Determinants of Teacher Attrition: Evidence from District-Teacher Matched Data[1]

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Abstract: This study examines various factors influencing teacher attrition. Relying on nationally representative, district-teacher matched data, we attempt to identify key determinants of teacher attrition by employing multilevel mixed-effects linear models, which control for commonalities among teachers within the same school district. We find that a stronger teacher voice, a more supportive work environment, fewer school problems, and greater teacher morale significantly reduce teacher attrition. We also show that teacher base salary and returns to experience are negatively associated with teacher attrition. Among all these factors, teacher voice shows one of the largest impacts on teacher attrition, and its effects are much greater for novice teachers than for experienced teachers.
Keywords: district-teacher matched data; teacher attrition; teacher voice

Determinantes del abandono de los profesores: Evidencia usando datos emparejados de distritos y profesores
Resumen: Este estudio examina varios factores que influyen en el abandono docente. Basándonos en datos representativos a nivel nacional, resultantes de emparejar distritos y profesores, identificamos los determinantes clave del abandono docente mediante el empleo de modelos multinivel lineales de efectos mixtos, que controlan por factores comunes entre los docentes dentro del mismo distrito escolar. Encontramos que una mayor voz en el profesor, un entorno de trabajo que ofrece más respaldo, menos problemas escolares y una mayor moral en el profesor reducen significativamente el abandono docente. También mostramos que el salario base de los profesores y los retornos a la experiencia están relacionados negativamente con el abandono docente. Entre todos estos factores, la voz del docente muestra uno de los mayores impactos en el abandono docente, y sus efectos son mucho mayores para los docentes novicios que para los docentes experimentados.
Palabras clave: datos emparejados de distritos y profesores; abandono docente; voz del profesor

Determinantes do abandono de professores: Evidências usando dados correspondentes de distritos e profesores
Resumo: Este estudo examina vários fatores que influenciam o abandono do professor. Baseando-se em dados nacionalmente representativos da correspondência de professores entre distritos, identificamos os principais determinantes da perda de professores usando modelos de efeitos mistos lineares de vários níveis, que controlam fatores comuns entre professores no mesmo distrito escolar. Descobrimos que uma voz mais forte do professor, um ambiente de trabalho mais favorável, menos problemas escolares e maior moral do professor reduzem significativamente o abandono do professor. Também mostramos que o salário base do professor e o retorno à experiência estão negativamente associados ao abandono do professor. Entre todos esses fatores, a voz do professor apresenta um dos maiores impactos no abandono do professor, e seus efeitos são muito maiores para professores iniciantes do que para professores experientes.
Palavras-chave: dados correspondentes do distrito e do professor; abandono do professor; voz do professor

Determinants of Teacher Attrition:
Evidence from District-Teacher Matched Data

Teacher attrition and turnover rates in U.S. public schools are high in both absolute and relative terms. Turnover and attrition have been increasing over time (Goldring, Taie, & Riddles, 2014), and, compared to teachers in other countries, U.S. teachers experience higher turnover (Darling-Hammond et al., 2017). Moreover, U.S. teachers see much higher attrition than their peers in most non-teaching occupations: About 30% of college graduates who became teachers were not in the profession five years later, compared with 19% of nurses and lawyers, 16% of engineers, and 14% of pharmacists (Ingersoll, 2014).[2]

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[2] Among other professions Ingersoll described in his study, the only ones with higher attrition rates than teachers are secretaries, childcare workers, paralegals, and correctional officers.

Excessive teacher turnover and voluntary attrition are problematic in several respects. First of all, they reduce resources that could be used for other, more productive, purposes. Filling a vacancy costs up to $21,000 in urban districts (Carver-Thomas & Darling-Hammond, 2017; Learning Policy Institute, 2017), and Carroll (2007) estimates the total annual cost of U.S. teacher turnover at $7.3 billion per year. Second, instability in a school's teacher workforce due to high turnover and/or high attrition diminishes teacher effectiveness and education quality, negatively affecting student achievement (Jackson & Bruegmann, 2009; Kraft & Papay, 2014; Ronfeldt et al., 2013; Sorensen & Ladd, 2020). Some teachers who leave teaching voluntarily return to classrooms, and they also contribute to schools' need to either allocate teachers to new assignments, or to temporarily fill a position, if they return to the same school (Atteberry et al., 2017; DeAngelis, 2016). In addition, to the extent that such instability correlates with the teacher shortage problem, the need for finding sufficient qualified teachers grows, ultimately threatening students' ability to learn (Darling-Hammond, 1999; Ladd & Sorensen, 2016).

The teacher shortage, measured by the gap between the projected number of qualified teachers needed in the nation's K–12 schools and the projected number available for hire, was about 110,000 teachers in the 2018–2019 school year (Sutcher et al., 2016). This number grows if we also take into consideration that some current teachers lack the credentials associated with being an effective teacher, such as experience, educational background, and route into teaching (García & Weiss, 2019a). Other trends observed in U.S. public schools can also contribute to the overall teacher shortage. For instance, an increase in the student population and decrease in the number of teachers (see Table 1), as well as the decline in the number of individuals enrolling and completing teacher preparation programs (see Figure 1), are also factors that can exacerbate the teacher shortage problem.
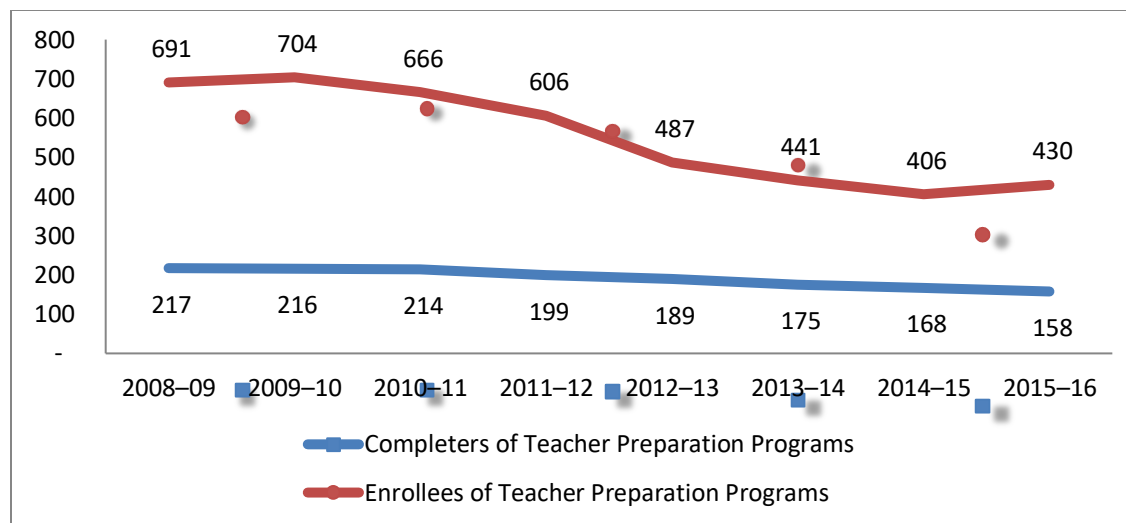
Table 1

Student Enrollment, Teachers, and Student-Reacher Ratio

Year	Student Enrollment	Number of Teachers	Student-Teacher Ratio
2008	49,266	3,222	15.29050279
2009	49,361	3,210	15.37725857
2010	49,484	3,099	15.96773153
2011	49,522	3,103	15.95939413
2012	49,771	3,109	16.00868446
2013	50,045	3,114	16.07096981
2014	50,313	3,132	16.06417625
2015	50,438	3,151	16.00698191

Notes: Teachers are primary and secondary school teachers in U.S. public schools. Student-teacher ratio is computed by student enrollment divided by number of teachers.
Source: U.S. Department of Education, National Center for Education Statistics (NCES) (2018). "Table 208.20. Public and Private Elementary and Secondary Teachers, Enrollment, Pupil/Teacher Ratios, and New Teacher Hires: Selected Years, Fall 1955 Through 2027." Digest of Education Statistics: 2017.

Figure 1

Enrollment and Completion of Teacher Preparation Programs

Source: U.S. Department of Education. (2017a), "Completers, by State, by Program Type" [data table]. Data from the Higher Education Act Title II State Report Card (SRC) Reporting System. U.S. Department of Education. (2017b), "Enrollment, by State, by Program Type" [data table]. Data from the Higher Education Act Title II State Report Card (SRC) Reporting System.

Furthermore, schools' staffing problems are expected to worsen in response to the COVID-19 pandemic and its impact on the economy. As was true in prior recessions, decimated state budgets may lead to cuts in teacher demand, and COVID-19's related challenges for teachers, such as safety and added stress, may also increase voluntary attrition, reducing the supply of teachers. Both the known trends and the current context make it essential to identify all factors to which teacher attrition is sensitive, in an attempt to find new ways to build a stable and strong teaching workforce.

In this study, we examine the role that "teacher voice" could play in driving teacher labor market dynamics, using national-level data and quantitative methods. In this paper, teacher voice represents teachers' influence in the school and control in the classroom. The motivation for our approach is threefold. First, there has been significantly increased attention to teacher issues in the media and in policymaking discussions in recent years, followed by a series of teacher protests, during which teachers themselves highlighted the importance of their voices being heard as a critical factor (Booker, 2019; Kolins Givan & Schrager Lang, 2020; Rich, 2015; Strauss, 2015, 2017; Westervelt, 2015). Second, though there is ample qualitative evidence on how and why voice—and related traits, such as autonomy or control—influence teachers' careers, including decisions to leave their school or the profession (Aydarova & Berliner, 2018; Rigsby & DeMulder, 2003; Torres, 2014), quantitative evidence on this factor is scarce. Our study attempts to fill this knowledge gap and identify strategies that help counter persistent challenges to attracting and retaining highly qualified teachers on a national scale. Finally, it is noteworthy that researchers often treat teacher voice as a professional feature in response to the evolution of the teaching career over time, rather than as the part of organizational characteristics of schools (Borman & Dowling, 2008; Ingersoll, 2001, 2003; Ingersoll & Collins, 2018). Thus, this study emphasizes that it is important to how teachers perceive their voices, which emanate from their personal or professional background, rather than treating

voices and their correlates as being determined by schools' organization and other factors that are beyond teachers' control.

We rely on a district-teacher matched dataset, based on the U.S. Department of Education's National Center for Education Statistics' *Schools and Staffing Survey* (2011-2012) and *Teacher Follow-up Survey* (2012-2013) microdata, and employ multilevel mixed-effects linear models to identify key determinants of teacher attrition. The district-teacher matched dataset allows us to control for both teacher and district characteristics, substantially reducing potential omitted variable bias. In particular, our dataset includes information on teacher pay and working conditions, as well as contractual status between teachers' unions and their districts, all of which could capture important aspects of teacher voice, while serving as determinants of teacher attrition. By controlling for these confounding factors, we can further reduce the bias in our estimates. With the multilevel linear models, we are also able to account for unobservable commonalities that are shared by the teachers in the same district that may contribute to differences in teacher attrition (Bryk & Raudenbush, 1992).

We construct four principal factors that characterize workplace environments for teachers: school support, obstacles to teaching and learning ("school problems," hereafter), teacher morale, and teacher voice (teachers' influence in schools and teacher control in classrooms). The first three factors are conventional determinants for teacher turnover, and our study also shows that they affect teacher attrition in the expected direction: greater school support, fewer school problems, and higher teacher morale are all associated with reduced attrition. We also find that teacher voice, which is our main addition to the literature, plays a significant role in driving teachers' decisions to remain in their classrooms. When viewed in isolation, teacher voice has one of the largest impacts on teacher attrition, and its effects are much greater for novice teachers than for experienced teachers. These findings are robust even after accounting for other, better-known correlates of teacher attrition including the influence of teachers' unions.

Literature

Reflecting a significant interest around teacher labor markets and their dynamics over the last decades, there exists an abundant literature examining teacher retention, attrition and turnover. Seminal studies—including multiple syntheses—have concluded that several individual, school, and institutional factors are statistically significant determinants of teachers' working status (Borman & Dowling, 2008; Guarino et al., 2006; Nguyen et al., 2019; etc.). Recent meta-analyses that synthesize this knowledge and incorporate more reliable causal findings show that the number of determinants that can be at play is large (Nguyen et al., 2019). Of particular relevance are studies that show that these factors are often interconnected (Loeb et al., 2005; García & Weiss, 2020b).

Numerous studies find that teacher pay is an essential factor for retaining and attracting teachers (Boyd et al., 2005; Gray & Taie, 2015; Grissom et al., 2015; Hendricks, 2014; Katz, 2018; Loeb et al., 2005; Manski, 1987; Murnane & Olsen, 1989; Podolsky et al., 2019; Stockard & Lehman, 2004). Salary level is especially important for retention of teachers early in their careers and in high-poverty or high-needs schools, where issues of both turnover and quality are more critical (Boyd et al., 2005; García & Weiss, 2019b; Hanushek et al., 1999; McCreight, 2000; Sorensen & Ladd, 2020).

Using data from Texas between 1996–2012 and controlling for time-varying or fixed-district characteristics and labor-market conditions that could be correlated with teacher pay, Hendricks (2014) finds that a 1% increase in teacher pay reduces teacher turnover by 0.16 percentage points,

and that the effect is larger for less experienced teachers.[3] Also using Texas data, Hanushek et al. (1999) find that increasing salaries within a district by 10% reduces the probability that a teacher leaves the district by 2% for probationary teachers, and by 1% for teachers with three to five years of experience.

Similar evidence is found in research examining salary schedules. Murnane and Olsen (1990) find that an increase of $1,000 in each salary step would increase teachers' mean duration in that district by two to three years in North Carolina. Using salary schedule measures for teachers' salaries at three different points during their career, Loeb et al. (2005) find that schools with lower salaries are more likely to have reported turnover problems.

Even having salaries more comparable between teachers and non-teachers reduces teacher turnover. For instance, examining how the salary of the best job alternative outside of teaching affects teachers' retention, Murnane and Olsen (1989) find that $1,000 (in 1967 dollars) in the opportunity cost salary correlates with a decrease of four years in the median length of stay in teaching in Michigan.[4]

Some studies also focus on other working conditions and workplace environment as determinants of teacher retention and turnover. Loeb et al. (2005) show that large class sizes, facilities problems, multitrack schools, and lack of textbooks are all predictors of higher rates of turnover. Rees (1991) reports that teachers with strong grievance procedures in their contracts had a lower probability of quitting than those working under weaker grievance procedures.

Related, the evidence on how school environments, professional development, professional relationships and "voice" influence retention is relatively slim. Teachers being unprepared for the realities of teaching, rigorous certification examinations, lack of career advancement opportunities, and low emphasis on professional development or support for new teachers all correlate with high turnover and attrition (McCreight, 2000). One synthesis and some recent descriptive studies suggest that a lack of say on daily tasks and poorer supports are correlated with high teacher attrition (Katz, 2018; García & Weiss, 2019c; 2019d). Few studies, however, carefully examined how teacher perceptions of job satisfaction and autonomy drive retention (Warner-Griffin et al., 2018; Katz, 2018). In the quantitative research, factors associated with voice have received very little attention even as descriptors of teachers' working conditions (see Sparks & Malkus, 2015), and the most recent meta-analysis on these issues has no category for teachers' voice.

We note that qualitative evidence has used the term "voice" more generally. For example, using data from teachers' essays, Rigsby and DeMulder (2003) highlight how creating standards and implementing testing undermine the professionalism of teachers as they ignore teachers' voice, loosely implying their views and experience. Torres (2014) shows that, when leaving their positions, teachers have expressed concerns over a lack of voice, which indicates autonomy with decisions, based on data from 20 teachers in a charter school in New York City. Aydarova and Berliner (2018) argue that the teacher education community should reclaim "a collective voice over the directions of change and its future such that the profession's collective voice would be heard by policy-makers and by the public at large."

Other factors, such as school characteristics and geographic variation, also affect the probability of turnover and retention. Turnover and attrition are higher for teachers at high-poverty schools, specifically, and, more generally, in high-poverty, high-minority, and rural schools,

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[3] He also simulates that, through higher retention, and through increasing the average experience of teachers in the district, paying teachers more improves student achievement.

[4] They use data from Michigan's State Department of Education, which followed teachers who started their teaching careers in the early 1970s until the 1984-1985 school year. A share of studies examining this issue incorporate the idea of the teacher salary gap into their empirical strategies.

sometimes referred to as "hard to staff" schools (Darling-Hammond, 2010; Ingersoll et al., 2014, Loeb et al., 2005; Papay et al., 2017; Podolsky et al., 2016; Simon & Johnson, 2015; Sutcher et al., 2016). However, the influence of schools' racial compositions and proportions of low-income students on turnover is substantially reduced once resources for teaching and learning and salaries and working conditions are taken into account (Loeb et al., 2005; Podolsky et al., 2016). Similarly, the shortages are more acute among some groups of teachers (for example, minority teachers, see Carver-Thomas, 2018; Ingersoll, 2015; Ingersoll & May, 2011) and in certain states (Berg-Jacobson & Levin, 2015; Keefe, 2018; Levin et al., 2015; U.S. Department of Education 2017c, 2019).[5]

Some of the evidence comes from examinations of the teacher shortage as reflected in the imbalance between the number of teachers needed and the number of teachers to be hired in a given year. Often, the arguments made in this literature are that the shortages particularly affect specific subjects/specialties such as science, technology, engineering, and mathematics (STEM) and special education (Dee & Goldhaber, 2017; Ingersoll et al., 2014)

Studies also look at hiring and personnel management as a determinant of teacher turnover. For instance, teachers' unions, in collaboration with management, may play a significant role in promoting teaching quality via teacher dismissal policies, promoting the use of rigorous evaluation of teachers, such as peer assistance and review programs, and encouraging staffing in hard-to-attract schools (Han, 2020; Moore-Johnson et al., 2007; NEA Foundation, 2012). Related, several studies examine the influence of principals' leadership and of school administrators on teacher retention. They suggest that school leadership, collegial relationships, elements of school culture, and teachers' perceptions of the school administration play significant roles in retention in public schools overall and in high-poverty schools (Boyd et al., 2011; Simon & Moore Johnson, 2015).[6]

A recent meta-analysis by Nguyen et al. (2019) is now particularly helpful because it classifies all of the factors driving teacher attrition that researchers have examined in recent decades. The analysis classifies about 120 studies by type of factors that influence teachers' decisions regarding their labor supply. There are three types of correlates: personal correlates (teacher characteristics and qualifications); school correlates (school resources, organizational characteristics, student body characteristics, and race/gender congruence); and a broad category called external correlates, which includes diverse subcategories including teacher evaluation systems, teacher merit pay, school accountability, principal effectiveness, teacher-principal race/gender matching, teacher-student race matching, comprehensive school reform, and research-practice partnership. (As the authors note, these external correlates had not been explored in prior research).

Overall, a growing number of categories have become available over time, showing a recognition of the expanded set of drivers of teacher attrition. However, the new trend also attests that education research has largely ignored the roles played by teachers' perspective and self-agency, cooperative environment, and satisfaction in their labor markets. Such information on teachers has been typically labeled as influence or autonomy. For example, Ingersoll (2003), for an examination of organizational theory, uses the term "influence." Ingersoll, May, and Collins (2019) use the terms "faculty influence" and "autonomy" in an examination of turnover among minority and nonminority teachers, and link both factors to organizational conditions of the schools. They find that classroom autonomy was a strong predictor of retention, especially for minority teachers. Oberfield (2016) uses the label of "autonomy" which is linked with accountability in charter schools. "Autonomy" is also

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[5] For example, Levin et al. (2015) find the evidence of teacher surplus in Massachusetts; Berg-Jacobson and Levin (2015) find teacher deficits in Oklahoma; and Keefe (2018) notes teacher shortages in Pennsylvania.
[6] See also Torres (2016) and Oberfield (2016) for evidence from charter management organizations and charter schools. See Atteberry et al. (2017) for a discussion of how "trust, peer collaboration, and shared decision making" are school environmental factors that influence whether teachers "improve over time."

the term chosen by Billingsley and Bettini (2019) and Conley and You (2017) in their work on attrition among special education teachers. For these teachers, autonomy is "the extent to which the social context provides special educators latitude to make decisions about their work," and does not significantly predict intent to leave their positions (a proxy of attrition). Nguyen et al. (2019), while including classroom "autonomy" as a school correlate based on five studies, finds that the odds of attrition for teachers who have more classroom autonomy are 0.96 times the odds of attrition of teachers who have less autonomy.[7] However, these attributes also reflect teachers' ability to use their professional knowledge and judgment in their daily activities, rather than just reacting to the organizational aspects in school and policy (Ingersoll, 2003; Simon & Moore Johnson, 2015). In this study, we refer to this broad feature as teacher "voice."

This stands in contrast to the standard labor economics literature, which has seen them as important determinants of worker retention. For instance, labor economics researchers find that providing employees a "voice," a channel to express their concerns and preferences in the workplace, through unionization, reduces their quit rates (Batt et al., 2012; Freeman, 1980; Freeman et al. 2007). According to the "exit-voice" hypothesis, workers can decide to leave their employer (exit-option) or express discontent with their employment conditions (voice-option), and unions can serve as a means for employees to address the problems they face at the workplace (Freeman & Medoff, 1984; Hirschman, 1970). This "voice" channel improves communication between employers and employees and enhances workers' commitment to the organization (Addison & Belfield, 2004; Batt et al., 2012; Freeman et al. 2007; Gunderson, 2015). The role of unions as a mediator between workers and employers is also applied in the teaching sector, reducing teacher attrition. Nguyen et al. (2019) show that unionized teachers' odds of attrition are 0.75 times the odds of attrition for teachers who do not belong to unions. Han (2020) also finds that teachers' unions decrease novice teachers' attrition.

Because teacher attrition is a crucial part of the teacher staffing issue, it is important to account for all channels sensitive to reducing attrition. In this study, therefore, we further expand the existing framework to shed light on this additional category. Across different disciplines, teacher voice captures important professional features such as engagement, agency, career-advancement, prestige, and intrinsic-motivation (Abbott, 2014; Hirschman, 1972; Ingersoll & Collins, 2018; Organization for Economic Cooperation and Development, 2019). Teacher voice must thus be included in analyses of determinants of teacher attrition, because the discussion around teaching has evolved recently to emphasize the status of teaching as a profession and the need to attract and keep more qualified teachers (García & Weiss, 2019a, 2020a; Ingersoll & Collins, 2018; Sutcher et al., 2016).

Our research makes several important contributions to literature. First, our study adds an additional category, teachers' voice, to the ones offered by Borman and Dowling (2008) and Nguyen et al. (2019). Through these meta-analyses, we also build on all of the studies that independently contributed to examining independent factors of teacher attrition/retention, especially those that used different iterations of the SASS data, but we focus on the frameworks that have been issued to represent the full breadth of variation of teachers' working environments.

Second, we rely on nationally representative data that allow us to utilize the full breadth of variation of teachers' working environments and conditions. Third, the district-teacher matched dataset allows us to control for various teacher and district characteristics, substantially reducing

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[7] This result is based on five studies and not statistically significant. With these references, we acknowledge the differences in the terms used to label constructs building on similar items across studies, which are included in the module "school climate and teacher attitudes" in the SASS 2011-12 teacher questionnaire.

potential omitted variable bias. Finally, we offer a more comprehensive perspective on teacher attrition by incorporating a new factor, teacher voice, into the analysis.

Data

The primary data source is the 2011-2012 *Schools and Staffing Survey* (SASS), administered by the National Center for Education Statistics (NCES). The SASS is a nationally representative study with a multi-level format, in which teachers are grouped within their schools and schools are grouped within their corresponding districts. We construct a district-teacher matched dataset by linking information on teachers and their districts.

One year after the SASS is collected, teachers who left the teaching sector are surveyed, forming the *Teacher Follow-up Survey* (TFS) for former teachers. The TFS contains information on teacher attrition, indicating teachers in the 2011-2012 school year who voluntarily quit teaching during the 2012-2013 school year. We combine the district-teacher matched SASS with the TFS to construct a SASS-TFS dataset for each survey year and merge them to form a pooled cross-sectional dataset covering 2011-2013.[8]

We also combine information from the *School Districts* (*local agency*) *Finance Survey* (SDFS), also known as the F-33 survey, which details annual fiscal data for every U.S. school district. Districts' finance information allows us to compare teacher attrition across districts with similar financial status, measured by districts' total revenue. Districts with fewer resources may drive the attrition of teachers, so by comparing districts with a similar level of educational inputs, we are able to rule out this hypothesis. Appendix I reports summary statistics from the SASS-TFS dataset merged with the SDFS.

Following Han (2019) who proposes the contractual status between teachers' unions and their districts as a measure of union strength, we use three types of contractual status: districts may have a collective bargaining (CB) agreement, meet- and confer- (MC) agreement, or no agreement (NA) with the unions. CB contracts specify wages and other terms and conditions of employment, and the outcomes are legally binding. During MC, unions and management exchange views and discuss proposals, which can lead to an agreement that is likely to affect the outcomes of employment, but, unlike CB, this agreement is legally unenforceable. Districts with neither CB nor MC have no specific agreements with unions regarding the employment conditions of teachers. Thus, the strength of teachers' unions is notably weaker in NA districts than in CB or MC districts. To the extent that CB districts can offer stronger support than NA districts to teachers, the contract status is a potentially important variable in shaping teachers' voice, capturing a large amount of variation in teachers' voice as well as in teacher attrition. Hence, the contractual status can directly control for the institutional feature of teachers' unions that is partly reflected in teachers' voice (Han, 2020).

In addition to the basic attributes of teachers, their schools, and their districts, how teachers perceive their profession and work environments may contribute to their decision to depart from teaching. To better understand this link, we construct additional factors to assess teacher attitudes and school environments in four different categories: teacher voice (which includes both teachers' influence in their schools and teachers' control in their classrooms), school support (based on a number of indicators of school climate, such as support from school principal and administrative staff), school problems (representing a set of obstacles or barriers to teaching and learning), and

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[8] The 2012-2013 TFS is the most recent data. According to the NCES (2021), "The next administration of the TFS is planned for 2021–22 and will be administered to a sample of teachers who complete the NTPS in 2020-21."

teacher morale. Each category is based on various teacher survey questions, whose answers are scaled 1-4 (see Appendix II for the questionnaires included in each category), and we employ principal components factor analysis to aggregate these questions into the four manageable categories described above. The Cronbach's Alpha scales indicate that they are well above the rule of thumb of 0.7, indicating that the items have relatively high internal consistency. This factor analytical approach produces a single factor each for teacher voice, school support, school problems, and teacher morale. We code these factors such that greater values indicate stronger teacher voice, more support from schools, more serious school problems, and higher teacher morale.[9]

Our dependent variable is the binary indicator for the attrition status of a teacher, such that the value =1 if teachers who were in the classroom during the 2011-2012 school year voluntarily left teaching in the 2012-2013 school year for reasons other than retirement, and the value =0 if the teachers continued teaching in the 2012-2013 school year.

Figure 2 describes the mean differences of these principal factors by attrition status. As the data show, compared to teachers who stay, teachers who quit teaching report a weaker voice, less school support, more school problems, and low morale, and all of these differences are statistically significant at the 1% level.

Figure 2

Principal Factors by Attrition Status
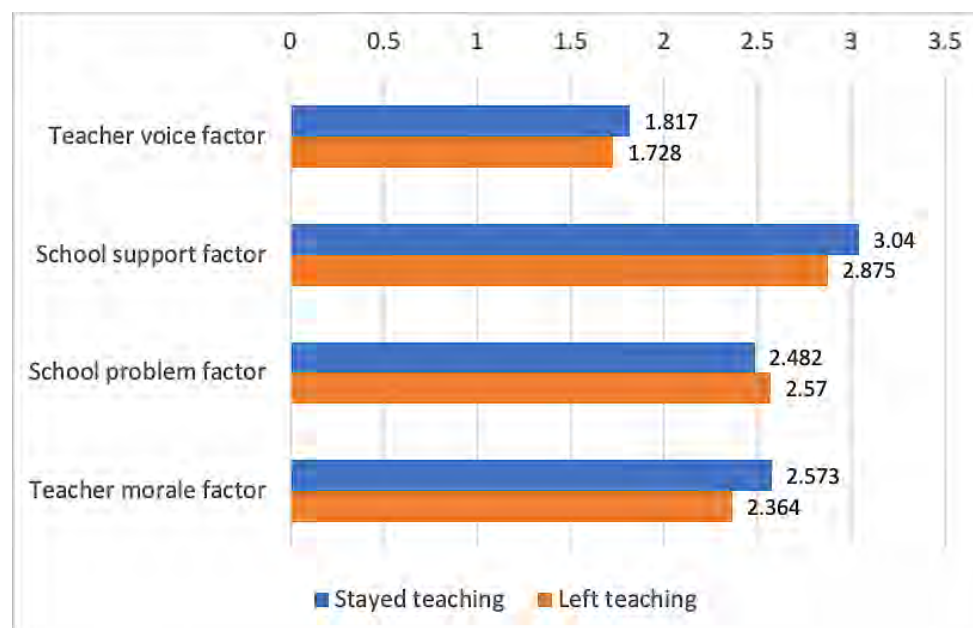
Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

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[9] Factor 1 explains 73% of total variance of teacher voice, and it is mostly defined by items d, e, f, and g in the "Teacher Influence in School" questionnaires listed in Appendix II. Factor 1 explains 57% of total variance of school support, and it is mostly defined by items a, g, j, and l in the "School Climate" questionnaires. Factor 1 explains 53% of total variance of school problem, and it is mostly defined by items g, h, and i in the "School Problems" questionnaires. Factor 1 explains 56% of total variance of school problems, and it is mostly defined by items b and c in the "Teacher Morale" questionnaires.

We also look at various aspects of teachers' working conditions as determinants of teacher attrition. The SASS contains four categories, or "lanes," of salary schedules: teachers with a bachelor's degree and no experience, bachelor's degree with ten years of experience, master's degree with no experience, and master's degree with ten years of experience. Based on these salary schedules, we construct two new variables for returns to ten years of experience: returns to experience for BA and returns to experience for MA. Returns to experience for BA is computed by (base salary with 10 years of experience – base salary with no experience)/base salary with no experience for teachers with bachelor's degree. Returns to experience for MA is computed by (base salary with 10 years of experience – base salary with no experience)/base salary with no experience for teachers with master's degree. Additionally, we consider teachers' base salary, class size (pupils per teacher) in each district, and required teaching hours.

Figure 3 displays the comparison of employment conditions by attrition status. On average, both base salaries and returns to experience are lower for teachers who quit than for teachers who stay, and these differences are also statistically significant at the 1% level. However, class size is slightly smaller and working hours are somewhat shorter for teachers who quit.

Figure 3

Employment conditions by Attrition Status

Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012-2013 *Teacher Follow-up Survey* (TFS).
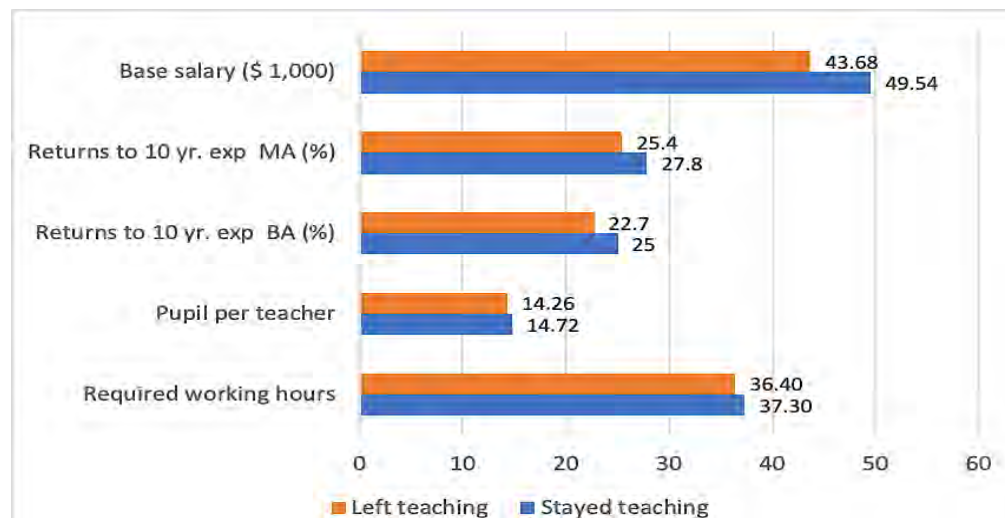
The patterns shown in Figures 2 and 3 may be affected by other factors that are associated with teacher attrition, teacher attitudes, school environments, and employment conditions. Indeed, this seems likely, as the characteristics of teachers, their schools, and their districts differ by teachers' attrition status, according to the summary statistics reported in Table 2, which presents the mean comparison between teachers who stayed and teachers who quit. Full-time teachers with greater experience and a Highly-Qualified Teachers (HQT) certificate are less likely to quit, while teachers with alternative certification have a greater tendency to quit. Schools with a greater fraction of black students, with a greater fraction of students participating in free and reduced-price lunch programs, and charter schools all show a greater attrition rate. Teachers in the CB districts are more likely to stay in teaching. Urban districts have a greater teacher attrition rate, whereas suburban districts have a greater retention rate.

Table 2

Comparison Between Teachers Who Stayed and Teachers Who Quit

Variables	Stayed Teaching (SD) N=33,100	Quit Teaching (SD) N=1,380	Difference = Stay – Quit (SE)
Teacher characteristics			
Male	0.314 (0.463)	0.286 (0.451)	0.028 (0.017)
White	0.928 (0.257)	0.921 (0.246)	0.007 (0.009)
Hispanic	0.051 (0.220)	0.055 (0.207)	-0.004 (0.008)
Black	0.052 (0.221)	0.066 (0.249)	-0.014 (0.009)
Asian	0.017 (0.130)	0.015 (0.100)	0.002 (0.005)
Other	0.019 (0.136)	0.017 (0.122)	0.002 (0.005)
Full time	0.925 (0.263)	0.819 (0.345)	0.106***(0.010)
Experience	13.271 (9.615)	10.038 (8.640)	3.232***(0.361)
Master's degree and above	0.543 (0.498)	0.555 (0.497)	-0.012 (0.018)
Alternative certification	0.143 (0.350)	0.185 (0.388)	-0.042***(0.013)
Highly Qualified Teacher	0.789 (0.407)	0.750 (0.433)	0.039**(0.015)
School Characteristics			
Charter school	0.061 (0.240)	0.122 (0.327)	-0.061***(0.009)
Hispanic student	0.147 (0.217)	0.149 (0.210)	-0.002 (0.008)
Black students	0.123 (0.201)	0.150 (0.233)	-0.027***(0.008)
Asian students	0.031 (0.060)	0.025 (0.012)	0.006***(0.002)
Other students	0.045 (0.110)	0.048 (0.119)	-0.003 (0.004)
Male students	0.507 (0.089)	0.506 (0.085)	0.001 (0.003)
Free/reduced-price lunch	0.445 (0.273)	0.472 (0.272)	-0.027***(0.010)
Elementary school	0.399 (0.489)	0.394 (0.488)	0.005 (0.018)
Secondary school	0.452 (0.497)	0.442 (0.497)	0.010 (0.018)
Combined school	0.149 (0.356)	0.164 (0.370)	-0.015 (0.013)
Regular	0.903 (0.295)	0.880 (0.326)	0.023**(0.011)
Special program emphasis	0.027 (0.163)	0.043 (0.203)	-0.016**(0.006)
Special education	0.016 (0.125)	0.012 (0.111)	0.004 (0.004)
Career/vocational education	0.015 (0.123)	0.011 (0.104)	0.004 (0.004)
Alternative program	0.037 (0.190)	0.054 (0.226)	-0.017**(0.007)
District characteristics			
Total enrollment	818.09 (677.96)	774.23 (732.91)	43.86*(26.53)
Total revenue ($ million)	335.87 (1,643.29)	357.74 (1,706.49)	-21.87 (61.99)
Collective bargaining (CB)	0.534 (0.498)	0.421 (0.494)	0.113***(0.018)
Meet and confer (MC)	0.117 (0.321)	0.110 (0.312)	0.007 (0.012)
City	0.212 (0.409)	0.247 (0.431)	-0.035**(0.015)
Suburb	0.276 (0.447)	0.228 (0.419)	0.048***(0.016)
Town	0.165 (0.371)	0.158 (0.365)	0.007 (0.014)
Rural	0.345 (0.475)	0.365 (0.018)	-0.020 (0.018)

Note: Standard deviation and standard errors are presented in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

Methods

To control for these characteristics of districts and teachers that are presented in Table 2, we could employ OLS analyses to estimate the relationship between teacher attrition and various working conditions. Even though we control for various factors to minimize potential omitted variable bias, however, there may exist unobservable factors that still pose an endogeneity problem. In particular, teachers in the same district may share unobservable common characteristics and experiences. When this commonality is large, these teachers may have the same value of the district-level residual, and the standard OLS estimates will suffer from omitted variable bias. To tackle this problem, we employ a multilevel linear model that separates the total variance into within-group and between-group components. To examine the role of the four principal factors on teacher attrition, we estimate the following multilevel mixed-effects linear model:

$$Attrition_{ij} = (\beta_0 + u_j) + \beta_1 Factor_{ij} + \beta_2 X_{ij} + \beta_3 Z_j + \varepsilon_{ij,} \tag{1}$$

where *i* and *j* indicate teachers and districts, respectively. *Attrition* represents the binary indicator for the attrition status, such that *Attrition* = 1 if teachers who were in the classroom during the 2011-2012 school year voluntarily left teaching in the 2012-2013 school year for reasons other than retirement, and *Attrition* = 0 otherwise. *Factor* represents principal factors in four categories: teacher voice, school support, school problems, and teacher morale. We use one factor for each regression to avoid the collinearity problem.[10] *X* is the vector of control variables at the teacher level, and *Z* is the vector of control variables at the district level. ε is the error term reflecting variation not accounted for in the model. The model is weighted by the final sampling weights at both the teacher and district levels.

Model (1) estimates a single coefficient for each independent variable (fixed effects), so the effect of each factor is assumed to be the same (β_1) for all districts. However, the model allows a district-specific intercept (u_k) for each district (random effects). This model is "mixed-effect" because it has both fixed-effects and random-effects components.[11]

To examine whether the commonality among teachers within the same district (or commonality among districts within the same state) is large or small, we estimate intraclass correlation (ϱ), a summary of the proportion of the outcome variability that is attributable to differences across districts.[7] When ϱ is large (close to 1), the within-district variation among teachers is so small that teachers in the same district behave almost identically. When ϱ is small (close to 0), the teachers in the same district are almost independent from each other, and the simple OLS regression could suffice for the analysis.

We estimate the between-district variance component ($\hat{\sigma}_u^2$) to be 0.078 and the within-district variance component ($\hat{\sigma}_\varepsilon^2$) to be 0.128, yielding the intra-class correlation (ϱ) of 0.272. This sizable value of ϱ implies that teachers in the same district do not behave independently of one another, and that there exist unobservable omitted factors in the error term. Therefore, the estimates from standard OLS regressions will be biased, and multilevel models are preferred.

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[10] For instance, the correlation coefficient is 0.36 between voice and morale factor, 0.39 between voice and support factor, and -0.17 between voice and problem factor. The support factor and morale factor show the correlation coefficient of 0.67, the largest correlation among these factors.

[11] Because our dataset contains three levels (with teachers as level one, schools as level two, and districts as level three), we initially started with a three-level multilevel model. However, the likelihood ratio test shows that the district-level with a random intercept improves the fit, but adding the school-level is not necessary.

We then conduct the likelihood ratio test, demonstrating that the random slope is not necessary for our samples. Thus, we treat the effects of principal factors similarly for all districts, and the model estimates a single regression line representing the population average, while the district-specific intercept shifts this regression line up or down.

We also examine the relationship between teacher employment conditions and attrition, using the same model (1) but replacing the "Factor" variable with "Employment Condition," measured by five metrics: base salary, returns to ten years of experience for BA, returns to ten years of experience for MA, class size, and working hours.

Researchers find that attrition is a predominant problem among novice teachers (Bobbitt et al., 1994; Boe et al., 1997; Grissmer & Kirby, 1987; Han, 2020), and that teachers may perceive their careers differently as they accumulate more experience. Thus, we conduct a separate analysis for three experience groups: novice, mid-career, and senior teachers. We define novice teachers as teachers with five years or less of experience, mid-career teachers as those with 6-20 years of experience, and senior teachers as those with more than 20 years of experience.

Results

Table 3 presents the predicted relationship between principal factors and teacher attrition, as estimated from the multilevel mixed-effects models. Column (1) of Panel A, which illustrates the results without controlling for union measures, shows that teacher attrition is negatively associated with the teacher voice factor, even after controlling for various teacher-, school-, and district-characteristics. On average, a one unit increase in teachers' influence over their school policies and in their classrooms, or teachers' voice, is associated with a 0.6% decrease in teacher attrition. The impact size of teacher voice is about 0.3 standard deviations of teacher attrition. This result implies that when teachers have greater influence over their school policies and greater autonomy in their classrooms, they are more likely to stay in teaching. A supportive work environment provided by principals and other administrative staff is also an important factor in teachers' decision to remain teaching, as seen in column (2). Column (3) shows that school problems are one of the factors that push teachers out of their profession. The more and more serious the school problems, the greater probability of teachers' leaving. In column (4), teacher morale shows a strong, statistically negative association with teacher attrition, indicating that teachers with greater morale and job satisfaction are less likely to quit. This makes intuitive sense; teacher morale can be seen as a summary of, or as reflecting, the other three factors (teacher voice, school support, school problems).[12]

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[12] When we include all four factors in the same regression, only the teacher morale and school support factors retain statistical significance. The magnitude of the coefficient for teacher moral factor (-0.0065***) is twice as big as the magnitude of the coefficient for school support factor (-0.0031**).

Table 3

Estimated Relationship between Principal Factors and Teacher Attrition

[Dependent Variable: Binary variable indicating if a teacher has left teaching career during the subsequent school year]

VARIABLES	Panel A: Without Union Controls (columns 1-4)				Panel B: With Union Controls (columns 5-8)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Teacher voice factor	-0.0060***				-0.0061***			
	(0.0014)				(0.00145)			
School support factor		-0.0080***				-0.0082***		
		(0.0014)				(0.0014)		
School problem factor			0.0045***				0.0046***	
			(0.0014)				(0.0014)	
Teacher morale factor				-0.0086***				-0.0089***
				(0.0014)				(0.0015)
Collective bargain					-0.0083***	-0.0086***	-0.0085***	-0.0086***
					(0.0025)	(0.0025)	(0.0025)	(0.0025)
Meet and confer					-0.0095**	-0.0096***	-0.0095***	-0.0096***
					(0.0036)	(0.00367)	(0.0036)	(0.0036)
Male	-0.0047*	-0.0046*	-0.0050*	-0.0049*	-0.0044*	-0.0043*	-0.0047**	-0.0047**
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
Hispanic	0.0033	0.0030	0.0037	0.0032	0.0034	0.0031	0.0039	0.0033
	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)
Black	-0.0064	-0.0063	-0.0059	-0.0064	-0.0066	-0.0065	-0.0061	-0.0066
	(0.0052)	(0.0052)	(0.0053)	(0.0052)	(0.0052)	(0.0052)	(0.0053)	(0.0052)
Asian	-0.0084	-0.0090	-0.0090	-0.0092	-0.0086	-0.0091	-0.0091	-0.0093
	(0.0082)	(0.0082)	(0.0082)	(0.0082)	(0.0082)	(0.0082)	(0.0082)	(0.0082)
Other	-0.0083	-0.0084	-0.0082	-0.0082	-0.0085	-0.0086	-0.0084	-0.0084
	(0.0078)	(0.0078)	(0.0078)	(0.0078)	(0.0078)	(0.0078)	(0.0078)	(0.0078)
Full time	-0.0291***	-0.029***	-0.0291***	-0.0291***	-0.0292***	-0.0292***	-0.0291***	-0.0292***
	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Experience	-0.0039***	-0.0039***	-0.0038***	-0.0038***	-0.0039***	-0.0039***	-0.0038***	-0.0038***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Experience^2	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***
	(9.96e-06)	(9.95e-06)	(9.95e-06)	(9.94e-06)	(9.96e-06)	(9.95e-06)	(9.94e-06)	(9.94e-06)

VARIABLES	Panel A: Without Union Controls (columns 1-4)				Panel B: With Union Controls (columns 5-8)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Master's and above	0.0036*	0.0035*	0.0036*	0.0034	0.0038*	0.0035*	0.0037*	0.0035*
	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Alternative certify	0.0076**	0.0077**	0.0078**	0.0076**	0.0068**	0.0069**	0.0070**	0.0068**
	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
Highly Qualified Teacher	-0.0070***	-0.0069***	-0.0071***	-0.0070***	-0.0073***	-0.0072***	-0.0074***	-0.0072***
	(0.0025)	(0.0025)	(0.0026)	(0.0025)	(0.0026)	(0.0025)	(0.0026)	(0.0025)
Charter school teacher	0.0200***	0.0195***	0.0205***	0.0195***	0.0169***	0.0162***	0.0173***	0.0162***
	(0.0055)	(0.0055)	(0.0055)	(0.0055)	(0.0056)	(0.0056)	(0.0056)	(0.0056)
% Hispanic students	0.0051	0.0052	0.0044	0.0041	0.0063	0.0056	0.0047	0.0045
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0063)	(0.0063)	(0.0064)	(0.0064)
% Black students	0.0103	0.0100	0.0092	0.0073	0.0068	0.0064	0.0056	0.0037
	(0.0068)	(0.0068)	(0.0069)	(0.0069)	(0.0069)	(0.0069)	(0.0069)	(0.0069)
% Asian students	-0.0064	-0.0070	-0.0028	-0.0050	-0.0073	-0.0078	-0.0035	-0.0058
	(0.0192)	(0.0192)	(0.0193)	(0.0192)	(0.0192)	(0.0192)	(0.0193)	(0.0192)
% Other students	0.0139	0.0131	0.0128	0.0120	0.0155	0.0147	0.0143	0.0136
	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)
% Male students	-0.0003	-0.0003	-0.0020	-0.0009	-0.0011	-0.0008	-0.0029	-0.0017
	(0.0129)	(0.0129)	(0.0129)	(0.0129)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
% Free/reduced price lunch	-0.0021	-0.0015	-0.0056	-0.0025	-0.0035	-0.00304	-0.0072	-0.0040
	(0.0049)	(0.0049)	(0.0051)	(0.0049)	(0.0050)	(0.0050)	(0.0051)	(0.0050)
Log(enrollment)	-0.0020	-0.0017	-0.0013	-0.0018	-0.0022	-0.0020	-0.0016	-0.0021
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Log(revenue)	-0.0007	-0.0006	-0.0007	-0.0006	-0.0007	-0.0005	-0.0007	-0.0005
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Constant	0.0705***	0.0784***	0.0501***	0.0798***	0.0788***	0.0871***	0.0581***	0.0887***
	(0.0188)	(0.0188)	(0.0188)	(0.0188)	(0.0189)	(0.0190)	(0.0189)	(0.0189)
Observations	32,590	32,590	32,590	32,590	32,590	32,590	32,590	32,590
Number of Groups	4,120	4,120	4,120	4,120	4,120	4,120	4,120	4,120

Note: Errors are clustered within districts (presented in parentheses). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Observation number and group number is rounded to nearest 10th. Additional covariates included are school level (primary, secondary, and combined), program types (Regular, special program emphasis, special education, career/vocational education, and alternative), and urbanism of districts.

Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

Teachers' unions may influence attrition beyond the voice mechanism, given the evidence that they aim to offer more favorable employment conditions, empower teachers, and provide a more supportive work environment and more resources for professional development (Allegretto & Tojerow, 2014; Budd, 2007; Eberts & Stone, 1984; Freeman & Medoff, 1984; Hirsch et al, 1997; Jones et al., 2016; Lyon, 2020; Moore-Johnson et al., 2007; NEA, 2012; Podgursky, 2003; Strunk, 2011; West, 2015). Thus, as a robustness check, we control for teacher unionism, measured by the contractual status (CB and MC) between teachers' unions and their districts. In this case, the hypothesis is that unions are intermediaries that could drive most of the estimated associations between attrition and the various factors, especially the voice factor.[13] The results are reported in Panel B of Table 3. The coefficients for the four factors are almost the same, indicating that the relationship between these factors and teacher attrition is not driven by union strength. However, both CB and MC show a statistically significantly negative association with teacher attrition, with the teacher attrition rate 1% lower in CB and MC districts, compared to that of districts with no such agreements with teachers' unions. This shows that teachers' unions are one of the determinants for reducing teacher attrition.

We also identify other determinants. Male teachers are less likely to quit, although the magnitude of the coefficient (0.5%) is small. Full-time teachers with HQT certificates are more likely to remain in their classrooms, while teachers with alternative certification and those working in charter schools show a higher attrition rate, as do teachers with higher educational attainment.

The relationship between teacher experience and teacher attrition is non-linear, as it is represented by a quadratic equation. The attrition initially falls as teacher experience increases, but it rises again after it reaches about 11.5 years of experience. This pattern suggests that teachers with different levels of experience may view their career paths differently, and that the determinants for their departure from teaching may also be different at these various points.

We conduct an additional robustness check by controlling for teachers' teaching subjects, and the alternative results are very similar to the findings presented in Table 3. Teachers who teach arts, music, ESL, or bilingual education are less likely to quit than their peers who are teaching other subjects. Science, technology, engineering, and mathematics (STEM) teachers show a slightly greater tendency to quit relative to other teachers, but the effects are not statistically significant.

Three survey questions used to construct the "school support" factor seem miscategorized.[14] Thus, as a sensitivity test, we drop these questions, reconstruct the "school support" factor, and re-do the analysis. The significance of this factor as a determinant of attrition is almost the same as before, indicating that the results are not driven by these underlying variables.

Table 4 presents the predicted relationship between employment conditions and teacher attrition, as estimated from the multilevel mixed-effects models. Panel A shows that teacher pay has a small (given the scale) but significant association with teacher attrition. A 1% increase in teacher base salary reduces teacher attrition by 0.023 percentage points. Returns to experience are also negatively associated with teacher attrition.

When we include the union measure as an additional control variable in Panel B, the coefficients for teacher compensation fall in magnitude, and statistical significance is also reduced. This suggests that some of the effect of teacher salary on teacher attrition is attributable to teacher

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[13] For a review of the literature on the role teacher unions play in improving working conditions and outcomes, see Han (2019).

[14] For instance, question b (I am satisfied with my teaching salary) and q (I am generally satisfied with being a teacher at this school) might belong to "teacher morale" and question p (The amount of student tardiness and class cutting in this school interferes with my teaching) belong to "school problem." See Appendix II for detailed factor classification.

unions, which indirectly influence teacher compensation. Teacher working hours also shows a negative association with attrition, once union strength is controlled. Class size has no relationship with attrition. As seen in Table 3, CB and MC districts display a lower attrition rate, relative to districts with no agreement with unions.

Table 4

Estimated Relationship between Teachers' Employment Conditions and Teacher Attrition

	Dependent Variable: Binary variable indicating if a teacher has left teaching career during the subsequent school year									
	Panel A: Without Union Controls (columns 1-5)					**Panel B: With Union Controls (columns 6-10)**				
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log(base salary)	-0.023***					-0.021***				
	(0.0041)					(0.003)				
Returns to exp (BA)		-0.017**					-0.012*			
		(0.0077)					(0.0070)			
Returns to exp (MA)			-0.010***					-0.0046		
			(0.0055)					(0.0078)		
Log(required hours)				-0.0115					-0.015***	
				(0.0074)					(0.0055)	
Pupils per teacher					-0.0003					-0.0003
					(0.0002)					(0.0002)
Collective bargain						-0.007***	-0.009***	-0.009***	-0.008***	-0.008***
						(0.0025)	(0.0029)	(0.0030)	(0.0025)	(0.0025)
Meet and confer						-0.010***	-0.010***	-0.011***	-0.010***	-0.010**
						(0.0036)	(0.0038)	(0.0039)	(0.0036)	(0.00367)
Covariates	X	X	X	X	X	X	X	X	X	X
Observations	32,590	29,360	29,360	32,590	32,590	32,590	29,360	29,360	32,590	32,590
Number of Groups	4,120	3,690	3,690	4,120	4,120	4,120	3,690	3,690	4,120	4,120

Note: Errors are clustered within districts (presented in parentheses). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Observation number and group number is rounded to nearest 10th. Covariates included are the same as in Table 3.

Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

Due to the non-linear nature of the relationship between teacher experience and teacher attrition (see Table 3), and because teaching experience is positively associated with teacher effectiveness (see Kini & Podolsky, 2016 for the literature review), the attrition of experienced teachers may be more costly than the attrition of novice teachers. Thus, we conduct a separate analysis by teacher experience, classified according to three groups. Table 5 presents the results for four principal factors in Panel A and for five employment conditions in Panel B.

Table 5

The Effects of Principal Factor and Employment Conditions on Teacher Attrition

Dependent Variable: Binary variable indicating if a teacher has left teaching career during the subsequent school year

VARIABLES	Novice teachers (Exp ≤ 5 yr)	Mid-career teachers (6 yr ≤ Exp ≤ 20 yr)	Senior teachers (Exp ≥ 21 yr)
Panel A: Principal factors			
Teacher voice factor	-0.0092***	-0.0042**	-0.0035**
	(0.0025)	(0.0017)	(0.0017)
School support factor	-0.0136***	-0.0063***	-0.0028*
	(0.0025)	(0.0016)	(0.0017)
School problem factor	0.0043*	0.0037**	0.0024
	(0.0025)	(0.0017)	(0.0018)
Teacher morale factor	-0.0127***	-0.0073***	-0.0036**
	(0.0026)	(0.0017)	(0.0018)
Panel B: Employment conditions			
Log(base salary)	-0.0097	-0.0199***	-0.0005
	(0.0080)	(0.0044)	(0.0045)
Returns to 10 yr. exp (BA)	-0.0037	-0.0252***	-0.0016
	(0.0137)	(0.0076)	(0.0095)
Returns to 10 yr. exp (MA)	0.0113	-0.0207**	-0.0042
	(0.0131)	(0.0073)	(0.0093)
Log(required hours)	-0.0026	-0.0033	-0.0097
	(0.0097)	(0.0058)	(0.0062)
Pupils per teacher	0.0005	-0.0002	-0.0001
	(0.0004)	(0.0002)	(0.0003)
Covariates	X	X	X
Observations	8,180	16,880	7530
Number of Groups	3,070	3,890	3,170

Note: Errors are clustered within districts (presented in parentheses). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All results are estimated from random effects models. Observation number and group number is rounded to nearest 10th. Covariates included are the same as in Table 3, and union measures are also included.
Source: District-teacher matched data, based on 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

Overall, Panel A shows that the principal factor components play important roles in teacher attrition for all three experience groups of teachers, but their impacts on attrition of novice teachers are the greatest. In particular, the teacher voice factor and the school support factor are the key determinants for teacher retention among this group. For senior teachers, those with at least 20 years of teaching, teacher voice factor remains a key factor for their departure from teaching. In panel B, only the mid-career teachers identify employment conditions, specifically teacher compensation, to be a determinant of their attrition. For both novice and senior teachers, higher pay is not the main factor that can stop them from leaving teaching.

Discussion and Conclusion

This study examines various factors influencing teachers' decisions to quit or remain in the classroom, while emphasizing the role of teacher voice that most studies fail to incorporate in the discussion on teacher turnover. Drawing on nationally representative, district-teacher matched data, we identify key determinants of teacher attrition by employing multilevel mixed-effects linear models that control for commonalities among teachers within the same school district.

We find that four principal factor components (teacher voice, school support, school problems, and teacher morale) play important roles in influencing teacher attrition. Specifically, strong teacher voice, supportive work environment, fewer school problems, and greater teacher morale significantly reduce teacher attrition. This is consistent with other studies that used similar metrics to find that classroom autonomy and teacher influence are negatively related with attrition, though the relationship was not systematically statistically significant (Nguyen et al., 2019; Ingersoll et al., 2019). In terms of working conditions, we show that teacher base salary and returns to experience are negatively associated with attrition.

We also find that the impact of principal factor components, especially teacher voice, on attrition is greater for novice teachers than for experienced teachers. Considering that high attrition is most prominent among novice teachers, these findings suggest that granting teachers more control over how their classrooms are run and increasing their influence on school policies will help districts retain the young teachers they tend to lose in large numbers.

Teacher salary and returns to education also continue to play important roles for teacher retention, and their impacts are most notable for mid-career teachers. This suggests that offering teachers a better compensation scheme is critical for retaining teachers who have already accumulated valuable experience and whose loss is costly for districts.

All of the factors we examined are correlated with attrition, offering policymakers a menu of options to improve teacher working conditions in order to boost teacher retention. Our research also points to the need to better understand the full set of factors, both those applicable to workers generally and those specific to teachers, that drive their decisions to remain in (or leave) the profession. Broadening our exploration to incorporate less-explored factors could help schools, districts, and states design more effective retention policies. Further research should continue to explore the joint influence of all these factors on attrition, as well as any moderating factor that comes from school characteristics or institutional factors that affect them. The information we provide on the roles the different factors play for younger, mid-career, and senior teachers could also be used to balance the initiatives that strengthen teachers' decisions to stay in the profession at different points in time.

We are not able to make a causal claim regarding our findings, due to the limitation of cross-sectional data. However, we control for various confounding factors and conduct multiple robustness checks, so our estimates appear to capture more than a simple correlation between various factors and teacher attrition. Exploring a causal mechanism is an important task in

estimating the true magnitude of the effect of determinants of teacher attrition. This subject is left for future study.

Acknowledgments

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Appendix I: Summary Statistics

VARIABLES	(1) N	(2) Mean	(3) SD	(4) Min	(5) Max
Teacher attrition	36,920	0.0373	0.189	0	1
Male	36,920	0.313	0.464	0	1
Hispanic	36,920	0.0508	0.220	0	1
White	36,920	0.929	0.257	0	1
Black	36,920	0.0519	0.222	0	1
Asian	36,920	0.0171	0.130	0	1
Other	36,920	0.0190	0.136	0	1
Master's and above	36,920	0.544	0.498	0	1
Experience	36,920	13.48	9.807	1	54
Full time	36,920	0.923	0.267	0	1
Alternative certification	36,920	0.143	0.350	0	1
HQT	36,920	0.788	0.408	0	1
Base salary	36,920	49,583	15,741	160	140,000
Required hours	36,920	37.33	6.21	5	80
Voice factor	36,920	1.814	0.735	0.266	4.669
Support factor	36,920	3.035	0.752	0.280	4.211
Problem factor	36,920	2.484	0.834	-0.001	4.441
Morale factor	36,920	2.569	0.715	0.282	4.000
Charter school	36,920	0.0625	0.242	0	1
Hispanic students	34,370	0.148	0.217	0	1
Black students	34,370	0.124	0.202	0	1
Asian students	34,370	0.0307	0.0599	0	0.823
Other students	34,370	0.0456	0.111	0	1
Male students	34,370	0.507	0.0891	0	1
Free/reduced-price lunch	33,210	0.445	0.273	0	1
Regular	36,920	0.903	0.296	0	1
Special program emphasis	36,920	0.0277	0.164	0	1
Special education	36,920	0.0159	0.125	0	1
Career/vocational education	36,920	0.0152	0.122	0	1
Alternative program	36,920	0.0381	0.191	0	1
Elementary school	36,920	0.399	0.490	0	1
Secondary school	36,920	0.452	0.498	0	1
Combined school	36,920	0.149	0.356	0	1
Log(enrollment)	34,370	6.386	0.867	0.693	9.210
Log(total revenue)	36,150	17.96	1.671	10.84	23.77
Pupil per teacher	34,370	14.70	5.735	0.512	139.9
Collective bargaining	36,920	0.533	0.499	0	1
Meet and confer	36,920	0.117	0.321	0	1
City	36,920	0.213	0.409	0	1
Suburban	36,920	0.275	0.447	0	1
Town	36,920	0.166	0.372	0	1
Rural	36,920	0.346	0.476	0	1

Source: District-teacher matched data, based on the 2011-2012 *Schools and Staffing Survey* (SASS) and 2012- 2013 *Teacher Follow-up Survey* (TFS).

Note: Teacher attrition represents the binary indicator of teacher attrition such that Attrition = 1 if teachers who were in the classroom during the 2011-2012 school year voluntarily left teaching in the 2012-2013 school year for reasons other than retirement, and Attrition = 0 if the teachers continued teaching in the 2012-2013 school year.

Appendix II: Factor Survey

Questionnaires for principal factors for teacher voice (influence in schools and teacher control in classrooms), school climate ("school support"), other obstacles/barriers to learning and teaching ("school problems"), and teacher morale

Teacher Influence in School: How much actual influence do you think teachers have over school policy AT THIS SCHOOL in each of the following areas? *1. No Influence to 4. Great Deal of Influence (%)*
   a. Setting performance standards for students at this school
   b. Establishing curriculum
   c. Determining the content of in-service professional development programs
   d. Evaluating teachers
   e. Hiring new full-time teachers
   f. Setting discipline policy
   g. deciding how the school budget will be spent

Teacher Control in Classroom: How much actual control do you have IN YOUR CLASSROOM at this school over the following areas of your planning and teaching? *1. No Control to A Great Deal of Control (%)*
   a. Selecting textbooks and other instructional materials
   b. Selecting content, topics, and skills to be taught
   c. Selecting teaching techniques
   d. Evaluating and grading students
   e. Disciplining students
   f. Determining the amount of homework to be assigned

School Climate ("School Support"): To what extent do you agree or disagree with each of the following statements? *1. Strongly Agree to 4. Strongly Disagree (%)*
   a. The school administration's behavior toward the staff is supportive and encouraging.
   b. I am satisfied with my teaching salary.
   c. The level of student misbehavior in this school (such as noise, horseplay or fighting in the halls, cafeteria, or student lounge) interferes with my teaching.
   d. I receive a great deal of support from parents for the work I do.
   e. Necessary materials such as textbooks, supplies, and copy machines are available as needed by the staff.
   f. Routine duties and paperwork interfere with my job of teaching.
   g. My principal enforces school rules for student conduct and backs me up when I need it.
   h. Rules for student behavior are consistently enforced by teachers in this school, even for students who are not in their classes.
   i. Most of my colleagues share my beliefs and values about what the central mission of the school should be.
   j. The principal knows what kind of school he or she wants and has communicated it to the staff.
   k. There is a great deal of cooperative effort among the staff members.
   l. In this school, staff members are recognized for a job well done.

m. I worry about the security of my job because of the performance of my students or my school on state and/or local tests.

n. State or district content standards have had a positive influence on my satisfaction with teaching.

o. I am given the support I need to teach students with special needs.

p. The amount of student tardiness and class cutting in this school interferes with my teaching.

q. I am generally satisfied with being a teacher at this school.

Other Obstacles/Barriers to Learning and Teaching ("School Problems"): To what extent is each of the following a problem in this school? *1. Serious Problem to 4. Not a Problem (%)*

a. Student tardiness

b. Student absenteeism

c. Student class cutting

d. Teacher absenteeism

e. Students dropping out

f. Student apathy

g. Lack of parental involvement

h. Poverty

i. Students come to school unprepared to learn

j. Poor student health

Teacher Morale: To what extent do you agree or disagree with each of the following statements? *1. Strongly Agree to 4. Strongly Disagree (%)*

a. The stress and disappointments involved in teaching at this school aren't really worth it.

b. The teachers at this school like being here; I would describe us as a satisfied group.

c. I like the way things are run at this school.

d. If I could get a higher paying job I'd leave teaching as soon as possible.

e. I think about transferring to another school.

f. I don't seem to have as much enthusiasm now as I did when I began teaching.

g. I think about staying home from school because I'm just too tired to go.

Source: 2011-2012 *Schools and Staffing Survey* (SASS).

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