Local pay and teacher retention in England

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Executive summary

In recent years, the Department for Education has struggled both to recruit new teachers and to retain existing teachers in the profession. This report reviews the supply of teachers and considers whether further changes to pay policy, particularly at a local level, may improve the situation.

Covid-19 has not solved teacher retention problems

- The teaching profession faces problems with retention at all levels of experience. The 5-year retention rate has fallen by 6.8 percentage points since 2010, from 74.2 per cent to 67.4 per cent. However, the 9-year rate has also fallen by 6.2pp since 2011, and even the 12-year rate has fallen by nearly 4pp.
- The Covid-19 pandemic has created a recession that will temporarily increase recruitment to the profession and reduce attrition, but international evidence shows that the teachers who were drawn into the profession by a recession may also be more likely to leave the profession when it ends. The government should aim to retain the additional new entrants after the pandemic and ensure a sustainable level of attrition.

Pay policy should continue to support retention

- Pay is one channel through which the government can support recruitment and retention. It may not be the principal factor in decisions to enter or leave the teaching profession, which are complex, personal, and influenced by numerous factors throughout an individual's career; however, it is one of the few that can be rapidly altered by a change in government policy.
- Using pay to affordably improve recruitment and retention requires a package of measures that target pay rises at the teachers most at risk of leaving the profession: those in shortage subjects, those in challenging schools, and those in areas with high-paying alternative occupations.
- Earlier work by EPI and Gatsby has recommended that targeted retention payments in shortage subjects and challenging schools be extended to all existing staff, not just new teachers. Doing this and doubling the extra payments for teachers in challenging schools would cost about £45 million each year. However, the government has instead cut the retention payments in response to the pandemic. It should reconsider that decision, which may hinder efforts to retain the large intake of new ITT graduates.

Differences in pay across regions can lead to teacher supply difficulties

- There are significant differences in the pay of non-teachers across England, which makes it harder to recruit and retain teachers in regions where they are relatively underpaid. In some parts of England, particularly areas bordering London, teachers earn over 11 per cent less than non-teaching professionals, which corresponds to about £5,400 per year.
- These local pay gaps are associated with greater difficulties in recruiting and retaining teachers so reducing the gaps could mitigate some teacher supply problems. Within a region – defined by local labour markets - a 1 percentage point reduction in the average pay gap is associated with a 2.6 per cent decline in the proportion of teachers without QTS and a 5 per cent decline in the

proportion of vacant posts. Most teachers without QTS will be in their NQT year and a large number of NQTs is likely to indicate high teacher turnover.

- If the pay gap were closed by 10 per cent in the regions where teachers earn less than other professional occupation it could reduce teacher attrition by 0.5 percentage points each year and increase recruitment by 3.4 per cent. That roughly equates to an extra 720 teachers in the workforce, and in the schools with some of the greatest recruitment and retention difficulties. More importantly – though it is difficult to measure – matching local wages is also likely to help headteachers attract and retain better teachers.

Regional pay and funding adjustments should be reviewed together

- The existing teacher pay regions do not provide enough of a pay increase to match the pay of non-teaching professionals in London, nor do they cover the many other high-paying, high-cost regions of the country. They create too little differentiation to match local labour market conditions and there are too few of them to adequately account for the diversity of conditions across the country.
- The national funding formula differentiates school funding across regions with an area cost adjustment, which is largely based on the pay regions. That means that school leaders in high-cost areas do not have sufficient funding to respond to local labour market conditions, even when they do have the freedom to set pay.
- However, changing the pay regions and area cost adjustment to better support the recruitment and retention of schools in high-cost areas would be likely to redistribute funding to more affluent areas of the country. In some parts of the country, such as London, pupils in the high-cost areas also have high levels of academic attainment, which may affect the value-for-money of redistributing funding towards those areas.
- The existing policies intended to deal with regional cost adjustments no longer match the distribution of costs and should be reviewed. The review should consider both funding and pay policy together because neither can effectively support recruitment and retention on its own. It should also consider the distributional impact of any changes.
- Finally, if the adjustments for local costs are changed, other measures that reduce pay flexibility may prove counterproductive. For example, the recently introduced advisory pay points are likely to make teachers' pay more similar within pay regions. The School Teachers' Review Body (STRB) could consider whether it allows headteachers sufficient flexibility to meet local labour market conditions.

Introduction

The struggle to recruit and retain enough teachers to stabilise class sizes has dominated the Department for Education's school workforce policy for several years. In 2013, nearly three-quarters of new teachers were still teaching in state schools after five years; in 2019 that had fallen to barely more than two-thirds. Until the Covid-19 pandemic, teacher recruitment had fallen short of its targets for several successive years.

In response to these difficulties, the government introduced a broadly well-received recruitment and retention strategy in 2019, which has so far led to a series of new measures, including the new Early Career Framework (ECF), accountability changes, and the scrapping of the Professional Skills Test for entry to teacher training.[1] The strategy also led to a shift in financial incentives for teacher training, with the previous training bursaries to encourage recruitment being restructured to put some of that funding towards early-career pay supplements. These are designed to support retention over the first four years of a teacher's career. The restructure focussed the new retention payments on shortage subjects, including physics and maths, and supplied an added top-up for teachers who worked in challenging schools. These changes were recommended by researchers at EPI and Gatsby to address the sizeable gap between what a STEM graduate could earn in teaching and what they might earn in another profession.[2]

The government later committed to increasing teachers' starting wages by 23 per cent, to £30,000, by 2022. The move was intended to lift the status of the teaching profession among graduates and improve recruitment figures that remained below target.[3]

The changes have been welcomed by the profession and there are hints that early-career retention might have improved in the past couple of years. Nonetheless, the profession has still struggled to attract and retain graduates in shortage subjects like maths and physics, and supply difficulties remain more acute in some parts of the country.

The alterations to financial incentives acknowledged that pay may be one of the reasons that the profession struggles to recruit and retain teachers. Pay may not be the principal factor in decisions to enter or leave the teaching profession, which are complex, personal, and influenced by numerous factors throughout an individual's career.[4] However, it is a prominent consideration for many teachers, and one of the few that can be rapidly altered by a change in government policy.[5] That makes it a particularly important channel through which the government could support recruitment and retention.

EPI's and Gatsby's earlier work on pay and incentives focussed on the benefits of differentiating pay between subjects to support recruitment and retention. We recommended financial incentives to support retention in shortage subjects and to encourage teachers to work in challenging schools.[6] In both cases, there is strong overseas evidence that targeted pay boosts could help overcome shortages in schools in England.

[1] Department for Education, 'Teacher Recruitment and Retention Strategy'.
[2] Sibieta, 'The Teacher Labour Market in England'; Sims, 'What Happens When You Pay Shortage-Subject Teachers More Money? Simulating the Effects of Early-Career Salary Supplements on Teacher Supply in England'.
[3] Department for Education, '£30,000 Starting Salaries Proposed for Teachers', 000.
[4] Department for Education, 'Analysis of School and Teacher Level Factors Relating to Teacher Supply', chap. 3.
[5] Smithers and Robinson, 'Factors Affecting Teachers' Decisions to Leave the Profession'.
[6] Sibieta, 'Teacher Shortages in England'.

In this report, we turn to the differences in pay across regions and the effect that has on teacher supply. We first consider the recruitment and retention challenges that continue to face the profession, despite the increased recruitment generated by the pandemic. We then review the evidence for allowing teachers' pay to vary across regions to reduce attrition. Finally, we estimate how well teachers are presently paid, compared to other professionals, in local areas and relate those estimates to measures of teacher supply difficulties.

Teacher numbers and retention

The 2020/21 report of the School Teachers' Review Body (STRB) requested views on the state of the teaching labour market and received a clear message from consultees:[7]

> *The Department [for Education] stated that the current teacher supply situation presents challenges, while the unions representing teachers and school leaders characterised this situation as a crisis. The Department's submission also emphasised that there were particular challenges with retention in the early stages of teachers' careers. In contrast, many consultees contended that retention was a pervasive issue, affecting classroom teachers at all career stages[...]*

There are differences over the precise characterisation, but all agreed that there is an acute problem with low recruitment and falling retention. Moreover, most consultees agreed that there is a problem with uncompetitive pay for early-career teachers, and many also felt that teachers' pay is low compared to other graduate professions.

However, that consultation was prepared before the consequences of the Covid-19 pandemic were felt and did not fully address the changes in the teaching labour market that it precipitated. Recruitment and retention both rose as graduates struggled to find jobs, and the department decided to cut many of its teacher training bursaries.

Below, we briefly review the current evidence on teacher numbers, recruitment, and retention to outline the scale of the problems the sector faces. We also consider whether the retention problems are isolated to early-career teachers, as the department contends.

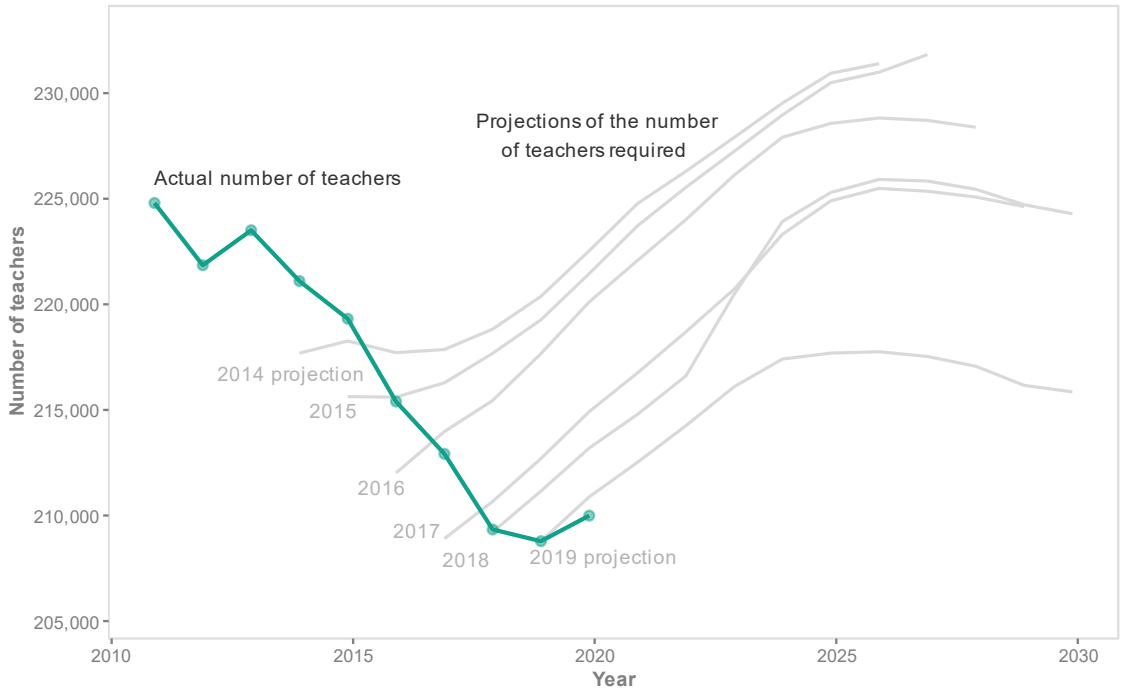
Numbers are below forecast requirements

Pupil numbers are surging in secondary schools and teacher numbers are falling. Secondary pupil numbers have been rising for several years and are forecast to increase by another five per cent between 2021 and 2024.[8] To manage its funding of teacher training the department annually projects how many teachers are needed to support the current pupil-teacher ratios, given the expected number of pupils. As Figure 1 below illustrates, each year that projection shows the number of teachers needs to rise and, each year until 2019, the number of secondary teachers has fallen.

The projected targets are being missed year on year, even though the targets adjust to more achievable levels each year. That is not because pupil numbers fall but because the projections rely on an expected pupil-teacher ratio. The pupil-teacher ratio is revised upwards annually, to reflect the reality of recent years, resulting in a smaller number of teachers being needed. The implication is that achieving the projection would still only maintain the current class sizes, which have grown from under 15 pupils per teacher in 2011 to 16.6 in the latest projections.

[7] School Teachers' Review Body, 'School Teachers' Review Body Thirtieth Report - 2020', para. 2.32.
[8] Department for Education, 'National Pupil Projections, Reporting Year 2020'.

Figure 1 The number of secondary teachers is still short of projected needs



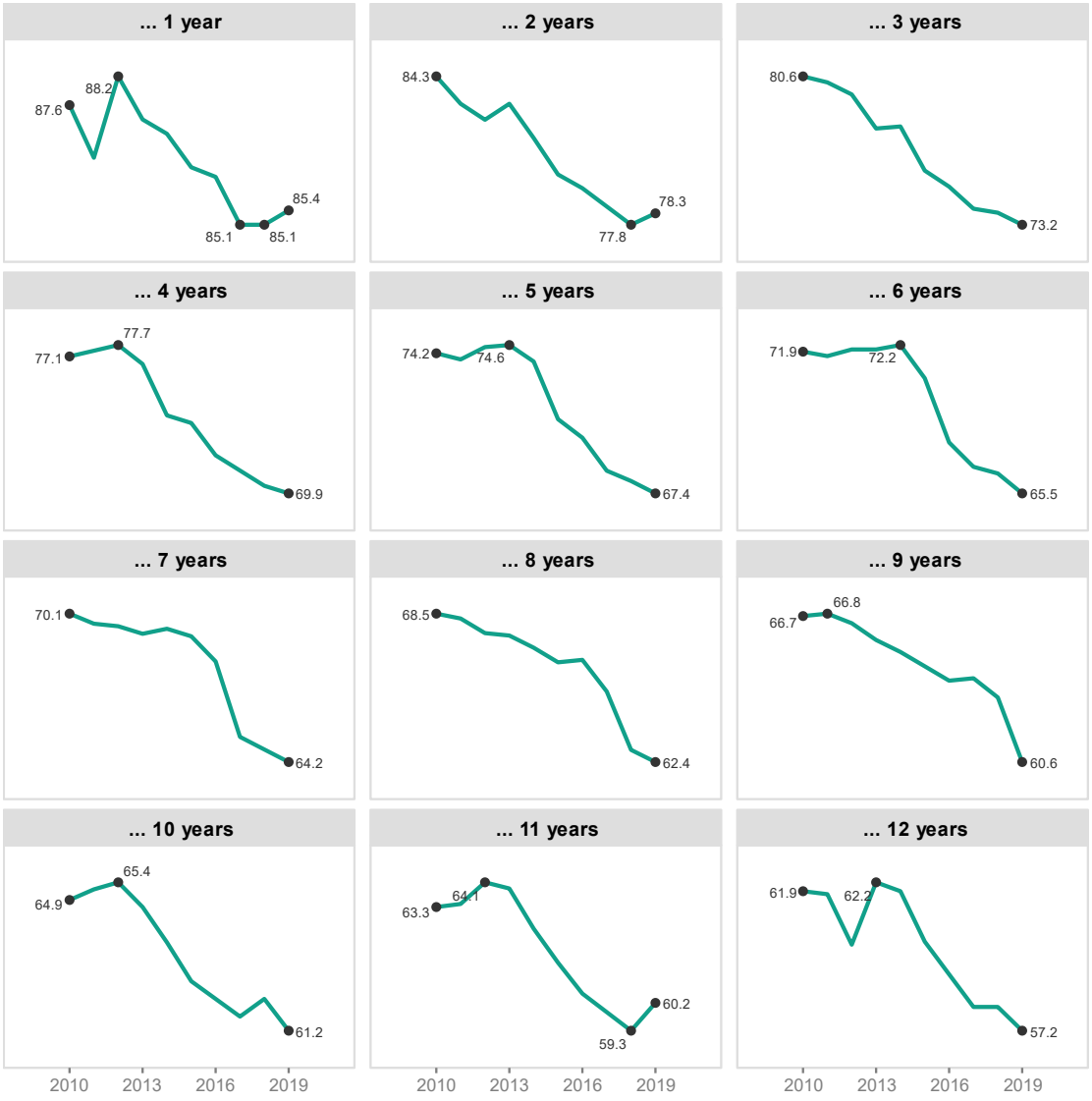
Sources: Department for Education Teacher Supply Models

Note: Each line represents an annual projection of teacher need by the DfE. Historical figures are revised each year but only the latest historical figures are shown, which is why forecasts do not necessarily start at the latest historical value.

Retention is falling

The government's retention statistics show the proportion of teachers who stay in the profession each year and, as Figure 2 below shows, that proportion has been falling for the past decade and falling for teachers of up to at least twelve years of experience. Most of the attrition from the profession happens in the first few years of a teacher's career but Figure 2 shows that the retention problems are not isolated to early-career teachers. For example, the 5-year retention rate has fallen by 6.8pp since 2010, from 74.2 per cent to 67.4 per cent. However, the 9-year rate has also fallen by 6.2pp since 2011, and even the 12-year rate has fallen by nearly 4pp.

Figure 2 What proportion of teachers are still in the profession after...



Source: School Workforce in England, November 2019.

Note: Figures shows the percentage of teachers who still teach in a state-funded school, 2010-2019

Only in the most recent data – gathered in November 2019, before Covid-19 struck – is there a sign that teachers in the first few years of their careers might now be more likely to remain in state-funded schools. In 2018-19, the retention rate for that group flattened out and, now that cohort is in their second year, they are slightly more likely than their predecessors to remain in teaching. Their successors as first-year teachers are more likely again to remain in the profession. However, we should be cautious about interpreting two years of data, particularly when the numbers for nearly all other cohorts of teachers still show falling retention.

An important lesson from the retention figures, highlighted in the Gatsby Foundation's report of 2018, is that a dramatic increase in recruitment is not necessary to stem the fall in teacher numbers.[9] All that is required is that retention improves to the level of a decade ago.

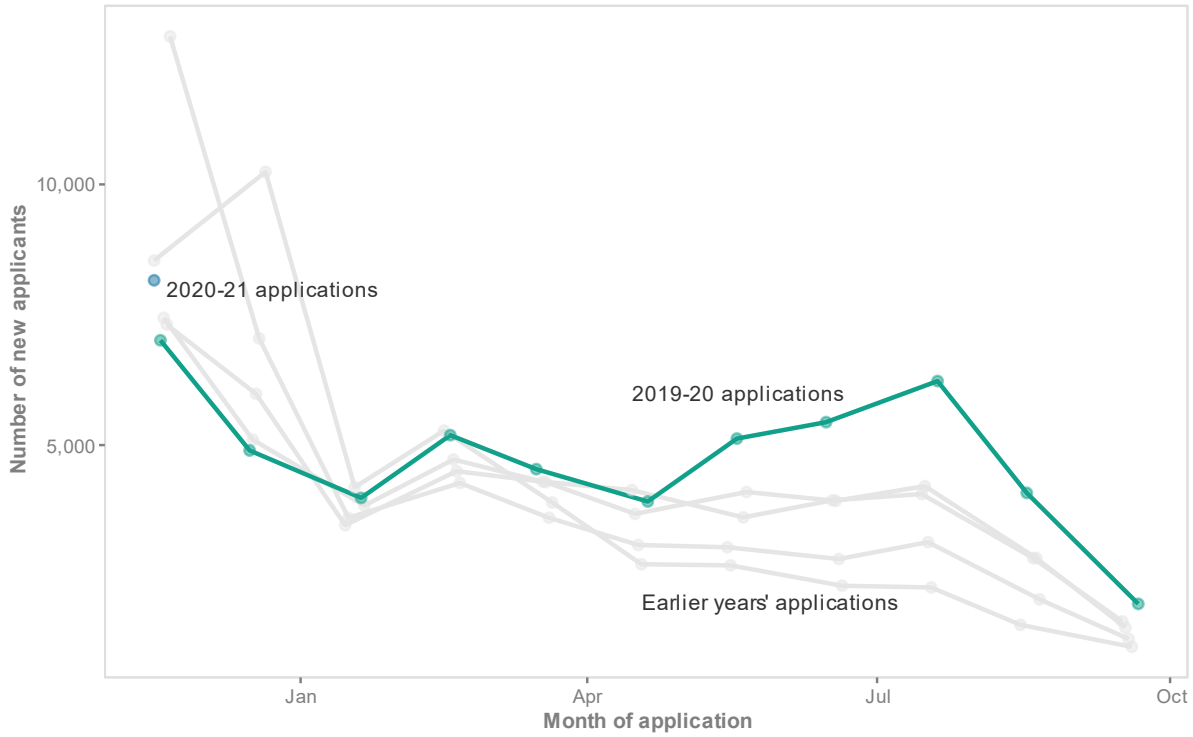
[9] Sims, 'What Happens When You Pay Shortage-Subject Teachers More Money? Simulating the Effects of Early-Career Salary Supplements on Teacher Supply in England'.

The pandemic boost to recruitment is likely to be temporary

In recent years, the government has struggled to reach its recruitment targets for initial teacher training, despite the targets being revised down each year. In 2019/20 only 87 per cent of the target number of teachers were recruited, with huge variation across subjects. In some shortage subjects, like physics, recruitment was only 42 per cent of the required number.[10]

However, the onset of the Covid-19 pandemic led to a surge in applications to teacher training programmes (Figure 3) and the target level of recruitment was achieved for the first time in some years.

Figure 3 Initial teacher training applications have surged since the pandemic



Source: UCAS ITT Statistics

Note: Adjusted number of new ITT applicants UCAS has received each month in England and Wales, 2016-2020. UCAS statistical releases occur at uneven intervals. We have adjusted for that by reporting 30.4 x the average number of applications per day during the period, which allows the points on the chart to be interpreted as if they were monthly.

A similar surge in teacher recruitment was seen following the 2008 financial crisis, and these surges during recessions have also occurred internationally. When job opportunities dry up in the private sector, stable jobs like teaching tend to experience an increase in demand. However, when the recession passes, international evidence shows that the teachers who were drawn into the profession by the stability may also be more likely to leave the profession.[11] That makes a focus on retention particularly important at a time when more recruits have entered the profession.

However, in response to the surge in demand, the DfE began to roll back the financial incentives that were designed to encourage recruitment and support retention. It cut bursaries by up to 75 per cent in some subjects, dropped the planned retention payments for new ITT entrants, and postponed its ambition to lift starting salaries to £30,000.[12] These measures reduce the targeted support for

[10] Department for Education, 'Initial Teacher Training'.
[11] Nagler, Piopiunik, and West, 'Weak Markets, Strong Teachers'.
[12] Whittaker, 'DfE Slashes ITT Bursaries as Covid Causes Supply Rises'.

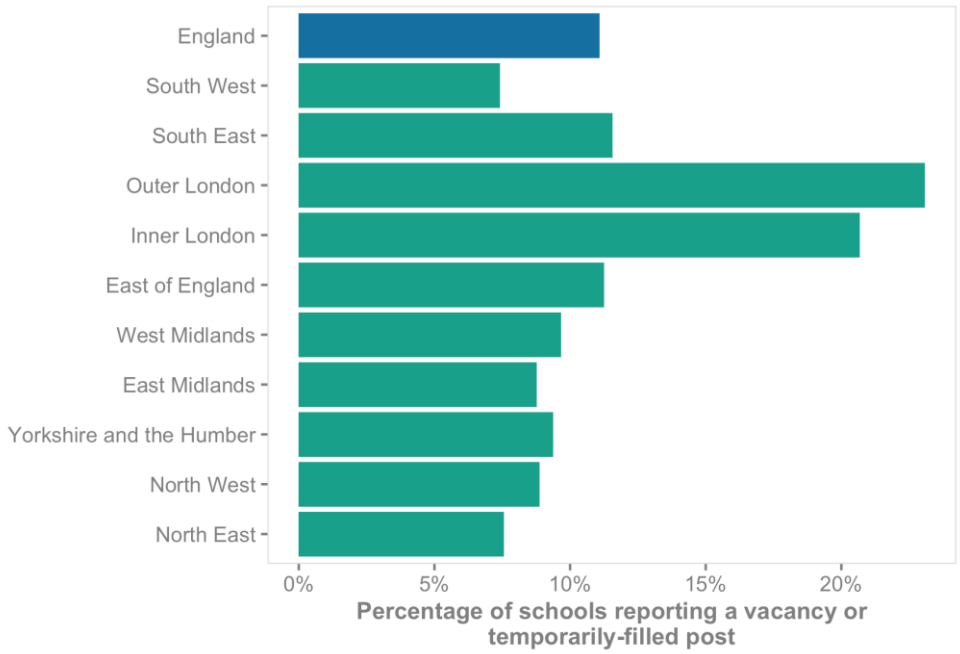
recruitment and retention in challenging areas.

Differences exist across regions

Not all parts of the country suffer equally from difficulties with teacher recruitment and retention. EPI's recent work has shown the stark distinction between London and the rest of England in the type of teachers that can be recruited.[13] That work used the proportion of secondary teachers who hold a qualification in their subject as a proxy for teacher supply problems. It found, for example, that while less than 20 per cent of the hours of key stage 4 physics in disadvantaged schools outside of London are taught by a teacher holding a physics degree, in more affluent schools and London schools that rises to about 50 per cent.

The STRB came to a similar conclusion in its most recent report. Using data at a regional level, it highlighted the stark difference between recruitment difficulties around London and in the rest of England. Their findings align with EPI's and show that schools in the London area are far more likely to carry vacancies and temporarily-filled posts (Figure 4).

Figure 4 Proportion of schools reporting a vacancy or temporarily-filled post



Source: STRB report 2020/21 drawing on analysis of DfE School Workforce in England, November 2018 by the Office of Manpower Economics[14]

It also found that retention rates are far lower in London than in the rest of the country. Five years after graduating, 39 per cent of new teachers who began in London had quit the profession. In contrast, for the rest of England, only 29 per cent were no longer teaching in state-funded schools.

Summarising its investigations into regional labour markets, it concluded that "pay progression for teachers in Inner London is lower than that for the wider graduate market. The earnings of teachers compared to those in other professional occupations have deteriorated in recent years. The gaps are widest for younger teachers and for those in London."[15] These facts illustrate the complexity of the

[13] Sibieta, 'Teacher Shortages in England'.
[14] School Teachers' Review Body, 'School Teachers' Review Body Thirtieth Report - 2020', fig. 14.
[15] School Teachers' Review Body, para. 3.64.

teacher labour market: it is both easy to recruit highly qualified young graduates in London but difficult to retain them in the region. Each area of the country has similar complexities of its own, which contributes to the difficulty of finding a single pay policy that works for all regions and all schools.

These findings suggest that it is worth revisiting the question of regional pay differences. Regional pay was last thoroughly explored in 2012 after the government asked all pay review bodies to examine the issue.[16] At the time the STRB recommended that schools be given greater autonomy to set teachers' pay within a broad national framework but felt that the existing pay regions remained suitable.[17] Most pay bodies agreed, and the majority stuck with a London weighting that is similar to the system employed by the STRB.

However, some pay review bodies have recently begun to question whether having only a London weighting is sufficient to support recruitment and retention across the country. In its 2020 report, the NHS pay review body expressed concern that the London weightings no longer reflected genuine differences in costs, "particularly the rationale for differentials between inner and outer London, and between …. areas to the south-east and north-west of the zones … [There] does not appear to be evidence to justify these boundaries".[18] The police pay review body was similarly concerned in its 2020 report and called for an urgent review of all geographical allowances.[19] Finally, the prison service pay review body heard that the expiry of market supplements - paid at 31 sites across the country – would reduce the ability of the service to retain experienced staff in the face of competition in local labour markets.[20]

[16] HM Treasury, *Autumn Statement 2011*, para. 1.110.
[17] School Teachers' Review Body, 'School Teachers' Review Body 21st Report', para. 3.59.
[18] NHS Pay Review Body, 'Thirty-Third Report 2020', para. 4.283.
[19] Police Remuneration Review Body, 'Police Remuneration Review Body Sixth Report England and Wales 2020', para. 37.
[20] Prison Service Pay Review Body, 'Prison Service Pay Review Body Nineteenth Report on England and Wales 2020', para. 4.32.

Pay and retention

The most notable feature of teachers' pay is that it is remarkably similar across the country, and across teachers with differing experience and qualifications. Whereas a physics graduate is likely to earn more than a history graduate in the private sector, they will earn similarly if they both become teachers. Someone working as a professional in Manchester is likely to earn more than a similar person working in Cornwall, but teachers in the two areas will earn about the same.

The lack of variability in teachers' pay means that people in high-earning regions, or with high-earning qualifications, will need to sacrifice income to work as a teacher. Conversely, people in lower-earning regions are likely to be paid well, compared to their job alternatives. This has clear implications for the recruitment and retention of teachers in particular subjects and regions. In high-cost regions, it is likely to make it slightly more difficult to attract and retain staff, while schools in lower-cost regions may find that the relatively high pay in the teaching profession helps.

In this section, we outline the reasoning behind the influence of relative pay differences, the policy decisions that have led to the current situation, and the earlier research on the subject.

Relative pay differences

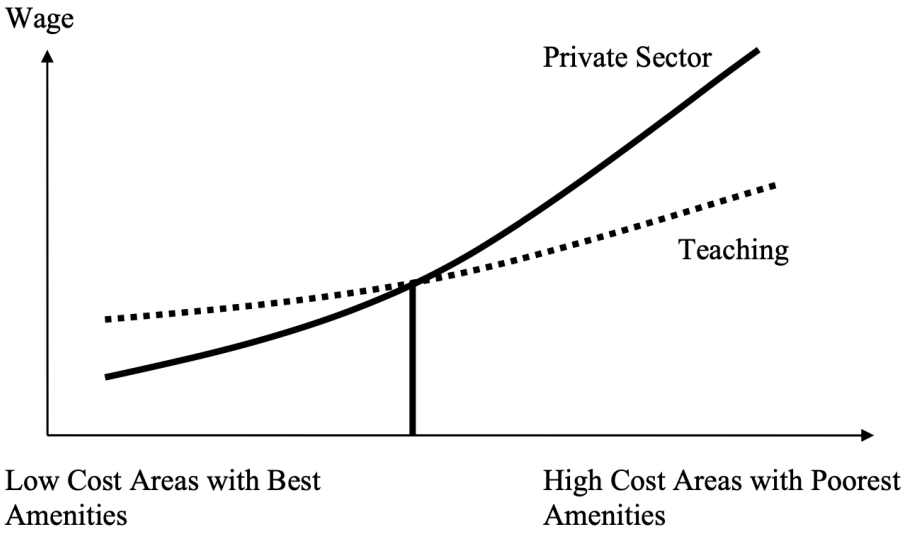
Pay varies among jobs due to the characteristics of the employee, the job, and the location, among other things. People with greater experience, or greater skill, tend to earn more. People in dangerous jobs will earn a premium for the risk they take, and people living in regions with limited amenities, or a high cost of living, will ask for a higher wage to compensate. Both the costs of living and the amenities of a region affect its attractiveness. For example, even though teachers in London typically face a higher cost of living than in other regions, London schools do not struggle to attract young teachers because young people want to live and work in London.

Some of the differences in average pay across regions are explained by the type of jobs in the region, while others are explained by differences in the characteristics of the region: the cost of living and the attractiveness to potential residents. However, those pay differences across regions can be blunted by national pay bargaining, as happens in teaching, and pay ends up being set very similarly across regions. That leads to the situation described by the stylised Figure 5 from Ma et al (2010).[21]

Private sector wages vary across regions to a far greater degree than teaching wages, which leads to a wage premium for teaching in low-cost areas with the best amenities, and a wage penalty for teachers in high-cost areas with poor amenities, compared to local jobs in the private sector.

[21] Ma, Battu, and Elliott, 'Local Pay Differences and Vacancy Rates for School Teachers in England and Wales: Regional Differences in Teachers' Rates of Pay and Teacher Vacancy Rates'.

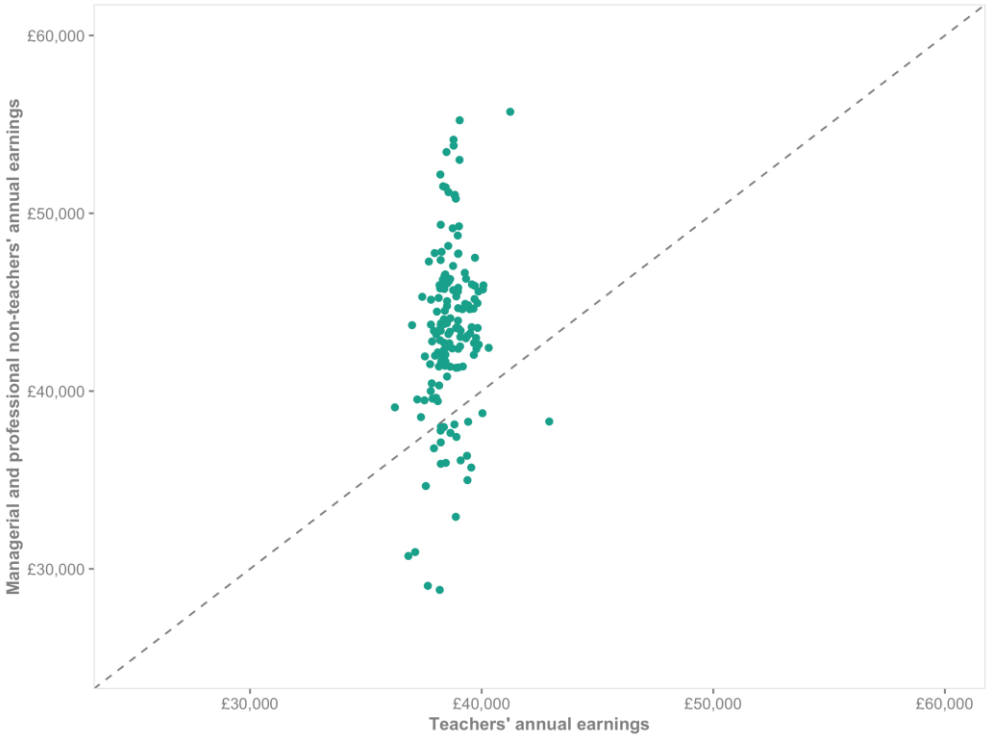
Figure 5 A stylised theory of teaching wage premia



Source: Ma et al (2010)

This pattern can be clearly seen by comparing teachers' wages with the wages of other professionals. Figure 6 plots the wages of teachers against the wages of non-teaching professionals across 155 local labour markets in England.[22] The scales on the two axes are the same and teachers' annual earnings vary little across regions, while the earnings of non-teachers are far more dispersed.

Figure 6 Earnings of teachers and non-teachers across local labour markets



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: Each point shows the average annual earnings for one travel-to-work area.

[22] The local labour markets are travel-to-work areas defined by the ONS and described in more detail later in the report. The non-teaching professionals include all employees classified in SOC 1-2.

There are three main reasons why teachers' pay might differ across the country. The first is that there are different pay bands for teachers in the vicinity of London, which create some variation. Secondly, there may be differences in the school workforce composition. Salaries increase with experience so a region with a more experienced workforce would, on average, pay higher salaries than a region with many newly qualified teachers (NQTs). While this may explain some of the differences it does not explain everything as teachers in the north-east tend to be younger than those in the south-west but earn more. Finally, schools in some regions might have been more likely to use their pay freedoms granted in 2013 than others.[23]

Mapping the same data – again with an identical scale across maps – highlights the lack of variation in teachers' wages across England (Figure 7). The maps below compare the distribution of teachers' wages to the distribution of non-teachers' wages across England. On the left are teachers' wages, which vary little across the country, though the increased wages in the London pay regions are visible. On the right are the wages of people in professional and managerial occupations outside teaching, which vary dramatically.

The difference in distributions means that people with the right skills have far greater opportunities for high earnings in some parts of the country, while teachers earn more only in London. Even then, the difference in London for teachers is far less than the difference for people in other professional and managerial occupations. In contrast, the wages of non-teaching professionals vary dramatically, with some regions having average earnings over twice as high as others.

Figure 7 Map of earnings across local labour markets

Teachers' earnings **Non-teaching professionals' earnings**

Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

There are two possible consequences of this mismatch in areas where teaching has a wage penalty. The first is that schools in regions where teaching has a wage penalty will have a harder time recruiting and retaining teachers. The attraction of higher wages in another job will prove too much for potential teachers and schools will experience supply difficulties. This is consistent with the evidence gathered by the STRB and described above (for example, Figure 4).

[23] See Caroline Sharp et al., 'Evaluation of Teachers' Pay Reform' for a review of the impact of the pay reforms.

The second possibility is that schools will be forced to settle for teachers who may not have been their first choice and the quality of teaching in the school will suffer. If some of the best candidates are drawn away from teaching by the promise of higher wages in another job, then the school may not be able to hire from as strong a pool of candidates as in regions where there is less of a penalty.[24]

There are also areas of the country where teachers, on average, earn more than other professionals. This is particularly the case in parts of the south-west of England. In these areas, it may sometimes be difficult to attract excellent candidates for reasons unrelated to the cost of living and pay of other professionals in the region. In some cases, pay incentives can help to attract and retain teachers in these areas, which is why the differences in relative pay across regions are only one part of a complete pay policy. In addition to accounting for regional differences in relative pay, a pay settlement must at least account for subject-specific shortages and the recruitment difficulties faced by schools in challenging circumstances.[25]

Pay policy for schools in England

Pay policy for schools in England has undergone significant changes over the past decade, much of it intended to introduce more differentiation in pay to retain and reward good teachers. Before September 2013, there was a national pay scale for maintained schools and teachers progressed up the scale as they gained experience.

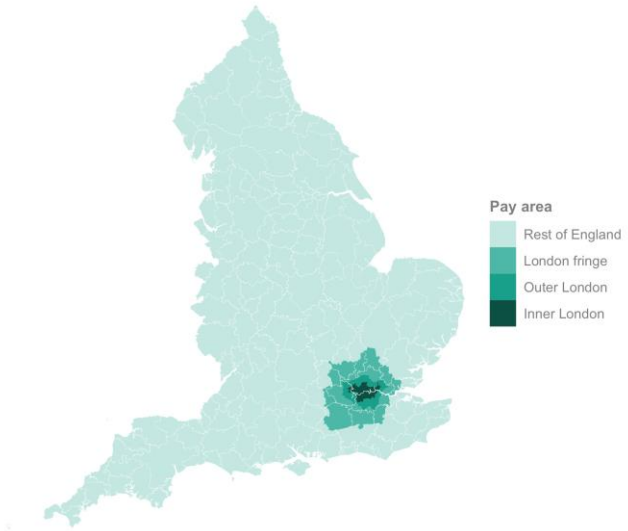
Teachers began on the unqualified teachers' pay scale, moved to the main pay scale when they qualified, and could then progress to the upper pay scale once they reached the top of the main pay scale. Moving to the upper pay scale required the approval of the headteacher but nearly half of the teachers at the top of the main pay scale progressed each year.[26]

Movement up the main pay scale was automatic as teachers gained experience. Each year, the School Teachers' Review Body (STRB) would recommend a new set of pay scales, which would then be decided on by the government. Academy schools were never bound by the pay scales but most chose to adhere to them.[27]

The pay scales differed across four pay regions in England: Inner London, Outer London, the London fringe, and the rest of England. Differentiating teachers' pay across these regions was, and still is, intended to recognise broad labour market differences that bear on recruitment and retention.[28]

[24] There is some support for this effect in England in Britton and Propper, 'Teacher Pay and School Productivity'.
[25] Sibieta, 'Teacher Shortages in England'.
[26] Department for Education, 'Evidence to the STRB: The Case for Change', para. B9.
[27] Milsome and Withers, 'Academies' Approaches to Teachers' Pay'.
[28] School Teachers' Review Body, 'School Teachers' Review Body 21st Report', para. 3.59.

Figure 8 Teachers' pay regions in England



Sources: Department for Education, Get Information About Schools; TTWA 2011 shapefile from ONS

Note: Regional boundaries for local labour markets defined by ONS travel-to-work areas.

The figure above shows that the three differentiated pay regions around London each cover a small number of the country's schools while most schools are in the rest-of-England region. In addition, the local labour markets outlined on the map do not tesselate with the pay regions. The 'rest of England' region collects well over 100 local labour markets in England together in a single pay region.

In 2012 and 2013, that system underwent intensive scrutiny and alteration. The government asked the STRB to consider removing automatic progression, ending the pay scales, and allowing for more local flexibility in pay.[29] The 2011 Autumn Statement acknowledged that, because public sector pay is often set nationally, it does not always reflect individual local labour market conditions.[30] The DfE's 2012 evidence to the STRB suggested changes to the pay regions to avoid the level of teachers' pay, relative to local pay levels, leading to shortages in some areas.[31]

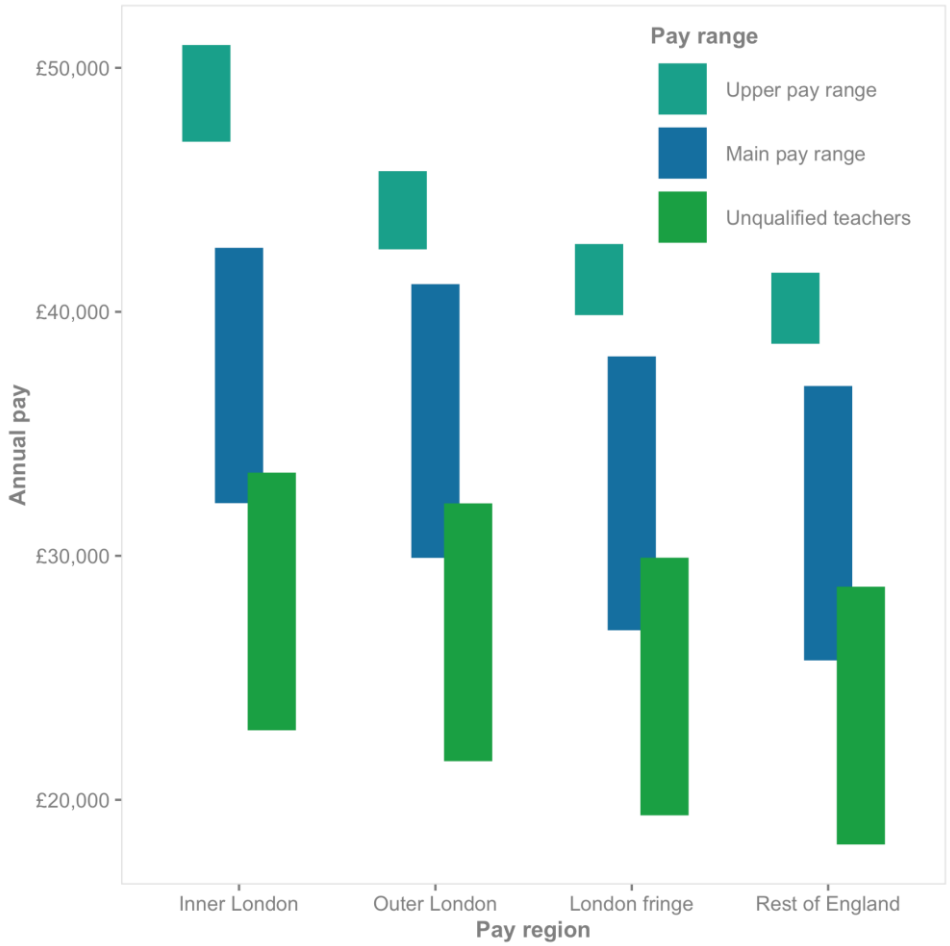
In response, the STRB report recommended that schools be given greater autonomy to set teachers' pay within a broad national framework to enable schools to set salaries in the context of their local labour markets, but felt that the existing pay regions were suitable at the time.[32]It recommended allowing performance-based progression through the pay scales and removing the reliance on pay points so that they became purely advisory. However, it recommended keeping the four pay regions because it felt the meaningful variation in teachers' pay should exist at school level and could not be effectively targeted with a centrally-determined regional pay structure.

In his response, the Secretary of State for Education agreed to the STRB recommendations and, from September 2014, all maintained schools had to implement a performance-based system of pay progression. Progress up a pay scale could no longer be automatic with experience. The STRB continued to produce recommendations for pay each year but issued only minima and maxima for the pay ranges,

[29] Department for Education, 'Evidence to the STRB: The Case for Change'.
[30] HM Treasury, *Autumn Statement 2011*.
[31] Department for Education, 'Evidence to the STRB: The Case for Change'.
[32] School Teachers' Review Body, 'School Teachers' Review Body 21st Report'.

rather than also producing the pay points along the range (Figure 8). It was then up to headteachers to decide how to assess performance and what pay progression to provide. However, teaching unions continued to publish recommended pay points and negotiating positions to their members so it is still common to find people referring to the points on the pay scales.

Figure 9 Allowable pay ranges in local authority schools for 2020/21



Source: Department for Education, Get Into Teaching

After the changes, headteachers were free to begin adjusting pay at their schools to better match the local circumstances. Burgess et al (2019) found that there was a marked increase in the proportion of teachers who did not receive their expected pay progression in 2014 and 2015, which suggests that headteachers did begin to use their newfound freedoms.[33] However, the decisions of most headteachers are still guided by the annual STRB advice, which sets both the minima and maxima of the pay scales and includes a regional adjustment for teachers living in London and its environs.

That system has largely persisted between 2013 and 2020 but, in 2020, the government decided to ask the STRB to consider reintroducing advisory pay points within the pay ranges, and to flatten the pay structure by significantly lifting the minimum of the main pay range. This was then recommended.[34] These moves, which add greater structure to the existing pay requirements, are a reversal of the earlier trend towards greater delegation of pay decisions to school leaders.

[33] Burgess, Greaves, and Murphy, 'Deregulating Teacher Labor Markets'.
[34] School Teachers' Review Body, 'School Teachers' Review Body Thirtieth Report - 2020'.

Measuring regional pay variation

In this section, we investigate the relationships between local pay and teacher supply difficulties by calculating the gap between professional pay and teachers' pay for each of 155 local labour markets. This allows us to estimate the association between the wage gap and indicators of teacher shortages.

Regional pay differentials

Figure 6 illustrated the differences in wages of both teachers and other professionals across England. Those differences are striking but can be caused by many aspects of the area's demographics and labour market. For example, regions with younger residents will tend to have lower wages. Regions with many financial services jobs will tend to have higher wages.

To compare regional wage premia on a like-for-like basis we can adjust the wage differences for these factors. We refer to these adjusted, region-specific, pay premia as adjusted pay differentials. They are calculated as the percentage extra that employees in an industry are paid in a particular region after accounting for the other measurable factors that might influence wages. In some other studies, they are termed standardised spatial wage differentials.[35] For more detail on the estimation of the pay differentials in our datasets, see Appendix B.

In this project, we account for regional differences in age, gender, occupation, and industry, which leaves many things that might influence the pay differentials – from the weather to house prices to the quality of local amenities. Not all of these are measurable but they are implicitly included in the region's pay differential. This means that the pay differential reflects the entire bundle of characteristics associated with a region and measures how much of a premium an employer must pay to retain staff in that region, compared to other regions.

We estimate pay differentials for 154 of the 155 travel-to-work areas (TTWAs), with the remaining region, Birmingham, used as the reference group. That means all pay differentials are reported as the percentage pay premium, or deficit, compared to Birmingham's pay level.

Regional data

Regions

When defining a teacher's local labour market, to estimate the relative earnings of teachers, it must be small enough to accurately capture local differences in labour market conditions but large enough to capture where most teachers live and work. The ONS's travel-to-work areas (TTWAs) are a geography created to approximate labour market areas. Each TTWA is a self-contained region where at least 75 per cent of the economically active resident population work in the region and at least 75 per cent of the people who work in the area also live in the area. We use the most recently released TTWAs, which were estimated for England in 2011. There are 149 that fall wholly within England and 6 that cross the borders with Scotland or Wales.

[35] For example, Ma, Battu, and Elliott, 'Local Pay Differences and Vacancy Rates for School Teachers in England and Wales: Regional Differences in Teachers' Rates of Pay and Teacher Vacancy Rates'.

The travel-to-work-areas of England do not contain similar populations and schools are unevenly distributed across them. The largest TTWA, London, has 2,300 schools, 63,700 teachers, and 1,230,000 pupils in our sample, while the smallest has only 3 schools and fewer than 1,500 pupils.

These TTWAs also do not closely correspond to school administrative boundaries such as local authorities or regions. For example, a single TTWA covers all inner London, which contains several local authorities. Measuring at the TTWA level encompasses these local labour markets in a way that administrative boundaries do not.

Pay data

The ONS' Annual Survey of Hours and Earnings (ASHE) is the largest survey of earnings in England and we intended to use it to estimate wages for both teachers and non-teachers. Unfortunately, the teachers' wages in that dataset do not appear to correspond with DfE data at a regional level (see Appendix A for a comparison). Instead, we estimate the wages of non-teachers using ASHE and rely on DfE data for teachers' wages.

For non-teachers' wages, we only include the earnings of full-time employees and pool eight waves of ASHE across 2012-2019 to increase the sample size and precision of our estimates, which leaves us with approximately 358,000 non-teachers in our sample across 155 TTWAs. Wages are inflated to 2019 levels using the consumer price index.

Teaching is a graduate profession so our estimates of non-teachers' wages would ideally match that, and other characteristics of the teaching profession. However, ASHE does not provide detailed personal information about respondents, so instead, we limit non-teachers to those employed in occupations described as managers, directors and senior officials, or professional occupations, all of which require at least an undergraduate degree. These groups are often referred to as SOC 1-2 and in this report, we refer to them as 'professional occupations'.

For teachers' wages, we have used the DfE's published School Workforce in England (SWiE) data, based on the November 2018 School Workforce Census. This data is published at school level and includes the average salary of classroom teachers.

For comparability, we limit our analysis to mainstream schools, which include academies and maintained schools delivering primary or secondary education. That excludes, for example, nurseries, special schools, and post-16 provision. These schools are treated differently under pay arrangements and cannot be pooled with mainstream schools.

With those restrictions, our SWiE sample has 20,164 schools, which employ 406,319 teachers.

School and region characteristics

Data on the schools' characteristics are drawn from DfE's Schools, Pupils and their Characteristics, January 2019, and from Get Information About Schools, which provides location data to match schools to TTWAs. In combination with the School Workforce in England data, they supply a rich set of statistics about the school workforces and pupils in each TTWA.

In key stage 2 and key stage 4, we also match progress measures as an indicator of school performance. At key stage 2, the average of the progress scores in reading, writing, and maths is used. At key stage 4, the Progress 8 measure is used.

Finally, we include ONS median house price data from the house price statistics for small areas (HPSSA) and the TTWAs' average index of multiple deprivation from the English Indices of Deprivation 2019.

All measures are aggregated to TTWA level using weights based on the appropriate population. For example, the proportion of children eligible for free school meals is aggregated using the number of pupils in the TTWA, while teachers' wages are aggregated using the number of teachers in the region.

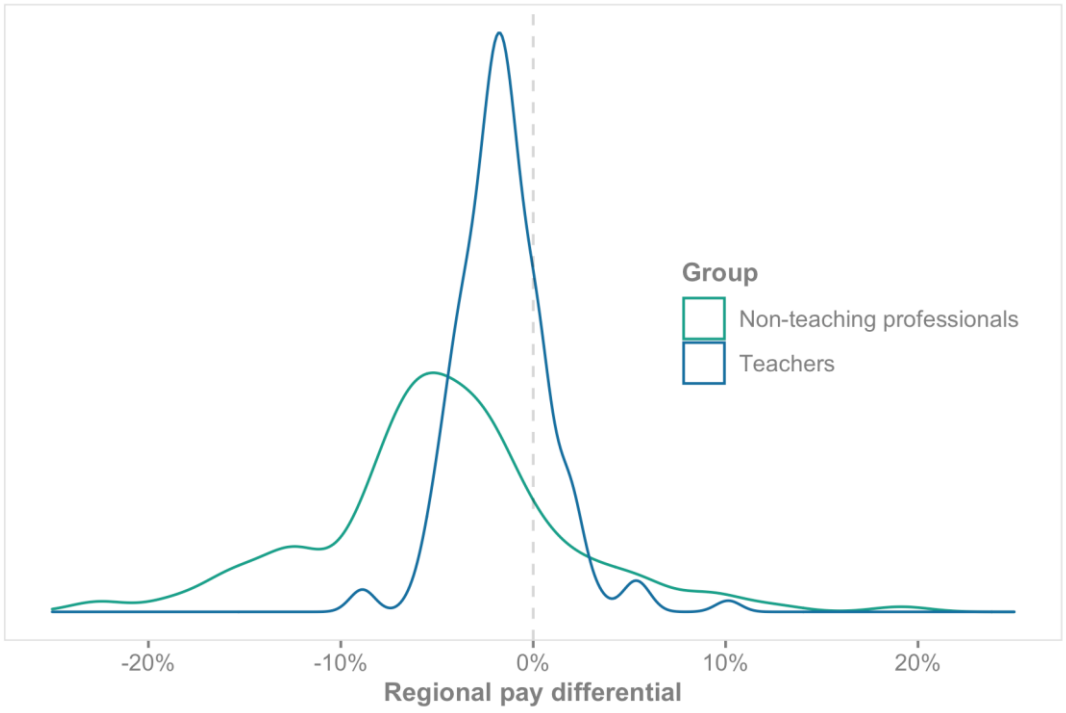
Pay differentials across England

Figure 10 shows the distribution of regional pay differentials across England. The first thing to note is that, for both teachers and other professional occupations, the average pay differential is slightly negative because the reference region is Birmingham, which is an area with high pay.

Secondly, the dispersion of pay differentials for non-teaching professionals is far greater than the dispersion of teachers' pay differentials. That reflects the far greater variation in non-teachers' pay, compared to teachers, that was previously seen in Figure 6.

Finally, teachers' average pay differential is greater than non-teachers'. This is simply an artefact of where Birmingham sits in the distribution of teachers' pay relative to non-teachers' pay and does not indicate that teachers are better paid on average. Both sets of pay differentials are estimated within an occupation and differences in the distributions do not reflect average differences in pay between the groups.

Figure 10 Distribution of pay differentials



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: All percentage differences are expressed relative to Birmingham.

Mapping the pay differentials shows that, for both groups, the pay differentials are greatest around London. However, the teachers' pay differentials are high only in a narrow area around London, reflecting the official pay regions. Across the rest of the country, teachers' pay is fairly similar.

In contrast, the high-paying region around London is far larger for non-teaching professionals and extends much further from London than the teacher pay regions. In addition, the low-paying regions pay far less, with several having pay differentials of -20 per cent, compared to the reference region.

The implication is that, in many regions where professionals' pay differentials are high, teachers are not enjoying the same pay premium as professionals who work within their region but in other occupations. That suggests the existing teacher pay regions no longer accurately reflect the geography of the broader labour market.

Figure 11 Pay differentials across England

Teachers' pay differentials **Non-teaching professionals' pay differentials**

Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: The Birmingham TTWA has been used as the reference level and is left blank. All percentage differences are expressed relative to Birmingham. Values have been restricted to the -15 per cent - 11 per cent range for legibility, affecting 16 of 154 TTWAs.

Comparing teachers' and non-teachers' pay premia: the adjusted pay gap

The regional pay premium, or penalty, that teachers enjoy can be summarised by the difference between the pay differentials of professionals and teachers. We refer to this as the adjusted pay gap. It is the regional pay premium that non-teaching professionals receive, over and above the premium teachers receive. This is the key measure for understanding whether teachers are paid relatively well, or relatively poorly in their local labour market, as described in Figure 5.

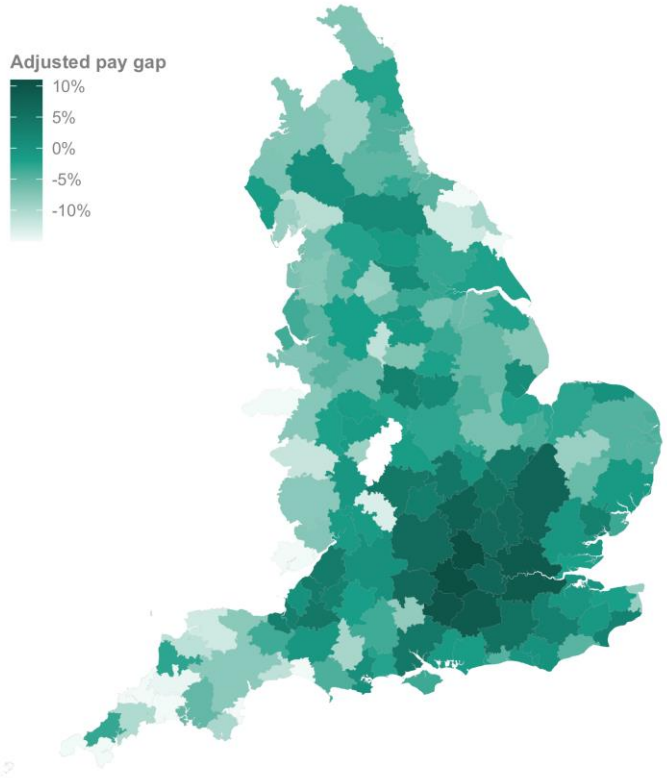
To illustrate how it works, take the example of Bath's TTWA. In Bath's local labour market non-teaching professionals earn about the same as their counterparts in the reference region who are of a similar age and work in similar industries and occupations. They have a pay differential of zero. However, Bath's teachers earn nearly 3 per cent less than teachers in the reference region, after similarly adjusting for the characteristics of teachers in the two regions, so they have a pay differential of -3 per cent. That makes Bath's adjusted pay gap about 3 per cent, which is the added premium that non-teachers receive in Bath, in comparison to teachers.

That is likely to make it slightly more difficult to attract and retain teachers around Bath because teachers suffer a small pay penalty for living in Bath compared to other professional occupations. Of

course, there may be many other reasons why people choose to teach in Bath that outweigh the slight pay penalty and it is only one of the many factors that affect teacher supply in a region. Nonetheless, it may still affect the decision of some prospective teachers in the area.

Figure 12 maps the distribution of adjusted pay gaps across the country. Comparing the adjusted pay gap to the previous maps of teachers' and non-teachers' pay differentials (Figure 7) shows that the gap is strongly influenced by the pay premium among non-teachers. That is to be expected because non-teachers' wages vary far more across the country than teachers' wages. However, the effect of the teacher pay regions can still be seen on the map: the greatest gaps are not in London itself but in the surrounding regions of High Wycombe and Reading, which both have an adjusted pay gap of over 11 per cent, which corresponds to about £5,400 per year. At the other end of the distribution, regions in the south-west such as Penzance and Falmouth have adjusted pay gaps of -20 to -25 per cent or over £9,000 per year.

Figure 12 Adjusted pay gaps

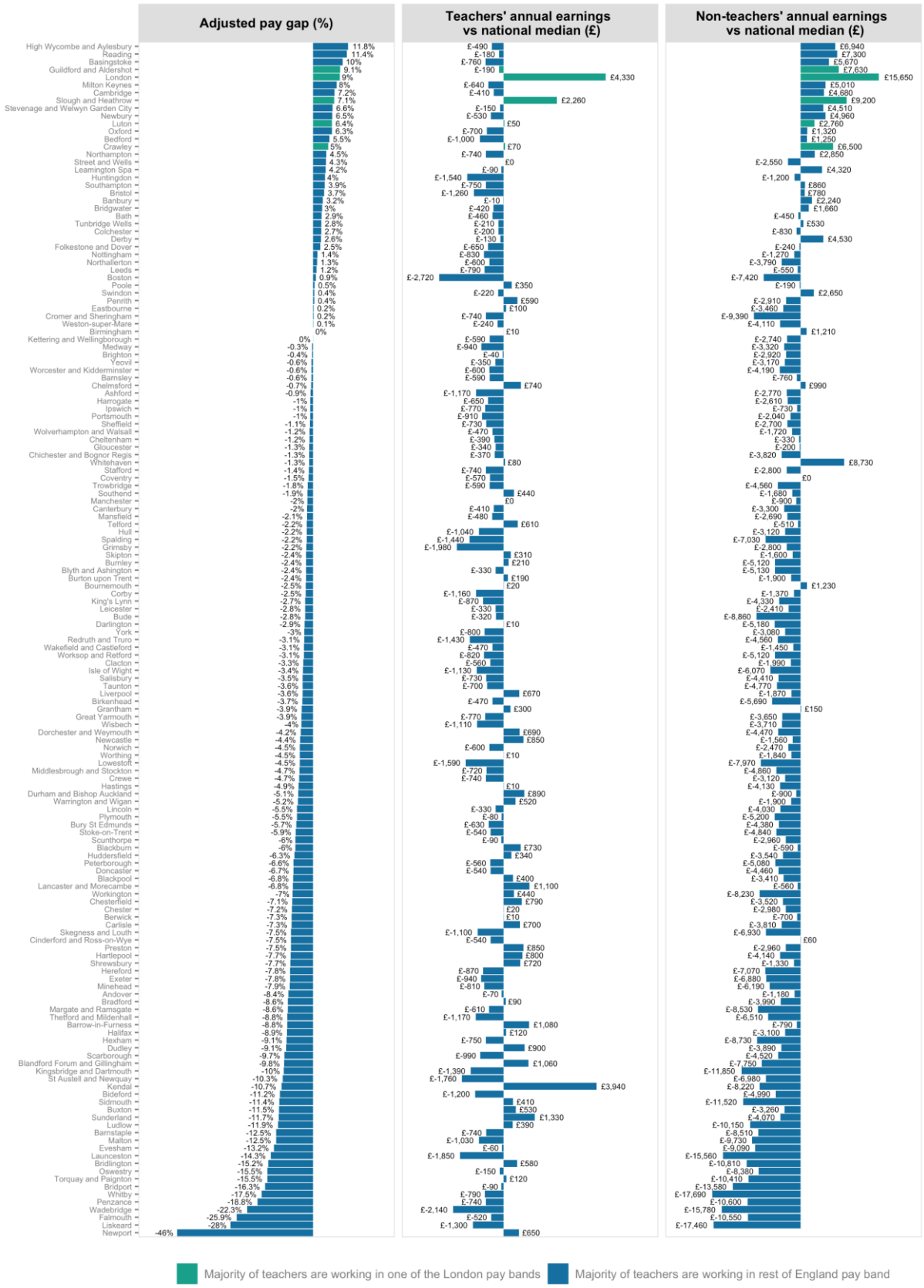


Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: The Birmingham TTWA has been used as the reference level and is left blank. All percentage differences are expressed relative to Birmingham. Values have been restricted to the -15 per cent - 11 per cent range for legibility, affecting 11 of 154 TTWAs.

The differences between regions can be seen in Figure 13, which shows the adjusted pay gap, and the raw pay differences from the national median, for all local labour markets. The pay figures in this chart are not adjusted for the composition of the workforce, so the differences across regions may be due to differences in the age or qualifications of the population and will be greater than the percentage difference in the left panel.

Figure 13 Pay differences and adjusted pay gaps



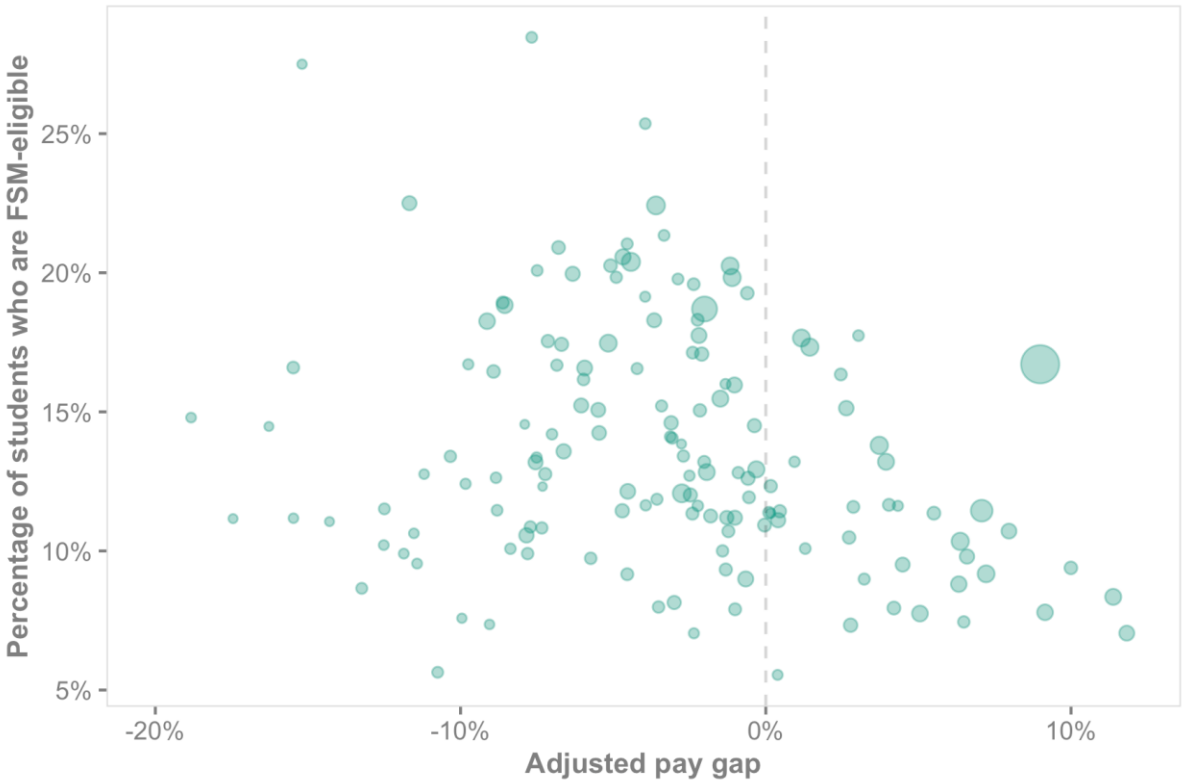
Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: The percentage gap between pay columns will differ from the adjusted pay gap because the adjusted pay gap considers the composition of the workforce in each TTWA.

The adjusted pay gap tends to be greater in areas that have a high cost of living, which are often the more affluent parts of the country (Figure 14).

This reinforces the need to consider the factors influencing teachers' pay as a package. Pay incentives can adjust for difficulties recruiting in disadvantaged areas, difficulties recruiting in shortage subjects, and difficulties in regions where non-teachers' pay and the cost of living is high. However, not every element of the pay settlement can deal with all these factors. As happens with school funding, there can be several reasons for introducing variation to teachers' pay.

Figure 14 Adjusted pay gaps and disadvantage



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Pay differences and recruitment difficulties

The previous sections have discussed the likely effect on teacher recruitment and retention of a relative pay gap. In this section, we review earlier empirical findings and use several indirect measures of recruitment difficulties to establish whether current supply difficulties are related to the adjusted pay gaps.

The impact of pay differentials on teacher supply

Many researchers have investigated the effect that teachers' pay, relative to other professionals, has on recruitment and retention. Early work from 1979 showed that starting salaries influence the decision to go into teaching.[36] Since then, the relationship between teachers' salaries and teacher supply has been established in a variety of settings around the world.[37]

One of the most notable consequences of wage differentials is that many countries struggle to recruit and retain science and mathematics teachers. Individuals with a degree in a STEM subject tend to be among the highest earners and these individuals are likely to face a higher pay penalty for becoming a teacher. Indeed, some of the earliest work in America shows that a $1,000 increase in science and mathematics teachers' wages, relative to engineers, is associated with a 0.19 percentage point decrease in the likelihood of a school experiencing shortages among mathematics and science teachers.[38] More recent evidence from the United States shows that a bonus of $1,800 reduced the attrition of STEM teachers in North Carolina by 17 per cent.[39] This is supported by EPI's work on the impact of salary supplements on the retention of STEM teachers in England.[40]

In the UK, several studies have shown the effect that relative wages can have on both recruitment and retention. Using graduate cohort data from the 1980s Dolton (1990) found that a 10 per cent increase in teachers' wages, relative to non-teaching graduates, increased the probability that a graduate will go into teaching by 0.35 per cent while Chevalier et al (2007), using graduate cohort data from the 1960s to the 1990s, finds a much larger effect of 8.7 per cent.[41] Related work from 1980 shows that a 10 per cent increase in teachers wages, relative to non-teachers with similar demographics, leads to a nine per cent fall in the probability that a teacher will leave after five years.[42]

The most recent empirical evidence in England finds that the 2013 policy reforms (discussed above) increased the salaries of teachers in regions where non-teachers earn more, narrowing the relative wage gap and increasing teacher retention. Specifically, they found an eight per cent increase in teachers' relative wages increased the number of teachers by three per cent.[43] This is supported by Allen et al. (2016) who also found that a 10 per cent increase in teachers' relative wages (relative to non-

[36] Zabalza, 'The Determinants of Teacher Supply'.
[37] Bravo and Alves, 'The Curriculum Development Process'; Dengelis, 'The Relationship between Teachers' Salaries and the Quality of the Supply of Recent College Graduates to Teaching.'; Murnane and Olsen, 'The Effects of Salaries and Opportunity Costs on Length of Stay in Teaching'.
[38] Rumberger, 'The Impact of Salary Differentials on Teacher Shortages and Turnover'.
[39] Clotfelter et al., 'Would Higher Salaries Keep Teachers in High-Poverty Schools?'
[40] Sibieta, 'The Teacher Labour Market in England'.
[41] Dolton, 'The Economics of UK Teacher Supply'; Chevalier, Dolton, and McIntosh, 'Recruiting and Retaining Teachers in the UK'.
[42] Dolton and Klaauw, 'Leaving Teaching in the UK'.
[43] Burgess, Greaves, and Murphy, 'Deregulating Teacher Labor Markets'.

manual occupations) reduced the likelihood that a teacher will leave teaching by one percentage point each year.[44]

The DfE recently examined the question by constructing a Teacher Supply Index, which gauges the severity of supply issues in a school by combining factors such as vacancies and temporarily filled posts, percentage of staff on permanent contracts, loss of experience through turnover, and percentage of hours taught by subject specialists. They found that supply issues are most acute in areas where property is unaffordable, and where teachers could easily earn more by moving across a border.[45]

These quantitative studies provide strong evidence for the proposition that paying teachers less than comparable professionals has a detrimental effect on their recruitment and retention. However, the studies all attempt to isolate the effect of relative pay from other factors and hold them constant. They do not indicate that pay is the most important influence on teachers' decisions, only that it has a meaningful influence.

Measures of teacher supply difficulties

Turning to the current situation, the first challenge is measuring the effect of relative pay on teacher supply difficulties. There are two main ways that recruitment and retention difficulties affect a school: it may struggle to recruit teachers with the skills and experience they hoped for, or it may struggle to retain their most valuable staff. It is only in the most severe circumstances that schools with vacant posts will be unable to recruit anyone to teach a class. For example, in 2019 there were fewer than 1,000 vacant posts on census day in November among a cohort of over 450,000 teachers, a rate of only 0.3 per cent.

Unfortunately, we do not have good data on how happy headteachers are with their staff recruitment and turnover in 2018/19. Instead, we use a small set of indirect measures that are frequently relied upon in education research and reported by the DfE:[46]

- **The proportion of teachers in a region without qualified teacher status (QTS)** – About five per cent of teachers do not have qualified teacher status (QTS) in state-funded schools in England. Most who do not have QTS are early in their careers and US evidence suggests they might be slightly less effective than qualified teachers.[47] Most of the unqualified teachers will be in their NQT year, though academies are also able to employ teaching staff without QTS, and employing a large proportion of NQTs also suggests supply difficulties.
- **The proportion of posts that are temporarily appointed** – A temporary appointment may indicate that the headteacher was unable to find the candidate they hoped for. Across TTWAs, between zero and 12 per cent of posts are temporary appointments.
- **The proportion of posts that are unfilled vacancies** – Unfilled vacancies in November are unusual and a high proportion of them in a TTWA is likely to indicate recruitment difficulties. Across TTWAs, between zero and 2.3 per cent of posts are unfilled vacancies.

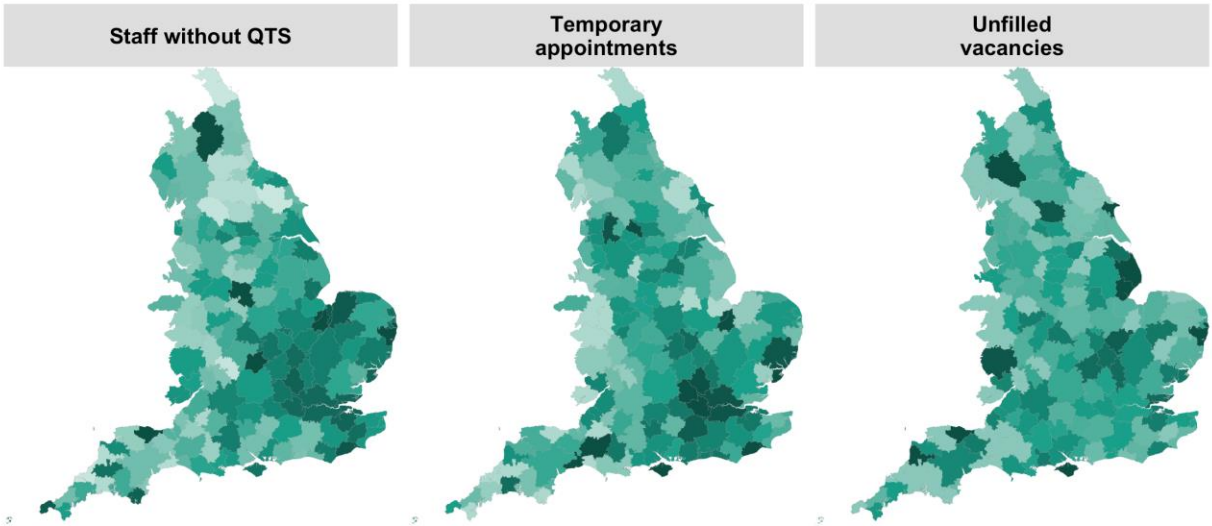
Neither of the three is an ideal measure of recruitment or retention difficulties but all three are likely to be correlated with them.

[44] Allen et al., 'The Longer-Term Costs and Benefits of Different Initial Teacher Training Routes'.
[45] Department for Education, 'Analysis of School and Teacher Level Factors Relating to Teacher Supply'.
[46] For example, Sibieta, 'Teacher Shortages in England'; Allen and Sims, 'Do Pupils from Low-Income Families Get Low-Quality Teachers?'
[47] Kane, Rockoff, and Staiger, 'What Does Certification Tell Us about Teacher Effectiveness?'

For ease of comparison across shortage measures, all three are centred and rescaled to a mean of zero and a standard deviation of one. That means an increase of one unit in any of the measures corresponds to a one standard deviation increase in that measure. It does not affect the distribution of any of the measures.

Figure 15 maps these indicators across the TTWAs with darker regions indicating greater difficulties on that measure. It shows that the three are not identically distributed across the country, which is not surprising because all three are imperfect indicators and are likely to be capturing distinct aspects of schools' recruitment problems. However, it can immediately be seen that the proportion of staff without QTS and the proportion of temporary appointments appear to be higher in the regions around London that also suffer from the largest pay penalty for teachers.

Figure 15 Indicators of teacher supply

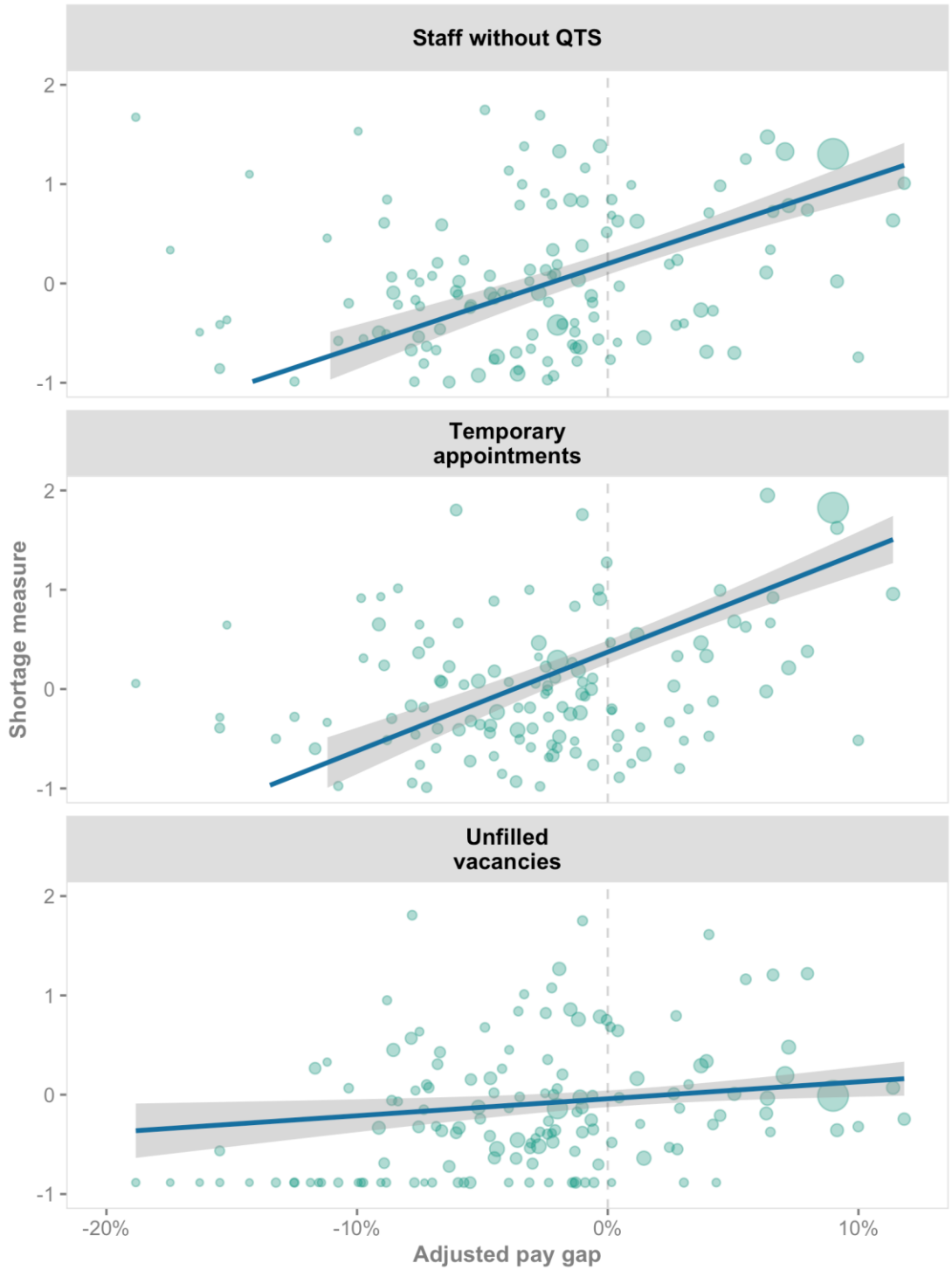


Source: EPI calculations from Department for Education, School Workforce in England 2019

Note: All indicators have been centred, scaled, and Winsorized for comparability and legibility.

Examining the relationship between the measures of supply difficulties and the adjusted pay gaps shows a strong correlation on all measures (Figure 16). The chart plots the three measures against the previously constructed adjusted pay gap, where each bubble is a TTWA and the size of the bubble is proportionate to the number of teachers in the TTWA. Taking account of the number of teachers is important because small TTWAs are more likely to have extreme results that could otherwise sway our interpretation of the correlation.

Figure 16 Relationship between adjusted pay gap and teacher supply



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: Lines fitted with weighted linear regression. Bubble size proportionate to the number of teachers in TTWA.

The correlations in Figure 16 suggest that higher gaps, where the non-teaching professionals' regional wage premium exceeds that of teachers, are associated with greater teacher recruitment difficulties on all three measures. That is consistent with our model of the relationship between the two, and with the previous research on the topic, dating back to the 1960s.

It is important to bear in mind that these are only indicators of supply difficulties in a region. The everyday difficulties faced by a headteacher – being unable to appoint a well-qualified physics teacher or struggling to find enough experience in early reading among job applicants – are likely to also be magnified in these regions. The difficulties we can measure here are only a weak indicator of the problems with supply shortages.

Non-pay factors that explain regional supply difficulties

Relative pay is one factor that influences recruitment and retention difficulties for a school but it is far from the only one, many of which could be idiosyncratic to particular schools. Perhaps they are in a remote location where few people wish to live in, or perhaps they have an unusual ethos and it is challenging to find candidates who are a good fit. There are also regional characteristics, other than pay, that affect the supply of teachers. We focus here on the measurable characteristics of the region that may affect a teacher's decision to apply for a job in that region: the cost of living, the level of deprivation and the characteristics of the schools.

We proxy the cost of living with the **median house price** in a TTWA. Due to the variation in house prices in England teachers are considerably better off in some regions. For example, the average salaries of teachers in Hartlepool, Sunderland and Durham, and Bishop Auckland (all in the north-east) are more than one-third of the average house price in these regions, while London teachers' salaries are just eight per cent of the average London house price.

The level of deprivation is measured using the English **index of multiple deprivation** (IMD), which combines information on a region's income, employment, education, health, crime, housing, and living environment. The index is calculated by the Ministry of Housing, Communities, and Local Government, and reports the IMD decile of each lower-layer super output area (LSOA) in England. We aggregate the LSOAs to TTWAs by taking a weighted average of the deciles in the TTWA.

The characteristics of schools and their pupils that we include are:

- **The proportion of pupils eligible for free school meals (FSM)** – this is similar to IMD but specifically captures the affluence of the families of children at the region's schools, which may be more relevant to teachers' decisions.
- **The proportion of pupils who speak English as an additional language (EAL)** – this is a proxy for the presence of migrant communities, who have been found to sometimes greatly affect the culture and performance of local schools.[48]
- **The proportion of pupils in primary schools** – supply difficulties vary between phases of schooling.
- **The proportion of pupils in urban areas** – urban areas tend to have more amenities than rural areas, and stronger labour markets, both of which might affect the supply of teachers.
- **The proportion of schools that are academies** – academy schools have greater freedoms over pay and conditions, which may affect the ease of recruitment and retention.
- **The average progress score of a school in the region** – it is possible that teachers may prefer to work in high-performing schools. A measure of school performance is drawn from the performance tables for key stage 2 and key stage 4. At key stage 2, the average of the progress

[48] See, for example, Burgess, 'Understanding the Success of London's Schools'.

scores in reading, writing, and maths is used. At key stage 4, the progress 8 measure is used. A weighted average progress measure is constructed for the region.

Each of the measures has been centred and scaled for comparability. Figure 17 shows the relationship between these regional characteristics and the measures of supply difficulties. Each column pertains to a single shortage measure and each row pertains to a single regional characteristic. The panels each show the relationship between one shortage measure and one regional characteristic across the TTWAs. Each bubble is a TTWA and they are sized in proportion to the number of teachers in the TTWA. Lines of best fit have been superimposed to aid interpretation.

Overall, the charts show that the proportion of teachers without QTS and the proportion of temporary appointments are strongly associated with many of the chosen regional characteristics. The two exhibit a similar relationship, which can be seen from the similarity in the slope of the regression lines in each of the charts in the first two columns. Conversely, the proportion of vacant positions has little association with any of the regional characteristics, as can be seen from the nearly horizontal lines in the third column.

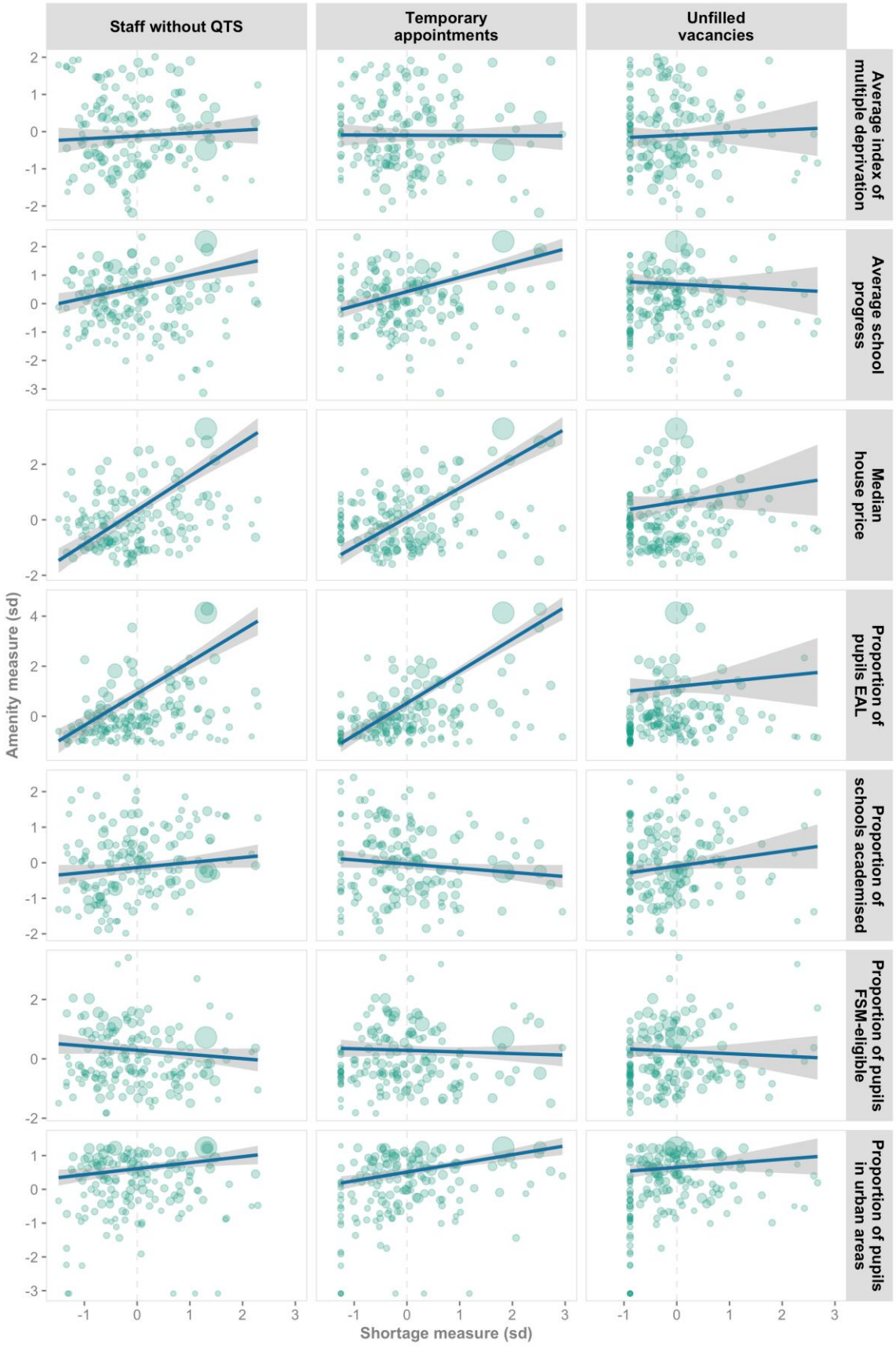
Notably, there is little association between either measure of disadvantage (IMD and FSM) and the shortage measures. That suggests less affluent areas do not disproportionately struggle with these indicators of shortages. However, within local labour markets, other studies have found that schools with a more disadvantaged student body are more likely to have difficulties with recruitment and retention. For example, EPI's recent work found that, outside London, 29 per cent of the most disadvantaged quintile of schools carried vacancies or temporarily filled positions, while that was true of only 22 per cent of the most affluent quintile of schools.[49] This reinforces the STRB's finding in 2012 that no system of pay regions could be sufficiently detailed to account for the circumstances of each school.[50]

Among the characteristics, two others that stand out are the median house price and the proportion of children with EAL. Both are highly correlated with the shortage measures, indicating that higher house prices and higher proportions of EAL are strongly associated with areas that also employ unusually many unqualified teachers and have a high rate of temporary appointments. These are two characteristics that are strongly associated with the London region, which is also the largest TTWA by some margin. However, re-estimating the chart with London removed (not shown) gives similar results, though with a slightly weaker association, which suggests that the pattern also holds across the rest of the country.

One final association worth picking out is with the school progress in a region. The chart shows a moderate correlation between the average school progress score in a region and two of the shortage measures. However, in this case, the association is almost entirely due to the impact of London's unusual teacher labour market. The London area is unusual in having a very high proportion of young teachers, correspondingly high attrition, and very strong pupil progress. If London is excluded, the relationship disappears.

[49] Sibieta, 'Teacher Shortages in England', 14.
[50] School Teachers' Review Body, 'School Teachers' Review Body 21st Report', para. 3.58.

Figure 17 Regional characteristics are associated with teacher shortages



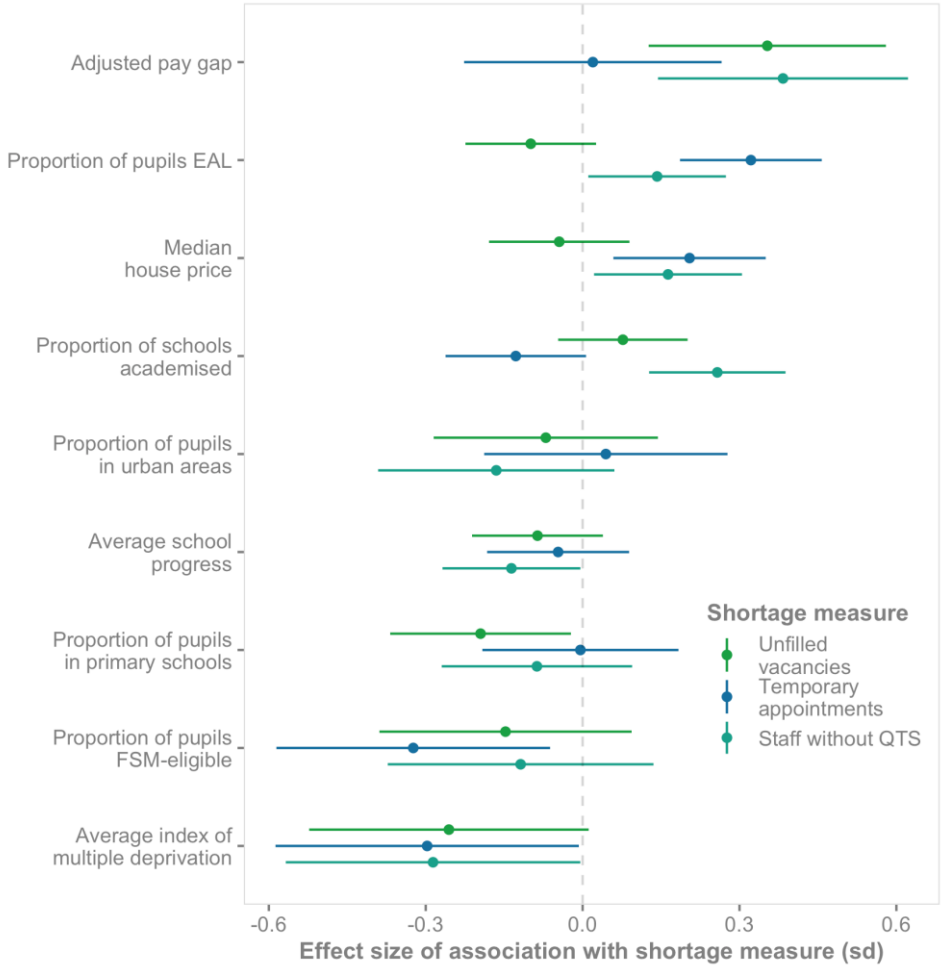
Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019.

Note: Each bubble represents a TTWA, sized in proportion to the number of teachers. Lines fitted with weighted linear regression.

The next question is whether these regional characteristics can explain the relationship between the adjusted pay gap and indicators of supply difficulties. To answer that, we regress the shortage indicators on the adjusted pay gap and include all the measures of regional characteristics in the regression. This shows which of the regional characteristics and adjusted pay gaps are best able to explain the differences in teacher supply difficulties across TTWAs, and what the strength of the associations is once all factors are accounted for.

We conduct three separate regressions: one for each of the shortage measures and all including the full set of regional characteristics and the adjusted pay gaps. The coefficients from all three regressions are displayed in Figure 18, which shows both the point estimates for each variable and the 95 per cent confidence interval. The effect size is standardised, which means that an increase of 1 standard deviation in the adjusted pay gap is associated with an increase of approximately 0.38 standard deviations in the proportion of staff without QTS in a region. This magnitude can be interpreted in a similar fashion to other effect sizes in education, with the strong caveat that this is not a causal estimate.

Figure 18 Strength of association between regional characteristics and shortage measures



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: Coefficients for each independent variable in multiple regression of shortage measure on regional characteristics. Estimated with robust linear regression at TTWA level, weighted by teacher numbers. Variables scaled and centred.

Unfortunately, estimating across only 154 TTWAs is a fairly small number of observations for the number of variables included and the confidence intervals are correspondingly wide. For many variables

there is no discernible relationship with the shortage indicators; however, for some, there is a pattern in the effects, though it is not consistent across all shortage indicators.

On two of the three shortage indicators, the median house price is associated with greater shortages, as is the proportion of pupils with EAL. This is after accounting for the average effect of the adjusted pay gap, so the effect is unlikely to be one transmitted through wages.

The proportion of academy schools in the region is associated with a greater proportion of unqualified staff. This may indicate shortages in regions with a high proportion of academy schools but EPI's earlier research has also found a pattern of multi-academy trusts employing younger staff and promoting them sooner, which might explain it.[51]

The association with the adjusted pay gap remains strong for two of the three measures. There is no remaining association with temporary appointments after accounting for regional characteristics but the association with unfilled vacancies is 0.35sd, and the association with a lack of QTS is 0.38sd. That indicates the adjusted pay gap retains explanatory power for understanding teacher supply difficulties, over and above the other regional characteristics included in this analysis, which is consistent with earlier work.

To convert that back into the underlying percentages, a 1 percentage point reduction in the adjusted pay gap is associated with a 0.11 percentage point reduction in the proportion of unqualified teachers (from an average of 4.1 per cent in our sample), and a 0.012 percentage point decrease in the proportion of vacant posts (an average of 0.2 per cent). Those are changes, compared to the average, of a 2.6 per cent decline in the proportion of teachers without QTS, and a 5 per cent decline in the proportion of vacant posts.

To put these results into perspective a 5 percentage point decrease in the pay differential would decrease the average number of vacancies by 1.3 in each region and increase the number of teachers with QTS by 63 in each region at a total cost of £873m. But, even just increasing salaries in regions that face a pay penalty would cost £288m.

For example, High Wycombe has one of the highest pay differentials in the country – teachers are paid almost £5,500 less. If we were to close this gap entirely, we would expect it to reduce unfilled vacancies by almost 20 per cent at a cost of £13m. Wolverhampton has one of the highest full-time teacher vacancies and a 5 per cent pay rise would decrease the number of vacancies by almost 15 per cent (move it from among the highest vacancies to roughly the 75th percentile) at a cost of £10m. This is especially important given that Wolverhampton has one of the highest proportions of FSM (20.2 per cent).

Looking at the areas with the highest proportion of FSM students (the 75 percentile or above) where teachers also face a pay penalty, there is an average pay difference of £1,800. If we were to end the pay parity in these areas, we would expect it to reduce unfilled vacancies by 5 per cent and half the number of unqualified teachers. At a cost of £118 million which is roughly a 5 per cent increase in the expenditure on teacher salaries in these regions.

In the regions where teachers earn less than other professional occupations if the pay gap closed by 10 per cent, the number of vacancies could decline by 198 and the number of unqualified teachers by 6 per region (a reduction of 198 and 4.3 respectively across all the regions where teachers face a pay penalty). In addition, we would expect this boost to reduce teacher attrition by 0.5 percentage points (420) each

[51] Andrews, 'Teacher Recruitment, Progression and Retention in Multi-Academy Trusts'.

year and increase recruitment by 3.35 per cent (300). This means an added 720 teachers in the school workforce in these areas. This would cost approximately £29 million, the majority of which could be paid for using a fraction of the money saved from cutting teaching bursaries (£130 million).

If we were to instead halve the pay gap, we would reduce the number of vacancies by 0.6 and reduce the number of unqualified teachers by 33 per region (1,089 and 20 nationally), reduce teacher attrition by about 2.6 percentage points (2,200) each year and increase recruitment by 18 per cent (1,560) – 3,700 more teachers in these areas. The cost of this (£147 million) could be largely paid for by the money saved from cutting teaching bursaries (£130 million).

Drawing on prior research to estimate the effect on recruitment and retention, a 1 per cent pay rise for teachers in areas with an existing pay penalty could reduce teacher attrition by 0.1 percentage points each year and increase recruitment by 0.87 per cent.[52] That roughly equates to an added 300 teachers in the workforce, and schools with some of the greatest recruitment and retention difficulties.

[52] Dolton, 'The Economics of UK Teacher Supply'; Chevalier, Dolton, and McIntosh, 'Recruiting and Retaining Teachers in the UK'; Allen et al., 'The Longer-Term Costs and Benefits of Different Initial Teacher Training Routes'.

Policy implications

This report highlights the association between regional pay gaps and teacher supply difficulties. There is also extensive evidence that supply difficulties are greatest in particular subjects and schools with a greater level of disadvantage. These concurrent policy challenges present a difficult set of policy trade-offs.

Targeted supplements

The recruitment and retention challenges caused by regional pay gaps, subject-specific shortages and challenging schools cannot all be dealt with through a single mechanism. To address the latter two, we previously wrote:

> *The government has introduced new salary supplements for shortage subjects (£2,000 per year if still teaching 2, 3 and 4 years after training) and challenging areas of the country (an extra £1,000). However, these are only for new teachers. It would be relatively inexpensive to extend these to existing teachers to help keep them in the profession and double the extra payments for challenging areas or schools to attract teachers to such schools, costing around £55m in total or £35m more than the existing scheme. This compares with a total budget for teacher training bursaries of more than £170m.*[53]

Since then, the government has scrapped retention payments and cut bursaries for the 2021/22 academic year, though the department said that those who have started their training up to, and including, 2020/21 will still receive their early-career payments as planned. Considering the existing retention difficulties, which are likely to recur as the pandemic recedes, this change of direction may prove to be a mistake. **We recommend the government reinstates the supplements and extend them to existing teachers.**

Regional pay gaps

The analysis in this report, in conjunction with prior work on the subject, demonstrates a clear association between pay gaps in local labour markets and difficulties with teacher recruitment. When non-teaching professionals in the local area earn significantly more than teachers, it is more common to find recruitment problems. This finding is reinforced by earlier work that finds causal associations between pay gaps and teacher retention. Reducing the pay gap in high-paying, high-cost, or unattractive areas is likely to help mitigate the recruitment and retention difficulties.

The existing London pay regions do not provide enough additional pay support to close the pay gap in London, nor do they cover the other high-paying, high-cost regions of the country, many of which are close to the London area. Moreover, local labour markets are not easily defined by administrative boundaries and centrally adjusting pay through the mechanism of pay regions is unlikely to usefully close the pay gap in the places it is most needed.

This analysis confirms the findings of the STRB as long ago as 2012: “the real need is for the pay system to have the flexibility to target school-level recruitment and retention problems … [which] cannot be addressed effectively through the further refinement of a centrally determined structure of geographic

[53] Sibieta, ‘Teacher Shortages in England’, 41.

pay bands or zones."[54] The STRB is not the only pay review body to be reconsidering London weightings or local labour market costs, with both the NHS and police pay review bodies expressing concern in the past year.

The most obvious policy solution is to remove pay regions, fund schools at a level commensurate with the local costs they face and let school leaders set pay structures for their schools within broader pay scales than currently exist. They are best placed to understand the local labour market they face and adjust their pay structure for the specific conditions of their school.

The current national funding formula includes an area cost adjustment (ACA) element to account for geographical differences in labour costs and ensure that headteachers have the funding to match.[55] The ACA has two main components: a teachers' pay component, which is based on the four teachers' pay regions, and a non-teachers' pay component, which is based on non-teachers' wages in 55 local areas across the country. These are weighted by the relative contribution of each to schools' costs.

It would be relatively straightforward to modify the ACA so that it relied entirely on non-teachers' wages in the local labour market, rather than being primarily based on the pay regions. That would alter the distribution of funding to better match local labour market conditions, but it is possible that the 55 regions used are not small enough to capture local variation. The NHS has a similar adjustment to its tariffs – the market forces factor – that uses TTWAs and accounts for differences in industry and demographic composition, much as we do in this report to calculate pay differentials (Figure 11).[56]

However, the analysis in this report shows that a mechanism like this would be likely to direct additional funding to London and the surrounding regions. These are some of the most affluent areas of the country and, in addition, London pupils tend to outperform students in the rest of England on standardised tests. With limited budgets, there is a case to be made that redistributing funding towards these areas would not be the best use of the money.

This is a complex issue because the purpose of the ACA is to adjust for the cost of staff but, if it is to function effectively, then it will need to direct money to areas where schools face higher costs to recruit and retain staff. Underfunding those schools is likely to lead to an inability to recruit and retain the most attractive staff in those areas. However, those are also likely to be the most affluent parts of the country, which is why costs are high. Balancing the need for funding to follow local costs against the need to support schools in challenging circumstances is a central difficulty for policy formation.

Pay scales and funding

The difficulty of using teachers' pay to reduce supply difficulties is exacerbated by the national guidance on pay. The advisory pay points that were recently introduced are set within pay regions, which we have previously established are a poor proxy for local labour costs. These defaults are likely to restrain school leaders from exercising their freedoms to adjust pay to local conditions. However, even if the advisory pay points were removed, the funding difficulties considered above would restrict their freedom to set pay for local conditions.

These considerations mean that it is essential that pay freedoms and funding patterns considered together, rather than independently. The purpose of the ACA and the pay regions is to adjust local pay

[54] School Teachers' Review Body, 'School Teachers' Review Body 21st Report', para. 3.58.
[55] Department for Education, 'Schools Block National Funding Formula: Technical Note', para. 3.29.
[56] NHS, '2020/21 National Tariff Payment System: A Guide to the Market Forces Factor', 7.

to local conditions but the pay regions underpinning both no longer match the distribution of costs. **The DfE should review its approach to dealing with local costs, having regard to both the equity of the distribution and the impact of changes on recruitment and retention.**

Appendix A: Datasets and assumptions

ASHE

The Annual Survey of Hours and Earnings (ASHE) is a survey carried out on a 1 per cent sample of employees' jobs (roughly 300,000) taken from HM Revenue and Customs (HMRC's) Pay As You Earn (PAYE) records. The ASHE survey is conducted annually every April. The data that is included in the ASHE dataset include gross pay and hours worked as well as a variety of background job (industry and occupation codes) and individuals (sex, age, region of decile and employment) characteristics.[57]

Occupational classification

We restrict our analysis to those who work full time.[58] To maximise the number of TTWAs we can use we pool data from 2012-2019 to ensure that we have enough power to estimate non-teachers' wages in each local labour market (What per cent of TTWAs do we not estimate). Note that we adjust the wages to 2019 prices using the Consumer Price Index.

Teaching is a professional occupation. In England, individuals must hold an undergraduate degree to gain qualified teacher status. Therefore, it makes sense to compare teachers' salaries to the salaries in occupations that teachers are likely to have done had they not gone into teaching.

We drop all individuals who work in the following occupations as they do not represent the type of jobs that teachers are likely to sort into: Elementary occupations (SOC 9), process, plant and machine operatives (SOC 8); sales and customer service occupations (SOC 7); caring, leisure and other service occupations (SOC 6); skilled trades occupations (SOC 5); administrative and secretarial occupations (SOC 4). Depending on our definition of non-teachers, we also drop associate professional and technical occupations (SOC 3).

Therefore, we compare the earnings of teachers to other professional occupations using the ONS's SOC 1-2 classification. This includes occupations ranging from charted accountants and architects to social workers and nurses. But this definition might be too restrictive, and it might make sense to include associate professional and technical occupations (SOC 1-3) in our comparison group. This would include occupations such as ranging from youth workers, housing officers and paramedics to brokers, estate agents and graphic designers.

As teaching is a vocational occupation, we accept that teachers and non-teachers systematically differ on unobservable characteristics however, due to data limitations, we are unable to account for these differences. For example, HESA data suggests that teachers are underrepresented among Russell Group graduates and overrepresented among graduates with a lower second-degree classification.

We restrict our analysis to those between the age of 21 and 65. Teaching is a graduate-level occupation typically undertaken by those 21 or over. People over 65 were over the retirement age until 2018 and retirees are also unlikely to form a good comparison group. In addition, we drop individuals whose reported earnings is below the expected minimum wage.

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[57] Office for National Statistics, 'Annual Survey of Hours and Earnings (ASHE)'.

[58] As in Walker et al., 'The Costs and Benefits of Different Initial Teacher Training Routes'.

Using this sample, we estimate geographic wage differentials for non-teachers using ASHE data by regressing TTWA dummies on logged wages controlling for sex, age, age squared, occupation, industry, and year fixed effects. We do this separately using our SOC 1-2 and SOC 1-3 sample.

The coefficients for our TTWA dummies report the conditional difference in logged wages between each TTWA and Birmingham (our reference group).

Pooling across years

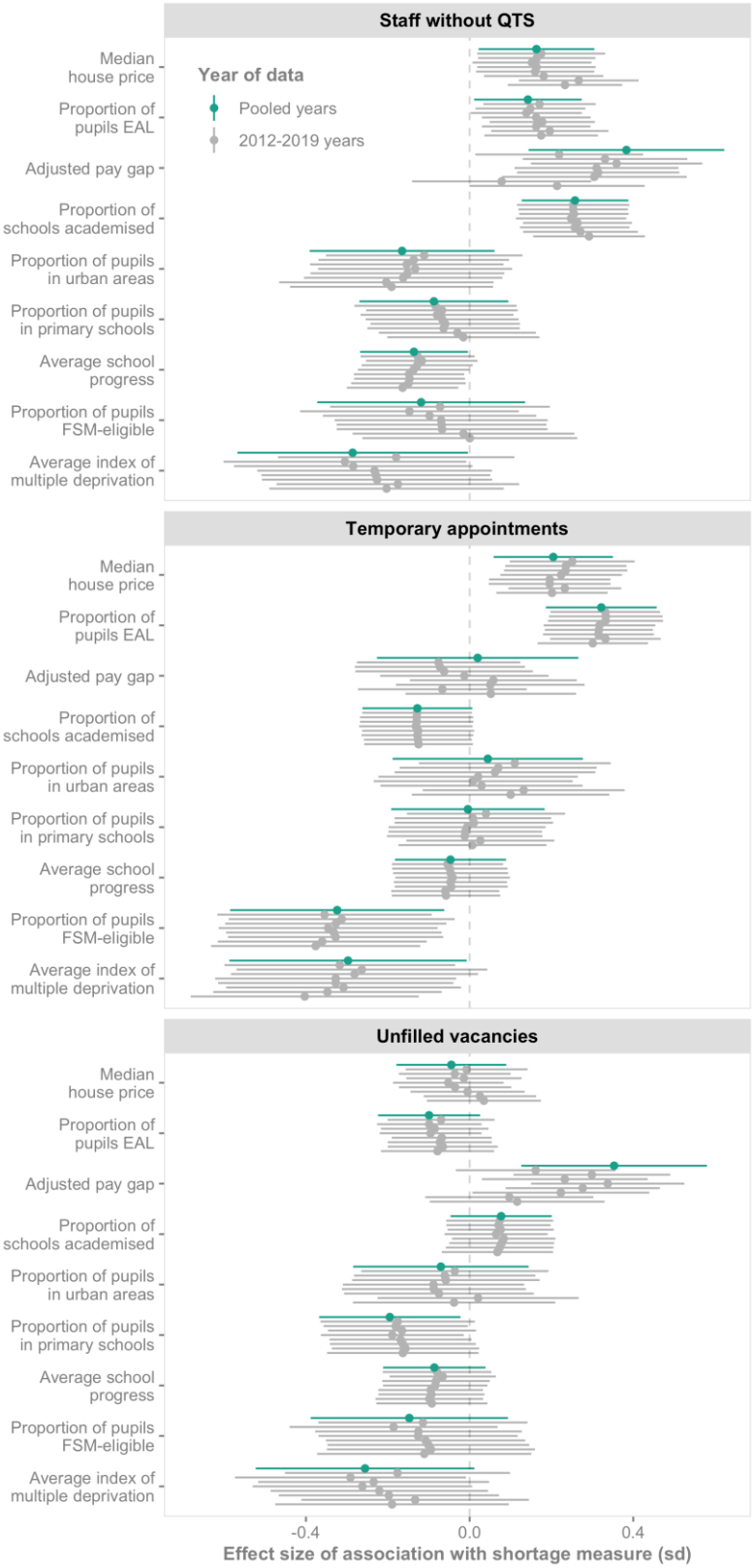
To ensure that we have a large sample size in our TTWAs we pool eight years of merged ASHE data. The benefit from using a pooled sample is that we get a precise estimate of how much non-teachers earn in each local labour market. Using a sample from an individual year, such as 2019, means that for many of our smaller TTWA's our estimates are either unable to estimate the pay differential (due to ONS data requirements) or they are very imprecise.

Our underlying assumption is that pay differentials are stable over time. To check this is the case we estimate the pay differentials for each year (2012-2019) and each TTWA.

Figure 19 below extends Figure 18 by estimating the coefficients from a single year of ASHE data rather than the pooled sample. Each panel contains the estimated coefficients and confidence intervals for all years of ASHE, for a single shortage measure. The grey points and intervals each represent the coefficients for a single year of ASHE. The green points are the coefficients from Figure 18 for ease of comparison.

The figure shows that the coefficients for all variables are stable over time, justifying the decision to pool across years. What the plot does not include is a measure of the additional precision gained by pooling the ASHE data. The confidence intervals represent only the uncertainty in this regression across TTWAs and do not include the additional uncertainty in the measure of the adjusted pay gap. That uncertainty is dramatically less than in the single-year estimates, which means that this chart underestimates the uncertainty associated with that measurement error.

Figure 19 Comparison of coefficients across annual samples of ASHE



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Teachers' outside options

One of the key challenges when estimating the wage premium is identifying how much teachers could earn if they decided to leave the profession. Some studies have estimated what teachers could earn in an alternative profession by comparing the earnings of current teachers to the earnings of non-teaching graduates who look like them based on personal characteristics such as age, sex, ethnicity, educational attainment.[59]

In the UK, Chevalier et al. (2007) estimate teachers relative wages by comparing teachers to non-teaching graduates controlling for differences in observable characteristics.[60] But these studies estimate teachers' relative wages at the national level, not the local level. While this does make sense in general – graduates in the UK are highly mobile – it might not be appropriate for teaching because most teachers tend to stay within commuting distance when moving schools.[61]

In recent years England has moved from a centrally managed, university-led teacher training system to a more devolved and locally responsive one.[62] Consequently, an approach that estimates teachers' outside option – how much current teachers could earn if they quit teaching – by comparing current teachers' wages to the earning of others in their local labour market might be a more appropriate method of estimating teachers' outside option.

As teachers tend to stay in the same geographical area when changing jobs, it makes sense to do this at a local level. To get a sample size large enough to estimate teachers outside option at a local level we must either use a broad definition of non-teachers – such as all non-manual occupations – or aggregate multiple years of data. The latter allows for a more restrictive definition, such as non-teachers in other professional (SOC 1-2) or associate professional (SOC 1-3) occupations.[63]

The challenge with using a broad definition of non-teachers is that non-manual workers and teachers differ in many respects and are unlikely to be comparable. Differences in wages between teachers and a broad definition of non-teachers is likely to be due to differences in the characteristics of the two groups, rather than representing a genuine wage premium or penalty for teachers. Using a more restrictive definition requires us to assume that non-teachers' wages are stable over time.

Taking the first approach, Walker et al (2014) and Britton and Propper (2016) used ASHE to investigate the effect of teachers' relative wages, measured at the regional level where they defined the local labour market as all local authorities within 30 km of the school.[64] Using this definition of the outside option they find that regions where teachers earn high relative wages have higher retention rates and student performance.

In this project, we use the second approach to estimate how much teachers could earn if they left the profession. Like Allen et al. (2014) and Britton and Propper (2016) we use ASHE to estimate teachers outside option, but we use the more restrictive definition of non-teachers, we assume teachers only leave teaching for a similarly professional occupation, and we define teachers local labour market using

[59] Greaves and Sibieta, 'Estimating the Effect of Teacher Pay on Pupil Attainment Using Boundary Discontinuities'; Fullard, 'Relative Wages and Pupil Performance, Evidence from TIMSS'.
[60] Chevalier, Dolton, and McIntosh, 'Recruiting and Retaining Teachers in the UK'.
[61] Department for Education, 'Analysis of Teacher Supply, Retention and Mobility'.
[62] Walker et al., 'The Costs and Benefits of Different Initial Teacher Training Routes'.
[63] Britton and Propper, 'Teacher Pay and School Productivity'.
[64] Walker et al., 'The Costs and Benefits of Different Initial Teacher Training Routes'; Britton and Propper, 'Teacher Pay and School Productivity'.

the ONS's TTWAs. The advantage of using TTWAs is that at least 75 per cent of the economically active population work and live in these areas.

Therefore, the non-teachers' earnings, measured using professional occupations at the TTWA level is likely to be a good indicator of the actual earnings that teachers would be likely to earn in an alternative profession. The disadvantage of this approach is that to get a sample size large enough for each region we have to aggregate our data (merge the 2012 to 2019 years of ASHE) but even then many of our estimates are still relatively imprecise due to the modest sample size in many of our smaller TTWA's.

Our estimates are likely to differ from teachers' true outside option as we are comparing teachers' earnings to a combination of graduates and non-graduates. This means that our estimates may underestimate what teachers would be likely to earn as teaching is a graduate-level occupation. However, teachers do tend to come from the lower end of the graduate earnings distribution (due to degree class, institution attended and degree subject), so it is also possible that we overestimate teachers' outside option.

Non-teachers' pay represents the average wages in a teacher's local labour market. We are assuming regional wages are positively correlated with teachers' outside option. In addition, we are assuming that the error in teachers' beliefs/expectations about their outside option is consistent across regions. For example, if teachers in London underestimate their outside option and teachers in Doncaster overestimate their outside option the difference in expectations might explain observed differences.

Finally, we do not account for differences in local labour market conditions with respect to employability. Despite similar non-teaching salaries it might be more difficult to get a job in some areas than others.

School workforce in England

We use the 2019 SWiE dataset, based on the November 2018 school workforce census and augmented from the Database of Teacher Records by the DfE. It reports data on the school workforce at a school (URN) level.

School type is limited to:

- Academies
- LA maintained
- Free schools

School phase is limited to:

- Primary
- Secondary
- All through
- Middle deemed primary
- Middle deemed secondary

Extreme outliers on the shortage measures are treated as missing as follows:

- Treated all observations of fewer than half of staff having QTS as missing per DfE advice on dataset. Affects 1,022 schools, 5 per cent of dataset.
- Treated all observations with more than 30 per cent of posts being temporarily filled as missing. Affects 142 schools, 0.7 per cent of dataset.

- Treated all observations of more than a quarter of posts being vacant as missing. Affects 26 schools, 0.1 per cent of dataset.
- Overlap between these figures means that a total of 1,077 schools (5 per cent of dataset) have at least one item of missing information across the three.

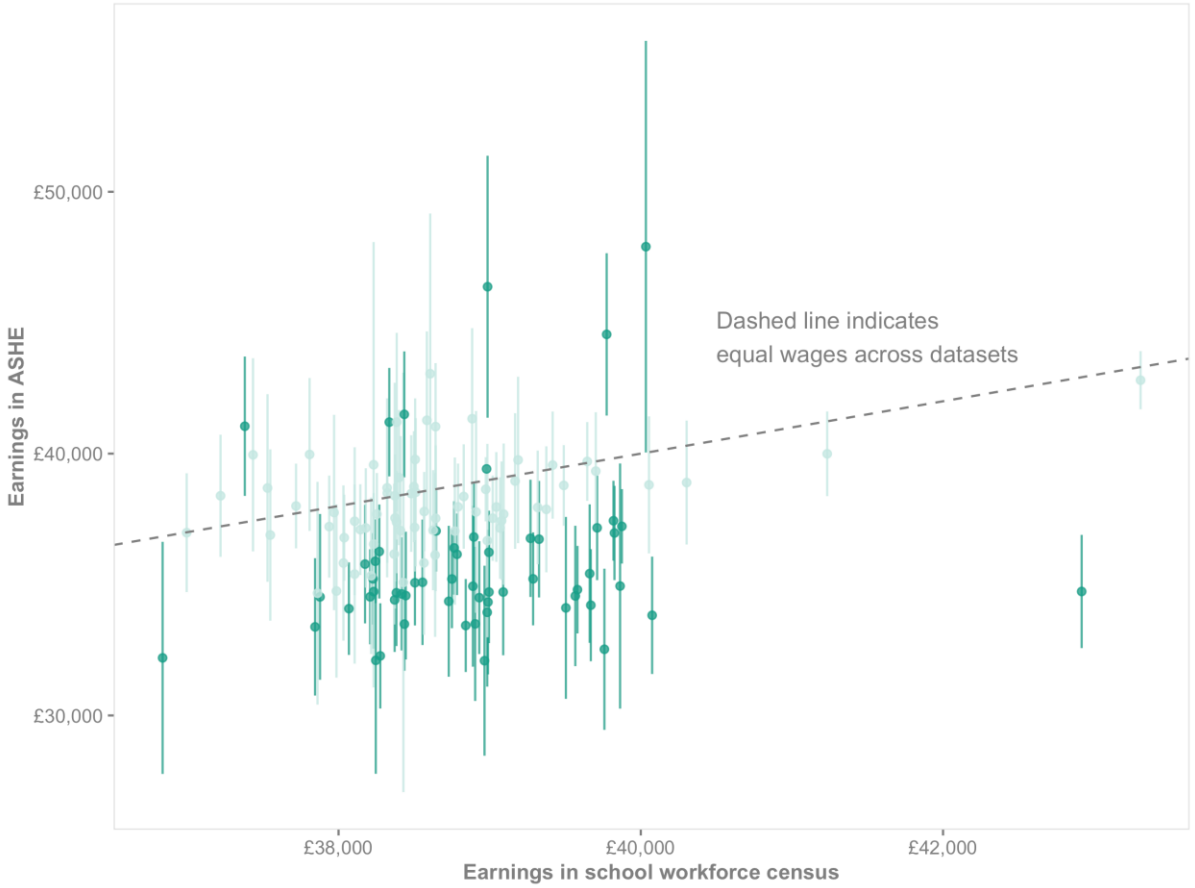
Wages are adjusted to 2019 levels using the ONS CPI all items index (D7BT).

Using SWiE for teachers' wages instead of ASHE

We estimate teachers' outside option using non-teachers' wages from ASHE but teachers' wages come directly from the School Workforce in England (SWiE). We originally intended to use ASHE to estimate both teachers and non-teachers' wages. However, when we compared our estimates of teachers' wages at the regional level to the SWiE (the population) we found there were non-trivial discrepancies (Figure 16). Consequently, we decided to use teachers' wages from the SWiE and use ASHE to estimate their outside option.

A plausible reason for the discrepancy between ASHE and SWiE is that our definition of teachers (using SIC and SOC codes) includes some teaching support staff and/or other individuals who are not teachers. This is because Cascot, the software used for occupational and industrial coding, has a relatively high error rate, particularly among more educated individuals.

Figure 20 Comparing teachers' annual earnings across datasets



Source: EPI calculations using ASHE 2012-2019 and School Workforce in England 2019.

Note: Mean annual earnings in travel-to-work areas in England. Each point represents a TTWA, darker points are those where the ASHE 95 per cent CI does not contain the SWiE value. Some TTWAs omitted because ASHE results are suppressed due to small samples.

Stability of teachers' wages over time

In our report, we use teachers' salaries from one year (2018) while we estimate non-teachers' wages using ASHE data from pooled sample (2012-2019). The reason we use a sample of non-teachers across multiple years is to get a sample size large enough to estimate non-teachers' wages by TTWA. As our teacher data comes from the SWiE we do not have to aggregate over multiple years and we decide to use the mode recent year that school-level data is available (2018).

As schools have been given more autonomy in deciding teachers' pay this could be problematic if there is variation in teachers' pay, at the regional level, across time. However, we find that teachers' salaries are highly stable over time – there is a strong correlation between the regional mean in teachers' salaries over time.

Figure 17 Correlation matrix of teachers' wages by year

Year	2012	2013	2014	2015	2016	2017	2018	2019
2012	1							
2013	0.916	1						
2014	0.945	0.906	1					
2015	0.909	0.938	0.928	1				
2016	0.895	0.903	0.927	0.933	1			
2017	0.879	0.853	0.931	0.904	0.956	1		
2018	0.825	0.757	0.866	0.796	0.883	0.913	1	
2019	0.866	0.874	0.864	0.889	0.910	0.858	0.801	1

Source: EPI calculations using School Workforce in England 2012-2019.

Note: Spearman correlation matrix of teachers' regional pay (by Local Authority). The closer the correlation coefficient is to 1 the stronger the correlation.

Issues with aggregation

In this report we estimate non-teachers' wages using ASHE and impute these estimates onto a dataset containing pupil performance, teacher and school characteristics at the TTWA level. This means we are investigating the relationship between teachers' relative wages and our different measures of teacher supply, controlling for a set of regional, pupil, and school covariates, by exploiting variation in teachers' relative wages and the supply of teachers across regions. Consequently, we have a lot less variation to exploit than if we were looking at the relationship at the school or individual pupil level.

Joining datasets

Across the DfE datasets, some schools have been renamed, converted to academies, or otherwise changed hands between our earliest dataset (November 2018 SWiE) and our latest dataset (October 2020 GIAS). To ensure that we pick up as many schools as possible we have used the DfE's published URN successor tables to link schools over time and maintain continuity where possible.

The difficulty with linking over time is that schools merge and separate, which can introduce duplicates into the dataset and lead to undercounting or overcounting. There is no single snapshot we can use for all variables so differences between the datasets are inevitable.

In this project, our focus is the wages of teachers so we have ensured that the number of teachers in our combined dataset remains at the level of the November 2018 SWiE. That means our number of pupils and number of schools differs slightly from the numbers in the original DfE releases we draw upon. However, those differences are less than 0.5 per cent, relative to the original publication.

Appendix B: Estimating pay differentials

Pay differentials in ASHE

The pay differentials (SSWDs) are calculated by estimating

$$ln(w_{ijs}) = x'\beta_s + SSWD_{js} + \epsilon_{ijs}$$

Where w_{ijs} is the hourly earnings of individual i who works in area j within the sector s. The areas are the TTWAs with Birmingham as the reference group. The sectors are the private sector and state-funded schools sector. Vector x contains personal and job-related characteristics:

- age
- age-squared
- gender
- year dummies
- industry
- occupation

The $SSWD_{js}$ are the TTWA-specific effects for sector s operating in area j, and ϵ_{ijs} is the individual-specific error term.

Estimation is performed using the lm function of the R programming language.[65]

Pay differentials for the school workforce

For the school workforce, pay differentials are calculated from school-level data in a similar fashion, save that the i are schools, not individuals. The variables used are as close to the ASHE variables as is possible using the publicly available data:

- proportion of teachers in a school aged over 50
- percentage of teachers working part-time
- percentage of male teachers

Year, industry, and occupation dummies are unnecessary because the dataset contains only teachers in service on the census day in 2018. The linear regression is weighted by the headcount of teachers at each school.

A central concern with using pay at the school level is that the control variables are insufficient to account for the age variation in the teacher pay differentials. We cannot account for that without individual-level data; however, we can demonstrate that it would not materially affect our conclusions.

If we were to account for the variation caused by the distribution of ages across the country then the variation in teachers' pay differentials would decline. If we were to reduce the variation in pay differentials to be only that caused by the pay regions then we can be certain that none of the variation generated by age differences is causing it. That represents a lower bound on the variation in teachers' pay differentials.

Using that lower bound in the calculation of the adjusted pay gap and regression coefficients leaves all the variation in the adjusted pay gap to the non-teachers' pay differentials. If similar patterns emerge

[65] R Core Team, *R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing*.

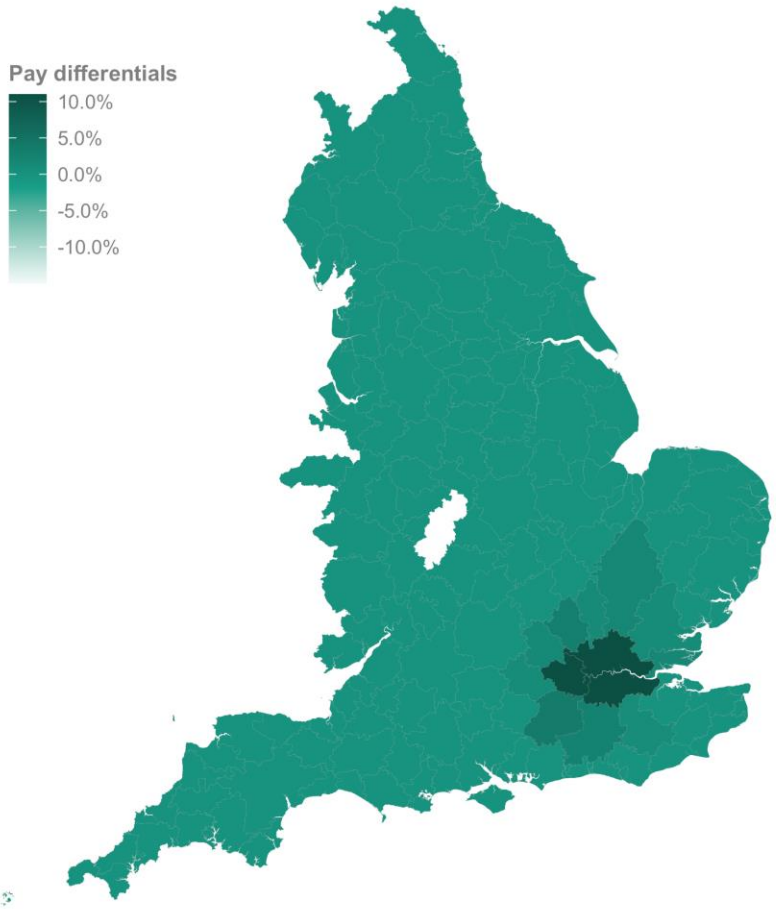
then we can be confident that the lack of individual-level variables in our estimation of the teachers' pay differentials is not causing us to misinterpret the results.

To generate pay differentials from the pay regions, which do not nest easily within the TTWAs, we:

- Assign each school a pay region based on its location.
- Assign a nominal pay level at the bottom of the main pay scale in the September 2018 STPCD (also referred to as M1). (Note that the level does not affect the pay differentials, only the difference across schools, so choosing another point on the pay scale would not alter the estimates.)
- Calculate an average pay level for the TTWA as a weighted average of the school-level pay, weighting by the number of teachers.
- Calculate pay differentials from those pay levels without controlling for any characteristics of the teachers or regions.

Mapping the pay differentials for the pay regions alone, using the same colour scale as previously gives Figure 21. The lack of variation and the effect of the pay regions is clearly visible.

Figure 21 Pay differentials for the bottom of main pay scale

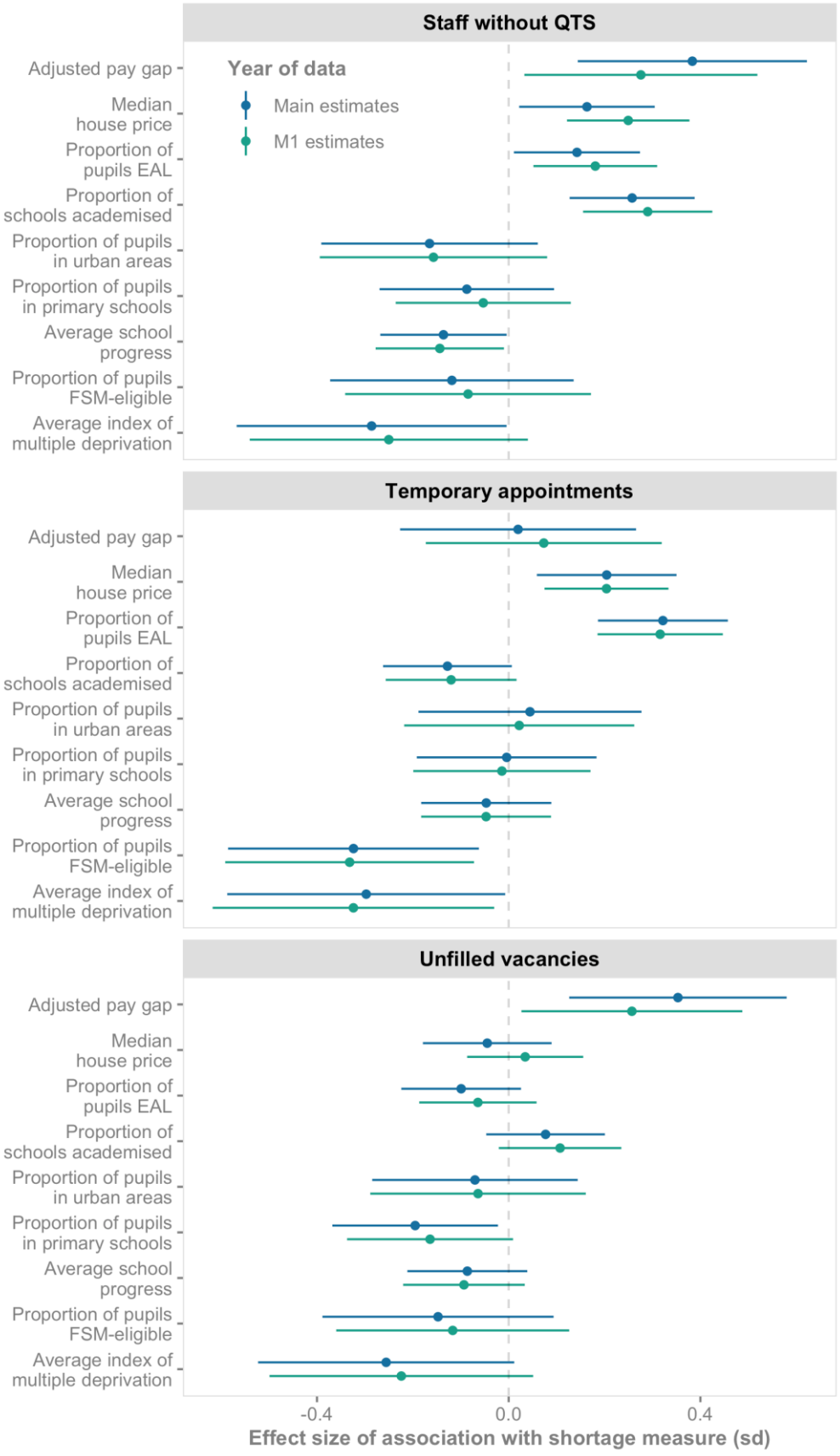


Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

Note: The Birmingham TTWA has been used as the reference level and is left blank.

Using those M1 pay differentials to replicate Figure 18 and calculate the coefficients on regional amenities gives Figure 22.

Figure 22 Comparing main estimates to M1 estimates



Source: EPI calculations using ONS ASHE 2012-2019; Department for Education, School Workforce in England 2019

While there are slight differences between these coefficients and the main estimates, they are small and indistinguishable from noise. That means we can be confident that the lack of control variables in the school-level data is not driving our conclusions.

Reference category

When calculating the pay differentials using region dummies our reference group is Birmingham. We decide to use Birmingham because a reliable comparison group needs to be both large enough and not an outlier. Birmingham is the third-largest TTWA behind Manchester and London and is not an outlier (as London is).

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