 88, 33-62.

Epple, Dennis, Elizabeth Newlon and Richard Romano (2002). "Ability Tracking, School Competition, and the Distribution of Economic Benefits." *Journal of Public Economics*, 83, 1-48.

Friedman, Milton (1962). *Capitalism and Freedom.* University of Chicago Press. Chicago.

Gibbons, Stephen, and Stephen Machin (2003). "Valuing English Primary Schools." *Journal of Urban Economics*, 53, 197-219.

Gibbons, Stephen, and Stephen Machin (2006). "Paying for Primary Schools: Admissions Constraints, School Popularity or Congestion." *Economic Journal,* 116, C77-C92.

Gibbons, Stephen, and Shqiponja Telhaj (2007a). "Mobility and School Disruption." Centre for the Economics of Education Discussion Paper, London School of Economics, forthcoming.

Gibbons, Stephen, and Shqiponja Telhaj (2007b). "Are Schools Drifting Apart: Ability Stratification in English secondary Schools." *Urban Studies*, forthcoming.

Glennerster, Howard (1991). "Quasi-Markets for Education." *Economic Journal*, 101, 1268-76.

Goldstein, Harvey, and Philip Noden (2003). "Modelling social segregation." *Oxford Review of Education*, 29(2), 225-237.

Gorard, Stephen, Chris Taylor and John Fitz (2003). *Schools, Markets and Choice Policies.* RoutledgeFarmer. London.

Hanushek, Eric A. (2003). "The Failure of Input-based School Policies." *Economic Journal*, 113, F64-98.

Hanushek, Eric A., John F. Kain and Steve G. Rivkin (2004). "Disruption versus Tiebout improvement: the costs and benefits of switching schools." *Journal of Public Economics*, 88, 1721-1746

Heckman, Jim (2000). "Policies to Foster Human Capital." *Research in Economics*, 54, 3-56.

Holmes, George M., Jeff DeSimone and Nicholas G. Rupp (2003). "Does School Choice Increase School Quality?" NBER Working Paper, 9683.

Hoxby, Caroline (1994). "Do Private Schools Provide Competition for Public Schools?" NBER Working Paper, 4978.

Hoxby, Caroline (2000). "Does Competition Among Public Schools Benefit Students and Taxpayers?" *American Economic Review*, 90(5), 1209-38.

Hoxby, Caroline (2003). "School Choice and School Productivity (Or, Could School Choice be a Rising Tide that Lifts All Boats?)" In Caroline Hoxby, ed.: *The Economics of School Choice*. University of Chicago Press. Chicago.

Hoxby, Caroline (2004). "School Choice and School Competition: Evidence from the United States." *Swedish Economic Policy Review*, 10(2).

Hoxby, C. (2006). "Competition Among Public Schools: A reply to Rothstein (2004)." NBER Working Paper, 11216.

Hoxby, Caroline, and Jonah Rockoff (2004). "The Impact of Charter Schools on Student Achievement." HIER Working Paper.

Lavy, Victor (2005). "From Forced Bussing to Free Choice in Public Schools: Individual and General Equilibrium Effects." Mimeo, Hebrew University, Israel.

Le Grand, Julian (1991). *Equity and choice.* Harper Collins. London.

Le Grand, Julian. (1993). *Quasi-markets and social policy*. Macmillan. London.

Labour Party (2005a). "Labour Party Election Manifesto."

Labour Party (2005b). "Schools forward not backward." Labour Party Policy Document.

Levacic, Rosalind (2004). "Competition and the Performance of English Secondary Schools: Further Evidence." *Education Economics*, 12(2), 177-93.

Machin, Stephen, and Anna Vignoles (2005). *What's the Good of Education?* Princeton University Press. Princeton.

McMillan, Robert (2000). "Competition, Parental Involvement and Public School Performance." *National Tax Association Proceedings*, 150-55.

McMillan, Robert (2004). "Competition, Incentives and Public School Productivity." *Journal of Public Economics*, 88, 1871-1892.

Mizala, Alejandra, and Pilar Romaguera (2000). "School Performance and Choice: The Chilean Experience." *Journal of Human Resources*, 35, 392-417.

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

Nechyba, Thomas J. (2003). "School Finance, Spatial Income Segregation and the Nature of Communities." *Journal of Urban Economics*, 54, 61-88.

Nechyba, Thomas J. (2005). "Mobilizing the Private Sector: A Theoretical Overview." Paper presented at PEPG Conference "Mobilizing the Private Sector for Public Education". Harvard. October 2005.

Plank, David, and Gary Sykes, eds. (2003). "*Choosing Choice: School Choice in International Perspective*", Teachers College Press, Columbia University. New York.

Rothstein, Jesse (2006a). "Good Principals or Good Peers? Parental Valuation of School Characteristics, Tiebout Equilibrium, and the Incentive Effects of Competition among Jurisdictions." NBER Working Paper, 10666.

Rothstein, Jesse (2006b). "Does Competition Among Public Schools Benefit Students and Taxpayers? A Comment on Hoxby (2000)." NBER Working Paper, 11215.

Rouse, Cecilia (1998). "Private School Vouchers and Student Achievement: An Evaluation of the Milwaukee Parental Choice Program." *Quarterly Journal of Economics*, 113, 553-602.

Staiger, Douglas O., and James H. Stock (1997). "Instrumental Variable Regression with Weak Instruments." *Econometrica*, 65(3) 555-586.

Tiebout, Charles (1956). "A Pure Theory of Local Expenditures." *Journal of Political Economy*, 64(5), 416-424.

Todd, Petra E., and Kenneth I. Wolpin (2003). "On the Specification and Estimation of the Production Function for Cognitive Achievement." *Economic Journal*, 113(485), 3-33.