

UCD CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2011

School Tenure and Student Achievement

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WP11/24

November 2011

**UCD SCHOOL OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4**

School Tenure and Student Achievement*

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November 2011

Abstract

While much empirical work concerns job tenure, this paper introduces the concept of school tenure -- the length of time one student has been in a given school. I examine whether and how school tenure impacts students' output using rich cohort data on England's secondary schools. Ordinary Least Squares (OLS) estimates suggest that, on average, students benefit from longer own school tenure but suffer from that of their peers. Using the number of times the student moved school during the academic year as an instrument for school tenure to deal with potential endogeneity, the resulting Two-Stage Least Squares (TSLS) estimates suggest the effects of school tenure are positive and heterogeneous across students. While advantaged students are more likely to gain from own longer school tenure, disadvantaged ones benefit if their peers have longer tenure.

JEL Classification: I21; Z13

Keywords: school tenure; school moving; peer effects

* I acknowledge the Economic and Social Data Service (ESDS) for access to the Longitudinal Study of Young People in England dataset (including the reduced National Pupil Database). I also gratefully acknowledge financial support from the Irish Research Council for the Humanities and Social Sciences (IRCHSS). I am grateful to Paul Devereux for constant advice. I thank Kevin Denny, Colm Harmon and Orla Doyle for helpful comments. I also thank participants in GREP conference and Geary Institute Students Workshop. The usual disclaimer applies.

1. Introduction

While researchers have long been interested in the relationship between workers' output and job tenure (measured as how long a worker stays in a given firm), school tenure, measured as how long a student stays in a given school, has received much less attention.. Hanushek *et al.* (2004) find school movers tend to impose a negative externality on other students. As the inverse of school moving, school tenure may positively impact student achievement through multiple channels.

Firstly, there are at least two reasons why pupils would benefit from their own school tenure: 1) just as wage increases with job tenure are taken as evidence of firm-specific skills (Lazear, 2009), students staying in a certain school longer are also likely to obtain more school-specific skills such as how to use school's computers, where to get useful learning material, what kind of questions one teacher would like to ask in the exams and so on, which are expected to raise performance; 2) while school movers lose ground in academic attainment (Hanushek *et al.*, 2004), students with longer school tenure may enjoy stable academic progress and then score higher.

Secondly, as Hanushelk *et al.* (2004) find negative externalities of moving, school tenure may generate positive spillovers if longer school tenure reflects a stable class atmosphere in which teachers and students are both likely to perform better. For example, Bandiera *et al.* (2010) find teachers could better identify students and more efficiently respond to their learning when class size is small. Frequent changes in class composition are somewhat equivalent to increasing class size which means students performance might be lowered due to less attention received from teachers. In contrast, stable student composition is helpful for teachers to set up an effective teaching style and materials and deliver more efficient assistance and assessment for student's learning in class. From a student's perspective, stable social connections with other students help to establish friendship and

trust which are typically found to have positive effects (Arnott and Stiglitz 1991, Bandiera *et al.* 2005, Charness and Dufwenberg 2006, Bandiera *et al.* 2009, Jackson and Schneider 2010). For instance, “order” students, who stay longer in a certain school, intend to produce a positive externality to their classmates through sharing their information and knowledge about school and this may increase everybody’s test scores.

Taken together, people might expect student achievement would positively associate with the school tenure of pupils as well as their peers, *ceteris paribus*. To probe whether this is the case, I thereby include both individual and peers school tenure in my empirical models. According to Manski (2000), the combined peer effects are identified. More details about peer effects are addressed in the next section.

This paper also contributes to the literature by offering evidence of peer effects from secondary school. While much work finds peer effects on academic achievements in primary schools (see Hanushek *et al.* 2003, Ammermueller and Pischke 2009, Elder and Lubotsky 2009), and in college (see Sacerdote 2001, Arcidiacono and Nicholson 2005, Foster 2006, Carrell *et al.* 2009, Han and Li 2009), little evidence has been found in secondary schools (see Cullen *et al.* 2005, Black *et al.* 2010, Clark 2010)¹. Clark (2009) points out that peer effects on test scores may be weaker in high schools. Using England’s secondary school dataset, I examine how school tenure and its externality affect student’s General Certificate of Secondary Education (GCSE) achievements (Table 1 outlines the educational system in England). GCSE is an examination taken at the end of Year 11 when most students turn 16. In schools in England, Year 11 is the eleventh year after Reception. It is the eleventh full year of compulsory education, with students being admitted who are aged 15 by the 1st September in any given academic year. Year 11 is usually the final year of secondary school. Achieving 5 or more higher grades (A*-C) in GCSE is a general requirement to further education (usually

¹ Gaviria and Raphael (2001) find some peer effects in high school but they are interested in juvenile behaviour rather than test scores

A-levels study); students who fail to do so tend to leave the traditional education route. Therefore, as a key determinant of continuing education through formal channels, also as a key indicator measuring education outputs across different parties including students, schools and parents over the whole of compulsory education, GCSE achievement is an informative outcome to evaluate the education output and education spillovers for secondary schools in the UK.

Ordinary Least Squares (OLS) estimates report positive own school tenure but negative peer tenure effects for the full sample of students. With regard to potential endogeneity problems, I utilize information on how many times students moved school during the academic year (not in July, August and September), which serves as a desirable instrument for school tenure given moving within term time is more likely to be driven by random shocks rather than parental choice. The Two-Stage Least Squares (TSLS) estimates show that there is no tenure effect of peers for the full sample of students, suggesting the negative peer effects found in OLS are possibly biased. As expected, the positive individual tenure effects still hold in TSLS. After I split the sample by student background, the results suggest some interesting heterogeneous effects --- while advantaged students are more likely to gain from own longer school tenure, students with disadvantaged background benefit from their peers having longer school tenure.

The remainder of this paper is organised as follows: Section 2 describes the intuition of peer effects; Section 3 compares my work to the existing literature; Section 4 discusses the data; Section 5 presents OLS results; Section 6 offers TSLS estimates and discusses heterogeneous effects. Section 7 illustrates the understanding of peer effects versus individual effects of school tenure. Section 8 addresses measurement error issues, and Section 9 concludes.

2. Peer Effects

While quantifying externalities in education is of interest to policymakers, schools, parents, and teachers interested in efficient educational production given student heterogeneity, it is usually difficult to distinguish among the various forms of social interactions. Putting Manski (2000) notation in the education context, there are three main routes through which peers would impact students' exam results. The first one is called exogenous peer effects, which occur if students score high due to their peers' positive characteristics such as more highly educated parents, stable family structure and so on; the second one is labelled as endogenous peer effects, which suggests a learning effect among students, say students perform well because other classmates also perform well; the last one is correlation effects that refer to non-peer effects reasons. For example, students in the same class often have the same teachers so some effects of the teacher may be wrongly attributed to peers.

Empirically, researchers separate the last effect from the first two through three main identification strategies: 1) Randomization of peer assignment, which is closest to ideal, however, often subject to doubts about its generalizability; besides, this method cannot eliminate all common shocks shared within a defined group so may still fail to distinguish between exogenous and endogenous effects; 2) With individual or institution fixed effect controls, people can wash away correlation effects, however, this method can also produce inefficient estimates if useful exogenous variation is removed; more problematically, estimates would be biased if the remaining variation is endogenous; 3) Use of idiosyncratic variation in peers is growing in popularity in recent research, the success of which is highly dependent on whether such variation is uncorrelated with student predetermined characteristics.

In this paper, I try to identify peer effects of school tenure. While variation in tenure is

possibly endogenous, the instrument --- peers moving behaviour during the school year --- instead forms idiosyncratic variation in peers. As a result, I hope to get unbiased estimates of peer tenure effects using instrumental variable methods. In terms of methodology, there are three main challenges under consideration (Manski 1993). The first one is known as selection or sorting effects --- people behave similarly due to their similar observed as well as unobserved characteristics. For example, when families sort themselves across school districts according to their willingness to invest in their children's future, the resulting estimates would be biased if this willingness is unobserved. A rich set of personal controls particularly which involve long-run, non-pecuniary factors such as preference toward education and family stability that have important effects on achievement (Hanushk *et al.* (2004)) can substantially help to eliminate sorting effects. In addition to variables that relate to students and their families (the corresponding variables for peers are also included), education preferences, which are omitted from most studies, are also taken into account in my case²³. The second issue is a common shock in which case people involved in the same environment tend to be exposed to the same set of policies so that it is hard to rule out the possibility that the observed association between peer characteristics and individual outcomes is driven by some group-level factors. This could not be a big issue here because what I focus on is the variation in *ex ante* peer characteristics, i.e. school tenure predates the exam results and is therefore unaffected by common shocks, e.g. school-level unobservables. The last problem considered by Manski, the reflection problem, is irrelevant here given there are no simultaneous variables involved in my estimation.

² Parental aspiration and attitude to education are both categorical variables for which higher values indicate lower aspirations and more negative attitude.

³ Mare (1980) argues that exposure to cognitive stimuli and parental attitudes toward education are more important determinants of academic achievement than income.

3. Literature Review

To my best knowledge, this paper is the first paper to clearly introduce the school tenure concept, and then to directly examine its effects and spillovers on student achievement.

With regard to my instrument --- switching school, Hanushek wrote several papers on how moving school impacts student outcomes. Hanushek *et al.* (2004) investigate the costs and benefits of switching schools in US, finding student turnover, particularly student entry during the school year reduces achievement gain, and the effects are felt by everyone in the school, not just those who themselves move. However, their primary interest is to separate disruption effects of moves from changes in school quality. Hanushek *et al.* (2003) use school switchers as the main source of peer variation but they may encounter endogeneity problems because the switch could be a choice made by parents in their case. The moves during the school year used in this paper are more likely to be exogenous, and then facilitate TSLS estimates which help to correct the bias caused by omitted variables in regular OLS regression.

4. Data

The Longitudinal Study of Young People in England (LSYPE) is a large-scale and innovative panel study of young people, which began in 2004 when its sample of young people were aged between 13 and 14. The survey I am using consists of 4 waves on a year basis so was finished up in 2007 when pupils turned 17, in which wave different modules were answered by parents⁴ and young people separately. All sample members were those born between 1st September 1989 and 31st August 1990 so basically attended school in the same academic year and studied at the same grade⁵. My peer group is defined as all sampled

⁴ I only use information on main parents who assert they take most care of the child.

⁵ There are very few students repeating or skipping a grade in the U.K.

students in the pupil's grade and school except the pupil herself. The original sample drawn for the first wave was of over 33,000 young people in Year 9 attending maintained schools, independent schools and pupil referral units (PRUs) in England on February 2004⁶. Exclusions were children solely at home, pupils in school with fewer than a certain number of students (10 for maintained schools and 6 for independent schools), boarders and children residing in the UK solely for education purpose. On average, 33.25 students were surveyed per school. Minority students were over-sampled to reach 1000 for major ethnic groups for research purpose; other students were selected randomly within school. The outcome variables --- GCSE achievements including GCSE new style point scores (New Scoring System for GCSE is in Appendix Table 1), whether achieving 5 or more GCSE (Grade A*-C), number of GCSEs for three grades measures (A*-A, A*-C, A*-G) --- are from the National Pupil Database which could be linked with the LSYPE individual identifier.

Two aspects of the data structure are of note. First, although the original dataset is longitudinal, I reshape it to be purely cross-sectional by averaging all variables over waves for each person and her peers. As a result, my observations end up at about 14,000. The inclusion of some boosts⁷ is in order to ensure an adequate representation of the relevant sub-population in England and the personal weighting are used to eliminate bias in the estimates of population quantities. Figure 1 shows histograms of number of observations per school. Although the average number of pupils sampled per school was 33.25 at the beginning⁸, the final sample contains around 22.65 students for each school because of attrition; only about 2% schools have more than 30 students or fewer than 15⁹. Second, for each selected school except independent schools, information is only collected from some

⁶ Only about 4% of the final sample come from independent schools or referral units.

⁷ Sample boosts included the 20% of schools with the most pupils in receipt of Free School Meals, and therefore pupils in these schools.

⁸ The number sampled per school varied according to the ethnic group composition of the school population. All year 9 pupils were selected in schools / PRUs containing fewer than 34 but more than 5 year 9 pupils.

⁹ I report actual school size by region in Appendix Figure 1. The difference between school size and number of children sampled per school would not affect my estimates as sample design weights can help to make my sample representative to national population

students at that grade so a measurement error issue could arise. I will stress how to deal with the measurement error problem in Section 8.

Before proceeding to estimation, it is helpful to clarify how school tenure is measured. School Tenure denotes how many years pupils stay in the current secondary school. In England, pupils start secondary education when they turn 12 so the cohort studied in this paper (born from Sep. 1st 1989 to August 31st 1990) entered secondary school in 2001. The information on exact entry date to current secondary school for each student enables me to calculate how long one student stayed in this school until the end of June in 2006 when they took GCSE exams (when most students turned 16). Month of school tenure is calculated as: $66 - [(entry\ year - 2001) \times 12 + entry\ month - 0.5^{10}]$ so the maximum school tenure up to GCSE exams equals to 57.5 months ($66 - (0 \times 12 + 9 - 0.5)$) for students who enrolled in school in September 2001. Figure 2 shows that over 80% pupils have the maximum school tenure --- 57.5 months.

For simplicity and without loss of generality, I use year of school tenure in analysis. Figure 3 illustrates the distribution of school tenure for peers and youths, showing mean school tenure is about 4.7 years both¹¹.

The information on school tenure and school moving is missing for some students, to ensure everybody under study has the appropriate peer measures, I drop those missing values¹². Summary statistics are reported in Table 2. Description of the corresponding variables for peers is provided in Appendix Table 2.

¹⁰ The 0.5 means for the entry month, a half month will be added into school tenure on average no matter on which date students entered.

¹¹ A 10% random sample is used to draw Figure 2 given NLOGIT has a limit for number of observations.

¹² Most missing school tenure is from independent schools.

5. OLS Results

5.1. Estimates

$$(1) Y_{is} = \beta_0 + \beta_1 TENURE_{is} + \beta_2 TENURE_{(-i)s} + \beta_3 X_{is} + \beta_4 \bar{X}_{(-i)s} + \varepsilon_{is}$$

Equation (1) represents the OLS specification where Y denotes educational outcomes for individual i in school s , which include GCSE new style point scores; whether achieving 5 or more higher grades (A*-C) in GCSE, a standard requirement for further education; the number of GCSE achievement for each grade level (grade A*-A, A*-C and A*-G). $TENURE_{is}$ and $TENURE_{(-i)s}$ separately denote average years of school tenure in school s for person i and for her *peers*. X denotes a vector of control variables including female, white, UK born, young starter¹³, free meal eligibility, non Special Education Needs (SENs), Key Stage 2 Point Score¹⁴, income index, multiple deprivation index¹⁵, family size, number of siblings, house renting status, lone parent family, region of residence¹⁶, main parent's (who takes most care of child) age, education, ethnicity, social class status, employment status, aspiration for child's education and attitude to child's education. GCSE point scores and numbers of GCSE for each grade are divided by the standard deviation of students' achievement to facilitate a comparison across different tests.

To avoid endogeneity, I try to avoid including any variables which could be affected by school tenure. Amongst all control variables, parental aspiration and attitude to child education may be more likely to correlate with own and peers school tenure. To examine this possibility, Figures 2a-2d in the Appendix depict how these two variables vary with tenure. Reassuringly, although children whose parent with lower aspiration and more negative attitude to education tend to end up with shorter school tenure, there is little evidence

¹³ Students are defined as younger starters if they are younger than the average age of their sampled peers.

¹⁴ The Key Stage 2 point score has been achieved prior to secondary education so will not be affected by school tenure counted from secondary school.

¹⁵ The income and deprivation index are both derived variables that were surveyed at the end of Key Stage 3.

¹⁶ Region of residence only enters once as I suppose students in the same school live in the same region.

showing parental aspiration and attitude are clearly affected by own and peers school tenure.

The results are presented in Table 4 where a probit model is used in Col. [2] and OLS is used in other columns. While students considerably benefit from their own school tenure, i.e. individual school tenure is significantly positively correlated with all GCSE exam measures; they tend to get lower attainment if their peers have long tenure. For example, one year more school tenure increases the probability achieving 5 or more GCSE (grade A*-C) by 6% for youths, which suggests they are 6% more likely to continue their further education. However, this likelihood will drop by 3.7% if their peers' school tenure increases by 1 year. A similar pattern is found for GCSE point scores and number of GCSE (Grade A*-G).

5.2 Potential Bias

However, the OLS estimates above are likely to be biased because of two econometric problems --- endogeneity and measurement error. The latter will be discussed in Section 8.

There are two main sources of an endogeneity problem: 1) a correlation effect is usually a confounder to peer effects estimates, typically when people use cross-sectional data. As a result, the estimated effects of peer's school tenure would be spurious due to unobservables shared within schools. For example, if teacher quality is omitted, people may mistakenly attribute the effect of teachers on test score to peers. 2) the high correlation coefficient between own and peer school tenures, .75, suggests peer groups might be endogenous in which case students choose to attend the same school probably because they share similar characteristics. If such characteristics are not observed by researchers, the estimated peer effects may not imply a causal relationship.

6. TSLS Estimates

6.1 Instrumental Variables

People usually use TSLS estimates to overcome endogeneity problems. However, it is not easy to find a good instrument in practice. As the inverse of school tenure, school switch serves a natural instrument for school tenure in my case. The number of times moved school not in July, August and September is a derived variable from the history file, which describes how frequently students moved school during the school year by the end of Key Stage 3¹⁷. Figure 4 shows the frequency distribution of such moving. In line with Figure 2, most pupils never moved within term time. There are about 13% pupils who moved once, about 5% moved twice and less than 1% of pupils moved more than twice.

In principle, an ideal instrument should be highly correlated with the endogenous variable but not correlated with unobservables. Two attractive features of the moving variable manifest itself to be a good instrument. First, unlike some instruments that only entail a weak relation with endogenous variables, mobility has a strong linkage to school tenure because frequent switchers should end up with shorter tenure¹⁸. Hanushek *et al.* (2003) point out that changes in parental employment, earnings or family structure may be the main drivers for students to move. Figure 5a shows how individual school tenure varies by parental employment status, house tenure and family structure (i.e. whether parents ever got divorce or remarried) for different movers. Moving during the school year always induces much shorter school tenure in each case compared to normal moving (defined as moving at the start of school year or due to school transition), which convinces us it meets the first requirement for being a good instrument.

Second, while mobility could be chosen by parents in normal circumstances (e.g.

¹⁷ The updated information on mobility is up to Key Stage 3. As a result, people might expect IV to have a high ability to distinguish medium from long school tenure effects but less ability to distinguish short from medium given there is no further information for Key Stage 4.

¹⁸ The correlation between school tenure and switching is about .14.

Hanushek *et al.* 2003) so would not be perfectly orthogonal to unobservables, the unusual mobility variable used here to some extent breaks this endogenous linkage¹⁹. To show this, I show that while normal moving behaviour varies evidently across observed characteristics, e.g. family income, parental education and parental aspiration for child's education²⁰, there is no significant pattern for my instrument. Figure 5b shows that students who are from low income or high aspiration families are more likely to have a normal switch; in contrast, the instrument --- moving within term time --- seems not to be influenced by income or parental aspiration. This supports the previous assumption that moving during the school year is less likely to be a choice variable. Both moving behaviours show little relationship to parental education.

In addition to showing the instrument is fairly unrelated to predetermined family background characteristics, we need to be convinced that such moving behaviour is not driven by students' previous school performance either²¹. If school movers are people who were expelled from their previous school, one might worry they would differ in some way from non-movers in which case our instrument might not be valid. To examine this issue, Figure 5c illustrates the proportion of midyear movers by their school performance, contextual value added scores (CVA)²². It is clear to see that students from two extreme quintiles, persons with the lowest and highest scores are both more likely to move school relative to students in the middle of the distribution. This suggests that midyear moving may not be systematically correlated with school achievement.

¹⁹Hanushek *et al.* (2004) find moves during term produce more severe disruption in academic progress relative to moving at the start of the school year. Given the considerable pain stemming from moving during the school year, one would expect parents should try to avoid it unless unpredictable events occur. In my case, the average number of such moves is low, about 0.26 for individuals and peers.

²⁰According to "Tiebout" mobility theory, parents change districts in pursuit of higher quality schools or better matches for their children (Hanushek *et al.* 2004), it is reasonable to assume more ambitious parents are more willing to do so.

²¹ Although the test score of Key Stage 2 is included in my regression, given the survey started when students took the second year of Key Stage 3, it makes sense to figure out whether the performance in the first year of Key Stage 3 would induce a move.

²²CVA is a statistic used by the government of the United Kingdom to assess the performance of schools. Unlike statistics such as exam performance, CVA attempts to take into account the circumstances of children attending the school that are beyond the school's control.

Although all comparisons shown in the pictures do not necessarily prove that there is no correlation between moving and both observable and unobservable background characteristics, the lack of a significant pattern for observables suggests that unobservable characteristics are also unlikely to be correlated with instrument. This idea will further apply to the following balancing tests.

6.2 Balancing Tests

Given I look at both individual and peers school tenure, two instruments, individual and peer moving are correspondingly involved. To further probe their validity, Appendix Table 3 presents two balancing tests: the first one is to regress pre-determined *individual* characteristics on *peer* switching, the rationale is that, conditional on other peer controls, peer switching behaviour should be as if random and so would not be correlated with a pupil's own characteristics; the second one is to regress identical pre-determined characteristics for *peers* on *individual* switching to ascertain that, conditioning on own backgrounds, a pupil's school moving is not driven by any characteristics of their peers. Reassuringly, both balancing tests offer evidence that school moving appears to be a fairly nice proxy for school tenure because very few (2 or 4 out of 20) pre-determined variables of pupils (or peers) are significantly correlated with peer (or pupils) moves, and none of them are significant at the 1% level²³.

6.3 Estimates

Unlike the conventional case with only one endogenous variable, there are two here. Equations (2a) and (2b) present first stage estimates in which own tenure is instrumented by the number of times the individual moved school during the academic year and peer tenure is instrumented by that of peers respectively. Equation (3) presents the TSLS estimates, other controls are defined as previous.

²³ In fact, there is no significant relationship between peer switching and pupil school tenure, but I cannot rule out a relationship between individual switching and peer tenure.

$$(2a) \quad TENURE_{is} = \gamma_0 + \gamma_1 SWITCH_{is} + \gamma_2 X_{is} + \gamma_3 \bar{X}_{(-i)s} + \nu_{is}$$

$$(2b) \quad TENURE_{(-i)s} = \delta_0 + \delta_1 SWITCH_{(-i)s} + \delta_2 X_{is} + \delta_3 \bar{X}_{(-i)s} + \nu_{is}$$

$$(3) \quad Y_{is} = \chi_0 + \chi_1 TENURE_{is} + \chi_2 TENURE_{(-i)s} + \chi_3 X_{is} + \chi_4 \bar{X}_{(-i)s} + \mu_{is}$$

First stage estimates reported in Table 4a show that moving school is a strong instrument for school tenure in both cases. A one point increase in moving school during the school year of peers (or pupils) will reduce peers (or pupils) school tenure by .43 years and .3 years, respectively. The remaining TSLS estimates show a very different picture from OLS ---almost all coefficients on peer school tenure turn positive and none of them is significant; in the meanwhile, pupil's GCSE point score and GCSE (A*-G) are both increased by about 11 percent of a standard deviation if she/he stays in the current school one year longer. Two preliminary findings are of note: 1) the change in the sign of most peer tenure coefficients in TSLS confirms the previous conjecture that the previous OLS estimates are possibly biased by endogeneity problems, although the estimates are a bit imprecise²⁴; 2) the generally similar own tenure effects found in TSLS imply the bias of OLS for individuals is not as big as for peers, and further suggest that school tenure tends to benefit students in a similar manner as job tenure does. To improve the precision of TSLS, I instead use dummies on moving once, twice and more than twice as instruments and report the results in Table 4b. The increase in the number of instruments reduces standard errors a little bit, however, unfortunately weakens the first stages as well. Thus, I will use the initial instruments throughout the rest of the analysis.

6.4 Heterogeneous Effects

Zero peer tenure effects and some individual tenure effects have been found for *all students*. In this section, I further probe how school tenure effects are heterogeneous across

²⁴ TSLS is not significantly different from OLS for the full sample in a Hausman test; however, a Hausman test for OLS cannot accept the consistency of OLS.

students.

Gender

Proud (2008), Han and Li (2009), and Black *et al.* (2010) have found evidence that peers effects tend to vary across gender. It is plausible to examine whether this is the case here also. Table 5 reports separate estimates for boys and girls. There is no effect of peer school tenure on achievement for either boys or girls. However, I do find, girls get more benefit from own school tenure compared to boys, for example, a one year increase in school tenure induces an increase in GCSE point scores by about 15 percent of a standard deviation for girls. Similarly, girls also tend to attain more GCSE (A*-C) and (A*-G) if they stay in a given school longer. Descriptive statistics show that girls have starkly better academic records than boys on average; this finding would also suggest higher achieving students are more likely to gain from their own tenure.

Ethnicity

Hoxby (2000) finds strong intra-race peer effects in U.S. elementary schools. Table 6 illustrates how white and non-white students are affected differently by school tenure and the main finding is non white students are more likely to gain from peers positive characteristics (say longer school tenure here) relative to white. A one year increase in peer tenure improves achievement of GCSE (A*-A) and GCSE (A*-C) by 80 and 38 percent of a standard deviation for minority (non-white) students. For white students, a 12 percent of a standard deviation of GCSE point scores rises is associated with 1 extra year of own school tenure. Marmaros and Sacerdote (2006) find one of the key factors in forming friendships is race, where the interaction across race groups is less frequent than within group. Minority students are more motivated to socialise with people from similar backgrounds compared to nonminority (white students) and therefore build up close ties with each other, so people

might expect they are more likely to get peer's influence²⁵. The other possibility is the disadvantaged pupils are more sensitive to their peer compositions. Hanushek *et al.* (2004) point out the costs of switching schools appears to be larger for lower income students who attend higher turnover schools; Gould *et al.* (2009) also find that disadvantaged students are more likely to be adversely affected by certain peer groups. Provided non-whites are more likely to come from disadvantaged family, my results suggest, they are also more likely to be positively affected by positive characteristics of their peers.

Income & Multiple Deprivation

As mentioned above, Hanushek *et al.* (2004) and Gould *et al.* (2009) investigate peer effects through student's financial dimension. However, while they simply refer income as "ever low income" or "low socio-economic background", I am able to scrutinize whether the effect of school tenure varies across students financial background more precisely with administrative indexes on income and multiple deprivation. Tables 7 and 8 provide similar results, that is poor students tend to be affected by their peers' school tenure. First stages of peers' school tenure are insignificant for wealthier students so the resulting 2SLS estimates are not very informative. Overall, the two sets of estimates reach similar conclusion: on the one hand, compared to students who are from high income or less deprived families, those with disadvantaged backgrounds are more likely to be positively impacted by peer school tenure, which is consistent with the finding for ethnicity. This further suggests that disadvantaged students are more sensitive to their peer characteristics, irrespective of whether they are positive or negative; on the other hand, school tenure *per se* has more significantly positive effects on achievement for wealthy students.

²⁵ I have tested whether minorities may be particularly affected by other minorities; the results turn out to be very imprecise with hugely increased standard errors but the coefficients do increase a lot as well. As a result, there is somewhat supportive evidence here. Similarly, girls tend to be more influenced by girl peers although the result is not significantly different from the previous one.

Student's Previous Achievement

As discussed in the gender section, girls (who achieved higher scores on average) tend to gain more from own long tenure. Following this line I probe whether peer effects vary by student's previous Key Stage 2 achievement. Table 9 reports estimates where students are stratified into high, median and low distribution of test scores. While low and median score students are hardly impacted by own school tenure or their peers', high achieving students are strikingly benefited from staying in a given school longer. Taking the findings by gender, and by income/multiple deprivation together, my results indicate that students with advantaged backgrounds (either high-achieving or high income) are likely benefited by longer school tenure.

In summary, I find clear school tenure effects allowing for students heterogeneity. Individual and peer school tenure tend to separately impact different types of students significantly. Non-white, low income/high deprivation students gain in education attainment if their peers have long school tenure, whereas girls, high income/low deprivation and high-achieving students score higher when staying in a school longer.

7. Peer vs. Individual Effects

Although the evidence shown above suggests in-term school moving should be a valid instrument, I further examine this issue here. Figure 6 shows that students moving during the school year are more likely to come from unstable families that do not own a house. Also, the parents are more likely to have ever changed jobs and to have ever got divorced or remarried. Even though I include these variables in my specifications and I control for many more variables than do conventional studies on student achievement, it is still impossible to exhaustively control for all factors. If unobservables are at play, my estimates are likely to over- or under-state the effect of school tenure. However, it is plausible to believe the effects

of peers moving would less likely to be contaminated by this issue because the unobservables of peer would be less relevant to individual achievement relative to that of individuals. Figure 7 presents a set of comparisons between individual and peers school tenure by family background. We can see the differences between movers and non-movers in peers tenure become much smaller than those in individual's, which suggests the estimated peer tenure effect is more convincing than the individual tenure effect. Nevertheless, if we believe the instruments are valid, which cannot be tested, either effect should be reliable.

8. Measurement Error

Micklewright *et al.* (2010) find measurement error due to sampling variation will induce big biases in peer effects if only a few students are sampled. To probe whether it is an important issue here, I consider the measurement error issue in two stages: 1) I provide some evidence that the attenuation bias appears to be small in my case; 2) Because I do not have the required information to make a direct measurement error correction²⁶, I create two measures of peer school tenure at random and use an instrumental variables strategy²⁷ that has been suggested in the literature (Cameron and Trivedi, 2005; Greene, 2008). If IV estimates turn out to be close to the original OLS estimates, I will be fairly confident that measurement error is not be a big issue here.

8.1 Attenuation Bias

My estimates on peer effects are unlikely to suffer from serious attenuation bias for two reasons. First, according to Jenkins *et al.* (2008) and Micklewright *et al.* (2010), other things being equal, people would expect to find less attenuation bias if between-school

²⁶ In empirical work, Ammermueller and Pischke (2009) implement a straightforward technique for adjusting the coefficient estimates to obtain consistent estimates free from measurement error, which is also adopted by Neidell and Waldfogel (2010). The major requirement of this method is to know the total number of students in each sampled school, which is unfortunately not available in my case. Additionally, their adjustments are based on within-school estimates, which is also not appropriate as my identification relies on across-school variation.

²⁷ The conventional instrument variable is the second report or information on concerned variables. See Ammermueller and Pischke (2009) for details.

variation in pupil characteristics is high. The logic is that low within-school variation implies high social segregation in which case students in the same school tend to have similar family backgrounds. As a result, sampled students are well representative of all students in a school so the estimates on peer effects should be less biased by measurement error. Table 10 shows that although within-school variation is bigger than between- for most variables under study, for some variables that people might think should be more relevant to social segregation, i.e. ethnicity, income, multiple deprivation and parents' social class, the gap between within- and across-school variance is not that large. Most importantly, the key variable, school tenure has smaller variance within school than across school. Taken together, these suggest small attenuation bias here.

Secondly, students from independent schools are fully sampled in my data. Figures 8 and 9 depict that the distribution of peer switching of independent schools and the rest²⁸. These distributions are very similar suggesting the attenuation bias may not be a big issue in 2SLS estimation²⁹.

8.2 Measurement Error Corrected OLS Estimates³⁰

Using an instrumental variables approach, I create instruments following three steps:

- 1) Randomise students: for each school, I randomly assign students into groups A and B. Each group contains same number of students if the school size is even, differs in size by 1 otherwise.
- 2) Construct peer measures: a simple example of how to construct peers' school tenure is shown in Figure 10, where $X_1 \dots X_6$ denote the school tenure for students 1 to 6 who are randomly assigned to *GROUP A* and *GROUP B* in step 1. For example, for Student 1 from *GROUP A*, her *PEER A* is the mean school tenure of the other two students 2 and 3 in her group; whereas her *PEER B* is the average school tenure of *GROUP B*. Likewise for

²⁸ I am not able to run separate regressions for the two groups due to insufficient observations for independent schools.

²⁹ Although student backgrounds should be different between independent schools and the maintained schools, as moving during the school year is generally bad for pupils, people would expect such behaviour is rare in both types of school.

³⁰ I also tried to generalize this method to get measurement error corrected 2SLS estimates but unfortunately the results are very imprecise as the standard errors increase a lot..

Student 4 from *GROUP B*, her *PEER B* is the mean school tenure of the other two students 5 and 6 in her group; whereas her *PEER A* is the average school tenure of *GROUP A*. Following this way, I can obtain *PEER A* and *PEER B* for every student for every school. 3) Simulation: I repeat steps 1 and 2 and then obtain the average estimates of parameter θ_2 in Eq. 4a and 4b³¹.

$$(4a) \text{ PEER } A_{is} = \kappa_0 + \kappa_1 \text{ PEER } B_{is} + \kappa_2 X_{is} + \kappa_3 \bar{X}_{(-i)s} + \tau_{is}$$

$$(4b) Y_{is} = \theta_0 + \theta_1 \text{ TENURE }_{is} + \theta_2 \text{ PEER } A_{is} + \theta_3 X_{is} + \theta_4 \bar{X}_{(-i)s} + \xi_{is}$$

The correlation coefficient between PEER A and PEER B is about .92. The average coefficient in the first stage (Eq. 4a) is .824 (.018). Table 11 presents the simulation results with comparisons to previous OLS estimates. All coefficients in IV estimation are bigger than OLS in absolute terms, which is consistent with the theory that measurement error usually tends to bias estimates towards zero. Overall, the similar results found in measurement error corrected OLS estimates indicate there is no severe measurement error issue in this paper.

9. Conclusions

This paper introduces a new concept, school tenure, which is defined as how many years a given student has been in a particular school. Given longer school tenure usually brings more school-specific knowledge and more stable academic progress to students, I explore whether school tenure plays a similar role in students achievement as job tenure does in earnings by linking school tenure and its spillovers to GCSE achievement in England's secondary schools. After controlling for numerous personal and family characteristics for pupils and their peers, OLS estimates show that individuals with longer school tenure tend to perform better; in contrast, some negative effects of peer tenure are also found in OLS. Since

³¹ 100 simulation replications are performed here, I tried 500 replications once which is really time consuming and generates even closer results to OLS.

peer effects are often biased in regular OLS estimates with cross-sectional data, I instead use 2SLS estimates where the number of times moved during the school year is assumed to be exogenous and then used as an instrument for school tenure. The resulting 2SLS estimates show that the individual school tenure effects are still positive, which supports the hypothesis that school tenure tends to benefit students. Furthermore, negative peer tenure effects disappear in the 2SLS estimates, indicating there is a zero externality of school tenure for all students.

I obtain very interesting results when student heterogeneity is taken into account, individual and peers school tenure impact child achievement differently with respect to personal backgrounds. High achieving and advantaged students gain from their own school tenure but are not impacted by their peers. This finding could be interpreted from a self-motivation perspective, i.e. self-motivated or very confident people are less likely to care about and then get impacted by their peers. By contrast, much literature has found students from disadvantaged background are more likely to be adversely affected by their peers, suggesting those kind of students would be more sensitive to the environment they are exposed to. My study further indicates they are also more likely to get benefit from positive peer characteristics as minority and low income/high deprivation students tend to perform better if their peers have longer school tenure. The significant heterogeneous effects of school tenure found in this paper also imply school tenure may be a potential determinant of student achievement to be considered in future work,

Table 1 Educational System in England

Age	Year	Curriculum stage	Schools		
3-4	Nursery	Foundation Stage	Nursery school		
4-5	Reception		Infant school	Primary school	First school
5-6	Year 1	Key Stage 1			
6-7	Year 2				
7-8	Year 3	Key Stage 2	Junior school	Middle school	
8-9	Year 4				
9-10	Year 5				
10-11	Year 6				
11-12	Year 7	Key Stage 3	Secondary school	Upper school or High school	
12-13	Year 8				
13-14	Year 9				
14-15	Year 10	Key Stage 4 / GCSE	Secondary school with sixth form		
15-16	Year 11				
16-17	Year 12 (Lower Sixth)	Sixth form / International Baccalaureate or A level	College/Sixth Form		
17-18	Year 13 (Upper Sixth)				

Source: Wikipedia

Table 2 Summary Statistics

Variable	N	Mean	Std. Dev.
<i>Individual Characteristics</i>			
School Tenure	14180	4.437	0.843
Number of Times Moved School during the Academic Year	14180	0.264	0.624
Year of Birth	14180	1989.677	0.468
Month of Birth	14180	6.469	3.411
Female	14180	0.496	0.500
White	14180	0.671	0.470
UK Born	13858	0.926	0.262
Young Starter	14180	0.504	0.500
Renting Status	14033	0.319	0.466
Tercile Income Deprivation	11036	2.012	0.815
Tercile Multiple Deprivation	11036	2.000	0.825
Family Size	14166	4.495	1.421
Numbers of Siblings	14162	1.212	0.971
Lone Parent Family	14159	0.303	0.460
Free School Meal Eligibility	14107	0.172	0.377
No Special Education Needs(SENs)	14107	0.823	0.382
Key Stage 2 Scores	13630	26.850	4.064
Age of Main Parent	14180	43.114	5.823
Education of Main Parent	13903	16.261	1.226
White Main Parent	14139	0.702	0.456
Social Class of Main Parent	13875	4.517	2.168
Employment Status of Main Parent	14113	3.544	3.044
Aspiration on Child's Higher Education	13711	2.163	1.063
Attitude to Child's Education	13741	1.290	0.651
Region of Residence	12379	5.326	2.411
GCSE New Style Point Scores	14180	369.398	157.727
Whether Achieved 5 or more GCSE (Grade A*-C)	14180	0.580	0.494
Numbers of GCSE (Grade A*-A)	14180	1.416	2.675
Numbers of GCSE (Grade A*-C)	14180	5.756	4.263
Numbers of GCSE (Grade A*-G)	14180	9.180	2.898
<i>Peer Characteristics</i>			
School Tenure	14166	4.464	0.616
Number of Times Moved School during the Academic Year	14166	0.256	0.198
Number of Students per School		22.65	
Number of Schools		633	

Table 3 OLS Estimates of School Tenure on Youth GCSE Achievements
Robust Standard Errors in Parentheses

	[1]	[2]	[3]	[4]	[5]
	GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCS E(Grade A*-A))	Num(GCS E(Grade A*-C))	Num(GCS E(Grade A*-G))
Peers School Tenure	-.071** (.036)	-.037* (.023)	-.026 (.028)	-.041 (.028)	-.106** (.051)
Individuals School Tenure	.129*** (.027)	.059*** (.017)	.034** (.016)	.081*** (.018)	.159*** (.039)
Number of Schools	611	611	611	611	611
Observations	8,484	8,484	8,484	8,484	8,484

Notes: Probit model is used in Col. [2] and OLS is used in the rest columns. All specifications also control for same individual and peer variables including female, white, UK born, young starter, free meal eligibility, non Special Education Needs (SENs), Key Stage 2 Point Score, renting status, income index, multiple deprivation index; main parent's (who takes most care of child) age, education, ethnicity, social class status, employment status, aspiration on child's education, attitude to child's education, family size, number of siblings, lone parent family. Dummies of region of residence include once. Robust standard errors in Brackets allow for clustering by school. All regressions are weighted by the personal weighting fully allowing for the sample design.

*** p<0.01, ** p<0.05, * p<0.1

Table 4a TSLS Estimates of School Tenure on Youth GCSE Achievements
Robust Standard Errors in Parentheses

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A))	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
Peers School Tenure	-.427*** (.137)	.015 (.170)	.062 (.126)	-.012 (.179)	.180 (.151)	.134 (.254)
Individuals School Tenure	-.298*** (.023)	.114** (.048)	.030 (.045)	.032 (.050)	.045 (.043)	.107* (.063)
Number of Schools	611	611	611	611	611	611
Observations	8,484	8,484	8,484	8,484	8,484	8,484

**Table 4b TSLS Estimates of School Tenure on Youth GCSE Achievements
Robust Standard Errors in Parentheses**

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GC SE(Grad e A*-A))	Num(GC SE(Grad e A*-C))	Num(GC SE(Grad e A*-G))
Peers Moved Once	-.731*** (.281)					
Peers Moved Twice	-.372 (.425)					
Peers Moved more than Twice	-1.483 (.929)					
Peers School Tenure		-.003 (.160)	.068 (.121)	-.060 (.164)	.167 (.144)	.087 (.239)
Individuals Moved Once	-.194*** (.031)					
Individuals Moved Twice	-.743*** (.074)					
Individuals Moved more than Twice	-1.085*** (.145)					
Individuals School Tenure		.119*** (.044)	.032 (.042)	.040 (.046)	.059 (.040)	.106* (.057)
Number of Schools	611	611	611	611	611	611
Observations	8,484	8,484	8,484	8,484	8,484	8,484

Notes: see notes for Table 3 and text for details

*** p<0.01, ** p<0.05, * p<0.1

Table 5 TSLS Estimates of School Tenure on Youth GCSE Achievements by Gender
Robust Standard Errors in Parentheses

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A))	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
<i>Boys</i>						
Peers School Tenure	-0.537*** (.147)	.108 (.164)	.148 (.142)	.001 (.152)	.126 (.147)	.160 (.263)
Individuals School Tenure	-0.287*** (.027)	.070 (.066)	-.021 (.079)	-.058 (.071)	-.015 (.064)	.076 (.094)
Number of Schools	555	555	555	555	555	555
Observations	4,278	4,278	4,278	4,278	4,278	4,278
<i>Girls</i>						
Peers School Tenure	-.334** (.142)	-.180 (.252)	-.090 (.179)	-.034 (.275)	.154 (.235)	-.002 (.314)
Individuals School Tenure	-.312*** (.033)	.144** (.061)	.064 (.055)	.126* (.072)	.096 (.062)	.116* (.070)
Number of Schools	574	574	574	574	574	574
Observations	4,206	4,206	4,206	4,206	4,206	4,206

Table 6 TSLS Estimates of School Tenure on Youth GCSE Achievements by Ethnicity
Robust Standard Errors in Parentheses

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A))	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
<i>White</i>						
Peers School Tenure	-0.399*** (.142)	-.041 (.192)	-.016 (.147)	-.119 (.198)	.139 (.170)	.143 (.285)
Individuals School Tenure	-.295*** (.025)	.122** (.053)	.029 (.051)	.043 (.054)	.050 (.047)	.095 (.071)
Number of Schools	558	558	558	558	558	558
Observations	6,234	6,234	6,234	6,234	6,234	6,234
<i>Non-white</i>						
Peers School Tenure	-.666*** (.152)	.184 (.200)	.168 (.155)	.806*** (.259)	.379* (.197)	-.264 (.247)
Individuals School Tenure	-.322*** (.047)	.040 (.103)	.065 (.086)	.056 (.139)	.036 (.099)	.114 (.121)
Number of Schools	462	462	462	462	462	462
Observations	2,250	2,250	2,250	2,250	2,250	2,250

Table 7 TSLS Estimates of School Tenure on Youth GCSE Achievements by Income Index
Robust Standard Errors in Parentheses

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A)	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
<i>Low Income</i>						
Peers School Tenure	-.694*** (.138)	.307* (.160)	.296*** (.113)	.005 (.112)	.400*** (.137)	.465* (.246)
Individuals School Tenure	-.348*** (.045)	.128* (.077)	-.050 (.060)	.005 (.048)	-.030 (.070)	.211** (.105)
Number of Schools	492	492	492	492	492	492
Observations	2,558	2,558	2,558	2,558	2,558	2,558
<i>Median Income</i>						
Peers School Tenure	-.491*** (.175)	.226 (.195)	.178 (.175)	.076 (.214)	.191 (.188)	.226 (.274)
Individuals School Tenure	-.324*** (.037)	.042 (.072)	.080 (.073)	-.066 (.077)	.084 (.068)	-.008 (.087)
Number of Schools	556	556	556	556	556	556
Observations	2,919	2,919	2,919	2,919	2,919	2,919
<i>High Income</i>						
Peers School Tenure	-.214 (.161)	-1.134** (.450)	-.493** (.229)	-.278 (.490)	-.461 (.410)	-.907* (.483)
Individuals School Tenure	-.216*** (.028)	.236** (.100)	.065 (.072)	.303** (.145)	.122 (.097)	.161 (.112)
Number of Schools	449	449	449	449	449	449
Observations	3,007	3,007	3,007	3,007	3,007	3,007

**Table 8 TSLS Estimates of School Tenure on Youth GCSE Achievements by Multiple Deprivation Index
Robust Standard Errors in Parentheses**

	FIRST STAGE	TSLS				
		GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A)	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
<i>High Deprivation</i>						
Peers School Tenure	-.680*** (.134)	.262 (.172)	.273** (.124)	.138 (.117)	.422*** (.142)	.352 (.264)
Individuals School Tenure	-.366*** (.047)	.070 (.079)	-.037 (.062)	-.012 (.046)	-.014 (.069)	.087 (.110)
Number of Schools	457	457	457	457	457	457
Observations	2,564	2,564	2,564	2,564	2,564	2,564
<i>Median Deprivation</i>						
Peers School Tenure	-.498*** (.174)	.308 (.207)	.183 (.186)	-.212 (.223)	.239 (.212)	.523* (.280)
Individuals School Tenure	-.326*** (.036)	.126* (.077)	.100 (.079)	-.009 (.082)	.067 (.072)	.159* (.096)
Number of Schools	537	537	537	537	537	537
Observations	2,788	2,788	2,788	2,788	2,788	2,788
<i>Low Deprivation</i>						
Peers School Tenure	-.247 (.178)	-.898** (.398)	-.339* (.185)	-.051 (.426)	-.387 (.323)	-.971** (.420)
Individuals School Tenure	-.216*** (.028)	.162* (.099)	.025 (.080)	.149 (.133)	.105 (.093)	.073 (.109)
Number of Schools	408	408	408	408	408	408
Observations	3,132	3,132	3,132	3,132	3,132	3,132

**Table 9 TSLS Estimates of School Tenure on Youth GCSE Achievements by Previous Test Score
Robust Standard Errors in Parentheses**

	FIRST STAGE	GCSE New Style Point Score	5 or more GCSE (Grade A*-C)	Num(GCSE(Grade A*-A))	Num(GCSE(Grade A*-C))	Num(GCSE(Grade A*-G))
<i>Low Key Stage 2 Scores</i>						
Peers School Tenure	-0.640*** (.143)	-.088 (.134)	.024 (.056)	-.004 (.024)	.081 (.102)	.005 (.207)
Individuals School Tenure	-.339*** (.045)	.085 (.072)	-.016 (.034)	-.035 (.022)	-.068 (.055)	.188* (.112)
Number of Schools	568	568	568	568	568	568
Observations	2,405	2,405	2,405	2,405	2,405	2,405
<i>Median Key Stage 2 Scores</i>						
Peers School Tenure	-.270* (.161)	-.100 (.410)	.039 (.272)	-.296 (.221)	.025 (.438)	.207 (.456)
Individuals School Tenure	-.295*** (.034)	.093 (.074)	-.026 (.069)	.041 (.050)	.051 (.088)	.013 (.086)
Number of Schools	579	579	579	579	579	579
Observations	2,867	2,867	2,867	2,867	2,867	2,867
<i>High Key Stage 2 Scores</i>						
Peers School Tenure	-.321** (.161)	.454 (.399)	-.012 (.050)	-.330 (.470)	.389 (.302)	.769 (.471)
Individuals School Tenure	-.248*** (.031)	.222** (.103)	.048*** (.018)	.066 (.161)	.254*** (.098)	.165* (.098)
Number of Schools	556	556	556	556	556	556
Observations	3,212	3,212	3,212	3,212	3,212	3,212

Notes: see notes for Table 3 and text for details

*** p<0.01, ** p<0.05, * p<0.1

Table 10 Between- and Within-School Variances of Pupil Characteristics

Variable	Between School	Within School
School Tenure	0.720	0.571
Number of Times Moved School during the Academic Year	0.296	0.594
Female	0.218	0.459
White	0.341	0.328
UK Born	0.131	0.241
Young Starter	0.103	0.494
Renting Status	0.230	0.416
Tercile Income Deprivation	0.573	0.589
Tercile Multiple Deprivation	0.633	0.537
Family Size	0.581	1.302
Numbers of Siblings	0.408	0.886
Lone Parent Family	0.163	0.437
Free School Meal Eligibility	0.194	0.330
No Special Education Needs(SENs)	0.185	0.348
Key Stage 2 Scores	2.354	3.542
Age of Main Parent	2.251	5.520
Education of Main Parent	0.504	1.147
White Main Parent	0.335	0.315
Social Class of Main Parent	1.111	1.911
Employment Status of Main Parent	1.381	2.761
Aspiration on Child's Higher Education	0.550	0.936
Attitude to Child's Education	0.226	0.612

**Table 11 Measurement Error Corrected OLS Estimates
Robust Standard Errors in Parentheses**

	[1]	[2]
	Original	Corrected
GCSE New Style Point Score		
Peers School Tenure	-.071* (.036)	-.084* (.041)
Individuals School Tenure	.129*** (.027)	.140*** (.030)
5 or more GCSE (Grade A*-C)^a		
Peers School Tenure	-.099* (.060)	-.110 (.070)
Individuals School Tenure	.158*** (.046)	.164*** (.051)
Num(GCSE(Grade A*-A))		
Peers School Tenure	-.026 (.028)	-.028 (.033)
Individuals School Tenure	.034* (.016)	.034* (.018)
Num(GCSE(Grade A*-C))		
Peers School Tenure	-.041 (.028)	-.045 (.032)
Individuals School Tenure	.081*** (.018)	.084*** (.020)
Num(GCSE(Grade A*-G))		
Peers School Tenure	-.106** (.051)	-.118** (.058)
Individuals School Tenure	.159*** (.039)	.166*** (.043)
Number of Schools	611	609
Observations	8,484	8,481

Notes: 100 simulation replications are performed.

a: I report coefficients of probit model rather than marginal effects to make a comparison between OLS and simulation.

*** p<0.01, ** p<0.05, * p<0.1

Figure 1 Number of Students per School

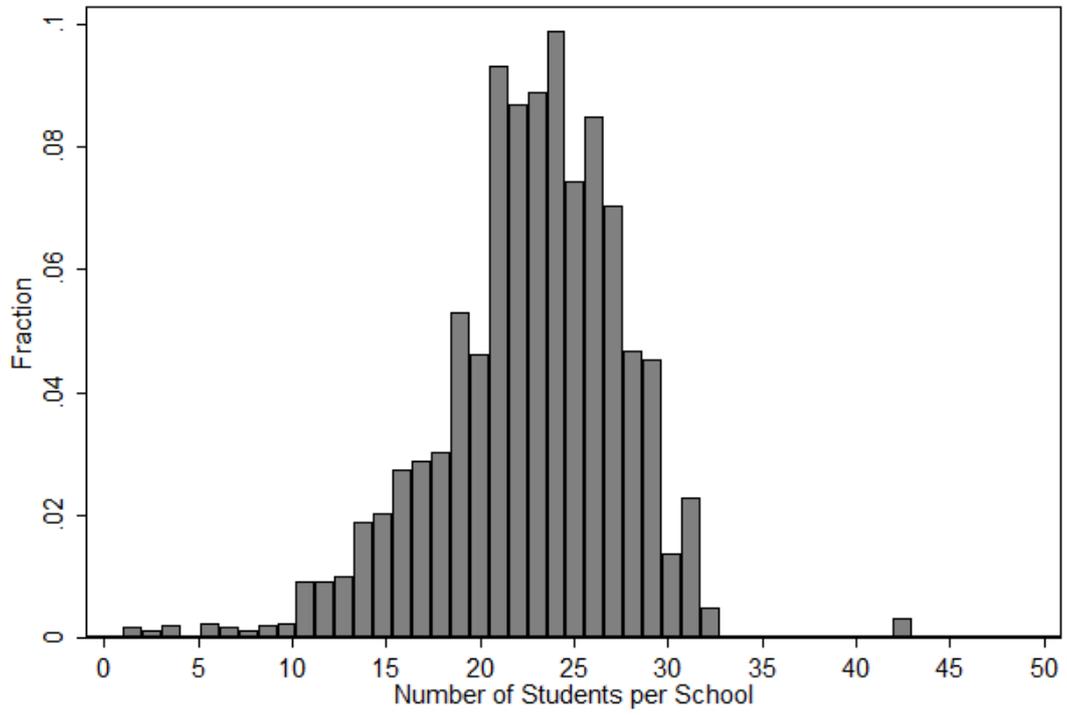


Figure 2 Individual Month of School Tenure

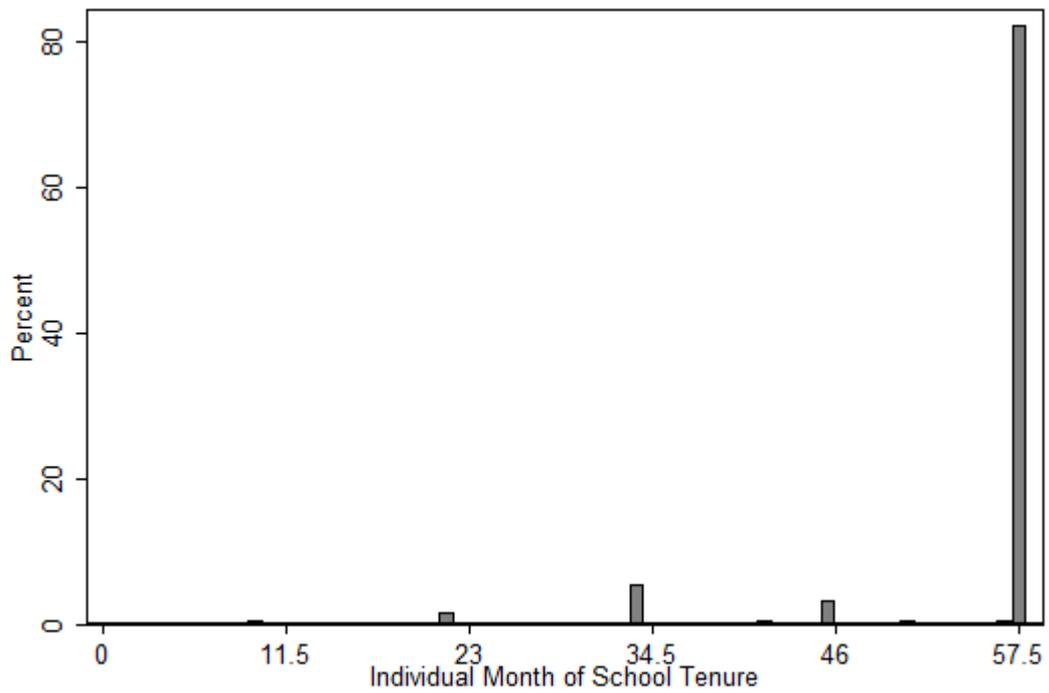


Figure 3 Distribution of School Tenure for Peers and Youth

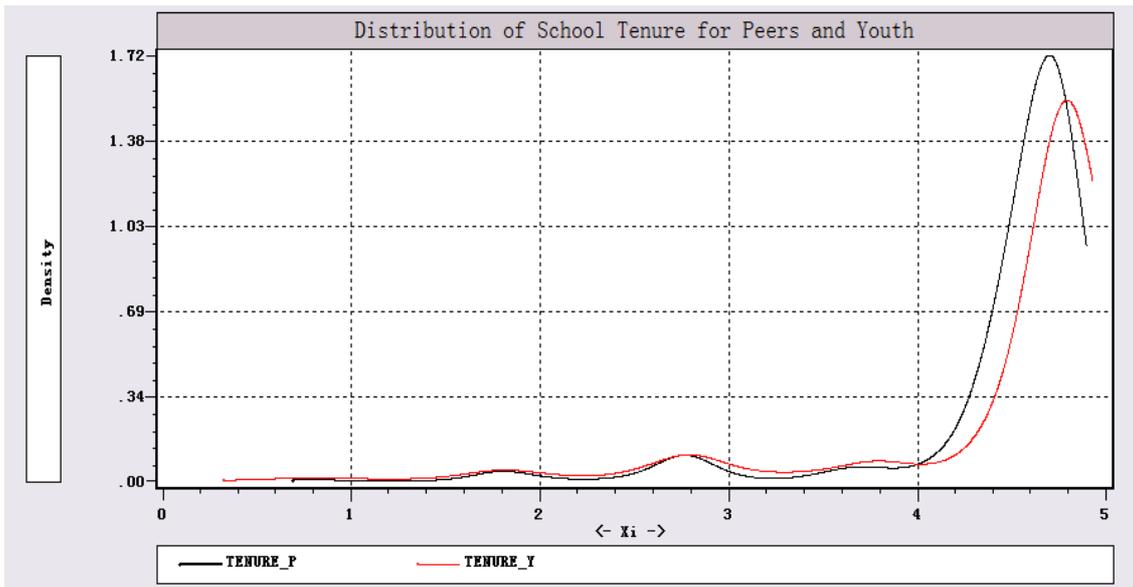


Figure 4 Number of Times Moved During School Year

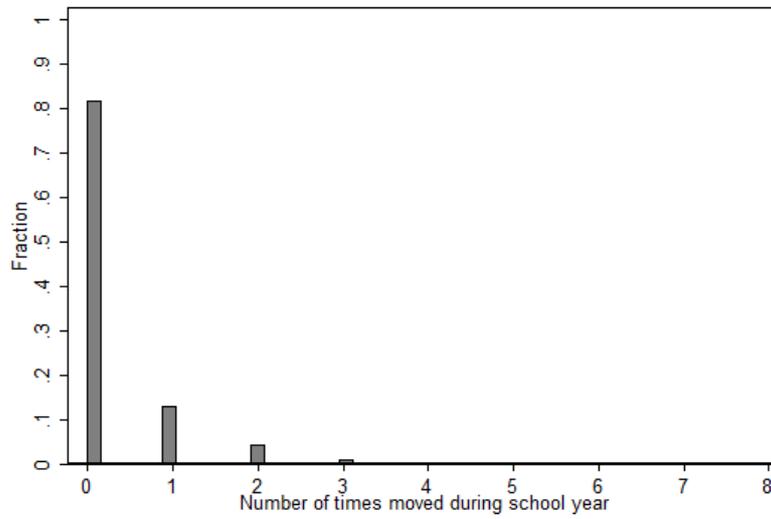


Figure 5a Individual Year of School Tenure by Family Backgrounds

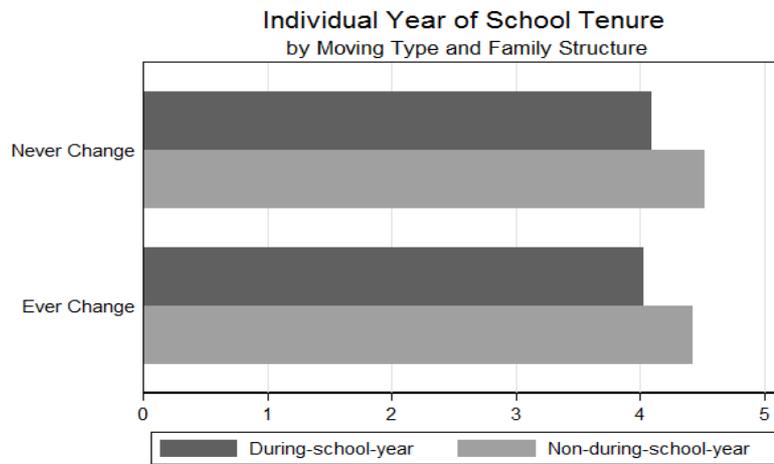
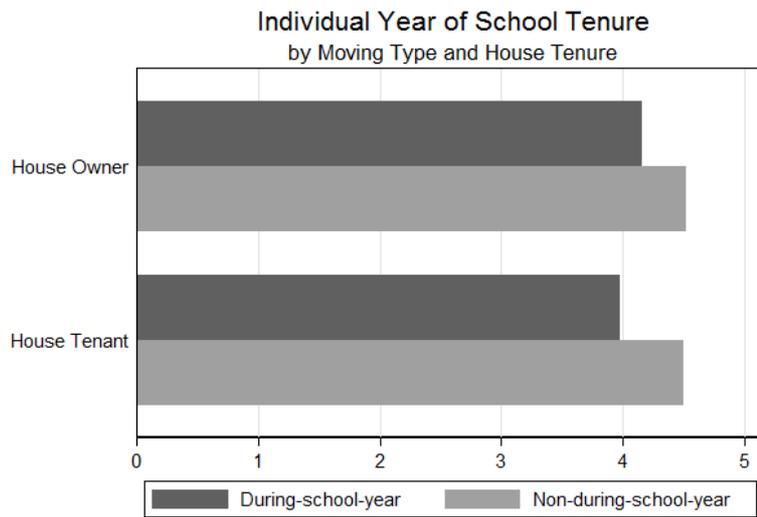
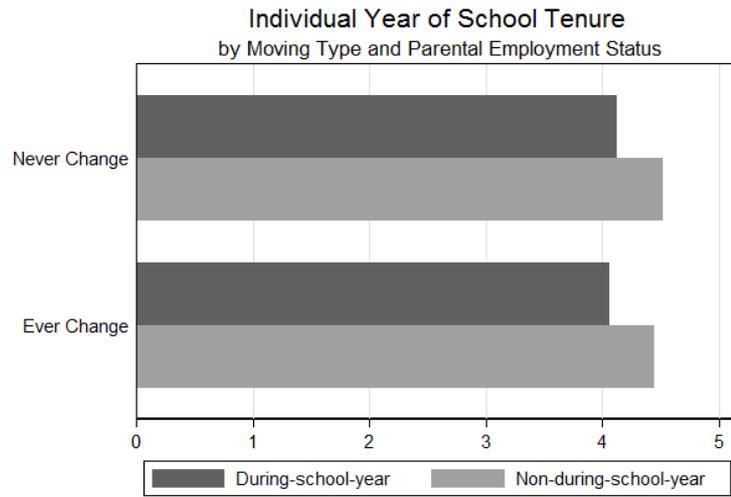


Figure 5b Proportion of School Movers by Family Background

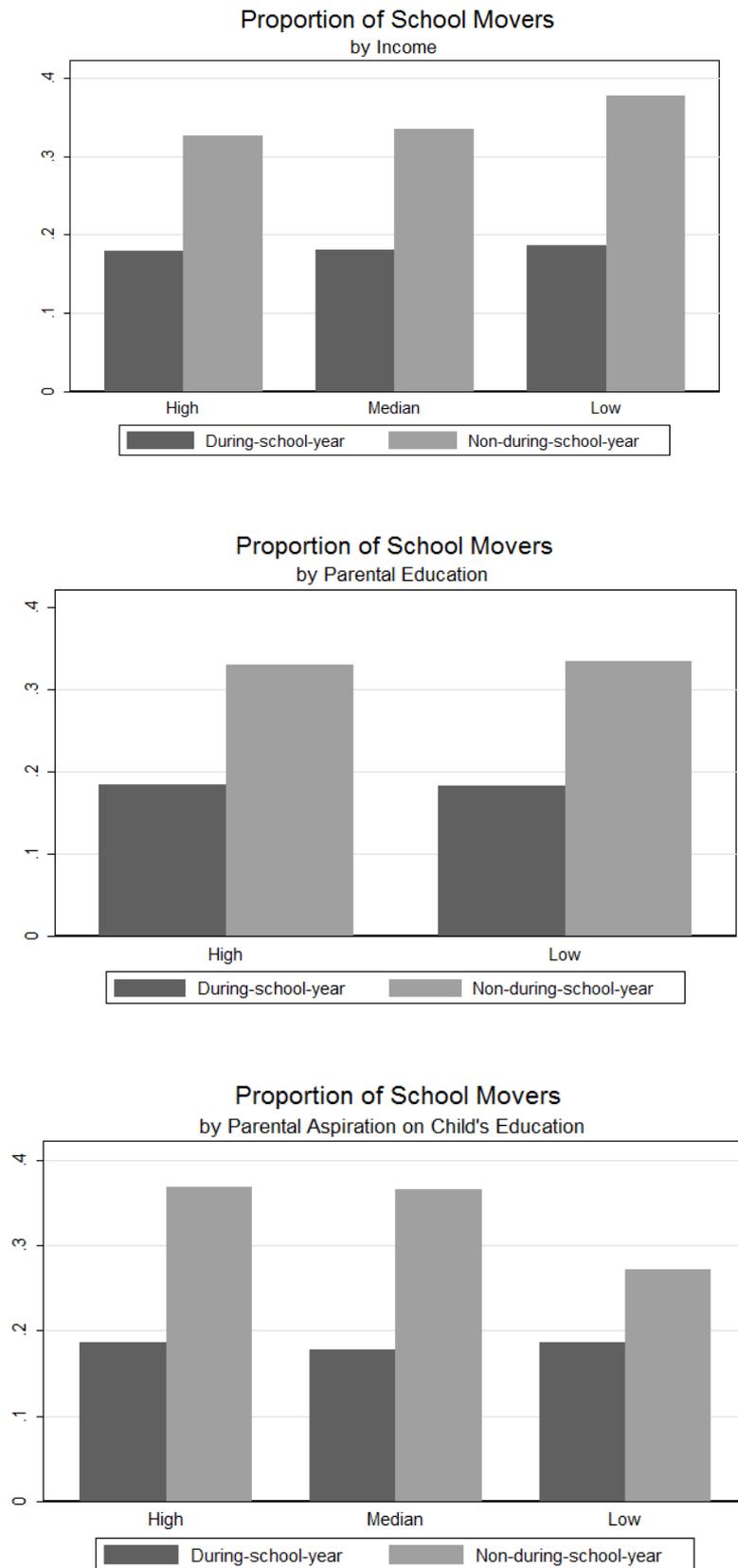


Figure 5c Proportion of Midyear Movers

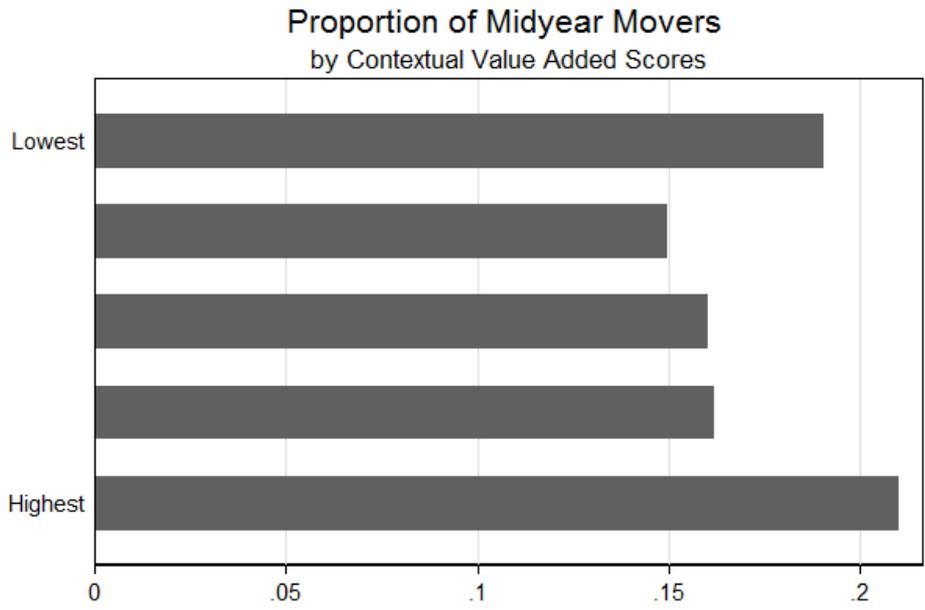
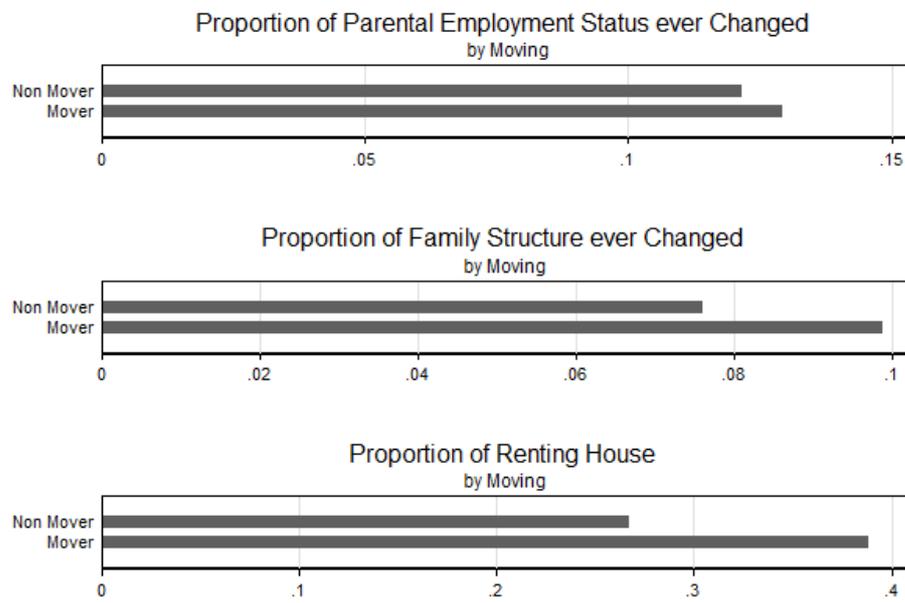


Figure 6 Comparisons of Movers and Non-movers by Family Background



**Figure 7 Individual and Peers Year of School Tenure
by Moving and Family Backgrounds**

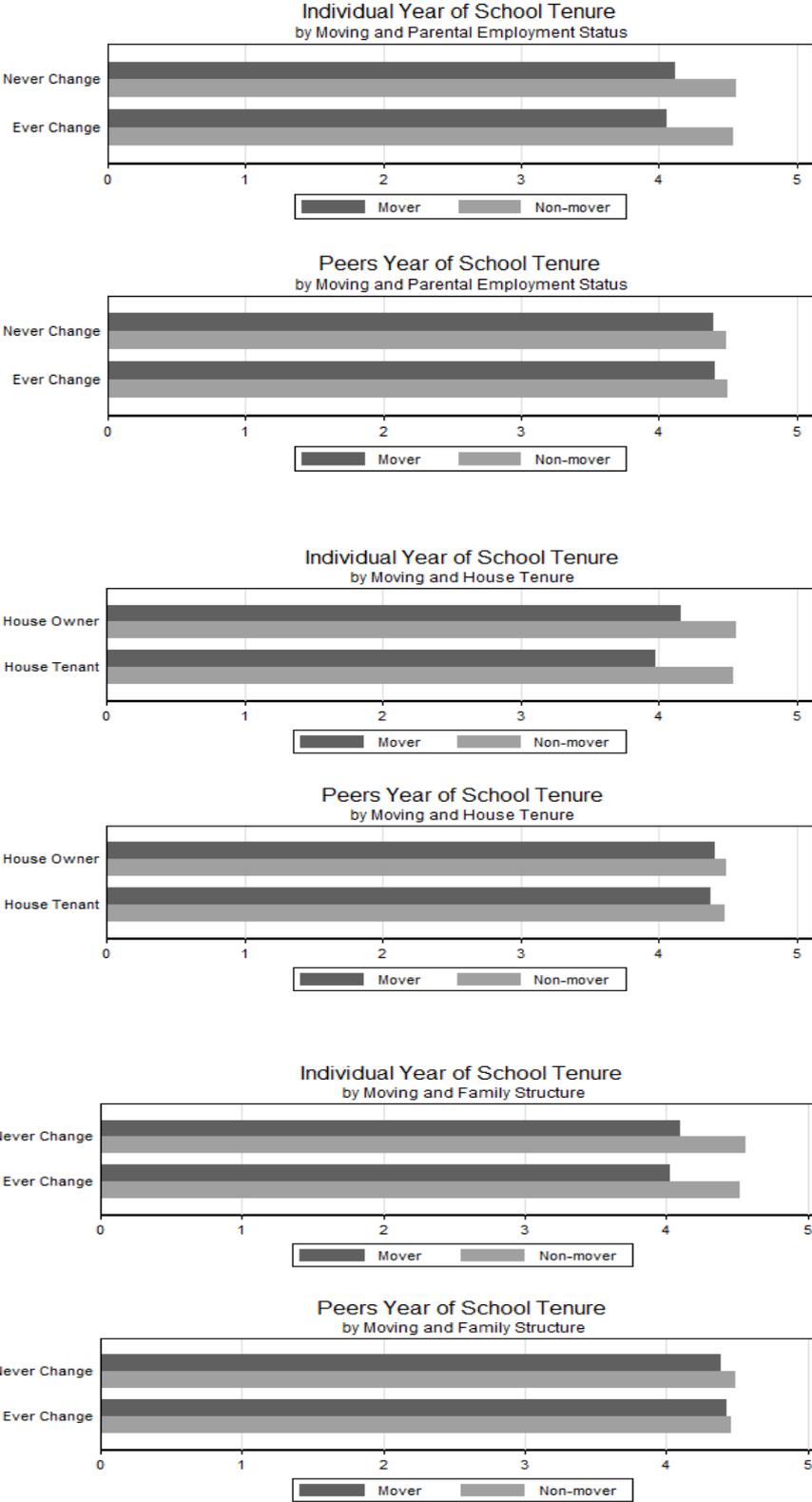


Figure 8 Number of School Switches for Peers
(Schools where only Some Students Sampled)

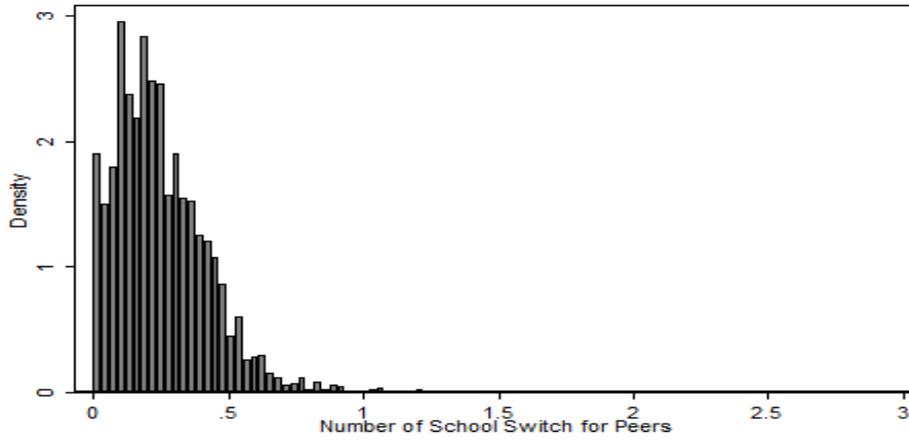


Figure 9 Number of School Switches for Peers
(Schools where all Students Sampled)

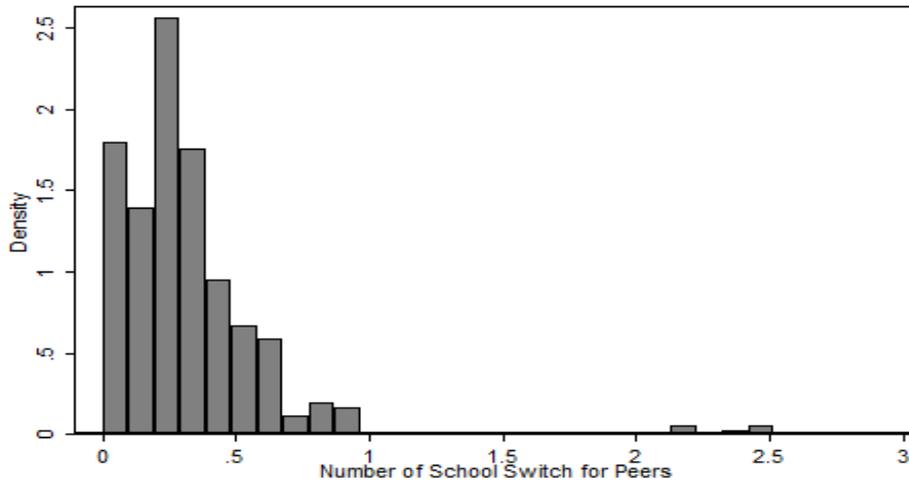


Figure 10 Computations of Peer Measures on School Tenure

		<i>PEERA</i>	<i>PEER B</i>
<i>GROUP A</i>	{	$X_1 \quad \frac{X_2 + X_3}{2}$	$\frac{X_4 + X_5 + X_6}{3}$
	{	$X_2 \quad \frac{X_1 + X_3}{2}$	$\frac{X_4 + X_5 + X_6}{3}$
	{	$X_3 \quad \frac{X_1 + X_2}{2}$	$\frac{X_4 + X_5 + X_6}{3}$
<i>GROUP B</i>	{	$X_4 \quad \frac{X_1 + X_2 + X_3}{3}$	$\frac{X_5 + X_6}{2}$
	{	$X_5 \quad \frac{X_1 + X_2 + X_3}{3}$	$\frac{X_4 + X_6}{2}$
	{	$X_6 \quad \frac{X_1 + X_2 + X_3}{3}$	$\frac{X_4 + X_5}{2}$

References

Ammermueller, A., and Pischke, J. (2009), “Peer Effects in European Primary Schools: Evidence from the Progress in International Reading Literacy Study”, *Journal of Labor Economics*, 2009, vol. 27, no.3.

Arcidiacono, P. and Nicholson, S. (2004), “Peer Effects in Medical School”, *Journal of Public Economics* 89 (2005) 327-350

Arnott, R. and Stiglitz, J. E. (1991), “Moral Hazard and Nonmarket Institutions: Dysfunctional Crowding Out or Peer Monitoring?”, *The American Economic Review*, vol. 81, No. 1 (March 1991), 179-190.

Bandiera, O., Larcinese, V. and Rasul I. (2005), “Social Preferences and the Response to Incentives: Evidence from Personnel Data”, *The Quarterly Journal of Economics*, August 2005.

Bandiera, O., Larcinese, V. and Rasul I. (2009), “Social Connection and Incentives in the Workplace: Evidence from PERSONNEL Data”, *Econometrica*, vol. 77, No. 4 (July, 2009), 1074-1094.

Bandiera, O., Larcinese, V. and Rasul I. (2010), “Heterogeneous Class Size Effects: New Evidence from a Panel of University Students”, *The Economic Journal*, 120 (December), 1365-1398.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2010), “Under Pressure? The Effect of Peers on Outcomes of Young Adults”, *UCD Geary Institute Discussion Paper Series*, May 2010.

Cameron A. C. and Trivedi P. K. (2005), *Microeconometrics, Methods and Applications*, Cambridge University Press.

Carrel, S. E., Fullerton, R. L. and West, J. E. (2009), “Does Your Cohort Matter? Measuring Peer Effects in College Achievement”, *Journal of Labor Economics*, 2009, vol. 27, no. 3.

Charness, G. and Defwenberg, M. (2006), “Promises and Partnership”, *Econometrica*, vol. 74, No. 6 (Nov., 2006), pp. 1579-1601.

Clark, D. (2009), “The performance and Competitive Effects of School Autonomy”, *Journal of Political Economy*, 2009, vol. 117, no. 4.

Clark, D. (2010), “Selective Schools and Academic Achievement”, *The B.E. Journal of Economic Analysis & Policy: Vol. 10: Iss. 1 (Advances)*, Article 9.

Elder, T. E. and Lubotsky D. H. (2009) “Kindergarten Entrance Age and Children’s Achievement”, *The Journal of Human Resources*, 44, 3.

Cullen, J. B., Jacob, B. A. and Levitt, S. D. (2005), “The Impact of School Choice on Student Outcomes: An Analysis of the Chicago Public Schools”, *Journal of Public Economics* 89 (2005) 729-760.

Foster, G. (2005), “It’s not Your Peers, and it’s not Your Friends: Some Progress Toward Understanding the Educational Peer Effect Mechanism”, *Journal of Public Economics* 90(2006) 1455-1475.

Gaviria, A. and Raphael, S. (2001), “School-based Peer Effects and Juvenile Behavior”, *The Review of Economics and Statistics*, May 2001, 83(2): 257-268.

Gould, E. D., Lavy, V. and Paserman, M. D. (2009), “Does Immigration Affect the Long-term Educational outcomes of Natives? Quasi-experimental Evidence”, *The Economic Journal*, 119(October), pp.1243-1369.

Greene, W. (2008), *Econometric Analysis*, Prentice Hall, 7th Edition, 2008

Han, L. and Li, T. (2009), “The Gender Difference of Peer Influence in Higher Education”, *Economic of Education Review* 28 (2009), pp.129-134.

Hanushek, E. A., Fain, J. F., Markman, J. M. and Rivkin, S. G. (2003), “Does Peer Ability Affect Student Achievement? ”, *Journal of Applied Econometrics* 18: 527-544 (2003).

Hanushek, E. A., Fain, J. F. and Rivkin, S. G. (2004), “Disruption versus Tiebout Improvement; the Costs and Benefits of Switching Schools”, *Journal of Public Economics* 88 (2004) pp. 1721-1746.

Hoxby, C. (2000), “Peer Effects in the Classroom: Learning from Gender and Race Variation”, *NBER Working Paper NO. 7867*.

Jackson, C. K. and Schneider, H. S. (2010), “Do Social Connections Reduce Moral Hazard? Evidence from the New York City Taxi Industry”, *NBER Working Paper 16279*

Jenkins, S. P., Micklewright, J. and Schnepf, S. V. (2008), “Social Segregation in Secondary Schools: How Does England Compare with Other Countries?”, *Oxford Review of Education* vol. 24(1), pp. 21-38.

Lavy, V. and Schlosser, A. (2007), “Mechanisms and Impacts of Gender Peer Effects at School”, *NBER Working Paper NO. 13292*

Lazear, E. P. (2009), “Firm-Specific Human Capital: A Skill-Weights Approach”, *Journal of Political Economy*, 2009, vol. 117, no.5.

Micklewright, J., Schnepf S. and Silva, P. N. (2010) “Peer Effects and Measurement Error: the Impact of Sampling Variation in School Survey Data.” *NCRM Working Paper. IOE, London. (Unpublished)*

Manski, C. F. (1993), “Identification of Endogenous Social Effects: The Reflection Problem”, *Review of Economic Studies* 60, pp. 531-542.

Manski, C. F. (2000), “Economic Analysis of Social Interactions”, *Journal of Economic Perspectives*, Vol. 14, No.3, pp.115-136.

Mare, B. D. (1980), “Social Background and School Continuation Decisions”, *Journal of the American Statistical Association*, June 1980, 75(370), pp. 295-305.

Marmaros D. and Sacerdote B. (2006), “How do Friendships form?”, *The Quarterly Journal of Economics*, February 2006.

Neidell, M. and Waldfogel J. (2010) “Cognitive and Non-Cognitive Peer Effects in Early Education”, *The Review of Economics and Statistics*, August 2010, Vol. 92, No. 3, Pages 562-576.

Proud, S. (2008), “Girl Power? An Analysis of Peer Effects using Exogenous Changes in the Gender Make-up of the Peer Group”, *CMPO Working Paper No. 08/186*.

Sacerdote, B. (2001), “Peer Effects with Random Assignment: Results for Dartmouth Roommates”, *Quarterly Journal of Economics*, 116(2), 681-704

Appendix

Table 1 The New Scoring System for GCSE

Grade	Old Points	New Points
Level 2		
A*	8	58
A	7	52
B	6	46
C	5	40
Level 1		
D	4	34
E	3	28
F	2	22
G	1	16

Source: Department for Education (DfES)

Table 2 Summary Statistics for Peers

Variable	N	Mean	Std. Dev.
Female	14166	0.498	0.200
White	14166	0.677	0.338
UK Born	13845	0.911	0.113
Young Starter	14166	0.509	0.067
Renting Status	14019	0.300	0.210
Tercile Income Deprivation	11026	1.850	0.506
Tercile Multiple Deprivation	11026	1.838	0.567
Family Size	14152	4.492	0.572
Numbers of Siblings	14148	1.195	0.392
Lone Parent Family	14145	0.300	0.143
Free School Meal Eligibility	14093	0.164	0.180
No Special Education Needs(SENs)	14093	0.828	0.158
Key Stage 2 Scores	13618	26.098	2.665
Age of Main Parent	14166	43.416	1.816
Education of Main Parent	13889	16.038	0.856
White Main Parent	14125	0.706	0.331
Social Class of Main Parent	13861	4.403	1.027
Employment Status of Main Parent	14099	3.343	1.193
Aspiration on Child's Higher Education	13697	2.114	0.500
Attitude to Child's Education	13729	1.263	0.230

**Table 3 Balancing Tests for Instrumental Variables
Robust Standard Errors in Parentheses**

	Peers School Switch	Own School Switch
<i>Pre-determined Characteristics</i>		
Female	.016 (.027)	.002 (.004)
White	.005 (.017)	.003 (.004)
Born in UK	-.018 (.012)	-.002 (.002)
Young Starter	.081 (.053)	.004** (.002)
Income Deprivation Distribution	-.037 (.041)	-.009 (.008)
Multiple Deprivation Distribution	-.082** (.040)	-.017** (.008)
Family Size	.078 (.093)	-.001 (.008)
Numbers of Siblings	.065 (.064)	-.002 (.005)
Lone Parent Family	-.012 (.033)	-.003 (.003)
Whether Taking Free Meal	.012 (.018)	-.001 (.003)
Non Special Education Needs (SENs)	.005 (.023)	-.001 (.003)
Key Stage 2 Point Scores	-.068 (.330)	-.121* (.064)
Renting Status	.012 (.027)	.001 (.004)
Age of Main Parent	-.903** (.390)	-.036 (.037)
Education of Main Parent	.096 (.071)	.023* (.012)
Social Class of Main Parent	.163 (.116)	.002 (.017)
Employment Status of Main Parent	.023 (.015)	.009 (.020)
White Main Parent	.011 (.016)	.003 (.004)
Aspiration on Child's Higher Education	-.033 (.058)	.007 (.009)

Attitude to Child's Education	-0.026 (.045)	-.001 (.005)
Number of Schools	611	611
Observations	8,484	8,563

Notes: I regress pupil (or peers) pre-determined variable in each row on peer (or own) school switch and represent the coefficients from separate regressions of the relevant dependent variable in Col. [1] (or [2]). For Col. [1], peer controls include female, white, UK born, young starter, free meal eligibility, non Special Education Needs (SENs), Key Stage 2 Point Score, renting status, income index, multiple deprivation index; main parent's (who takes most care of child) age, education, ethnicity, social class status, employment status, aspiration on child's education, attitude to child's education, family size, number of siblings, lone parent family and region of residence. For Col. [2], same variables for pupils are used instead. See text for details.

Robust standard errors are adjusted for clustering at the school level.

All regressions are weighted by the personal weighting fully allowing for the sample design.

*** p<0.01, ** p<0.05, * p<0.1

Figure 1

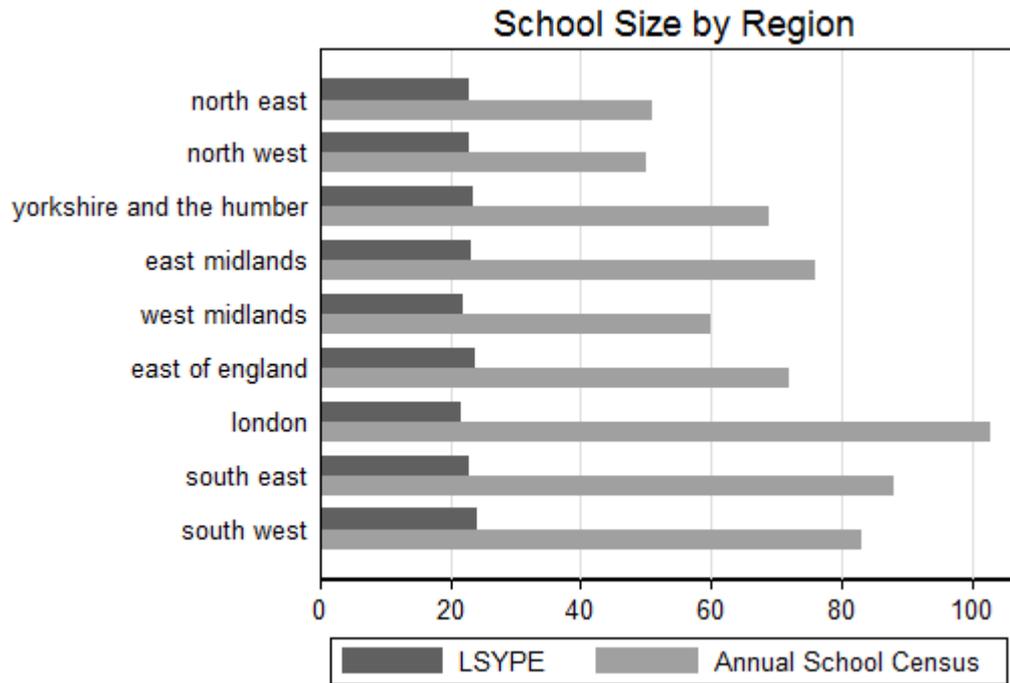


Figure 2a

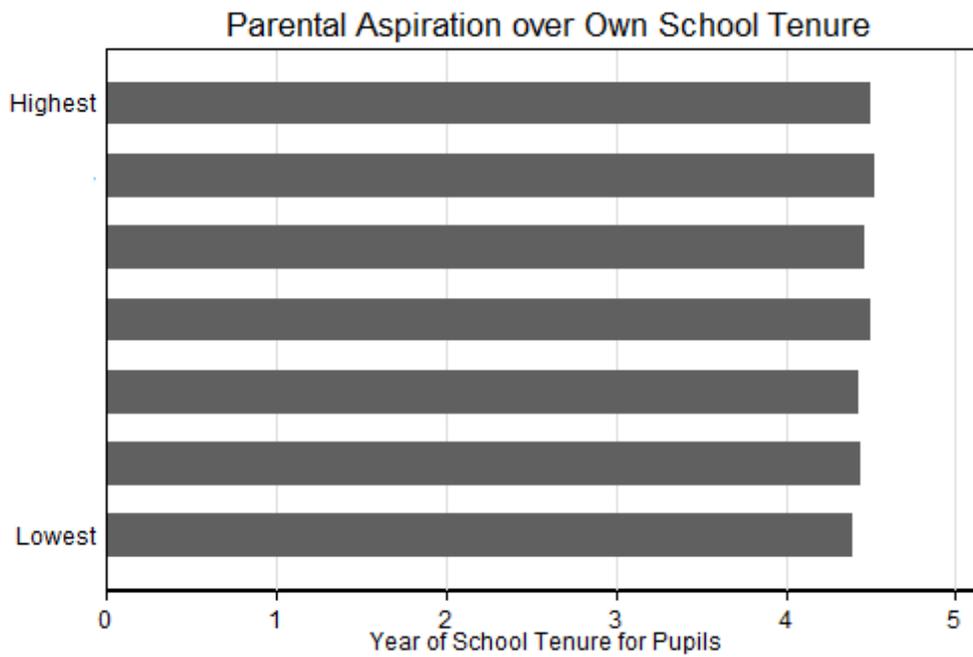


Figure 2b

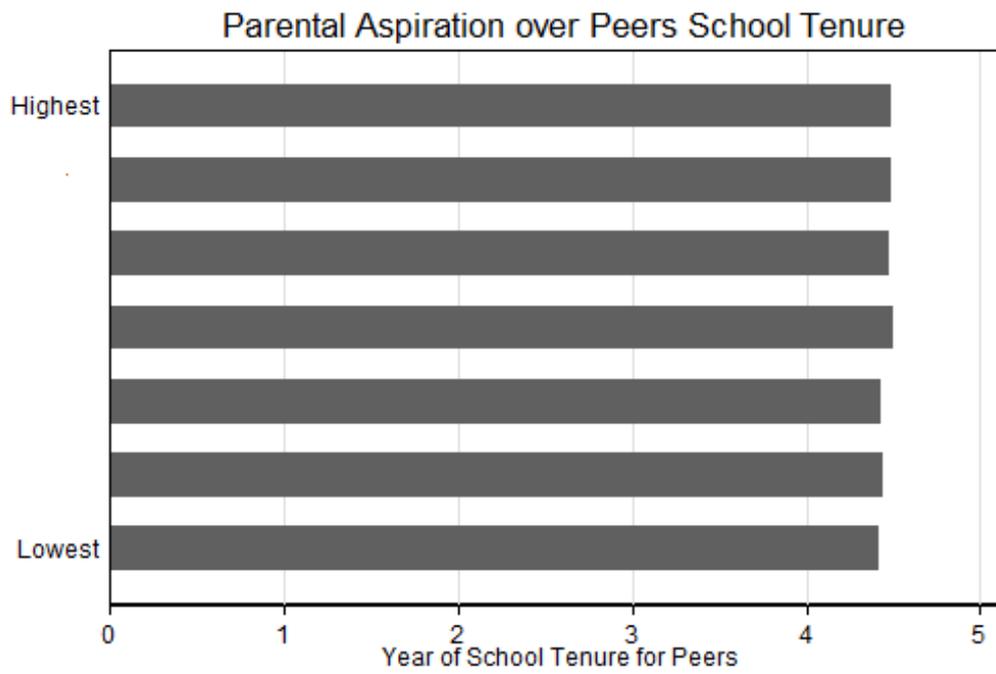


Figure 2c

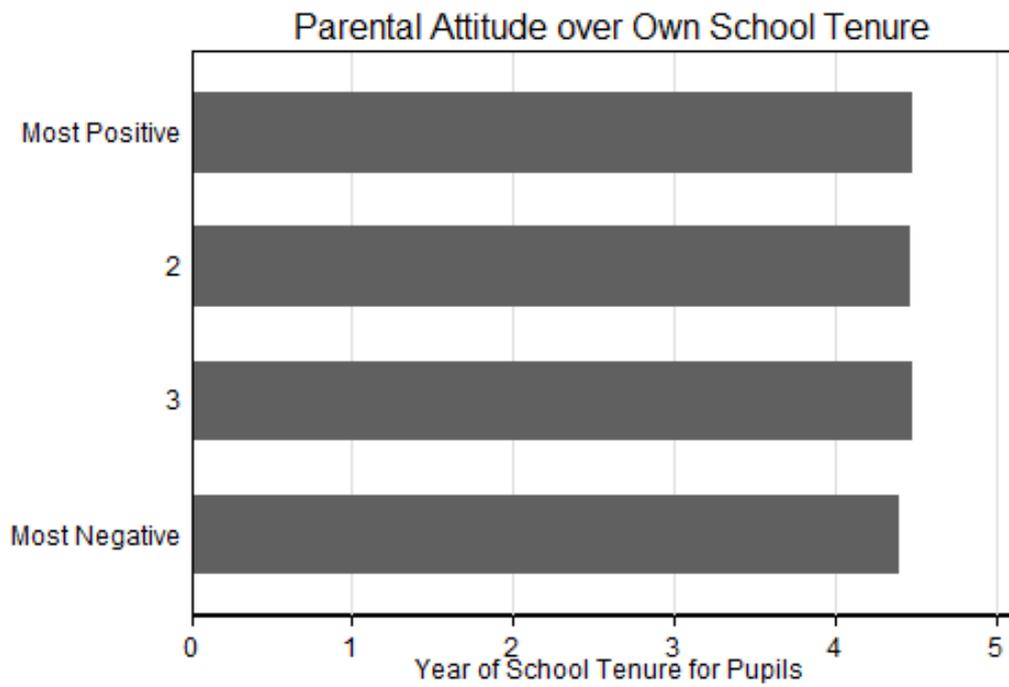
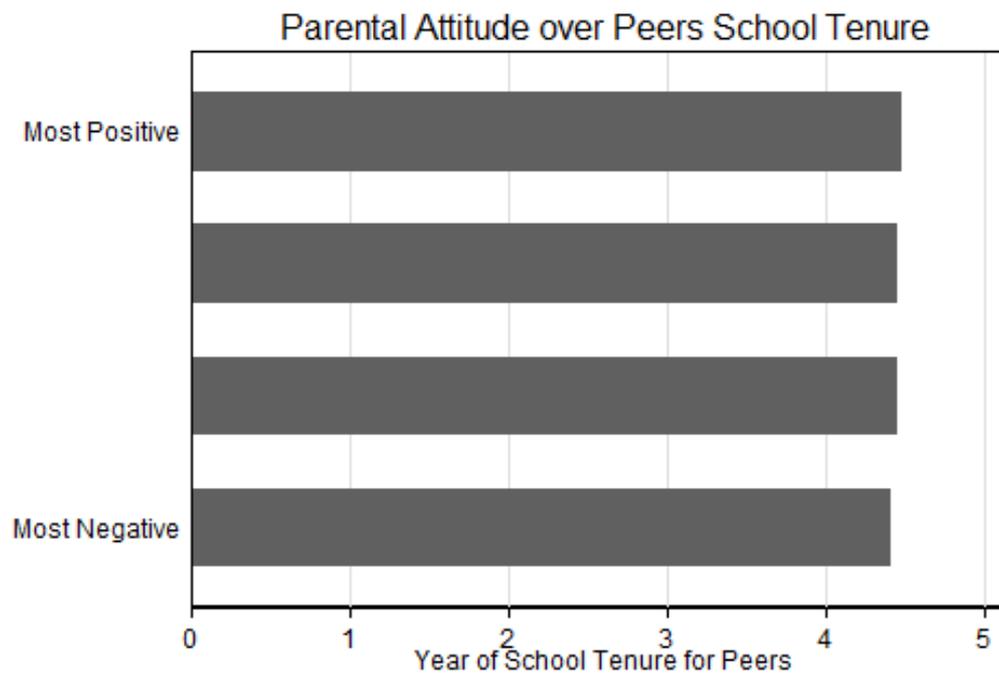


Figure 2d



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