Pandemic-Era School Staff Shortages: Evidence from Unfilled Position Data in Illinois

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Abstract

Concerns about school staff shortages are longstanding. However, data on shortages are limited, dated, and rare for non-teaching staff. I use administrative data on unfilled certificated positions in Illinois public schools from the fall of 2022 to paint a detailed picture of shortages across teaching, administrative, and other roles, between districts, and between schools. Teacher and administrator shortage rates are low on average, but shortages of other staff – mostly paraprofessionals – are more severe. However, staff-to-student ratios have increased recently for all staff types. Shortages vary substantially between schools within districts and across urbanicity, grade level, and student characteristics, often in ways that likely exacerbate inequities.

For decades, stakeholders have had concerns about school staffing problems (Associated Press 1951; Rich 2015), and especially teacher shortages (Sutcher, Darling-Hammond, and Carver-Thomas 2019; Goldhaber et al. 2020; Beilstein and Withee 2022). These concerns have if anything only grown due to the pressures that the COVID-19 pandemic placed on schools (Associated Press 2021; Cullotta 2022). Yet concerns about school staffing challenges have often outpaced the related evidence. This is in part because school staff labor markets are large, diverse, and segmented, making them difficult to characterize (Pounder, Galvin, and Shepherd 2003; Bruno 2022). There is also a lack of detailed, timely information about shortages, such as the specific roles that are most difficult to fill and the specific schools in which those positions are located. This complicates discussions of, and may thwart efforts to address, school staffing problems (Bleiberg and Kraft 2023; Nguyen, Lam, and Bruno 2024).

I bring additional clarity to these discussions using data on actual unfilled certificated positions in Illinois public schools in the fall of 2022. The detail of these data allows me to quantify shortages both for teachers and for other types of staff often neglected in the literature (e.g., paraprofessionals). Because Illinois is large and diverse, I can quantify variation in these shortages along student, district, and school characteristics that previous research has suggested are important. Specifically, I ask the following research questions:

1. What are overall teacher, administrator, and other certificated staff shortage rates?
2. How do these staff shortage rates differ between districts?
3. How do these staff shortage rates differ between schools within districts?
4. How do the staff shortage rates experienced by students differ by race, family income, disability status, and English learner (EL) status?

Background and Previous Research

Measurement of Overall School Staff Shortages

A core challenge to measuring school staff shortages is that the appropriate measure depends on what underlying phenomenon is of interest. Existing research does not offer fully developed frameworks for selecting shortage measures. Developing such a framework is beyond the scope of this paper. For present purposes, I assume that what is of interest about school staff shortages is that they prevent schools from providing valuable services to students. Ideally, then, a measure of staff shortages would capture the extent to which services for students are limited by the quantity or quality of potential staff. This provides a starting point for comparing measures of staff shortages and for articulating the assumptions they require to be informative.

Unfilled Positions

Perhaps the most intuitive way to identify school staff shortages is in terms of positions administrators would like to fill but cannot, as this is roughly how the term "shortage" is used colloquially. Positions that have not been filled also correspond in a relatively direct way to services that are not provided to students. However, evidence on unfilled positions has been sparse. This likely reflects that local education agencies (LEAs) have more rigorous reporting requirements for staff they employ than for staff they do not employ. Additionally, the willingness of administrators to attempt to staff a position may be driven by prevailing supplies of workers. Reported unfilled positions may therefore conflate differences in staff supply and demand with administrators' beliefs about how labor market conditions should impact their staffing practices. Recent work estimates that 1.8% of teaching positions are vacant across the United States. However, the authors emphasize that they are forced to rely on sources of questionable comparability and that data are often dated or not available (Nguyen, Lam, and Bruno 2024).

Application Rates

Measuring the number of applications submitted by candidates for open staff positions may provide more information than unfilled positions because it may provide some information not only about whether a gap exists between the supply of and the demand for staff, but also about the size of the gap. However, whether positions are posted at all may again reflect administrators' views of the candidate supply. Additionally, one individual may apply for multiple positions, inflating the apparent supply of candidates or complicating the relationship between the number of applications and the probability a position is filled. And application rates are not highly related to the quality of new hires (e.g., James, Kraft, and Papay 2023), so the size of the applicant pool may be misleading about the implications for staff quality and service provision.

Studies using application rates to study staffing challenges are not common. Those that exist find that the number of applications from candidates typically substantially exceeds the number of open positions for which they could be hired. For instance, researchers find that the mean school participating in job fairs in Chicago received over 50 applications at each job fair while expecting to make fewer than five new hires (Engel, Jacob, and Curran 2014). Similarly, in a statewide study of Wisconsin school districts the median district received between 36 and 52 applications for each posted school principal position, depending on urbanicity (Yang, Lee, and Goff 2021).

Aggregate Supply and Demand

Researchers have often had to rely on less direct measures of shortages. Perhaps most closely related conceptually to unfilled positions are aggregate measures of the supply of and the demand for school staff. For example, Sutcher, Darling-Hammond, and Carver-Thomas (2016) use a variety of data (e.g., existing staffing levels and turnover rates) to estimate the nationwide demand for teachers over time. They then model the supply of teachers (e.g., using teacher preparation data). By their estimates, the number of teachers needed nationwide would exceed the number of available teachers by 112,000 in 2018, a number they suggested later was largely accurate (Sutcher, Darling-Hammond, and Carver-Thomas 2019).

Yet how such projections translate into implications for schools is not clear. For example, this kind of modeling can be sensitive to assumptions about factors like re-entry rates into the profession, pupil:staff ratios, and which teacher preparation programs see decreased enrollment (Cowan et al. 2016; Goldhaber and Theobald 2016). Additionally, as I discuss below, there is substantial variation in school staff shortages across job types and schools that is obscured by broad aggregation and generalization. This makes it difficult to know which students, if any, see reduced educational service provision because of estimated shortages.

Staff Certification

Given the difficulties in interpreting aggregated shortage figures, researchers have often relied on other proxies available at the school or district level, such as teachers working without being fully certified for their position (Sutcher, Darling-Hammond, and Carver-Thomas 2019; Goldhaber et al. 2020). The logic of this approach is that if schools prefer or are required to hire fully certified candidates, the presence of an uncertified employee is evidence that administrators struggled to find candidates.

This approach also has its limitations. Certification is a weak indicator of quality (Goldhaber 2007; Kane, Rockoff, and Staiger 2008) and administrators may prefer a candidate with a lesser certification even if a fully certified candidate is available (Edelman, Perera, and Schweig 2018; American Association for Employment in Education 2022). Certification requirements also differ across states, complicating between-state comparisons. The extent to which teacher certification rates indicate true shortages or reductions in educational service provision is therefore unclear. In any case, recent work estimates that approximately 9% of teaching positions nationwide are held by teachers without full certification, though data limitations again introduce a great deal of uncertainty into that estimate (Nguyen, Lam, and Bruno 2024).

Survey Measures

An alternative approach is to survey education officials about their perceptions about their ability to staff their schools (Podolsky and Sutcher 2016; Beilstein and Withee 2022). This avoids some limitations of administrative data, such as the possibilities that administrators alter their staffing plans in response to labor market conditions. Surveys can also avoid challenges associated with modeling aggregate supply and demand, instead asking administrators about their experience of the mismatch between them. However, interpreting such surveys presents its own challenges since the magnitude of hiring challenges and resulting impacts on students are hard to quantify. Different administrators or reporting agencies may also have different standards for what counts as a “shortage” or may have standards that evolve over time, for example because tight labor markets result in lower expectations for the number and quality of applicants.

Surveys tend to paint shortages as severe and widespread. For example, a recent survey found that district administrators on average reported at least “some” shortages of “qualified applicants” for nearly all types of teacher and school administrator positions, and a surplus for none (American Association for Employment in Education 2022). Similarly, most states report teacher shortages to the federal government in at least one, and often in many, subjects and grades (U.S. Department of Education 2022).

In sum, it is difficult to generalize about school staff shortages in the United States because the relevant data, if they exist, are limited and difficult to interpret or to compare across contexts. This is true even when considering teacher shortages, about which the data and research are most comprehensive. Moreover, there is evidence that variation in school staff shortages is as important as whatever generalization might be possible with even the best data.

Evidence that School Staff Shortages Vary Considerably

Because there is no single nationwide educator labor market, school staff shortages vary considerably across contexts (Cowan et al. 2016; Nguyen, Lam, and Bruno 2024). However, the evidence on exactly how these shortages vary is limited and often mixed.

For example, one of the most common explanations for variation in school staffing challenges is that schools in rural or urban areas face greater challenges than other (e.g., suburban) schools. Rural schools may enjoy fewer economies of scale (Andrews, Duncombe, and Yinger 2002) or face higher costs due to student sparsity (Killeen and Sipple 2000). This may reduce the available budget for competitive staff compensation. Additionally, remoteness may mean rural districts have less access to potential employees who grew up or were certified nearby (Killeen and Loeb 2022). Urban schools, meanwhile, may have to navigate more complex bureaucracies or more competition for workers, thwarting hiring efforts (Liu and Johnson 2006; Jacob 2007).

Yet the evidence on these differences by urbanicity is mixed. On the one hand, in California rural districts tend to have more job postings and emergency credentials than their non-rural counterparts (Goldhaber et al. 2020). On the other hand, districts in Wisconsin receive comparable numbers of applications for open principal positions regardless of their urbanicity (Yang, Lee, and Goff 2021). Similarly, urban districts in California do not appear to have much greater teacher staffing challenges than other districts (Goldhaber et al. 2020).

There is more consistent evidence that staff shortages tend to be more severe in schools serving disadvantaged students at higher rates. For example, schools in Tennessee serving larger percentages of Black students report higher teacher vacancy rates (Edwards et al. 2024). Similarly, rural schools with higher rates of poverty receive fewer applications for principal positions compared to other rural districts (Yang, Lee, and Goff 2021). Within Chicago, schools with more advantaged students receive more applicants for teaching positions (Engel, Jacob, and Curran 2014).

Previous work also finds that shortages can vary for positions in the same school. Administrators report more difficulty filling teaching positions for science, math, and special education, compared to elementary and social studies (Goldhaber, Krieg, et al. 2015; American Association for Employment in Education 2022; Edwards et al. 2024). Those differences, as well as relative difficulties hiring English language learner teachers, are apparent in the prevalence of job postings (Goldhaber et al. 2020).

There is little evidence on shortages of non-teaching staff in schools, and even less comparing teaching and non-teaching roles. Yet there are reasons to believe that students and schools are substantially impacted by non-teaching staff such as administrators (Grissom, Egalite, and Lindsay 2021) and paraprofessionals (Giangreco, Suter, and Doyle 2010). What evidence exists suggests differences across these groups of staff. As noted above, the relative challenges faced by rural districts seem more pronounced for teaching positions (Goldhaber et al. 2020) than for administrative positions (Yang, Lee, and Goff 2021). A recent survey of district administrators similarly finds greater perceptions of hiring difficulties for teaching roles compared to administrative roles (American Association for Employment in Education 2022).

Evidence About Pandemic-Era School Staff Shortages

Evidence on school staffing challenges during the COVID-19 pandemic has focused largely on teacher attrition. This evidence suggests that teacher attrition was either flat or fell in the first year or two of the pandemic (i.e., entering the falls of 2020 or 2021). However, attrition appears to have risen back to or above pre-pandemic levels in subsequent years (i.e., entering the falls of 2021 or 2022). This pattern was found in statewide studies in Arkansas (Camp, Zamarro, and McGee 2022), Massachusetts (Bacher-Hicks, Chi, and Orellana 2023), and Washington (Goldhaber and Theobald 2023a; 2023b). In North Carolina, this pattern extended to administrators (Bastian and Fuller 2023).

The evidence on vacancy rates during the pandemic is much more limited. As noted above, recent work attempting to characterize nationwide teacher vacancy and certification rates finds that shortage rates are low on average, including in Illinois, the context of this study (Nguyen, Lam, and Bruno 2024). Yet that work provides no information about within-state variation or non-teaching staff. Recent surveys indicate that administrators perceive shortages to be widespread and more severe than in the pre-pandemic era (American Association for Employment in Education 2022; Beilstein and Withee 2022; Carver-Thomas et al. 2022). However, because such surveys often paint a more dire picture of shortages than other measures, they are difficult to interpret. Moreover, despite what appears to be growing teacher attrition during this period, in a nationwide panel survey administrators perceived shortages as less severe in 2022-2023 than in the previous year, perhaps reflecting widespread efforts to recruit and retain teachers (e.g., via compensation; Diliberti and Schwartz 2023). This again points to the potentially complicated relationship between staff attrition and staff shortages. This relationship is likely complicated further by influxes of pandemic-related federal aid to schools from

Elementary and Secondary School Emergency Relief (ESSER) grants, particularly to lower-income schools. Districts had considerable flexibility in spending ESSER dollars, so ESSER might have varying effects. For instance, districts spending ESSER dollars on recruitment and retention bonuses might see fewer vacancies, while spending on tutoring or other academic recovery programming may have contributed to higher staffing levels (e.g., Aldeman 2023; Carbonari et al. 2024) and, consequently, higher shortage rates.

Some indirect evidence on pandemic-era school staff shortages comes from Goldhaber, Falken, and Theobald (2024a), who collect district job postings in Washington state in 2022. They find that on average across all months three quarters of schools post fewer than 1.3 new teacher job postings per 100 staff. However, as the authors note, these posting rates can be difficult to interpret. Notably, they also find that teacher turnover rates are only weakly predictive of job posting rates, again pointing to the importance of factors other than attrition that might drive staff shortages.

Summary

Research suggests that many schools experience staff shortages and that these shortages are more severe for some positions and schools. However, evidence on this topic is sometimes mixed (e.g., in the case of urbanicity). It also has many limitations, four of which are particularly relevant. First, despite recent increases in teacher turnover and widespread concerns that the pandemic has exacerbated shortages, we have little evidence about pandemic-era shortages. Second, existing research often relies on indirect proxies for shortages, such as enrollment in teacher preparation programs or rates of teacher certification. This is particularly true of research examining variation in shortages across schools and positions, which is often limited to analyses of either supply (e.g., teacher preparation enrollments) or demand (e.g., attrition of current staff), but not both. Third, even studies able to estimate shortage rates more directly provide limited evidence about within-state or within-district variation. Fourth, much of the existing research focuses on teachers, resulting in even greater uncertainty about other school staff, such as administrators and paraprofessionals. I contribute to this literature using data on actual unfilled positions for both teaching and non-teaching staff at the school level.

Data

To measure shortages, I use data on unfilled full-time equivalent (FTE) certificated positions collected each fall by the Illinois State Board of Education (ISBE) since 2017. Because these and other data are derived from fall data collections, here and in what follows references to years refer to the fall of a given academic year (e.g., “2017” refers to the 2017-2018 school year). LEAs report unfilled positions as of October 1, where unfilled positions are specified by ISBE to be positions that administrators are actively seeking to fill. Thus, a position for which an employee has been hired is considered filled even if the employee has yet to begin work, but a position filled temporarily (e.g., by a substitute) while a search for a permanent hire continues is considered unfilled. I focus on the 2022 collection for two reasons. First, ISBE has gradually increased vacancy reporting requirements, and only by 2022 was the vacancy reporting system fully integrated into the pre-existing Employment Information System for school employees with a requirement that LEAs verify when no positions were unfilled. Second, in earlier years unfilled positions were not consistently reported at the school level. I use ISBE’s broad staff categories to group unfilled positions: teachers, administrators, and other certificated staff. The latter group is 77% paraprofessional positions, with the remainder being support staff (e.g., nurses and social workers) and other licensed staff (e.g., occupational therapists and librarians).

I combine data on unfilled positions with “Illinois Report Card” data, also from ISBE.

These annual reports include school-level information about student demographics, grade levels, charter status, average class size, and teacher retention. ISBE reports teacher retention as the three-year average of the percentage of full-time teachers returning to the same school from the previous year; I subtract this number from 100 to produce an attrition rate.[1] Similar information is provided at the state and district level, and at these higher levels the Report Cards also include FTE teachers, administrators, and total certificated staff, teachers' mean salary and experience, and the percentage of teachers with a master's degree. I pull data on districts' ESSER aid from ISBE's ESSER Dashboard. I get urbanicity information from the Common Core of Data.[2]

My primary measure of staff shortages is unfilled positions as a percentage of combined filled and unfilled positions in the same category of job (e.g., unfilled administrator positions as a percentage of the sum of administrators and unfilled administrator positions). However, an important limitation of this sort measure of shortage is that educator labor markets are not perfectly competitive. This means that the number of staff a school attempts to employ may not have a clear interpretation as to what the school needs. For example, schools may lack the budgetary capacity to hire additional staff or be constrained by staff-to-student ratios governed by collective bargaining agreements. Consequently, as an alternative measure of shortages, I use the number of unfilled positions per 10,000 enrolled students. Though this does not entirely remove the influence of choices about staffing levels, it is less mechanically linked to those choices than a measure that includes existing staffing levels in the denominator. Additionally, this measure can be used for my school-level analyses, as I do not have data on school-level employment. Summary statistics are presented in Appendix Tables A1 and A2.

[1] For example, the 2022 attrition rate is the mean of the percentages of full-time teachers leaving their schools from fall 2019 to fall 2020, fall 2020 to fall 2021, and fall 2021 to fall 2022.
[2] Common Core of Data, Education Data Portal (Version 0.18.0), Urban Institute, accessed June 14, 2023, https://educationdata.urban.org/documentation/, made available under the ODC Attribution License.

As discussed above, unfilled positions are a plausibly more direct indicator of shortages than other commonly used measures and plausibly indicate that actual service provision to students will be reduced in some way relative to what schools would prefer to do within their budget constraints. For instance, while data about job postings may provide timely information about some aspects of school hiring, it is not obvious how to quantify the relationship between the number of job postings and the extent of “shortages”, or even the number of job openings (Goldhaber, Falken, and Theobald 2024a). Moreover, while Edwards et al. (2024) also focus on unfilled positions to measure teacher shortages, they rely on surveys administered in the spring of 2020. This required administrators working during the onset of the COVID-19 pandemic to recall vacancies several months prior, in the fall of 2019. Because my data were collected administratively in the fall, they may be less prone to measurement error (e.g., due to non-response or recall biases) in addition to being more recent and including staff other than teachers.

At the same time, given the relative novelty of these administrative vacancy data it is worth at least briefly considering what they measure and whether they reflect genuine staffing difficulties. I present additional evidence about the relationship between unfilled positions and staffing levels in Appendix B. In short, districts tend to report higher numbers of vacancies when they employ larger numbers of staff, which suggests that vacancies are driven to a substantial degree by expanded hiring. However, after accounting for plausible supply and demand factors (e.g., enrollment and turnover), unfilled positions are associated with lower staffing levels, in some cases on a close to one-to-one basis. This is consistent with unfilled position reports providing meaningful information about staffing difficulties, though results vary across models and staff types. Still, given potential changes over time in reporting practices, I’m unable to confidently quantify changes in shortage rates over time or what factors might be driving them.

Methods

For my first research question, on overall shortage rates, I use basic descriptive methods. To compare shortages across districts (my second research question) I first compare shortages in 2022 across district characteristics that the research discussed above suggests are important determinants of shortages: geography, urbanicity, and grade level. I then estimate the following district-level model via ordinary least squares to attempt to statistically explain shortages:

$$shortage_{dc} = \alpha_1 city_{dc} + \alpha_2 town_{dc} + \alpha_3 nonremote_{dc} + \alpha_4 remote_{dc} + \alpha_5 unit_{dc} + \alpha_6 high_{dc} + \boldsymbol{\theta X}_{dc} + \gamma_c + \varepsilon_{dc} \tag{1}$$

Model 1 predicts the *shortage* rate (e.g., unfilled positions as a share total filled plus unfilled positions) in district *d* in county *c*. On the right-hand side, I include dummy variables to estimate how shortages differ between districts in a suburb (the omitted group) and districts, respectively, in a *city*, *town*, or rural area. Because previous work has found that it is the most remote rural districts that are most operationally distinct from non-rural districts (Dhaliwal and Bruno 2021), I include separate dummy variables for rural districts that are *nonremote* or *remote*; remote rural districts are those more than 25 miles from an urbanized area and more than 10 miles from an urban cluster. Similarly, I include indicator variables for *unit* (K-12) and *high* school (9-12) districts to compare their shortages to those in elementary (K-8) districts.

I include a vector of student characteristics indicative of types of disadvantage noted in previous work. This includes the percentages of students from each reported race group or classified as economically disadvantaged, ELs, or with a disability. I include three teacher characteristics: mean salary, mean years of experience, and the percentage with a master's degree. Though similar variables are not available for other staff, these collectively provide a sense of teacher salary levels because salaries are largely determined by education and experience. I also include average class size and the average rate at which teachers left their school over the previous three years, and the funding received cumulatively over the three waves of ESSER per 2022 pupil as of April 2023.[3] These variables provide some evidence on demand for teachers or staffing needs. I include a set of county fixed effects (γ_c) to account for regional differences between Illinois' 102 counties. In all cases, estimated standard errors are heteroskedasticity-robust.

To analyze school-level variation in staff shortages – my third research question – I estimate:

$$shortage_{sd} = \beta_1 charter_{sd} + \beta_2 middle_{sd} + \beta_3 high_{sd} + \boldsymbol{\theta X}_{sd} + \gamma_d + \varepsilon_{sd} \qquad (2)$$

Model 2 is like model 1, but because school-level employment data are unavailable I predict each *shortage* for school *s* in district *d* only as unfilled positions per 10,000 students.[4] Though I exclude schools in non-district LEAs, if a *charter* school is associated with a district it is indicated with a dummy variable. Schools classified by ISBE as *middle* or *high* schools are indicated with dummy variables to estimate differences from elementary schools (the omitted group). The vector of student demographics is the same as in model 1 but measured at the school level. I do not observe teacher characteristics at the school level, but I again include school-level average class sizes and teacher attrition. I use district fixed effects (γ_d) to isolate within-district variation in staff shortages. In all iterations of model 2 I cluster standard errors on districts.

Given that shortage rates cannot be negative and that summary statistics indicate that

[3] All three rounds ESSER funding were passed by March 2021, states were encouraged to distribute funds rapidly, and most were distributed via known formulas. By Fall 2022 districts would have received most of their funds or had a good idea what those allocations would be. Using reports from April 2023 provides additional time for allocations to be documented. Because districts were given latitude in how to spend all three waves (U.S. Department of Education 2021), the latter waves dominated in size, and the three waves would have been highly correlated due to the formula, I do not distinguish the funding rounds.
[4] While 10,000 students is large relative to typical school or district sizes, using it as the denominator avoids extremely small coefficient estimates. This is helpful when vacancy rates are low, such as for administrators, though for consistency I use the same denominator for all staff types.

shortage rates are often quite low, as a specification check, Appendix Tables A3 and A4 present results from Poisson models predicting unfilled positions at the district and school levels, respectively. Results are generally similar. Given their ease of interpretation and their ability to retain the full samples for estimation, I focus on results from models 1 and 2 in what follows.

Finally, for my fourth research question, I estimate weighted averages of staff shortage rates at both the school and district levels. To do this, I estimate the mean vacancy rate in schools or districts, weighted by the number of enrolled students who belong to a group of interest (e.g., economically disadvantaged students). I derive the student group enrollments from reported total enrollment and the reported share of students who belong to that group. Thus, for example, I can estimate the mean school- or district-level vacancy rate experienced by students who are economically disadvantaged and then, for comparison, estimate the mean vacancy rate experienced by economically non-disadvantaged students.

Results

RQ1: Overall Staff Shortage Rates

Figure 1 presents unfilled positions in the Fall of 2022 aggregated across the state. The three panels of Figure 1 present FTE vacancies, respectively, as a raw count, as a percentage of all (i.e., filled and unfilled) positions of the same type, and per 10,000 students.

Insert Figure 1 About Here

Despite widespread attention on teacher shortages, the number of unfilled other (i.e., non-teaching, non-administrative) positions is similar to the number of unfilled teaching positions. Moreover, shares of teacher and administrator positions that are unfilled are far lower than in other roles, amounting to just 2.6% and 0.9% of positions, respectively. The analogous figure for other certificated staff is 5.6%. For comparison, in October 2022 the United States had about

10.5 million unfilled vacancies across the economy, and approximately 153.9 million nonfarm employees. That implies a vacancy rate of about 6.4% by the methods I use here.[5]

Staffing levels provide information about service provision to students not captured by shortages and may shed light on whether shortages are driven by staff supply or demand. Enrollment in Illinois schools in 2022 (1.86 million) was 8% lower than in 2016. This may have been expected to decrease demand for staff but, compared to 2016, in 2022 Illinois schools employed 4% more teachers (134,897), 24% more administrators (13,213), and 43% more other certificated staff (58,311). As a result, between 2016 and 2022 the number of pupils per teacher, administrator, or other certificated staff fell by, respectively, 9%, 26%, and 36%. This highlights that levels of service provision can remain flat or increase even in the presence of shortages. Changes in enrollment, staffing, and pupil:staff ratios are shown in Appendix Figures A1 and A2. Figure A2 also shows declining teacher attrition, consistent with work discussed above.

In sum, I find little evidence that school staff shortages were particularly severe, on average, in Fall 2022. An exception is for non-teaching, non-administrative roles, where shortages are more severe. If anything, schools have been able to increase the number of teachers and administrators they employ even as enrollment has fallen, and with low vacancy rates. This is true despite extreme tightness in the labor market, particularly for college-educated workers.

RQ2: Shortage Rates Across School Districts

Staff shortage rates vary considerably across school districts. As suggested by the low statewide vacancy rates, districts commonly report no unfilled positions at all. In 2022, 51% of districts reported no unfilled teaching positions, 95% reported no unfilled administrator positions, and 67% reported no vacancies for other certificated staff. However, shortage rates

[5] I pull economy-wide figures from the Federal Reserve Bank of St. Louis: Unfilled Vacancies for United States [series LMJVTTUVUSM647S] and All Employees, Total Nonfarm [series PAYEMS].

vary considerably even across districts reporting vacancies. For instance, 18% of districts reporting teacher vacancies report vacancies amounting to less than 1% of positions. At the same time, there is a long right tail of vacancy rates, with 10% of districts reporting vacancy rates of 7.6% or more. Kernel density plots of district vacancy rates are shown in Appendix Figure A3.

Geographic Variation in Shortages

A substantial amount of between-district variation is regional. One way to operationalize this is by aggregating districts to the county level. Among Illinois' 102 counties, 60 report aggregate teacher vacancy rates below 2%, including nine that report none. In 80% of counties unfilled administrator positions represent at most 0.5% of positions. In the median county the "other" staff vacancy rate is 1.1%. Yet shortages are much more severe in some counties. For instance, aggregated teacher shortage rates are above 6% in 14% of counties. Districts' aggregated vacancies for "other" staff positions amount to more than 5% in 20% of counties and more than 9% in 8% of counties. For full county-level maps, see Appendix Figure A4.

Shortages are more severe around the edges of the state. In t-tests allowing for unequal variances, districts in counties along Illinois' border report larger percentages of positions unfilled than in interior counties for teachers, administrators, and other staff by 0.80 (43%, $p < .01$), 0.11 (26%, $p = .62$), and 1.35 (60%, $p < .01$), respectively. This may reflect limited opportunities to recruit staff from neighboring communities due to limited cross-state mobility of certificated staff (Goldhaber, Grout, et al. 2015). However, correlations between a county's vacancy rate for one of the three types of position and the others are not high (r = .36-.41). This points to the importance of considering different staff as having distinct labor markets.

Variation in Shortages by Urbanicity and Grade Level

The patterns in Figure 2 are evidence for some, but not all, of the differences across urbanicity considered in previous research. Staff shortages for “other” staff are more severe in cities than elsewhere, amounting to 4.5% of positions in the mean city-based district. That is more than twice as high as in towns or non-remote rural districts, but similar to suburban districts. Remote rural districts report unfilled positions in these jobs at much lower rates than other districts. Remote rural districts may enjoy fewer economies of scale that make these staff affordable or be more reliant on supra-district entities to provide these services and staff.

Insert Figure 2 About Here

This is not to say that shortages are not severe in rural districts. Teacher vacancy rates in remote rural districts are 5% at the mean, at least 72% higher than the rate observed in any other locale. Districts in cities, suburbs, towns, and non-remote rural districts differ relatively little in their mean teacher vacancy rate. This points to the importance of distinguishing labor markets for different kinds of staff. And, as in some previous work (Dhaliwal and Bruno 2021), non-remote rural districts look at least as much like non-rural districts as they do remote rural districts.

Previous research suggests that staffing challenges are more severe at the secondary level than at the elementary level. However, as shown in Figure 2, this does not necessarily translate into relatively high district-level shortage rates in high school districts. Rather, teacher vacancy rates are highest in unit districts (2.6%) and lowest in high school districts (0.4%). High school districts also have lower vacancy rates for administrative and other staff than other districts. Patterns are very similar if shortages are expressed per 10,000 students (Appendix Figure A5).

Regressions Predicting District-Level Shortages

One challenge for interpreting these differences is that grade level and urbanicity may be correlated with each other or with other district or regional characteristics that matter for staffing. I thus estimate regressions that predict vacancy rates as a function several of these characteristics to see whether they affect the relationships I describe above or can explain shortage rates. Results are shown in Table 1. As shown in Appendix Table A5, district vacancy rates measured in terms of employment or enrollment are highly correlated (r = .77-.97). Consequently, results predicting unfilled positions per 10,000 students are very similar (Appendix Table A6).

Insert Table 1 About Here

Estimates from models predicting vacancy rates using only urbanicity and grade level are very similar to the unadjusted differences shown in Figure 2. Collectively, urbanicity and grade level account for no more than 5% of the variation in districts' shortage rates (Appendix Table A7). Rural districts are more likely to be in certain counties, but accounting for county fixed effects (columns 1, 4, and 7) only modestly affects the differences between rural and non-rural districts considered above. For example, remote rural districts continue to exhibit teacher vacancy rates that are higher than in suburbs by 2.1 percentage points, only modestly smaller than the 3 percentage point difference in Figure 2. Similarly, the relative severity of shortages for administrative and other staff in remote rural districts is only slightly explained by county fixed effects. This suggests the differences are not primarily driven by regional factors within the state.

The difference in teacher shortage rates grows and gains statistical significance when controlling for student demographics (column 2). This also increases the relative severity of teacher shortages in non-remote rural districts, though not to remote rural levels. That these challenges persist even when comparing districts in the same county and serving similar student populations points to the likely importance of urbanicity-specific factors, particularly for the most remote rural districts. If student characteristics are associated with working conditions that matter to teachers, this may indicate that rural districts face distinctive recruitment and retention challenges that are partially counterbalanced by attractive working conditions. Conversely, the addition of student characteristics to the model substantially explains differences in other certificated staff vacancy rates between districts of different urbanicities (column 8). This could indicate that rural districts enroll students less likely to have the needs that motivate the hiring of these staff (e.g., related to disabilities or language proficiency), or that they are less likely to attempt to provide those services when they are needed (e.g., due to capacity constraints).

Accounting for urbanicity and county fixed effects only slightly changes the relative severity of shortages by grade level. Accounting for student characteristics, however, accounts for about 30% of the remaining difference in teacher shortages between elementary and high school districts (columns 1 and 2) and nearly all of the difference in “other” staff shortage rates (columns 7 and 8). Again, this may indicate more desirable working conditions or lower levels of student support needed in high school districts than in other districts (e.g., because higher-need students have dropped out or transitioned out of service provision programs.)

Columns 3, 6, and 9 add additional controls for class size, teacher characteristics, and ESSER funding. On the one hand, these variables may represent important aspects of supply or demand in school districts and may therefore drive shortages. On the other hand, coefficients on these predictors should be interpreted cautiously given that they may be correlated with other predictors or with important unobserved factors or may reflect reverse causality (e.g., because teacher shortages drive up class sizes). I highlight a few results because of their potential policy significance. First, average class size is marginally significantly associated with higher teacher vacancies, potentially reflecting a consequence of teacher shortages. Second, teacher turnover rates are positively related to teacher shortages, as expected. This could reflect a combination of turnover producing vacancies, turnover reflecting working conditions that make vacancies hard to fill, or persistent staff shortages creating working conditions that induce teacher exit.

Third, I find little evidence that compensation levels explain differences in district-level staff shortages. The coefficients on the teacher salary, experience, and education variables are mostly small and insignificant, even for teacher vacancies. Fourth, the teacher-related characteristics are of particularly limited use for predicting shortages of non-teaching staff, suggesting they are poor proxies for the causes of those shortages. For instance, as reflected in the R-squared values, adding in these six new predictors (including ESSER funding) explains roughly an additional 8% of the variation in teacher shortage rates, but only 1-3% more of the variation for other staff shortage rates. These variables do, however, explain about half of the difference in teacher shortage rates that remains between elementary and high school districts after accounting for student characteristics, and cause teacher shortages in rural districts to appear slightly more severe. This suggests that rural districts may find it particularly difficult to fill vacancies when they arise (i.e., controlling for turnover), while high school districts may enjoy relatively low shortage rates because their teachers are relatively less likely to turn over.

Fifth, ESSER funding is positively related to shortages. This is again difficult to interpret given that ESSER allocation rules distributed funds in ways closely related to student demographics. In this sample, ESSER funding is highly correlated with the percentage of students who are economically disadvantaged ($r = .72$). Also, ESSER funds may have had effects that increase shortages (e.g., funding new positions) as well as effects that prevent shortages (e.g., funding higher pay or better working conditions). Still, districts with more ESSER funding tend to have higher shortage rates compared to observably similar districts, and bivariate correlations between ESSER funding and vacancy rates are at least weakly positive for teachers ($r = .39$), administrators ($r = .12$), and other staff ($r = .21$; Appendix Figure A6). Districts with higher shortage rates may be in for particularly difficult times as ESSER funds expire, facing cuts that either entail staffing reductions or that further exacerbate shortages (e.g., compensation cuts). Finally, no model in Table 1 explains even half of the variation in vacancy rates for any job type. There thus remains much work to be done to understand the drivers of school staff shortages.[6]

I do not present coefficients on the variables representing student characteristics as those variables are often correlated with one another in ways that make them hard to interpret. Instead, I present those coefficients in Appendix Table A8 for interested readers. Bivariate correlations between district vacancy rates and student demographic characteristics are presented in Appendix Table A5. These results collectively suggest that districts with educationally disadvantaged students have more severe shortages, particularly districts with larger shares of Black or economically disadvantaged students. This is consistent with prior work discussed above, and previews results below where I consider shortage rates experienced by different groups of students.

RQ3: Shortage Rates Between Schools within Districts

Table 2 presents regressions predicting school-level unfilled positions per 10,000 students. As noted above, and as shown by the pairwise correlations in Appendix Table A5, the choice of how to operationalize vacancy rates makes little difference at the district level, so seems unlikely to substantially affect inferences here. Grade level and charter status together explain less than 1% of the variation in schools' vacancy rates (models 1, 5, and 9). Even adding district fixed effects (models 2, 6, and 10) explains less than half of the variation in vacancy rates and less than 6% for administrator vacancies. Models including district fixed effects alone (not

[6] Limited within-county variation could make it difficult to estimate some relationships of interest. For instance, while the median county includes five districts, 13% of counties contain only one district. In any case, results without county fixed effects are only modestly different (Appendix Table A7).

shown) explain 40%, 5%, and 41% of the between-school variation in shortage rates for teachers, administrators, and other certificated staff, respectively. This is consistent with work suggesting the quantity of applicants varies substantially within district (Engel, Jacob, and Curran 2014).

Insert Table 2 About Here

Charter schools affiliated with districts report relatively high shortage rates compared to non-charter schools (models 1, 5, and 9), but the reverse is often true after controlling for district fixed effects (models 2, 6, and 10). The large coefficients on the charter dummies and how they change across models reflect that charter schools are mostly located in a few districts with high vacancy rates, especially Chicago, and so should be interpreted and generalized cautiously. Even large within-district differences between charter and non-charter schools grow in magnitude after accounting for student characteristics (models 3, 7, and 11) and again when controlling for class size and teacher turnover (models 4, 8, and 12). Lower shortage rates may reflect charter schools' relative flexibility in responding to labor market factors, at least when hiring non-administrative staff, though I do not observe many school-level variables that might mediate this (e.g., salaries).

In contrast to district-level results, within districts secondary schools, and especially high schools, report higher teacher vacancy rates than elementary schools (column 2). This is in line with previous research on the relative difficulty of hiring secondary teachers. As with high school districts, secondary schools report relatively low vacancy rates for "other" certificated positions, though this is substantially attenuated by district fixed effects for both middle schools and high schools (column 10). Controlling for student characteristics makes the coefficients on the middle school and high school dummies more positive for all three types of staff vacancy rates (columns 3, 7, and 11). This is again suggestive of staffing challenges in secondary schools being partially obscured by relatively favorable student characteristics (or associated working conditions).

Controlling for class size and teacher turnover does little to explain differences in teacher shortage rates between elementary and secondary schools, though coefficients on both predictors are in the expected directions (column 4). This may point to additional challenges faced by secondary schools filling vacancies when they arise, relative to similar elementary schools in the same district. Class size and teacher turnover also both predict "other" staff shortage rates; the coefficients are smaller but they have the same directions and are similarly statistically significant. However, these predictors again do not consistently or meaningfully explain grade-level differences in shortage rates for non-teaching staff and, for administrators, teacher turnover predicts if anything lower vacancy rates. In sum, even if these factors are important drivers of vacancy rates, they do not appear to be the main drivers of differences in vacancy rates between elementary and secondary schools. However, as with district-level results above, these results should be interpreted cautiously given the potential for reverse causality or omitted variable bias, and because of potential correlations between predictors entered in the model simultaneously.

Again, given their correlations with one another (see Appendix Table A9), I present the coefficients on the student characteristic predictors only in Appendix Table A10. Additionally, results from bivariate regressions of vacancy rates on student characteristics are shown in Appendix Figure A7. These results again suggest that schools serving disadvantaged students at higher rates experience higher vacancy rates. Comparing the top and bottom panels of Figure A7 shows that these relationships are not consistently or substantially attenuated by the inclusion of district fixed effects. Only for EL and Hispanic student shares are the between- and within-district patterns notably different. Other inequities appear both between and within districts.

RQ4: Staff Shortage Rates Experienced by Students

The bivariate regression results in Figure A7 are consistent with at least some degree of inequity in staff shortage rates experienced by students. However, interpreting these relationships is complicated by the fact that both schools and districts vary substantially in enrollment; average school experiences may therefore not reflect average student experiences. I turn now to the staff shortage rates different groups of students experience on average at both the school and district levels. Figure 3 shows vacancies per 10,000 students the mean student from each subgroup experienced in 2022 in their district and school in the top and bottom panels, respectively.

Except for students with disabilities, disadvantaged students experience more severe staff shortages. Both between- and within-district inequities are apparent in Figure 3. For example, as shown in the top panel, compared to the mean economically non-disadvantaged student, the mean economically disadvantaged student is in a district where vacancies per 10,000 students are 11.8 (95%) higher for teachers, 0.5 (125%) higher for administrators, and 4.7 (33%) higher for other staff. When considering the mean rate at which those positions are unfilled at their school of enrollment, those gaps grow to 13.3 (130%) for teachers and 5.3 (47%) for other certificated staff. The absolute gap for unfilled administrative positions remains unchanged, but grows proportionally, to 250%.

Insert Figure 3 About Here

Patterns are similar or even more severe when considering inequities in staff shortages experienced by students of different races. For example, at the district level, the mean Black student experiences a teacher vacancy rate 2.5 times the rate experienced by the mean White student; at the school level, the rate is 3.6 times higher. Similarly, the mean Native American student attends a district with 14.2 more unfilled other positions per 10,000 students than the mean White student but attends a school with 21.4 more unfilled other positions per 10,000 students. The systematic nature of these differences raises equity concerns and highlights that some students – especially economically disadvantaged students, ELs, and Black, Hispanic, and Native American students – bear the brunt of the negative impacts from staff shortages.

Two features of these results bear emphasizing. First, comparing the top and bottom panels of Figure 3 reveals that average shortage rates in students' schools are lower than in their districts. This is because shortage rates tend to be higher at smaller schools within districts.[7] Thus, while staff shortage information is often reported at the district (or higher) level, this may tend to overstate the extent of shortages experienced by students. Second, this pattern of lower school-level vacancy rates does not hold for Black and Native American students. Students in these groups experience even higher "other" staff vacancy rates staff in their schools than in their districts, and for Black students school-level teacher vacancy rates are higher than district-level rates. This raises especially acute equity considerations for Black and Native American students.

As noted above, we might interpret differences in vacancy rates differently when they are driven by different factors. This is a salient consideration when considering vacancy rates in 2022, when ESSER funding was correlated, in some cases strongly, with student characteristics (Appendix Table A5) as well as with vacancy rates (Appendix Figure A6). This influx of dollars was both unusual and may have driven the creation of new positions, both of which might affect how we interpret the differences in vacancy rates shown in Figure 3. I do not attempt to definitively identify the staffing effects of ESSER funding, but I explore several ways that ESSER funding might affect my results. First, I estimate bivariate regressions of district vacancy rates on student characteristics in 2022. The results are in top panel of Appendix Figure A8. The estimates are mostly consistent with the student-level means shown here (e.g., higher district-

[7] In regressions controlling only for district fixed effects, each additional 100 students enrolled predicts 1.1 fewer teaching vacancies (p = .26), 0.10 fewer administrator vacancies (p = .43), and 0.90 fewer other vacancies per 10,000 students (p = .02).

level vacancy rates for districts with larger shares of Black or economically disadvantaged students). Controlling for the percentage change in FTE employed staff since 2020 (the middle panel) has little effect on these estimates. This may indicate that disparities in 2022 are not substantially driven by the creation of new positions, though this is hard to know since employed staff counts do not include vacant positions and my validation exercises in Appendix B also suggest a role for hiring in driving vacancies. Controlling instead for per-pupil ESSER allocations does attenuate many of the bivariate relationships, particularly between teacher vacancies and student race or income (the bottom panel). This is not surprising given the targeting of ESSER funds to schools with economically disadvantaged students. It is also more consistent with vacancies being driven to some degree by those funds being used to hire staff, especially teachers, as other work has found (Goldhaber, Falken, and Theobald 2024b).

As another check for anomalies related to ESSER I calculate mean district-level vacancy rates experienced by students, like those in Figure 3, for every year since 2017. This has the disadvantage that the validity of earlier years of these data is less clear. However, these enrollment-weighted means account for differences in enrollment between districts and are in that respect more comparable to results in Figure 3. I present those results in Appendix Figure A9. Despite concerns about reporting practices in earlier years, these results suggest that the gaps (or lack thereof) between groups of students in their experienced vacancy rates are quite persistent; the observed gaps in 2022 are qualitatively – and often quantitatively – very similar to what was observed in 2017. This suggests that ESSER funding – or other pandemic-related factors – have not drastically impacted observed disparities in shortage rates. Still, some widening gaps are apparent in Figure A9, such as in the case of teachers by student race or family income, again consistent with at least some role for ESSER funding in driving shortages.

Discussion and Conclusion

I present some of the first and most detailed evidence on school staff shortages in the COVID-19 pandemic era at both the school and district levels and for staff other than teachers. I extend previous work aggregating administrator perceptions or analyzing recent staff turnover rates and show that shortage rates are often low and may obscure increased staff levels.

Importantly, average statewide shortage rates obscure substantial variation between districts and schools. Teacher shortages are more severe in remote rural districts, unit districts, and districts serving more Black and economically disadvantaged students. Shortages of administrators are more severe in rural and unit districts. Shortages for other certificated staff are most severe in cities, suburbs, and elementary districts. Within districts, teacher shortages are more severe in secondary schools, especially high schools, but elementary schools experience more severe shortages of non-teaching, non-administrative staff. Finally, I present evidence of inequities in the shortage rates students experience. Economically disadvantaged students and ELs experience higher shortage rates in their districts than their economically non-disadvantaged and non-EL peers. Similarly, many students of color experience higher shortage rates than do White students. Particularly for Black and Native American students, these inequities are compounded by the schools they attend in their districts.

There are important limitations to my analyses. While Illinois is a large and diverse state, my findings may not generalize to other states. Similarly, given the unusual, and potentially temporary, circumstances of the pandemic (e.g., ESSER funding targeted at schools with economically disadvantaged students), generalizing my results beyond the pandemic context should be done only cautiously. Also, my results do not speak to potentially important variation between more specific job categories (e.g., between teachers of different content areas). And while it is likely that schools prefer to be fully staffed by the start of the school year, they can engage in hiring all year. Vacancy rates observed in October may not reflect staffing circumstances at other times of year.

As noted above, vacancy reporting may be impacted by choices administrators make in response to the supply of candidates. If variation in staffing practices is correlated with school characteristics, this could bias my estimates. I suspect that these kind of vacancy data tend to attenuate apparent differences in staffing challenges between schools because administrators tend to search more for new hires when the candidate supply is larger. For instance, an administrator dealing with many vacancies or with a weak candidate pool may choose not to post a position. This would tend to reduce the estimated differences between easier- and harder-to-staff schools. Additionally, given changes over time in reporting and validation processes, I am unable to determine how or why staff shortages may have changed since the onset of the pandemic.

Nevertheless, my results have important implications. For policymakers, it will be important to pay attention to the staffing implications of the expiration of ESSER funding. The effects of ESSER funding on shortage rates are complex and may work in competing directions. However, I find that larger per-pupil ESSER allocations are associated with higher district-level vacancy rates. This may indicate that as ESSER funding runs out, staffing challenges will exacerbate most painfully in the districts already experiencing those challenges most severely. Moreover, the fact that disadvantaged students already attend both schools with relatively high staff shortage rates and districts that tended to receive larger amounts of pandemic relief aid means those students may be particularly vulnerable to staffing challenges as that aid expires.

My results also suggest that policy discussions of school staff shortages require more nuance. To the extent that recent discussions have, as discussed above, focused on high teacher shortage rates driven by attrition, they may be missing the mark. Policy attention may be better directed at non-teaching staff, schools with the most severe shortages, and recruitment. For example, rather than subsidizing teacher certification generally, states may more effectively address the shortages experienced by schools by subsidizing pathways into remote rural districts specifically (e.g., via grow-your-own programs), into schools with disadvantaged students (e.g., via targeted funding increases), or into paraprofessional roles. It is unlikely that school staff shortages will be solved by policies that do not characterize those shortages precisely.

I note three implications for research. First, more work is needed on the correlates and causes of school staff shortages, particularly as pandemic-related shocks fade. Even my most comprehensive models explain only a minority of the between-school variation in shortage rates. This suggests that our theoretical accounts of school staff shortages are incomplete. Second, research would benefit from attending more carefully to shortages of non-teaching staff. Though research focuses primarily on teachers, I find that shortages for other staff may be more severe. It is hard to know whether the focus on teachers is justified because it is not obvious how to quantify the relative impacts of shortages of teachers, administrators, and other school staff.

Third, and more generally, research on school staff shortages would benefit from more rigorous frameworks and definitions. Definitional ambiguity has introduced a great deal of confusion into academic and practical conversations about school staff shortages because these conversations are largely divorced from estimates of impacts on students and schools. For example, many definitions of “staff shortages”, including those used here, allow for measured shortage rates to increase no matter how many staff schools hire. One possible path forward is for researchers to develop models of staffing adequacy that are applicable across many contexts, like work done on school funding (Baker, Di Carlo, and Weber 2020). And, as noted above, shortage measures based on vacancies may lead to different conclusions than other measures that rely on different assumptions or that have different limitations. This points to the need for work validating these measures and understanding how they relate to one another. In any case, discussions of school staff shortages would benefit from both additional evidence and additional conceptual clarity.

References

Aldeman, Chad. 2023. “New Employment Data: 5 Things to Know About the State of the Education Workforce.” *The 74*, July 31, 2023. https://www.the74million.org/article/new-employment-data-5-things-to-know-about-the-state-of-the-education-workforce/.

American Association for Employment in Education. 2022. “Educator Supply and Demand Report 2021-22.” Sycamore, IL: American Association for Employment in Education.

Andrews, Matthew, William Duncombe, and John Yinger. 2002. “Revisiting Economies of Size in American Education: Are We Any Closer to a Consensus?” *Economics of Education Review* 21 (3): 245–62. https://doi.org/10.1016/S0272-7757(01)00006-1.

Associated Press. 1951. “Schools Ignoring Hiring Requisite.” *The New York Times*, October 13, 1951.

———. 2021. “COVID-19 Creates Dire US Shortage of Teachers, School Staff.” *US News & World Report*, September 22, 2021. http://www.usnews.com/news/business/articles/2021-09-22/covid-19-creates-dire-us-shortage-of-teachers-school-staff.

Bacher-Hicks, Andrew, Olivia L. Chi, and Alexis Orellana. 2023. “Two Years Later: How COVID-19 Has Shaped the Teacher Workforce.” *Educational Researcher* 52 (4): 219–29. https://doi.org/10.3102/0013189X231153659.

Baker, Bruce D., Matthew Di Carlo, and Mark Weber. 2020. “The Adequacy and Fairness of State School Finance Systems: Key Findings from the School Finance Indicators Database School Year 2016-2017 (2nd Edition).” Albert Shanker Institute.

Bastian, Kevin C., and Sarah Crittenden Fuller. 2023. “Educator Attrition and Hiring in North Carolina Public Schools During the COVID-19 Pandemic.” Education Policy Initiative at

Carolina. https://epic.unc.edu/wp-content/uploads/sites/1268/2023/02/Educator-Attrition-and-Hiring-in-NC.pdf.

Beilstein, Shereen Oca, and Tom Withee. 2022. "2021 Illinois Educator Shortage Survey Illinois' Persistent Educator Shortage." Illinois Workforce and Education Research Collaborative. https://omsdpiprod.wpenginepowered.com/wp-content/uploads/2022/10/Persistent_Educator.pdf.

Bleiberg, Joshua F., and Matthew A. Kraft. 2023. "What Happened to the K–12 Education Labor Market During COVID? The Acute Need for Better Data Systems." *Education Finance and Policy* 18 (1): 156–72. https://doi.org/10.1162/edfp_a_00391.

Bruno, Paul. 2022. "Figuring Out When to Panic About 'Teacher Shortages': How Journalism Could Clarify Stories about Teacher Hiring Problems." *Education Next* (blog). August 8, 2022. https://www.educationnext.org/figuring-out-when-to-panic-about-teacher-shortages/.

Camp, Andrew, Gema Zamarro, and Josh B. McGee. 2022. "Changes in Teachers' Mobility and Attrition in Arkansas During the First Two Years of the COVID-19 Pandemic." EDRE Working Paper 2022–06. Education Reform Faculty and Graduate Students Publications. https://scholarworks.uark.edu/edrepub/138.

Carbonari, Maria V., Michael DeArmond, Daniel Dewey, Elise Dizon-Ross, Dan Goldhaber, Thomas J. Kane, Anna McDonald, et al. 2024. "Impacts of Academic Recovery Interventions on Student Achievement in 2022-23." CALDER Working Paper 303–0724. https://caldercenter.org/publications/impacts-academic-recovery-interventions-student-achievement-2022-23.

Carver-Thomas, Desiree, Dion Burns, Melanie Leung, and Naomi Ondrasek. 2022. "Teacher Shortages During the Pandemic: How California Districts Are Responding." Palo Alto, CA: Learning Policy Institute. https://learningpolicyinstitute.org/product/california-teacher-shortages-response-report.

Cowan, James, Dan Goldhaber, Kyle Hayes, and Roddy Theobald. 2016. "Missing Elements in the Discussion of Teacher Shortages." *Educational Researcher* 45 (8): 460–62. https://doi.org/10.3102/0013189X16679145.

Cullotta, Karen Ann. 2022. "As School Staff Shortages Worsen, Illinois Educators Cast Wary Eye on Fall Reopening." *Chicago Tribune*, July 12, 2022. https://www.chicagotribune.com/news/breaking/ct-ilinois-teacher-shortage-summer-hiring-20220712-xgp5syfmjrfu5hdog3gysg6cca-story.html.

Dhaliwal, Tasminda K., and Paul Bruno. 2021. "The Rural/Nonrural Divide? K–12 District Spending and Implications of Equity-Based School Funding." *AERA Open* 7 (1): 1–21. https://doi.org/10.1177/2332858420982549.

Diliberti, Melissa Kay, and Heather L. Schwartz. 2023. "Educator Turnover Has Markedly Increased, but Districts Have Taken Actions to Boost Teacher Ranks: Selected Findings from the Sixth American School District Panel Survey." Santa Monica, CA: RAND Corporation. https://doi.org/10.7249/RRA956-14.

Edelman, Amanda F., Rachel Perera, and Jonathan Schweig. 2018. *Results from the Teach For America 2017 National Principal Survey: School Leader Perspectives on Induction, Support, and School Partnerships*. Santa Monica, CA: RAND Corporation. https://doi.org/10.7249/RR2192.

Edwards, Danielle Sanderson, Matthew A. Kraft, Alvin Christian, and Christopher A. Candelaria. 2024. "Teacher Shortages: A Framework for Understanding and Predicting Vacancies." *Educational Evaluation and Policy Analysis*, April, 01623737241235224. https://doi.org/10.3102/01623737241235224.

Engel, Mimi, Brian A. Jacob, and F. Chris Curran. 2014. "New Evidence on Teacher Labor Supply." *American Educational Research Journal* 51 (1): 36–72. https://doi.org/10.3102/0002831213503031.

Giangreco, Michael F., Jesse C. Suter, and Mary   Beth Doyle. 2010. "Paraprofessionals in Inclusive Schools: A Review of Recent Research." *Journal of Educational and Psychological Consultation* 20 (1): 41–57. https://doi.org/10.1080/10474410903535356.

Goldhaber, Dan. 2007. "Everyone's Doing It, But What Does Teacher Testing Tell Us About Teacher Effectiveness?" *Journal of Human Resources* XLII (4): 765–94. https://doi.org/10.3368/jhr.XLII.4.765.

Goldhaber, Dan, Grace T. Falken, and Roddy Theobald. 2024a. "What Do Teacher Job Postings Tell Us About School Hiring Needs and Equity?" *Educational Evaluation and Policy Analysis*, May, 01623737241246548. https://doi.org/10.3102/01623737241246548.

Goldhaber, Dan, Grace Falken, and Roddy Theobald. 2024b. "ESSER Funding and School System Jobs: Evidence from Job Posting Data." CALDER Working Paper 297–0424. National Center for Analysis of Longitudinal Data in Education Research. https://caldercenter.org/publications/esser-funding-and-school-system-jobs-evidence-job-posting-data.

Goldhaber, Dan, Cyrus Grout, Kristian L. Holden, and Nate Brown. 2015. "Crossing the Border? Exploring the Cross-State Mobility of the Teacher Workforce." *Educational Researcher* 44 (8): 421–31. https://doi.org/10.3102/0013189X15613981.

Goldhaber, Dan, John Krieg, Roddy Theobald, and Nate Brown. 2015. "Refueling the STEM and Special Education Teacher Pipelines." *Phi Delta Kappan* 97 (4): 56–62. https://doi.org/10.1177/0031721715619921.

Goldhaber, Dan, Katharine O. Strunk, Nate Brown, Natsumi Naito, and Malcolm Wolff. 2020. "Teacher Staffing Challenges in California: Examining the Uniqueness of Rural School Districts." *AERA Open* 6 (3). https://doi.org/10.1177/2332858420951833.

Goldhaber, Dan, and Roddy Theobald. 2016. "Opinion: Sorting Out the Issues in the Teacher Shortage Crisis." *The 74* (blog). September 22, 2016. https://www.the74million.org/article/article-opinion-sorting-out-the-issues-in-the-teacher-shortage-crisis/.

———. 2023a. "Teacher Attrition and Mobility in the Pandemic." *Educational Evaluation and Policy Analysis* 45 (4): 682–87. https://doi.org/10.3102/01623737221139285.

———. 2023b. "Teacher Turnover Three Years into the Pandemic Era: Evidence from Washington State." CALDER Policy Brief 32. Center for Analysis of Longitudinal Data in Education Research (CALDER). https://caldercenter.org/publications/teacher-turnover-three-years-pandemic-era-evidence-washington-state.

Grissom, Jason A., Anna J. Egalite, and Constance A. Lindsay. 2021. "How Principals Affect Students and Schools: A Systematic Synthesis of Two Decades of Research." New York: The Wallace Foundation. http://www.wallacefoundation.org/principalsynthesis.

Jacob, Brian A. 2007. “The Challenges of Staffing Urban Schools with Effective Teachers.” *The Future of Children* 17 (1): 129–53.

James, Jessalynn, Matthew A. Kraft, and John P. Papay. 2023. “Local Supply, Temporal Dynamics, and Unrealized Potential in Teacher Hiring.” *Journal of Policy Analysis and Management* 42 (4): 1010–44. https://doi.org/10.1002/pam.22496.

Kane, Thomas J., Jonah E. Rockoff, and Douglas O. Staiger. 2008. “What Does Certification Tell Us about Teacher Effectiveness? Evidence from New York City.” *Economics of Education Review* 27 (6): 615–31. https://doi.org/10.1016/j.econedurev.2007.05.005.

Killeen, K, and J Sipple. 2000. “School Consolidation and Transportation Policy: An Empirical and Institutional Analysis.” Rural School and Community Trust. http://www.ruraledu.org/user_uploads/file/school_consolidation_and_transportation_policy.pdf.

Killeen, Kieran M., and Susanna Loeb. 2022. “A Double Draw of Proximity: The Importance of Geography in Teacher Application and Hiring Decisions.” In *Recent Advancements in Education Finance and Policy*, edited by Thomas Downes and Kieran M. Killeen, 319–62. Research in Education Fiscal Policy and Practice. Charlotte, NC: Information Age Publishing, Inc.

Liu, Edward, and Susan Moore Johnson. 2006. “New Teachers’ Experiences of Hiring: Late, Rushed, and Information-Poor.” *Educational Administration Quarterly* 42 (3): 324–60. https://doi.org/10.1177/0013161X05282610.

Nguyen, Tuan D., Chanh B. Lam, and Paul Bruno. 2024. “What Do We Know About the Extent of Teacher Shortages Nationwide? A Systematic Examination of Reports of U.S. Teacher Shortages.” *AERA Open* 10 (January). https://doi.org/10.1177/23328584241276512.

Podolsky, Anne, and Leib Sutcher. 2016. "California Teacher Shortages: A Persistent Problem." *Learning Policy Institute*. Learning Policy Institute. https://eric.ed.gov/?id=ED606761.

Pounder, Diana G., Patrick Galvin, and Paul Shepherd. 2003. "An Analysis of the United States Educational Administrator Shortage." *Australian Journal of Education* 47 (2): 133–45. https://doi.org/10.1177/000494410304700203.

Rich, Motoko. 2015. "Teacher Shortages Spur a Nationwide Hiring Scramble (Credentials Optional)." *The New York Times*, August 9, 2015. http://www.nytimes.com/2015/08/10/us/teacher-shortages-spur-a-nationwide-hiring-scramble-credentials-optional.html.

Sutcher, Leib, Linda Darling-Hammond, and Desiree Carver-Thomas. 2016. "A Coming Crisis in Teaching? Teacher Supply, Demand, and Shortages in the U.S." Palo Alto, CA: Learning Policy Institute. https://doi.org/10.54300/247.242.

———. 2019. "Understanding Teacher Shortages: An Analysis of Teacher Supply and Demand in the United States." *Education Policy Analysis Archives* 27 (April):35. https://doi.org/10.14507/epaa.27.3696.

U.S. Department of Education. 2021. "Frequently Asked Questions: Elementary and Secondary School Emergency Relief Programs Governor's Emergency Education Relief Programs." Washington, D.C.: U.S. Department of Education. https://oese.ed.gov/files/2021/05/ESSER.GEER_.FAQs_5.26.21_745AM_FINALb0cd6833f6f46e03ba2d97d30aff953260028045f9ef3b18ea602db4b32b1d99.pdf.

———. 2022. "Teacher Shortage Areas." 2022. https://tsa.ed.gov/#/home/.

Yang, Minseok, Se Woong Lee, and Peter T. Goff. 2021. "Labor Dynamics of School Principals in Rural Contexts." *AERA Open* 7. https://doi.org/10.1177/2332858420986189.

Figures

Figure 1 – Unfilled Certificated Positions in Illinois Public Schools, Fall 2022

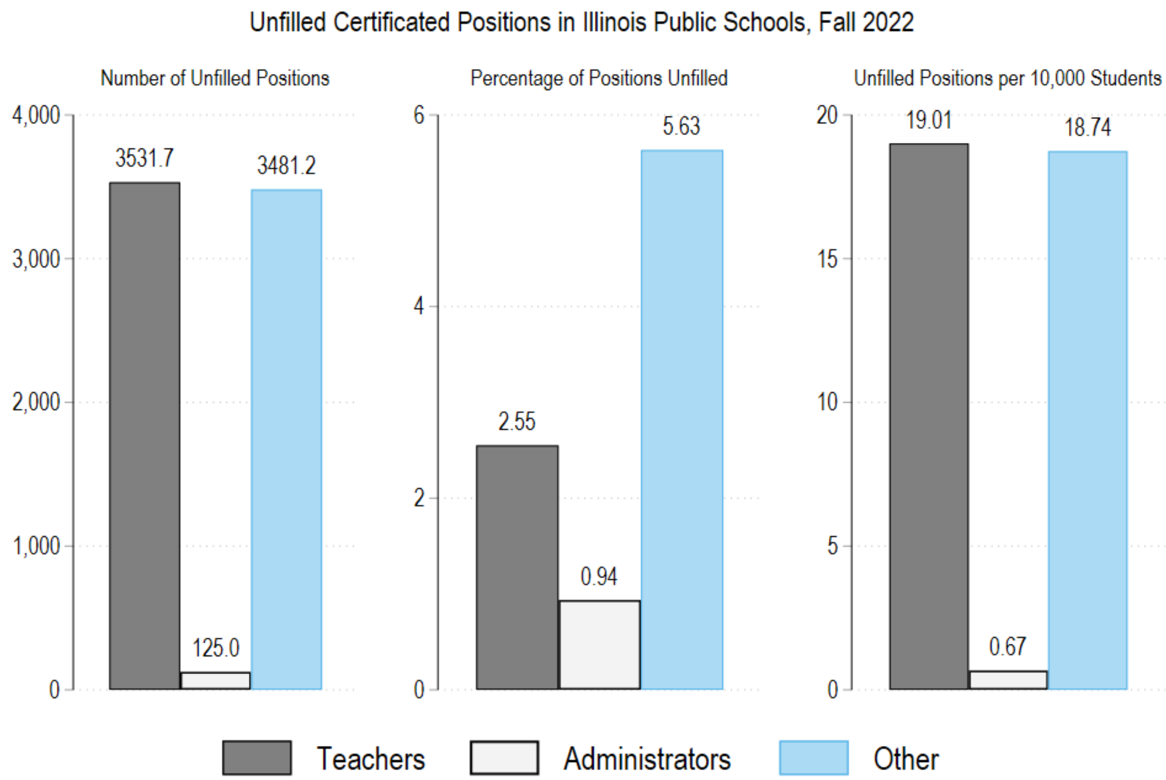


Figure 2 – Unfilled Positions by Urbanicity and Grade Level

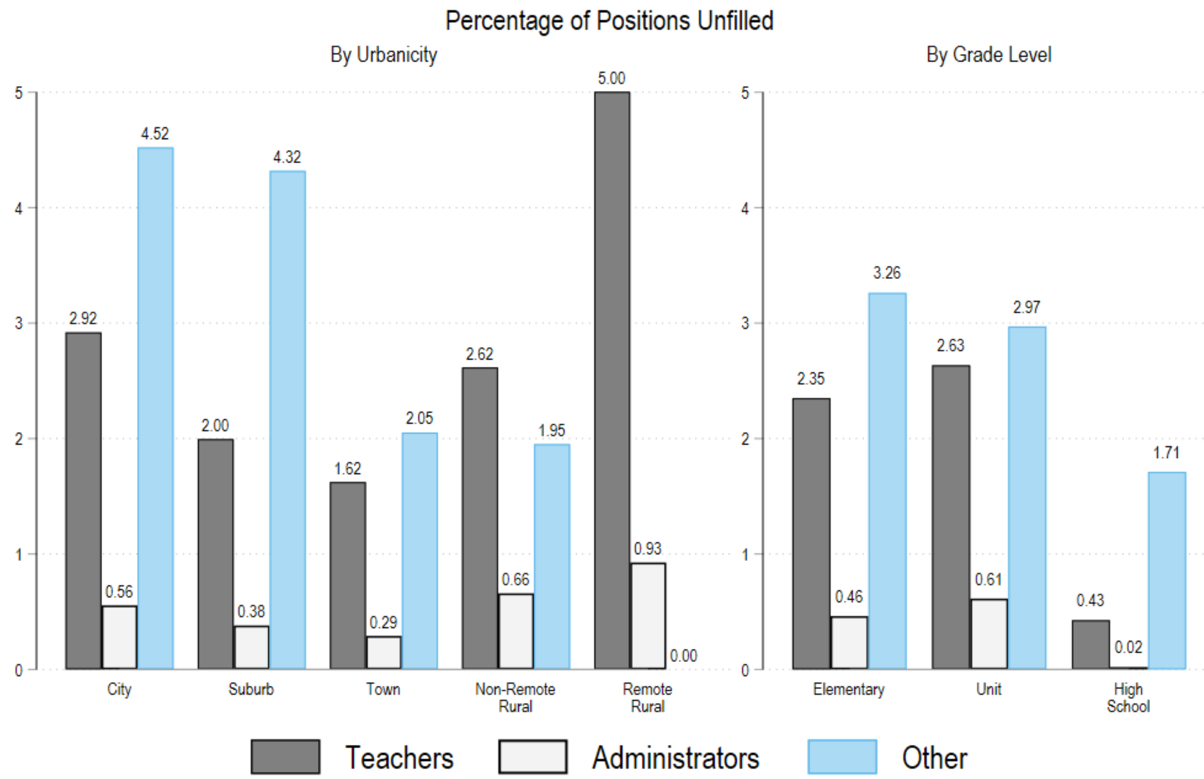
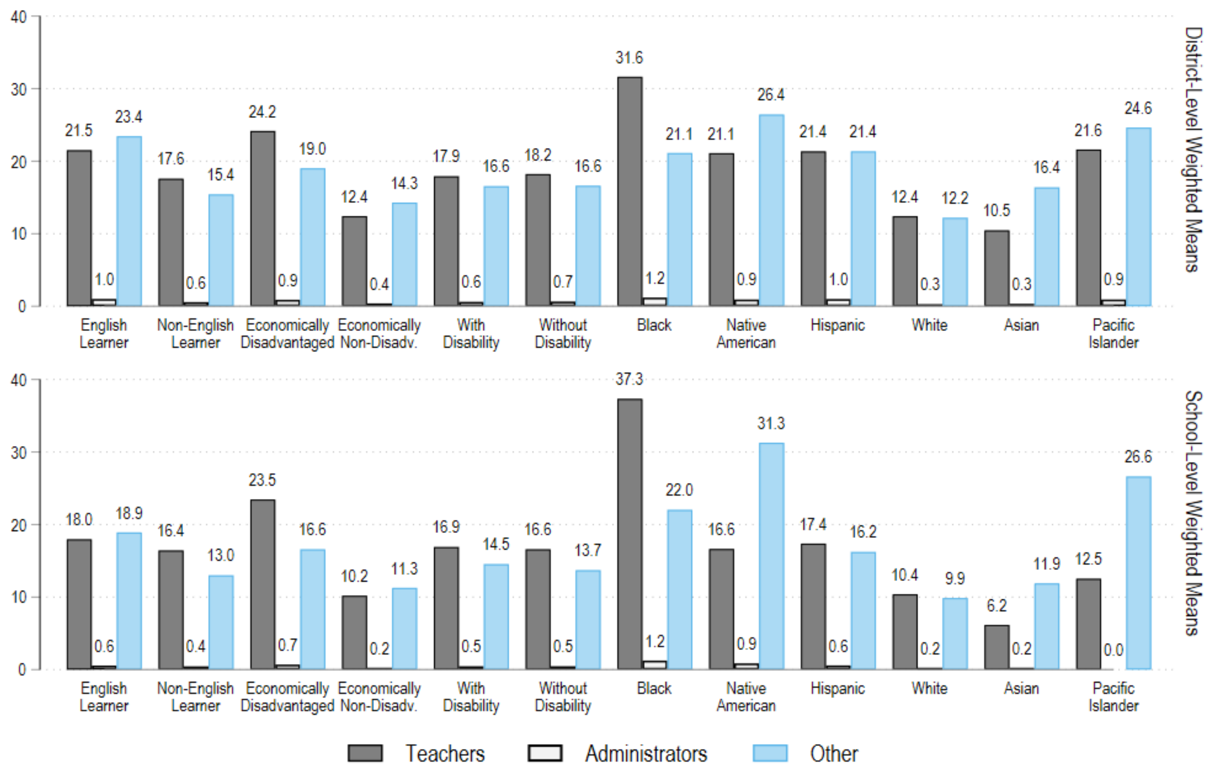


Figure 3 –Unfilled Positions in 2022 Per 10,000 Students Experienced by Students



Tables

Table 1 – Regressions Predicting Percentage of Positions Unfilled in Districts in 2022

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Urbanicity (Reference Group = Suburb)									
City	0.54	0.13	0.47	0.19	0.30	0.06	0.14	-1.11	-0.45
	(0.82)	(0.60)	(0.54)	(0.30)	(0.33)	(0.34)	(1.40)	(1.45)	(1.38)
Town	-0.60	0.36	0.32	0.04	0.26	0.11	-0.91	0.32	0.65
	(0.44)	(0.43)	(0.42)	(0.43)	(0.43)	(0.42)	(1.28)	(1.19)	(1.08)
Non-Remote Rural	0.02	1.37**	1.41**	0.48	0.66	0.31	-1.47	0.25	0.73
	(0.43)	(0.43)	(0.50)	(0.46)	(0.45)	(0.36)	(1.17)	(1.13)	(0.97)
Remote Rural	2.06	3.27*	3.38*	0.72	0.88	0.46	-4.17*	-2.39	-1.71
	(1.61)	(1.64)	(1.64)	(1.13)	(1.18)	(1.19)	(1.68)	(1.62)	(1.53)
Level (Reference Group = Elementary)									
Unit	0.02	0.05	0.19	-0.10	-0.14	-0.14	1.54	1.44	0.81
	(0.44)	(0.42)	(0.39)	(0.61)	(0.61)	(0.63)	(1.12)	(0.94)	(0.73)
High School	-1.93***	-1.36***	-0.66	-0.45*	-0.42	-0.64	-1.58**	-0.18	-0.13
	(0.31)	(0.35)	(0.42)	(0.21)	(0.28)	(0.45)	(0.59)	(0.63)	(0.86)
Average Class Size			0.11+			-0.09			0.12
			(0.06)			(0.08)			(0.09)
Teacher Turnover Rate (3-Year Average)			0.29***			-0.04			0.13**
			(0.05)			(0.03)			(0.05)
Average Teacher Salary (Thousands of $)			-0.01			0.02			0.02
			(0.02)			(0.02)			(0.04)
Average Teacher Experience (Years)			0.23+			-0.08			0.15
			(0.12)			(0.06)			(0.13)
Percentage Teachers with MA			0.02			-0.00			-0.03
			(0.02)			(0.01)			(0.03)
ESSER Allocations Per Pupil (Thousands of $)			0.23*			0.15			0.23
			(0.10)			(0.10)			(0.24)
County Fixed Effects	X	X	X	X	X	X	X	X	X
Student Characteristics		X	X		X	X		X	X
Districts	851	851	845	851	851	845	846	846	840
R-sq.	0.24	0.41	0.49	0.14	0.16	0.17	0.16	0.25	0.28

Note. Heteroskedasticity-robust standard errors in parentheses. All models include one observation per district in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 as a percentage of all positions of the same type. Student characteristics include the shares of students who are Black, Hispanic, Asian, Pacific Islander, Native American, unknown or multiple races, economically disadvantaged, English learners, and who have a disability. $^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 2 – Regressions Predicting Unfilled Positions per 10,000 Students in Schools in 2022

	Teachers				Administrators				Other			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Charter School	10.84^{***}	-14.38^{***}	-20.50^{***}	-41.92^{***}	2.94^{***}	1.06^{***}	0.83^{**}	1.85^{***}	3.20^{*}	-12.37^{***}	-14.12^{***}	-20.76^{***}
	(1.99)	(2.62)	(1.97)	(4.60)	(0.27)	(0.28)	(0.30)	(0.27)	(1.43)	(1.98)	(2.22)	(2.95)
Level (Reference Group = Elementary)												
Middle School	4.54	9.75^{***}	10.95^{***}	12.02^{***}	0.26	0.68^{+}	0.84^{*}	1.14^{*}	-4.54^{+}	-0.93	-0.45	-0.25
	(4.56)	(2.07)	(2.44)	(2.63)	(0.33)	(0.36)	(0.41)	(0.57)	(2.62)	(0.96)	(1.08)	(1.08)
High School	10.23^{***}	16.58^{***}	17.69^{***}	15.24^{***}	1.27	1.76	2.10	1.49	-7.96^{***}	-3.22^{*}	-2.60	-2.87
	(2.12)	(2.28)	(2.74)	(2.71)	(0.86)	(1.36)	(1.38)	(1.06)	(1.31)	(1.45)	(2.52)	(2.75)
Average Class Size				-0.98^{**}				-0.31				-0.31^{**}
				(0.31)				(0.19)				(0.10)
Teacher Turnover Rate (3-Year Average)				0.65^{***}				-0.05^{*}				0.20^{***}
				(0.16)				(0.02)				(0.06)
Constant	19.08^{***}				0.35^{*}				16.57^{***}			
	(4.27)				(0.15)				(2.88)			
District Fixed Effects		X	X	X		X	X	X		X	X	X
Student Characteristics			X	X			X	X			X	X
Schools	3729	3729	3724	3661	3729	3729	3724	3661	3729	3729	3724	3661
Districts	851	851	851	844	851	851	851	844	851	851	851	844
R-sq.	0.009	0.416	0.469	0.491	0.005	0.054	0.060	0.068	0.009	0.412	0.450	0.459

Note. Standard errors clustered on districts in parentheses. All models include one observation per school in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 per 10,000 students enrolled. Student characteristics include the shares of students who are Black, Hispanic, Asian, Pacific Islander, Native American, unknown or multiple races, economically disadvantaged, English learners, and who have a disability. $^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix A

Appendix A Figures

Figure A1 – Cumulative Changes in Enrollment and Staffing Over Time

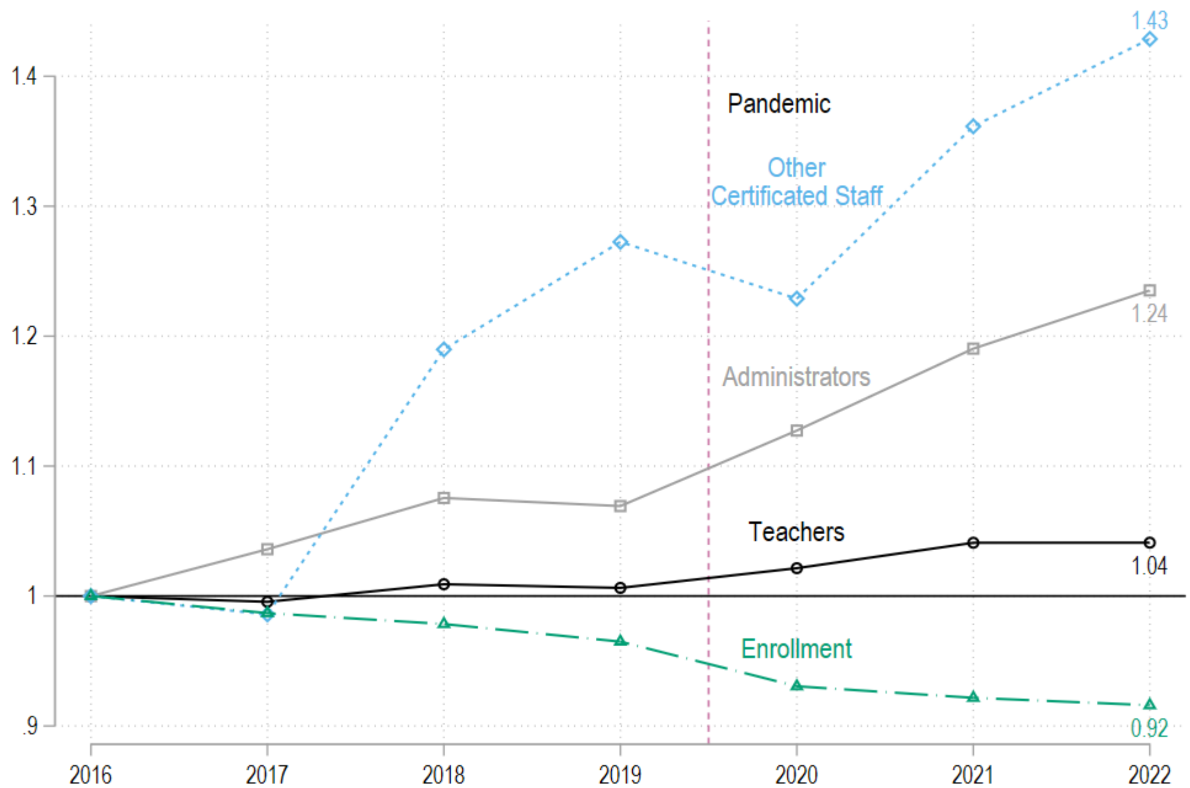


Figure A2 – Student:Staff Ratios and Teacher Attrition Ove Time

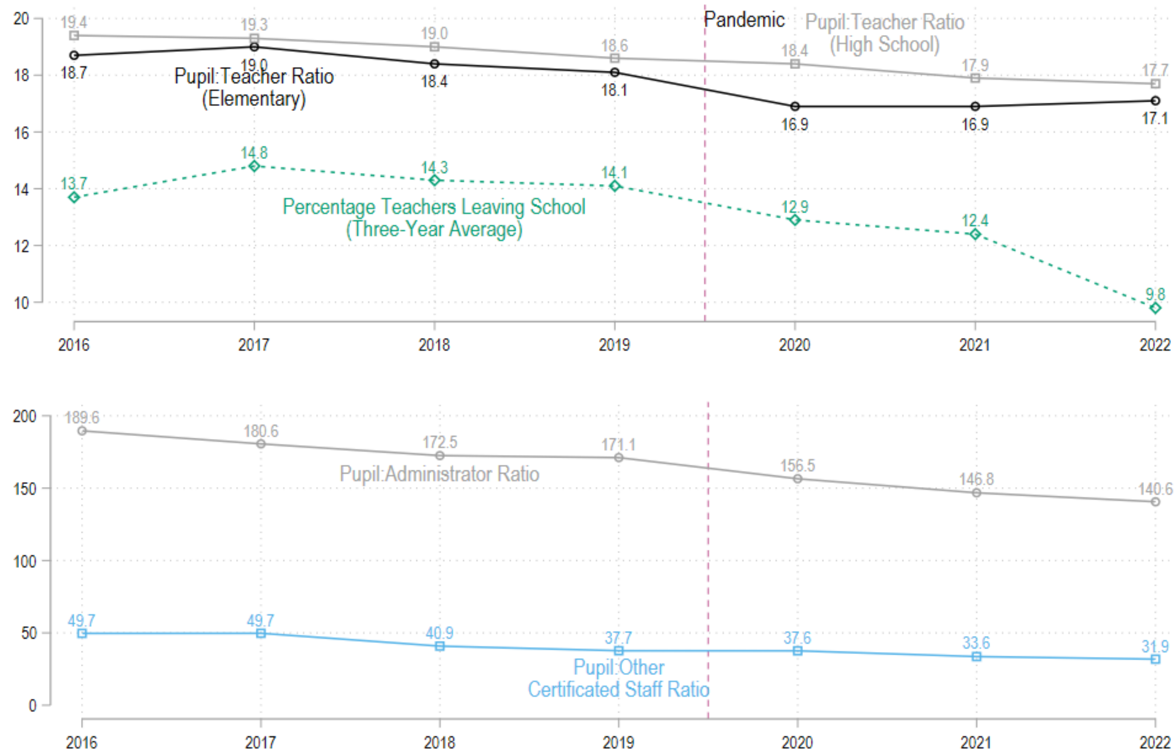
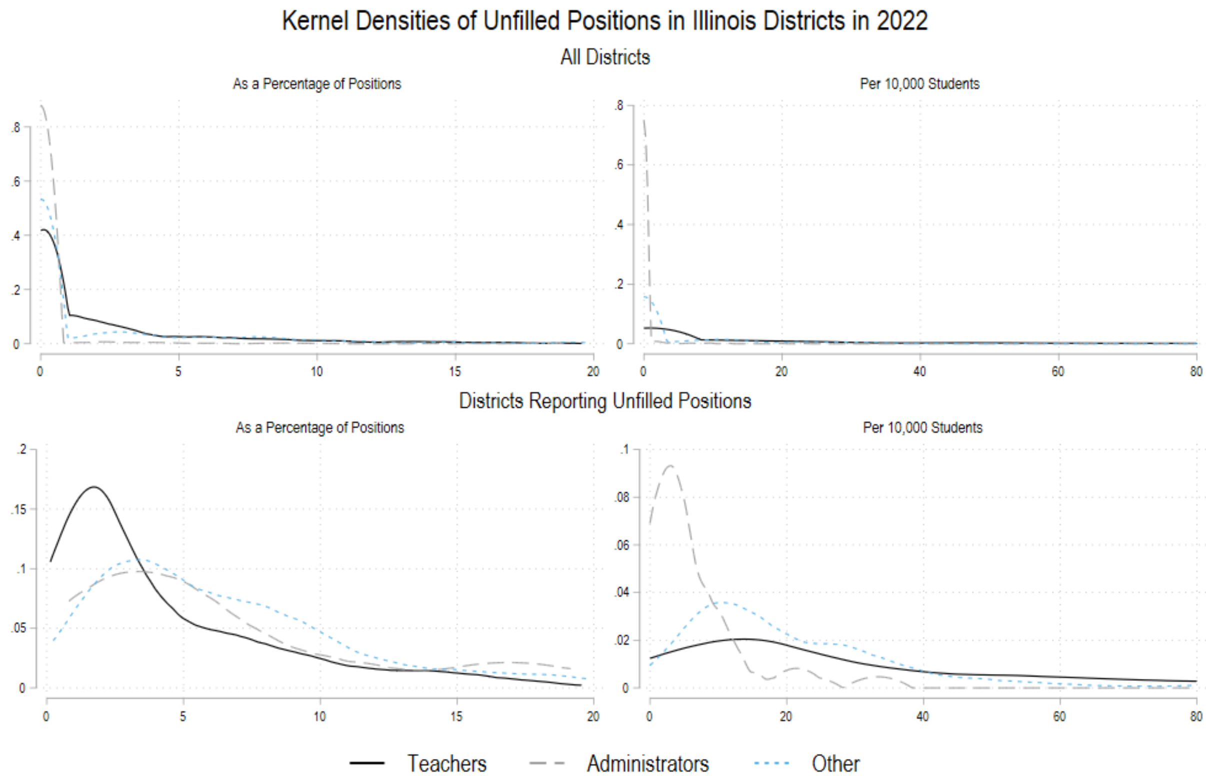


Figure A3 – Distributions of District Vacancy Rates in 2022



Note. Districts with vacancy rates above 20% are not shown.

Figure A4 – Unfilled Positions in 2022 as a Percentage of Employment by County

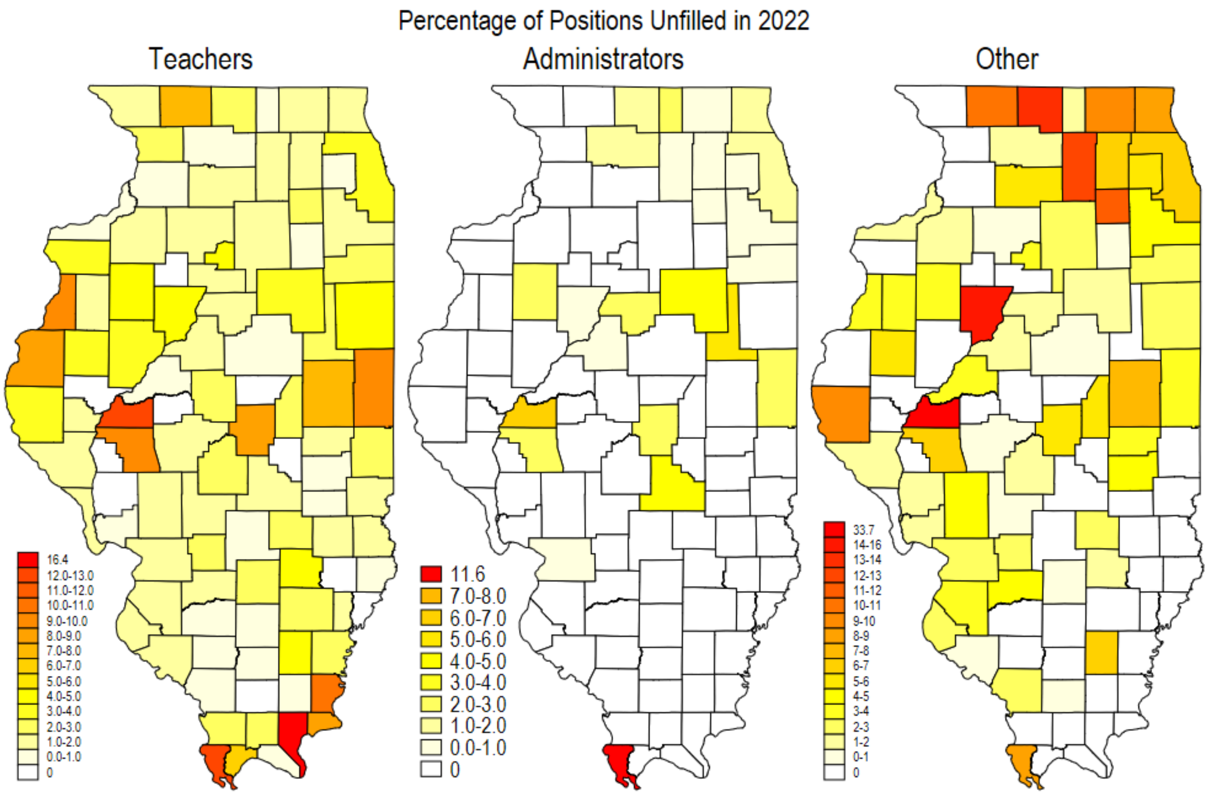


Figure A5 – Unfilled Positions Per 10,000 Students by Urbanicity and Grade Level

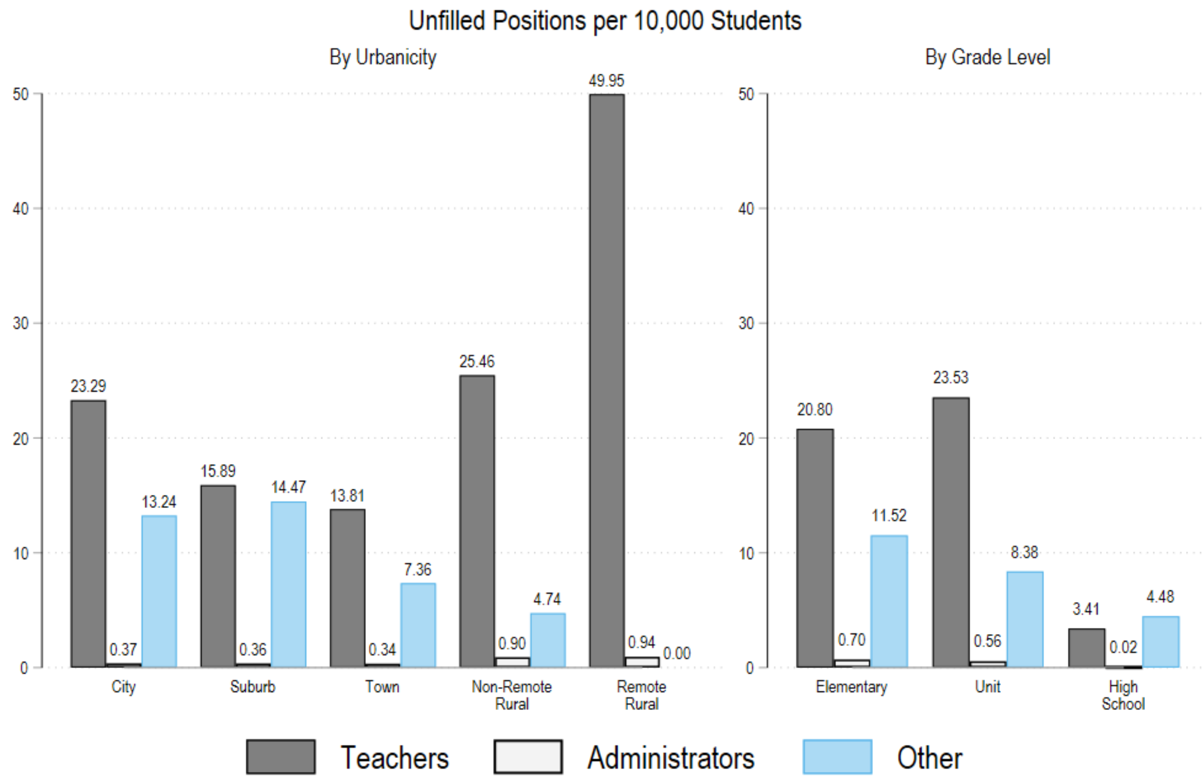


Figure A6 **– Correlations Between Vacancy Rates and ESSER Funding, 2022**

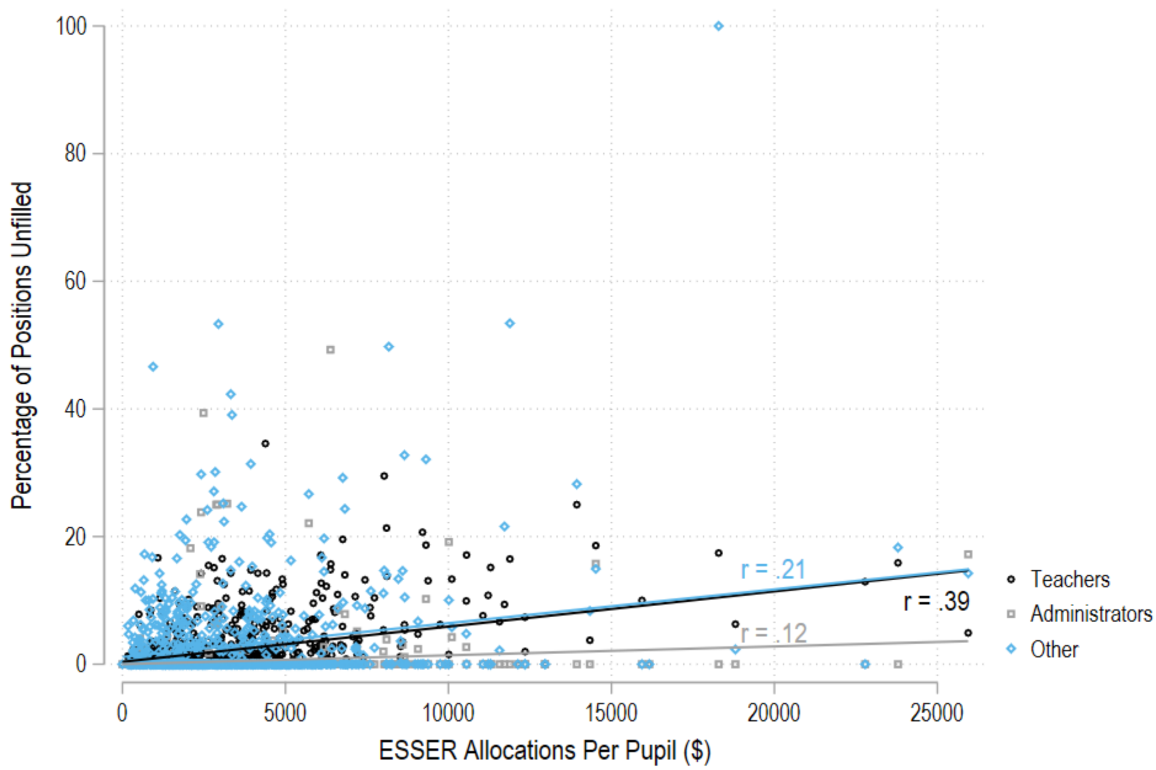
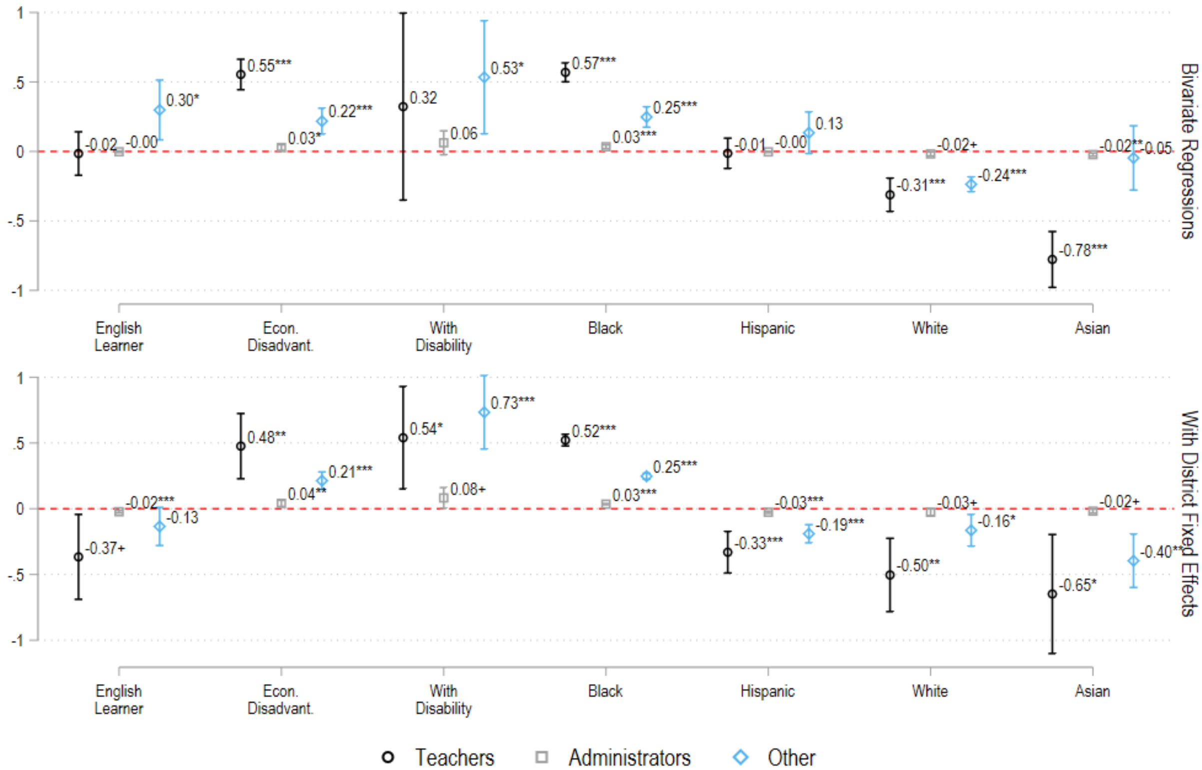
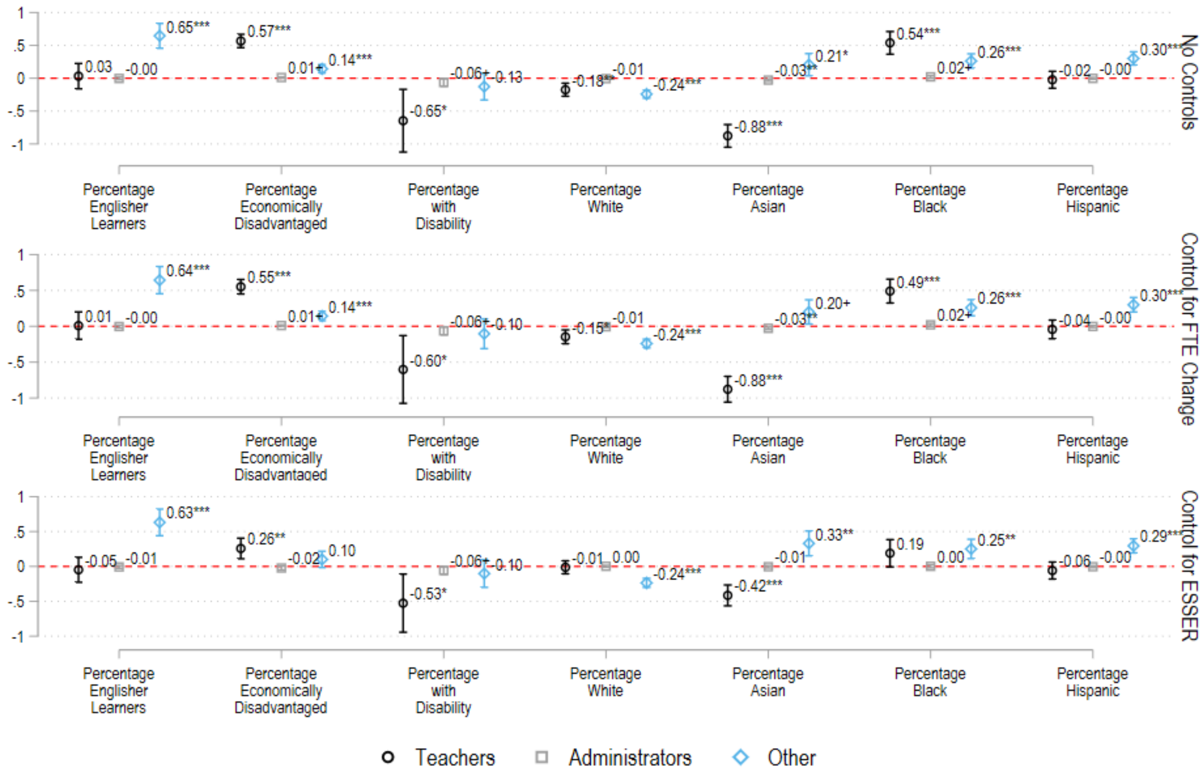


Figure A7 –Regressions of Unfilled Positions Per 10,000 Students in 2022 on School Demographic Characteristics



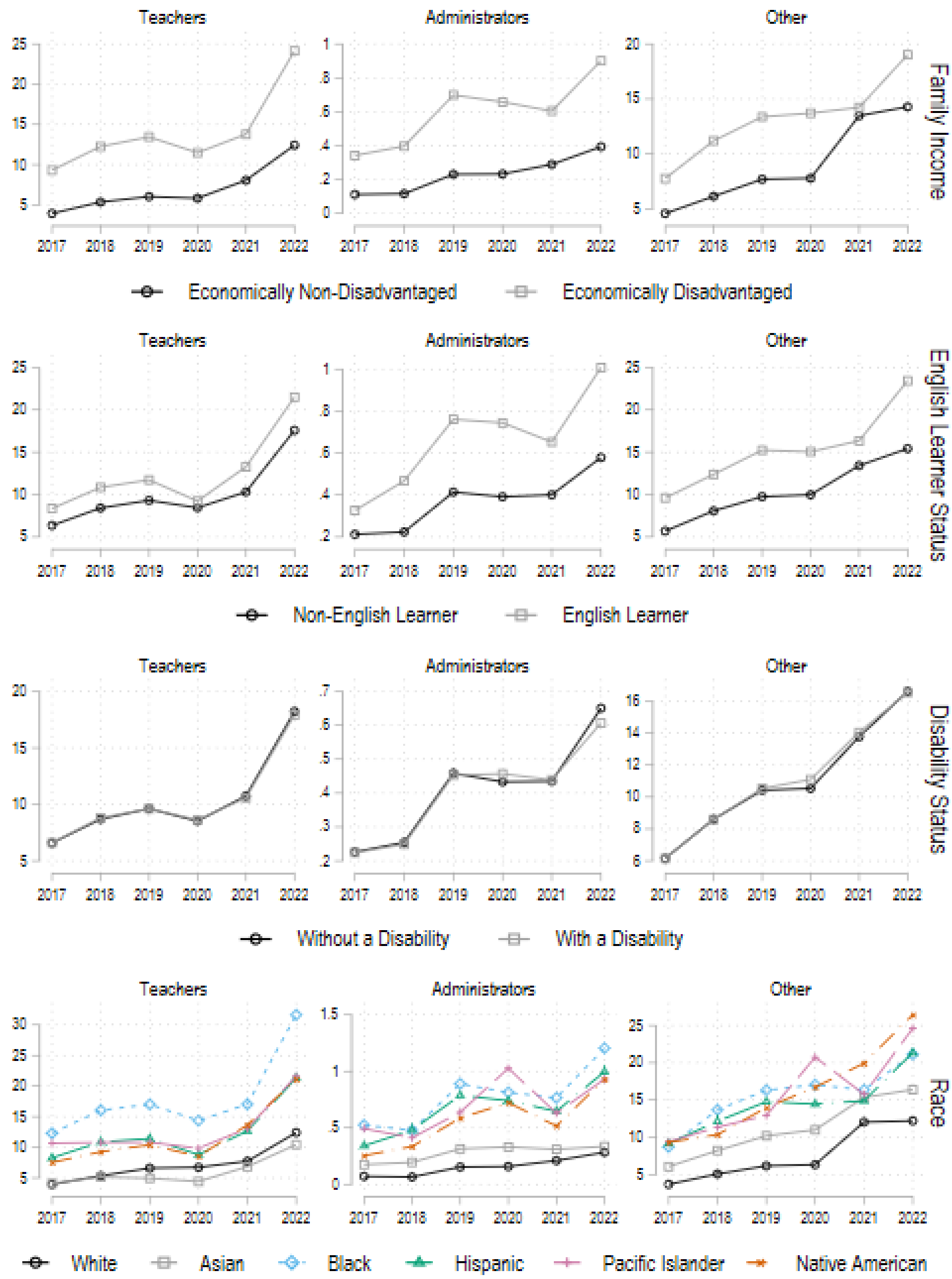
Note. Each point estimate and 90% confidence interval come from a separate regression of school-level vacancy rates on the percentage of students in the school who belong to the indicated groups. Each estimate comes from a model similar to those used in Table 2, except that the only predictor in each model is the percentage of students in the school who belong to the indicated group. Standard errors are clustered on districts. Results from models including the shares of students who are Native American or Pacific Islander are not shown due to their substantial imprecision. Econ. Disadvant. = Economically Disadvantaged. + p < .1, * p < .05, ** p < .01, *** p < .001

Figure A8 – Linear Relationships Between Student Characteristics and District-Level Unfilled Positions per 10,000 Students



Note. Each estimate is the point estimate and 90% confidence interval on the indicated student demographic characteristic when predicting unfilled positions per 10,000 students in the district in 2022, estimated with heteroskedasticity-robust standard errors. The top panel includes coefficients from bivariate regressions. The middle panel additionally controls for the percentage by which employed FTE in the given staff position (e.g., administrators) has changed in the district since 2020. The bottom panel controls instead for each district's ESSER allocation per pupil.

Figure A9 – District-Level Unfilled Positions per 10,000 Students Experienced by Students Since 2017



Note. Estimates are district-level enrollment-weighted means like those in the top panel of Figure 3 but estimated separately for each fall since 2017.

Appendix A Tables

Table A1 – District-Level Summary Statistics for 2022

	N	Mean	SD	Min	Max
Unfilled Positions as a Percentage of Positions					
Teachers	851	2.3	4.1	0.0	34.6
Administrators	851	0.5	3.2	0.0	49.3
Other	846	3.0	7.3	0.0	100.0
Unfilled Positions per 10,000 Students					
Teachers	851	20.1	39.4	0.0	402.0
Administrators	851	0.6	5.0	0.0	119.0
Other	851	9.3	22.0	0.0	202.9
Other District Characteristics					
City	851	0.0	0.2	0.0	1.0
Suburb	851	0.4	0.5	0.0	1.0
Town	851	0.2	0.4	0.0	1.0
Non-Remote Rural	851	0.3	0.5	0.0	1.0
Remote Rural	851	0.0	0.2	0.0	1.0
Elementary District	851	0.4	0.5	0.0	1.0
High School District	851	0.1	0.3	0.0	1.0
Unit District	851	0.5	0.5	0.0	1.0
Percentage Black	851	8.5	18.2	0.0	98.6
Percentage Hispanic	851	14.1	18.0	0.0	97.2
Percentage Asian	851	2.6	6.7	0.0	56.2
Percentage Pacific Islander	851	0.0	0.1	0.0	1.8
Percentage Native American	851	0.0	0.2	0.0	2.8
Percentage Unknown or Multi-Race	851	5.4	3.3	0.0	22.9
Percentage White	851	69.4	28.4	0.0	99.4
Percentage Economically Disadvantaged	851	44.4	21.9	0.0	100.0
Percentage Englisher Learners	851	6.9	10.9	0.0	63.8
Percentage with Disability	851	18.2	5.2	3.6	97.9
Average Class Size	845	18.1	4.0	3.0	26.3
Teacher Turnover Rate (%age, 3-Year Average)	851	11.0	5.6	0.0	47.4
Average Teacher Salary (Thousands of Dollars)	851	62.0	15.8	34.5	131.1
Teachers' Average Years Experience	851	13.6	2.4	4.0	23.0
Percentage of Teachers with MA	851	48.2	17.8	0.0	94.6
ESSER Allocations Per Pupil ($)	851	3415.1	2884.0	0.0	25945.2

Note. Unfilled paraprofessional, support staff, and other positions are combined into a single “other” category. Positions are assumed to be the sum of employed individuals and unfilled positions in a given position type. All positions are full-time equivalent. Elementary and Secondary School Emergency Relief (ESSER) allocations include allocations from all waves of ESSER funding as of April 2023. MA = Master's Degree

Table A2 – School-Level Summary Statistics

	N	Mean	SD	Min	Max
Unfilled Positions per 10,000 Students					
Teachers	3729	22.1	47.6	0.0	625.0
Administrators	3729	0.7	11.2	0.0	588.2
Other	3729	14.5	33.7	0.0	420.4
Other School Characteristics					
Elementary School	3858	0.6	0.5	0.0	1.0
Middle School	3858	0.2	0.4	0.0	1.0
High School	3858	0.2	0.4	0.0	1.0
Percentage Black	3730	17.2	28.5	0.0	100.0
Percentage Hispanic	3730	22.1	26.8	0.0	99.4
Percentage Asian	3730	3.7	8.5	0.0	83.4
Percentage Pacific Islander	3730	0.0	0.1	0.0	3.0
Percentage Native American	3730	0.0	0.4	0.0	20.3
Percentage Unknown or Multi-Race	3730	5.9	4.8	0.0	100.0
Percentage White	3730	51.2	35.0	0.0	100.0
Percentage Economically Disadvantaged	3730	51.7	27.1	0.0	100.0
Percentage Englisher Learners	3730	13.0	17.5	0.0	85.8
Percentage with Disability	3724	18.5	6.2	2.1	97.9
Average Class Size	3680	20.2	4.5	2.0	34.2
Teacher Turnover Rate (%age, 3-Year Average)	3710	14.2	10.4	0.0	100.0

Note. Unfilled paraprofessional, support staff, and other positions are combined into a single "other" category. All positions are full-time equivalent.

Table A3 – Poisson Regression Estimates of Unfilled Positions in Districts in 2022 per 10,000 students

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Urbanicity (Reference Group = Suburb)									
City	0.25	0.18	0.32	0.08	2.02*	1.44	0.01	-0.25	-0.26
	(0.31)	(0.26)	(0.23)	(0.53)	(1.00)	(1.15)	(0.25)	(0.30)	(0.30)
Town	-0.22	0.11	0.21	0.52	0.38	0.26	-0.14	0.11	0.12
	(0.24)	(0.23)	(0.23)	(0.82)	(0.82)	(0.99)	(0.35)	(0.30)	(0.30)
Non-Remote Rural	0.21	0.85***	0.70**	1.24**	1.52*	0.99	-0.64*	-0.16	-0.12
	(0.19)	(0.20)	(0.22)	(0.46)	(0.60)	(0.76)	(0.28)	(0.28)	(0.30)
Remote Rural	0.66+	1.23***	1.07**	1.34	2.19*	2.11+			
	(0.36)	(0.36)	(0.36)	(1.22)	(1.10)	(1.14)			
Level (Reference Group = Elementary)									
Unit	-0.18	-0.08	0.07	-2.05*	-2.05*	-0.41	0.28	0.27	0.26
	(0.21)	(0.21)	(0.20)	(0.91)	(1.02)	(0.88)	(0.22)	(0.23)	(0.24)
High School	-1.80***	-1.43***	-0.82*	-3.95**	-4.13***	-4.64**	-0.98***	-0.64*	-0.58
	(0.36)	(0.36)	(0.39)	(1.24)	(1.22)	(1.43)	(0.25)	(0.30)	(0.39)
Average Class Size			-0.00			-0.19***			0.02
			(0.02)			(0.05)			(0.03)
Teacher Turnover Rate (3-Year Average)			0.08***			-0.08+			0.04**
			(0.01)			(0.05)			(0.02)
Average Teacher Salary (Thousands of $)			-0.02			-0.00			-0.00
			(0.01)			(0.03)			(0.01)
Average Teacher Experience (Years)			0.04			-0.19+			0.02
			(0.04)			(0.11)			(0.04)
Percentage Teachers with MA			0.00			0.04			0.01
			(0.01)			(0.03)			(0.01)
ESSER Allocations Per Pupil (Thousands of $)			-0.00			-0.00			0.03
			(0.02)			(0.09)			(0.04)
County Fixed Effects	X	X	X	X	X	X	X	X	X
Student Characteristics		X	X		X	X		X	X
Districts	851	851	845	851	851	845	824	824	818
Pseudo R-sq.	0.303	0.477	0.546	0.525	0.612	0.657	0.345	0.419	0.428

Note. Heteroskedasticity-robust standard errors in parentheses. All models include one observation per district in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 per 10,000 students enrolled. Student characteristics include the shares of students who are Black, Hispanic, Asian, Pacific Islander, Native American, unknown or multiple races, economically disadvantaged, English learners, and who have a disability. Estimation samples differ across models to a greater extent than in the main results tables because observations need to be dropped to facilitate maximum likelihood estimation (Correia, Guimarães, and Zylkin 2020).

$^{+}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table A4 – Poisson Regression Estimates of Unfilled Positions in Schools in 2022 per 10,000 Students

	Teachers				Administrators				Other			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Charter School	0.37***	-0.44***	-0.60***	-1.20***	1.44**	-0.02	-0.10	-0.03	0.22+	-0.54***	-0.53***	-0.91***
	(0.10)	(0.11)	(0.13)	(0.26)	(0.50)	(0.07)	(0.07)	(0.10)	(0.12)	(0.10)	(0.13)	(0.19)
Level (Reference Group = Elementary)												
Middle School	0.21	0.49***	0.54***	0.54***	0.45	1.55**	1.31**	1.65***	-0.32+	-0.05	-0.05	-0.04
	(0.23)	(0.09)	(0.12)	(0.12)	(0.67)	(0.53)	(0.48)	(0.47)	(0.16)	(0.06)	(0.07)	(0.07)
High School	0.42***	0.59***	0.62**	0.50**	1.33***	1.47***	1.59***	1.17***	-0.64***	-0.26***	-0.35**	-0.39**
	(0.11)	(0.14)	(0.19)	(0.16)	(0.22)	(0.24)	(0.18)	(0.20)	(0.13)	(0.06)	(0.12)	(0.12)
Average Class Size				-0.03*				-0.15***				-0.01*
				(0.01)				(0.02)				(0.00)
Teacher Turnover Rate (3-Year Average)				0.01***				-0.02***				0.01***
				(0.00)				(0.00)				(0.00)
Constant	2.95***				-0.95*				2.81***			
	(0.22)				(0.46)				(0.17)			
District Fixed Effects		X	X	X		X	X	X		X	X	X
Student Characteristics			X	X			X	X			X	X
Schools	3729	3729	3724	2515	3729	3729	3714	809	3729	3729	3724	2049
Districts	851	851	851	346	851	851	850	26	851	851	851	227
Pseudo R-sq.	0.014	0.569	0.619	0.496	0.072	0.449	0.511	0.360	0.017	0.563	0.604	0.386

Note. Standard errors clustered on districts in parentheses. All models include one observation per school in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 per 10,000 students enrolled. Student characteristics include the shares of students who are Black, Hispanic, Asian, Pacific Islander, Native American, unknown or multiple races, economically disadvantaged, English learners, and who have a disability. Estimation samples differ across models to a greater extent than in the main results tables because observations need to be dropped to facilitate maximum likelihood estimation (Correia, Guimarães, and Zylkin 2020).

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table A5 – Pairwise Correlations Between Vacancy Rates and Student Characteristics at the District Level in 2022

	Unfilled Positions (Percentage)			Unfilled Positions (per 10,000 Students)				Percentage of Students									
	Teach	Admin	Other	Teach	Admin	Other	ESSER Allocations Per Pupil	White	Black	Hispanic	Asian	Pacific Islander	Native American	Unknown or Multi-Race	with Disability	ELs	Ec. Dis.
Unfilled Positions (Percentage)																	
Teachers	1.00																
Administrators	0.15^{***}	1.00															
Other	0.35^{***}	0.09^{*}	1.00														
Unfilled Positions (per 10,000 Students)																	
Teachers	0.97^{***}	0.18^{***}	0.31^{***}	1.00													
Administrators	0.15^{***}	0.90^{***}	0.05	0.21^{***}	1.00												
Other	0.29^{***}	0.12^{***}	0.77^{***}	0.28^{***}	0.09^{*}	1.00											
ESSER $ Per Pupil	0.39^{***}	0.12^{***}	0.21^{***}	0.34^{***}	0.13^{***}	0.13^{***}	1.00										
Percentage of Students																	
White	-0.19^{***}	-0.07^{+}	-0.30^{***}	-0.13^{***}	-0.04	-0.31^{***}	-0.35^{***}	1.00									
Black	0.33^{***}	0.09^{**}	0.27^{***}	0.25^{***}	0.07^{*}	0.22^{***}	0.55^{***}	-0.74^{***}	1.00								
Hispanic	0.01	0.03	0.18^{***}	-0.01	-0.01	0.25^{***}	0.05	-0.73^{***}	0.16^{***}	1.00							
Asian	-0.15^{***}	-0.05	0.02	-0.15^{***}	-0.04	0.06^{+}	-0.24^{***}	-0.26^{***}	-0.05	0.09^{**}	1.00						
Pacific Islander	0.03	0.00	0.11^{**}	0.01	-0.01	0.20^{***}	-0.02	-0.12^{***}	0.04	0.12^{***}	0.06^{+}	1.00					
Nat. American	-0.01	0.01	0.15^{***}	-0.02	-0.01	0.22^{***}	-0.01	-0.25^{***}	0.06^{+}	0.28^{***}	0.15^{***}	0.14^{***}	1.00				
Unk./Multi-Race	0.06^{+}	-0.01	-0.00	0.08^{*}	0.01	0.02	0.17^{***}	-0.00	0.05	-0.22^{***}	0.01	0.02	-0.08^{*}	1.00			
with Disability	-0.10^{**}	-0.08^{*}	-0.11^{**}	-0.08^{*}	-0.07^{+}	-0.03	-0.05	0.08^{*}	-0.05	-0.09^{**}	-0.04	0.00	-0.03	0.17^{***}	1.00		
ELs	0.03	0.02	0.23^{***}	0.01	-0.01	0.32^{***}	0.07^{+}	-0.69^{***}	0.14^{***}	0.86^{***}	0.32^{***}	0.19^{***}	0.35^{***}	-0.16^{***}	-0.13^{***}	1.00	
Econ. Disadv.	0.35^{***}	0.06^{+}	0.17^{***}	0.31^{***}	0.05	0.14^{***}	0.72^{***}	-0.40^{***}	0.46^{***}	0.26^{***}	-0.30^{***}	0.00	0.09^{*}	0.12^{***}	0.02	0.23^{***}	1.00

Note. Includes between 846 and 851 district-level observations from 2022. Unfilled paraprofessional, support staff, and other positions are combined into a single “other” category. ELs = English Learners Econ. Disadv./Ec. Dis. = Economically Disadvantaged. $^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table A6 – Regressions Predicting Unfilled Positions in Districts in 2022 Per 10,000 Students

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Urbanicity (Reference Group = Suburb)									
City	5.11	1.84	3.64	0.10	0.20	-0.20	0.32	-4.46	-4.17
	(7.43)	(6.08)	(5.42)	(0.45)	(0.48)	(0.52)	(3.61)	(4.04)	(4.15)
Town	-4.89	2.83	2.64	0.57	0.82	0.54	-2.19	1.85	1.90
	(4.19)	(4.07)	(3.91)	(0.75)	(0.75)	(0.65)	(3.42)	(3.38)	(3.31)
Non-Remote Rural	3.48	14.68^{***}	12.98^{**}	1.07	1.21	0.41	-6.01^{*}	0.15	0.46
	(3.97)	(3.98)	(4.64)	(0.92)	(0.88)	(0.56)	(2.67)	(2.84)	(2.74)
Remote Rural	26.14	35.56^{+}	34.38^{+}	1.26	1.38	0.37	-16.34^{**}	-9.43^{+}	-8.89
	(18.67)	(19.13)	(19.46)	(1.45)	(1.50)	(1.37)	(5.89)	(5.52)	(5.56)
Level (Reference Group = Elementary)									
Unit	-2.98	-1.70	-0.21	-1.12	-1.16	-1.17	2.52	2.34	2.56
	(4.83)	(4.71)	(4.46)	(1.24)	(1.26)	(1.28)	(2.15)	(2.11)	(2.33)
High School	-17.48^{***}	-11.96^{***}	-5.80	-0.73^{+}	-0.73	-1.14	-7.72^{***}	-3.28^{+}	-2.19
	(2.96)	(3.45)	(3.96)	(0.43)	(0.50)	(0.81)	(1.86)	(1.95)	(2.67)
Average Class Size			0.45			-0.20			0.21
			(0.63)			(0.18)			(0.27)
Teacher Turnover Rate (3-Year Average)			2.45^{***}			-0.04			0.32^{*}
			(0.42)			(0.03)			(0.16)
Average Teacher Salary (Thousands of $)			0.02			0.03			0.01
			(0.16)			(0.03)			(0.12)
Average Teacher Experience (Years)			0.90			-0.08			-0.02
			(1.13)			(0.07)			(0.41)
Percentage Teachers with MA			0.15			-0.01			0.01
			(0.17)			(0.01)			(0.10)
ESSER Allocations Per Pupil (Thousands of $)			2.00^{*}			0.24			0.45
			(1.00)			(0.15)			(0.75)
County Fixed Effects	X	X	X	X	X	X	X	X	X
Student Characteristics		X	X		X	X		X	X
Districts	851	851	845	851	851	845	851	851	845
R-sq.	0.250	0.376	0.443	0.130	0.145	0.165	0.218	0.297	0.302

Note. Heteroskedasticity-robust standard errors in parentheses. All models include one observation per district in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 per 10,000 enrolled students. Student characteristics include the shares of students who are Black, Hispanic, Asian, Pacific Islander, Native American, unknown or multiple races, economically disadvantaged, English learners, and who have a disability.

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table A7 – Regressions Predicting Unfilled Positions in Districts in 2022 as a Percentage of All Positions, without County Fixed Effects

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Urbanicity (Reference Group = Suburb)									
City	0.83	-0.27	0.18	0.13	-0.01	-0.15	-0.25	-1.98	-1.05
	(0.83)	(0.69)	(0.63)	(0.25)	(0.30)	(0.29)	(1.38)	(1.41)	(1.28)
Town	-0.49	0.29	0.05	-0.15	0.37	0.18	-2.85***	-0.31	0.04
	(0.33)	(0.31)	(0.34)	(0.22)	(0.26)	(0.26)	(0.80)	(0.76)	(0.70)
Non-Remote Rural	0.34	1.50***	1.09**	0.18	0.74*	0.26	-3.12***	-0.13	0.41
	(0.35)	(0.32)	(0.41)	(0.35)	(0.30)	(0.34)	(0.74)	(0.70)	(0.66)
Remote Rural	2.68+	3.75*	3.41*	0.42	1.12	0.59	-5.38***	-2.06*	-1.28+
	(1.55)	(1.53)	(1.55)	(0.93)	(0.95)	(1.06)	(0.78)	(0.82)	(0.75)
Level (Reference Group = Elementary)									
Unit	0.12	0.20	0.45	0.11	0.21	0.29	1.21+	1.66**	1.37*
	(0.36)	(0.36)	(0.35)	(0.31)	(0.34)	(0.32)	(0.71)	(0.64)	(0.53)
High School	-1.86***	-1.19***	-0.29	-0.41*	-0.31	-0.40	-1.52**	-0.25	-0.15
	(0.28)	(0.32)	(0.37)	(0.16)	(0.22)	(0.30)	(0.55)	(0.60)	(0.76)
Average Class Size			0.09			-0.11			0.10
			(0.06)			(0.08)			(0.08)
Teacher Turnover Rate (3-Year Average)			0.31***			-0.02			0.19***
			(0.05)			(0.03)			(0.05)
Average Teacher Salary (Thousands of $)			-0.02			0.01			-0.00
			(0.02)			(0.01)			(0.03)
Average Teacher Experience (Years)			0.23*			-0.07			0.11
			(0.11)			(0.05)			(0.12)
Percentage Teachers with MA			0.02			0.00			0.02
			(0.01)			(0.01)			(0.02)
ESSER Allocations Per Pupil (Thousands of $)			0.19*			0.16			0.09
			(0.09)			(0.11)			(0.21)
Constant	2.29***	0.21	-7.61***	0.43**	0.43	3.39	4.36***	2.18	-5.29*
	(0.27)	(0.61)	(1.98)	(0.14)	(0.53)	(2.39)	(0.45)	(1.37)	(2.62)
Student Characteristics		X	X		X	X		X	X
Districts	851	851	845	851	851	845	846	846	840
R-sq.	0.05	0.23	0.33	0.00	0.03	0.05	0.04	0.14	0.15

Note. Models and samples are identical to those in Table 1 except that models in this table exclude county fixed effects. $^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table A8 – Coefficients on Student Characteristic Predictors from Regressions Predicting the Percentage of Unfilled Positions in Districts in 2022

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Percentage Black	0.05***	0.07***	0.04**	0.01+	0.03*	0.02*	0.10**	0.09*	0.04
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.03)
Percentage Hispanic	-0.04***	-0.00	0.00	-0.00	0.01	0.01	-0.04	-0.06+	-0.04
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)
Percentage Asian	-0.06***	-0.03*	-0.02	-0.03*	-0.01	-0.01	-0.05	-0.04	-0.06
	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.04)	(0.05)	(0.04)
Percentage Pacific Islander	1.41	-1.88*	-0.88	-0.05	-3.71	-3.73	5.67*	-0.39	0.53
	(0.97)	(0.85)	(0.69)	(0.50)	(3.39)	(3.33)	(2.86)	(4.52)	(4.46)
Percentage Native American	-0.47	-0.26	-0.03	0.12	0.41	0.48	2.63	2.23	2.67
	(0.36)	(0.33)	(0.29)	(0.36)	(0.42)	(0.45)	(1.74)	(1.95)	(1.86)
Percentage Unknown	0.02	0.07	0.01	0.00	-0.01	-0.03	0.04	0.04	0.07
or Multiple Races	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.03)	(0.13)	(0.13)	(0.11)
Percentage Economically	0.04***	0.04***	0.02+	0.00	-0.01	-0.02	0.00	0.03	0.01
Disadvantaged	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Percentage English Learners	0.05*	-0.00	-0.01	0.01	0.01	0.00	0.16***	0.15**	0.14**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)	(0.05)	(0.05)
Percentage with Disability	-0.08**	-0.06*	-0.03	-0.05*	-0.03+	-0.04*	-0.11+	-0.11	-0.04
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.06)	(0.07)	(0.04)
Urbanicity (Reference Group = Suburb)									
City		0.13	0.47		0.30	0.06		-1.11	-0.45
		(0.60)	(0.54)		(0.33)	(0.34)		(1.45)	(1.38)
Town		0.36	0.32		0.26	0.11		0.32	0.65
		(0.43)	(0.42)		(0.43)	(0.42)		(1.19)	(1.08)
Non-Remote Rural		1.37**	1.41**		0.66	0.31		0.25	0.73
		(0.43)	(0.50)		(0.45)	(0.36)		(1.13)	(0.97)
Remote Rural		3.27*	3.38*		0.88	0.46		-2.39	-1.71
		(1.64)	(1.64)		(1.18)	(1.19)		(1.62)	(1.53)
Level (Reference Group = Elementary)									
Unit		0.05	0.19		-0.14	-0.14		1.44	0.81
		(0.42)	(0.39)		(0.61)	(0.63)		(0.94)	(0.73)
High School		-1.36***	-0.66		-0.42	-0.64		-0.18	-0.13
		(0.35)	(0.42)		(0.28)	(0.45)		(0.63)	(0.86)
Constant	1.61**			1.17*			3.18*		
	(0.56)			(0.52)			(1.41)		
County Fixed Effects		X	X		X	X		X	X
Potential Demand Factors			X			X			X
Districts	851	851	845	851	851	845	846	846	840
R-sq.	0.19	0.41	0.49	0.02	0.16	0.17	0.13	0.25	0.28

Note. Heteroskedasticity-robust standard errors in parentheses. All models include one observation per district in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 as a percentage of total (filled and unfilled) positions in the same type of position. Columns 2, 3, 5, 6, 7, and 8 replicate the same-numbered columns in Table 1 (i.e., potential demand factors include teacher characteristics, class size, and ESSER allocations). White students are the omitted race group. $^{+}p < .1$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table A9 – Pairwise Correlations Between Schools' Vacancy Rates and Student Characteristics

	Unfilled Positions (per 10,000 Students)			Percentage of Students									
	Teachers	Admin	Other	White	Black	Hispanic	Asian	Pacific Islander	Native American	Unknown or Multi-Race	with Disability	ELs	Ec. Dis.
Unfilled Positions (per 10,000 Students)													
Teachers	1.00												
Administrators	0.21^{***}	1.00											
Other	0.23^{***}	0.01	1.00										
Percentage of Students													
White	-0.23^{***}	-0.06^{***}	-0.25^{***}	1.00									
Black	0.34^{***}	0.09^{***}	0.21^{***}	-0.66^{***}	1.00								
Hispanic	-0.01	-0.01	0.11^{***}	-0.61^{***}	-0.14^{***}	1.00							
Asian	-0.14^{***}	-0.02	-0.01	-0.09^{***}	-0.14^{***}	-0.04^{**}	1.00						
Pacific Islander	-0.00	-0.00	0.07^{***}	-0.02	-0.01	0.02	0.02	1.00					
Native American	0.01	-0.00	0.10^{***}	-0.05^{**}	-0.02	0.07^{***}	0.01	0.00	1.00				
Unknown or Multi-Race	-0.06^{***}	-0.02	-0.03^{+}	0.15^{***}	-0.11^{***}	-0.25^{***}	-0.01	0.03^{+}	-0.04^{*}	1.00			
with Disability	0.04^{**}	0.03^{*}	0.10^{***}	0.01	-0.01	-0.01	-0.10^{***}	0.01	-0.02	0.19^{***}	1.00		
ELs	-0.01	-0.00	0.16^{***}	-0.57^{***}	-0.13^{***}	0.86^{***}	0.17^{***}	0.03^{+}	0.11^{***}	-0.17^{***}	-0.05^{**}	1.00	
Econ. Disadvantaged	0.31^{***}	0.07^{***}	0.18^{***}	-0.65^{***}	0.57^{***}	0.37^{***}	-0.33^{***}	-0.01	0.03^{*}	-0.10^{***}	0.08^{***}	0.32^{***}	1.00

Note. Includes between 3724 and 3730 school-level observations from 2022. Unfilled paraprofessional, support staff, and other positions are combined into a single "other" category. ELs = English Learners. Ec. Dis. = Economically Disadvantaged.

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table A10 – Coefficients on Student Characteristic Predictors from Regressions Predicting the Number of Unfilled Positions per 10,000 Students in Schools in 2022

	Teachers			Administrators			Other		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Percentage Black	0.35***	0.43***	0.35***	0.02***	-0.02	-0.02	0.32***	0.19*	0.15
	(0.05)	(0.09)	(0.07)	(0.01)	(0.01)	(0.02)	(0.06)	(0.09)	(0.09)
Percentage Hispanic	-0.21***	-0.30***	-0.26***	-0.02+	-0.08*	-0.09*	-0.11	-0.24**	-0.24**
	(0.05)	(0.08)	(0.08)	(0.01)	(0.03)	(0.04)	(0.07)	(0.08)	(0.08)
Percentage Asian	-0.33***	-0.30*	-0.17	0.00	-0.02	-0.01	-0.14	-0.32+	-0.28
	(0.07)	(0.13)	(0.14)	(0.01)	(0.02)	(0.02)	(0.11)	(0.18)	(0.17)
Percentage Pacific Islander	1.01	-4.85	-3.42	-0.18	-0.42	-0.26	27.58	12.69	12.15
	(2.25)	(4.95)	(5.45)	(0.14)	(0.55)	(0.27)	(22.97)	(15.04)	(14.31)
Percentage Native American	0.41	0.72	0.58	-0.10	-0.15	-0.07	6.39*	3.64**	3.72**
	(1.38)	(1.90)	(1.87)	(0.07)	(0.11)	(0.08)	(2.96)	(1.30)	(1.31)
Percentage Unknown or Multiple Races	-0.47*	-0.52**	-0.46	-0.07*	-0.07+	-0.08	-0.01	-0.14	0.22
	(0.23)	(0.19)	(0.28)	(0.03)	(0.04)	(0.07)	(0.21)	(0.19)	(0.27)
Percentage with Disability	0.26	0.59	0.65+	0.07	0.08	0.10+	0.63**	0.79**	0.97***
	(0.37)	(0.36)	(0.34)	(0.05)	(0.06)	(0.05)	(0.20)	(0.27)	(0.25)
Percentage English Learners	0.18*	0.46***	0.38**	0.02	0.05	0.05	0.54***	0.30**	0.29**
	(0.09)	(0.14)	(0.12)	(0.02)	(0.03)	(0.03)	(0.15)	(0.09)	(0.09)
Percentage Economically Disadvantaged	0.33***	0.22+	0.21	0.01*	0.06***	0.06***	-0.07	0.07	0.08
	(0.05)	(0.13)	(0.13)	(0.01)	(0.01)	(0.02)	(0.05)	(0.08)	(0.07)
Constant	0.11			-1.13			-3.33		
	(6.73)			(1.12)			(3.09)		
District, Grade, & Charter FEs		X	X		X	X		X	X
Turnover & Class Size Controls			X			X			X
Schools	3724	3724	3661	3724	3724	3661	3724	3724	3661
Districts	851	851	844	851	851	844	851	851	844
R-sq.	0.146	0.469	0.491	0.010	0.060	0.068	0.104	0.450	0.459

Note. Standard errors clustered on districts in parentheses. All models include one observation per school in Illinois and predict unfilled teacher, administrator, or other certificated staff positions in the fall of 2022 per 10,000 students enrolled. Models 2, 3, 5, 6, 7, and 8 replicate models 3, 4, 7, 8, 11, and 12 in Table 2, respectively.

+ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix A References

Correia, Sergio, Paulo Guimarães, and Tom Zylkin. 2020. "Fast Poisson Estimation with High-Dimensional Fixed Effects." *The Stata Journal: Promoting Communications on Statistics and Stata* 20 (1): 95–115. https://doi.org/10.1177/1536867X20909691.

Appendix B

In this appendix I explore the relationship between the unfilled position data I rely on in my analyses and school districts' staffing levels (i.e., the number of FTE staff districts are able to employ). This kind of analysis is potentially important given the relative novelty of these kind of administrative data and my reliance on the assumption that these data capture information about limitations in the abilities of administrators to staff their schools up to their intended levels.

At the same time, it is not obvious what kind of tests would validate these vacancy data because unfilled positions – even when correctly measured – could reflect a complicated combination of factors related to budgetary constraints, local labor market conditions, enrollment-related needs, local or evolving expectations about appropriate staffing levels, legal constraints on student-to-staff ratios, and so on.

I adapt the approach used by Goldhaber, Falken, and Theobald (2024) to validate data on job postings. My approach differs from theirs in two broad ways. First, they aim to validate filled job postings as indicators of real future hiring. This differs somewhat from my goal, which is to validate reported vacancies (rather than job postings) as indicators of schools' ability to staff themselves generally. Thus, while they estimate regressions predicting filled job postings in the prior year as a function of new hires, I estimate regressions predicting FTE staff (or changes in FTE staff) as a function of reported vacancies.

Second, I take a somewhat different approach to accounting for other factors that might affect the bivariate relationships of interest. Like Goldhaber, Falken, and Theobald (2024), I consider models with district fixed effects (FEs) to account for potential differences in hiring (or staffing) practices across districts, such as candidate search intensity. However, I additionally consider models that control for other factors that could vary within districts over time while also being correlated with vacancies and staffing levels. Specifically, I estimate models that control for different combinations of student enrollment and its interaction with the number of students with disabilities, teacher turnover, uncertified teacher counts, and ESSER funding.

These controls would be less relevant in the Goldhaber, Falken, and Theobald (2024) context because one would expect filled job postings (though not necessarily all job postings) to correspond more directly to new hires regardless of whether the job was posted because of staff turnover, growing enrollment, or any other factor. For my purposes, the expected relationship between vacancies and staffing levels is more ambiguous and depends on the underlying forces in the district (e.g., whether funding or enrollment is increasing). It is therefore useful to see how the observed relationship between vacancies and staff counts varies as other factors are controlled for.

Vacancy-FTE Relationships for Teachers

Appendix Table B1 presents two sets of analyses focused on teachers, as teachers are the staff for which I observe the most information (e.g., certification and turnover rates). The first set of models (columns 1-5) predict the change in FTE teachers at the district level between fall of 2021 and fall of 2022 as a function of unfilled teacher positions in the fall of 2022 (the period that is the focus of most of my analyses). These models rely only on one year of vacancy data to minimize concerns about data quality in earlier years. The second set of models (columns 6-9) use all years of data beginning in fall 2017 and predict total teacher FTE (rather than the change). While these models include older, potentially lower-quality vacancy data, they allow me to control for between-district heterogeneity. To that end, these models include district fixed effects to account for unobservable between-district differences (e.g., mean community differences or willingness to search for candidates). These models also include year fixed effects, though results are nearly identical if they are excluded.

As shown in column 1, a district reporting an additional unfilled teaching position is predicted to see a slightly larger increase in its FTE teachers from year to year (by 0.14). This is perhaps counterintuitive, but potentially reflects that vacancies tend to be created precisely because districts are expanding their staff (and thus putting more pressure on their prospective candidate pools or internal hiring capacity). This relationship shrinks only slightly in magnitude after accounting for the teacher turnover number (inferred from the reported turnover rate and the number of employed teachers) and the change in enrollment (column 2). This is somewhat surprising but likely reflects that staffing levels have not been highly related to enrollment in recent years (and statewide they have even moved in opposite directions).

Allowing the effect of enrollment changes to vary with the change in the number of students with disabilities (which may have different staffing implications) causes the coefficient on unfilled teacher positions to become (insignificantly) negative (column 3). This also results in enrollment changes having a more intuitive relationship with FTE teacher changes: an increase in enrollment of 100 students without disabilities predicts an additional change of 3.8 in teacher FTE, an estimate that grows in magnitude as more of that increase is among students with disabilities (as indicated by the positive coefficient on the interaction term). This is what we would expect if students with disabilities require more staff than an equivalent number of students without disabilities.

Additionally accounting for a change in the number of uncertified teachers and the availability of federal pandemic aid (in the form of ESSER dollars) causes the relationship between unfilled positions and FTE changes to become somewhat more negative and statistically significant (columns 4-5). These predictors plausibly capture factors correlated with both vacancies and employment levels (e.g., because the alternative to an uncertified teacher is often to leave a position vacant). This now-negative relationship between teacher vacancies and teacher FTE changes is consistent with unfilled positions capturing some information about the inability of districts to hire up to their desired staffing levels, though the relationship is not one-to-one.

Potential unobserved heterogeneity between districts could affect the relationship between reported vacancies and eventual staffing. This motivates the models in columns 6-9, which explore the within-district relationship between reported teaching vacancies and overall teacher staffing levels. These models consume nearly all of the variation available to me, as evidenced by the R-squared values, but the patterns are qualitatively consistent with the previous models focused on FTE changes. For instance, as shown in column 6, unfilled positions appear to be driven by staffing changes: on average, when a given district reports an additional unfilled teacher position, it also reports 0.66 additional FTE teachers.

If the positive bivariate relationship between vacancies and employment is driven by increased hiring, it should become more negative after accounting for factors representing demand for teachers. This is precisely what I observe: accounting for potential demand-side factors related to enrollment and turnover again makes this relationship more negative. In this case, the estimates approach negative one, particularly if enrollment effects are allowed to vary with the number of students with disabilities (columns 7-8). This is potentially more in line with intuitions about what an unfilled position represents (viz., a one-position reduction in employment levels).

As discussed in the manuscript, variation in hiring and reporting practices might affect the measurement of staffing challenges using vacancy data. If staffing challenges and associated staffing and vacancy reporting practices are relatively persistent within school districts over time, this could explain why I find that reported unfilled positions have a closer-to-one-to-one relationship to employed FTE within districts over time than to year-to-year FTE changes between districts.[1] However, both sets of models indicate (1) that vacancies may be driven by newly created positions (i.e., increased hiring or staffing) to at least some degree and (2) that accounting for other supply and demand factors makes the relationship between vacancies and staffing levels more negative, consistent with vacancies representing real hiring challenges.

Notably, while a change in uncertified teachers makes the relationship between unfilled positions and *changes* in teacher FTE more negative (columns 3 and 4), within district accounting for teacher certification rates makes the relationship between unfilled positions and *total* teacher FTE more positive. Though I cannot explain this definitively, it may suggest some between-district variation in how staffing challenges are managed. However, the role of teacher

[1] While the overall R-squared in the fixed effect models is very high, vacancies alone explain very little of the variation that remains (as indicated by the within-R-squared value in column 6). Rather, enrollment and retention are much more explanatory of the within-district variation. This is suggestive of the fixed effects leaving sufficient variation for these exercises. Additionally, while adding additional predictors increases the within-R-squared substantially, this does not appear to be the only driving factor behind the nearly one-to-one relationship I observe between teacher vacancies and teacher FTE; as I discuss below, similarly-limited variation does not produce similar estimates for other certificated staff.

Another potential consideration is whether my interaction between students with disabilities and overall enrollment is capturing nonlinear effects of overall enrollment. In results not shown but available upon request, replacing students with disabilities with a squared enrollment term explains less of the variation in FTE, albeit with only modest impacts on my coefficients of interest. For example, in model 8 of Table B1, replacing the main and interaction effects of students with disabilities with enrollment squared reduces the within-R-squared from .93 to .85 and results in an estimate of the relationship between vacancies and FTE of -0.82 rather than -0.96. Even additionally including a linear effect for students with disabilities (i.e., in addition to the squared enrollment term) only brings the within-R-squared up to .91. This suggests at least some distinctive role for the enrollment of students with disabilities over and above any nonlinear enrollment effects, though the precise contribution of each is difficult to disentangle.

certification should be interpreted cautiously here because in some cases a position filled by a teacher lacking full certification may also be listed as unfilled (e.g., if the administration is still seeking a permanent hire) and because the uncertified teacher count is not available in earlier years.

Vacancy-FTE Relationships for Administrators and Other Staff

Appendix Table B2 presents similar analyses for administrators and other certificated staff. I do not have as much information about these staff as I do about teachers (e.g., turnover and certification rates) but I use teacher turnover as a proxy for turnover generally. Despite this limited information, the results are similar in many respects. For instance, unfilled positions are positively related to staffing changes and levels for both groups of staff, as was the case with teachers (columns 1, 3, 6, and 8). This is again consistent with vacancies being driven by increases in hiring.

Also as was the case with teachers, these relationships become notably more negative when accounting for enrollment and other factors. Indeed, for administrators the estimated relationships are if anything closer to negative one than in the case of teachers. However, for other certificated staff estimated relationships between unfilled positions and staffing changes or levels are never more than very slightly negative. This is hard to interpret given my limited information about these staff but may indicate some differences in how districts hire different kinds of staff.

Table B1 - Relationships between Unfilled Teacher Positions and Teacher Staff Changes and Levels

	Change in Teacher FTE, Fall 2021-Fall 2022					Teacher FTE			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unfilled FTE, Teachers	0.14***	0.11	-0.13	-0.21**	-0.18*	0.66***	-0.91***	-0.96***	-0.67***
	(0.01)	(0.13)	(0.09)	(0.08)	(0.08)	(0.07)	(0.10)	(0.13)	(0.15)
Number of Teachers Who Left		0.05	-0.02	-0.08*	-0.09*		-1.10***	-1.02***	-0.75***
		(0.05)	(0.04)	(0.04)	(0.04)		(0.14)	(0.17)	(0.19)
Enrollment Change (100s)		1.23	3.79**	4.36***	4.31***				
		(1.45)	(1.20)	(1.21)	(1.20)				
Change in Students with Disabilities (SWDs, 100s)			-0.07	-0.12	-0.13				
			(0.27)	(0.26)	(0.27)				
Enrollment Change (100s) x Change in SWDs (100s)			0.27***	0.37***	0.36***				
			(0.03)	(0.05)	(0.05)				
Change in Uncertified Teacher Count				0.47**	0.46**				
				(0.15)	(0.15)				
ESSER Allocation Per Pupil ($)					-0.00+				
					(0.00)				
Enrollment (100s)							-1.54***	1.35**	0.84
							(0.26)	(0.42)	(0.78)
Students with Disabilities (100s)								1.48+	2.02*
								(0.87)	(0.80)
Enrollment (100s) x SWDs (100s)								-0.00***	-0.00***
								(0.00)	(0.00)
Uncertified Teacher Count									0.49
									(0.33)
District and Year FEs						X	X	X	X
Observations	851	851	851	851	851	5104	5101	5101	4252
R^2	0.356	0.364	0.526	0.555	0.556	0.998	1.000	1.000	1.000
Within R^2						0.023	0.831	0.927	0.789

Note. Standard errors in parentheses. Standard errors are heteroskedasticity-robust in columns predicting changes in full time equivalent (FTE) staff and are clustered on school districts in models with district and year fixed effects (FEs). Number of teachers who left is inferred from teacher turnover rate and prior-year teacher FTE. An uncertified teacher is one holding a short-term or provisional license.

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table B2 – Relationships between Unfilled Positions and Staffing Changes and Levels for Administrators and Other Certificated Staff

	Administrators					Other Certificated Staff				
	FTE Change		Total FTE			FTE Change		Total FTE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Unfilled FTE, Administrators	1.15***	-0.71**	3.09	-1.03**	-1.41**					
	(0.19)	(0.25)	(1.91)	(0.39)	(0.44)					
Unfilled FTE, Other						0.88***	0.03	1.65***	1.28*	-0.01
						(0.13)	(0.06)	(0.43)	(0.56)	(0.15)
Number of Teachers Who Left		0.03*		-0.32***	-0.32***		0.10*		0.20	-0.01
		(0.01)		(0.05)	(0.05)		(0.05)		(0.21)	(0.04)
Enrollment Change (100s)		-0.73*					1.00			
		(0.36)					(0.86)			
Change in SWDs (100s)		0.02					0.61			
		(0.06)					(0.39)			
Enrollment Change x Change in SWDs		-0.01					0.22***			
		(0.01)					(0.04)			
ESSER Allocation Per Pupil ($)		0.00					-0.00*			
		(0.00)					(0.00)			
Enrollment (100s)				0.10	0.18				-6.41***	-2.01***
				(0.14)	(0.14)				(0.72)	(0.39)
Students with Disabilities (100s)					0.11					0.88
					(0.16)					(0.99)
Enrollment (100s) x SWDs (100s)					-0.00					-0.00***
					(0.00)					(0.00)
District and Year FEs			X	X	X			X	X	X
Observations	851	851	5099	5096	5096	851	851	5098	5095	5095
R^2	0.530	0.683	0.988	0.999	0.999	0.807	0.922	0.982	0.998	0.999
Within R^2			0.035	0.881	0.882			0.094	0.881	0.942

Note. Standard errors in parentheses. Standard errors are heteroskedasticity-robust in columns predicting changes in full time equivalent (FTE) staff and are clustered on school districts in models with district and year fixed effects (FEs). Number of teachers who left is inferred from teacher turnover rate and prior-year teacher FTE. FTE Change is change from fall 2021 to fall 2022. SWDs = Students with disabilities.

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix B References

Goldhaber, Dan, Grace T. Falken, and Roddy Theobald. 2024. "What Do Teacher Job Postings Tell Us About School Hiring Needs and Equity?" *Educational Evaluation and Policy Analysis*, May, 01623737241246548. https://doi.org/10.3102/01623737241246548.