The influence of headteachers on their schools

James Zuccollo, Joana Cardim Dias, Eva Jiménez and Nils Braakmann

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About the Authors

Nils Braakmann is a Professor of Economics at Newcastle University. His work focuses on empirical microeconomics, typically using large-scale datasets and microeconometric techniques to investigate questions mainly drawn from labour economics, the economics of crime, health economics, international economics and urban economics. He is also currently an elected member of Newcastle University's Senate.

Joana Cardim Dias is a Senior Researcher at EPI. Her research has included evaluating the impact of a technology-aided learning programme in schools, examining the effects of free childcare on girls' behavioural outcomes, analysing the trends and geography of education mobility in Europe and exploring the link between community-driven development and learning outcomes. Joana participates in the NOVAFRICA knowledge centre and has designed and managed field experiments in Portugal, Mozambique and Angola.

Eva Jiménez is a Researcher at EPI, holding a PhD in psychology from the University of Warwick. Prior to EPI she worked as a postdoctoral researcher in Warwick's Institute of Advanced Study as part of her Early Career Fellowship. Previously, Eva gained significant experience working with children with special educational needs and learning disabilities as a speech therapist and educational psychologist in Spain, and as a SEN teaching assistant and SEN teacher in the UK.

James Zuccollo is the Director for School Workforce at EPI. He leads a research programme on teacher policy that provides evidence on issues such as recruitment and retention, workload, pay, and professional development. It supports policymakers to foster an environment in which the teaching profession can thrive.

Acknowledgements

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Executive summary

This report assesses the impact of headteachers on school performance in England, and the mechanisms through which headteachers influence performance. In addition, the study explores whether a headteacher's gender and ethnicity have an impact on the composition of the pupil and staff bodies, and on the attainment of specific demographic groups.

Using national data on all pupils and headteachers in England between 2004 and 2019, we follow 22,300 primary and 5,400 secondary headteachers and track their impact on pupils' progress, teacher turnover, teacher absences, and the composition of the staff and pupil bodies. By tracking headteachers as they move between schools, we can separate the effect of the headteacher from the effect of the school's circumstances, the pupils' circumstances, and government policy changes.

For primary schools, the main outcome measure is a pupil's educational attainment adjusted for their baseline characteristics; for secondary schools, we use a contextual value-added (CVA) measure of pupils' educational progress that also accounts for their prior attainment.

The main result is an estimate of the degree to which an effective headteacher improves the attainment of pupils at their school. As a convenient shorthand we will refer to an 'effective' headteacher if the headteacher is at the 84th percentile of effectiveness, an 'average' headteacher if the headteacher is at the median, and a 'less-effective' headteacher is if the headteacher at the 16th percentile of effectiveness. If a school were to recruit an effective headteacher to replace an average headteacher, our results indicate the likely impact on the educational attainment of the pupils at the school, on the turnover of teachers, and on the absences of teachers.

Headteachers have a strong influence on the attainment of pupils at their school

- A secondary school with a less-effective headteacher that recruits a median headteacher can expect to see the progress of pupils in their school improve by 0.08 standard deviations (sd). Using common conversion factors, that is roughly equivalent to all pupils making an additional 1 month of progress or gaining an extra grade in one of their GCSE subjects (see Table 1).
- For primary schools, the impact on pupils' progress is 0.12sd, which is about 2 months of additional progress.
- Similarly, a secondary school with a less-effective headteacher that manages to replace them with an effective headteacher can expect to see an average improvement in their pupils' progress of 0.16sd, which is approximately an extra grade in two GCSE subjects.
- Previous research has estimated an extra grade in a GCSE to be worth about £8,000 in additional lifetime earnings to an individual. Across an average secondary school of 1,000 pupils, that means switching from an average headteacher to an effective headteacher and retaining them in post for five years could add £8 million to the value of pupils' lifetime earnings.
- These effects seem to be stronger for headteachers that remain in the school for several years. The effect of switching from an average to an effective headteacher rises from 0.08sd to 0.13sd after a headteacher has remained in the same secondary school for three years.
- We do not find any evidence that headteachers' effectiveness depends on the match between the headteacher and the school. In other words, our results suggest that good headteachers are equally effective in all schools we observe them in. That does not necessarily mean that a good fit between the headteacher and the school is unimportant. For example, some headteachers

might have expertise in solving particular issues that a school might have, but perhaps schools and headteachers cannot tell whether they will be a good fit during the hiring process. Our approach is unable to distinguish these possibilities.

Table 1: Effect of switching from less effective to average headteacher on pupils' results

Measure	Primary schools (attainment)		Secondary schools (progress)	
	Moving from headteacher in 16th percentile to one in 50th percentile	Moving from headteacher in 16th percentile to one in 84th percentile	Moving from headteacher in 16th percentile to one in 50th percentile	Moving from headteacher in 16th percentile to one in 84th percentile
Raw effect size	+ 0.12sd	+ 0.24sd	+ 0.08sd	+ 0.16sd
Months of progress	+ 2 months progress	+ 3 months progress	+ 1 month progress	+ 2 months progress
Additional grades	-	-	+ 1 GCSE grade in one subject	+ 1 GCSE grade in two subjects
Additional lifetime earnings	-	-	+ £8,000 net present value per pupil	+ £16,000 net present value per pupil

Effective headteachers also reduce teacher turnover and absenteeism

Headteachers influence pupil attainment indirectly through their strategic and operational decisions, particularly those that affect staff composition and motivation. We quantify their effect on both teacher turnover at a school and teacher absenteeism (including sick leave), which is directly related to teacher motivation.

- Headteachers who are effective at improving attainment also seem to reduce both annual teacher turnover and four-year cumulative teacher turnover.
- Effective headteachers can reduce annual turnover by 0.02sd in primary schools and 0.03sd in secondary schools. They also reduce four-year cumulative teacher turnover by 0.03sd in primary schools and 0.06sd in secondary schools.
- While effective headteachers were found to reduce teacher absenteeism in secondary schools, no consistent effect was discovered in primary schools. In secondary schools, switching from a less-effective headteacher to an average headteacher brought a reduction in absences equal to an average of 10.7 days (a 0.06sd reduction).
- All effects are small, which suggests that these are not the most important mechanisms through which headteachers influence pupils' progress.

Headteacher effectiveness varies little by school characteristics

- Effective headteachers are equally distributed across academies and local authority-maintained schools.
- Effective headteachers are equally distributed between more and less affluent schools.

Headteacher effectiveness is greatest in London

To explore regional differences in the effectiveness of headteachers, we compare the average effectiveness of headteachers across regions in England. This is a comparison between the average effectiveness in each region, not a comparison between average and effective headteachers. It is not possible to be certain whether differences between regions are generated by differences in the effectiveness of the headteachers who choose to work in those regions, or by the way the regions enable headteachers to function.

- In London primary schools headteachers improve student attainment by about 0.05sd more than the nationally-average headteacher. The North East also appears to have slightly more effective primary headteachers, though that effect is not replicated in secondary schools.
- In secondary schools in London headteachers contribute about 0.05sd more than the regions with the lowest-average quality, equivalent to 2/3 of a GCSE grade and 1 additional month of progress. This amounts to £5,500 of additional lifetime earnings per student and an additional £5.5m of net present value for each average school. No other regions have an average effectiveness that is materially different from the national average.

Effective headteachers earn more

- In primary schools, a less-effective headteacher has historically earned on average £59,300, while an average headteacher has earned £61,100 and a highly effective headteacher earned £61,700.
- In secondary schools a less-effective headteacher has historically been paid around £86,400 on average, while median headteachers were paid around £89,700 and highly effective headteachers earned about £91,800.
- While these results may signal that some governors can identify good headteachers, this is a relatively small pay premium when compared with the large benefit that a more-effective headteacher brings to a school.

Experienced headteachers tend to be better headteachers

- Both in primary and secondary schools more-effective headteachers have more years of experience as headteachers and have more experience as headteachers in the school they lead.
- For both primary and secondary schools, having five more years of experience is associated with an increase of 0.1sd in headteacher effectiveness. This equates to an extra two months of progress for primary and secondary school students, or an increase of 1.25 GCSE grades for secondary school students. In value, this translates into £10,000 additional lifetime earnings for each secondary school pupil and an additional £10m of net present value for each average school.
- Five more years of experience in the same school is associated with a 0.1sd increase in average effectiveness in primary schools, which is equivalent to two months of additional progress. For secondary schools, it is associated with a 0.15sd increase, which is an increase of almost two grades in one GCSE and two additional months of progress. This is comparable to the effects of pupils having a more experienced teacher.

Effective headteachers in secondary schools do earn better Ofsted grades for their schools

- Secondary schools with more-effective headteachers receive better Ofsted grades, but these differences are extremely small.
- Primary schools with mor-effective headteachers do not earn better Ofsted grades.

A change in the gender or ethnicity of a school's headteacher appears not to have an impact on the composition of the student body and workforce

The second part of the project investigated whether having a headteacher of a particular gender or ethnicity influenced the composition of a school's workforce and student body, or student attainment. We tested separately for all combinations of headteacher and pupil/staff gender and ethnicity.

- Of 264 combinations tested, we found only 5 results that were significantly different from zero. With so many tests, it is likely that some will differ from zero by chance and so we cannot rule out there being no detectable effect in any of the combinations we tested.
- Consequently, we find no evidence that recruiting headteachers from a particular gender or ethnicity will benefit pupils of a particular gender or ethnic group, nor that it affects the gender and ethnic composition of the workforce.
- Further research is needed to explore whether there are wider impacts of headteacher diversity, such as on attendance and exclusion of pupils, as well as on the impact of classroom teacher and middle leadership diversity.

Policy implications

- Effective headteachers significantly improve pupil attainment, teacher retention, and teacher absenteeism. Gains from increased effectiveness are very large by grades and net present value. Enhancing the quality of school leadership may be a cost-effective way of improving school performance and more work should be done on how to achieve it.
- School governors and Ofsted inspectors should acknowledge that it may take years to realise the full improvement in results from switching headteachers and support new headteachers accordingly. They should also recognise that the cost of losing experienced leaders is high and focus on supporting them to remain in the profession.
- If the government wishes to close the attainment gap, it it could encouragemore high-quality headteachers to work in the most-disadvantaged schools and in areas outside London. Multi-academy trusts and local authorities could also consider how they can encourage their most-effective school leaders into the most-challenging schools. Although this would introduce an uneven distribution in headteacher effectiveness between disadvantaged and affluent school, it may improve the performance of disadvantaged pupils and of the education system.
- There is no evidence that pupils or teachers from certain genders or ethnicities benefit from headteachers from the same gender or ethnic group to the degree that they benefit from having a more-effective headteacher. There are many reasons to prefer to have headteachers that represent the communities they lead but this evidence suggests that effectiveness can be assessed independent of that matching.

Introduction

There is a strong belief that good school leadership is essential for creating and sustaining good schools. The Department for Education (DfE) claims leadership is one of the greatest influences on pupil outcomes, researchers claim that leaders shape the school to improve pupils' outcomes, and the effectiveness of a school's leadership is one of the five areas assessed by Ofsted.[1]

This belief is reflected by the fact that the autonomy of school leaders in England is among the highest in the OECD, and the increasing number of academy schools over the past decade has given headteachers even greater freedom from central direction.[2] Most headteachers in England can distribute resources as they wish, set teachers' pay and conditions, choose their school's curriculum, and set the length of a school day.

However, the importance of headteachers for pupils has never been quantified in England. This makes it hard for policy makers and school governors to make informed decisions about budget allocation between leadership and other school resources. Quantifying headteachers' impact is even more important because they are often held responsible by school governing bodies, and Ofsted, for meeting the demands of the accountability system and improving pupils' academic performance.

The inability, so far, to quantify headteacher effectiveness has also prevented policy makers from understanding whether certain regions, or schools with pupils from highly-disadvantaged backgrounds, find it hard to recruit and retain high-quality headteachers. The attainment gap is no longer closing, despite efforts to allocate school funding towards pupils from more-disadvantaged backgrounds. An inability to attract highly-effective headteachers to these contexts might contribute to this inequality.[3]

There is also little quantitative evidence on the mechanisms through which headteachers affect pupil attainment. Qualitative research has argued that school leaders improve teaching and learning indirectly through their impact on staff motivation, commitment, and working conditions, and that one of the first things successful headteachers do when starting their new position is to focus on staff.[4] Research from the US also shows that one of the mechanisms through which headteachers affect a school may be teacher retention and recruitment.[5]

Like teachers, more headteachers are leaving the profession before the retirement age. This is especially true in secondary schools and is illustrated by high school leadership vacancies.[6] This puts extra pressure on governing bodies to recruit and keep high quality leaders.

Finally, it is unclear the extent to which headteachers may shape the student body, although there is some evidence that this might be the case. In particular, it is unclear whether a match between headteachers and pupils, or staff, of the same ethnicity, or gender, can improve pupils' outcomes. A large literature has suggested that having a same-ethnicity or same-gender instructor can improve the

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[1] Department for Education, 'School Leadership in England 2010 to 2016: Characteristics and Trends'; Day et al., '10 Strong Claims about Successful School Leadership'.
[2] OECD, 'School Autonomy and Accountability: Are They Related to Student Performance?'
[3] Tuckett et al., 'Covid-19 and Disadvantage Gaps in England 2021'.
[4] Day et al., '10 Strong Claims about Successful School Leadership'.
[5] Branch, Hanushek, and Rivkin, 'Estimating the Effect of Leaders on Public Sector Productivity', February 2012.
[6] Worth et al., 'Teacher Workforce Dynamics in England'; Weale, 'School Leader Retention Rates in England Declining, DfE Data Shows'; Department for Education, 'School Leadership in England 2010 to 2016: Characteristics and Trends'; Martin, 'School Leader Pressure'.

performance of students.[7] While conceivable that similar effects operate at the level of school choice and that a school run by a woman or an ethnic-minority headteacher becomes more attractive for students or teachers sharing these characteristics, this has not been tested in England.

In this report we:

- Measure and describe the effect that headteachers have on overall school performance and study its implications.
- Explore the effect of exposure to a headteacher of a certain gender or ethnicity on the characteristics of the student body, the teaching workforce, and pupils' progress.

Does changing headteacher change a school's performance?

This central question asks how much of the variation in a school's performance can be explained by the choice of headteacher. Understanding this has immediate implications for accountability policy. Beyond that, it enables us to answer:

- What might be the mechanisms through which headteachers affect pupil performance? Do headteachers that excel on one dimension of performance also excel on others? In particular, do headteachers that generate good grades also tend to lower teacher turnover or absences?
- How is headteacher effectiveness distributed across school and pupil characteristics? For example, do schools with a disadvantaged intake attract better headteachers?
- Is headteacher effectiveness rewarded through pay?Is it easy to identify effective headteachers? For example, is a more effective headteacher more experienced?

Does a change of headteacher change a school's student body and workforce?

We investigate whether the characteristics of the headteacher, such as their gender and ethnicity, affect:

- The proportion and relative performance of pupils of different genders and ethnicities.
- The turnover of the teaching workforce within a school.

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[7] Gong, Lu, and Song, 'The Effect of Teacher Gender on Students' Academic and Noncognitive Outcomes' on gender; Lusher, Campbell, and Carrell, 'TAs like Me' on ethnicity.

Approach

In this section we outline our approach to measuring the influence of headteachers on their schools. Details on the statistical approach are contained in Appendix A.

Influence on pupil attainment

To identify the contribution of headteachers to school performance across different domains, we must account for other influences on pupils' performance. Figure 1 shows a simplified conceptual model composed of four factors that influence performance:[8]

- **Pupils' context:** These are the aptitudes, experiences, and skills that a pupil brings with them to their education. It is typically measured using a combination of information about a pupil's demographic and socio-economic context and their prior attainment on related assessments.
- **School's characteristics:** These are the characteristics of the school that do not typically change over time. For example, its location and phase.
- **Headteacher's effectiveness:** This is what we wish to isolate. Here we assume that any characteristics of the school environment that change over time - the workforce, for example - are controlled by the headteacher.
- **Government policy changes:** Government policy changes to school governance and funding arrangements will affect all schools, as will changes to the way pupils' performance is measured.

Figure 1: Elements contributing to pupil performance
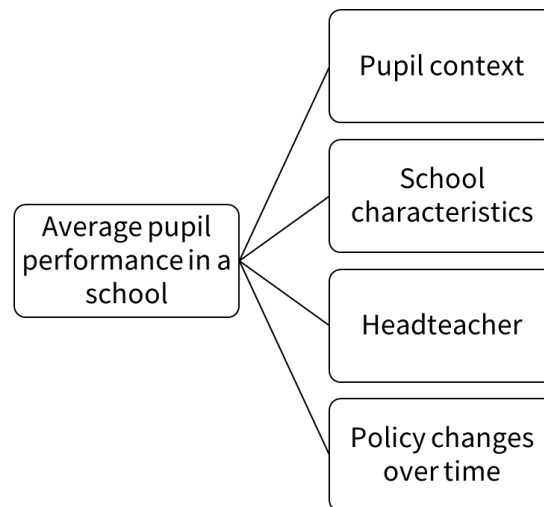
Separating the effects of headteachers from the effects of other factors is challenging because different schools hire different headteachers at different points in time for different reasons. That means headteachers are not randomly distributed across schools and a simple comparison of school performance would be biased. For example, schools with a poor Ofsted rating may struggle to attract high-performing headteachers, who fear for their reputations. If weaker headteachers systematically end up at schools with lower attainment, the apparent effect of headteachers on their schools will be exaggerated. Similarly, changes to policies at the level of local education authorities (LAs) or multi-academy trusts (MATs) might cause schools to hire headteachers with certain characteristics.

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[8] This model is based on previous research by Branch, Hanushek, and Rivkin, 'Estimating the Effect of Leaders on Public Sector Productivity', February 2012.

To overcome the problem of headteachers selecting into persistently better attaining and performing schools, we follow the work of Branch et al by exploiting headteachers' moves between schools to separate the effect of the headteacher from the persistent effect of the school's circumstances.[9] Since the school workforce census (SWC) allows headteachers to be tracked over time, we can observe the outcomes for a school across multiple headteachers and the outcomes for a headteacher across multiple schools. This allows us to decompose the outcome for a school-headteacher combination observed in a certain year into a headteacher component (the headteacher fixed effect), a school characteristics component (the school fixed effect) and a time effect that captures policy changes.

To account for pupils' context, we use a measure of pupil performance that adjusts attainment for pupils' circumstances. For primary schools we adjust only for pupils' demographic characteristics; for secondary schools we also adjust for prior performance. This distinction is discussed in more detail below. Throughout the report we refer to our measure as 'pupil progress'. However, because we are not adjusting primary performance for prior attainment, for primary schools we actually measure contextual attainment. Only the secondary school measure is a true contextual value-added.

Our approach differs slightly from the one used by Branch et al because we find that, in England, headteachers move only within fairly tightly connected networks so it is only possible to separately identify school and headteacher effects within a "connected set", linked by teacher mobility. To overcome this challenge we adopt a group fixed effects approach that entails modelling differences between schools for groups of similar schools instead of at the level of individual school.[10] We form these groups based on a cluster analysis that uses pupils' FSM eligibility, gender, and attainment. Exploring moves within the largest connected group of clusters allows us to identify the headteacher effect. This group contains over 99 per cent of schools for both primary and secondary phases. More details on this approach are presented in Appendix A.

The main output of this model will be a causal estimate of the effect that a headteacher has upon a school's exam performance - measured using pupil progress - within each group of schools. Comparing within groups of schools and including the aspects of schools that do not change over time (the group fixed effect) ensures that our estimate will be robust to the systematic selection of schools by students and headteachers.

One of the most widely-noted issues is that a headteacher's influence on a school may take years to manifest. Branch et al deal with this by estimating headteacher effects on a sample restricted to the first three years a headteacher spends leading a school. Along with the estimation using the full sample, we estimate effects separately for the first three years a headteacher is in a school and excluding the first three years a headteacher is in a school. The latter subsample accounts for the possibility that it takes time for the effect of a headteacher to manifest. If the estimates differ between the subsamples that suggests the effect of a headteacher is not constant throughout their tenure at a school.

Our main approach treats headteacher effects and school effects as separate, which implies that an effective headteacher will bring improvements to every school they lead. However, it could also be the case that the fit between headteachers and schools matters.[11] If fit matters it is not sufficient for a school to merely hire a good headteacher: it must hire a good headteacher for the school's particular circumstances. For instance, a good fit could be a headteacher who has the right knowledge and skills to

[9] Branch, Hanushek, and Rivkin, 'Estimating the Effect of Leaders on Public Sector Productivity', February 2012.
[10] We follow the approach developed in Bonhomme, Lamadon, and Manresa, 'A Distributional Framework for Matched Employer Employee Data'; Bonhomme, Lamadon, and Manresa, 'Discretizing Unobserved Heterogeneity'.
[11] As modelled in Coelli and Green, 'Leadership Effects'.

deal with pupil absenteeism leading a school that suffers from high levels of absenteeism. We test this by comparing a model in which we allow headteacher effects to vary by group of schools to a model in which each headteacher has the same impact, independent of the school they are in.

After estimating a measure of headteacher effectiveness, we relate it to other indicators to answer the policy questions outlined in the introduction:

- To understand the potential mechanisms through which headteachers influence performance, we explore correlations between headteacher effectiveness and improving attainment and headteacher impacts on teacher turnover and absences.
- To explore whether effective headteachers are present where they are most needed, we analyse differences in the impact of headteachers across different contexts and the distribution of headteacher quality across type of school, region, and percentage of disadvantaged pupils in a school.
- To infer whether effective headteachers are being rewarded, we explore relationships between their effectiveness and pay.
- To study whether headteachers can be identified through characteristics that schools and policy makers can easily observe, we estimate the relationship between their effectiveness in raising performance and their school's Ofsted grade.
- To study the extent to which headteachers improve over time, we examine the correlation between their effectiveness, their experience as a headteacher, and their tenure at a school.[12]

Unlike the estimates of headteachers' influence, these comparisons are not causal. For example, they would not tell us that certain schools are better at attracting more effective headteachers, only that those schools are typically observed to have more effective headteachers.

Influence on pupil and staff composition

This second stage of the project investigates the effect of headteachers' characteristics on the composition of a school's workforce and student body. In terms of relevant headteacher characteristics, a particular interest is the effect of having a headteacher as a role model, which has been found to influence pupil attainment in the US.[13] We focus on headteacher ethnicity and gender, where such a connection can be made comparatively easily. For pupils, our outcome measures are:

- The proportion of male and female students, and students from each ethnic group in each school.
- The performance of male and female students, and of students from each ethnic group.

For staff, it is the turnover of staff of each gender and ethnic group.

Our main analysis in this second part focuses on the effects of headteachers on students and teachers of the same demographic group. For example, the effect of having a male headteacher on the proportion of male teachers in a school, and the attainment of male students. We then extend our analysis to the effects of headteachers with on teachers and students with different demographic characteristics.

The estimation strategy in this step is conceptually similar to the one used in the first part of the report. We use cases where headteachers switch schools to separate the effects of headteachers'

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[12] See Kraft and Papay, 'Can Professional Environments in Schools Promote Teacher Development?' for an exploration of the rate at which teachers improve.

[13] Dee, 'Teachers, Race, and Student Achievement in a Randomized Experiment'; Dee, 'A Teacher Like Me'.

characteristics from general school characteristics. More details on the econometric approach can be found in Appendix A.

Data

We use three types of longitudinal data:

- Data on pupil attainment.
- Data on individual headteachers.
- Data on the characteristics of the student body and school workforce.

Pupil attainment

Our main school performance measure for primary schools is key stage 2 English and maths results, adjusted for pupils' characteristics. This is a contextual attainment measure, not a progress measure, because of the lack of a consistent measure of prior attainment over the period of our study, 2004-2019.

For secondary schools, we use key stage 4 English and maths results adjusted for both pupil characteristics and their prior attainment at key stage 2. This is a progress measure commonly referred to as contextual value-added (CVA), though there is no definitive method for calculating CVA so our measure will not necessarily be identical to other CVA measures.

When interpreting differences between our primary and secondary results, it is important to keep in mind that the differences in prior attainment between primary school pupils have not been accounted for in the analysis. Pupils' circumstances in younger years are highly correlated to their attainment at that time but not perfectly so. If primary schools with higher-attaining pupil intakes are more successful at attracting good headteachers then our model would be overestimating the impact of headteachers in primary schools. This limitation does not affect our estimates for secondary schools. As mentioned previously, for simplicity we will refer to both throughout the report as 'pupil progress'.

The advantage of using these measures is that we can account for a wide range of pupil characteristics that might affect attainment. However, the drawback is that our outcome measure is no longer as straightforward to interpret as, for example, a GCSE grade. Instead, we report the impact of headteachers on these adjusted measures as a standardised effect size by rescaling the distribution of the outcome measure to have a standard deviation of one. Effect sizes are commonly used to report the results of education interventions, so this allows a degree of comparability between our results and other education interventions. We use the Education Endowment Foundation's conversion tables to report months of progress as an outcome, calculated from the effect size.

Pupil data was obtained from the National Pupil Database (NPD). We use data from 2004 to 2019 for primary schools and 2006 to 2019 for secondary schools.[14] This is the longest continuous time series of attainment data available for pupils in England. We stop at 2019 despite the existence of later data to avoid the effects of the covid-19 pandemic.

Workforce

We primarily use the DfE's longitudinal School Workforce Census (SWC) to gather information on headteachers and their workforce. The SWC is an annual census of all publicly-funded schools in England and captures information about the entire school workforce's employment terms, personal characteristics, qualifications, and teaching schedule. It includes all headteachers, teachers and support staff employed in the year of the census. The SWC has been collected annually since 2010 and we use all

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[14] We do not use 2004-2006 data in the analysis for secondary schools as there is no prior attainment available in the datasets for those years.

years of data before the pandemic (2019), which gives us nine years of microdata. Crucially, the SWC allows staff members to be tracked across those years as they move between roles and schools. The record level for the SWC varies across the modules but is essentially a single contract of an individual with a school in a census year.

Using the SWC enables us to identify when headteachers change schools, which is essential to our estimation strategy. A time series of nine years is similar to that used by Branch et al in the US. However, we can capture a longer time series by linking the SWC to DfE's Database of Teacher Records (DTR). The DTR is primarily designed to capture teachers' salary and service information to inform pension calculations. It extends back to the 1990s but does not include the extensive information on personal characteristics and backgrounds in the SWC. By linking the two datasets for teachers who have a SWC record we can capture this time-invariant information from the SWC, while still observing a longer time series of school moves from the DTR.

Linking the SWC and DTR gives us an analysis sample of 22,308 headteachers in primary schools spanning 15 years and 5,439 headteachers in secondary schools spanning 13 years (see Table 2 for more details).

Table 2: Description of the analysis sample

School phase	Number of headteachers	Number of years in sample			Number of schools	Number of school-year combinations	Number of headteacher moves
		Average	Min	Max			
Primary	22,308	4.95	1	15	17,739	110,339	28,697
Secondary	5,439	3.77	1	-	4,991	20,492	7,070

Source: EPI calculations using DTR and SWC

Note: Maximum number of years a secondary headteacher spends in the sample is suppressed due to low counts at the maximum number.

Along with data on headteachers, the SWC also provides nine years of data with details on teacher characteristics, including measures of annual and cumulative turnover, absenteeism, experience in the profession, tenure in a school, and pay.

We use two measures of staff turnover at a school. Annual turnover is the number of teachers that leave in a year as a proportion of the number of teachers that are in the school. Four-year cumulative turnover is the number of teachers that have left within three years as a proportion of the number of teachers that are in the school in the first year of that period. We use DfE's definition of absenteeism as the total number of days teachers were absent from school on a normal working day, including sick leave.

School characteristics

Data on schools' characteristics and context is gathered from the SWC, NPD records, and an extract of Get Information About Schools, and aggregated at school level or used at pupil level for the calculation of progress. We link datasets at the year and school level so that each contract record in the SWC will be associated with the characteristics and outcomes of the school that is their primary employer for that year.

Influence on pupil attainment

Effect on attainment

Our central estimates of the influence of headteachers on pupil's progress are reported as the effect size of a school switching from an average headteacher to a highly-effective headteacher. As a convenient shorthand, we will typically refer to an 'effective head' when we mean one in the 84th percentile of effectiveness, a 'median' or 'average' headteacher for one in the 50th percentile of effectiveness and a 'less-effective head' for one in the 16th percentile of effectiveness. That means an 'effective headteacher' leads to more pupil progress than 84 per cent of headteachers, whereas a 'less-effective headteacher' enables more progress than only 16 per cent of headteachers.

Table 3 shows the impact of headteachers on school performance measured in three ways: the first uses the full sample, the second includes only the first three years a headteacher is in a school, and the third excludes the first three years a headteacher is in a school. The results – measured in standard deviations of headteacher effectiveness – show the effect size of switching from an average headteacher to an effective headteacher. For example, the cell in the top left shows that, across our full sample of primary schools, switching from an average headteacher to a highly-effective headteacher leads to pupils achieving an additional 0.12 standard deviations (sd) of adjusted attainment on their Key Stage 2 (KS2) assessments, on average. Using EEF conversion tables, that is approximately two months of additional progress.

Table 3: Headteachers have a substantial impact on school performance

	Standard deviation of headteacher effects	
Sample	**Primary schools**	**Secondary schools**
1. Full sample	0.12sd (~2 months of progress)	0.08sd (~1 month of progress, ~1 grade, ~£8,000)
2. Keeping only first 3 years of a headteacher in a school	0.14sd	0.08sd
3. Excluding first 3 years of a headteacher in a school	0.15sd	0.13sd

Similarly, the effect size in secondary schools for the full sample is 0.08sd, which represents about an additional month of progress or about one extra GCSE grade in a single subject. Using DfE estimates of the value of GCSE grades, that translates into £8,000 more in lifetime earnings. For a secondary school of 1,000 pupils this is equivalent to £8m of net present value (NPV).[15]

The effect size is larger in primary schools but, as detailed in the data section, these numbers are not directly comparable because the primary results are not adjusted for prior attainment, which we expect will bias them upwards.

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[15] Months of progress are converted from sd using Education Endowment Foundation, 'The EEF's Months of Additional Progress Measure'; The value of higher GCSE attainment is drawn from calculations in Van den Brande and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students'.

These results are very similar to those from a US study on pupils from grade 3 to grade 8, which found an effect size of 0.11sd.[16] Relative to other interventions, these effect sizes are higher than those often reported for providing CPD to teachers and roughly similar to having an experienced teacher instead of a new graduate.[17] Compared to interventions in the EEF Teaching and Learning Toolkit, it is similar in effect size to implementing mentoring of pupils but less effective than introducing small-group tuition.[18]

The obvious question is how long it takes to realise these improvements in pupil performance and over what period the improvements are observed. Unfortunately, our identification strategy makes this difficult to estimate. The results we report in Table 3 average a headteacher's impact, relative to their peers, across all schools they have led and across all years they have led those schools. It may be that they have an initial impact that is far lower and an eventual impact that is far greater, or vice versa.

To investigate whether that is the case, rows 2 and 3 report effect sizes for the first three years of a headteacher's tenure at their schools and for all but the first three years, respectively. They show that effect sizes are consistently greater in the later years of a headteacher's tenure than in the earlier years. That suggests the impact of a headteacher may grow over time and eventually be significantly greater than the 1-2 months of progress reported in the first row. The difference appears greater in secondary schools.

Proportion of progress explained by the choice of headteacher

To understand the importance of the headteacher relative to other elements of the school, we partition the variance in the model between the elements in Figure 1. Table 4 shows the proportion of the difference in pupil progress that is explained by each element. For example, the top left cell shows that 5.7 per cent of the difference in pupil progress can be explained by differences between headteachers at primary schools. For secondary schools, differences between headteachers explain 7.6 per cent of the differences in pupil progress.

Table 4: Partitioning the variance in pupil progress

Proportion of variance explained by differences between…	Primary schools	Secondary schools
Headteachers	5.7%	7.6%
School clusters	79.5%	81.4%
Policy changes	0.1%	0.6%

The table does not include pupil context because that is already accounted for in our outcome measures. The absence of pupil context from this partitioning also accounts for the high contribution of the school clusters. A typical partition of the variance in a multilevel model of pupil progress finds a contribution of about 8% for schools.[19] Our outcome measure is pupil progress – the result of a

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[16] US results come from Branch et al. There are two main methodological differences between our approach and theirs. First, they look at differences within schools, while we look at differences within groups of schools; second, they estimate the impact of headteachers on individual pupil attainment while we estimate the impact on school performance. We also estimate the impact separately for primary and secondary school pupils, while Branch et al estimate the impact of headteachers on pupils from grade 3 to grade 8.

[17] Van den Brande and Zuccollo, 'The Effects of High-Quality Professional Development on Teachers and Students'; Papay and Kraft, 'Productivity Returns to Experience in the Teacher Labor Market'.

[18] 'Teaching and Learning Toolkit'.

[19] Evans, *Value-Added in English Schools*.

contextual value-added model – so this result essentially finds that headteachers are responsible for about 5-8 per cent of the differences within the school component of the CVA model.

Headteacher fit

The main results assume that a headteacher performs equally well at all schools, but that may not be the case. To check for evidence of a 'matching' effect, where headteachers are more effective at some schools than others, we fitted a model that allowed headteachers' effectiveness to differ across the schools they have led. If matching is important then we would expect this model to better fit the observed data. Table 5 compares the fit of our original model (row 1 of Table 3) and a near-identical model that allows headteachers' effectiveness to vary across schools. The adjusted R^2 we report shows how well the model fits the data, with a number close to zero being a poor fit and a number close to one being a near perfect fit.

Table 5: Allowing matching did not improve the fit of the model

School phase	Model fit – no matching	Model fit – with matching
Primary	0.38	0.19
Secondary	0.66	0.41

Note: The statistic reported is the adjusted R2 of the model. In the matching model, headteacher-by-school fixed effects are included, whereas the no-matching model has only constant, independent, headteacher and school fixed effects.

In both primary and secondary schools the adjusted R^2 is lower when we allow headteacher effects to vary between schools, which means that there is no evidence here that headteacher's effectiveness varies between the schools they lead. However, that is not strong evidence that matching a headteacher to the 'right' school is unimportant. It could equally be that the fit of a headteacher and school is important but that neither party is able to tell whether the fit will be good during the hiring process. What it does suggest is that, if there are gains from getting the fit right – which seems plausible – then, on average, schools in England are not yet reaping the benefits.

Finally, the lack of evidence for a matching effect also serves as a robustness check on our main estimates. The main approach decomposes school outcomes into a headteacher and a school component, which is reasonable only if these two quantities can be treated as separable. That we do not find evidence of individual headteacher effects varying across different schools suggests that this separation is possible.

Possible mechanisms

We now examine the potential mechanisms through which headteachers affect attainment. The main route headteachers affect pupils is thought to be through their influence on teachers, either by improving their skills or their motivation.[20] We test whether headteachers who are effective at improving attainment also tend to reduce teacher turnover and teacher absences, proxies for motivation.

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[20] eg Bloom et al., 'Does Management Matter in Schools?'; Bryson, Stokes, and Wilkinson, 'Can HRM Improve Schools' Performance?'

Teacher turnover

Figure 2 shows the relationship between headteacher effectiveness and headteacher impact on the annual and four-year cumulative turnover of teachers. The x-axis of the chart represents percentiles of headteacher effectiveness. The y-axis represents the impact headteachers have on turnover, measured as a standardised effect size. Each point illustrates the average impact headteachers in each percentile have on either annual turnover or four-year cumulative turnover. For example, a positive effect size of 0.05sd means that the headteachers in that percentile of effectiveness increase the turnover rate by 0.05sd relative to the average headteacher. In primary schools, 0.05sd translates to about a 0.5 percentage point change in the one-year turnover rate.

Figure 2: Schools with less effective headteachers have higher turnover
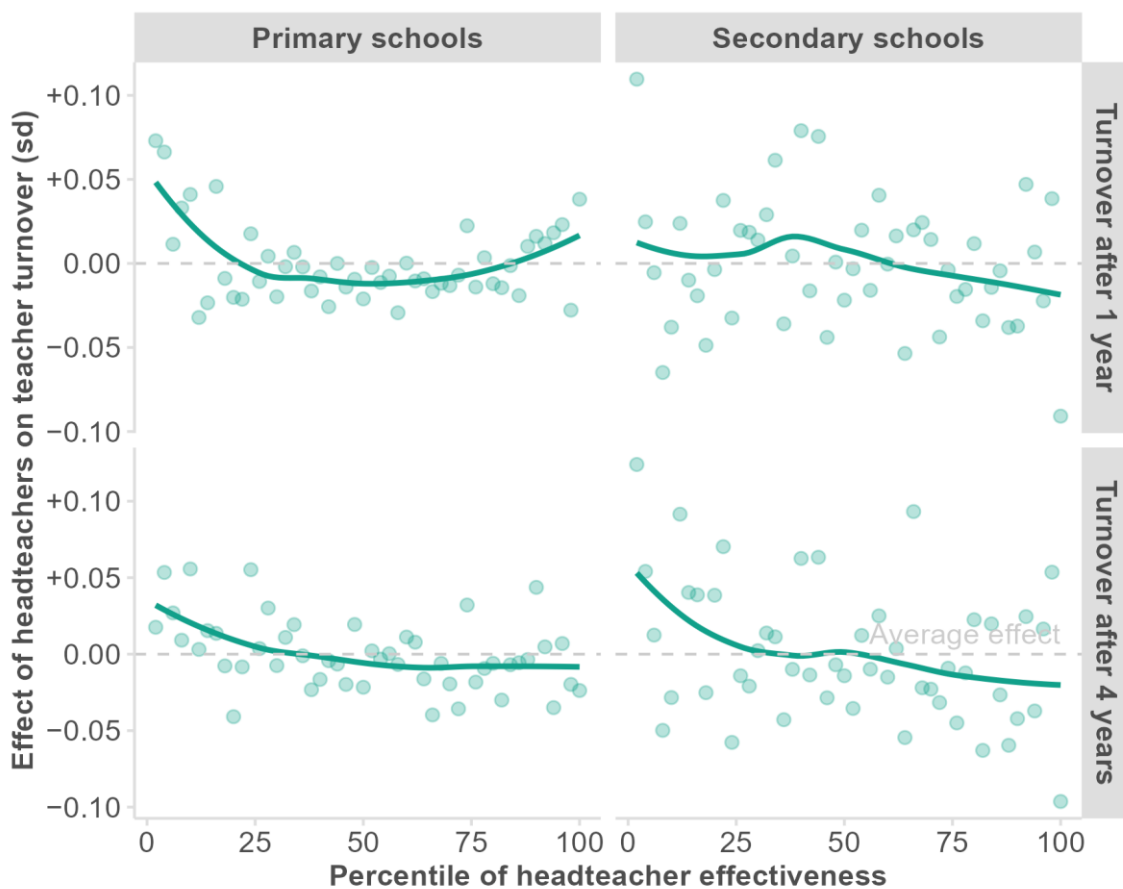
Note: Headteacher impact on turnover is measured using the same method used to calculate effectiveness at improving attainment, but with turnover as the outcome variable. Turnover is measured as the proportion of teachers that leave the school. Each point is the average headteacher impact on the turnover rate of schools with headteachers at a given percentile of headteacher effectiveness. The outcome is standardised and centred. Fit line estimated with loess.

We find that headteachers who are less effective tend to increase annual teacher turnover in their schools, though the effect size is far smaller than the effect on pupil progress. In primary schools, moving from a headteacher that is less effective at improving attainment (16th percentile) to an average headteacher (50th percentile) is associated with a 0.02sd reduction in teacher turnover. In secondary schools, the effect is 0.03sd.[21] Both charts also show a negative slope in the lower percentiles of

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[21] See Table 6 in Appendix B for regression results.

headteacher effectiveness but, perhaps surprisingly, the most-effective primary headteachers also increase annual turnover of their teaching workforce.

Headteachers who are less effective at increasing pupil attainment are also less effective at reducing four-year cumulative turnover both in primary and secondary schools. In secondary schools, moving from a less-effective headteacher to an average headteacher is associated with a 0.06sd reduction in cumulative turnover and in primary schools with a 0.03sd reduction. Again, both charts exhibit negative slopes in the bottom percentiles of headteacher effectiveness.

Teacher absenteeism

Figure 3 shows the relationship between headteachers' effectiveness and the number of days teachers are absent. The interpretation of the chart as an effect size centred on the national average is the same as in Figure 2.

Figure 3. Teacher absences are greater at secondary schools with less effective headteachers
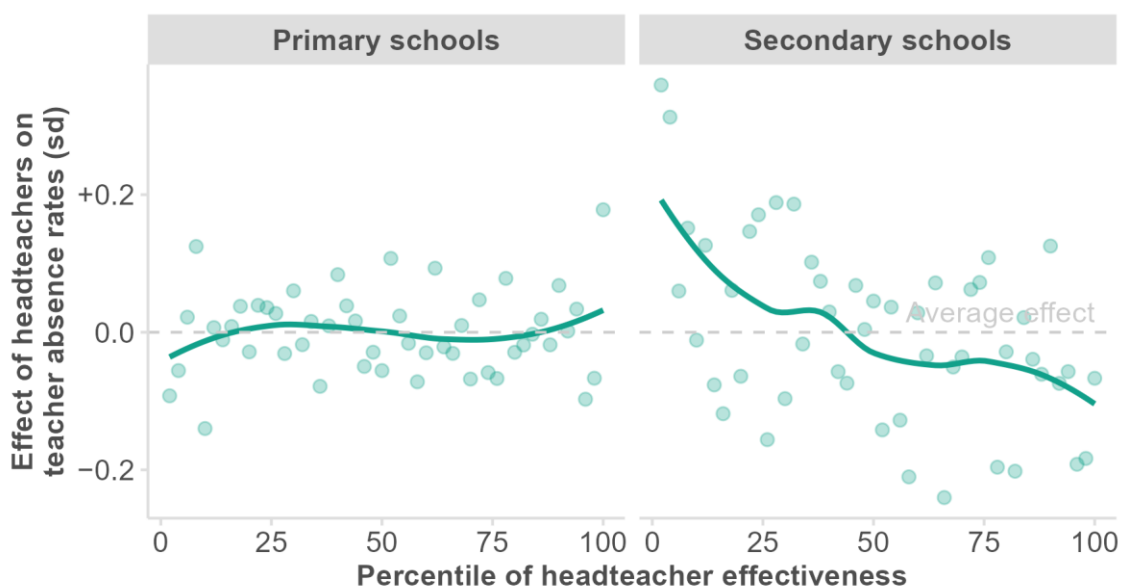
Note: Headteacher impact on absence rates is measured using the same method used to calculate effectiveness at improving attainment, but with teacher absence rates as the outcome variable. Absence is measured as the proportion of working days missed through absence each year. Each point is the average headteacher impact on the absence rate of schools with headteachers at a given percentile of headteacher effectiveness. The outcome is standardised and centred. Fit line estimated with loess

Effective headteachers appear to markedly reduce teacher absenteeism in secondary schools. Moving from a less effective headteacher to an average headteacher is associated with a 0.06sd reduction in the number of absences in secondary schools, which is an average of 10.7 days of absence.

Surprisingly, the effect is not replicated in primary schools, where no consistent effect is detectable.

School performance and headteacher effectiveness

We have shown above that effective headteachers have a substantial impact on school performance. In this section we explore the extent to which high-performing schools are likely to hire effective headteachers, which might explain part of their academic success. Figure 4 displays the relation between pupil progress and headteacher effectiveness. As can be seen in the chart, high-performance primary and secondary schools hire the most effective headteachers. The relation between school performance and teacher effectiveness seems to be significantly sharper in the lower effectiveness

percentiles. For secondary schools, the schools with the highest performance appear to hire the very best headteachers.

Figure 4: Schools with low average attainment hire less effective headteachers
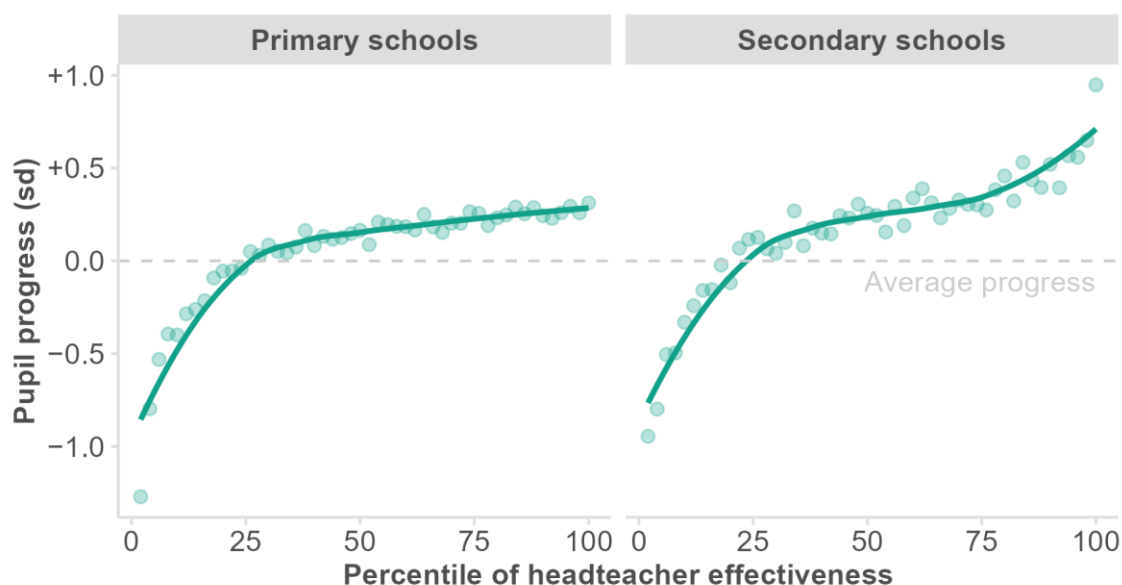
Note: Pupil progress scores are centred on zero. Each point is the average headteacher impact on school attainment at a given percentile of headteacher effectiveness. Fit line estimated with loess.

Differences across school characteristics

Figure 5 describes differences in headteacher effectiveness between schools with different levels of disadvantage and between different governance structures (local authority maintained schools and academies). The chart should, again, be interpreted as a standardised effect size centred around the average of all headteachers.

Notably, the differences we find here are extremely small, only about a tenth of the size of the effect on turnover, for example.

In primary schools, more-effective headteachers are slightly more present in less-affluent schools. Although the difference between the first and fifth FSM quintiles is statistically significant, it is only 0.005sd in size, which translates to less than a single month of additional progress and is too small to be materially relevant.

In secondary schools more-effective headteachers are marginally more prevalent in more-affluent schools. Although greater than the difference in primary schools, and also statistically significant, the difference is still negligible at only about 0.01sd, 1/10 of a GCSE grade, and less than one month of additional progress.

The differences in the average effectiveness of headteachers between local authority-maintained and academy schools are, again, immaterial. Overall, effectiveness varies little by school characteristics.

Figure 5. Effectiveness varies little by school characteristics
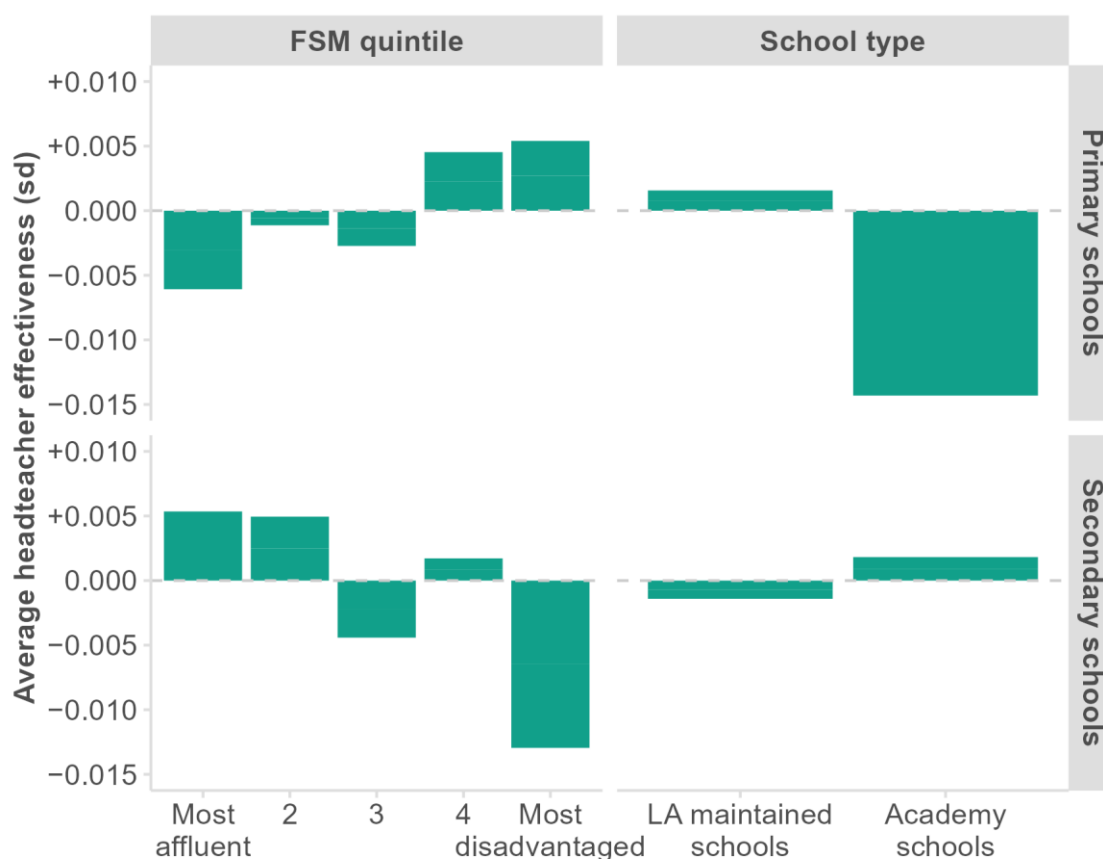
Note: Headteacher effectiveness is the centred mean headteacher effectiveness, averaged over the named group.
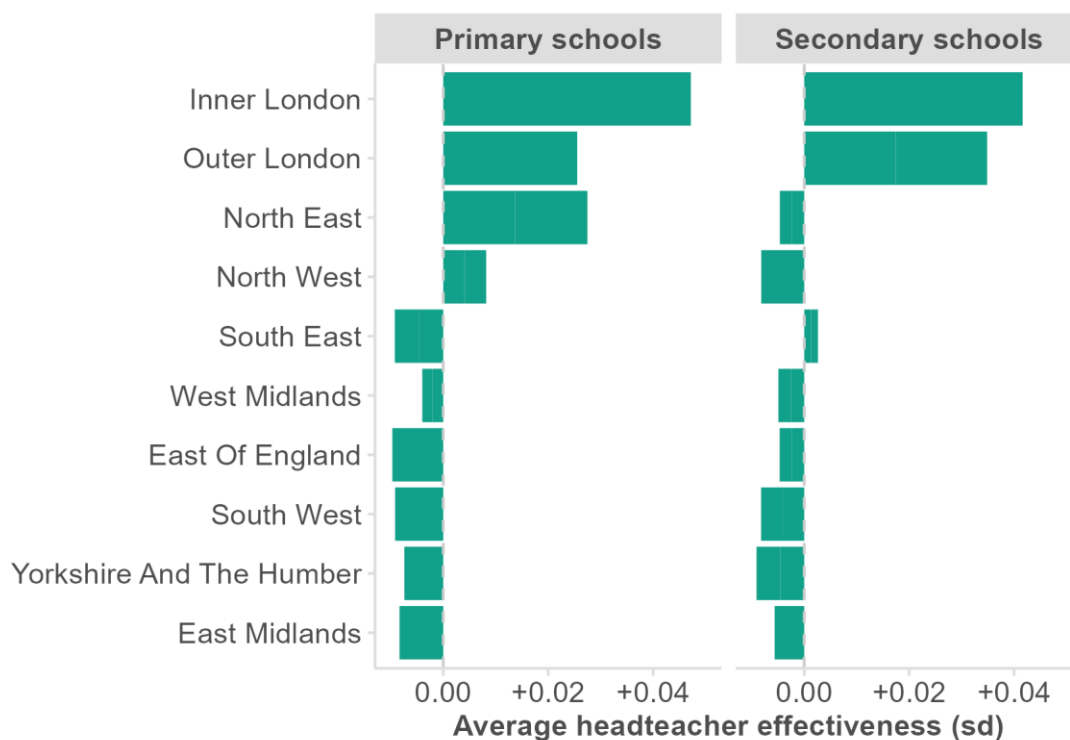
Differences across regions

Figure 6 illustrates the variation in headteacher effectiveness across regions. Inner and Outer London have more-effective headteachers in both primary and secondary schools compared to other regions, where headteacher quality is more evenly distributed. In London primary schools, headteachers improve student attainment by about 0.05sd more than the average headteacher. The North East also appears to have slightly more-effective primary headteachers, though that effect is not replicated in secondary schools.

In secondary schools, London headteachers contribute about 0.05sd more than the regions with the lowest average quality, which is equivalent to 2/3 of a GCSE grade and 1 additional month of progress. That amounts to £5,500 of additional lifetime earnings per student and an additional £5.5m of NPV. These differences are statistically significant.

The fact that headteacher effectiveness is evenly spread outside London suggests that differences in average headteacher quality do not explain the observed regional differences in student progress.

Figure 6. Headteachers' effectiveness is greatest in London

Note: Headteacher effectiveness is the centred, mean headteacher effectiveness averaged over the named region.

It is important to note that these differences across regions are not causal estimates of the effect of the region on the effectiveness of headteachers, only the observed average effectiveness in each region. The approach we have used to estimate effectiveness separates the persistent effect of the headteacher from the persistent effect of the school cluster. However, it is possible there are features of the region that influence the effectiveness of the headteacher and are not captured by the clustering. In that case, it could be that some headteachers are more effective because they are in London, rather than London attracting more effective headteachers.

Differences across headteacher characteristics

The charts in Figure 7 show how headteachers' pay varies with their effectiveness. Table 7 in Appendix B includes regression coefficients for the raw data.

Figure 7: Effective headteachers earn more
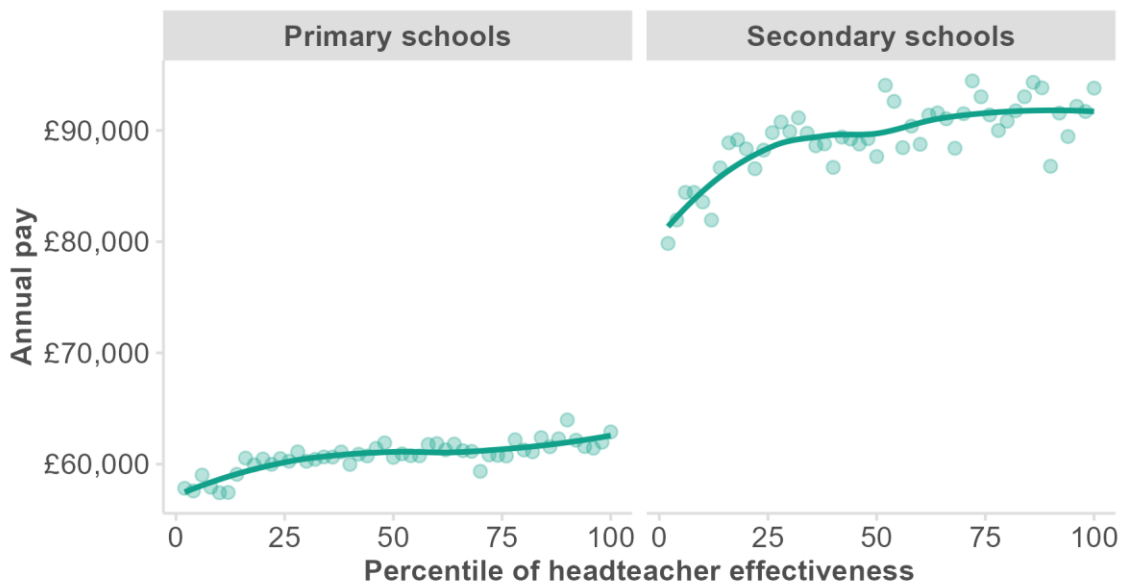
Note: Annual pay is total pay, excluding retirement benefits, averaged across a headteacher's time in the sample.

The positive slopes in both panes indicate that more-effective headteachers earn more, which is supported by the regression results. For instance, in primary schools, a median headteacher earns around £2,000 more per year than a less-effective one, whose annual salary is around £59,000. Similarly, in secondary schools, a less-effective headteacher has an average salary of £86,500 per year while a median headteacher earns on average £89,500. However, compared to the impact that an effective headteacher has on pupils' lifetime earnings (an extra £8,000 per student in secondary schools), the pay difference is relatively small.

However, it should be noted that these are unadjusted correlations. For example, more effective headteachers are more likely to be found in London schools, where national pay scales are higher, which may account for some of the difference.

Figure 8 shows how headteachers' effectiveness varies with their experience as a headteacher and their tenure in a particular school. Each point is the average headteacher effectiveness for each year of experience or tenure. Table 7 in Appendix B shows linear regression coefficients for the effect of experience and tenure on headteachers' effectiveness.
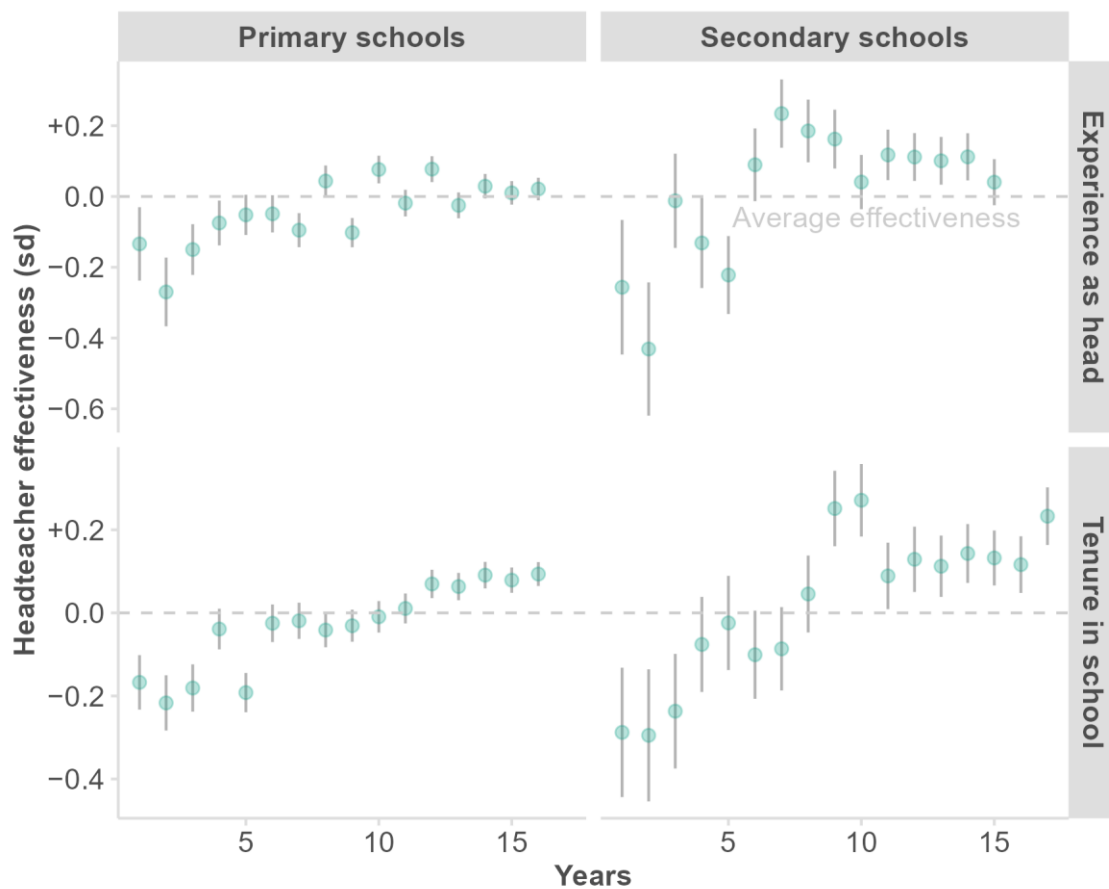
**Figure 8: Effectiveness varies by headteachers' experience and tenure**

Note: Headteacher effectiveness is the centred, mean headteacher effectiveness. Experience is the number of years a headteacher has served as a head. Tenure is the number of years they have served in a single school. Ranges show 95% Cis.

In both primary and secondary schools, more-effective headteachers have more years of experience as headteachers and have more experience as headteachers in their current school. Figure 8 illustrates this with positive slopes, which is supported by linear regression coefficients. For both primary and secondary schools, having five more years of experience is associated with an increase of 0.1sd in headteacher effectiveness. This equates to an extra two months of progress for primary and secondary school students, or an increase of 1.25 GCSE grades for secondary school students. In value, this translates into £10,000 additional lifetime earnings for each secondary school pupil and an additional £10m of NPV.

Experience as a headteacher in the same school is as important as experience as a headteacher in any school for primary schools and slightly more important than experience as a headteacher in any school for secondary schools. For instance, our regressions suggest that five more years in the same school is associated with a 0.1sd increase in average effectiveness in primary schools, which is equivalent to two months of additional progress. For secondary schools, it is associated with a 0.15sd increase in progress, which is an increase of a grade in two GCSEs and two additional months of progress. This is comparable to the effects of pupils having a more-experienced teacher: having a teacher with five years of experience, as opposed to a newly-qualified teacher, is associated with an attainment increase of approximately 0.09sd.[22]

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[22] Papay and Kraft, 'Productivity Returns to Experience in the Teacher Labor Market'.

Figure 9: Effective headteachers achieve better Ofsted gradings for secondary schools, but the effect is small
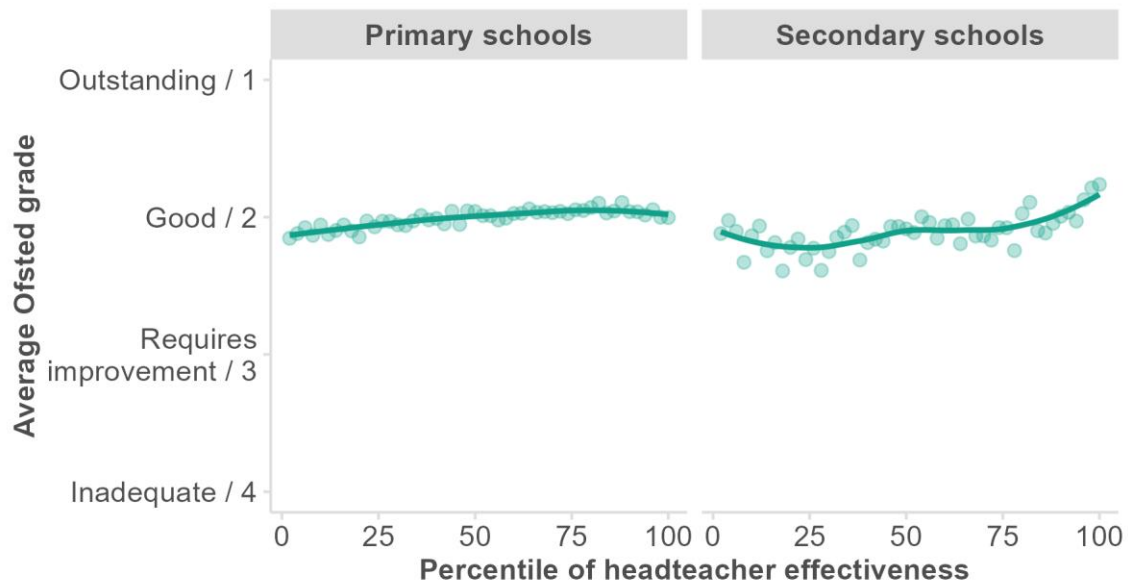
Note: Ofsted grade is the average overall inspection grade of the school in the first three years of the head's tenure, averaged for each two-percentile band of headteacher effectiveness.

Figure 9 shows how the Ofsted grade given to a school in the first three years of a headteacher's tenure relates to their estimated effectiveness. The x-axis represents the different percentiles of headteacher effectiveness and each point represents the average Ofsted grade for that percentile.

Our analysis results show that better headteachers achieve better Ofsted grades in both primary and secondary schools, and these effects are statistically significant. However, after controlling for school attainment, these results only show a weak significance for primary schools and no significance for secondary schools (see Table 8 in Appendix B for the average attainment of schools that receive each Ofsted rating).

Influence of ethnicity and gender

To explore how the characteristics of headteachers shape the composition and outcomes of different ethnic and gender groups, we investigate multiple combinations of headteachers, pupils and staff of different groups. We examine the effect of having a headteacher of each gender on the gender composition of pupils in schools, the relative attainment of pupils of each gender, the annual turnover and the four-year cumulative turnover of each gender. We also examine the effect of having a headteacher of a specific ethnicity on the ethnic composition of pupils in schools, the relative attainment of pupils of each ethnic group, and the annual and four-year cumulative turnover of each ethnic group, relative to other ethnic groups.

In total, we tested 264 hypotheses to see if there were any significant relationships between these factors. However, when testing for multiple hypotheses simultaneously, it is possible to find some results that are just due to random chance, but do not reflect underlying relationships. In our case, we only found significant results for five out of the 264 hypotheses we tested. The likelihood of these results being due to chance is over 99 per cent. Therefore, we should be cautious about interpreting these results, and more information on our testing calculations can be found in Appendix A.

Implications

Improving leadership may be a cost-effective route to school improvement

These results show that the influence headteachers have on school performance is significant: equivalent to the effect of improving teacher quality through high-quality professional development or hiring more experienced teachers. This is because while teachers only affect their own students, headteachers have a broad impact on all students within the school.

In addition to raising pupils' educational attainment, effective headteachers also reduce staff turnover and absenteeism, which suggests that they may be improving the morale and well-being of their teachers. This finding is particularly relevant given the current challenges faced by the teaching profession in attracting and retaining qualified staff and underscores the importance of leadership quality as a critical element of the Department for Education's workforce strategy.

Our findings suggest that enhancing the quality of school leadership may be an effective means of improving school performance, provided that an effective approach to enhancing it can be identified. Although leadership improvement programmes already exist, our work underscores the need to evaluate their impact and ensure that they are effective, given the high potential payoff for good leadership development.

Retaining effective headteachers requires more focus

Headteachers' effectiveness increases with their experience as a headteacher and the time they spend as a headteacher at a particular school. These gains from experience are similar in magnitude to those reported for teachers. School governors and Ofsted inspectors should acknowledge that it may take years to realise the full improvement in results following a change in the headteacher of a school and support new headteachers accordingly.

That also implies the cost of losing experienced and effective headteachers from the profession is high. Much of the focus of retention policy in recent years has been on early career teachers but the pressure on school leaders through the pandemic means that they may now be at greater risk of leaving the profession early. A greater focus on supporting them to remain in post may pay off in both better results for pupils and better retention for the teachers in their schools.

Reallocation of effective headteachers may help reduce inequalities in attainment in England

Our results reveal that highly effective headteachers are fairly evenly distributed between academies and local authority maintained schools, as well as schools with different proportions of free school meal (FSM) pupils. This means that high-quality headteachers do not appear to be concentrated in more affluent schools, but nor do they appear to be concentrated in the challenging schools where they might make the most difference. However, there appears to be a concentration of highly effective headteachers in London, where pupil attainment is already relatively high.

It would be worth considering whether policies to encourage effective headteachers to move to the schools where they are most needed could help reduce the gap in attainment between disadvantaged and more affluent children. The government already provides financial incentives for early-career teachers to work in challenging schools through the levelling up premium payments, but it may be that encouraging school leaders to make those choices could have a greater impact. On the other hand,

school leaders are likely to be less responsive than early-career teachers to small financial incentives, so any scheme would require careful consideration.

There are also options for groups of schools, including MATs and LAs, to consider how they might actively allocate headteachers within their group to achieve their goals. One to five per cent of headteachers working in a school group move to a different school within the same school group each year.[23] School groups could evaluate the potential impact of these movements based on the headteachers' effectiveness and might want to encourage their most effective school leaders to move to challenging areas where they are most needed.

Any reallocation would deprive another school of the benefit of that effective headteacher. However, although not analysed in this report, it is possible that disadvantaged pupils benefit more from having a high quality headteacher, as is the case for teachers.[24] If this is true, a reallocation of effective headteachers to more disadvantaged schools would not only raise the attainment of this group but also the average attainment of the whole education system.

Headteachers' gender or ethnicity does not appear to influence pupils' results or staff turnover

Finally, we find no evidence that pupils from certain genders or ethnicities benefit more from headteachers from the same gender or ethnic group. Additionally, we did not find headteachers' characteristics to influence the ethnicity and gender of their schools' workforces. However, these are the results most affected by small sample sizes in our study, so it is possible that the reason we failed to detect meaningful effects is because the true effect exists but is small.[25]

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[23] E.g., Andrews, 'Teacher Recruitment, Progression and Retention in Multi-Academy Trusts'.
[24] E.g., Konstantopoulos and Chung, 'Teacher Effects on Minority and Disadvantaged Students' Grade 4 Achievement'; Konstantopoulos, 'Effects of Teachers on Minority and Disadvantaged Students' Achievement in the Early Grades'.
[25] Gong, Lu, and Song, 'The Effect of Teacher Gender on Students' Academic and Noncognitive Outcomes'; Lusher, Campbell, and Carrell, 'TAs like Me'.

Appendix A: Modelling approach

Influence on pupil attainment

General approach

The aim is to identify the contribution of headteachers to changes in school performance. The difficulty is that headteachers are not randomly distributed across schools. For example, schools with a poor Ofsted rating may struggle to attract high-performing headteachers, who fear for their reputations. If weaker headteachers systematically end up at schools with low attainment, then the apparent effect of headteachers on their schools will be exaggerated. Similarly, changes to policies at the level LAs or MATs might cause schools to hire headteachers with certain characteristics.

To overcome this selection problem, we exploit headteachers' moves between schools to separate the effect of the headteacher from the persistent effect of the school's circumstances.[26] Since the SWC allows headteachers to be tracked over time, we can observe the outcomes for a school across multiple headteachers and the outcomes for a headteacher across multiple schools. This allows us to separately identify school fixed effects and headteacher fixed effects, or individual characteristics.

This approach follows the 'AKM Model':[27]

$$\text{School performance}_{sht} = \text{Headteacher}_h + \text{Group}_s + \text{Time}_t + \varepsilon_{sht} \quad (1)$$

where $\text{School performance}_{sht}$ is performance of school s led by headteacher h at time t, Headteacher_h is a vector of headteacher fixed effects, Group_s is a vector of school fixed effects and Time_t is a vector of time fixed effects. With this model we can decompose the observed outcome of a school into parts due to time-invariant school characteristics, headteacher characteristics, common time trends and a purely random component.

Headteacher effects, just as the effects of any categorial variable, are only identified relative to an omitted category, in this case an arbitrarily chosen headteacher. As effects are standardised with mean zero and a standard deviation of one, it does not matter which headteacher serves as the base category. However, to be interpretable all estimated headteacher effects need to use the same base category, which means that headteacher and school effects are only identified within a sample of schools that are connected by headteacher mobility.[28]

Our approach differs from the one used by Branch et al because headteachers in England move in small networks. We adopt a strategy similar to the group fixed effects approach.[29] This approach models school-level heterogeneity at the level of groups of similar instead of individual schools. To do so we group schools into clusters (using k-means clustering) according to the following characteristics:

- School performance, measured by CVA (details below).
- Percentage of FSM eligible pupils.
- Percentage of male pupils.

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[26] Branch, Hanushek, and Rivkin, 'Estimating the Effect of Leaders on Public Sector Productivity', February 2012.

[27] Abowd, Kramarz, and Margolis, 'High Wage Workers and High Wage Firms'.

[28] Abowd, Kramarz, and Margolis.

[29] Adopted recently by Dauth et al., 'Matching in Cities' and developed as a strategy in; Bonhomme, Lamadon, and Manresa, 'Discretizing Unobserved Heterogeneity'; Bonhomme, Lamadon, and Manresa, 'A Distributional Framework for Matched Employer Employee Data'.

We then include effects for groups of schools instead of the individual school effects. Exploring moves within the largest connected group of clusters allows us to identify the headteacher effect. The main output of this core model will be an estimate of the within-group effect that a headteacher has upon a school's performance. We will assume that each individual teacher will have the same effect across schools.

Measuring school performance

To estimate school performance, we run a multilevel model to compute the contextual value added (CVA) for each school in each year.[30] For secondary schools, we computed the mean of English and maths Key Stage 4 (KS4) scores for each pupil and regressed it on the following variables:

- Prior attainment (KS2 maths and English scores).
- Income Deprivation Affecting Children Index (IDACI) scores.
- Eligibility for FSM.
- Gender.
- Ethnicity.
- Whether the pupil has English as an additional language.
- Interactions between the variables above.

For primary schools, we computed the mean score of maths and English at the end of KS2 for each pupil and regressed it on all the variables mentioned above except for prior attainment, as there is no consistent measure across years.

We estimate headteacher fixed effects and derive the variance and the mean (which are informative about variation in headteacher "quality" in England).

To explore whether headteachers and schools consider the fit between headteacher skills and schools' needs in their recruitment process we then allow the effect of an individual headteacher to vary across schools.[31] We employ the following specification:

$$\text{School performance}_{sht} = \text{Headteacher}_{hs} + \text{Group}_s + \text{Time}_t + \varepsilon_{sht} \quad (2)$$

where Headteacher_{hs} is a vector of time-invariant headteacher-by-school fixed effects.

Econometric issues

Our estimation strategy is closely related to one commonly used in labour economics to study the relationship between workers' and firms' characteristics, and wages.[32] Separating headteacher and school effects requires us to observe headteachers moving between schools as well as some assumption regarding the reasons for these moves. Importantly, we do not require that headteachers move between schools randomly or that headteachers are allocated to schools in a way that is independent of their respective characteristics.

Random movement by headteachers would be sufficient to identify a causal effect; however, it is by no means necessary. For example, any factor causing headteachers to move that is constant over time does not bias our estimates because our estimating equation conditions on fixed headteacher and school characteristics and thus controls for biases arising from these confounding factors. For example, some

[30] Following the approach of Evans, *Value-Added in English Schools*.
[31] Following Coelli and Green, 'Leadership Effects'.
[32] e.g. Abowd, Kramarz, and Margolis, 'High Wage Workers and High Wage Firms'; Card, Heining, and Kline, 'Workplace Heterogeneity and the Rise of West German Wage Inequality*'; Card, Cardoso, and Kline, 'Bargaining, Sorting, and the Gender Wage Gap'.

headteachers may be more or less transient, some governing bodies may be more or less active in switching headteachers, and some schools may have a higher- or lower-attaining intake, but none of these will bias our estimates if they are constant over the period of observation. Similarly, if more able headteachers have more options and consequently move more often, or if certain schools are more attractive to headteachers, our estimates will remain unbiased. Two papers clarify which reasons for moving would prove troublesome for the estimates:[33]

- School-level shocks to ε_{sht} at either the new or old school causing headteachers to move schools.
- Unobserved shocks at the headteacher level driving headteacher/teacher mobility. For example, changing headteacher may affect the school's performance due to a "changing of the guard" or Ashenfelter's dip effect rather than through the influence of the headteacher themselves - this would imply that school outcomes are better in the years following the change of a headteacher for reasons unrelated to characteristics of the head. Another possibility would be unobserved shocks at the individual level that trigger the arrival or departure of a new headteacher (say, a headteacher being forced to leave a prestigious school following unobserved disciplinary proceedings).
- Moves based on the compatibility of a specific school and headteacher (e.g., a match-specific effect as implied by some search models) would also lead to biases. Our main approach treats headteacher effects and school effects as separate, which implies that an effective headteacher will bring improvements to every school they lead. If match effects were important, it implies that it would not make sense to think of school and headteacher effects as separate entities as they would strongly interact - there would be no "good" headteacher and "good" schools, just "good" headteacher-school combinations.

We test for the importance of match-specific factors by comparing our baseline model to a model that replaces the headteacher and school effects with a combined match effect (a dummy variable for each headteacher-school combination). If match-efficiency matters this should lead to statistical improvements in model fit. We explore whether the adjusted R^2 changes from a model to the other.

Possible mechanisms

We start by estimating specification (1) on the following dependent variables:

- Annual teacher turnover.
- Cumulative four-year teacher turnover.
- Number of days a teacher has been absent.

As there are several missing values for teacher turnover, we estimate the headteacher effects on all variables above, as well as headteacher effects on CVA, in a slightly smaller sample so that we can draw meaningful comparisons. We then standardise headteacher effects by subtracting the mean and dividing by the standard deviation within that smaller dataset.

Figures are binned scatterplots in which we group headteacher effects on CVA into 50 equally sized bins and compute the average headteacher effects on the three outcomes above. We also compute linear regressions between standardised headteacher effects on CVA and standardised headteacher effects on the three outcomes above and present coefficients and standard deviations.

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[33] Card, Heining, and Kline, 'Workplace Heterogeneity and the Rise of West German Wage Inequality*'; Card, Cardoso, and Kline, 'Bargaining, Sorting, and the Gender Wage Gap'.

Differences across school characteristics

To examine the differences in the mean of the headteacher effects across school characteristics, we use the full headteacher by year dataset. To assess if differences in means across groups are statistically significant, we employ a t-test.

Differences across headteacher characteristics

We use our sample of one observation per headteacher and again present binned scatterplots, dividing the headteacher effects on CVA into 50 equally sized bins and averaging different characteristics in each bin. We also present linear regression estimates. For tenure and experience we use only a sample from 2017 to 2019 to ensure we have the widest distribution possible. We are only able to observe tenure and experience once we see a headteacher join a school, so, for example, in the second year of the dataset we observe only headteachers with one year of experience and tenure. By limiting the sample to the final few years of the dataset, we can observe headteachers with between 1- and 15-years' experience.

Influence on pupil and staff composition

We investigate the role of headteacher characteristics on the composition of a school's workforce and student body. The identification strategy in this step is conceptually similar to the one used in the first part of the project: focus on cases where headteachers switching schools allows us to separate the effects of headteacher characteristics from general school characteristics. Our two-way fixed effects model is:

$$\text{Student body}_{st} = \beta \text{Headteacher is gender/ethnicity}_{hst} + \text{School}_s + \text{Time}_t + \varepsilon_{st} \quad (4)$$

$$\text{School workforce}_{st} = \beta \text{Headteacher is gender/ethnicity}_{hst} + \text{School}_s + \text{Time}_t + \varepsilon_{st} (5)$$

where Student body_{st} and $\text{School workforce}_{st}$ are the outcomes of interest (for students or teachers) of school s at time t and $\text{Headteacher is gender/ethnicity}_{hst}$ is an indicator variable that takes the value of 1 if headteacher h is female or belongs to a certain ethnicity and 0 otherwise. Again, we control for both period specific and school specific shocks.

We are interested in combinations between headteachers and pupils/staff from belonging to the following five ethnic groups:

- White.
- Black.
- Asian.
- Mixed.
- Other.

Under the assumption that schools evolve in a similar way across time, we are then able to isolate the effects of headteachers characteristics by comparing schools exposed to those characteristics (we will call these "treated schools") and those not exposed. This is essentially a difference-in-differences (DID) approach, which is a common quasi-experimental tool in the education literature. Here however, we have multiple periods instead of two as well as varying treatment timing, i.e. the time that different schools are exposed to different headteacher characteristics varies.

A series of recent papers have shown that under these circumstances estimating difference-in-differences by Ordinary Least Squares (OLS)/two-way fixed effects regressions can suffer from a range of

econometric issues.[34] To briefly sketch the underlying problems, it can be shown that β in the equations above is a weighted average of the treatment effects estimated by all possible two group, two period differences-in-differences that can be formed from the data. Some of these comparisons involve using already treated units as controls for later-treated units, which can lead to problems in the presence of time-varying and heterogeneous treatment effects, in extreme cases leading to an estimate for β that is of opposite sign to all underpinning treatment effects.

In addition, OLS places higher weights on units treated towards the middle of the sampling period. We use the "did" package in R to follow Callaway and Sant'Anna's paper and estimate a difference-in-difference with multiple time periods. Conceptually, this approach estimates separate group-time fixed effects, where a "group" are units at the same time. These can then be aggregated into, for example, an aggregate average treatment effect on the treated or event studies that compare dynamic treatment effects for several periods before and after treatment.

Looking at the effects of exposure of headteachers of different genders and ethnicities on the composition and attainment of pupils of different genders and ethnicities, and on annual and three-year cumulative turnover of staff of different genders and ethnicities leads us to a total of 264 tests. With this number of tests and a significance level (alpha) of 0.05, the probability of rejecting the null hypothesis (that headteachers have no effect) at least five times, from a Poisson distribution, is 99 per cent.

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[34] de Chaisemartin and D'Haultfœuille, 'Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects'; Borusyak, Jaravel, and Spiess, 'Revisiting Event Study Designs'; Callaway and Sant'Anna, 'Difference-in-Differences with Multiple Time Periods'; Goodman-Bacon, 'Difference-in-Differences with Variation in Treatment Timing'.

Appendix B: Regression tables

Table 6: Linear regressions between headteacher effectiveness in improving pupil attainment and effect of headteacher on turnover and absenteeism

Primary				
	Estimate	**SE**	**P-value**	**Obs**
Turnover 1	-0.003692 (-0.01564)	0.001805 (0.007752)	0.0409 * (0.0437 *)	17,796
Turnover 3	0.009327 (-0.02604)	0.003451 (0.009108)	0.00689 ** (0.00425 **)	15,186
Absenteeism	-0.1922 (3.54E-04)	0.4322 (7.53E-03)	0.657 (0.963)	18,052
Secondary				
	Estimate	**SE**	**P-value**	**Obs**
Turnover 1	-0.010658 (-3.06E-02)	0.004429 (1.58E-02)	0.0161 * (0.0534)	3,997
Turnover 3	-0.018638 (-6.43E-02)	0.005548 (1.58E-02)	0.000789 *** (4.71e-05 ***)	3,997
Absenteeism	-10.639 (-0.06454)	2.58 (0.016196)	3.81e-05 *** (6.88e-05 ***)	3,911

Notes: This table represents linear regression estimates. Standardised values are in brackets. Dependent variables are in each row and represent headteacher impact on annual teacher turnover (Turnover 1), on four-year teacher cumulative turnover (Turnover 3) and on teacher absences (Absenteeism). The independent variable for each regression is headteacher effectiveness. SE represents the "standard error" of the estimate, and "Obs" represents the number of observations.

Table 7: Linear regressions between headteacher effectiveness and headteacher or school characteristics

Primary				
	Estimate	**SE**	**P-value**	**Obs**
Average age	0.00485	0.000953	3.63e-07 ***	18,747
Average pay (dependent variable)	60719.2	103.6	<2e-16 ***	18,453
Average experience	1.64E-02	3.40E-03	1.53e-06 ***	5,376
Average tenure	2.13E-02	3.09E-03	6.03e-12 ***	6,066
Average Ofsted rating	1.29E-01	1.29E-02	<2e-16 ***	19,173
Secondary				
	Estimate	**SE**	**P-value**	**Obs**
Average age	4.95E-03	2.01E-03	0.014 *	4,697
Average pay (dependent variable)	2.34E+03	2.88E+02	5.41e-16 ***	4,684
Average experience	0.02293	0.006255	0.000255 ***	1,500
Average tenure	0.03061	0.00622	9.53e-07 ***	1,589
Average Ofsted rating	0.13017	0.02186	2.83e-09 ***	3,971

Notes: This table represents linear regression estimates. Independent variables are in each row, except for "Average pay" that is used as an dependent variable. For the regression in which the dependent variable is "Average pay", the independent variable is headteacher effectiveness. For all other regressions, the dependent variable is headteacher effectiveness. Details on how each variable is constructed are in the Data section. SE represents the "standard error" of the estimate, and "Obs" represents the number of observations.

Table 8: Average attainment of schools that receive each Ofsted judgement

Primary	Outstanding	Good	Requires improvement	Serious weaknesses	Special measures	Inspections excluded

Average attainment	0.29	0.09	-0.11	-0.23	-0.30	-0.15
Count	2178	9865	1466	159	443	3628
Secondary						
Average attainment	0.67	0.09	0.04	-0.08	-0.12	0.28
Count	644	1627	521	90	212	1897

Note: Average attainment values are standardised. "Inspections excluded" refers to those Ofsted inspection that happened outside of three years of a headteacher arriving at a school.

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