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The teacher labour market, teacher turnover and disadvantaged schools: new evidence for England

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Abstract

We use a newly-released dataset on school teachers in England to study teacher turnover. We show that there is a positive raw association between the level of school disadvantage and the turnover rate of its teachers. This association diminishes as we control for school, pupil and local teacher labour market characteristics, but is not eliminated. The remaining association is largely accounted for by teacher characteristics, with the poorer schools hiring much younger teachers on average. We interpret this market equilibrium allocation as either deriving from the preferences of young teachers, or as reflecting the low market attractiveness of disadvantaged schools.

Keywords: teacher labour market, teacher turnover, disadvantaged schools, educational inequality

JEL Codes: I20

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1. Introduction

It is now well established that teacher effectiveness is central to good pupil progress in school. Recent studies have shown quantitatively very significant effect sizes for being taught by effective as opposed to ineffective teachers[1]. Substantial improvements in educational standards are only likely to come from improvements in general teacher effectiveness, and reductions in educational inequality from different allocations of teachers to schools. Such a policy is hampered by a lack of understanding of the teacher labour market, in turn made difficult by lack of data. The recent release of a new administrative dataset on teachers by the UK Department for Education offers the promise of making progress, and this paper is a contribution to that programme.

The flip side of attracting teachers to disadvantaged schools is modelling the separation rate of teachers from those same schools. As quitting and accepting jobs are essentially different sides of the same decision, bar transaction costs, studying teacher quits will help understand the matching of teachers to schools. In this paper we analyse teacher turnover across schools. We compute the distribution of job tenure in each school, both the fraction of teachers who have been at the school for ten years or more, and the fraction only just hired. Specifically we address the view that teacher turnover is a particular problem for disadvantaged urban schools[2]. It is argued that greater turnover coupled with the lower effectiveness of novice teachers might explain part of the substantial test score difference between schools in deprived and more affluent neighbourhoods. There is also evidence that turnover *per se* can be harmful to student progress (Ronfeldt et al 2011).

We first describe the distribution of job tenure for teachers. We then establish the nature and magnitude of the differential turnover between schools. We show that there are systematic differences in turnover: schools with many poor pupils do have more short-tenure teachers and fewer experienced teachers. However, on average the differences are small: 18% (22%) of teachers in the least (most) disadvantaged schools have tenure of 0-2 years, while 20% (17%) have tenure of over 10 years. We also use the richness of the data to decompose the relationship between turnover and poverty. We show that part can be accounted for by pupil characteristics, perhaps because students in schools in more deprived areas are harder to teach. Part also is accounted for by differences in the local teacher labour market around each school[3].

The remaining association is largely accounted for by teacher characteristics, with the poorer schools hiring much younger teachers on average. We interpret this market equilibrium allocation as either deriving from the preferences of young teachers, or as reflecting the low market attractiveness of disadvantaged schools. Teachers are not randomly assigned to schools but are hired through a search and matching process. Consequently, the relationships we estimate cannot be given a causal interpretation, and we see the results here as providing the first detailed description of teacher turnover in England.

[1] See for example Rockoff (2004), and Slater et al (2012) for England ; Hanushek (2012) estimates
[2] See for example Dolton and Newson (2003) and Smithers and Robinson (2004)
[3] The fact that the data is a census of teachers means that we can model all the schools around a focus school, and so the local labour market conditions facing a teacher.

Research on teacher turnover in the UK has been hampered by the lack of data, and a consequently greater reliance on turnover intentions than might otherwise be desirable. The literature has also used different concepts in addition to the separation rate with a focus on the 'wastage' rate, i.e. the fraction of teachers leaving the profession entirely.

The available evidence suggests an association between higher turnover and schools serving disadvantaged students, although the evidence base is not extensive in England. Dolton and Newson (2003) find that 10% more students eligible for free-school meals (FSM) is associated with 1% higher teacher turnover. The teacher labour market is different in many ways between England and the US, not least that schools are the employer in England as opposed to school districts in the US. Nevertheless, given the paucity of UK evidence, a brief review of US evidence is useful. Boyd et al (2011) use NYC administrative data on the applications-to-transfer for the years 2006-07 and 2007-08 and finds that schools with higher proportions of Black, Hispanic, low-income and low-achieving students receive about 40% fewer applicants to them and about 40% more away from them. Similarly Ronfeldt et al (2011) find that schools with least turnover have more high-achieving and Asian students, fewer poor, Black and Hispanic students, and fewer student absences and suspensions. Hanushek, Kain and Rivkin (2004) find that almost 20% of teachers in the bottom quartile of schools, ranked by student achievement, leave each year as opposed to 15% in the top quartile schools. Boyd et al (2008) show that among first-year teachers, the less effective (based on a value-added estimate) are more likely to leave, though this correlation disappears in the subsequent few years. Loeb et al (2011) study the hiring, deployment and retention of effective teachers and find that effective schools are better able to retain effective teachers. Interestingly, Falch and Ronning (2005) find the opposite correlation between turnover and disadvantage in Norwegian schools.

The remainder of the paper is as follows. Section 2 sets out the statistical and economic framework we use to interpret the results, and section 3 describes the data. Section 4 establishes the nature of the relationship between disadvantage and turnover, and section 5 analyses the source of that association. Finally, section 6 summarises the results and estimates the impact of the higher turnover on school performance.

2. Statistical and economic modelling of the tenure distribution

a. Statistical Modelling

Before setting out our methodology, we develop the statistical framework for interpreting our results. This has two components, understanding the relationship between elapsed tenure (our data) and completed tenure, and then between completed tenure and the separation rate.

Our data are a sample of teachers currently employed, so we necessarily have a distribution of elapsed tenure: how long each teacher has been in their job so far[4]. At an individual level, a specific teacher may leave the day after the survey, or stay for another ten years. However, over the data as a whole, there is a relationship between elapsed and completed tenure. The link is provided by renewal theory (see Lancaster, 1990). Suppose completed tenure, τ, has pdf g(τ) with mean μ,then

[4] The very nature of the data means that there are no completed spells of employment, so a hazard function analysis is not appropriate.

the pdf of elapsed tenure, ε, is $f(\varepsilon) = [1 - G(\varepsilon)]/\mu$. For individuals for whom the turnover process has been running a long time, the pdf of remaining tenure is the same as the pdf of elapsed tenure: so expected completed tenure is equal to two times the elapsed tenure.

The distribution of completed job tenure is closely related to the separation rate. In a simple case of a constant separation rate over tenure and in steady state, the expected length of job tenure is equal to one over the separation rate; for example, a constant separation rate of 10% per year gives an expected completed tenure of 10 years.

In a more general model, the situation is more complex. For one individual in a job, her tenure depends only on her own separation probability. But the distribution of tenure in an organisation depends in general on all the tenure-specific separation rates and on the hiring rate (Bartholomew, 1982). In steady-state, it depends only on the separation rates, but out of steady-state, it depends on hiring too. It is easy to see why: if an organisation is growing and experiences a burst of hiring, there will temporarily be a disproportionate number of people with very short tenures.

We can use a single cross-section of tenure data to roughly estimate separation rates. Suppose that instead we had a series of cross-sections, and in a specific school we count the number of teachers with tenure between 0 and 2 years, denoted A. Then revisit the school two years later and count the number with tenure between 2 and 4 years, denoted B with B ≤ A. The separation rate over that interval is the number who left (A – B) relative to the original stock A, so equals 1 – (B/A). In our case, we do not know B. However, if the school was in steady state, then the number with tenure between 2 and 4 years will be the same now, say B', as in two years time. Given this assumption, the separation rate is 1 – (B'/A). Clearly, many schools are not in steady state all of the time, and in some cases are small enough that the heterogeneity of transition rates between teachers may not average out. Nevertheless, to the extent that we can control for being out of steady state, this gives a useful addition to our analysis. We do this for the (0 – 2)|(2 – 4) year transition, and the (0 – 5)|(5 – 10) year transition.

b. Economic Modelling

We first discuss individual behaviour and then market equilibrium. Total separations from a school combine quits, retirements and layoffs. In fact, very few teachers are dismissed in England, so we can ignore that. Retirements obviously do happen and will form part of the separations at older ages, but the emphasis here is on quits. Teachers can leave their current school to work in another school, in another job outside teaching or to leave the labour force altogether. Standard models of quits emphasise wage offers, promotion or wage growth prospects, and non-pecuniary aspects of a job. In teaching, although wage schedules are very important, there is still important variation in pay for teachers with the same role, age[5] and qualifications, albeit much less than in the private sector. The SD of pay relative to mean pay for teachers[6] who are aged 23-25 is 0.153; 0.189 for those aged 33-35, 0.210 for those 43-45, and 0.160 for those aged 53-55. Wage growth and promotion prospects also vary, particularly with school size. Non-pecuniary aspects of different schools are likely to be very important given the relative fixity of public sector pay scales compared to private sector employers. These will include the characteristics of the students, and the general "teach-ability" of the student body; the resources available to the school, for example the provision of IT

[5] We can only approximate total teaching experience as we do not know the date of the first teaching job.
[6] These are statistics for full-time, secondary school, classroom teachers holding a degree.

and the availability of teaching assistants; and the ethos and management of the school. Some of these factors may only become apparent after starting in the job, but many including the level of disadvantage will be very evident at the job interview.

It is not possible to give the findings we present below a strong causal interpretation, because teachers are not distributed at random across schools of differing degrees of disadvantage. Specific types of teachers are hired into specific types of school, and their subsequent separation decisions are part of the expected outcome at the point of hiring. So to interpret our results we need to characterise the market equilibrium, most appropriately studied using a search and matching approach. The central reference is Shimer and Smith (2000) laying out a model of search and assortative matching that has many of the features required here. More recently Lise et al (2009) have begun the process of solving a richer model.

To be clear, because of the complexity of modelling such two-sided search and matching markets, neither of these papers directly and fully models this market, so the characterisation set out below is more of an impressionistic sketch extrapolating from the richest models currently available. The outcome is simply our conjecture.

Suppose teachers differ along one dimension, possibly only imprecisely observable beforehand ("effectiveness", denoted E) and that schools similarly differ in the "agreeable-ness" (A) of their students. This is a market with inflexible wages so wages cannot fully reflect these observable differences. The market will work as follows if both teachers and schools have fixed and equal preferences over A and E respectively, so all teachers agree on the ranking of desirable schools and all schools agree on the ranking of desirable teachers. The market equilibrium will see the high E teachers matched with the high A schools; depending on the set-up and parameters of the model they may continue job search, but at a low intensity. The lower E teachers will tend to be matched with lower A schools, and will engage in higher intensity job search. If there is sufficient exogenous turnover in the model to create new job slots, and if pre-hire estimates of A and E are sufficiently poor to give low E teachers a chance at a better A school, then this set-up will yield the prediction of greater quits out of (and hires into) low A schools. So low E teachers accept jobs in low A schools and continue job search, simply because it is better than searching whilst unemployed, intending and expecting to stay there not very long. The extent of differential separations out of high and low A schools is likely to depend on the precision of pre-hire measures of A and E, the degree of flexibility of wages and on the degree of exogenous turnover.

It is hard to argue that teachers would quit disadvantaged schools because the degree of disadvantage was a surprise. However, it could be that some novice teaches are surprised by how hard it is to deal with the challenges arising in disadvantaged schools. It could be that their preferences over A change, or it could be that it was an optimal strategy for them to accept the job temporarily and continue employed job search.

A number of things follow from this interpretation. First, a high level of disadvantage at a school gives rise to higher separation rates only indirectly, as it means that teachers will continue with job search and thus be more likely to leave. Second, any performance penalty that such schools suffer will derive from the fact that they only able to hire relatively ineffective teachers[7], as well as any

[7] We also know that inexperienced teachers are less effective for their first year or two.

further detrimental effect from the turnover of teachers *per se*. Thirdly, there are likely to be further equilibrium effects too. The low productivity of teachers hired to low A schools will produce poor academic results and hence we would expect better-off families to select away from them. To a degree we deal with this by using measures of neighbourhood disadvantage rather than the actual students admitted.

This exposition focuses on schools' attributes and teacher effectiveness to sketch out a model of an equilibrium allocation of teachers to schools. While we have very rich data on schools and pupils, and on a number of characteristics of teachers, the available data in England does not individually link teachers to pupils and so (unlike Boyd et al (2011) and Loeb et al (2011)) we cannot estimate teacher level measures of effectiveness.

c. Methodology

Our aim in this paper is to establish the nature of the relationship between teacher turnover and school disadvantage. Since we do not have a strongly exogenous source of variation in disadvantage, we do not claim that this relationship is simply the causal impact of poverty on turnover. There are two potential sources of endogeneity. The reverse causation story is that high teacher turnover reduces school performance, leading more affluent parents to avoid that school. To mitigate the effect of this we use a measure of neighbourhood disadvantage around the school rather than the current fraction of poor students in the school. The reverse causation argument would then have to be that more affluent parents leave the area rather than simply avoiding the focus school. While this is possible, given the degree of school choice available in urban areas, it is less likely.

A more plausible argument for endogeneity is the presence of correlated unobserved characteristics. A number of the relevant characteristics in the teacher-school match are important for that match and are not well measured. The rich data that we have on pupils, schools, and neighbourhoods means that we probably do a reasonable job of capturing school heterogeneity.

We also analyse what factors 'account' for the correlation. To do the latter we sequentially add a series of controls for different aspects of the school and its environment to see whether they account for the variation. First, we add to the baseline model the structural characteristics of the school, such as location, size and so on. Second, we include the characteristics of the pupils admitted to the school. Some characteristics of students, such as having special educational needs for example, are correlated with neighbourhood disadvantage and may reduce the desirability of the school for some teachers. Third, we look at the characteristics of the local teacher labour market around the focus school. High poverty schools tend to be in city centres and hence in thick markets generating more job offers. It may be that this explains the higher turnover rate in such schools.

Finally, we include the characteristics of the teachers themselves. This has to be interpreted carefully given the discussion above. Schools hire the teachers they can, so hiring teachers with particular characteristics is the school's optimal response to their circumstances, not an exogenous factor imposed on them. So it is the mechanism through which higher turnover arises, not the cause of the higher turnover itself.

3. Data

Our analysis combines three datasets: the first full collection of the School Workforce Census (SWC), the National Pupil Database (NPD) and Edubase, giving school characteristics. We categorise all schools as either primary or secondary using the DfE-standard approach for non-standard entry schools. All special schools and nursery schools are excluded from the analysis.

a. School Workforce Census

The School Workforce Census (SWC) is individual-role level data on all staff from local authorities, state-maintained schools and academies in England. The census is run by the Department for Education, with the first full sweep taking place on 4th November 2010. It is a statutory requirement on schools and local authorities (LAs) to submit the SWC return, with data being supplied from either schools or LAs, or a combination of the two. In the majority of LAs, data is sourced from schools, but where possible, some LAs provide all or most of the data (although schools may still be asked to check the data). Validation of the returns is carried out by the LA, with the exception of Academies and City Technical Colleges (CTCs), who approve their own returns.

The unit of observation is an individual-role, so it is possible for an individual who has, for example, one part-time contract as a lunchtime supervisor and another part-time contract as a classroom teacher to have two observations in the data. Similarly, an individual may also have two data entries if they are contracted as both a classroom teacher and Head of Department.

The full SWC initially has 1,292,494 observations from 21,423 primary and secondary schools including information on over 400,000 teachers and 270,000 teaching assistants. The census includes contract information such as the start date, hours worked, annual pay and all roles an individual has within a school (teacher, head of department, lunch time supervisor etc.), as well as an indicator for whether the member of staff is employed by the local authority or the school they are working at. It also includes personal characteristics such as date of birth, gender and ethnicity, an indicator of whether a teacher has attained qualified teacher status (QTS), information on subject studied and the level of qualification (degree, PGCE etc.), as well as on the amount of time spent in the classroom teaching each subject.

There are two data quality problems with SWC: missingness on particular variables and apparently missing observations. Missingness on variables is a particular problem for indicators such as subjects taught in the classroom (68% missing) and teacher qualifications, for example Qualified Teacher Status (QTS) route. Since this does not have to be back-filled for staff that already have QTS, it is missing for 78% of observations. Secondly, the very large variation in staff-pupil ratios across schools lead us to suspect that some schools have failed to submit a return for every member of staff and this should be borne in mind during the analysis section. However, our results still stand when excluding those schools that have a staff-pupil ratio of less than 0.02.

In order to focus on teacher turnover, we restrict our sample to classroom teachers, excluding anyone defined as support staff and teaching assistants[8]. Since most of the data on agency or service

[8] The SWC guidance from the DfE defines support staff as “those...that are not classroom based, eg matrons/nurses/medical staff, librarians, IT technicians, technicians, administrative officers/secretaries, bursars and other administration/clerical staff, premises and catering staff”; and teaching assistants as

agreement teachers is missing, we also drop them, as well as those teachers who teach less than half a day (three hours per week). Then, by using worker ID, we are able to merge together roles into one observation per person. This leaves us with a sample of 343,547 people who identify themselves as a "classroom teacher".

Table 1 presents some descriptive statistics from this sample. Primary school teachers are on average younger than their secondary school counterparts. Female secondary school teachers are also slightly younger than males. The vast majority of teachers are of white ethnicity and hold either a degree or higher, BEd or PGCE. The tables in Data Appendix Table 2 also show that teachers in London are generally younger, more ethnically diverse and more likely to hold a degree or higher.

We use the SWC to create a series of teacher and school level characteristics that are summarised in Appendix Table 1: annual pay, age, ethnicity, proportion of teaching staff working full time, proportion of teaching staff with tenure less than two years and main subject taught. We also estimate a school-level pay premium as the school fixed effect in a teacher pay regression that controls for years of tenure, gender, age (including interaction terms), ethnicity and whether part-time. In our analysis we simply use a binary indicator of whether the pay premium in a teacher's school is greater than zero.

b. Summarising the tenure data

Given that there is only one cross section of the SWC, there is a limit to the analysis that we can carry out. We are unable to look at any survival analysis as we have no completed spells of tenure – all are in progress. Thus instead, we focus on the distribution of elapsed tenure, how long a teacher has been in the job so far, and on imputed separation rates. We calculate tenure by using the date of arrival in school. The SWC guidance defines this as follows:

"This shows when a member of staff began their current period of continuous service at their current school...Long term absences, whether for sickness, maternity or paternity, should not cause this date to change neither should factors such as spine point progression or passing the threshold. However, a career break, which might be an extension of maternity leave, would be followed by a new date.

Date of Arrival in School should be provided for all teachers and teaching assistants that started their current period of continuous service with the school during the previous academic year, ie from 1 September 2009. For staff that began their current period of continuous service some time ago, it may not be possible to accurately provide this information. If this is the case the Department would prefer no date to be entered."

Despite the SWC guidance, there is no major problem of missingness with dates of arrival in school.

However, there is an issue of heaping in the data. This is because most hires start on a specific date (1st September), 64 days from the Census date, so there are local peaks in the distribution at 64 days and multiples of 64 thereafter (i.e. 429 = 64 + 365). Therefore, with the creation of the tenure bands, we account for the heaping by shifting the bands by 64 days. We use the following categories as our dependent variables:

- "hired 0 to 2 years" includes those teachers who have been at the school for less than or equal to 429 days;

"those...based in the classroom for learning and pupil support, eg HLTAs, teaching assistants, special needs support staff, nursery officers/assistants, minority ethnic pupils support staff and bilingual assistants."

- "hired 2 to 5 years" includes those who have been at the school more than 429 days, but less than or equal to 1,890 days
- "hired 5 to 10 years" includes those who have been at the school more than 1,890 days, but less than or equal to 3,716 days
- "hired 10 years or more" includes those who have been at the school at least 3,716 days

Table 2 presents summary statistics on tenure. Looking at all teachers, on average 7.5% were hired in the present year, and 8% of currently employed teachers were hired the previous year. Because this is a stock sample of currently employed teachers, we must be cautious of saying that the hiring rate last year was 8% because some of those hired will have left. Looking across the tenure categories, overall 20% of teachers have been in their current school for less than two years, and just over half have an elapsed tenure of less than five years. At the other end of the tenure distribution, nearly 20% have been in their present school for over 10 years, and in fact over 5% have stayed over 20 years. Mean tenure is 6.7 years.

The data show only minor gender differences in tenure, women very slightly more heavily represented in the longer tenure categories. Mean tenure is 6.6 years for women and 7.0 years for men. There is also very little overall difference in the job tenure distribution between primary and secondary school teachers. There are more substantial differences by part-time status, part-time teachers having spent much longer in their current schools. The lower panels of the table split this down by gender and age, and gender and phase of education, and show that, on average, females enjoy longer tenure in primary schools, while the reverse is true for secondary schools.

These are new data, and it would be useful to compare these results to previous studies. However, most of the existing UK studies focus on the rates at teachers leave the profession (the 'wastage' rate) rather than the separation rate. Barmby (2006) surveys 246 teachers in England and Wales to estimate a teacher wastage rate of 9.3% in England for the year 2000-01. He also finds that 26.8% of teachers in the sample were considering leaving teaching in the next 5 years. This is broadly in line with Tracey et al (2008), showing that 3% of the teachers surveyed said that they expected to leave the profession in 3 years' time, and 10% expected to move to a different school in the following year. In the UK, Dolton and van der Klaauw (1995) use the Department of Employment survey from 1987 and find a turnover rate of 37% over 6.5 years (where turnover is defined as exits out of teaching i.e. wastage). In other countries, turnover rate estimates include values of 13% to 25% for the US (Ingersoll, 2001, Boe et al, 2008, and Harris and Adams, 2007), and 9% for Norway (Falch and Ronning, 2005).

Comparing the sub-populations, Boe et al (1997) also report no real difference in turnover rates between phases of education, although Stuit and Smith (2009) find a higher separation rate in secondary schools. There is also evidence that turnover rates differ by gender (Grissmer and Kirby 1987, Ingersoll 2001) though more recently Hutchings (2011) finds that the gender gap in those leaving the profession altogether has become insignificant. There is evidence that part-time teachers have a higher turnover than full-time teachers (Boe et al, 2005), which is rather different from the results here. There is a good deal of evidence showing that young or less experienced teachers have a higher turnover rate than older or more experienced teachers (Loeb et al 2011; Kreig 2006; Zabalza 1978; Smithers and Robinson 2003, Boe et al (2007), Hanushek, Kain and Rivkin

(2004)). At the level of the whole profession, Dolton and van der Klaauw (1995) find that the hazard rate of leaving teaching entirely exhibits positive duration dependence.

Figure 1 displays the kernel density function of tenure days for teachers in primary and secondary schools, and clearly illustrates the heaping of the data at annual intervals.

Given that we have a single cross-section, we cannot calculate separation rates. However, we can estimate them by comparing different cuts of the tenure distribution. The derivation is set out in section 3 below.

c. National Pupil Database (NPD) and Edubase

The NPD is an administrative database covering all pupils in state-maintained schools in England. NPD contains pupil demographics such as gender, within-year age, and ethnicity, and test score histories. The data also include indicators of whether English is the pupil's mother tongue, and whether the pupil has special educational needs. Pupil characteristics are averaged to produce school-level descriptors.

We have two potential measures of poverty. Eligibility for free school meals (FSM) is based on eligibility for welfare benefits and is a reasonably good indicator of poverty (see Hobbs and Vignoles, 2007). The pupil's home address is tagged with an index of deprivation, the Index of Deprivation Affecting Children Index (IDACI), which gives a good measure of neighbourhood deprivation.

Edubase provides an administrative record for all schools, whether maintained or private, in England, which provides the structural characteristics of each school: region indicators (with additional indicators for the Inner, Outer and Fringe London pay regions); urban/rural indicators; school age span (highest and lowest ages of pupils); school governance type and whether it is a single-sex, grammar or boarding school; the number of full-time equivalent pupils and also the official school capacity; nursery school presence indicator and size; and sixth form indicator and size.

The distribution of these variables is summarised in Appendix Table 1.

d. Geographies

We are concerned with two key spatial constructs: the teacher labour market and the school catchment area.

We assume that the local teacher labour market extends to a maximum radius of 30km around the teacher's current school[9]. This is obviously ad hoc but is reasonable given data on average commute lengths (Dent and Bond, 2008, calculate the average commute to be 13km). We take the number of other schools (of the same phase of education) within the radius as a measure of the density of the market. The search and matching approach shows that, other things equal, a thick market will generate more alternative job offers and thus make quitting more likely. We distinguish high, average and low market density[10]. There is a clear correlation with neighbourhood poverty: the high levels of market density are disproportionately in poorer areas.

[9] We repeated all the analysis using a radius of 20km, and the results are very similar: same pattern of coefficients and same levels of (in)significance.

[10] For primary schools, we classify high market density as those schools which have more than 800 schools within 30km, and low market density as those which have less than or equal to 200 schools within 30km.

We also include indicators which capture the difference between the focus school and it's competitors in the local labour market. These are: whether the school has a higher percentage of students eligible for FSM than the average in the local labour market; whether the mean competitor pay premium is greater than zero; and whether the mean competitor pupil growth rate is greater than zero.

Our key explanatory variable is neighbourhood deprivation, and this is built up from the de facto school catchment area based on Lower Layer Super Output Areas (LLSOA). LLSOAs are a geographic hierarchy built from groups of contiguous Output Areas. They are generated to be as consistent in population size as possible, and typically contain from four to six Output Areas. The minimum population is 1000 and the mean is 1500. Since we know the postcodes of the pupils at the school, we can define the pupil catchment area as all the Lower Layer Super Output Areas from which pupils are drawn. Thus neighbourhood poverty is calculated by taking an unweighted average IDACI score of all the local neighbourhoods that the school draws from; this is in general all the local neighbourhoods. This differs from the straightforward school IDACI score which simply averages over the pupils which actually attend the school. We use the neighbourhood measure as this derives solely from where the school is situated rather than its actual admissions, and so can be considered as exogenous to school policies, and unobserved school and teacher characteristics.

4. Results 1: Do disadvantaged schools experience high teacher turnover?

We first describe the relationship of poverty with teacher turnover, before considering the source of the correlation.

a. School tenure distribution and school disadvantage

We present this information graphically, focussing on two cuts of the tenure distribution: teachers whose tenure is less than two years, and teachers with tenure greater than ten years[11]. Figure 2 shows how the percentage of teachers with tenure less than two years varies with school poverty. As noted above, we are using neighbourhood IDACI to provide the measure of school disadvantage. Because of the overwhelming importance of age, we do this separately for three age categories: aged under than 30; aged from 30 to 50; and aged over 50; we also split schools into primary and secondary phases. The graph shows 50 quantiles of neighbourhood IDACI, with higher numbers indicating higher levels of poverty. Other than secondary school teachers aged less than 30, we observe a positive correlation between neighbourhood IDACI and the proportion of teachers with short tenures: schools situated in disadvantaged neighbourhoods have a higher proportion of new, potentially less experienced, teachers. There is not much difference in the pattern across the age groups, although the strongest correlation appears in teachers aged over 50.

Amongst secondary schools, high market density is classified as more than 200 schools within 30km, and low market density as less than or equal to 50 schools within 30km.

[11] Appendix figures A1 and A2 present similar graphs for the percentage of teachers with tenure of 2-5 and 5-10 years. A3 to A6 show how the percentage of teachers with tenure less than two years and over ten years varies with neighbourhood IDACI, split by gender and location.

Given the pattern in the previous set of graphs, we might expect a negative correlation between neighbourhood IDACI and the proportion of teachers with tenure of more than ten years. Figure 3 shows that this is indeed the case for secondary schools, but not for primary schools. In secondary schools, the percentage of teachers with tenure of more than ten years is negatively correlated with neighbourhood IDACI. The opposite is true for primary school teachers. In other words, secondary schools situated in deprived neighbourhoods have a lower proportion of long-standing teachers.

Figure 4 takes a different cut through the data and shows quantiles of the distribution of tenure. Each vertical slice of the graph shows the 10^{th}, 25^{th}, 50^{th} and 75^{th} percentile of tenure for a 50^{th} of secondary schools by the neighbourhood IDACI score. The graph shows that there is little difference in short tenures across schools, and that there is a decline in longer tenures at schools in poor neighbourhoods.

We also consider the association between school % FSM and teacher turnover in Appendix Figures A7 and A8. As expected, the patterns are very similar.

We postpone a discussion of the quantitative significance of the relationship until later.

b. School separation rates and school disadvantage

We focus on the imputed separation rates at two and five years and plot the relationship with neighbourhood IDACI (this does not control for schools' growth rate; that is done in the regression results below). Figure 5 shows the separation rate at two years does vary with neighbourhood disadvantage. The patterns appear to differ for primary and secondary schools: in secondary schools, a higher neighbourhood IDACI is positively associated with the two-year separation rate, while the opposite is true in primary schools. The correlation appears to be strongest in primary schools among teachers aged between 30 and 50, and in secondary schools among those aged under 30.

Figure 6 displays the equivalent patterns at the five-year separation rate[12]. Here, there is a much clearer pattern: the positive correlation between neighbourhood IDACI and the separation rate implies that schools situated in more deprived neighbourhoods face a greater fraction of teachers leaving after five years tenure.

The two sets of graphs are largely consistent, showing that in general neighbourhood disadvantage is associated with higher teacher turnover. However, these are unconditional outcomes and we now move on to the regression results.

5. Results 2: Analysis of the school tenure distribution

What is it about poor schools and neighbourhoods that is associated with high turnover? The following set of regressions start with a very simple model, and progressively add more explanatory variables to see which if any characteristics 'account' for the correlation. We consider school characteristics, pupil characteristics, the nature of the local teacher labour market, and finally the characteristics of the teachers that the schools hired.

[12] Figure A9 displays the separation rate at three years and figures A10 to A13 show how the separation rate at two and five years varies with neighbourhood IDACI, by gender and location.

In each of the following series of regressions[13] we consider four dependent variables separately for primary and secondary schools. These are the school fraction of teachers with tenure less than two years, the fraction with tenure greater than ten years, the imputed separation rate at two years, and the imputed separation rate at 5 years.

The base regression controls for a few school characteristics[14]: the number of full time equivalent pupils, sixth form dummy and regional and urban dummies. As explained above, we also need to control for schools being 'out-of-steady-state', and to do this we include the 2007-2009 average growth in pupil numbers in all the regressions. The key variable of course is the neighbourhood poverty rate, and we include this flexibly to allow for non-linearities.

As expected, the results largely reflect Figures 2 to 6: a rise in neighbourhood deprivation is associated with higher teacher turnover. In terms of the other (non-displayed) coefficients, the main finding is that in accordance with Smithers and Robinson (2003), we find that teacher turnover is higher in London. Our results also show that turnover is lower in larger schools.

A primary school with a neighbourhood IDACI score in the highest bracket has 2.8 percentage points more teachers with short tenures, relative to a value of 17.1% in the least disadvantaged schools, so 16.4% higher. For the most deprived secondary schools, the short tenure group is 2.3 percentage points higher, relative to the mean in the most affluent groups of 18.3%. The fraction of highly experienced teaching staff (tenure greater than 10 years) is 1 percentage point lower in primary schools (relative to 18.8%), and 5.5 percentage points lower in secondary schools (relative to 20.6%).

This pattern is supported in the analysis of imputed separation rates, particularly over the (0-5)|(5-10) transition.

a. The role of pupil characteristics

Table 4 builds on the base regression by introducing school average pupil characteristics as independent variables. These are the proportion of pupils with special educational needs (SEN), the proportion with English as an additional language (EAL), the ethnic composition of the pupil body, and the proportion of female students[15]. As expected, some of these characteristics are significant. Consistent with Smithers and Robinson (2004), we find that turnover is higher in schools with a greater proportion of pupils with SEN. In secondary schools, a greater proportion of students with EAL is associated with higher teacher turnover. In terms of pupil ethnicity, our results support Ronfeldt et al (2011) in finding that schools with lower turnover generally have more white and Asian students.

More importantly, we still find neighbourhood deprivation to be statistically significant. For example, the coefficient on the highest disadvantage group on the (0-5)|(5-10) separation rate has declined

[13] These are simple linear probability models for ease of interpretation, but nothing qualitatively changes when we use a probit model.

[14] There are other school characteristics that we cannot measure: Ingersoll (2001) reports that a 1-unit difference between schools in support (on a 4-unit scale) is associated with a 23% difference in the odds of a teacher departing, while a 1-unit difference in reported teacher influence between schools (on a 6-unit scale) is associated with a 26% difference in the odds of a teacher departing.

[15] Again, there are other variables that would be useful to have: Ingersoll (2001) reports that a 1-unit difference in reported student discipline problems between two schools (on a 4-unit scale) is associated with a 47% difference in the odds of a teacher departing.

from 0.054 to 0.043 for primary schools, and from 0.080 to 0.074 in secondary schools. Thus pupil characteristics explain little of the relationship between neighbourhood deprivation and teacher turnover[16].

b. The role of the local teacher labour market

Table 5 adds the characteristics of the local teacher labour market as independent variables, in order to capture thick market and competition effects. These characteristics are market density, the focus school's pay premium, dummies for the competitor's pay premium, %FSM and pupil growth rate.

The focus school's pay premium is negatively associated with turnover, as one might expect[17]. We also find that a school experiences a higher turnover if the fraction of its students eligible for FSM is higher than its competitors in the teacher labour market. This speaks quite directly to an association between turnover and deprivation. Market density is significant for the long tenure categories in the expected direction: primary schools with fewer competitors have 1.3 percentage points more teachers with long tenures. Similarly, for secondary schools in thin markets, the long tenure group is 2.6 percentage points higher.

Obviously, there is a great deal more that can be done using these local teacher labour markets, which we intend to follow up in subsequent papers.

Our central focus is the neighbourhood deprivation results and they remain significant, though reduced from tables 3 and 4. Primary schools with a neighbourhood IDACI score in the highest bracket have 1.3 percentage points more teachers with short tenures, relative to a value of 17.1% in the least disadvantaged schools, so 7.6% higher. For the most deprived secondary schools, the short tenure group is 2.2 percentage points higher, relative to the mean in the most affluent groups of 18.3%. Thus much of the correlation between neighbourhood deprivation and teacher turnover is not accounted for by pupil characteristics and the surrounding teacher labour market.

c. The role of teacher characteristics

Table 6 adds teacher characteristics to the regressions: age, gender, gender*age interactions, shortage/surplus subject dummy, ethnicity and a full-time dummy.

As noted above, the interpretation of these results is different to the previous sub-sections. The characteristics of the incumbent workforce are not exogenous characteristics of the school, but reflect decisions made by the school given its circumstances. So the sorts of teachers that schools can hire are part of the mechanism through which the relationship between deprivation and turnover is mediated.

As expected, most teacher characteristics are highly significant, and explain much of the tenure decision. Our results also support a U-shaped life-cycle pattern of turnover, with higher turnover for young and old teachers (the latter is likely to include retirements). Interestingly, we find that those teachers that teach shortage subjects (maths, physics, chemistry and foreign languages) have higher

[16] However, Appendix Table 3, which presents the same results for London only, displays almost a total loss of significance for neighbourhood deprivation when pupil characteristics are added. This suggests that, in London, the relationship between neighbourhood deprivation and teacher turnover is almost entirely accounted for by pupil characteristics.

[17] See also Ingersoll (2011).

turnover rates. This result is supported in the literature (Grissmer and Kirby, 1992; Podgursky et al, 2004; and Smithers and Robinson, 2004) and may be due to the fact that shortage subject teachers receive more job offers. We do not find consistent gender differences across all the specifications, as might have been expected given the simple unconditional means. Unlike Ingersoll (2001) and Boyd et al (2011), we find that minority teachers have a higher turnover rate.

Adding teacher characteristics, there is a total loss of significance in the separation rate regressions for primary schools, and almost total for secondary schools. Looking directly at the tenure categories, there is still a quantitatively marginal association between neighbourhood IDACI score and short tenures in primary schools, and essentially no association in secondary schools. Similarly, there is a small association left between deprivation and longer tenures in secondary schools, and actually a perversely signed effect for the poorest primary schools. Because we are unable to link teachers to pupils we cannot look at turnover and teacher effectiveness as Boyd et al (2008) do.

These results suggest that much of the correlation between neighbourhood deprivation and teacher turnover is mediated through teacher characteristics. In other words, deprived schools appear to hire younger and more ethnically diverse teachers than more affluent schools.

d. Discussion

We collect the key coefficients together in Table 7. The secondary school results are generally consistent across the tenure categories shown, and across the two metrics of imputed separation rates and cuts of the tenure distribution. The size of the association is greater for the longer tenure lengths. Controlling for school, student and teacher labour market factors reduces the association between school poverty and turnover, but does not eliminate it. Adding teacher characteristics does. The results are slightly less clear cut and consistent in primary schools, but the same overall picture emerges.

Once we control for basic teacher characteristics, there is little remaining relationship between disadvantage and turnover. This is because teachers hired by schools in poor communities tend to be younger and less well-qualified, as Figure 7 illustrates.

How should we interpret this? There are a number of possibilities. First, it could be that this is a desired career path for young teachers. New teachers may look for their first jobs near to where they trained, which implies predominantly urban and therefore on average deprived, schools. Alternatively it could be a desired career path deriving from younger teachers possibly having more idealistic preferences, and welcoming the opportunity to work in deprived schools. Under these interpretations, the market equilibrium allocation reflects the desire of younger teachers to work in deprived schools, and the higher turnover in such schools derives from this.

The alternative interpretation is the matching story set above in which the more effective teachers sort on average into the more affluent schools, and the disproportionate number of inexperienced teachers in the poorer urban schools reflects the fact that these are the best teachers that those schools can hire[18].

[18] If idealistic teachers are also ineffective teachers, then these two stories are not dis-similar, but we are unaware of any evidence available to date that can link teacher preferences and effectiveness.

Distinguishing between these interpretations is a task for future work; it will need further sweeps of the SWC and possibly attitudinal data from teachers as well.

6. Conclusion

We have used a newly-released dataset on school teachers in England to study teacher turnover. We have shown that there is a positive raw association between the level of disadvantage in the neighbourhood that a school serves and the turnover rate of its teachers, although this is not large. For example, a secondary school in the most disadvantaged category has 2.3 percentage points more teachers with short tenure than does a school located in the most affluent quartile, or 12.6% higher. This association diminishes as we control for school, pupil and local teacher labour market characteristics, but is not eliminated. The remaining association is largely accounted for by teacher characteristics, with the poorer schools hiring much younger teachers on average. We interpret this market equilibrium allocation as either deriving from the preferences of young teachers, or as reflecting the low market attractiveness of disadvantaged schools.

We finally consider what our results mean for school effectiveness, and evaluate the contribution of differential turnover to the lower performance of schools with disadvantaged students. A simple framework is as follows. Consider a school with N teachers, who each teach S students. We abstract from growth or decline, the school remains the same size so always replaces teachers who leave. If the separation rate is λ per year, then there are λN novice teachers[19] and the remaining $(1 - \lambda)N$ are non-novice. The students taught by non-novice teachers each achieve a test score of g, but the students of novice teachers suffer an inexperience penalty of δ, so achieve $(1 - \delta).g$. The total test score in the school is $N(1 - \lambda).S.g + N\lambda.S.g(1 - \delta)$. The mean student score is $g.(1 - \lambda\delta)$. The higher is the separation rate or the inexperience penalty, the lower the mean test score.

Comparing two otherwise identical schools with high and low turnover, the gap in their test scores is equal to $-g\delta(\lambda^H - \lambda^L)$, or as a fraction of the low turnover school's mean score, $-\delta(\lambda^H - \lambda^L)/(1 - \lambda^L\delta)$. We can use the results obtained here plus an estimate of δ to put a rough empirical magnitude on this. The results from table 5 show a conditional gap in short tenure teachers in secondary schools of 2 percentage points. The mean short tenure fraction in the least poor schools is 0.18. We use an estimate[20] of δ from Slater et al (2012): 0.042. Plugging these into the formula yields a gap in mean student test score relative to the test score in the low turnover school of 0.00085. This channel contributes almost nothing to the test score gaps between disadvantaged and affluent schools. Of course, there are likely to be costs to student progress from the disruption to their studies from new teachers, but differential teacher turnover does not seem likely to be able to explain much of the test score gap[21].

[19] Not all newly hired teachers will be teaching novices. About 40% of new hires in our data are of an age that makes them likely to be novices.
[20] The novice penalty relative to the mean GCSE score.
[21] This finding fits with others using other data. Ronfeldt (2011) finds that within the same school and year, students in grade levels that experienced 100% turnover had 4-7% of a standard deviation lower test scores in math and 3-7% of a standard deviation lower in English Language Arts (ELA) as compared to grade levels with no turnover at all. Reducing teacher attrition rates from one-quarter of teachers leaving to none corresponds

While the direct impact of turnover differences cannot explain socio-economic test score gaps, we know that differences in teacher effectiveness in general are very substantial (see Slater et al, 2012). Analysis of the operation of the teacher labour market will give us a better understanding of how particular teachers are matched and re-matched with particular schools. The results in this paper provide a contribution to this research programme.

to an increase in student math achievement of about 2% of a standard deviation. Dolton and Newson (2003) find that increasing teacher turnover by 10% leads to SATS scores declining by 2% for English and 2.5% for Maths.

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Figures

Figure 1: Kernel density function

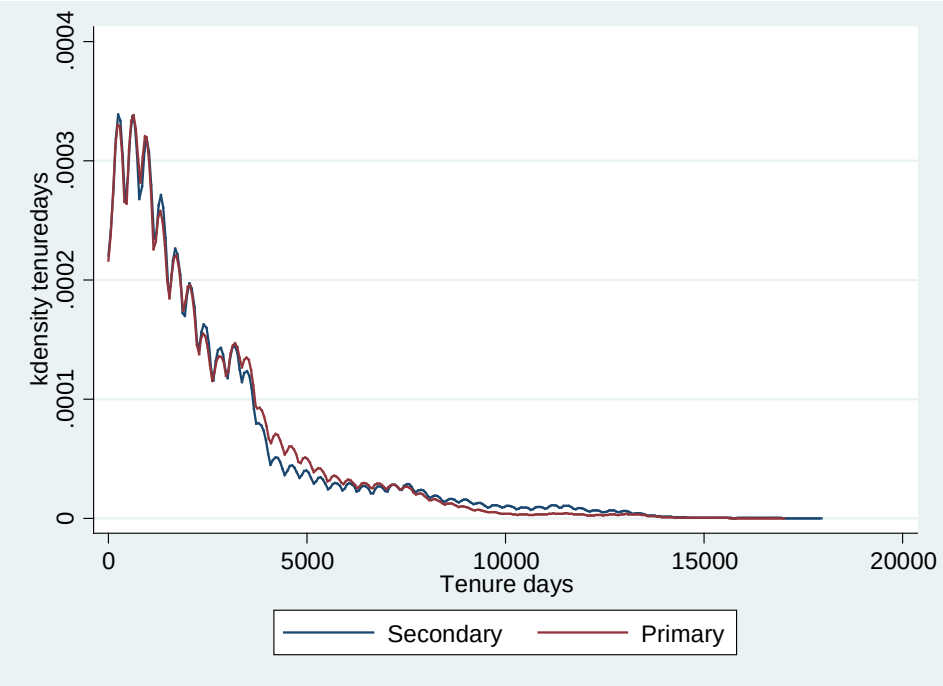


Figure 2: % Tenure 0-2 years

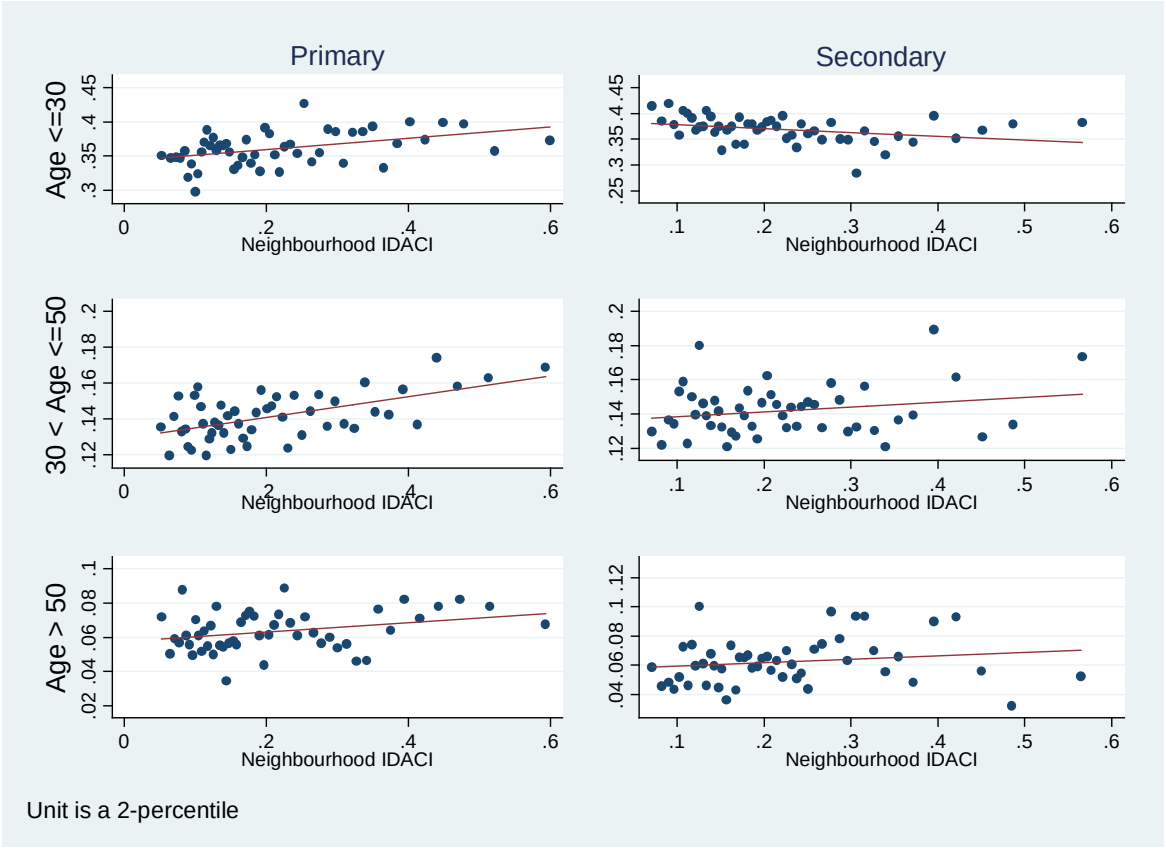
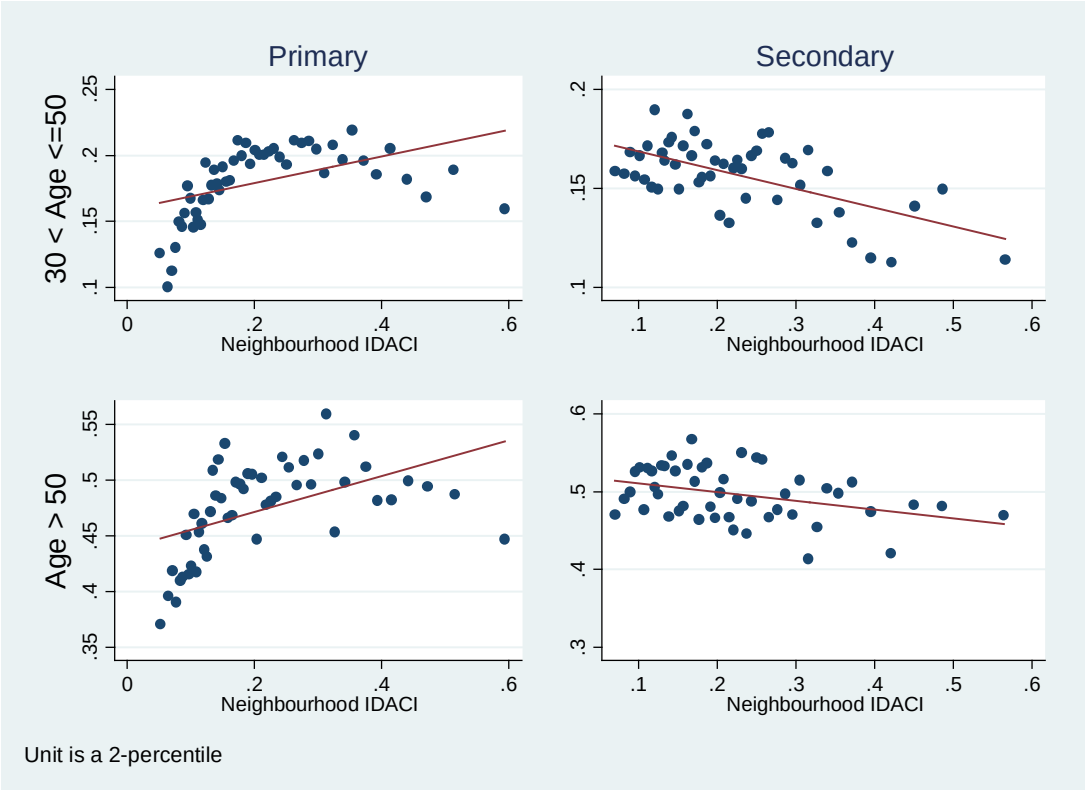
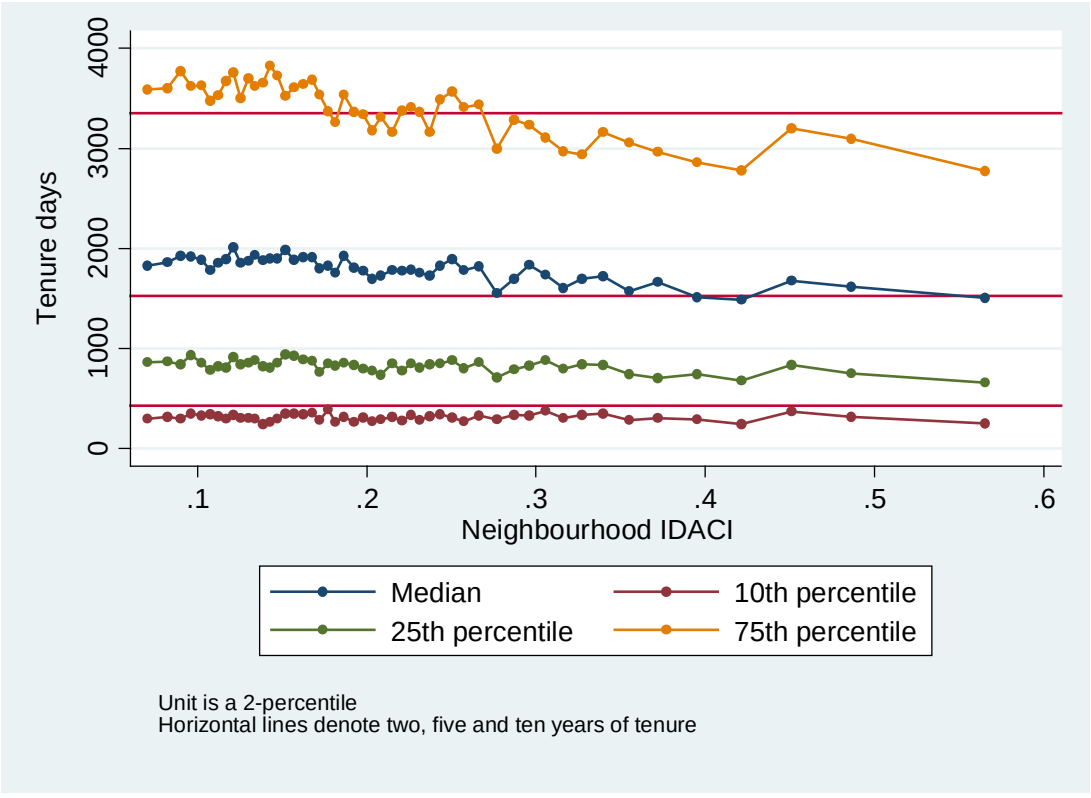


Figure 3: % Tenure 10+ years



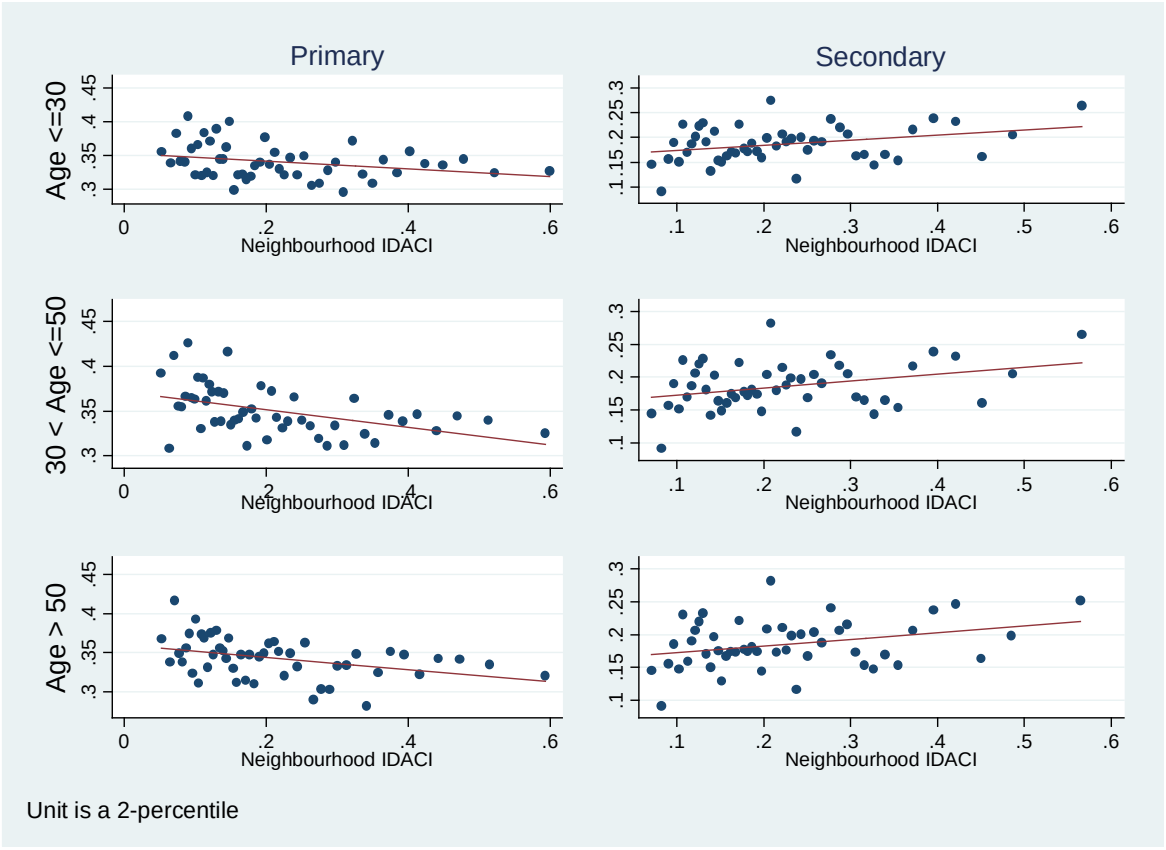
Unit is a 2-percentile

Figure 4: Elapsed tenure by neighbourhood IDACI



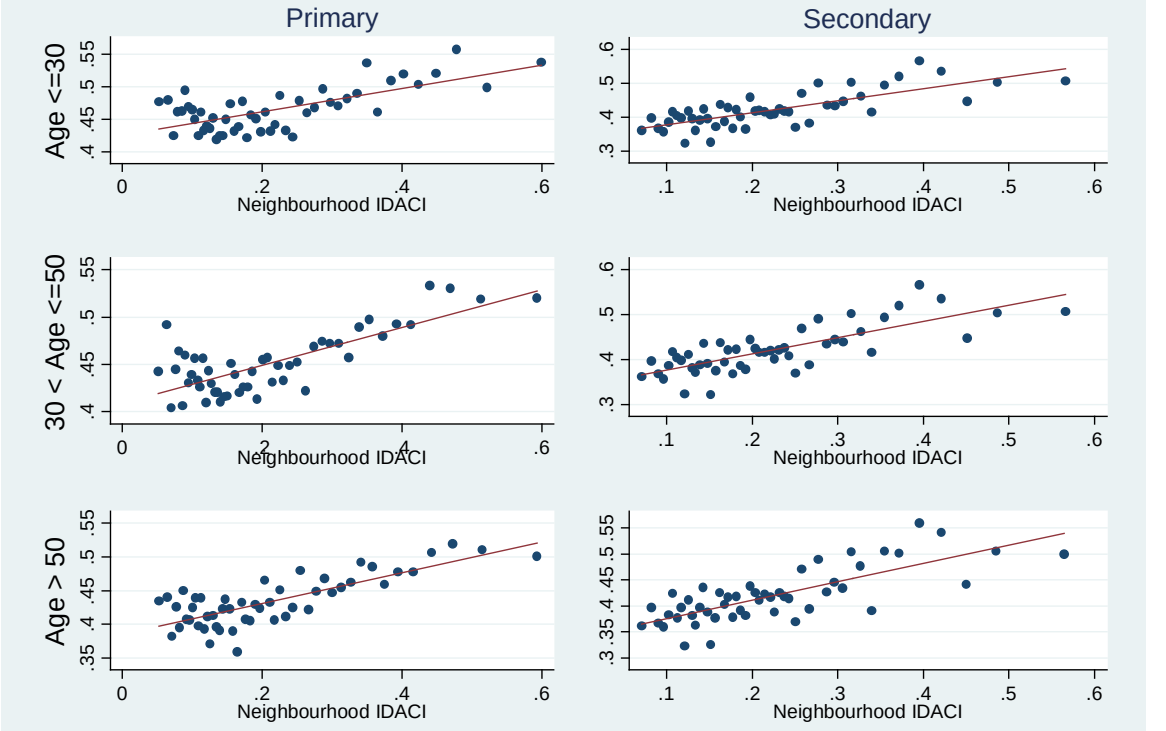
Unit is a 2-percentile
Horizontal lines denote two, five and ten years of tenure

Figure 5: Separation rate at 2 years



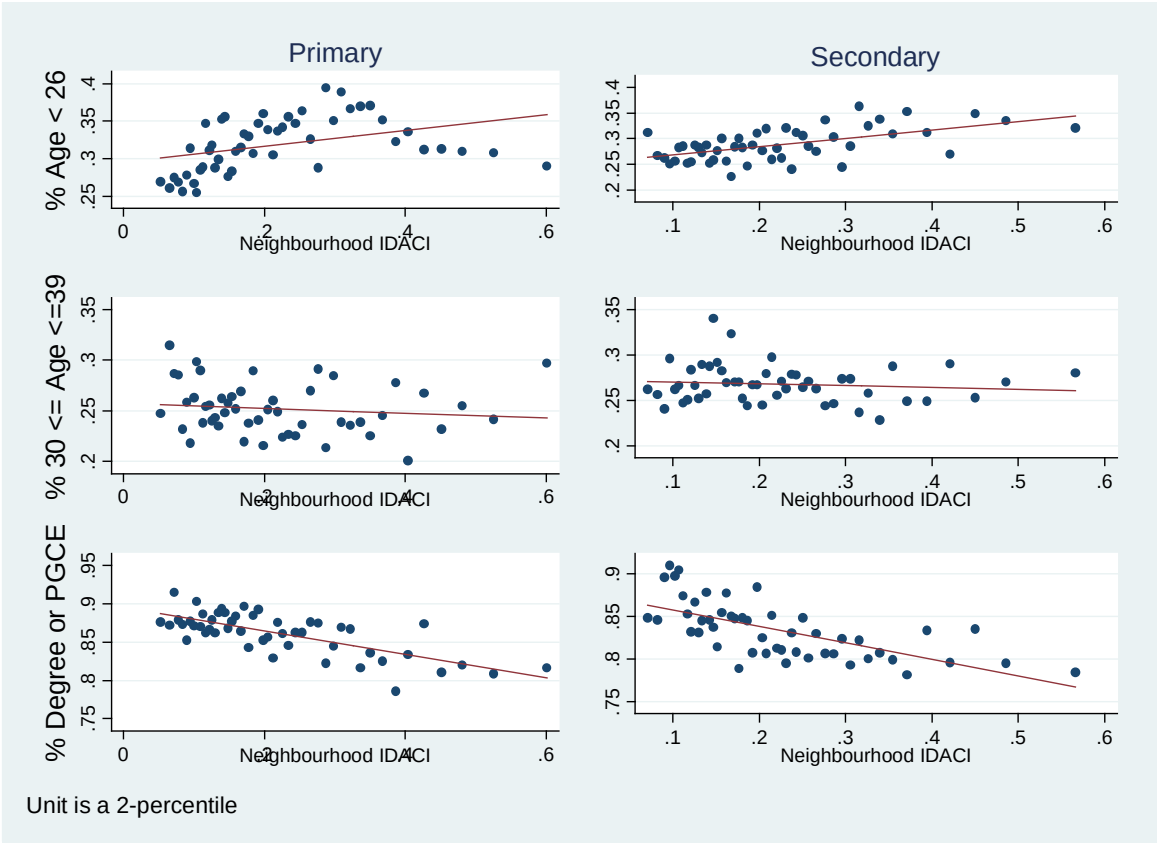
Unit is a 2-percentile

Figure 6: Separation rate at 5 years



Unit is a 2-percentile

Figure 7: Teacher characteristics and school disadvantage



Tables

Table 1: Teacher numbers and characteristics

	---------- Primary ----------			---------- Secondary ----------		
	Male	*Female*	*Total*	*Male*	*Female*	*Total*
Age category						
Age <= 30	29.9	28.8	28.9	25.6	31.0	29.1
30 < Age <= 50	53.5	51.5	51.7	52.2	50.4	51.0
Age > 50	16.6	19.8	19.4	22.2	18.6	19.9
Highest Qualification						
Degree or higher	69.4	61.8	62.6	78.2	78.3	78.2
BEd	15.4	22.1	21.4	7.9	7.1	7.4
PGCE	3.5	2.7	2.8	3.7	3.2	3.4
Other qualification	3.8	6.4	6.1	2.7	3.5	3.2
Qualification not supplied	7.9	7.0	7.1	7.6	8.0	7.8
Ethnicity						
White ethnicity	91.9	91.6	91.6	87.2	87.8	87.6
Other incl Chinese ethnicity	1.0	0.8	0.9	1.0	1.2	1.1
Asian excl Chinese ethnicity	1.9	2.8	2.7	3.6	3.6	3.6
Black ethnicity	1.2	1.3	1.3	2.8	2.3	2.5
Ethnicity refused or missing	3.9	3.5	3.5	5.5	5.1	5.3
N	**61,566**	**109,844**	**171,410**	**19,138**	**152,999**	**172,137**

Note: Classroom teachers

Table 2: Tenure descriptive

	All teachers	Male	Female	Primary	Secondary	Full-time	Part-time	Age<=30	30<age<50	Age>50	London	Non-London
Recently hired												
Hired last year	7.0	7.3	7.0	6.9	7.2	8.0	3.9	14.0	5.1	1.9	7.5	7.0
Hired this year	7.5	7.9	7.4	7.7	7.3	8.6	4.2	15.6	5.2	1.8	9.1	7.3
Tenure distribution												
0-2 years	19.4	20.4	19.2	19.5	19.4	21.6	12.4	37.9	14.1	6.3	23.5	18.7
2-5 years	36.8	37.0	36.7	36.6	37.0	38.7	30.7	51.6	35.7	18.0	38.7	36.5
5-10 years	24.8	23.5	25.2	24.8	24.8	22.7	31.5	10.4	32.6	25.6	23.0	25.2
10 years or more	18.9	19.1	18.9	19.1	18.8	16.9	25.4	0.0	17.7	50.1	14.9	19.7
N	**343,547**	**80,704**	**262,843**	**172,137**	**171,410**	**262,020**	**81,527**	**99,564**	**176,457**	**67,526**	**53,434**	**290,113**

Note: Classroom teachers

Table 3: Base case

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.010**	-0.001	-0.012	0.012	0.000	-0.016***	0.001	0.017
	(0.004)	(0.004)	(0.012)	(0.012)	(0.005)	(0.005)	(0.014)	(0.014)
0.2 < Neighbourhood IDACI <= 0.3	0.033***	-0.016***	-0.002	0.040***	0.018***	-0.035***	0.032**	0.050***
	(0.004)	(0.004)	(0.011)	(0.009)	(0.006)	(0.006)	(0.015)	(0.015)
Neighbourhood IDACI > 0.3	0.028***	-0.010**	0.016	0.053***	0.023***	-0.055***	0.027	0.080***
	(0.004)	(0.004)	(0.011)	(0.009)	(0.007)	(0.007)	(0.018)	(0.018)
Pupil characteristics included?	N	N	N	N	N	N	N	N
Market characteristics included?	N	N	N	N	N	N	N	N
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	16268	16268	12747	15695	2770	2770	2755	2769
R-squared	0.083	0.176	0.049	0.087	0.187	0.321	0.063	0.185

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Table 4: Base case plus pupil characteristics

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.010***	-0.000	-0.012	0.011	0.001	-0.014***	0.004	0.016
	(0.004)	(0.004)	(0.012)	(0.009)	(0.006)	(0.005)	(0.014)	(0.015)
0.2 < Neighbourhood IDACI <= 0.3	0.031***	-0.012***	-0.002	0.036***	0.018***	-0.030***	0.036**	0.048***
	(0.004)	(0.004)	(0.012)	(0.009)	(0.006)	(0.006)	(0.016)	(0.016)
Neighbourhood IDACI > 0.3	0.022***	-0.000	0.014	0.042***	0.023***	-0.044***	0.037*	0.074***
	(0.004)	(0.004)	(0.012)	(0.009)	(0.007)	(0.007)	(0.019)	(0.019)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	N	N	N	N	N	N	N	N
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	16268	16268	12747	15695	2770	2770	2755	2769
R-squared	0.085	0.181	0.049	0.088	0.189	0.332	0.066	0.186

Notes: Standard errors are clustered by school

* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%

Unit of observation is a school

Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years

2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)

Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies

Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy

Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status

Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Table 5: Base case plus pupil plus local market characteristics

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.007*	0.001	-0.012	0.005	0.001	-0.013**	0.004	0.016
	(0.004)	(0.004)	(0.012)	(0.010)	(0.006)	(0.005)	(0.014)	(0.014)
0.2 < Neighbourhood IDACI <= 0.3	0.024***	-0.007*	-0.002	0.019*	0.018***	-0.027***	0.033**	0.045***
	(0.005)	(0.004)	(0.012)	(0.010)	(0.006)	(0.006)	(0.016)	(0.016)
Neighbourhood IDACI > 0.3	0.013***	0.007	0.013	0.018*	0.022***	-0.036***	0.032	0.067***
	(0.005)	(0.005)	(0.013)	(0.010)	(0.007)	(0.007)	(0.020)	(0.020)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	16267	16267	12747	15694	2769	2769	2754	2768
R-squared	0.087	0.192	0.049	0.092	0.192	0.336	0.066	0.194

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Table 6: Base case plus pupil plus local market plus teacher characteristics

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.003	0.008**	-0.010	-0.006	-0.004	-0.004	0.001	-0.004
	(0.004)	(0.004)	(0.012)	(0.009)	(0.004)	(0.004)	(0.014)	(0.014)
0.2 < Neighbourhood IDACI <= 0.3	0.013***	0.003	-0.005	-0.002	0.007	-0.012***	0.027*	0.011
	(0.004)	(0.004)	(0.012)	(0.009)	(0.005)	(0.005)	(0.016)	(0.015)
Neighbourhood IDACI > 0.3	0.008*	0.011***	0.010	-0.001	0.008	-0.017***	0.026	0.023
	(0.004)	(0.004)	(0.013)	(0.010)	(0.006)	(0.006)	(0.020)	(0.019)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Teacher characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
N	168446	168446	12747	15694	166084	166084	2754	2768
R-squared	0.180	0.245	0.070	0.168	0.173	0.276	0.087	0.315

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is an individual when tenure is the dependent variable, but a school when the separation rate is the dependent variable
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

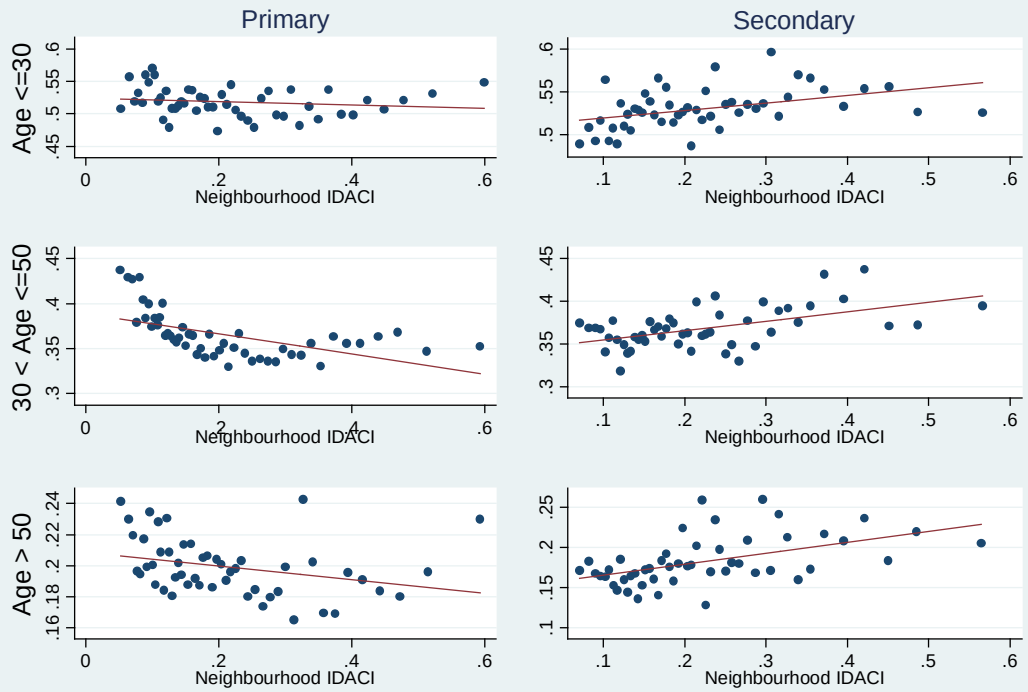
Table 7: Results Summary: Conditional relationship between school disadvantage and turnover

	-------- Primary --------		------ Secondary ------	
TENURE				
	Short	**Long**	**Short**	**Long**
Base	16.38	-5.32	12.57	-26.70
+ pupil characteristics	12.87	(-0.00)	12.57	-21.36
+ market characteristics	7.60	(3.72)	12.02	-17.48
+ teacher characteristics	4.68	5.85	4.37	-8.25
SEPARATION RATES				
	(0 - 2) | (2 - 4)	**(0 - 5) | (5 - 10)**	**(0 - 2) | (2 - 4)**	**(0 - 5) | (5 - 10)**
Base	(4.94)	12.96	(16.88)	20.51
+ pupil characteristics	(4.32)	10.27	23.13	18.97
+ market characteristics	(4.01)	4.40	(20.00)	17.18
+ teacher characteristics	(3.09)	(-0.24)	(16.25)	(5.90)

Notes: Derived from tables 3, 4, 5, 6.
Each entry is the coefficient on the highest IDACI category relative to the mean value of the dependent variable for the lowest IDACI category.
Values in parentheses are not significantly different from zero at 10%

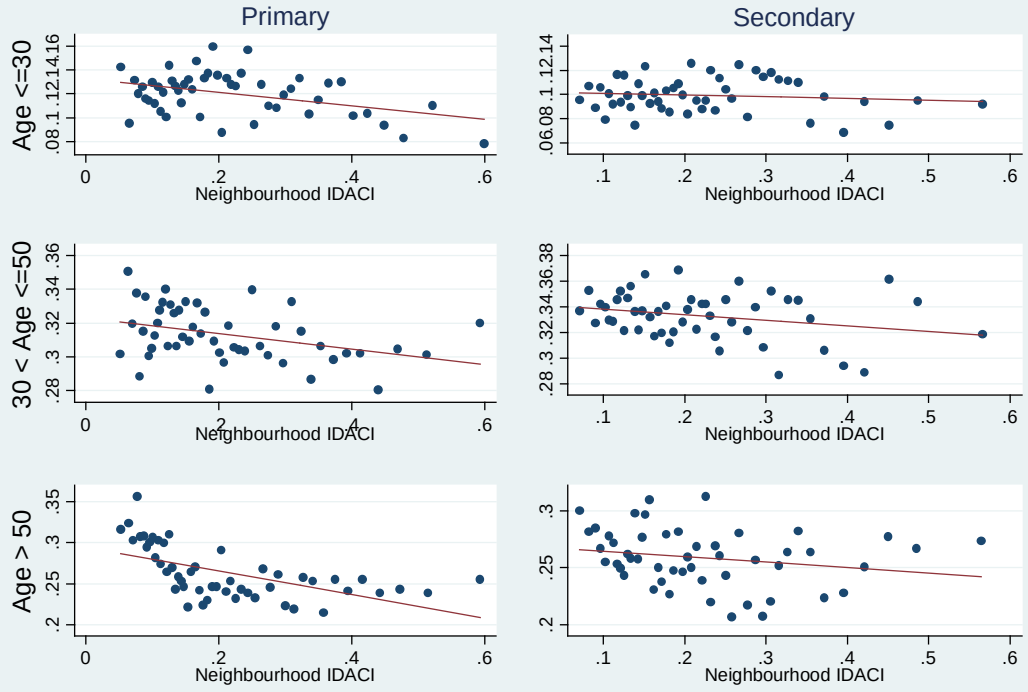
Appendix Figures and Tables

Appendix figure 1: % Tenure 2-5 years



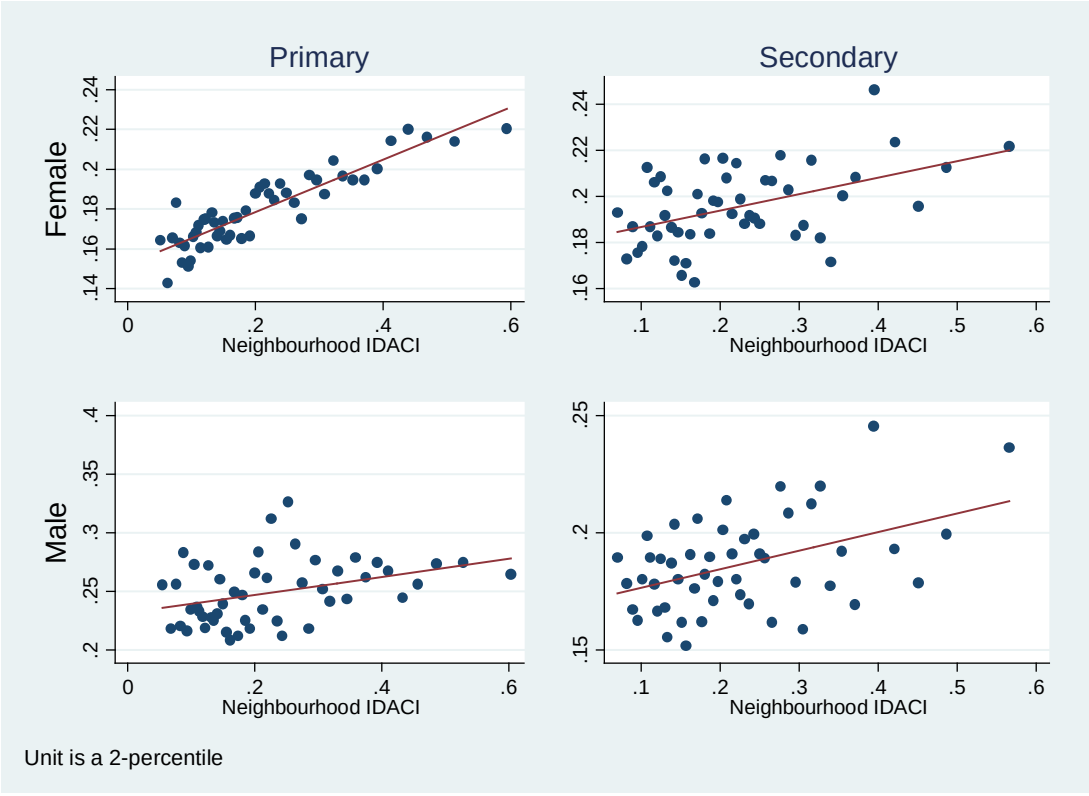
Unit is a 2-percentile

Appendix figure 2: % Tenure 5-10 years



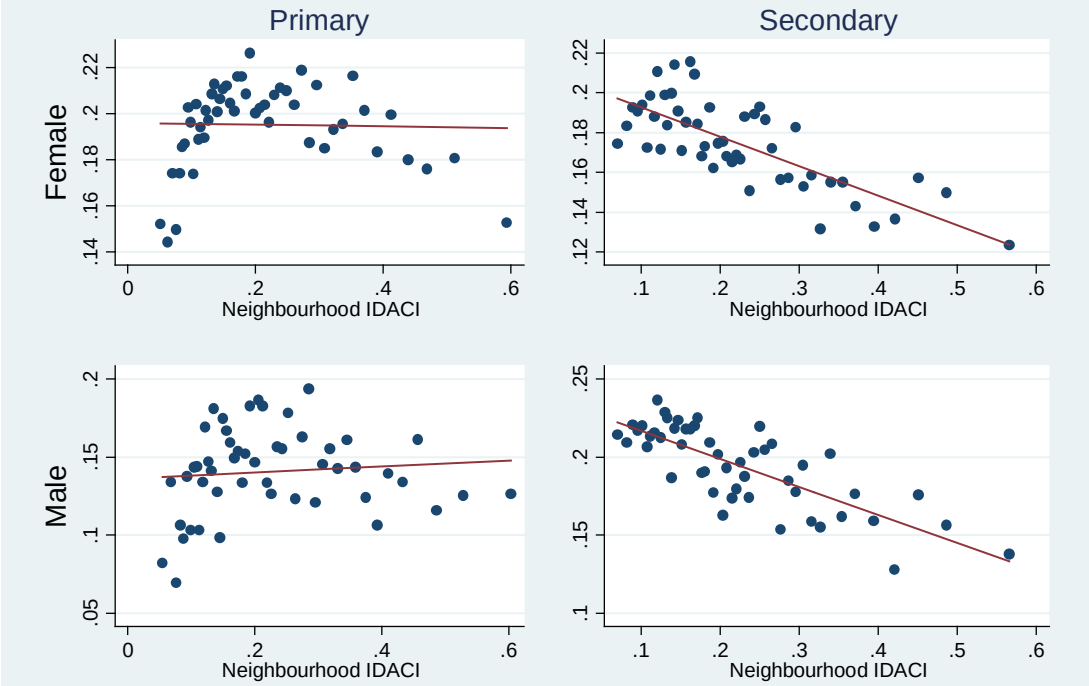
Unit is a 2-percentile

Appendix figure 3: % Tenure 0-2 years



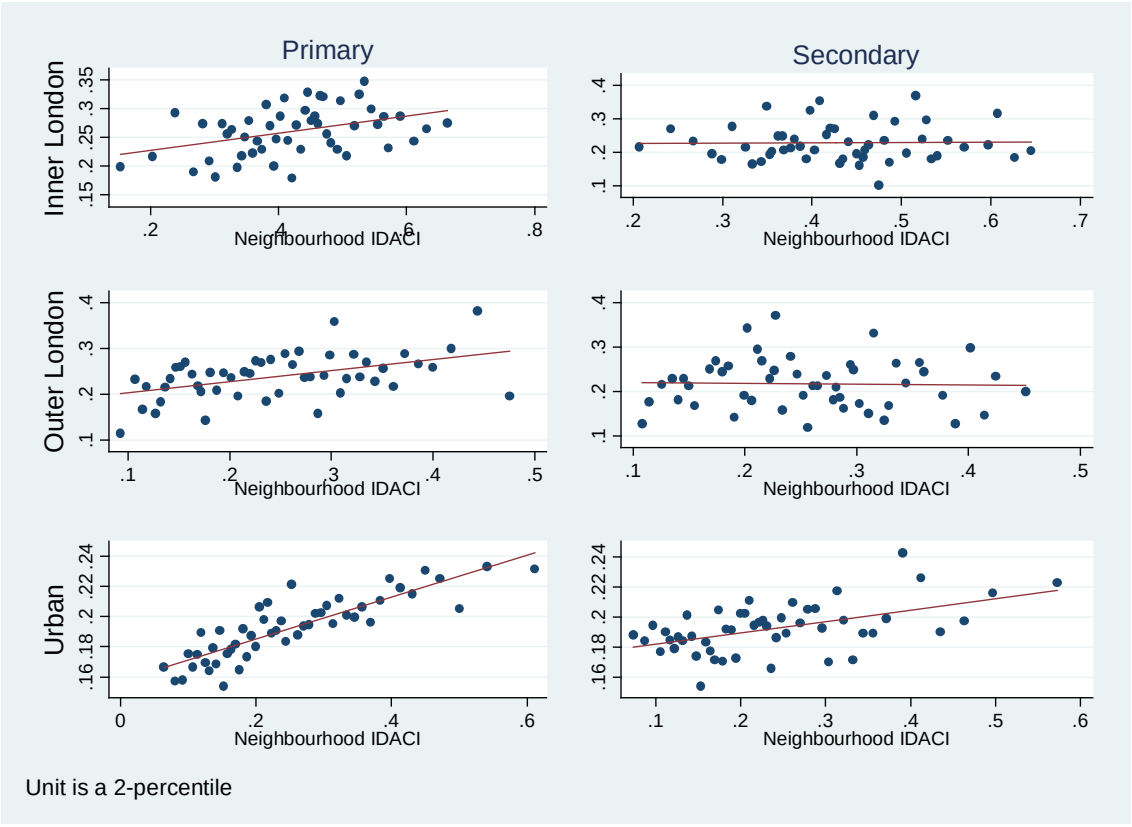
Unit is a 2-percentile

Appendix figure 4: % Tenure 10+ years



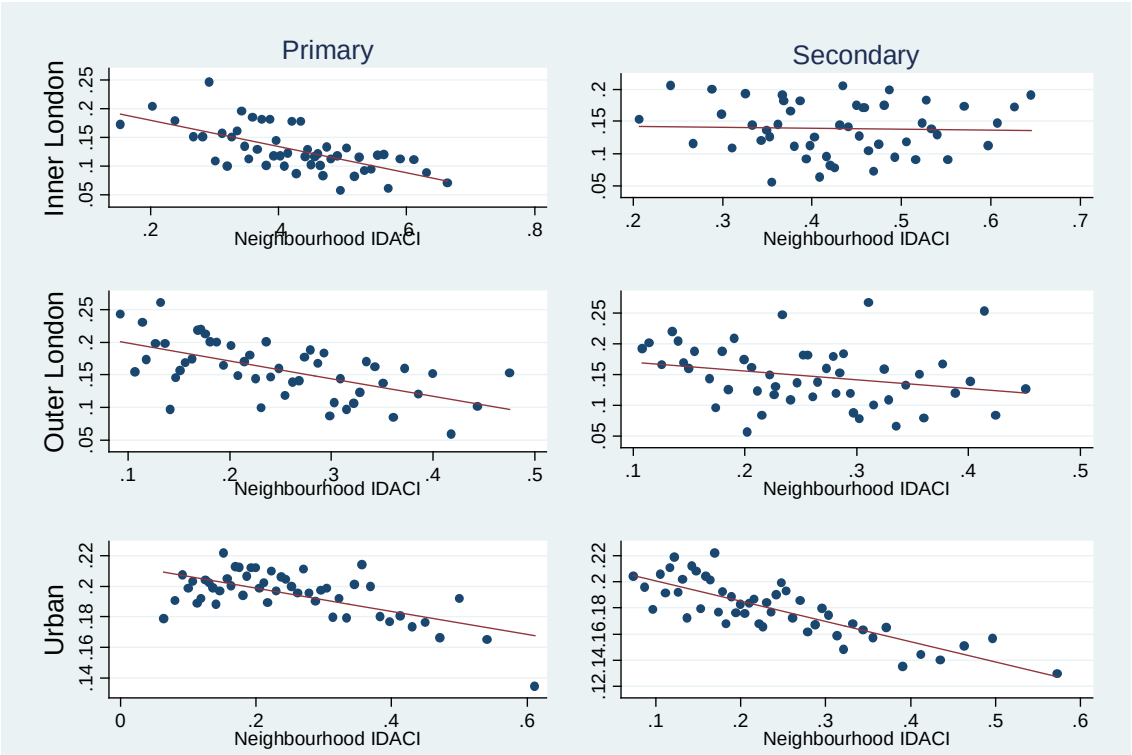
Unit is a 2-percentile

Appendix figure 5: % Tenure 0-2 years



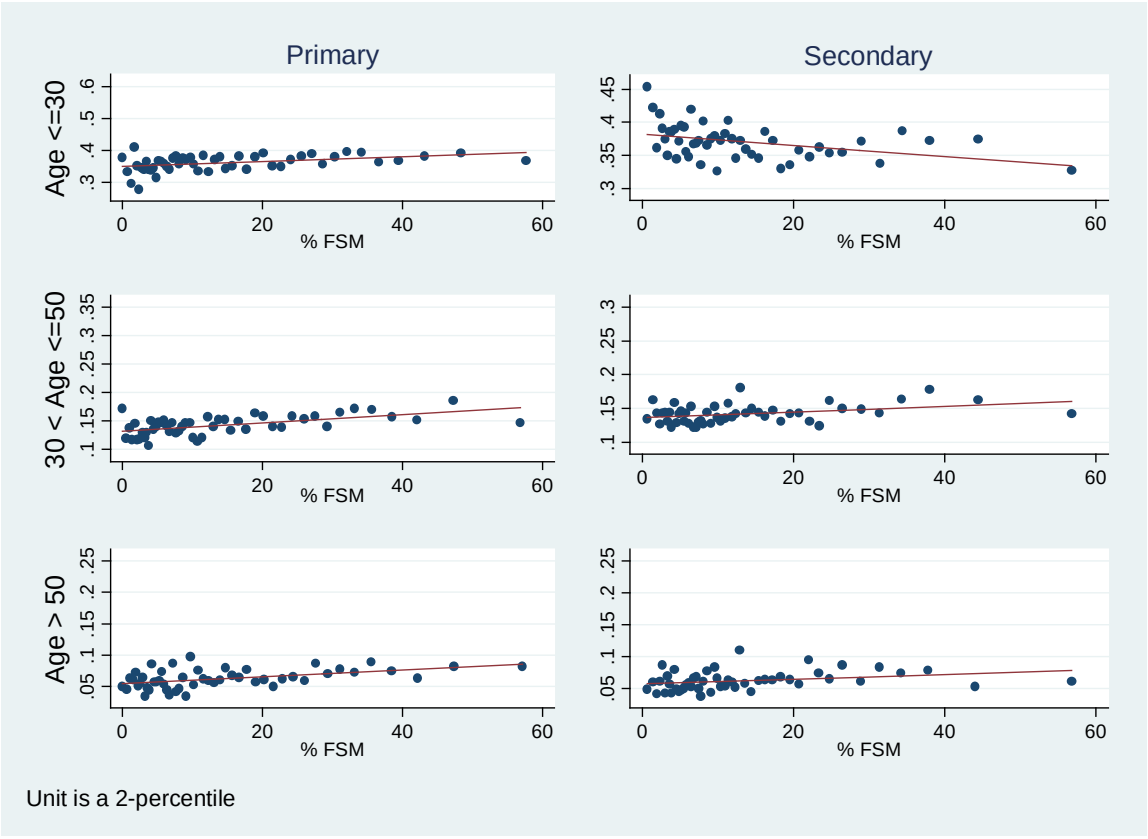
Unit is a 2-percentile

Appendix figure 6: % Tenure 10+ years

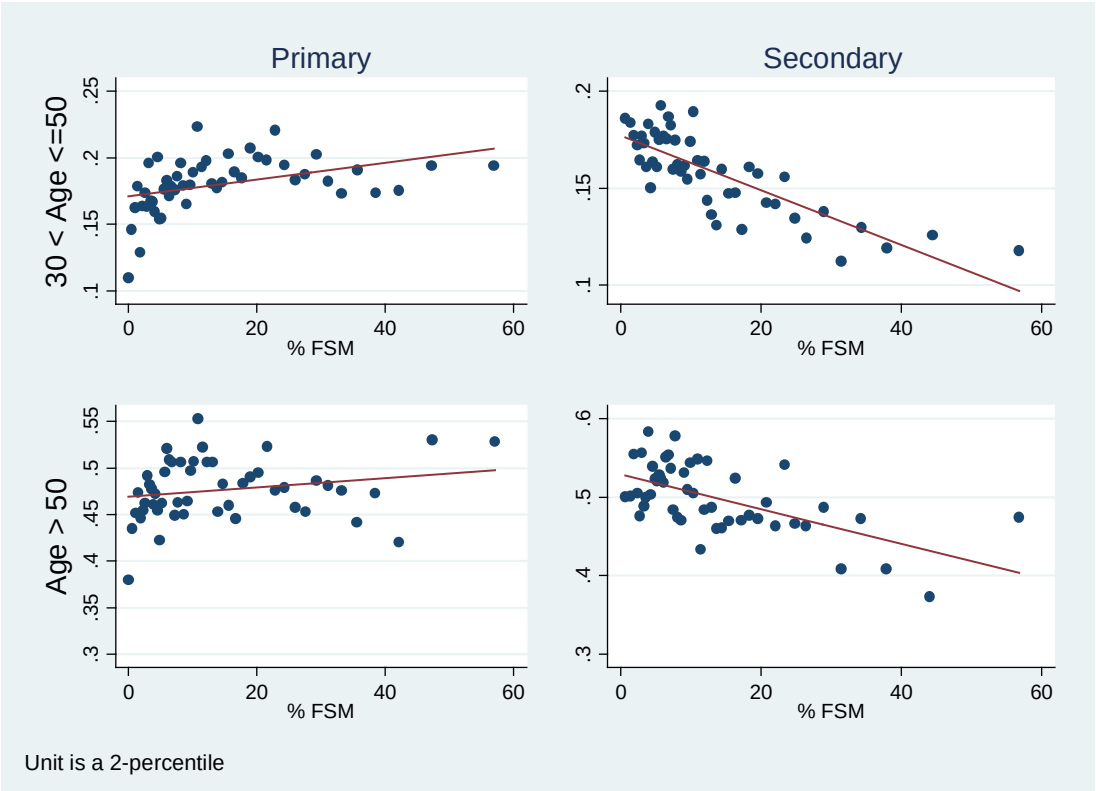


Unit is a 2-percentile

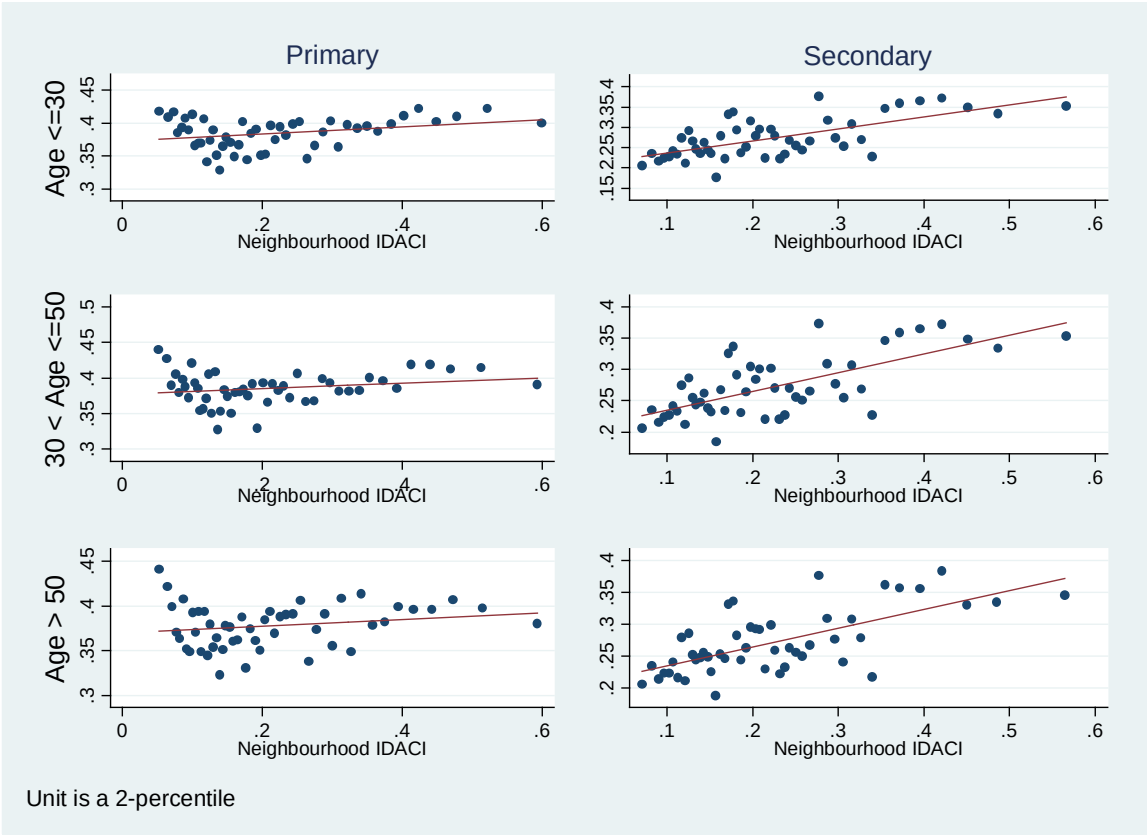
Appendix figure 7: % Tenure 0-2 years



Appendix figure 8: % Tenure 10+ years

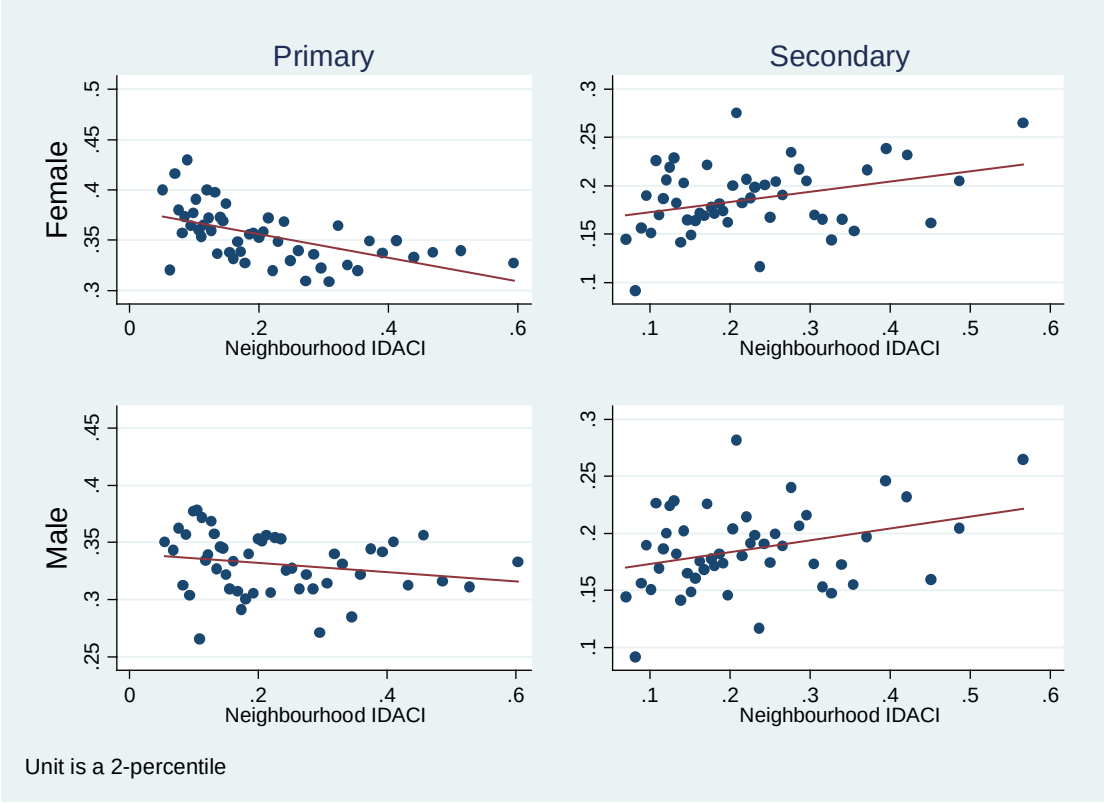


Appendix figure 9: Separation rate at three years

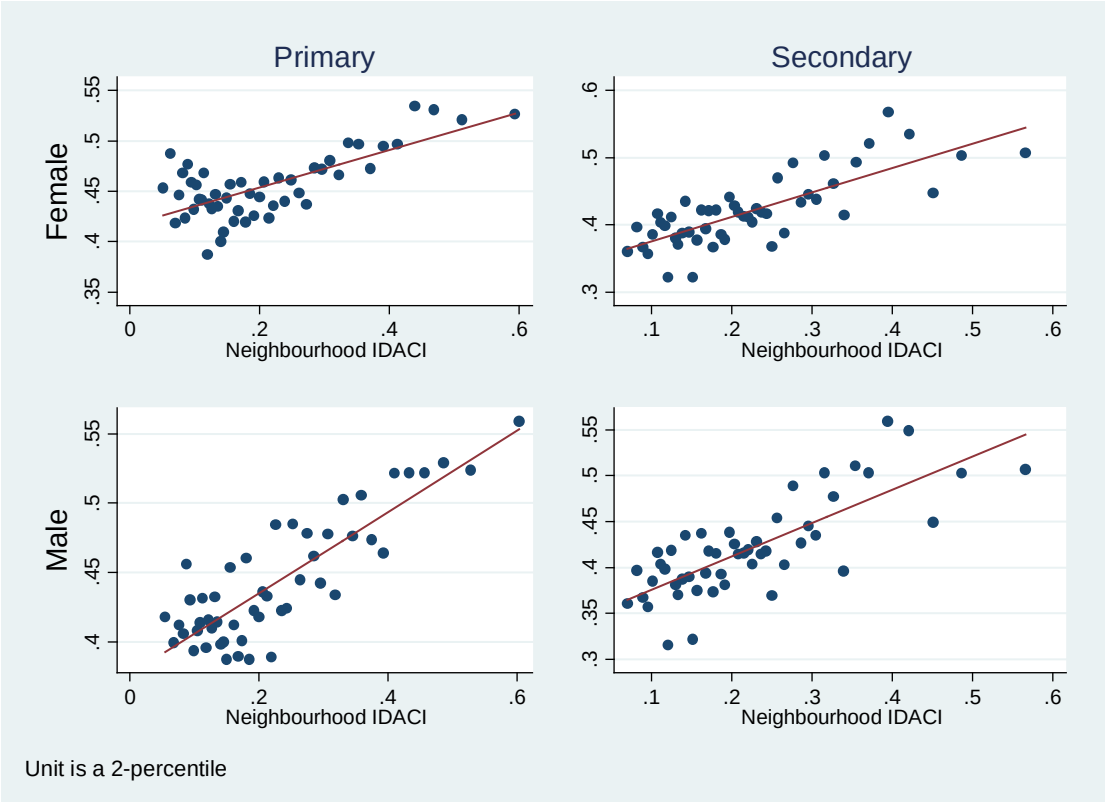


Unit is a 2-percentile

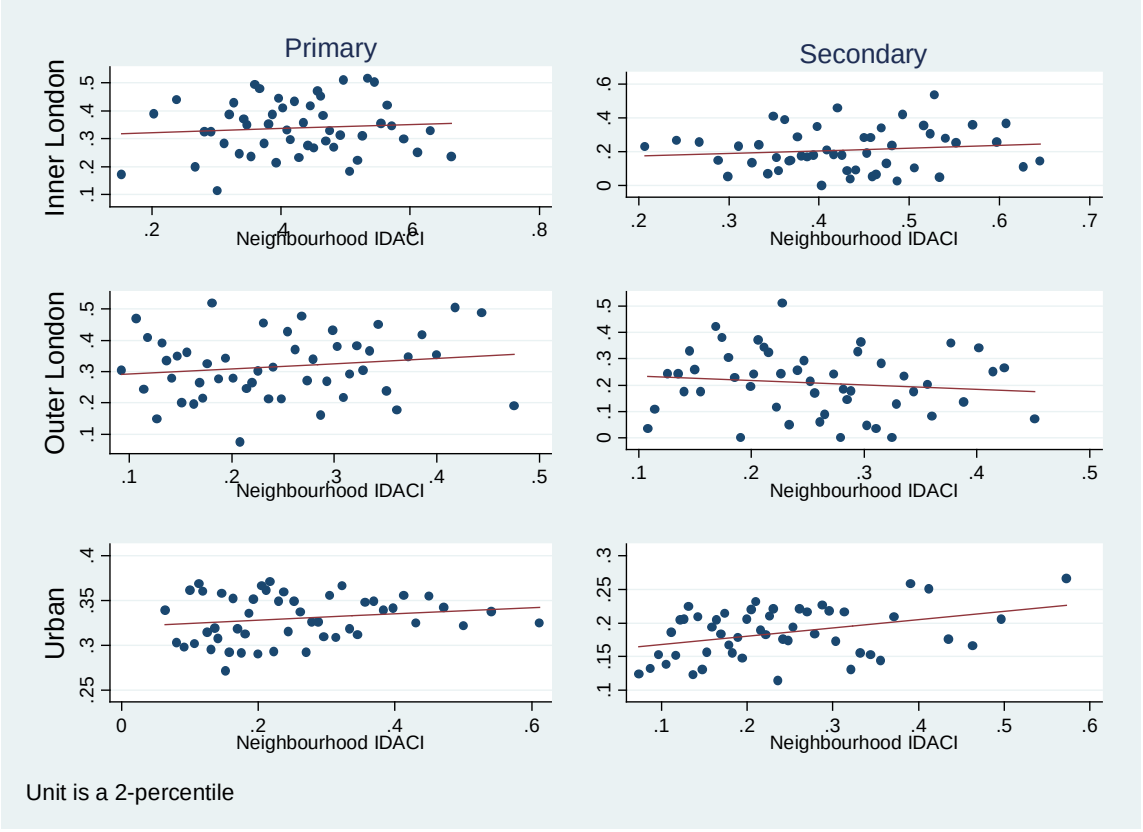
Appendix figure 10: Separation rate at two years



Appendix figure 11: Separation rate at five years

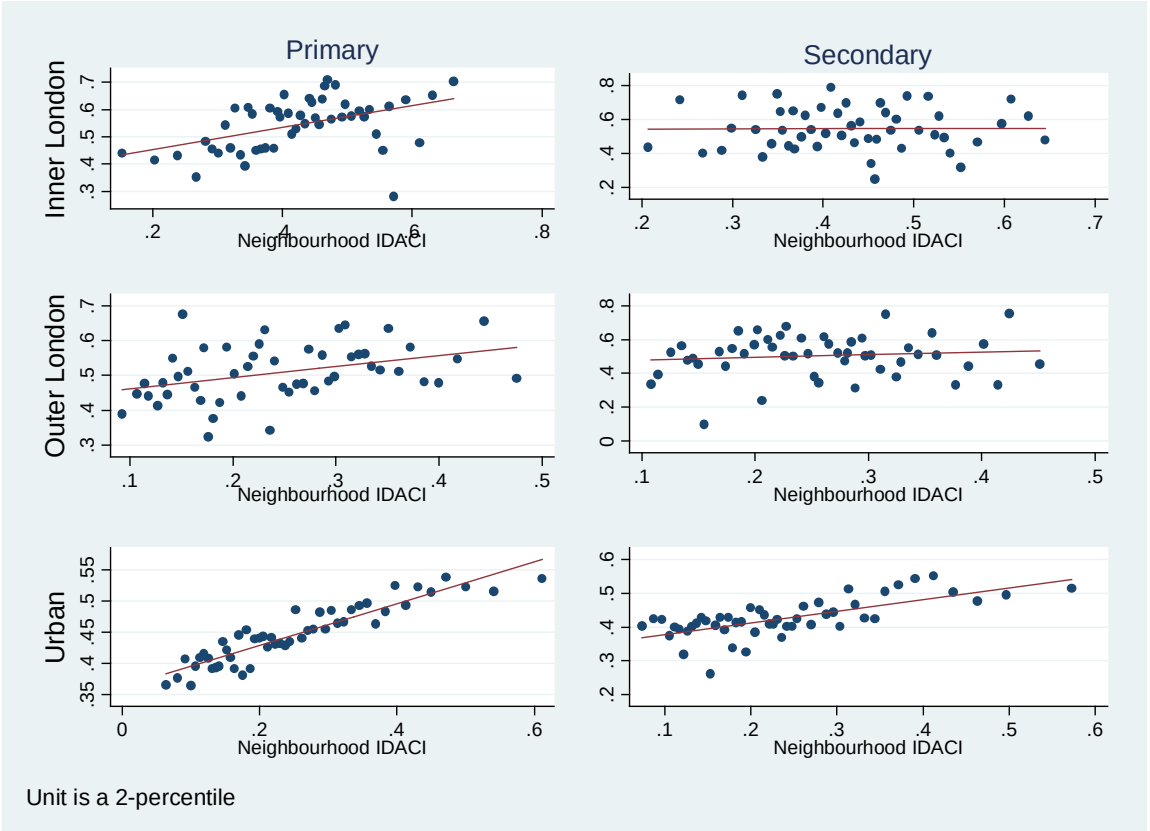


Appendix figure 12: Separation rate at two years



Unit is a 2-percentile

Appendix figure 13: Separation rate at five years



Unit is a 2-percentile

Appendix table 1

Variable	Obs	Mean	Std. Dev.	Min	Max
Female	343,547	0.765	0.424	0	1
Age	343,529	38.91	10.96	20	88
White ethnicity	343,547	0.896	0.305	0	1
Number of days in school at 4th Nov 2010	343,541	2,441.1	2,452.4	1	17,961
Full-time equivalent hours	343,547	0.895	0.214	0	1
Gross salary (at 1.0 FTE)	336,240	34,199.1	7,989.0	1.54	399,641
Employee based in London	343,547	0.156	0.362	0	1
Employee based in urban area	343,547	0.822	0.383	0	1
Employee teaches a shortage subject	343,547	0.079	0.270	0	1
Teacher expenditure (£k)	310,866	2,136.6	1,658.8	75.8	7,672.6
School has a 6th form	343,547	0.321	0.467	0	1
Proportion of female students	341,061	0.493	0.126	0	1
Number of teaching assistants per school	343,547	9.58	10.86	0	83
Number of FTE pupils	338,218	736.4	511.0	2.01	2,620
Proportion of pupils of white ethnicity	338,218	0.787	0.256	0	1
Proportion of pupils with SEN	338,218	0.017	0.015	0	0.235
Proportion of pupils with EAL	338,218	0.139	0.217	0	1
Proportion of pupils FSM eligible	338,218	0.143	0.127	0	0.798
School IDACI score	338,218	0.226	0.140	0.021	0.949

Appendix table 2: Teacher numbers and characteristics – without London

	---------- Secondary ----------			---------- Primary ----------		
	Male	*Female*	*Total*	*Male*	*Female*	*Total*
Age category						
Age <= 30	24.7	30.3	28.3	29.0	27.7	27.9
30 < Age <= 50	52.5	50.6	51.3	53.9	52.1	52.3
Age > 50	22.8	19.1	20.4	17.1	20.2	19.9
Highest Qualification						
Degree or higher	77.7	78.1	77.9	69.5	61.1	62.0
BEd	8.3	7.4	7.7	16.6	23.3	22.5
PGCE	3.8	3.1	3.4	3.1	2.5	2.5
Other qualification	2.8	3.6	3.3	3.8	6.5	6.2
Qualification not supplied	7.5	7.9	7.7	7.1	6.7	6.7
Ethnicity						
White ethnicity	89.9	91.0	90.6	94.0	94.0	94.0
Other incl Chinese ethnicity	0.7	0.9	0.8	0.6	0.5	0.5
Asian excl Chinese ethnicity	2.7	2.5	2.5	1.3	1.9	1.8
Black ethnicity	1.6	1.0	1.2	0.5	0.4	0.4
Ethnicity refused or missing	5.1	4.7	4.8	3.6	3.2	3.2
N	**52,276**	**93,359**	**145,635**	**15,683**	**128,795**	**144,478**

Note: Classroom teachers

Appendix table 3: Teacher numbers and characteristics – just London

	---------- Secondary ----------			---------- Primary ----------		
	Male	*Female*	*Total*	*Male*	*Female*	*Total*
Age category						
Age <= 30	30.6	35.1	33.5	33.7	34.3	34.2
30 < Age <= 50	50.8	48.9	49.6	51.8	48.1	48.6
Age > 50	18.6	16.0	16.9	14.5	17.6	17.2
Highest Qualification						
Degree or higher	80.7	79.5	79.9	69.1	65.5	65.9
BEd	5.8	5.6	5.7	10.1	16.0	15.3
PGCE	3.3	3.3	3.3	5.2	3.7	3.9
Other qualification	2.3	2.9	2.7	4.0	6.1	5.8
Qualification not supplied	7.9	8.7	8.4	11.6	8.7	9.1
Ethnicity						
White ethnicity	71.7	69.5	70.3	82.5	78.8	79.3
Other incl Chinese ethnicity	2.5	2.9	2.7	2.6	2.4	2.4
Asian excl Chinese ethnicity	8.4	10.3	9.6	4.7	7.9	7.5
Black ethnicity	9.7	9.6	9.6	4.8	5.9	5.8
Ethnicity refused or missing	7.7	7.8	7.8	5.6	4.9	5.0
N	**9,290**	**16,485**	**25,775**	**3,455**	**24,204**	**27,659**

Note: Classroom teachers

Appendix table 4: Base case plus pupil characteristics for LONDON ONLY

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.005	0.013	-0.029	-0.011	0.016	-0.021	0.016	0.005
	(0.017)	(0.016)	(0.045)	(0.039)	(0.021)	(0.019)	(0.060)	(0.057)
0.2 < Neighbourhood IDACI <= 0.3	0.022	-0.003	-0.024	-0.015	0.021	-0.031*	0.033	0.029
	(0.017)	(0.015)	(0.041)	(0.036)	(0.019)	(0.017)	(0.055)	(0.045)
Neighbourhood IDACI > 0.3	0.025	-0.005	0.017	0.017	0.025	-0.023	0.055	0.058
	(0.018)	(0.016)	(0.043)	(0.037)	(0.023)	(0.021)	(0.052)	(0.052)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	N	N	N	N	N	N	N	N
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	1708	1708	1578	1700	381	381	381	381
R-squared	0.041	0.066	0.029	0.028	0.104	0.138	0.026	0.111

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Appendix table 5: Base case EXCLUDING LONDON

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.011**	-0.002	-0.012	0.013	-0.000	-0.016***	0.000	0.017
	(0.004)	(0.005)	(0.012)	(0.010)	(0.006)	(0.006)	(0.014)	(0.015)
0.2 < Neighbourhood IDACI <= 0.3	0.034***	-0.016***	0.000	0.044***	0.018***	-0.035***	0.035**	0.052***
	(0.004)	(0.004)	(0.012)	(0.010)	(0.006)	(0.006)	(0.016)	(0.017)
Neighbourhood IDACI > 0.3	0.026***	-0.006	0.012	0.050***	0.027***	-0.059***	0.033*	0.084***
	(0.004)	(0.004)	(0.012)	(0.009)	(0.007)	(0.007)	(0.020)	(0.020)
Pupil characteristics included?	N	N	N	N	N	N	N	N
Market characteristics included?	N	N	N	N	N	N	N	N
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	14560	14560	11169	13995	2389	2389	2374	2388
R-squared	0.076	0.178	0.050	0.090	0.189	0.329	0.074	0.166

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Appendix table 6: Base case plus pupil characteristics EXCLUDING LONDON

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.010**	-0.001	-0.011	0.011	-0.000	-0.013**	0.001	0.017
	(0.005)	(0.005)	(0.012)	(0.010)	(0.006)	(0.006)	(0.015)	(0.015)
0.2 < Neighbourhood IDACI <= 0.3	0.031***	-0.013***	0.001	0.040***	0.017***	-0.028***	0.033**	0.050***
	(0.005)	(0.005)	(0.012)	(0.010)	(0.006)	(0.006)	(0.017)	(0.017)
Neighbourhood IDACI > 0.3	0.021***	0.001	0.011	0.041***	0.022***	-0.046***	0.030	0.074***
	(0.005)	(0.005)	(0.012)	(0.010)	(0.008)	(0.008)	(0.021)	(0.021)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	N	N	N	N	N	N	N	N
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	14560	14560	11169	13995	2389	2389	2374	2388
R-squared	0.077	0.183	0.051	0.091	0.191	0.340	0.074	0.167

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Appendix table 7: Base case plus pupil plus local market characteristics EXCLUDING LONDON

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.007	0.001	-0.011	0.005	0.000	-0.013**	0.002	0.018
	(0.005)	(0.005)	(0.012)	(0.010)	(0.006)	(0.006)	(0.015)	(0.015)
0.2 < Neighbourhood IDACI <= 0.3	0.025***	-0.009*	0.001	0.022**	0.018***	-0.025***	0.034**	0.049***
	(0.005)	(0.005)	(0.013)	(0.010)	(0.006)	(0.006)	(0.017)	(0.017)
Neighbourhood IDACI > 0.3	0.013***	0.006	0.011	0.019*	0.023***	-0.040***	0.031	0.073***
	(0.005)	(0.005)	(0.013)	(0.011)	(0.008)	(0.008)	(0.022)	(0.022)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Teacher characteristics included?	N	N	N	N	N	N	N	N
N	14559	14559	11169	13994	2388	2388	2373	2387
R-squared	0.080	0.194	0.051	0.094	0.195	0.344	0.074	0.176

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies

Appendix table 8: Base case plus pupil plus local market plus teacher characteristics EXCLUDING LONDON

	PRIMARY				SECONDARY			
	Tenure categories		Separation rates		Tenure categories		Separation rates	
	0-2 yrs	10+ yrs	2 yrs	5 yrs	0-2 yrs	10+ yrs	2 yrs	5 yrs
0.15 < Neighbourhood IDACI <= 0.2	0.004	0.009**	-0.008	-0.006	-0.005	-0.004	-0.001	-0.002
	(0.004)	(0.004)	(0.012)	(0.010)	(0.004)	(0.004)	(0.015)	(0.014)
0.2 < Neighbourhood IDACI <= 0.3	0.014***	0.004	-0.001	0.002	0.008	-0.011**	0.028	0.015
	(0.004)	(0.004)	(0.013)	(0.010)	(0.005)	(0.005)	(0.017)	(0.017)
Neighbourhood IDACI > 0.3	0.008**	0.010***	0.010	0.001	0.009	-0.022***	0.024	0.027
	(0.004)	(0.004)	(0.013)	(0.010)	(0.007)	(0.007)	(0.022)	(0.021)
Pupil characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Market characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
Teacher characteristics included?	Y	Y	Y	Y	Y	Y	Y	Y
N	141300	141300	11169	13994	140974	140974	2373	2387
R-squared	0.181	0.247	0.073	0.163	0.174	0.276	0.091	0.284

Notes: Standard errors are clustered by school
* indicates significant at 10%, ** indicates significant at 5%, *** indicates significant at 1%
Unit of observation is a school
Dependent variables measured as the proportion of teachers with tenure 0-2 (10+) years; separation rate at 2 (5) years
2 yrs separation rate = [(sum of teachers with tenure <= 2 years) – (sum of teachers with 2 years < tenure <= 4 years)] / (sum of teachers with tenure <= 2 years)
Variables included in all regressions are: pupil growth rate, school size dummies, sixth form, inner/outer London pay regions, local authority and urban dummies
Teacher characteristics are: age, gender, age/gender interaction terms, ethnicity, full-time/part-time dummy and shortage/surplus subject dummy
Pupil characteristics are: ethnicity, proportion of female students, SEN status and EAL status
Market characteristics included: school pay premium, market density dummies, and competitor pay premium, pupil growth rate and %FSM dummies