Modelling socioeconomic neighbourhood change due to internal migration in England

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Stephen Jivraj
Stephen.Jivraj@postgrad.manchester.ac.uk

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This paper examines the effect of internal migration on the concentration of low income families in neighbourhoods in England during 2002-2007 using a multilevel growth curve model. Explanatory variables in the model include the regional area and district type of a neighbourhood as well as whether the neighbourhood is ranked within the 20% most deprived in England. The findings suggest that deprived neighbourhoods increase their concentration of poor families at a faster rate than all other neighbourhoods. However, the increase is marginal.

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Stephen Jivraj

Cathie Marsh Centre for Census and Survey Research, School of Social Sciences, University of Manchester, Manchester M13 9PL, UK

stephen.jivraj@gmail.com

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Abstract

In England, deprived neighbourhoods were the focus of a number of policy initiatives constructed by the previous Labour government. The most notable was the New Deal for Communities programme. The evaluations of this programme and earlier interventions have shown that attempts to improve neighbourhood outcomes might be affected by people selectively moving in and out of targeted areas. Nonetheless, there is very little evidence that provides an appreciation of this effect.

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1. Introduction

This paper models change in neighbourhood deprivation in England during 2002-2007 which is a result of internal migration. Prior research in the UK and US has shown that internal migration acts to reinforce the concentration of deprivation in the most deprived areas (Bailey and Livingston, 2007, 2008; Foulkes and Schafft, 2010). Bailey and Livingston (2007, 2008) have shown that although the size of the effect is small, on average, it varies in both direction and size of effect by region because of the different nature of housing and labour markets across England. In the North and Midlands, they found that internal migration increased the concentration of deprivation more rapidly in contrast with London where internal migration flows were reducing concentrations. There is also a suggestion that internal migration is acting to increase the deprivation levels in the largest central metropolitan areas throughout the UK (T. Champion and Coombes, 2007; T. Champion et al., 2007; T. Champion and Fisher, 2003). This is because, in aggregate terms, people are choosing to move away from large cities when migrating within the country in favour of more rural areas, a process referred to as counterurbanisation (A. G. Champion, 1989). However, settlement in suburban and rural areas is less likely to be realised by poor households because low cost and social housing is not widely available in these areas. This leads to increased polarisation between poorer urban neighbourhoods and relatively affluent suburban and rural neighbourhoods.

The effect will have implications for any policy maker who wishes to stem spatial inequalities. For example, area-based initiatives (ABI) including the previous Labour government's New Deal for Communities (NDC) programme which aimed to narrow the gap between the most deprived neighbourhoods and the national average on a range of socioeconomic outcomes in England (Beatty and Cole, 2009). The neighbourhoods which have received this type of funding include the most deprived in England. However, the funding has been distributed across all parts of the country. It has been recognised that what works in one part of the country in terms of achieving the overarching objectives might not work in another (Meen et al., 2005). Therefore, the effect of internal migration on the ability to meet the desired policy objectives is likely to vary in different parts of England. Nonetheless, it is difficult without evidence to appreciate the barriers some neighbourhoods will face in terms of meeting desired policy objectives in different regions and within urban areas compared with more suburban and rural areas.

This paper is structured as follows. The second section explains the data and measures used. Section three introduces the modelling framework. Section four provides results of the statistical analysis. The results are presented using two nested models. The first provides estimates of a basic growth curve model and the second model includes all explanatory variables discussed in section two. The final section summarises the findings and discusses implications for policy.

2. Data and measures

This paper analyses the change in the concentration of low income primary school-aged[1] pupils due to internal migration at the neighbourhood scale by using data from the School Census in England during 2002-2007. The School Census records details of all state-school pupils in England, and is updated annually. The data is derived from an electronic administrative form completed by each school to cover all enrolled pupils in January of each year (Machin et al., 2006). It is collated nationally by the Department for Education through Local Education Authorities. The School Census includes the home postcode of each pupil. A change in the home postcode of a pupil between academic years can be used to determine a migrant. Simpson *et al*. (2010) provide details of the validity of the School Census for measuring internal migration. They indicate that it can provide more up to date information and geographical detail than any existing data source.

The data also includes a binary indicator of socioeconomic status of each pupil. This is measured by whether a pupil claims Free School Meals (FSM). FSM status has been used widely as a proxy measure of low socioeconomic status in educational research (Machin et al., 2006; Styles, 2008). To be eligible for FSM, a child must be living in a household claiming a means-tested income benefit (Hobbs and Vignoles, 2010). Hobbs and Vignoles (2010) found that the vast majority of pupils claiming FSM live in low income families, but not all pupils living in low income families claim FSM. This is because not all low income families are eligible or are willing to claim the means-tested benefits which allow them to access FSM for their children.

Migration flows by FSM status are aggregated to the Lower Super Output Area (LSOA) level to determine the impact of migration on deprivation concentration at a neighbourhood scale. In England, LSOAs are widely used in policy and academic literature as a unit of neighbourhood geography (Bailey and Livingston, 2008; Robson et al., 2008). They have been used as the spatial scale for most recent releases of the government's Indices of Multiple Deprivation (CLG, 2008, 2011; ODPM, 2004). On average, a LSOA neighbourhood contained 120 primary school-aged pupils in 2002. The change over time in the concentration of FSM pupils in a neighbourhood due to internal migration is modelled using a multilevel growth curve framework. The model addresses the research question: are internal migration flows increasing the concentration of poor pupils in the most deprived neighbourhoods? The use of a statistical model adds to earlier descriptive analysis of this effect using the School Census (Jivraj, forthcoming, 2012) by determining whether the effect is moderated by region and district type of a neighbourhood during 2002-2007.

The proportion of primary school FSM pupils in a neighbourhood is used as the dependent variable. The change over time in this measure is calculated as follows. The proportion of FSM pupils is calculated for each neighbourhood in 2002. Net migration by FSM status of all primary school pupils for each one-year period during 2002-2007 is added cumulatively to the primary pupil population for each neighbourhood in 2002. A proportion of FSM pupils is then derived for each neighbourhood in each year after 2002 and until 2007 which accounts for the effect of internal migration. This measure also accounts for the 12% of pupils that moved during an average one-year period between 2002 and 2007 and changed their FSM status during the same period. It is not possible to completely isolate internal migration from the effect of other components of socioeconomic change between one-year periods because the FSM pupil population will change due to school turnover, international migration and in-situ socioeconomic change (Jivraj, forthcoming, 2012). This could be overcome by using one cohort, for example, pupils aged 5 in 2002 for the analysis and therefore limiting the impact of other components. This was considered but was not implemented because there were less than 20 pupils aged 5, on average, in each neighbourhood in 2002.

The effect of including all primary school-aged pupils between 2002 and 2007 led to the proportion of FSM pupils in some neighbourhoods rising above 1 or falling below 0 when the cumulative effect of internal migration was added. This occurred when more pupils moved in or out of a neighbourhood who entered the school system after 2002 than were living in a neighbourhood in 2002. To limit this effect the neighbourhoods with a population of less than 30 pupils in each year between 2002 and 2007 were excluded from the analysis. In these neighbourhoods a small denominator might lead to bigger changes in the proportion of FSM pupils than would be expected in similar neighbourhoods with larger populations. The result of this condition was an exclusion of 3% or 993 LSOA neighbourhoods. A similar exclusion was used by Pillinger (2009) to model ethnic segregation in schools during the same time period.

Figure 1 shows the average proportion of FSM pupils in neighbourhoods in England in 2002 and the proportion in each subsequent year until 2007 when the effect of internal migration is added. Almost 17% of pupils were claiming FSM in 2002 and this remained fairly constant over time. However, it is unlikely to be the case that every neighbourhood had a uniform trajectory over time and it is more likely that trends will vary for certain types of neighbourhoods as described below.

<Insert Figure 1 about here>

Explanatory variables are included in a model to explore how between neighbourhood variability in the concentration of FSM pupils might accentuate or moderate neighbourhood trajectories over time. The main variable of interest was whether the neighbourhood was considered deprived. To test this effect a dummy variable is included that had the value of one if a neighbourhood is ranked within the 20% most deprived LSOAs on the Townsend deprivation index and zero if not. Neighbourhoods are dichotomised in this way because previous analysis showed that, on average, neighbourhoods in this quintile had a higher change in the concentration of FSM pupils than any other quintile as a result of internal migration (Jivraj, forthcoming, 2012). These neighbourhoods are likely to reflect the poorest in the country and will include the vast majority of areas that were eligible for ABIs, especially the NDC programme. A dummy variable is used rather than the rank or score of deprivation for the neighbourhood to aid interpretation of the model coefficients.

Dummy variables are also included in the model for the region and the district type that a neighbourhood is located. London is used as the reference category for the region variable for Government Office Region (GOR) boundaries. Bailey and Livingston (2008) found that the more deprived a neighbourhood located within the London city-region, the more likely it is to decrease its concentration of deprivation as a result of internal migration. In all other regions they found that migration flows act to increase the concentration, the more deprived the neighbourhood. They used low educational attainment[2] as a measure of deprivation of those aged 25 to 74. The different measure of deprivation and to a greater extent the use of a different age group in their analysis might lead to different findings compared with the analysis in this paper. The results in this paper will also differ slightly from Bailey and Livingston's findings because they divide England into amalgamations of GORs except for London where they use a city-region definition developed by Coombes (1996). This definition of the London city-region is not used in the analysis for this paper because it would limit the relevance to policies which take account of London in terms of its GOR[3]. The London GOR is the boundary of the Greater London Authority.

A district type variable is collapsed from an OPCS classification produced to distinguish between neighbourhoods located in urban and rural districts in England (T. Champion, 2005). The metropolitan district type is used as the reference category with other neighbourhoods located in town and rural district types. Champion and Fisher (2003) found that from the results of the 1991 Census the larger metropolitan conurbations in the UK were becoming less concentrated with professional and managerial workers because of internal migration. Results from the 2001 Census confirmed that this migration process was still operating for most metropolitan areas with the notable exception of London. London is described as experiencing an urban renaissance because it was attracting a high number of young professionals from the rest of the UK (T. Champion and Coombes, 2007; T. Champion et al., 2007). Champion *et al*. (2007) used a city-region boundary to define London and found that migration was increasing the number of people aged 16-24, but for all other age groups more people were leaving each of the largest metropolitan areas, including London, than were moving in.

3. Model framework

An alternative to a growth curve model would be to use a difference score i.e. the difference between the concentration before and after the effect of internal migration is added. However, this approach would limit analysis to only two points in time and assume change is linear for all areas. An innovative approach to modelling the change over time involves predicting trajectories over repeated measures which makes more use of the data when it is available at more than two time points (Goldstein, 1986). The School Census has been collected on an annual basis during 2002-2007. This allows change in the concentration of primary school-aged pupils at the neighbourhood level to be analysed for each one year period when only taking into account internal migration. It allows analysis of whether more deprived neighbourhoods become poorer over time as a result of internal migration. The author understands that longitudinal analysis of the effect of internal migration using a multilevel modelling framework has not been conducted in this way before. The modelling is based on an approach used by Goldstein and Noden (2003) to model socioeconomic segregation in schools during the period 1994-1999.

The measurement of the outcome variable for each year within each neighbourhood provides a hierarchically structured dataset where repeated measures of the proportion of FSM pupils for each year (level 1) are nested within each neighbourhood (level 2). Figure 2 provides a representation of this structure.

<Insert Figure 2 about here>

Longitudinal data lends itself to analysis using multilevel modelling to take account of this hierarchy. Unlike a difference score analysis it can produce trajectories for each neighbourhood and estimate the amount of variability in each trajectory (slope) and baseline (intercept). By adding covariates one can see how much variation is explained at each level using a stepwise approach. All statistical analysis is carried out using MLwiN 2.21 (Rasbash et al., 2009). A logistic growth curve model is specified as follows:

$$
\begin{aligned}
&logit\left(Y_{tj}\right) = B_{0j} + B_{1j}(year) + B_2\left(deprived_j\right) + B_3\left(deprived * year_{tj}\right) \\
&B_{0j} = B_0 + u_{0j} \qquad (1) \\
&B_{1j} = B_1 + u_{1j}
\end{aligned}
$$

Where t (t = 2002 to 2007) indicates level 1 units (year) within j (j = 1 to 31,489) level 2 units (neighbourhood), Y_{tj} is the probability that a pupil at time t in neighbourhood j is claiming FSM, B_{1j} is the coefficient for year, and u_{Oj} and u_{1j} are neighbourhood level residuals which are assumed to have a bivariate Normal distribution with variance of σ_u^2 and covariance σ_u. The observed proportion of Y_{tj} is assumed to have a binomial distribution with mean of π_{tj}. This assumption may be unreasonable and can be tested by allowing for 'extra binomial' variation (Goldstein and Noden, 2003). A coefficient of the binomial variation is estimated in Model 1. A value of 1 would indicate the variation is exactly binomial.

The fixed effect of the intercept B_O indicates the mean proportion of FSM pupils in a non-deprived neighbourhood in 2002 on the logistic scale. The intercept value is allowed to vary between neighbourhoods represented by the random effect of u_{Oj}. The model also allows the slope to vary for the effect of year. This means that over time the rate of change in the concentration of FSM pupils for each neighbourhood B_2 could vary. This means that not all neighbourhoods increase or decrease their proportion of FSM pupils at the same rate. This model is equivalent to a multilevel random slopes model, but for longitudinal analysis is referred to as a growth curve model.

Model 1 also allows for a potentially moderating or accentuating effect of deprived status of a neighbourhood. The effect of whether a neighbourhood was ranked within the 20% most deprived in England using the Townsend deprivation index (B_2) indicates the proportion of FSM pupils on the logistic scale in a deprived neighbourhood when year equals zero. B_3 indicates the change rate in the proportion of FSM pupils in a deprived neighbourhood over time. The latter effect is a cross level interaction term of year and deprived status. The effect of the region and district type a neighbourhood is located are added to the model as follows:

$$
\begin{aligned}
&logit(Y_{tj}) = B_{0j} + B_{1j}(year) + B_2(X_j) + B_3(X * year_{tj}) \\
&B_{0j} = B_0 + u_{0j} \qquad (2) \\
&B_{1j} = B_1 + u_{1j}
\end{aligned}
$$

Where $B_2(X_j)$ indicates the difference in the concentration of FSM pupils when year equals zero as a function of each of the covariates discussed above (deprived neighbourhood status, region, and district type) and $B_3(X * year_{tj})$ indicates differences in the change rate in the concentration of FSM pupils as a function of the same covariates.

4. Statistical analysis

Table 1 shows the results of Model 1 fitted using a 2nd order penalized quasi-likelihood (PQL2) estimation procedure (Rasbash et al., 2009; Rodriguez and Goldman, 2001). Markov chain Monte Carlo (MCMC) estimation was also used but it produced fixed and random estimates almost identical to the PQL2 estimation procedure, and therefore the results are not reported here.

In Table 1, the fixed part coefficients for Model 1 indicate the effects on the logistic scale for the constant when year and deprived status equal zero. This refers to a non-deprived neighbourhood in 2002. The logit values can be converted to predicted probabilities using a transformation given by exp (logit)/[1 + exp (logit)] or, equivalently, by 1/[1 + exp (- logit)] (Subramanian et al., 2001). The predicted proportion of FSM pupils for a neighbourhood in 2002 that is not deprived, calculated from the coefficient of the constant, is 0.062 or 6.2%. This is lower than the observed proportion for a non-deprived neighbourhood in 2002 which is 0.105. The predicted probability of a deprived neighbourhood in 2002 is

0.398. The observed proportion of FSM pupils in a deprived neighbourhood in 2002 is 0.403.

The reason why the coefficient for the constant is lower for non-deprived neighbourhoods compared with the observed value is because the PQL2 estimation uses level 2 predicted residual values to estimate parameters (Goldstein and Rasbash, 1996). Model 1 assumes that the distribution of the residual values at the neighbourhood level is normal. However, Figure 3 shows that this is not the case for the residuals of the constant values at level 2 because there is deviation from the normal distribution for neighbourhoods with a low proportion of FSM pupils. This is caused by a minority of neighbourhoods with zero FSM pupils present throughout the period 2002-2007. The distribution of residuals at level 2 for the effect of year is fairly normally distributed.

The estimate for the binomial variation, which is assumed to be 1, also points to the problem of a large number of neighbourhoods with a constant zero proportion of FSM pupils over time. The value from Model 1 is 0.267 which means there is considerable under dispersion in the model. Under dispersion is a common problem with repeated measures multilevel analysis where the values at level 1 (time) are not independent within level 2 units. For example, an affluent neighbourhood with a zero proportion of FSM pupils is likely to remain that way over time. Yang *et al*. (2000) suggest an alternative model specification to resolve this issue. They have used a multivariate model where the value at each time point is used as a separate response variable. This allows the natural covariance over time to be accounted for.

A multivariate logistic model was considered that was equivalent to Model 1. However, the model would not converge using the MLwiN software. A multivariate model with continuous variables for the percentage of FSM pupils in a neighbourhood for each year between 2002 and 2007 did converge. The results, not shown here (available from the author), indicate a similar effect of the deprived status of a neighbourhood over time as well as the other covariates.

Table 1 shows that the logit value of the effect of the interaction between the deprived status of a neighbourhood and year (0.017) indicates that over time deprived neighbourhoods will become more deprived, on average, as a result of internal migration than less deprived neighbourhoods. By 2007 the average deprived neighbourhood would have a predicted proportion of FSM pupils of 41.1%, which is an increase of 1.3% compared with 2002. Although the effect of this change is not dramatic, the direction may concern policy makers. The change over time for non-deprived neighbourhoods is negative but much smaller than for deprived neighbourhoods. This means that non-deprived neighbourhoods are predicted to see a slight decrease in the proportion of FSM pupils over time. An average non-deprived neighbourhood is predicted to have 6% FSM pupils by 2007, which is a decrease of less than 0.3% compared with 2002.

In Table 1, the random estimates from Model 1 show the extent and nature of the variation between neighbourhoods in the proportion of FSM pupils at intercept (2002) and over time (up to 2007). The variance in the intercept values between neighbourhoods is large (1.653) even when controlling for the deprived status of a neighbourhood. This suggests some non-deprived and deprived neighbourhoods had a much higher proportion of FSM pupils than other non-deprived and deprived neighbourhoods in 2002. The variance in the random effect of year (0.007) is small. However, it is almost as large as the fixed effect estimate which means that some neighbourhoods are predicted to have no change in the proportion of FSM pupils over time. Chi-squared tests of significance show that the random effects for the intercept and slope are significant.

<Insert Table 1 about here>

<Insert Figure 3 about here>

The positive covariance between the random effects for the constant and year implies that neighbourhoods with a high proportion of FSM pupils in 2002 tend to increase their proportion of FSM pupils at a higher rate. This effect is significant even when controlling for whether a neighbourhood is considered deprived. This means that there will be more variation in the proportion of FSM pupils in later years which implies greater inequality between neighbourhoods over time. The between-neighbourhood variance in the proportion of FSM pupils on the logistic scale is estimated as $1.653 + 0.005*\text{year} + 0.007*\text{year}^2$ (Snijders and Bosker, 1999). Figure 4 shows the between-neighbourhood variance increases with time which means that between neighbourhood differences in the proportion of FSM pupils are greater in later years.

<Insert Figure 4 about here>

Table 2 shows the parameter estimates of Model 2 which includes main effects for region and district type of the neighbourhood as well as interactions for these main effects with year. These estimates indicate an effect on the intercept and rate of change in the proportion of FSM pupils over time. The value of the intercept now represents the proportion of FSM pupils in a neighbourhood when year and all other variables equal zero. This refers to a non-deprived neighbourhood located in a metropolitan district in London in 2002.

The parameter estimate for the main effect of region indicates that neighbourhoods located outside London will have a lower intercept value except for neighbourhoods in the North East, South West and East. Only neighbourhoods in the East have a significantly higher estimate for the proportion of FSM pupils when holding all other effects constant. The effect of the interaction term between year and region suggests that neighbourhoods in all regions located outside of London are predicted to have a lower change in the concentration of FSM pupils as a result of internal migration. The significant estimates for each region are similar and larger than the effect of deprived neighbourhood status for all regions with the exception of the West Midlands. This suggests that internal migration dynamics are more important in terms of increasing the concentration of FSM pupils over time in neighbourhoods in London compared with all other regions regardless of deprived status.

The type of district a neighbourhood is located also had a significant effect on the intercept value. Neighbourhoods located in districts categorised as town and to a greater extent rural, had a lower proportion of FSM pupils in 2002 compared with neighbourhoods in metropolitan districts. For example, the predicted proportion of FSM pupils in a non-deprived neighbourhood in the South East in 2002 was 7.1% in metropolitan districts, 6.2% in town districts and 3.7% in rural districts. The effect of the change in the concentration of FSM pupils is not very strong between district types of a neighbourhood, shown by the interaction between year and district type. Neighbourhoods located in towns and rural districts are predicted to have a lower rate of change (-0.007 for town districts and -0.006 for rural districts on the logistic scale) compared with neighbourhoods in metropolitan districts. Nonetheless, the effects are significant.

Table 2 shows that the inclusion of the fixed effects for region and district type reduces the amount of variation between the random intercept values of neighbourhoods. The reduction is not large but indicates that the region and type of district that a neighbourhood is located explains some of the difference between the proportions of FSM pupils in 2002. The effect of the region and district type variables does not change the estimate for extra binomial variation nor the residual values at level 2 suggesting there is under dispersion in Model 2.

<Insert Table 2 about here>

5. Discussion

This paper has addressed the question of whether internal migration flows are increasing the concentration of primary school-aged FSM pupils in the most deprived neighbourhoods and whether this effect is moderated by the region and district type a neighbourhood is located in. Modelling change in the proportion of FSM pupils between 2002 and 2007 shows that internal migration flows are expected to increase the concentration in deprived neighbourhoods. Deprived neighbourhoods are predicted to become 1.3% poorer over this period when only controlling for the deprived status and change over time. The proportion of FSM pupils in non-deprived neighbourhoods is predicted to remain fairly constant during the same period. These findings support existing research which suggests that the size of the added increase in the concentration of deprivation due to internal in the most deprived areas is small (Bailey and Livingston, 2007, 2008; Jivraj, forthcoming, 2012). However, the trend of increased concentration of poor pupils in deprived neighbourhoods and greater inequality between deprived and non-deprived neighbourhoods may concern policy makers.

The results of the more elaborate model suggest there are greater differences between neighbourhoods in London compared with other regions than between those that are deprived and non-deprived. More specifically, the effect of increased concentration of FSM pupils in deprived neighbourhoods is negated for neighbourhoods in all regions outside of London except for those located in the West Midlands. This suggests that neighbourhoods in London are becoming significantly poorer due to the internal migration of primary school-aged pupils compared with most other neighbourhoods outside the capital. This contradicts findings from Champion *et al*. (2007) and Champion and Coombes (2007). It is likely to reflect the definition of London using the city-region rather than the Government Office Region and the restriction of data to primary school-aged pupils discussed below. The latter is likely to be the main factor responsible for this different conclusion because Champion *et al*. (2007) show that for all other age groups except 16-24 more people are moving out of London than are moving in. The outward movement of child-rearing aged people from the capital therefore appear to be selective of higher occupational status households which are not balanced by similar inward movements (Hamnett, 1990).

The effect of internal migration for primary school-aged pupils in London is likely to reflect the high level of dynamism in terms of migration from within the capital (Dennett and Stillwell, 2008). People of child rearing age with or without children are tending to move away from Inner London areas in favour of suburban housing on the fringe of the Greater London administrative boundary (Andrew and Meen, 2006; Bate et al., 2000). The motivations for this movement are complex but moving to access better schools is likely to be one motivating factor for those with children. Better schools and other local facilities are likely to be found in suburban areas where quality of life generally could be said to be higher (Boyle et al., 1998). It could be argued that the larger the metropolitan conurbation the more likely people will choose to make a move to escape inner city living. The effect of district type in Model 2 indicates that metropolitan areas throughout England are predicted to have a higher change in the concentration of FSM pupils relative to town and rural districts. This is likely to reflect the restriction of a counterurbanising move to higher income families. However, the effect of the type of district a neighbourhood is located in is very small when taking into account the region and deprived status of a neighbourhood.

The precision of the model results described above are questionable because the assumptions of the logistic multilevel model fitted are not satisfied. The residual values at level 2 for the random effect of the intercept are assumed to be normally distributed. It is shown in Figure 2 that this is not the case. The under dispersion in the model which is a result of a large minority of neighbourhoods with a zero proportion of FSM pupils over time has a considerable effect on the value of the intercept when using the preferred PQL2 estimation procedure. Nonetheless, the substantive effects of deprived status, region and district type on the proportion of FSM pupils in a neighbourhood over time remain largely unchanged regardless of the estimation procedure used for the logistic model and the use of a multivariate normal model. However, caution should be exercised when interpreting exact predicted probabilities, particularly when only using the value of the constant.

These findings have clear implication for policies related to programmes that aim to reduce spatial income inequalities. The ABIs of the previous Labour government attempted to narrow the gap between the most deprived neighbourhoods and the national average. The results of the growth curve model concur with a number of evaluation studies of the NDC programme by suggesting that practitioners are battling against internal migration to improve the aggregate socioeconomic condition of deprived neighbourhoods (Beatty and Cole, 2009; Cole et al., 2007). However, the effect of internal migration on socioeconomic composition is small, on average, even in the most deprived neighbourhoods. Those programmes located in metropolitan areas, particularly London, could be given special consideration when measuring the success of achieving objectives to improve the aggregate socioeconomic composition because internal migration appears to be producing poorer neighbourhoods more so than in other neighbourhoods located outside the capital. Higher skilled young people moving to London for their first graduate job are likely to offset this negative effect of area change in these neighbourhoods. Nonetheless, if policy makers are concerned about the spatial economic segregation of school children then these findings will be particularly worrying. Poorer pupils are being increasingly surrounded by other poor pupils in London who are unlikely to live in families with realistic hopes of moving out of the inner city.

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[1] In England, primary school-age pupils range from 5 to 10 at start of school year. Secondary school-age pupils (11 to 15 at start of school year) are excluded from the analysis because of a high number of changes in address recorded in error when a pupil moves from primary to secondary school. See Simpson *et al.* (2010) for more detail.

[2] CSEs only, 1–4 O-levels/GCSEs or NVQ Level 1 or below.

[3] The use of London city-region rather than London GOR attenuated the difference between London and other regions in the current analysis but did not alter the substantive findings in this paper.

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Tables and Figures

Table 1 – Logistic growth model of neighbourhood FSM proportion including deprived status effect, 2002-2007

	Estimate	S.E.
Fixed Part		
Constant	-2.710	0.008
Year	-0.008	0.001
Deprived	2.296	0.018
Deprived*year	0.017	0.001
Random Part		
Level: lsoa		
Cons/cons	1.653	0.013
Year/cons	0.005	0.001
Year/year	0.007	0.000
Level: year		
Extra binomial term	0.267	0.001
Units: Neighbourhood	31,489	
Units: Year	188,934	

See Model 1

Table 2 – Logistic growth model of neighbourhood FSM proportion including deprived status, regional and district type effects, 2002-2007

	Estimate	S.E.
Fixed Part		
Cons	-2.344	0.021
Year	0.011	0.002
Deprived	2.025	0.019
Deprived*year	0.011	0.001
Town	-0.151	0.021
Rural	-0.697	0.022
Town*year	-0.007	0.002
Rural*year	-0.006	0.002
North West	-0.014	0.028
Yorkshire and The Humber	-0.123	0.030
North East	0.065	0.038
West Midlands	-0.094	0.030
East Midlands	-0.257	0.035
South West	0.012	0.033
East of England	0.174	0.034
South East	-0.227	0.031
North West*year	-0.021	0.002
Yorkshire and The Humber*year	-0.022	0.002
North East*year	-0.019	0.003
West Midlands*year	-0.009	0.002
East Midlands*year	-0.013	0.003
South West*year	-0.020	0.003
East of England*year	-0.015	0.003
South East*year	-0.015	0.002
Random Part		
Level: lsoa		
Cons/cons	1.547	0.013
Year/cons	0.004	0.001
Year/year	0.007	0.000
Level: year		
Extra binomial term	0.268	0.001
Units: Neighbourhood	31,489	
Units: Year	188,934	

See Model 2

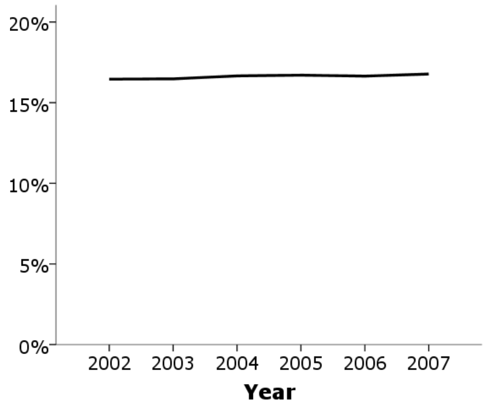

Figure 1 - Proportion of FSM pupils in England during 2002-07 when the effect of internal migration is added

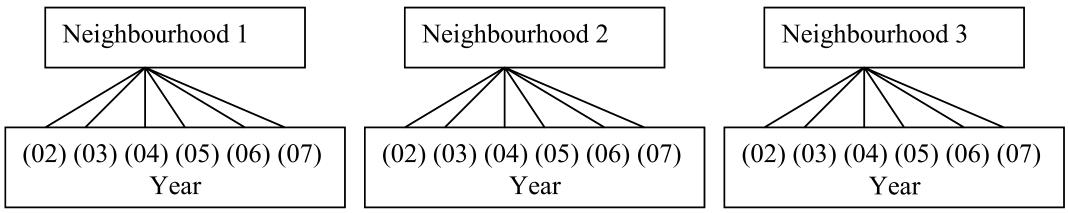

Figure 2 - Hierarchical structure of the School Census data at neighbourhood level over time

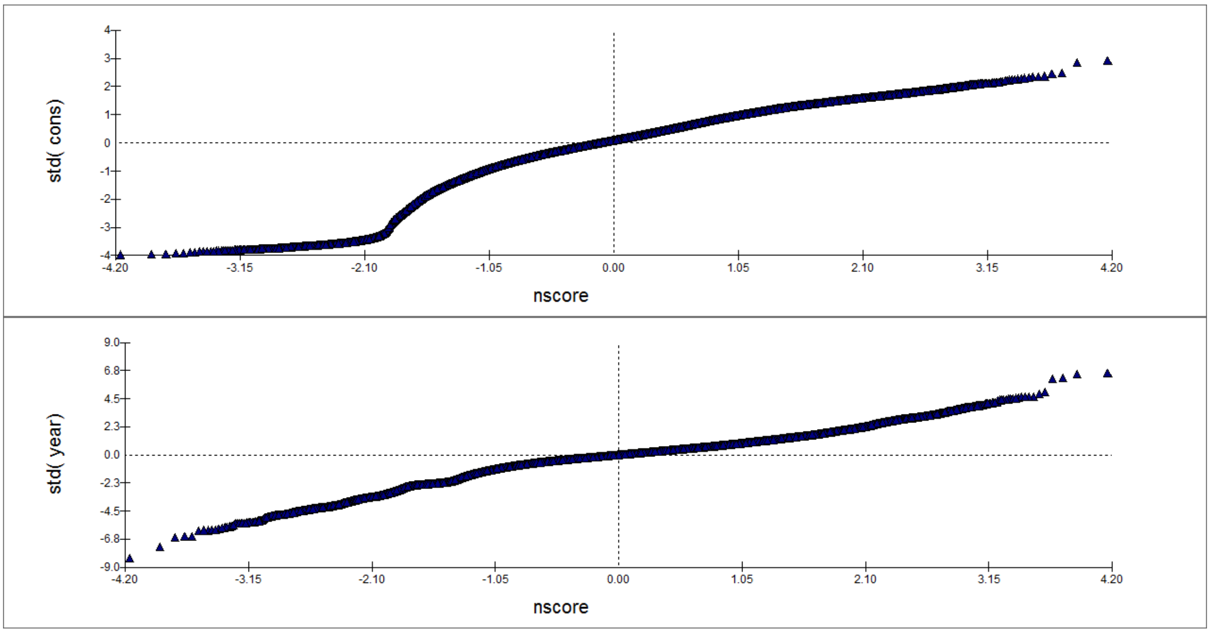

Figure 3 - Q-Q normality plot for level 2 (neighbourhood) residuals for random effect of constant and slope (year)

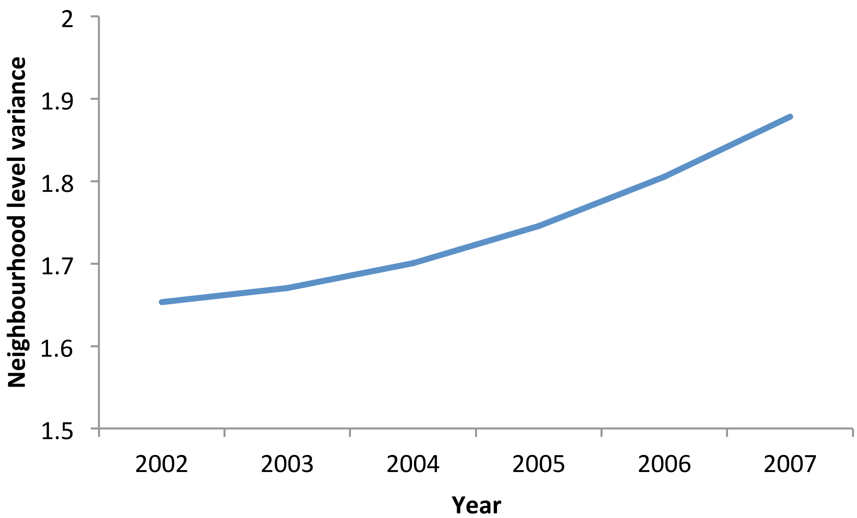

Figure 4 Neighbourhood level variance in proportion of FSM pupils on logit scale as a function of year