The limitations of using school league tables to inform school choice

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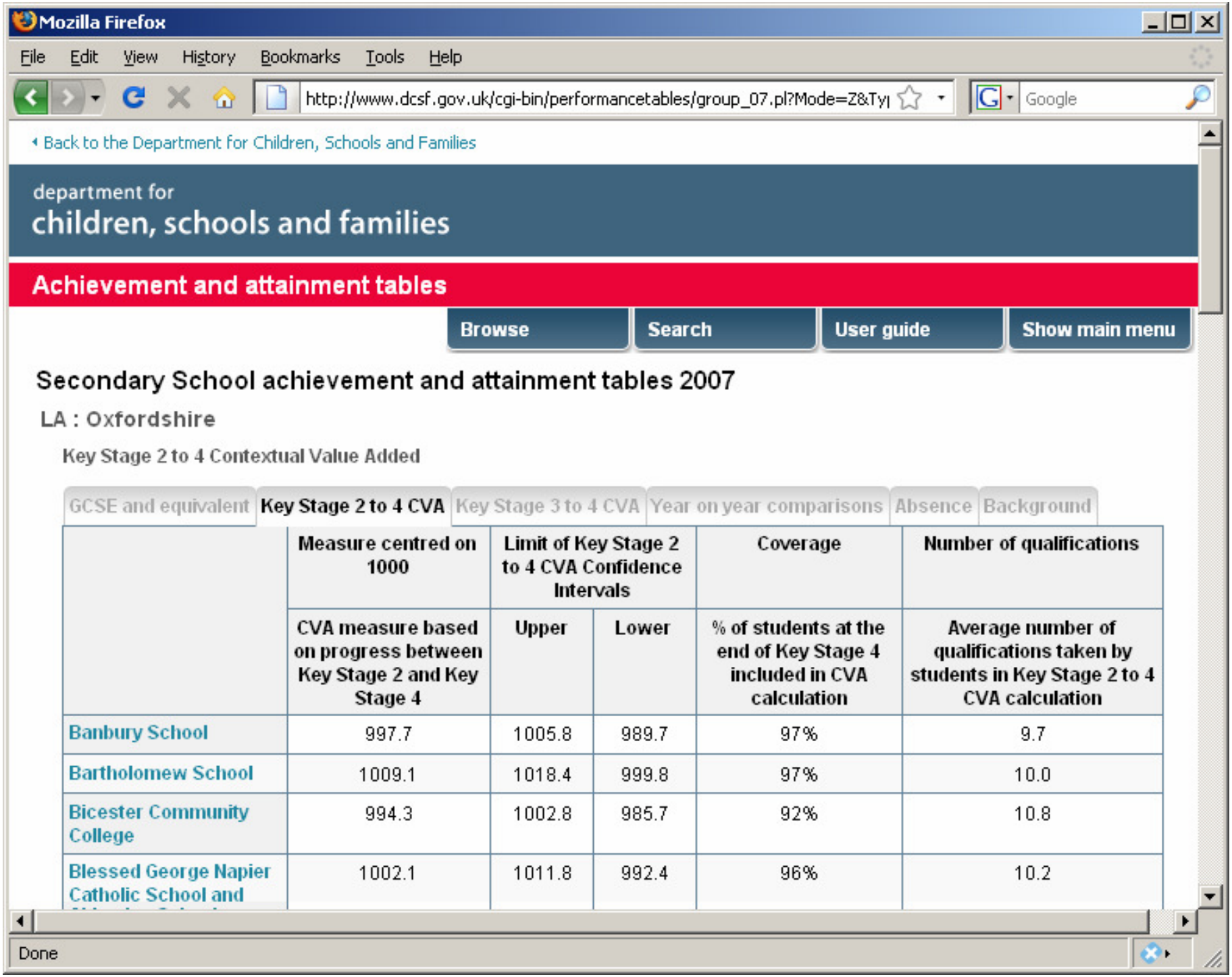
Introduction

- Each year the government publishes schools' GCSE results and contextual value-added (CVA) performances in school league tables
  - They estimate value-added scores using multilevel models
- A principal justification for this is to inform parental choice of secondary schools
- A crucial limitation of these tables is that the most recent published information is based on a cohort of pupils who are 7 years ahead of the cohort of interest
- For choosing a school, it is the future performance of schools that is of interest
- The government make no adjustment for the statistical uncertainty that arises from making predictions into the future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Key Stage 2 to 4 Contextual Value Added
GCSE and equivalent
Key Stage 2 to 4 CVA
Key Stage 3 to 4 CVA
Year on year comparisons
Absence
Background
Measure centred on 1000
Limit of Key Stage 2 to 4 CVA Confidence Intervals
Coverage
Number of qualifications
CVA measure based on progress between Key Stage 2 and Key Stage 4
Upper
Lower
% of students at the end of Key Stage 4 included in CVA calculation
Average number of qualifications taken by students in Key Stage 2 to 4 CVA calculation
Banbury School 997.7 1005.8 989.7 97% 9.7
Bartholomew School 1009.1 1018.4 999.8 97% 10.0
Bicester Community College 994.3 1002.8 985.7 92% 10.8
Blessed George Napier Catholic School and 1002.1 1011.8 992.4 96% 10.2
Done

Seven years out of date

- During October 2008 parents will choose which secondary schools to send their children to
- These pupils will start secondary schooling in September 2009 and will take their GCSE examinations in 2014
- When choosing their secondary schools, the most recent published information will be for the cohort of pupils who take their GCSEs in 2007
- These two cohorts are seven years apart

Stability of school effects

- Previous literature has shown that whilst simple school averages are strongly correlated over time, value-added estimates of school effects are only moderately correlated

- Correlations of 0.5 - 0.6 for value-added estimates five years apart

- This limits the extent to which current school performance can be used as a guide to future performance

Data

- National Pupil Database (NPD)
  - Census of all state school pupils in England
  - Pupils test scores data at ages 11 and 16
  - Same data as is used to produce government school league tables
- Pupil Level Annual School Census (PLASC)
  - Provides data on pupil background characteristics
  - These are included in the CVA model specification
- We use data on the cohort of pupils that took their GCSEs in 2007
- We analyse a 10% random sample of all English secondary schools
  - 274 schools, approximately 190 pupils per school

Two-level multilevel model

- The traditional school effectiveness model is

$$y_{ij} = \beta_0 + \beta_1 x_{ij} + u_j + e_{ij}$$
$$u_j \sim N\left(0, \sigma_u^2\right), \qquad e_{ij} \sim N\left(0, \sigma_e^2\right)$$

- y_{ij} is the total GCSE score for pupil *i* in secondary school *j*
- x_{ij} is their achievement at age 11 intake
- u_j is the value-added school effect for secondary school *j*
- e_{ij} is the pupil level random effect

Predictor variables

- At the pupil level (level 1) we adjust for
  - Achievement at age 11
  - Month of birth
  - Gender
  - Free school meals
  - Special educational needs
  - English as an additional language
  - Ethnicity
  - Local neighbourhood deprivation
- We do not adjust for any school level (level 2) variables

School effects for the 2007 cohort

- Posterior estimates of the school effects and their associated variances are given by

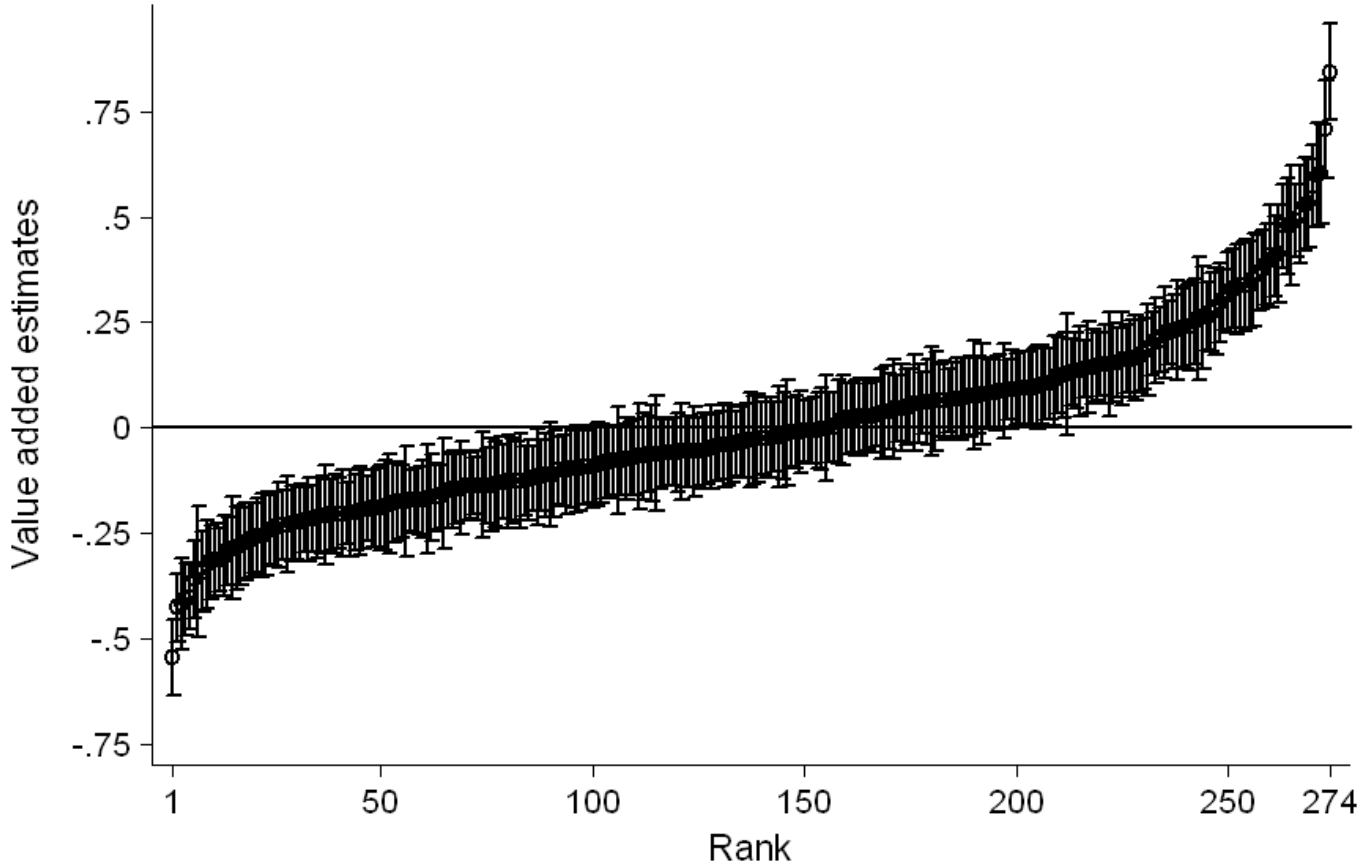
$$\hat{u}_j = \frac{n_j \sigma_u^2}{n_j \sigma_u^2 + \sigma_e^2} \tilde{y}_j, \qquad \text{var}\left(\hat{u}_j - u_j\right) = \frac{\sigma_u^2 \sigma_e^2}{n_j \sigma_u^2 + \sigma_e^2}$$

- Assuming normality, standard 95% confidence intervals are calculated as

$$\hat{u}_j \pm 1.96 \sqrt{\text{var}\left(\hat{u}_j - u_j\right)}$$

- These school effects are published in the DCSF school league tables

School effects for the 2007 cohort



~60% of schools are significantly different from the overall average

School effects for the 2014 cohort

- The previous school effects allow us to make inferences about how schools performed for the cohort that took their GCSEs in 2007
- However, they do not allow us to make inferences about the likely performance of schools for future cohorts
- We want to know whether the same significant differences remain in 2014
- To do this, we need to adjust the estimates and standard errors of the 2007 school effects to reflect the additional uncertainty that arises from predicting into the future
- The bivariate response version of the school effectiveness model provides a way to do this

Bivariate response model

- The traditional school effectiveness model for two cohorts of pupils is

$$y_{ij}^{(2007)} = \beta_0^{(2007)} + \beta_1^{(2007)} x_{ij}^{(2007)} + u_j^{(2007)} + e_{ij}^{(2007)}$$
$$y_{ij}^{(2014)} = \beta_0^{(2014)} + \beta_1^{(2014)} x_{ij}^{(2014)} + u_j^{(2014)} + e_{ij}^{(2014)}$$

$$\begin{bmatrix} u_j^{(2007)} \\ u_j^{(2014)} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{u2007} & \\ \sigma_{u2007,2014} & \sigma^2_{u2014} \end{bmatrix} \right), \quad \begin{bmatrix} e_{ij}^{(2007)} \\ e_{ij}^{(2014)} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{e2007} & \\ 0 & \sigma^2_{e2014} \end{bmatrix} \right)$$

- The level 2 residuals are allowed to be correlated. The correlation measures the stability of school effects between the two cohorts
- The level 1 residuals are modelled as independent as a pupil can only belong to one cohort

School effects for the 2014 cohort

- It can be shown that the posterior estimates and variances of the school effects for the second cohort, given data only on the first cohort, are

$$\hat{u}_j^{(2014)} = \frac{\rho\, n_j^{(2007)}\sigma_u^2}{n_j^{(2007)}\sigma_u^2 + \sigma_{e2007}^2}\tilde{y}_j^{(2007)}, \qquad \mathrm{var}\left(\hat{u}_j^{(2014)} - u_j^{(2014)}\right) = \frac{n_j^{(2007)}\sigma_u^4\left(1-\rho^2\right) + \sigma_u^2\sigma_{e2007}^2}{n_j^{(2007)}\sigma_u^2 + \sigma_{e2007}^2}$$

- Where, for simplicity, we have assumed that the school level variance is constant across cohorts

$$\sigma_{u2007}^2 = \sigma_{u2014}^2 = \sigma_u^2$$

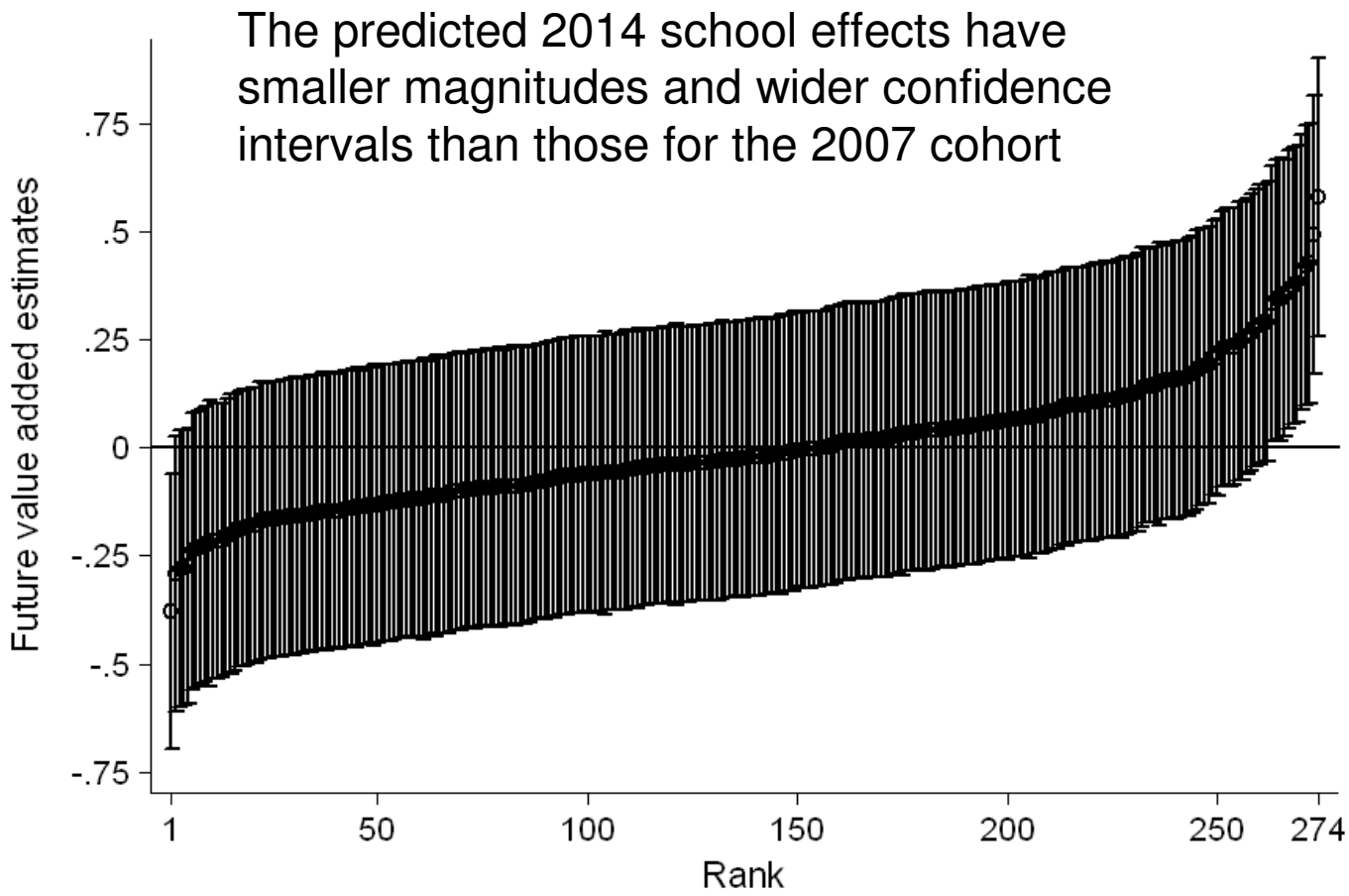
- The two equations are the same as before, except for the addition of the terms in red

- The only term we don't know is ρ the correlation between the two sets of school effects

Stability of school effects

- We want to estimate ρ the 7 year apart correlation
- Ideally, we would estimate the bivariate response model based on two cohorts of pupils 7 years apart to obtain an estimate of ρ
  - Note, we assume that ρ remains stable over time
- However, we only have data for cohorts five years apart (2002 and 2007)
  - The estimated correlation is 0.69
  - This is an overestimate of the 7 year apart correlation
- We can now adjust the estimates and standard errors of the 2007 school effects

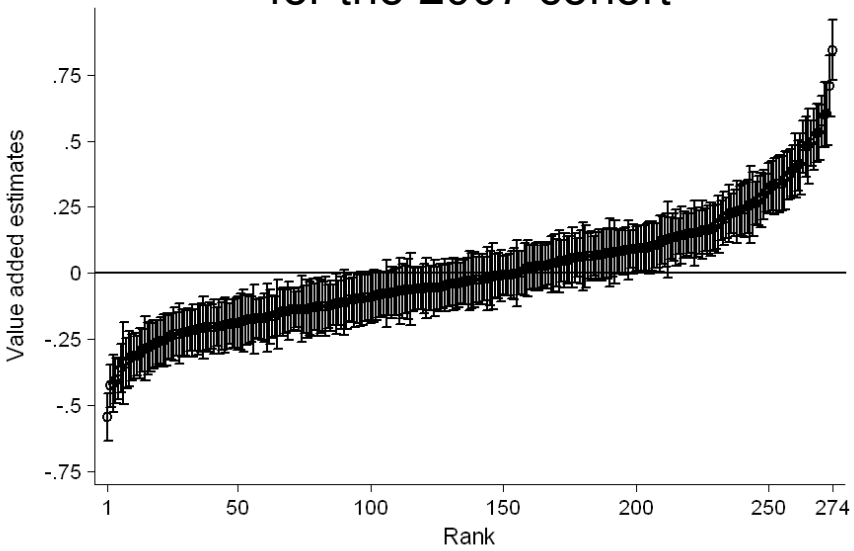
School effects for the 2014 cohort



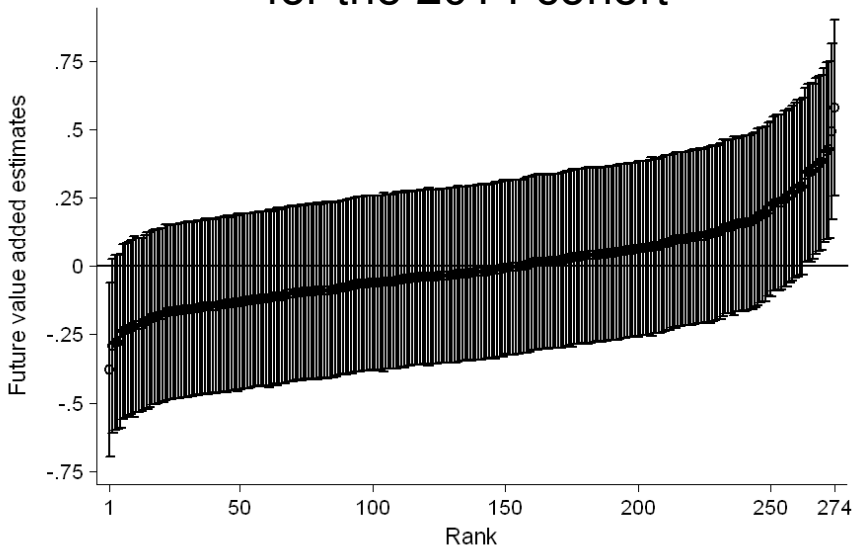
Only ~5% of schools are significantly different from the overall average

Comparison of the school effects for the 2007 and 2014 cohorts

School effects
for the 2007 cohort



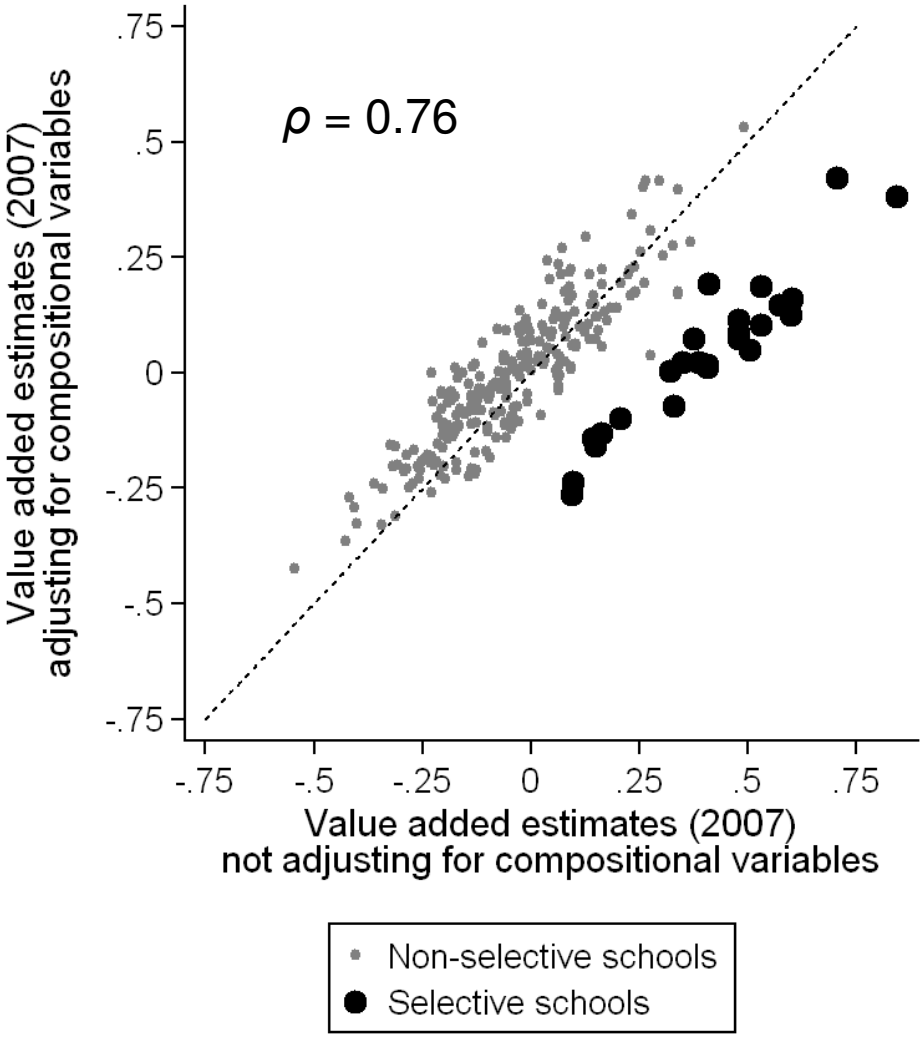
Predicted school effects
for the 2014 cohort



- Note, these caterpillar plots only allow schools to be compared at the 5% level to the *average* school

- Different confidence intervals are required for pairwise comparisons
  - These are the types of comparisons which parents are interested in

Adjusting and not adjusting for school compositional variables



- The CVA model adjusts for two school level compositional variables
  - School mean of intake achievement
  - School spread of intake achievement
- This lowers the rankings of grammar schools
- Grammar schools admission policies lead them to have a high mean and narrow a spread of achievement at intake
- However, parents are interested in which schools will produce better subsequent achievement irrespective of whether this is due to school composition, policies or practices

Conclusions

- School league tables make no adjustment for the statistical uncertainty that arises when current school performance is used to predict future school performance
- Our main result is that, when we adjust for this uncertainty, the number of schools that can be separated from the average school drops from 60% to almost none
- We also argue that, for the purpose of school choice, value-added measures should not adjust for school-level factors, since this is part of the very thing that parents are interested in
- We show that adjusting for the school-level intake composition substantially alters the rank order of school effects
  - Grammar schools drop down the rankings

Conclusions (cont.)

- We do not propose our approach as a new means of producing league tables
- What we focus on is just one of a long list of statistical concerns that have been expressed about using results as indicators of school performance
  - Other concerns include the side effects and perverse incentives generated by the use of league tables
- However, we do feel that there is an accountability role for performance indicators as monitoring and screening devices to identify schools for further investigation
  - In which case, estimates for the 2007 cohort are the most appropriate
  - However, it is not clear whether to adjust for school compositional variables
  - Performance indicators will be of most use if combined with other sources of school information

Conclusions (cont.)

- Whilst we have focussed on secondary school league tables, the issues we have discussed are relevant for other stages of schooling

- Indeed, for primary schools our main result will be even more dramatic, since the small size of primary schools makes their estimated schools effects particularly imprecise

- Scotland, Wales and Northern Ireland no longer publish school league tables, perhaps now is the time for England to stop