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Neighbourhood Turnover and Teenage Attainment

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Abstract
Theories about neighbours' influence on children based on social capital, cohesion and disorganisation stress the importance of neighbourhood stability. However, amongst the vast number of studies on the effect of neighbours on a child's education, none has tested whether neighbourhood stability matters. We fill this gap by estimating the causal effect of residential turnover on student test score gains. We show that high neighbourhood turnover reduces value added for students who stay in their neighbourhood, and this effect is more pronounced in more deprived neighbourhoods. Estimation is based on administrative data on four cohorts of secondary school children in England, allowing us to control for unobserved confounding individual effects, neighbourhood fixed effects and trends, plus school-by-cohort shocks. These main results, coupled with auxiliary findings based on survey data, suggest that neighbourhood turnover damages education through the disruption of local ties and social capital, highlighting a so-far undiscovered externality of mobility.

Keywords: Education, neighbourhood, turnover, social capital
JEL classification: C21; I20; R23

1. Introduction

The US and the UK are generally regarded as mobile societies, with workers and households moving in search of better jobs, housing and schooling. Available data confirm this intuition: the rate of mobility across US states has been around 2.5% during the late 1990s and 2000s, while the rate of cross-region mobility in the UK has stayed above 2% over the same period. These numbers are substantially lower for continental Europe, where mobility between similarly sized geographical regions has been approximately 1%, with figures as low as 0.2% and 0.4% for Spain and Italy in the 1990s, respectively (IZA, 2008). At a lower level of aggregation, the US and the UK still appear similarly mobile countries, with US cross-county mobility around 5% in the late 1990s (Partridge, 2012), and mobility across relatively comparable UK administrative units (i.e. NHS strategic areas) above the 3.5% mark (Champion, 2006).

As economists, we are inclined to regard this geographical mobility as a 'good thing', with high rates of mobility important for well-functioning and efficient markets. Geographical mobility of people offers opportunities for individual investment in human capital and adjustment to geographical changes in economic structure (Jovanovic, 1979; Greenwood, 2007; Partridge, 2012; Sjaasted, 1962).[1]

In contrast, researchers from other disciplines such as sociology and urban studies have emphasised that movements of people can, at the same time as generating benefits, impose considerable personal and external (social) costs in terms of human capital development. These external costs might fall on other members of a person's family, on their friends, their neighbours or community.

Our research bridges this gap by studying to what extent the educational achievement of children is affected by the residential turnover of neighbours of a similar age. Given its focus on residential mobility, our work clearly slots in and contributes to the empirical literature on neighbourhood effects. However, by estimating the external effects of neighbourhood turnover, we move the attention to important – but as yet ignored – questions about the social costs of mobility.

[1] Very few studies have shed light on potential negative effects from high levels of turnover (e.g. Huckman and Barro, 2005 for hospitals), with more work concentrated on the determinants of high mobility rates (Kaplan and Minton, 2006; Gentry and Hubbard, 2002).

Sutherland (1924) was among the first to suggest that higher levels of neighbourhood turnover break down strong ties among local residents, trigger 'social disorganization' and increase criminality. His initial insights stimulated a long line of related theoretical and empirical work in sociology (e.g. Shaw and Mackay, 1969; Sampson and Byron Groves, 1989). Within the urban study field, Jacobs (1961) was prominent in suggesting that neighbourhood turbulence can negatively affect children's well-being and learning. Similarly, residential mobility features as an important barrier to the accumulation of personal human capital in theories of 'social capital' (the antithesis of social disorganisation), because the "social relations that constitute social capital are broken at each move" (Coleman 1988, p.S113). This frequent fracturing in social relations in high mobility neighbourhoods presumably affects everyone in the community, not just those who move, leading to social as well as private costs.

The concepts of social disorganisation and social capital have filtered down to thinking in our field through the economics of social interactions, peer groups and neighbourhood effects. However, theoretical work in this area in economics has focussed on the influence of group members' behaviour and characteristics on the outcomes of other members of the group (Durlauf, 1996; Manski, 2000), rather than on the influence of the rate of turnover of members. Likewise, empirical work has largely focussed on measuring the effects of neighbourhood and peer group composition on individual outcomes (e.g., Kling et al., 2005 and 2007; Sanbonmatsu et al., 2012; Gibbons et al., 2013; Weinhardt, 2014). To the best of our knowledge, no previous work has instead looked at the specific causal influence of residential turnover. This is an important omission given the explicit role of community stability in the theories of social disorganization and social capital, and their counterparts in the economics of social interactions.

In order to investigate these issues, we use administrative data on the educational record of over 1.5 million school children in England tracking the progress of four cohorts as they transit from the end of primary to the middle of secondary schooling. Our data contains information on pupils' test scores, schools attended at different grades, background characteristics and detailed information on place of residence, which allows us to calculate changes in home address. We use these data to estimate the effect of neighbourhood residential turnover amongst children of similar age on a child's own educational progress in tests between ages 11 and 14. Our empirical strategy allows us to control for individual unobservables, neighbourhood fixed and trending effects as well as school-by-cohort shocks that might affect turnover rates and student achievement. We limit our main estimation sample to students who stay in the same neighbourhood between ages and 11 and 14. This allows us to identify the effect of movers on stayers – i.e. the effect of externalities associated with mobility – while by-passing the problem of identifying the effect of own mobility. However, we extend our analysis to consider mobile pupils and estimate 'intention-to-treat' turnover effects by assigning movers to the neighbourhood turnover they would have experienced had they not relocated. This mitigates selectivity concerns with the sample of stayers.

Even in highly saturated specifications with a full range of fixed effects and covariates, we find that pupils' test score progression between age 11 and 14 is reduced by the turnover of same-age students moving in and out of the neighbourhood. A twelve percentage point increase in annual turnover (about one standard deviation) causes a 0.3-0.4% of a standard deviation reduction in test score gains between ages 11 and 14. This effect *cannot* be caused by turnover in schools – or other school factors – since we control for these very flexibly by including in our specifications school-by-cohort effects. In England, it is feasible to identify neighbourhood effects conditional on school effects because there is not a one-to-one mapping between place of residence and attended school: on average, pupils living in the same neighbourhood attend two to three different secondary schools, and schools attract pupils from more than sixty residential areas. Similarly, our results are *not* driven by changes in neighbourhood composition, which we carefully control for, and have shown to have precisely estimated zero impact in previous work (Gibbons et al., 2013). Finally, our findings are *not* easily explained by unobserved features of the neighbourhood that drive mobility and attainments. First, our main regression specifications control for neighbourhood unobserved effects and thus estimation lives off the within neighbourhood, cohort-on-cohort variation in test scores and turnover. Second, we provide evidence that the value-added of secondary school pupils in a given cohort is not linked to the turnover of primary school children nor to the turnover of pupils in adjacent cohorts or adults (45-64 year old) more in general in the neighbourhood – instead, it is only affected by the residential mobility of same-age pupils.

The finding that pupils' achievements are adversely affected by turnover of children of a similar age suggests that the effects could be explained by the breaking down of social ties and friendship networks, which are presumably strongest among pupils in the same cohort. Using additional survey data for approximately 10,000 secondary school children, we find evidence consistent with this hypothesis: pupils living in neighbourhoods with high levels of turnover are less socially connected – for example, they tend to visit their friends' homes less frequently, are more likely to be excluded from groups of peers, and spend more of their free time 'hanging around' the house. A large sociological and psychological literature stresses the importance of friends and stable social circles for students' academic performance (Wentzel, 1993, and Reseth et al., 2008). Recently, Lavy and Sand (2012) have tested these theories using data on the disruption to social relationship among Israeli students during the transition from primary to secondary school, while Calvó-Armengol et al. (2009) have documented the importance of friends for educational attainments in general. Our findings contribute to this literature by showing that high levels of neighbourhood turnover lower pupils' attainment by undermining their local connections and social capital.

Our work also relates to the literature on mobility and individual outcomes. Much of this evidence concerns the private costs and benefits of mobility, i.e. the effects of mobility on the movers, rather than its externalities. A number of papers have found lower social capital amongst those undertaking more frequent residential moves (e.g. Pribesh and Downey, 1999; Pettit and McLanahan, 2006). Home ownership – a factor closely linked to lower rates of residential turnover – has also been associated with greater social capital (Di Pasquale and Glaeser, 1999, and Hilber, 2010). There is also evidence showing that children who move frequently (changing residence and/or school) have worse outcomes on various dimensions – including educational attainment (Coleman, 1988; Haganet et al., 1996; Hanushek et al., 2004; Schwartz et al., 2009). Work aimed at identifying the causal external effects of turnover is however almost non-existent. A small literature has developed on the external effects of turnover of children in schools, finding that higher rates of mobility have significant adverse effects on other children's subsequent achievement, both in the US (Hanushek et al. 2004) and England (Gibbons and Telhaj 2011). However, this approach has not been taken to investigating the social cost of neighbourhood turnover. Our study fills this gap.

The rest of the paper is structured as follows. Section 2 describes our data sources and the general institutional context. Section 3 sets out the empirical specification and the identifying assumptions. Sections 4, 5 and 6 describe the results, while and Section 7 concludes.

2. Context and Data

Our analysis is based on state-school students in England during the first three years of their secondary education. Compulsory primary education in England runs from age 5 (grade 0) to age 11 (grade 6), while compulsory secondary education runs from age 12 (grade 7) through to age 16 (grade 11). During our study period, students in England took a series of compulsory national assessments at age 7 (grade 2/Key Stage 1/KS1), at age 11 (grade 6/Key Stage 2/KS2) and age 14 (grade 9/Key Stage 3/KS3). At age 16, students took their end-of-compulsory education qualifications (GCSEs and equivalents). However, due to data limitations, in our study we do not analyse students beyond KS3.

School admission is closely, but not exactly, linked to place of residence. The exact details vary by school, school district (Local Education Authority, LEA) and have changed over time.[2] However, the general picture for the period of our analysis was that admission to state schools at both the primary and secondary phase was based on principles of parental choice, although in practice parents' 'freedom to choose' is constrained by the fact that popular schools become over-subscribed. When this occurs, various criteria are used to prioritise students, usually favouring those who live nearby, those with special educational needs, or those with siblings in the school. Certain types of schools can prioritise students according to other criteria – e.g. religion (faith-schools) or specific aptitudes (music and other specialist schools). A small proportion of state secondary schools select on prior achievement (Grammar schools), but students in these schools are excluded from our analysis. In general, for non-faith 'community' schools, parents apply to schools via the local authority, while for faith schools application is often made directly to the school. As result of these features of the admissions system, there is not a one-to-one link between place of residence and school attended, and neighbouring children may attend many different schools. These details are important for our analysis of the effects of residential turnover amongst similar age peers as it means that high residential turnover does not necessarily imply high school turnover, and vice versa.

[2] There are 150 LEAs in England. These are responsible for the strategic management of education services, including planning the supply of school places, intervening where a school is failing and allocating central funding to schools.

Our main data source is administrative information on students in England at the beginning of their secondary school careers taken from the National Pupil Database (NPD). We use records from the NPD for over 2 million students belonging to the four cohorts taking their KS3 assessments in 2005, 2006, 2007 and 2008, sitting for their KS2 tests four years earlier in 2002, 2003, 2004 and 2005, and taking KS1 exams in 1998, 1999, 2000 and 2001. The NPD provides various pieces of information on the students, including test scores in English, Mathematics and Science at KS2 and KS3; assessments in English and Maths at KS1; background characteristics, such as gender, eligibility for free meals, special educational needs and ethnicity; schools attended and their characteristics; and postcode of residence. Using the latter detail, we assign pupils to Census Output Areas (OAs) which constitute small neighbourhoods hosting on average 125 households and approximately 5 children of the same age.

Our main estimation focuses on the sub-set of these students who stay in the same residential neighbourhood – defined by the Census OA – over the years between their KS2 tests and KS3 tests. More precisely, the stayers are defined as students whose home address is recorded in the same OA in the year they take their KS2 tests and in year they take their KS3 tests, and in the two intervening years. For the remaining students in the NPD who move over the KS2-to-KS3 period, we still have complete information on place of residence, characteristics and test scores. We use these students to construct neighbourhood turnover rates specific to each cohort, as well as changes in the neighbourhood composition between KS2 and KS3 driven by this residential mobility.

Neighbourhood-by-cohort turnover rates are built from the inflow and outflow rates of same-age students in a given cohort (i.e. students taking their KS3 tests in a given year), within each student's residential census OA and averaged over the three-year interval between KS2 test (end of grade 6) and KS3 test (end of grade 9). More formally, we measure turnover as $mob_{nc} = 1/3\sum_{t=1}^{t=3}(in_{nct} + out_{nct}) / stock_{nct}$, where in_{nct} is the inflow of same-age students to neighbourhood n during one of the three one-year intervals between KS2 and KS3 for cohort c, out_{nct} is the outflow of same-age children from the neighbourhood over the same period for cohort c, and $stock_{nct}$ is the number of same-age students belonging to cohort c at the beginning of each of the one-year periods between KS2 and KS3. In some robustness checks, we also look at the effects of inflow and outflow rates separately. Furthermore, in order to allay concerns about selectivity of our sample of stayers, we also carry out our analysis on an extended sample that includes moving pupils, which we assign to the neighbourhood turnover they would have experience had they not relocated. In this case, our findings on the external effects of turnover should be interpreted as yielding 'intention-to-treat' estimates.

Note finally that we restrict the sample to individuals with non-missing information in all periods of our investigation, so that variation in neighbourhood mobility and neighbourhood characteristics is not driven by students dropping in and out of our sample, but only by residential changes. Given the quality of the administrative data, this restriction is virtually inconsequential in terms of sample size and representativeness.

For some parts of our analysis, we also make use of the Longitudinal Study of Young People in England (LSYPE), which sampled approximately 14,000 students aged 14 in 2004 in 800 schools, and followed them as they progressed through their secondary education up to age 16 and beyond. This set of pupils belongs to a cohort which is one year older than the first cohort included in our main sample. Most of the information available for our main sample is available for the LSYPE children too, except for age-7 KS1 test scores. However, information on place of residence is only available for grades 7, 8 and 9 (ages 12 to 14), so for this cohort we calculate neighbourhood turnover (and associated changes in neighbourhood composition) over the two-year interval corresponding to grades 8 and 9, rather than the three-year interval used in our main analysis.

The LSYPE survey covers students' experiences at school, at home and in their neighbourhood, and contains a number of questions related to pupils' social ties and use of their leisure time. These questions were asked in a confidential environment to encourage students to answer truthfully. We will use this information in Section 6 to investigate the link between neighbourhood turnover and social connectedness.

Other information on housing prices and demographic characteristics is merged in with the pupil level data using the residential postcodes and OAs. Our main data set provide us with information on more than 1.2 million students who stay in the same residential neighbourhood between ages 11 and 14, while the LSYPE data provides us with information on approximately 10,000 who do not change their address between ages 12 and 14. The next section discusses the empirical specifications we use to estimate the effects of neighbourhood turnover on these students' outcomes.

3. Empirical specification

The aim of our empirical work is to estimate the external effect of neighbourhood turnover on students' educational attainment during secondary schooling. Our empirical specification controls for a number of potential pupil-level, school-level and neighbourhood-level unobservables that might be correlated with both pupils' outcomes and neighbourhood turnover. To formalize our discussion, we assume a simple linear educational value-added in which the educational progress (test score gains) between KS2 and KS3 for student *i*, living in neighbourhood *n*, belonging to cohort *c*, and attending schools *s2* at KS2 and *s3* at KS3 depends on residential turnover in the student's home neighbourhood in the years between their KS2 and KS3 assessments (mob_{nc}) as described in Section 2. Furthermore, pupil value-added is affected by student, neighbourhood and school characteristics that are observed in our data (x_{incs}), as well as a combination of unobserved factors at the individual, neighbourhood, school and cohort level. These are potentially correlated with neighbourhood turnover and we allow them to affect test score progression very flexibly through a function *f(.)*. Finally, pupil value-added is affect by a random error term (ε_i) uncorrelated with all other factors.

Putting this all together, our empirical model takes the following form:[3]

$$\left(KS3 - KS2\right)_i = mob_{nc}\beta + x'_{incs}\lambda + f\left(\sigma_i, \nu_n, \tau_c, \upsilon_{s2}, \upsilon_{s3}\right) + \varepsilon_i \qquad (1)$$

In our main empirical application, we estimate Equation (1) on the subset of students who do not move neighbourhood between KS2 and KS3, so *n* is fixed for a given student *i*. This restriction means that individual student's own mobility between KS2 and KS3 does not enter into Equation (1). This allows us to focus on the external effects of turnover on stayers. When we estimate Equation (1) using the extended sample that include movers, we assign turnover based on the neighbourhood of origin since any subsequent measure of turnover is likely to be endogenous because of residential sorting.

[3] Appendix I provides more details about the analytics leading to this model specification.

Note that cohort *c* defines a group of students that are in the same school grade at the same point in time, and each cohort is effectively identified by the year when students took their KS3 tests (either 2005 or 2006 or 2007 or 2008). Since there is no grade repetition or skipping in England, these students remain in the same one-year age cohort throughout the period. In Equation (1), $KS3-KS2_i$ is the gain in individual student test scores (averaged across English, Mathematics and Science) between Key Stage 2 and Key Stage 3. In the empirical analysis, these test scores are standardised by converting to percentiles within the national student distribution for cohort *c*.

The focus of our interest is on the estimation of β, interpreted as the expected change in students' test score gains caused by an exogenous change in neighbourhood residential turnover during the years between the two sets of tests. The fundamental challenge to consistent estimation of β is that neighbourhood-cohort turnover mob_{nc} is likely to be correlated with the unobserved determinants of these test score gains in *f(.)*. This correlation occurs because residential mobility and student achievement are affected by similar unobserved factors, and students that differ in unobservable ways will sort into high and low turnover neighbourhoods. For example, mobility could be generally higher in areas populated by low-income/socioeconomic groups, with higher rates of job and family separation, and with a high incidence of short term rental housing. Residential sorting would imply that these factors also characterise a student's own family situation and hence have direct effects on student's achievement. Furthermore, as discussed in Section 2, England has a system of (partially) geographically constrained school choice, so residential turnover could also be related to local school quality (e.g. teaching quality, resources, and composition) through the school-choice processes. This implies that turnover in the neighbourhood might be correlated with turnover in schools – which has been shown to have direct effects on pupil achievement (Hanushek and Rivkin, 2004; Gibbons and Telhaj, 2011). These school-related effects are particularly pertinent in our context, because we study the period from KS2 to KS3, during which students also move between primary and secondary school, so there is considerable school-choice related mobility.

Our identification strategy exploits the detail and size of our data – coupled with institutional features of schooling in England – to control for the unobserved factors in *f(.)* as far as is feasible through a variety of neighbourhood, cohort, primary- and secondary-school fixed effects. In particular, the data allow us to include OA neighbourhood effects because we have multiple cohorts. In this case identification comes from the variation in neighbourhood-by-cohort turnover between cohorts. Furthermore, school-by-cohort effects can also be included in our specification because, as explained in Section 2, there is not a one-to-one mapping between the neighbourhood where a child lives and the school they attend. Pupils of the same age and living in the same OA attend, on average, two to three different secondary schools, and these schools usually attract pupils from more than 60 OAs. This institutional feature allows us to control for secondary school-by-cohort effects or primary-by-secondary-by-cohort effects. On the other hand, it is infeasible to include individual fixed effects directly, because we only observe the KS2-KS3 change in test scores once for each student. However, controlling for neighbourhood fixed effects eliminates unobserved individual effects σ_i assuming that the composition of the neighbourhood in terms of mean σ_i does not change between cohorts over our period of study, i.e. $E[\sigma_i|n,c] = E[\sigma_i|n,c+1]$ for all c. Given our focus on stayers, and some balancing regressions we present later, this assumption seems plausible.

In addition to these fixed effects, most of our specifications include a selection of conditioning variables in x_{incs} drawn from what we observe in our data. Individual characteristics include gender, KS1 (age-7) attainments, free school meal entitlement and special education needs. These characteristics are recorded in the year a student takes the KS2 test and treated as fixed/predetermined. We also account for time-varying features of the neighbourhood that relate to the cohort under analysis. First, we control for variation in neighbourhood characteristics by including neighbourhood-by-cohort changes in the means of the individual students' characteristics between KS2 and KS3. These measures are computed including moving individuals who effectively drive the neighbourhood changes in these predetermined measures. Second, we control for the initial levels of these neighbourhood characteristics to account for any correlation between cohort-specific turnover and the cohort-on-cohort variation in the initial characteristics of residential areas. Third, in all specifications that include covariates, we control for both the initial size of the neighbourhood – as measured by the number of same-age neighbour-peers – as well as its change between KS2 and KS3, i.e. the net inflow of students. This allows us to isolate the effect of turnover while controlling for any direct impact of size of a pupil's network, as well as any unobservable that attracts or deters movers (and so affect net inflows). Finally, in most specifications we include neighbourhood-by-cohort turnover rates for three-year lagged cohorts – i.e. turnover of primary school children who took their KS2 assessments in 2005, 2006, 2007 and 2008 (and will take their KS3 assessments in 2008, 2009, 2010 and 2011). These primary-schooling neighbourhood-by-cohort turnover rates are constructed in an analogous way to the KS2-to-KS3 mobility rates described in Section 2, but averaging the inflow and outflows of children moving into and out of each OA over the four years prior to KS2 in 2005, 2006, 2007 and 2008. We use this variable to further capture the effect of neighbourhood shocks not accounted for by the inclusion of neighbourhood effects and characteristics in our model that might drive both test score progression and turnover.[4]

Our identifying assumption in estimating Equation (1) is that the cohort-to-cohort changes in neighbourhood, cohort-specific residential turnover are uncorrelated with the unobserved determinants of student achievement, once we condition on a highly exhaustive set of neighbourhood, school and cohort effects. We assess our identifying assumptions by examining the sensitivity of the estimates of β to different combinations of these fixed effects and covariates. Moreover, we present 'balancing' tests that show that observable neighbourhood-by-cohort and individual characteristics are uncorrelated with neighbourhood turnover once we condition on neighbourhood fixed effects. Finally, we present some falsification tests where we replace our mobility measure with proxies calculated over primary school pupils, based on pupils who are either one year older or one year younger than the students under analysis, or calculated for adults (45-64 year old) in the neighbourhood. This extensive battery of tests suggests that our results are not spurious, but causally linked to pupil value added.

[4] Our control variable set includes school characteristics such as the size of the school attended at the beginning of secondary school (in grade 7) and school-type dummies (also referring to the school attended in grade 7 and including: Community, Voluntary Aided, Voluntary Controlled, Foundation, CTC and Academy) when school effects are not included. The exact details of each specification are set out in the Results section.

4. Main Results

4.1. Descriptive Statistics

Descriptive statistics for our estimation sample of residential stayers are presented in Table 1. The main estimation sample has 1.2 million students evenly spaced over four cohorts and living in around 133,000 OAs. The top panel of the table summarises the individual characteristics. The percentiles of the KS2 and KS3 test scores are based on the full set of stayers and movers, and for pupils who don't move have a mean of 50 and standard deviation of 26. The value-added in the full dataset has a mean of zero. The descriptive statistics in Table 1 show that the sample of stayers is broadly representative of the overall national sample (compare figures in Gibbons et al., 2013, Appendix Table 1), though stayers have marginally lower KS2 achievements (by 0.46 percentiles), higher KS3 achievements (by 0.64 percentiles) and hence a slightly higher value added (by 1.1 percentiles). Evidently, movers have lower educational progress than stayers, which is consistent with the literature that shows that frequent moves are associated with lower educational achievements. We do not go any further here in trying to establish the causality in this relationship.

Panel B presents descriptive statistics for the neighbourhoods of residence. These show that the average rate of annual turnover between KS2 and KS3 (grade 6 to grade 9) is 14.5%, split between 6.4% outward mobility and 8.1% inward mobility.[5] On average approximately 5.3 pupils of the same age live in the same census OA neighbourhood. Turnover amongst primary school children, from grade 3 to KS2 (grade 6) is larger at 20.4%. The fact that residential mobility is higher in primary school years has been previously documented in the UK (see Machin et al., 2006). The table also shows the change in neighbourhood composition for the stayers' sample. There is little overall change in the neighbourhood means of KS1 scores, or FSM, SEN and male proportions. Given that during this period there were no evident national trends in these variables, this suggests neighbourhoods with stayers are not changing in ways that are significantly different from those of neighbourhoods without any stayers.

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[5] For comparisons, Ihrke and Faber (2012) report that the share of individuals sampled by the US Current Population Survey who changed their residence over the previous 12 months is around 15% between 2005 and 2010. It should be noted that this figure includes respondents of all ages – and not 11 to 14 year old pupils as in our data.

Figure 1 uses histograms to display the extent of variation in KS2-to-KS3 neighbourhood turnover in the stayers' sample. The top-left plot shows that, although nearly 20% of the neighbourhood-by-cohort observations experience no mobility, there is a substantial amount of variation overall. The remaining plots show the distribution of the residuals from regressions of turnover rates on the various sets of fixed effects employed in the main regression analysis below. These plots show that there is considerable variation in neighbourhood-by-cohort turnover rates even when we control for either secondary school-by-cohort fixed effects (top right) or primary-by-secondary-by-cohort fixed effects (bottom left), or neighbourhood fixed effects (bottom right). The numbers in the notes to the figure show that the standard deviation in turnover rates changes little as we control for school-by-cohort effects, from 0.128 down to 0.110. The within-neighbourhood standard deviation of turnover rates is only slightly lower at 0.098. This shows that approximately 60% of the neighbourhood-by-cohort turnover variation occurs within the same neighbourhood and over time.

4.2. Main findings from the regression analysis

Our main set of results is presented in Table 2. The table reports regression coefficients and standard errors. Columns (1), (3), (5) and (7) do not include covariates, whereas Column (2), (4), (6) and (8) include individual characteristics, school size and school-type variables, plus neighbourhood variables (more details are provided listed in the notes to the table). The coefficients present the effect of a 100% increase in annual mobility on the test score gain, where the latter are measured in percentiles in the student cohort-specific national distribution. In the discussion below we also report these as standardised effect sizes, calculated from the coefficients and the standard deviations in Table 1 (i.e. the percentage standard deviation change in value added associated with a one standard deviation change in mobility). Note that we allow for some spatial and temporal autocorrelation and heteroskedasticity in the error term of students living within the same OA, and report standard errors that clustered at this level.[6]

[6] Clustering at a higher level – for example at the LEA level – does not affect the significance of our findings.

The first two estimates in Columns (1) and (2) show the association between neighbourhood turnover and pupil value-added when we do not include any school-by-cohort or neighbourhood effects.[7] In Column (1), the coefficient of -3.9 indicates that a 10 percentage point increase in turnover is associated with a 0.39 reduction in the percentile gain, equivalent to a standardised effect size of 3.7%. However, this estimate is likely to be biased by unobserved school and neighbourhood factors and is sensitive to the inclusion of our basic set of covariates, with a 40% reduction in the coefficient when moving from Column (1) to (2).

Column (3) and (4) introduce primary-by-secondary-by-cohort fixed effects into the specification. These account for any correlation between neighbourhood turnover in the years between KS2 and KS3 and school factors – such as composition, resources and mobility – that pupils experience upon transition from primary to secondary school and might affect their educational progress. Accounting for these school unobservables reduces our estimates by a factor of five compared to Column (1).[8] We now find a coefficient of -0.78, representing a standardized effect size of 0.7%. Importantly, once we include these fixed effects, the point estimate is less sensitive to the addition of individual, school and neighbourhood covariates, falling by only 20% when moving from Column (3) to Column (4).[9]

Column (5) and (6) replace primary-by-secondary-by-cohort effects with neighbourhood effects and thus rely on the cohort-on-cohort variation in turnover. Columns (7) and (8) further add school-by-cohort fixed effects, alongside neighbourhood effects.[10] The coefficient on turnover is now around -0.33 to -0.43, or a standardised effect size of 0.32-0.40%. Once we condition on neighbourhood fixed effects, the point estimates are fairly insensitive to the inclusion of covariates, given the standard errors, changing by only 10-14%. This suggests that variation over time in neighbourhood turnover is uncorrelated with the control characteristics. This reinforces our claim that turnover in the residential areas is balanced with respect to

[7] Note that we investigated whether our findings are substantially different when we consider English, Maths and Science separately, but found that this is not the case.
[8] Dropping pupils who change secondary school between year 7 and year 9 (approximately 10%), does not change our findings. For example, the coefficient in Column (4) marginally decreases to -0.581 (s.e. 0.110).
[9] Regressions that control for secondary-school-by-cohort effects (and not for primary-by-secondary-by-cohort effects) return slightly larger estimates, but still substantially smaller than in Columns (1) and (2). For example, conditional on secondary-by-cohort effects and our extensive set of controls, we find a coefficient of -0.952 (s.e. 0.104).
[10] Including primary-by-secondary-by-cohort dummies and neighbourhood effects proved computationally unfeasible, so our specification only include secondary-by-cohort and neighbourhood effects.

pupil and other neighbourhood characteristics once neighbourhood unobservables have been accounted for, and suggests that our estimates pin down the causal external effect of neighbourhood mobility. In the next section, we present more evidence to support this statement.

Although these point estimates and associated standardized effects are small, pupils spend five years in secondary education, and up to eleven years in compulsory education. So the (linearly) cumulated effect of annual mobility over the course of their education could substantially larger (up to nearly three times).

4.3. Balancing, robustness checks and further results

In Table 3, we directly assess the extent to which neighbourhood turnover is correlated with observed pupil, neighbourhood and school characteristics. The aim is to understand whether high and low mobility areas are comparable – or 'balanced' – in terms of observable characteristics, conditional on the neighbourhood fixed effects which we include in our preferred specification (Column 5 and 6 in Table 2). The table reports the coefficients and standard errors from separate regressions of various pupil (panel A), school (Panel B) and neighbourhood (Panel C) attributes on neighbourhood turnover. Column (1) includes no control variables other than cohort dummies, whereas Column (2) includes neighbourhood fixed effects. The various pupil, school and neighbourhood characteristics are described in the table notes. The estimates in Column (1) show a significant and sizeable association between neighbourhood mobility and a host of individual, school and neighbourhood features. The sign of these relations suggests that areas with higher levels of turnover are inhabited by more disadvantaged pupils who attend more disadvantaged schools, and that these neighbourhoods command lower prices. However, once we include neighbourhood effects as in Column (2), all the coefficients shrink substantially and most of them (11 out of 13) become statistically insignificant. Only one – secondary school size – is significant at the 5% level, but its effect is in any case accounted for by the school-by-cohort effects in Columns (7) and (8) of Table 2. These results suggests that the variation we use to estimate the external effect of mobility on pupils' value added is unlikely to be related to other potentially unobserved individual, school and neighbourhood aspects and that the estimates discussed above present a well-identified external effect of neighbourhood mobility on pupil value added.

Note that in our previous work, we provided additional evidence that mobility is unlikely to be driven by households' response to specific unobserved neighbourhood shocks (see Appendix Table 3 in Gibbons et al., 2013). In that analysis, we used information contained in the British Household Panel Survey on a representative sample of families to track residential movers and identify (through open ended questions) the reasons for moving. Using a sub-sample of 637 moving households with children for the years matching our main data, we found that the four main reasons for moving related to: physical attributes of the home (e.g. move to a bigger house); changes to household arrangements (e.g. family break-up); changes of tenure status (e.g. buying a home); and *(d)* job-related reasons. Conversely, less than 5% of the moving households reported reasons that had some connection to neighbourhood changes or local education issues.

To further validate our results, we perform an extensive set of falsification and robustness checks. These tests are presented in Table 4, which shows coefficients and standard errors from regressions of pupil value added on neighbourhood mobility using a similar specification to Column (6) of Table 2. The columns in Table 4 differ in terms of the measures of neighbourhood mobility used and/or the sample of students retained for estimation.

In Column (1), we replace our usual measure of secondary school students' neighbourhood mobility with a measure of neighbourhood turnover amongst primary school age children (calculated over the three-year interval when students in the estimation sample are in grades 7, 8 and 9; see Section 3 for more details). This test shows no significant association between pupil test score progression and primary school children's neighbourhood mobility.[11] Next, in Column (2) of the table, we include our usual mobility measure alongside neighbourhood turnover proxies computed using pupils who are one year younger and pupils who are one year older than the cohort in consideration. We find that the size and significance of the relationship between pupil value added and own-cohort mobility remain unaffected and similar to the one presented in Column (6) of Table 2. Conversely, we find no evidence that the mobility of older or younger pupils has a negative effect. It is useful to note that the correlation between turnover in one cohort, and

[11] Note that we include this variable as a control in the specifications in the even columns in Table 2, where our focus is on KS2-to-KS3 turnover. Even in those specifications, we do not detect any significant association between primary school turnover and value added.

turnover among younger and older cohorts in the same neighbourhood is low and always below 0.20. This low correlation reinforces our argument that cohort-specific variation in neighbourhood mobility is 'as good as random', and not driven by common neighbourhood shocks which affect all cohorts simultaneously and might have direct effects on student achievement.

In Column (3) we simultaneously include the usual indicator of neighbourhood turnover based on same-age pupils and a measure of neighbourhood turnover amongst 45-64 year-old adults. This measure of adult turnover is calculated using National Health Service (NHS) data on the number of individuals registering and deregistering from General Practitioners (GPs, local family doctors). This type of mobility is potentially relevant for our analysis since households usually register at a close-by local GP and change doctor when they move. More specifically, we calculate the share of 45-64 year-old registrants and de-registrants for every GP practice in England for each year in which pupils in our data take their KS3. We then assign GP mobility numbers to each pupil's neighbourhood using the closest GP practice.[12] When we include this additional control in our regression, we still find that the turnover of same-age pupils has a negative and significant effect at -0.388 (s.e. 0.166). Conversely, adult mobility has a smaller and non-significant effect – though negative – at -0.199 (s.e. 0.836).

All in all, the first three columns of Table 4 suggest that it is only the turnover of students of the same age that affects value added, and *not* other neighbourhood unobservable factors driving at the same time residential mobility and pupil achievements. This pattern also suggests that our findings are likely to be explained by the disruption of local social which are likely to be strongest among pupils of the same age.

One possible concern with the value-added specifications presented in Table 2 is that they restrict pupil KS2 lagged test scores to have full persistence on current KS3 outcomes. This might be problematic if *(i)* neighbourhood turnover is related to some transitory shocks that positively affect the performance of all pupils in the neighbourhood; *(ii)* this shock drives some pupils to leave the neighbourhood while other remain and then 'mean-revert' to lower levels of attainment (in relative terms) by the time they reach KS3.

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[12] Assigning pupils' neighbourhoods to the average mobility of the closest 3 or 5 GP practices does not change our findings. Similarly, using figures from the year before pupils sit for their KS3 exams produces similar results. Finally, using the shares of 15-64 year olds registering and deregistering from GP practices does not affect our findings.

If this was the case, estimating a restricted value-added specification would attribute the effect of transient shocks and mean-reversion to neighbourhood mobility – while this is instead just a mechanical feature. In order to address this concern, in Column (4) of Table 4 we estimate an unrestricted value added model where lagged (i.e. KS2) test scores are included on the right hand side of the regression and instrumented with teacher-based assessments of KS2 achievement to correct for transient components and errors in the KS2 test scores. This approach yields a larger negative estimate of the effect of neighbourhood mobility at approximately -0.38, largely comparable to our main estimates in Table 2.

Next in Column (5) we consider whether our results are potentially biased by selectivity issues related to the fact that we only consider pupils who do not move, i.e. the stayers. To do so, we augment our sample with pupils who move and assign them to the turnover they would have experienced had they not changed residence. As discussed in Section 2, we use neighbourhood of origins to avoid endogeneity of turnover for movers due to residential sorting. In this setting, our estimates are more properly interpreted as 'intention-to-treat' effects. Note also that we control for the effect of 'own' mobility although we do not show or interpret the estimated effect as this is likely to be biased by endogeneity. The estimate in Column (4) shows that the association between value-added and turnover increases to -0.62 for the sample that includes movers, with an associated standardised effect size of 0.6%. This suggests that our main estimates on the sample of stayers could be downward biased, although the 'intention to treat' estimate might be upward biased by the fact that we can only control for neighbourhood-of-origin fixed effects for the sample of movers. In any case, both estimates are significant and of a similar order of magnitude, suggesting that our main effects are not substantially biased by selectivity issues.

Next, in Column (6) and (7) of the table, we consider separately the effect on inwards and outwards mobility. Both effects are found to be negative, significant and of very similar magnitudes, with associated standardized effects of 0.37% and 0.41% for inward and outwards mobility, respectively. This finding supports our arguments that we are estimating the causal effects of random changes in turnover, rather than the spurious impact of 'flight' due to general neighbourhood decline or influx due to neighbourhood improvements – i.e. 'gentrification' – which might directly affect the achievements of the stayers. .

The final two columns of the table investigate whether the size of the neighbourhood we consider matters for our results. First, in Column (8), we drop the 30% smallest neighbourhoods with less than four pupils. Next, in Column (9), we include our usual OA-turnover measure alongside turnover computed for a larger geographical neighbourhood (Lower Super Output Area, containing 4-6 OAs, and 20-30 pupils of the same age). In both cases, the key result is essentially unchanged, although dropping the smallest neighbourhoods in Column (8) yields less precise estimates. Conversely, dropping the 30% biggest neighbourhoods with seven or more children yields a similar point estimate at -0.439, but very precisely estimated and significant at the 1% level (results not tabulated). Column (9) further suggests that mobility in the immediate OA neighbourhood has a more statistically significant influence than mobility in the wider area, although the point estimates are similar. Taken together, these results suggest that mobility in smaller groups matters more, which is consistent with our intuition that our results are explained by disruption to close social ties and friendship networks.

In a set of unreported results, we also studied whether the effect of turnover is non-linear by including quadratic and cubic terms of our mobility measure. We failed to find any significant pattern. We also studied whether mobility between KS2 and grade 7 has a differential effect from turnover between grade 7 and grade 8, or between grade 8 and KS3. We found that the joint effect of these three proxies was significant and negative, and that a test for the three effects to be the same clearly accepted the null.

5. Patterns of heterogeneity

5.1. Heterogeneity by individual and neighbourhood characteristics

In Tables 5, 6 and 7, we investigate whether our results differ for pupils with different background characteristics (Tables 5 and 6) or living in areas with different characteristics (Table 7). Looking at these patterns of heterogeneity may help shed light on some of the mechanisms behind our findings.

Starting with Table 5, the results suggest broadly similar effects across different types of student, although the point estimates are larger for boys, poor (FSM) students, those without special educational needs, and pupils with lower early age achievements. None of these differences is statistically significant at conventional levels, while the coefficients relating to the complementary group pairs (e.g. boys and girls) are jointly significant. The most notable difference is between boys and girls, with the effect on girls around half that on boys, and statistically insignificant. This is consistent with previous research showing that boys and girls respond differently to external circumstances (Cross and Madson, 1997, and Eagly, 1978).

Table 6 extends this analysis of individual heterogeneity by showing whether: *(a)* boys/girls are affected differently by the mobility of pupils of the same/different gender (Columns 1, 2a and 2b); and *(b)* whether pupils with high/low KS1 (age 7) attainments are affected differently by movers with high/low early achievements (Columns 3, 4a and 4b). The first set of results shows that turnover of girls has a larger and more significant effect than turnover of boys, and that this effect works particularly through the influence of girls' turnover on boys. However, tests at the bottom of the table again reveal that the differences in the effects of girls' and boys' mobility, and in the effects on boys and girls are not statistically significant. The second set of results shows some evidence of complementarities between the achievements of mobile students and those of stayers, with high-KS1 movers having a much larger impact on high-KS1 stayers than on low-KS1 stayers, and vice versa. On average, the effect of mobility of high-KS1 students dominates. Again, we find that most of the differences are not statistically significant – except for a marginally significant difference in the effect of high KS1 versus low KS1 movers on high KS1 students (Column 4a). A potential explanation for this finding is that high-ability students endogenously form local ties with other high-ability students, similar to Carrell *et al.* (2013) who find that students form homogeneous sub-groups in the US Air Force Academy (USAFA). We provide further evidence consistent with this friendship-related mechanism in Section 6.

Lastly, Table 7 reports heterogeneity along the dimension of neighbourhood characteristics, where these are split into above- and below-median categories. Specifically, we look at differences according to the proportions of residents who are in social housing (Columns 1a-1b), home owners (Columns 2a-2b), lone parents (Columns 3a-3b), highly qualified (Columns 4a-4b), and finally according to the average price of local houses (Columns 5a-5b).[13] Because of households' sorting, most of these area characteristics are likely to be highly correlated with the attributes of the households that inhabit them – even though we do not observe these directly. So the breakdowns we present in the table are likely to shed light on differences in the effect of neighbourhood mobility across pupils from different family backgrounds and living in different neighbourhood contexts. The results in Table 7 paint a fairly consistent picture in which the effects of mobility are much more pronounced in neighbourhoods where families face greater disadvantages. The effects of mobility are larger in areas with high social housing, low homeownership[14], high proportions of lone parents, fewer highly qualified adults and lower house prices. In most cases, these differences are statistically significant at the 10% level. The findings relating to homeownership and house prices are interesting in the light of research that suggests that owner-occupation promotes investment in social capital, and social capital is in turn associated with higher house prices (Hilber, 2010). Again, this suggests that social ties might be the force behind the disruptive impact of neighbourhood turnover that we document, with the effects weaker in places where these ties are strongest.[15]

We also investigated heterogeneity along the dimension of neighbourhood school quality and choice. Firstly, we categorised locally accessible schools – i.e. those attended by pupils living in the OA – by whether they are above or below the median in terms of the percentage of pupils achieving five or more A*-C grade GCSEs (age 16 qualifications).[16] The results indicate, that turnover affects pupils much less in areas with better school results (coefficient: -0.045, standard error: 0.200) than in areas with poor performing schools (coefficient: -0.603, standard error: 0.201), and that this difference is significant. This finding is in line with the other results in Table 7, given that the proportion achieving five A*-C grade GCSEs is strongly related to family background. Next, we check for differences according to the degree of

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[13] Prices come from the Land Registry dataset which covers all housing transactions in England, and are regression-adjusted for housing type (detached, semi-detached, terrace, flat, bungalow), year and month of transaction, legal status (freehold or leasehold) and new/resale property.
[14] This difference is not driven by the fact that high turnover is a feature of low homeownership neighbourhoods since both types of areas are characterised by similar levels of mobility (approximately 13% and 16% in high and low homeownership areas, respectively).
[15] We also investigated whether our results are more marked for larger urban areas (e.g. the ten biggest cities in England) or specific to London only, but found that this is not the case.
[16] Note that these attainments do *not* refer to pupils in our cohorts – rather to older pupils in the same schools.

school availability to study whether school choice exacerbates the negative effects of neighbourhood turnover by potentially reducing social cohesion. In order to do so, we compare students living in areas with only one accessible school (17% of students) with those in areas with more than one school, and students in areas with below the median number of accessible schools (three schools) with those in areas with above the median number of accessible schools. We find no clear patterns or statistically significant differences. Finally, we investigate whether neighbourhood turnover has a different impact on students' outcomes depending on whether or not the movers attend the same school as the stayers. This extension allows us to assess whether more cohesion affects the impact of turnover from a different angle – namely by studying whether stayers and movers are peers both at school and in the neighbourhood. To simplify the analysis, we focus on stayers who also do not change their school and consider movers who: either *(a)* stay in the same school as the stayers between year 7 and year 9 (but move neighbourhood); or *(b)* move in/out of the school between during these year. The turnover measure therefore becomes secondary school-by-cohort-by-neighbourhood specific, and is common to all stayers belonging to the same cohort and attending the same secondary school. Once again, we find no evidence of heterogeneity along this dimension.

5.2. Heterogeneity by types of mobility

To conclude the analysis of heterogeneity, in Table 8 we investigate whether different types of mobility have different effects on student's test score value added. We first look at differences in the impact of residential moves across districts (Local Education Authorities, LEAs) and within districts in Panel A; and between short (bottom 25%), medium distance (middle 50%) and long distance (top 25%) moves in Panel B. One reason for being interested in these patterns is that cross-LEA moves and long distance moves are arguably more closely linked to moves by families seeking better schools and local public goods (Hanushek et al, 2004). If our results arise primarily because of these kinds of 'Tiebout' choice moves, then we might be concerned that the effects are related to unobserved neighbourhood quality changes. Evidently, however, this is not the case: the point estimates suggest that the impact of mobility associated with an LEA change is much less than that associated with mobility within the same LEA, although the difference is not statistically significant. Similarly, the estimates in Panel B show that the most disruptive type of mobility is the one associated with middle distance moves (between 400 metres and 4km, with a median of 1.5km). The effects of mobility associated with the longest or shortest moves are less precisely estimated, although the point estimates are always negative and a battery to tests for the pair-wise and three-way differences always rejects the hypothesis of significant heterogeneity.

Finally, in Panels C and D, we split our mobility indicators according to whether the underlying relocation implies that the mover experiences an upgrade or downgrade in neighbourhood status. In Panel C, we split by whether the move entails an improvement or decline in the quality of accessible local schools, measured according to the proportion of students achieving five A*-C GCSE in the schools attended by the stayers in that neighbourhood. In Panel D, we focus on changes in average house prices (regression adjusted for housing characteristics, as described in Section 5.1). The patterns suggest that movers ‘going down’ the distribution of neighbourhood status exert a larger and more significant impact on the value added of the stayers. Conversely, neighbourhood turnover associated to either the top 25% improvements in end-of-secondary-school attainments or to the top 25% increases in house prices is less negatively associated to KS2-to-KS3 value added of the stayers. However, all point estimates are clearly negative and tests for the significance of the differences between the various estimates clearly fail to reject the null. Once more, this suggests that types of mobility associated with improvements in the quality of the locally accessible services – sometimes referred to as Tiebout-type relocations (e.g. Hanushek et al., 2004) – do not have significantly less detrimental effects on the value added of pupils who do not move.

Note that correlation between the average five A*-C GCSE at schools accessible from a given neighbourhood and turnover driven by people that experience a top-25% increase in average GCSE attainments is negative at -0.04. This figure becomes -0.13 and -0.08 when we consider people moving in the middle 50% and bottom 25% of the distribution of the changes in the average local-school five A*-C GCSEs. A similar pattern holds if we consider average house prices and relocations that entail a move up or down the house price distribution. This suggests that the mobility of people experiencing upgrades and downgrades is essentially uncorrelated with destination/origin neighbourhood status, and that the evidence in Table 8 does not simply replicate the results presented in Table 7 on the heterogeneity by neighbourhood characteristics.

6. Exploring the mechanism

Previous literature in sociology, psychology and economics suggests that high level of turnover might affect pupils' outcomes by disrupting their social ties, friendship networks and local 'connectedness'. In this section, we investigate whether this type of mechanisms could rationalize the evidence provided in the previous sections.

In order to study these issues, we use information collected through the LSYPE on pupils' friendship networks and leisure activities. The survey asked approximately 14,000 students aged 14 questions about their experiences at school, at home and in their neighbourhood, and contains a number of questions related to pupils' friends and their use of free time. We use this information to construct the following five binary indicators (yes=1; 0=no) of local social connections: *(1)* Friends regularly visit the pupil's home; *(2)* The pupil visit friends' home when free; *(3)* The pupil has been excluded from a group of friends; *(4)* The pupil joins a youth club during his/her free time; and *(5)* The pupil hangs around/messes at home during free time. More details about the original wording of the LSYPE questions and possible answers are provided in the notes to Table 9. Finally, we follow Kling et al. (2007) and combine these variables into a composite 'social connectedness' indicator by summing answers at *(1)*, *(2)* and *(4)*, and subtracting *(3)* and *(5)*. More positive values of this indicator correspond to more socially connected pupils.

The descriptive statistics for the main variables constructed for the LSYPE sample are presented in Appendix Table 1. These reveal that despite including only approximately 10,000 pupils who do not change residence between year 7 and 9, the sample is similar to our main data set and broadly representative of the national student population. We also find that about 23% of the pupils have friends visiting their home regularly every week; 21% join youth clubs during their free time; and about 19% visit their friends' homes regularly. Conversely, 27% hangs around and messes about the house when free, and 15% has been excluded from a group of friends or from joining activities in the past 12 months.

In Table 9 we present results from regressions that relate pupils' proxies for local social connections to the level of turnover in their place of residence.[17] Note that these come from specifications where we cannot control for neighbourhood effects since we only have data for one cohort. However, we control for secondary school effects (Columns 1 to 6) and secondary-by-primary school effects (Column 7) to partial out any confounding shock that is common to pupils attending the same school – including school turnover. Moreover, on top of the individual- and neighbourhood-level variables included in the analysis so far, we exploit the richness of the information collected by the LSYPE to further control for these aspects of pupils' background: number of older siblings; number of younger siblings; whether the household is headed by a single parent; parental occupational status and highest educational qualification; housing tenure status.

Our findings clearly suggest that pupils who live in neighbourhoods with higher level of turnover are less socially connected. A one standard deviation change in neighbourhood mobility reduces by 4.5% the probability that a pupil had friends regularly visiting his/her home, while increasing by 3.8% the chances that the pupil spends his/her free time hanging about and messing around the house – presumably alone. While the other coefficients on the binary indicators are not statistically significant, they still present sizeable effects. For example, pupils in neighbourhoods with turnover one standard deviation above the mean are 2.3% less likely to join youth clubs during their leisure time, and 3.7% more likely to have been excluded from groups of friends or from joining their activities than otherwise similar pupils.

When considering our composite social connection indicator, we find sizeable and highly significant results. A one standard deviation increase in neighbourhood turnover decreases social 'connectedness' by 3.8% of a standard deviation when only controlling for secondary school effects (Column 6), and by 4.9% when partialling out primary-by-secondary school shocks (Column 7).

Clearly, these results are to be treated with some caution and are meant to be mainly descriptive and supportive of our conjecture that broken social ties explain the negative impact of turnover on pupil attainment. This is because the nature of the LSYPE data – which samples only one cohort – does not allow us to partial out the confounding effects of neighbourhood unobservables by exploiting cohort-on-cohort

[17] Due to the small sample size, we cannot stratify our regressions by various groups as we did in Section 5.

variation. However, in our defence, we do control for the initial composition of the neighbourhood and its changes over time in terms of ethnicity, early achievements, gender, free-school meal eligibility and special educational needs of children. Similarly, unlike our value-added regressions, the results in Table 9 do not exploit changes in the outcome variables over time – rather a simple snapshot assessment taken at age 14. This means that family unobservables that lead to sorting of pupils with different propensities to be socially connected into neighbourhood with high/low levels of turnover might contaminate our findings. Nevertheless, our findings control for a vast array family background characteristics – ranging from family size and composition to parental employment and education. Further including some self-reported variables that capture whether children and their parents have good relationships does not affect our findings, though we prefer specifications that do not include these potentially endogenous controls.

In conclusion, we believe that – despite its small sample size – the evidence based on the LSYPE outcomes is highly informative and supports our interpretation that neighbourhood turnover negatively affects pupils' educational progress by disrupting their local ties, friendship networks and social capital.

7. Concluding remarks

In this paper, we have presented evidence that individuals engaging in mobility and changing their residential neighbourhood between age 11 and age 14 impose a negative externality on same-age students who do not move. This negative effect is stronger for vulnerable pupils residing in more deprived areas, and is more pronounced when the moves entail a worsening of the neighbourhood characteristics. However, moves that are more arguably linked to Tiebout-choice – such as those associated with improvements in the quality of the locally accessible schools or increases in house prices – do not have a positive effect on the outcomes of the stayers.

This finding is a novel contribution to the literature on neighbourhood effects on pupil attainment. The vast majority of the research in this field has studied how neighbourhood composition affects pupils' learning through role model and peer effects, and found little evidence of a causal link. Conversely, our study shifts the focus to the external impact of neighbourhood turnover, and finds convincing evidence of a negative causal link.

In order to rationalise our findings, we have suggested that high rates of turnover might have a negative impact on same-aged neighbourhood peers who do not relocate because this leads to a break-down of social ties and friendship networks. A vast literature in sociology and psychology has presented evidence suggesting that 'turbulence' among a young person's social circles can have detrimental effects on learning (e.g., Wentzel, 1993 and Reseth et al., 2008). These intuitions have been backed by more recent studies in the economics fields that pin down the negative causal effect stemming from disruption in friendship networks when pupils have to change schools (Lavy and Sand, 2012; Ly and Riegert, 2014).

Our findings are consistent with these arguments, and the evidence provided in Section 6 further supports this intuition: pupils living in areas with higher levels of turnover are associated with lower levels of local social 'connectedness'. While we cannot fully exclude alternative or complementary explanations – for example based on links among parents of same-age children that foster local networks and social capital, and thus raise pupils' attainments – our evidence is important as it clearly points to a previously neglected trade-off: although residential mobility might be good from an individual's perspective as well as for labour markets, this entails negative externalities on immobile individuals that experience high rates of turnover – irrespective of exact mediating factors.

How sizeable are these effects? In short, they are small: our estimates imply a 0.35%-0.4% standard deviation change in pupil value-added for a one standard deviation change in turnovers. This is around 40% of the effect that Gibbons and Telhaj (2011) estimate from turnover in primary schools, or 3-4% of some 'consensus' estimates for the effects of a one standard improvement in teacher quality (see discussion in Gibbons and McNally, 2013). However, while the magnitudes identified by Gibbons and Telhaj (2011) combine the disruptive effect of the potential break-down of a young person's social network with the adverse effect of pupil turnover on teachers' ability to focus their instruction time, our effects only captures the negative impact of neighbourhood churn on pupils' social ties, and thereby on their school attainments.

We can further benchmark our results against some studies that investigate the impact of resources in English schools. At the bottom end of the spectrum, Nicoletti and Rabe (2012) and Holmlund et al. (2010) find that £1000 increase in school expenditure (for secondary and primary schools, respectively) leads to a 2% to 5% increase in pupils' value-added. Gibbons et al. (2013) instead document much larger effects for urban primary schools, with a £1000 increase in expenditure associated to a 24% of a standard deviation improvement in students' test-score progression.

Considering the widest margins of variation in our data, moving from the least mobile neighbourhoods (bottom 5% of the turnover distribution) to the most mobile areas (top 5%), would entail a three standard deviation change in turnover, still corresponding to only around 1% change in pupil value-added. Given that schools attract pupils from a large set of neighbourhoods, these extremes are reproduced within schools: pupils coming from the most turbulent neighbourhood experience turnover rates that are three standard deviations larger than pupils *at the same school* but coming from less mobile areas, and so suffer a 1.2% loss to their value-added between age 11 and age 14.

Reverse engineering the numbers provided by Nicoletti and Rabe (2012) and Gibbons et al. (2013), this means that spending between approximately £50 and £600 on these pupils annually would allow schools to help these children compensate for the negative external effects of neighbourhood turnover. Further considering that there are approximately 550,000 pupils in each student cohort (including movers), the cost of neutralizing the negative external effect of neighbourhood turnover *for every pupil* would be between £10 million and £122 million annually per cohort. These numbers might seem trivial considering that in 2009 the combined expenditure on primary and secondary schools amounted to £28billion spread over 11 years of compulsory schooling (or about £2.5billion per school year). However, students stay in compulsory education for 11 years which suggests that – as much as the negative effects of turnover could accumulate over a long number of years – so could the cost of trying to compensate for it.

Do our results call for policies that reduce individuals' mobility to avoid the external cost it imposes on pupils' learning? We do not believe so. Given the likely benefits of mobility in terms of the efficient allocation of human capital across space and adjustments to geographical changes in the economic landscape – and the apparently small cost of compensating for the external cost of turnover – we think the most appropriate policy response to address education inequalities caused by neighbourhood turnover is to expand the educational budget and compensate negatively affected pupils through targeted school resources.

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Appendix I: More details on the empirical model

The empirical model of Equation (1) is based on an underlying assumption that levels of achievement are cumulative and depend on personal, neighbourhood and school characteristics. Residential turnover in a student's home neighbourhood is the focus of interest in our study.

To formalize our exposition, suppose that a student's achievement at a KS_t tests – where t is equivalent to an education phase – is determined by neighbourhood turnover in neighbourhood n during phase t (mob_{nt}), personal characteristics $\sigma_{i,t}$, neighbourhood characteristics $\nu_{n,t}$ and school characteristics $\upsilon_{s,t}$. Note that we allow for the following features in our model: *(i)* individual and neighbourhood characteristics have phase-specific effect on test scores; *(ii)* school effects enter as a moving average, with interactions between primary and secondary schooling, so that schools in the previous phase and current phase affect current achievement. The rationale for this formulation can be described as follows: when pupils move across educational stages and, most likely, move to a different school, changes in school resources, teachers, peers and mobility will affect their performance. So both current, past and an interaction of past-and-current school effects can affect pupil performance. This set-up gives rise to the following expressions:

$$
\begin{aligned}
KS_{i,t} &= KS_{i,t-1} + mob_{n,t}\beta + \sigma_{i,t} + \nu_{n,t} + \upsilon_{s,t} + \upsilon_{s,t-1} + \upsilon_{s,t}\upsilon_{s,t-1} + \varepsilon_{it} \\
KS_{i,t+1} &= KS_{i,t} + mob_{n,t+1}\beta + \sigma_{i,t+1} + \nu_{n,t+1} + \upsilon_{s,t+1} + \upsilon_{s,t} + \upsilon_{s,t+1}\upsilon_{s,t} + \varepsilon_{it+1} \qquad (2) \\
KS_{i,t+1} - KS_{i,t} &= mob_{n,t+1}\beta + \sigma_{i,t+1} + \nu_{n,t+1} + \upsilon_{s,t+1} + \upsilon_{s,t} + \upsilon_{s,t+1}\upsilon_{s,t} + \varepsilon_{it+1}
\end{aligned}
$$

Considering only the set of pupils who do not change neighbourhoods, this becomes:

$$KS_{i,t+1} - KS_{i,t} = mob_{n,t+1}\beta + \sigma_{i,t+1} + \nu_{n} + \upsilon_{s,t+1} + \upsilon_{s,t} + \upsilon_{s,t+1}\upsilon_{s,t} + \varepsilon_{it+1}$$

Note that in this expression, individual and neighbourhood attributes that affect baseline attainments – i.e. $KS_{i,t}$ – have dropped out implying that 'ability' and 'sorting' that affect early test scores and neighbourhood choice of household that do not move have been controlled for by the value-added specification. However, this expression still contains individual and neighbourhood effects that will drive pupils' test score progression alongside current and lagged school effects and their interaction.

In our data, we are able to observe multiple cohorts – denoted by c – of children from the same neighbourhoods and schools, leading to the following expression:

$$KS_{ic,t+1} - KS_{ic,t} = mob_{nc,t+1}\beta + \sigma_{ic,t+1} + \tau_{c,t} + \nu_{nc} + \upsilon_{sc,t+1} + \upsilon_{sc,t} + \upsilon_{sc,t+1}\upsilon_{sc,t} + \varepsilon_{ict+1} \qquad (3)$$

Where all variables now have a cohort-specific component and $\tau_{c,t}$ is a phase-by-cohort effect. We estimate Equation (3) using observable student, neighbourhood and school characteristics, and various permutations of school, neighbourhood and cohort fixed effects to capture the various observable and unobservable components that affect pupils' test score progression. School-by-cohort fixed effects can be estimated from students in a given cohort attending a given school. Primary-by-secondary-by-cohort effects can be estimated using pupils in a given cohort and transiting from primary to secondary school. Finally, neighbourhood fixed effects can be estimated from children from different cohorts living in the same neighbourhood. Note that school-by-cohort fixed effects can be included in our specification at the same time as neighbourhood effects because there is not a one-to-one mapping between the neighbourhood where children live and the primary or secondary school they attend. Moreover, there is quite a substantial reshuffling of pupils across schools when they moving from the primary to the secondary phase. On average, pupils in secondary schools meet 80% new peers – i.e. students that do not come from the same primary – and secondary schools are much bigger attracting pupils from a large number of primaries. This implies we can estimate effectively secondary-by-primary-by-cohort effects.

Among all these observable and unobservable factors, neighbourhood fixed effects are crucial given that neighbourhood turnover rates are likely to be determined and correlated with unobserved neighbourhood characteristics of other types – e.g. housing tenure and long-run demographic patterns – that can affect pupil educational progress. Neighbourhood fixed effects also allow us to control for sample selection of individuals into neighbourhoods on the basis of neighbourhood characteristics that affect pupil value added, since neighbourhood characteristics also control for $E\left[\sigma_i \mid n\right]$.

Tables

Table 1: Descriptive statistics of the main dataset

Variable	Mean	Standard Deviation
Panel A: Students' characteristics, stayers only		
KS2 percentiles, average English, Maths and Science	50.037	25.249
KS3 percentiles, average English, Maths and Science	51.143	25.837
KS2 to KS3 value-added	1.106	13.590
KS1 score, average English and Maths	15.108	3.617
Student is FSM eligible	0.158	0.364
Student is SEN	0.213	0.410
Student is Male	0.508	0.499
Secondary school size (in grade 7)	1084.3	384.77
Panel B: Mobility and other characteristics of neighbourhoods		
Annual rate of mobility in n'hood (grade 6 to 9)	0.145	0.128
Annual rate of mobility in n'hood, outward (grade 6 to 9)	0.064	0.068
Annual rate mobility in n'hood, inward (grade 6 to 9)	0.081	0.093
Primary school annual rate of total mobility in n'hood (grade 3 to 6)	0.204	0.194
KS1 score, average English and Maths – Grade 6	15.020	2.438
KS1 score, average English and Maths – Change grade 6 to 9	-0.031	1.446
Share FSM – Grade 6	0.166	0.251
Share FSM – Change grade 6 to 9	0.005	0.145
Share SEN – Grade 6	0.221	0.252
Share SEN – Change grade 6 to 9	0.002	0.165
Share Male – Grade 6 9	0.509	0.292
Share Male – Change grade 6 to 9	0.002	0.165
Number of students in neighbourhood, Grade 6	5.343	2.565
Number of students in neighbourhood, Change grade 6 to 9	-0.013	1.467

Note: Descriptive statistics refer to students who do not change OA of residence in any period between grade 6 and 9 in the non-selective part of the education system. Number of 'stayers': approximately 1,210,000 (evenly distributed over three cohorts). Number of Output Areas: approximately 133,000. KS1 refers to the average test score in Reading, Writing and Mathematics at the Key Stage 1 exams (at age 7); FSM: free school meal eligibility; SEN: special education needs (with and without statements). Secondary school type attended in grade 7: 66.7% Community; 14.8% Voluntary Aided; 3.1% Voluntary Controlled; 14.5% Foundation; 0.3% Technology College; 0.4% City Academy.

Table 2: Neighbourhood mobility: the effect on students' achievements

	Dependent Variable is value-added in percentiles between grade 6 (KS2) and grade 9 (KS3)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Neighbourhood mobility – Grade 6 to 9	-3.914 (0.115)***	-2.293 (0.115)***	-0.788 (0.103)***	-0.608 (0.104)***	-0.433 (0.142)***	-0.371 (0.143)***	-0.378 (0.136)***	-0.334 (0.138)***
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Second.×cohort FX	No	No	No	No	No	No	Yes	Yes
Second.×primary×cohort FX	No	No	Yes	Yes	No	No	No	No
Neighbourhood FX	No	No	No	No	Yes	Yes	Yes	Yes

Note: Table reports coefficients and standard errors clustered at the OA level in round parenthesis. Number of observations ~1,210,000 in ~123,000 Output Areas. Neighbourhood mobility is the annual rate of mobility in neighbourhood between grade 6 to 9 considering both outwards and inwards relocations. All regressions include cohort dummies. Controls include the following variables. At the individual level: student own KS1 test scores; student is FMSE; student is SEN; student is male; student own ethnicity (8 dummies); school size (refers to school attended in grade 7); school type dummies (refers to school attended in grade 7 and includes: Community, Voluntary Aided, Voluntary Controlled, Foundation, CTC and Academy). At the neighbourhood-by-cohort level: grade 6 and changes between grade 6 and grade 9 of neighbourhood average KS1 scores, average FSME eligibility, average SEN pupil status; average pupil gender, and average ethnic composition (8 groups); grade 6 and changes between grade 6 and grade 9 of the number of pupils in the same cohort (aged 11 in grade 6); primary school mobility. Secondary by cohort effects: ~12,300 groups (refer to school at grade 7 when students enter secondary education). Secondary by primary by cohort school effects: ~185,000 groups. Neighbourhood (OA) effects: ~133,000 groups. ***: 1% significant or better.

Table 3: Balancing properties of neighbourhood mobility

	Treatment is: Neighbourhood mobility – Grade 6 to grade 9	
	(1)	(2)
Dependent Variable is:	Unconditional	Neighbourhood FX
Panel A: Pupil level characteristics		
KS1 score,	-1.631	0.069
average English and Maths	(0.031)***	(0.035)*
Student is	0.200	-0.004
FSM eligible	(0.004)***	(0.003)
Student is	0.094	-0.004
SEN	(0.003)***	(0.004)
Student is	-0.003	-0.002
Male	(0.004)	(0.005)
Panel B: Attended school characteristics		
Grade 7 school average KS1 score	-0.920	-0.006
(English and Maths)	(0.013)***	(0.008)
Grade 7 school average KS2 score	-7.279	0.004
(English, Maths and Science)	(0.102)***	(0.064)
Grade 7 school std. dev. KS2 score	-0.055	0.004
(English, Maths and Science)	(0.019)	(0.019)
Secondary school size (in Grade 7)	-27.35	5.237
	(5.059)***	(2.625)**
Panel C: Neighbourhood and accessible school characteristics		
Number of schools opening within 5km	0.072	-0.007
of pupil's residence	(0.006)***	(0.008)
Number of schools closing within 5km	0.146	-0.005
of pupil's residence	(0.012)***	(0.015)
Percentage students achieving 5 A*-C	-14.76	-0.098
GCSEs – accessible schools	(0.213)***	(0.076)
Percentage days absent –	1.648	0.016
accessible schools	(0.026)	(0.012)
House prices (hedonic) –	-74784.6	418.9
Output Area of residence	(1150.4)***	(491.9)

Note: Table reports coefficients and standard errors clustered at the OA level in parenthesis from regressions of one of the dependent variables (listed in the first column) on neighbourhood mobility and year dummies. Regressions run at the individual level for students staying in the same neighbourhood (OA) between grade 7 and 9. Number of observations: approximately 1,210,000. Column (1) does not include any additional control. Column (2) includes neighbourhood (OA) fixed effects. Neighbourhood (OA) effects: ~133,000 groups. ***: 1% significant or better; **: at least 5% significant; *: at least 10% significant. Panel A presents results with student characteristics as the dependent variables. Panel B presents results for the following characteristics of the school attended by the individual student in grade 7: school-by-cohort mean of KS1 (grade 2) and KS2 (grade 6) test scores; school-by-cohort standard deviation of KS2 test scores; and secondary school size (numbers of pupils). Panel C presents results for the following neighbourhood (Output Area, OA) characteristics and for the characteristics of the set of schools accessible from the neighbourhood: number of new schools opening and closing within 5km of the neighbourhood; percentage of students achieving 5 A*-C GCSEs and percentage of days absent (authorised or not); house prices in the neighbourhood, adjusted for housing type (detached, semi-detached, terrace, flat, bungalow), year and month of transaction, legal status (freehold or leasehold) and new/resale property.

Characteristics of the schools accessible from the neighbourhood are averaged across the set of secondary schools that stayers attend from a given OA. House price information is obtained from the Land Registry dataset that covers all property sold and purchased in England.

Table 4: Neighbourhood mobility and students' achievements – Falsification and robustness checks

	Specification refers to/includes:								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Primary school mobility	Other cohorts' mobility	Adults' mobility 45-64 y.o.	KS3 control for KS2 – IV	Intention to treat – data set-up	Inward mobility only	Outward mobility only	Drop 30% smallest n'hoods	Larger n'hood mobility
Neighbourhood Mobility – Grade 6 to 9	0.029 (0.094)	-0.313 (0.154)**	-0.388 (0.166)**	-0.383 (0.131)***	-0.620 (0.123)***	-0.545 (0.234)**	-0.817 (0.317)***	-0.434 (0.238)*	-0.315 (0.156)**
N'hood mobility, 1-year older cohort		0.086 (0.112)							
N'hood mobility, 1 year younger cohort		0.112 (0.126)							
N'hood mobility, Adults, 45-64 year old			-0.199 (0.836)						
Neighbourhood Mobility – Larger n'hood									-0.265 (0.289)

Note: Table reports coefficients and standard errors clustered at the neighbourhood (OA) level in round parenthesis. ***: 1% significant or better; **: at least 5% significant; *: at least 10% significant. All regressions include cohort dummies, controls as detailed in the notes to Table 2 and neighbourhood (OA) fixed effects. Column (1) uses only mobility rates based rates on moves of primary school children between Grade 3 and KS2/Grade 6 for the same time windows used to construct neighbourhood mobility between Grade 6 and 9. Column (2) adds mobility rates based rates on moves of pupils one year younger and one year older than pupils in the main sample (calculated for the same time windows). . Column (2) adds mobility rates calculated using 45 to 65 year old individuals registering and deregistering at the NHS General Doctor Practice closest to the students' neighbourhood of residence in the calendar year in which they are sitting for their KS3 exams. Column (4) estimates a lagged dependent variable specification instrumenting KS2 percentiles with teacher-assessed KS2 test levels. KS2 estimate in second stage: 0.885 (s.e.: 0.001). Column (5) uses a full dataset that includes pupils who move. Movers are assigned the neighbourhood mobility (and characteristics) of the OA from which they originate. The specification further controls for the direct effect of mobility by including a dummy that identifies pupils who change the OA of residence between grade 6 and grade 9. Column (6) and (7) focus on inward only and outward only mobility rates, respectively. Column (8) drops the 30% smallest neighbourhoods (with less than 4 pupils; number of observations reduced to ~820,000 in ~91,000 OAs). Column (9) adds mobility measured at the Lower-Level Super Output Area (LSOA). LSOAs 4 to 6 OAs.

Table 5: Heterogeneity in the effect of neighbourhood mobility – By pupil background characteristics

	Dependent Variable is value-added in percentiles between grade 6 (KS2) and grade 9 (KS3)							
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
	Male student	Female student	FSM Student	Non-FSM student	SEN student	Non-SEN student	Low KS1 student	High KS1 student
N'hood mobility – Grade 6 to 9	-0.505 (0.176)***	-0.234 (0.179)	-0.558 (0.293)*	-0.333 (0.151)**	-0.216 (0.231)	-0.415 (0.157)***	-0.401 (0.173)**	-0.347 (0.187)*
P-value: equality	*0.1985*		*0.4580*		*0.4199*		*0.8036*	
P-value: joint significance	*0.0149*		*0.0277*		*0.0283*		*0.0303*	

Note: Table reports coefficients and standard errors clustered at the neighbourhood (OA) level in round parenthesis. ***: 1% significant or better; **: at least 5% significant; *: at least 10% significant. All regressions include cohort dummies, controls as detailed in the notes to Table 2 and neighbourhood (OA) fixed effects. Results obtained from regressions pooling all students and interacting individual characteristic specified in the heading with neighbourhood mobility. Number of observations ~1,210,000 in ~133,000 OAs.

Table 6: Heterogeneity in the effect of neighbourhood mobility – By background characteristics of stayers and movers

	Dependent Variable is value-added in percentiles between grade 6 (KS2) and grade 9 (KS3)					
	Gender breakdown			*Key Stage 1 breakdown*		
	(1)	(2a)	(2b)	(3)	(4a)	(4b)
	All students	Female Student	Male student	All students	High KS1 student	Low KS1 student
N'hood mobility – Grade 6 to 9; female students	-0.484 (0.201)**	-0.264 (0.256)	-0.695 (0.252)***			
N'hood mobility – Grade 6 to 9; male students	-0.270 (0.201)	-0.226 (0.254)	-0.316 (0.252)			
N'hood mobility – Grade 6 to 9; High KS1 students				-0.467 (0.225)**	-0.741 (0.291)***	-0.200 (0.285)
N'hood mobility – Grade 6 to 9; Low KS1 students				-0.322 (0.181)*	-0.111 (0.241)	-0.498 (0.215)**
P-value: equality	*0.4502*	*0.9170*	*0.2940*	*0.6092*	*0.0932*	*0.3996*
P-value: joint significance	*0.0236*	*0.3914*	*0.0095*	*0.0269*	*0.0357*	*0.0552*
P-value: overall equality		*0.4489*			*0.2265*	
P-value: overall joint significance		*0.0475*			*0.0208*	

Note: Table reports coefficients and standard errors clustered at the neighbourhood (OA) level in round parenthesis. ***: 1% significant or better; **: at least 5% significant; *: at least 10% significant. All regressions include cohort dummies, controls as detailed in the notes to Table 2 and neighbourhood (OA) fixed effects. Results in Columns (2a)-(2b) and (4a)-(4b) obtained from regressions pooling all students and interacting individual characteristic specified in the heading with neighbourhood mobility as specified in the first column. Mobility for female/male students separately considers the mobility of female/male students. Mobility for high/low KS1 students separately considers the mobility of pupils with KS1 test scores above/below the cohort-specific median. P-values for overall equality and overall joint significance refer to tests for the equality and joint significance of the four coefficients in in Columns (2a)-(2b) and Columns (4a)-(4b). Number of observations ~1,210,000 in ~133,000 OAs.

Table 7: Heterogeneity in the effect of neighbourhood mobility – By pupil neighbourhood characteristics

	Dependent Variable is value-added in percentiles between grade 6 (KS2) and grade 9 (KS3)									
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
	High social tenants	Low social tenants	Low home ownership	High home ownership	High lone parents	Low lone parents	Low high qual.	High high qual.	Low house prices	High house prices
N'hood mobility – Grade 6 to 9	-0.512 (0.200)***	-0.212 (0.200)	-0.623 (0.198)***	-0.077 (0.200)	-0.629 (0.195)***	-0.060 (0.205)	-0.606 (0.195)***	-0.085 (0.206)	-0.525 (0.200)***	-0.220 (0.213)
P-value: equality	*0.2829*		*0.0509*		*0.0422*		*0.0630*		*0.2913*	
P-value: joint Significance	*0.0227*		*0.0068*		*0.0054*		*0.0074*		*0.0201*	

Note: Table reports coefficients and standard errors clustered at the neighbourhood (OA) level in round parenthesis. ***: 1% significant or better; **: at least 5% significant; *: at least 10% significant. All regressions include cohort dummies, controls as detailed in the notes to Table 2 and neighbourhood (OA) fixed effects. Results obtained from regressions pooling all students and interacting neighbourhood characteristic specified in the heading with neighbourhood mobility. Number of observations ~1,210,000 in ~133,000 OAs. High and low social tenants (Columns 1a and 1b): above or below the median of the distribution of the share of households in the OA who rent from the council, from a housing association or from a social landlord (0.092). High and low home ownership rate (Columns 2a and 2b): above or below the median of the distribution of the shares of households in the OA who are homeowners (0.774). High and low lone parents (Columns 3a and 3b): above or below the median of the distribution of the shares of households in the OA who are headed by a single parent (0.059). High or low high qualifications (Columns 4a and 4b): above or below the median of the share of households in the OA whose head has educational qualifications at Level 4 or 5 (0.142). Low or high house prices (Columns 5a and 5b): above or below the median of the house prices in the neighbourhood on average across the years (£123,843). House prices corrected for housing characteristics using hedonic regressions.

Table 8: Heterogeneity in the effect of neighbourhood mobility – By different mobility types

		Dependent Variable is value-added in percentiles between grade 6 (KS2) and grade 9 (KS3)					
Panel B: LEA crossing		*Panel B: Distance*		*Panel C: School quality GCSE*		*Panel D: House prices*	
Same	-0.432	Bot. 25%	-0.385	Bot. 25%	-0.472	Bot. 25%	-0.901
LA	(0.158)***	distance	(0.283)	Δ(A*-C GCSE)	(0.350)	Δ(house prices)	(0.371)**
Change	-0.090	Mid 50%	-0.538	Mid 50%	-0.600	Mid 50%	-0.321
LA	(0.336)	distance	(0.204)***	Δ(A*-C GCSE)	(0.248)**	Δ(house prices)	(0.251)
		Top 25%	-0.019	Top 25%	-0.533	Top 25%	-0.314
		distance	(0.285)	Δ(A*-C GCSE)	(0.363)	Δ(house prices)	(0.375)
P-value: equality	*0.3577*		*0.3364*		*0.9439*		*0.3519*
P-value: joint significance	*0.0233*		*0.0320*		*0.0539*		*0.0714*

Note: Table reports coefficients and standard errors clustered at the neighbourhood (OA) level in round parenthesis. ***: at least 1% significant; **: at least 5% significant. All regressions include cohort dummies, controls as detailed in the notes to Table 2 and neighbourhood (OA) fixed effects. Panel C and D further controls for differential effects of mobility in OAs with percentage of GCSEs above the median (Panel C) and average house prices above the median (Panel D). Results obtained from regressions simultaneously including mobility computed rates for subgroup of pupils engaging in different types of moves. Approximately 11.9% of the moves are within an LEA and 2.6% across LEA boundaries. Distance thresholds as follows: bottom 25% ~400 to 800 metres; top 25% ~4000 to 6500 metres. Panel C ranks neighbourhoods by the average fraction of pupils achieving A*-C GCSEs in the schools attended by the stayers. Thresholds for the changes in A*-C GCSE as follows: bottom 25% ~-7.5 to -6.8 percentage points; top 25% ~8.7 to 9.4 percentage points. Panel D ranks neighbourhoods by the average house prices corrected for housing characteristics using hedonic regressions. Thresholds for the changes in house prices as follows: bottom 25% ~-£15,700 to -£13,000; top 25% ~£19,000 to £22,800. Number of observations ~1,210,000 in ~133,000 OAs.

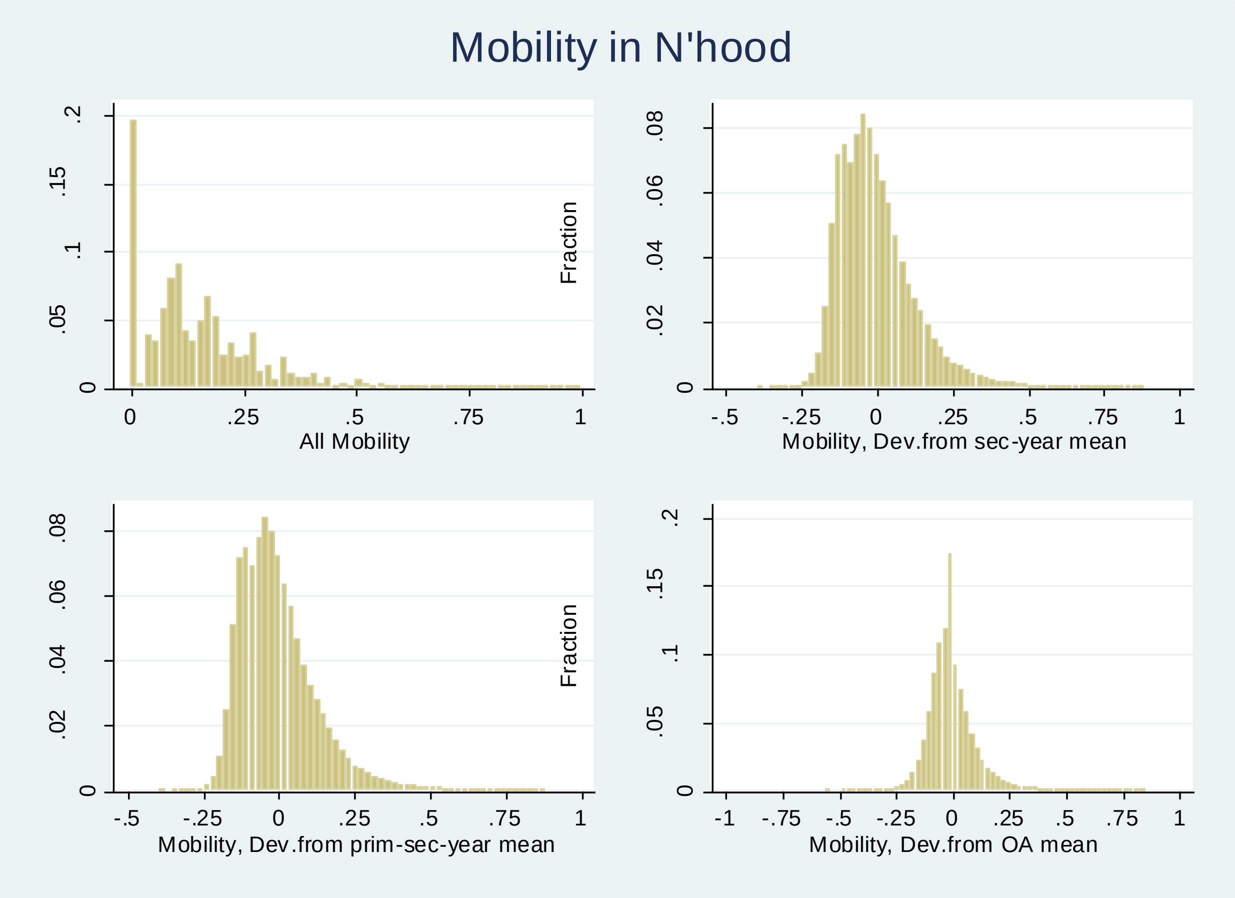
Table 9: Neighbourhood mobility: the effect on social connectedness in the neighbourhood

	Dependent variable is (measured in year 9):						
	(1) Friends regularly visit home	(2) Visits Friends' home when free	(3) Has been excluded from friends	(4) Join youth club during free time	(5) Hangs around at home during free time	(6) Social Connected. (standardized)	(7) Social Connected. (standardized)
Neighbourhood mobility – Grade 7 to 9	-0.069 (0.036)**	-0.017 (0.033)	0.036 (0.032)	-0.032 (0.035)	0.068 (0.038)*	-0.038 (0.013)***	-0.049 (0.024)***
Mean of dependent variable	*0.236*	*0.186*	*0.150*	*0.214*	*0.272*	--	--
Standard controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	No	No	No	No	Yes
Second. FX	Yes	Yes	Yes	Yes	Yes	Yes	No
Second.× primary FX	No	No	No	No	No	No	Yes

Note: Table reports coefficients and standard errors clustered at the OA level in round parenthesis. Number of observations ~10,000 in ~6,700 Output Areas and ~750 Secondary Schools (and 3950 Primary-by-Secondary school groups). Neighbourhood mobility is the annual rate of mobility in neighbourhood between grade 7 to 9 considering both outwards and inwards relocations. All regressions include cohort dummies. Controls include the following variables. At the individual level: student own KS2 test scores; student is FMSE; student is SEN; student is male; and student own ethnicity (8 dummies). At the neighbourhood-by-cohort level: grade 7 and changes between grade 7 and grade 9 of neighbourhood average KS2 scores, average FSME eligibility, average SEN pupil status; average pupil gender, and average ethnic composition (8 groups); grade 7 and changes between grade 7 and grade 9 of the number of pupils in the same cohort (aged 14 in grade 9); primary school mobility. Additional controls in Column (7) include: number of older siblings; number of younger siblings; dummy for single parent household; main parent occupational status; main parent highest educational qualification; housing tenure status. *: 10% significant; **: 5% significant or better; ***: 1% significant or better.

Figures:

Figure 1: Variation in the neighbourhood



Note: Descriptive statistics of neighbourhood mobility: mean 0.145; std.dev. 0.128. Descriptive statistics of deviations from secondary school-by-cohort mean: mean 0.000; std.dev. 0.123. Descriptive statistics of deviations from primary-by-secondary-by-cohort mean: mean 0.000; std.dev. 0.110. Descriptive statistics of deviations from neighbourhood (OA) mean: mean 0.000; std.dev. 0.093.

Appendix Material

Appendix Table 1: Selected descriptive statistics for the LSYPE dataset

Variable	Mean	Standard Deviation
Panel A: Students' characteristics, stayers only		
Friends regularly visit home (yes=1; 0=no)	0.236	0.425
Visits friends' home when free (yes=1; 0=no)	0.186	0.389
Has been excluded from a group of friends (yes=1; 0=no)	0.150	0.357
Join youth club during free time (yes=1; 0=no)	0.214	0.410
Hangs around/messes at home during free time (yes=1; 0=no)	0.272	0.445
Composite 'social connectedness' indicator	0.215	0.916
KS2 percentiles, average English, Maths and Science	50.07	25.22
Student is FSM eligible	0.176	0.381
Student is SEN	0.161	0.368
Student is Male	0.499	0.500
Panel B: Mobility and other characteristics of neighbourhoods		
Annual rate of mobility in n'hood (grade 7 to 9)	0.128	0.154
Primary school annual rate of total mobility in n'hood (grade 4 to 6)	0.215	0.213
KS2 score, average English, Maths and Science – Grade 7	49.27	17.45
KS1 score, average English and Maths – Change grade 7 to 9	-0.073	8.249
Share FSM – Grade 7	0.181	0.275
Share FSM – Change grade 7 to 9	0.003	0.124
Share SEN – Grade 7	0.171	0.243
Share SEN – Change grade 7 to 9	-0.002	0.127
Share Male – Grade 7	0.499	0.309
Share Male – Change grade 7 to 9	-0.002	0.169
Number of students in neighbourhood, Grade 7	4.678	2.493
Number of students in neighbourhood, Change grade 7 to 9	-0.029	1.067

Note: Descriptive statistics refer to LSYPE students (one cohort aged 14 in 2004) who do not change OA of residence in any period between grade 7 and 9. Number of 'stayers': approximately 10,000. Number of Output Areas: approximately 6,700. Number of secondary schools: approximately 750. KS2 refers to the average score in English, Maths and Science at the Key Stage 2 exams (at age 11); FSM: free school meal eligibility; SEN: special education needs (with and without statements). LSYPE outcome variables constructed from interviews carried out in year 9 (pupil aged 14) as follows. (1) Friends regularly visit home (yes=1; 0=no) derived from the following question: "Thinking back over the last 7 days, have you had friends round to your house? Is it: "None" (coded 0); "Once or twice" (coded 0); "3-5 times" (coded 1); "6 or more time" (coded 1). (2) Visit friends' home when free (yes=1; 0=no) derived from the following question: "When you have free time, do you mainly (multiple choices): go round to a friend's house (or friends come round to mine)" (coded 1; all valid alternatives coded 0). (3) Has been excluded from a group of friends derived from the following question: "In the last 12 months, have you ever been excluded from a group of friends of from joining in activities (yes=1; no=0)". (4) Join youth club during free time derived from the following question: "Here is a list of some more things people do when they are not at school. Can you please tell me which, if any, you have been to or done *in the last four weeks* (multiple choices)? Gone to a youth club or something like it" (coded 1; all valid alternatives coded 0). (5) Hangs around/messes at home during free time derived from the following question: "Here is a list of some more things people do when they are not at school. Can you please tell me which, if any, you have been to or done *in the last four weeks* (multiple choices)? Just hung around/messed about at home" (coded 1; all valid alternatives coded 0). Composite 'social connectedness' indicator is obtained as (1)+(2)-(3)+(4)-(5). More positive values correspond to more socially connected pupils.

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