

New Evidence on the Frequency of Teacher Turnover: Accounting for Within-Year Turnover

Christopher Redding¹ and Gary T. Henry²

¹University of Florida

² Vanderbilt University

Abstract

Teacher turnover occurs during and at the end of the school year, although documentation of within-year turnover currently rests on anecdotal evidence. On average, over 4.6 percent of teachers turn over during the school year, which amounts to 25 percent of total annual turnover. Teachers transfer within districts at higher rates at the beginning of the school year and leave teaching at higher rates at the beginning of the spring semester. Higher performing teachers are less likely to turn over during the school year and less likely to turnover within- than at the end-of-year. Teach For America corps members are much less likely and teachers from out-of-state much more likely to turnover during the school year than traditionally prepared teachers.

A substantial research base describes teacher turnover, including higher rates of turnover among novice teachers and retirees and from schools with high concentrations of traditionally underserved racial/ethnic groups and low-income students (Ingersoll, 2001; Lankford, Loeb, & Wyckoff, 2002; Papay, Bacher-Hicks, Page, & Marinell, 2017). A limitation of prior research is that teacher turnover is measured annually, with no distinction between the turnover that occurs during versus at the end of the school year. While prior research may not have been able to identify within-year teacher turnover, it is clear that some within-year turnover is inevitable given that it includes voluntary and involuntary exit from teaching, parental leave, medical leave, and intradistrict transfer. In this study, we measure the teacher turnover monthly throughout the year and examine its timing, magnitude, and associations with teacher and school characteristics, including demographics and working conditions.

A major consequence of within-year turnover is the disruption to student learning and school operations. When teacher turnover occurs during the school year, it is particularly

detrimental to students, as this turnover undermines instructional continuity within the classroom. The disruption faced by students is likely to be compounded when they are assigned to a long-term substitute while the school hires a replacement or their replacement teacher is selected from an applicant pool comprised mostly of lower quality teachers not previously hired to work elsewhere. Elsewhere, we show within-year teacher turnover to have a larger negative effect on student achievement when compared to the effect of end-of-year turnover (Henry & Redding, in press). Students who lose a teacher during the school year score, on average, 7.5% of a standard deviation lower on standardized tests. At the school level, within-year turnover undermines amassed social capital, which forms the basis of collegiality and collaboration between school staff (Simon & Johnson, 2015). Further, if within-year teacher turnover is highest in schools enrolling children from low-income families and traditionally underserved racial/ethnic groups, as is the case with end-of-year turnover (Borman & Dowling, 2008; Guarino, Santibañez, & Daley, 2006), administrators at these schools may be forced to dedicate time and effort to fill teacher vacancies in classrooms that may have been better spent on instructional improvements.

At the same time, within-year teacher turnover has potential benefits, depending on the type of turnover (i.e. moving schools or leaving teaching) and its timing during the school year. For instance, a sizable share of within-year turnover is likely due to parental and medical leave. This type of turnover could signify supportive family leave policies that are conducive to the recruitment of qualified female teachers who would otherwise pursue alternative occupations or delay their entry into teaching for family considerations (Flyer & Rosen, 1997; Grissom & Reininger, 2012). When teachers temporarily exit and return in this fashion, the high costs of recruiting new teachers are also defrayed (Papay et al., 2017). Intradistrict teacher transfer is

another form of within-year turnover that is likely less disruptive to school operations, especially when it occurs at the beginning of the school year. These transfers give school and district administrators flexibility in adequately staffing schools in response to enrollment fluctuations and even allow for strategic teacher assignments (Grissom, Loeb, & Nakashima, 2014). Finally, it is possible that teacher exits during the school year—whether teacher- or administrator-initiated—could be beneficial for student performance and school morale if the teacher had extremely poor performance prior to their exit. Recent evidence suggests that inducing the lowest performing teachers to exit can be beneficial to the composition of the teaching workforce and student achievement (Adnot, Dee, Katz, & Wyckoff, 2017; Cullen, Parsons, & Koedel, 2016). The diversity of within-year teacher turnover makes it difficult to ascertain the appropriate level as well as the full costs and benefits this type of turnover poses to school systems.

The purpose of this study is to quantify the rate at which within-year turnover occurs, to examine the teacher and school characteristics associated with within-year turnover, and consider how these associations compare to the turnover that occurs at the end of the school year. Measuring within- and end-of-year teacher turnover allows for a more complete and accurate picture of teacher mobility and better represents the phenomena that educators are grappling with. In doing so, we hope to introduce greater nuance into how researchers and policymakers understand teacher turnover, thereby being able to better target policies at reducing teacher turnover where it is most problematic for student performance and school operations. Elsewhere, we build off of this broader study of within-year teacher turnover to describe the specific mobility patterns of teachers throughout their first three years on the job and the effect of within-year teacher turnover (Henry & Redding, in press; Redding & Henry, in press).

By way of preview, we draw monthly pay file data from North Carolina to show that, annually, roughly five percent of teachers turn over during the school year. We find that within-year turnover is most distinct from end-of-year turnover in terms of teacher characteristics, particularly their experience and performance. Within-year turnover is most likely to occur during three key points: the beginning of their career, once teachers have reached retirement eligibility, and, for female teachers between the ages of 26 and 40. In addition, more effective teachers are less likely to turn over, particularly during the school year.

Characterizing Within-Year Turnover

Within-Year Turnover Among Novice Teachers

Previous research suggests that, other than for retirement, end-of-year turnover occurs most often at the beginning of teachers' careers (Ingersoll, Merrill, & Stuckey, 2014). The high turnover rates among early career teachers combine voluntary and involuntary turnover, both of which may occur at the end of the school year or during it. With less time invested in their careers, the demands of adjusting to the teaching profession, demoralization, burnout, or simply dissatisfaction with teaching may lead to an early exit, even during the school year. High novice teacher turnover rates are also attributable to seniority-based norms whereby less experienced teachers are assigned to lower-performing students and work in schools with more challenging working conditions (Guarino, Santibanez, & Daley, 2006). To the extent that these factors inhibit novice teachers' ability to develop professionally, they too might influence teachers' decision to leave their school during the school year (Johnson & Birkeland, 2003; Kraft & Papay, 2014; Smith & Ingersoll, 2004). Novice teacher turnover is further exacerbated by the large share of alternate entry and out-of-state prepared novice teachers. These teachers who may not have the level of investment in teaching or commitment to teaching in the state where they are currently

employed turn over at higher rates, both within and at the end of the school year (Redding & Henry, in press).

Novice teachers also have fewer job protections and, as a result, are most likely to face involuntary transfer or dismissal. Through inverse-seniority policies, new teachers are most likely to be laid off as part of staffing cuts (Goldhaber & Theobald, 2013), which may occur over the summer or during the school year. Seniority policies also shape intradistrict teacher transfer, with novice teachers more likely to be transferred in the first months of the school year to balance class sizes across schools in response to shifting enrollments within districts (Koski & Horng, 2007). In other work, we conduct a survival analysis to show that annually 6% of early career teachers turn over during the school year and that the rates of leaving teaching are elevated for alternate entry and out-of-state prepared teachers (Redding & Henry, in press).

Within-Year Exit for Family/Medical Leave

For mid-career teachers, one of the most common reasons for within-year turnover is family and medical leave. Although family and medical leave includes temporary exit from teaching to recover from personal illness or to care for a family member, the education policy literature has paid most attention to gender differences related to parental leave. Previous research finds that the turnover rates for female teachers are particularly high for married female teachers who have recently given birth (Stinebrickner 1998). Notably, 40% of teachers who leave teaching re-enter within ten years of their exit, with female teachers re-entering at much higher rates than men (Grissom and Reininger, 2012). As parental leave arguably occurs at any point in the calendar year, we will focus on within-year turnover to add evidence to this topic.

Retirement as Within-Year Exit

Teacher retirement is the final phase in teachers' careers when we expect to find high levels of within-year teacher turnover. Unlike previous phases in teachers' career where within-year turnover could compromise a teacher's chances of finding future employment, teachers nearing retirement do not face the same constraints. Koedel, Podgursky, and Shi (2013) explain how retirement eligibility also alters the opportunity cost of continued work. They write, "[C]ollection-eligible individuals who continue working could earn a fraction of their salary—typically a substantial fraction—without working at all" (p. 575). When teachers who are eligible for retirement face difficult students, frustrating school policies, or more difficult working conditions, it could ease their decisions to end their careers, even during the school year (Furgeson, Strauss, & Vogt, 2006; Hanushek, Kain, & Rivkin, 2004).

Teacher Quality

Research from North Carolina, New York City, and Texas show an inverse relationship between teacher effectiveness and turnover: less effective teachers are more likely to leave the teaching profession (Boyd et al., 2008; Goldhaber et al., 2011; Hanushek et al., 2004). Yet, in the case of within-year teacher turnover, any compositional benefits associated with the exit of lower performing teachers must be weighed against the immediate disruption it causes students who lose their teacher midyear. Even if lower performing teachers are found to turn over during the school year at higher rates than at the end of the year, it is possible that the disruption and quality of the replacement teacher may compromise any benefits from the exit of lower performing teachers.

Summary and Research Questions

In this paper, we first describe the frequency and timing of within-year teacher turnover. Then we examine the relationship between teacher and school characteristics and within- and end-of-year turnover. We address two main research questions:

- 1) To what extent do teachers turn over during the school year? How does this within-year turnover rate compare to end-of-year turnover?
- 2) To what extent are teacher characteristics, school demographics, and school working conditions associated with within-year turnover? How do the associations with within- and end-of-year turnover vary?

Data and Methods

Analytic Sample

We draw on administrative data from the state of North Carolina from the 2009-2010 through the 2014-2015 school years. The analytic sample includes all full-time teachers in traditional public schools from kindergarten through twelfth grade. From this sample, we exclude teachers assigned to multiple schools and teachers who are missing data on teacher or school characteristics. The analytic sample includes 452,861 teacher-year observations.

Dependent Variables

Drawing on monthly teacher pay data, we create six types of turnover variables for each year: (1) stayer, (2) within-year mover, (3) end-of-year mover, (4) within-year leaver, (5) end-of-year leaver, and (6) temporary exit and returner.¹ Stayers remained in their school throughout the year and return the following year. Within-year movers changed schools before the end of the school year. End-of-year movers changed schools between the end of one school year and the beginning of the next. We define within-year leavers as those who left teaching in the public

¹ We describe the creation of these variables in greater detail in Table A1.

schools during the school year. We define end-of-year leavers as those who left teaching after the end of one school year and prior to the beginning of the next. Due to data limitations for these last two categories, we are only able to define leavers as teachers leaving public schools in North Carolina. Temporary exit and return is defined for teachers who exit teaching for at least one month before returning to their current school by the beginning of the next school year. To construct these different categories, we draw on monthly teacher pay files, which give detailed information on where a teacher is employed in a given month. These data allows us to identify when in the school year a teacher moved or left their school.²

Covariates

The analysis of the teacher characteristics most strongly associated with within- and end-of-year turnover focuses on four main characteristics—teaching experience, age, gender, and teacher entry pathway—and three measures of teacher human capital and effectiveness. Teachers’ entry pathways include traditional, in-state preparation, alternate entry, Teach For America, out-of-state prepared, and other, including Visiting International Faculty and teachers from unclassifiable entry pathways. When analyzing the influence of retirement eligibility, we construct indicators of whether or not a teacher is eligible for full or reduced retirement benefits. In North Carolina, teachers are qualified for full retirement benefits under three conditions: 65 years old and over 5 years of experience, 60 years old and over 25 years of experience, or over 30 years of experience. Teachers are eligible for reduced benefits if they are over 50 years old and have 20 years of experience or over 60 years old and have 5 years of experience. The measures of teacher human capital and effectiveness include their lagged value-added score

² Similar to most other studies on teacher turnover, we are unable to distinguish between voluntary and involuntary turnover. For the present analysis, the chief consequence of this issue is that we are unable to identify teachers who were dismissed or involuntarily transferred to new schools during the school year.

(EVAAS), the median of the lagged evaluation score across five standards, and teachers' average score across teacher certification and college entrance exams. Models also control for teacher race/ethnicity (Black, Hispanic, and other non-White teachers).

To understand the relationship between turnover and school context, we create an underserved school index variable. This variable is the standardized fitted values from a regression model that uses the percentage of Black, Hispanic, and other non-White students, average student enrollment, the suspension rate, violent acts rate, per pupil expenditures, and the teacher salary supplement to predict school-level proficiency rates. Other school-level variables include indicators for the school level (elementary, middle, or high school) and urbanicity (city, suburb, rural, and town).

We also include three measures of teacher-reported working conditions from the biennial Teacher Working Conditions (TWC) survey. We use confirmatory factor analysis to generate three factors that have been used previously in turnover research: facilities and resources, distributed leadership, and principal leadership (Ladd, 2011; Schweig, 2014) Each factor has moderate to high internal consistency, with Cronbach's alpha ranging from 0.84 to 0.93, depending on the scale and year. As the survey was conducted every other year, for off years, we use linear interpolation to impute the school-level averages. Descriptive statistics across the different turnover categories are provided in Table A3.

Analytic Plan

To answer the first research question, we describe the annual frequency of within-year teacher turnover, contrasting it to end-of-year turnover. For comparison to other studies, we also construct another turnover measure used in earlier studies based on a teacher's active employment in October in year t compared to their employment status in October in year $t+1$.

The second research question asks about the extent to which teacher characteristics, school characteristics, and school working conditions are associated with turnover. To contrast the predictors of within- and end-of-year turnover, we first estimate a multinomial logistic regression model to compare within-year and end-of-year turnover with staying in the same school. This model takes the simplified form:

$$\Pr(\text{turnover})_{ijk} = \frac{e^f}{1 + e^f} \quad (1)$$

where

$$f = \beta_0 + \beta_1 T_{ik} + \beta_2 S_{jk} + \delta_k$$

is the log odds that teacher i turned over from school j in year k is a function of their background characteristics (T_{ik}) and a vector including school variables (S_{jk}). Models include year fixed effects (δ_k) to account time-specific correlates. We extend this model by distinguishing the type of turnover, estimating separate models for within- and end-of-year movers and leavers, respectively. In all analyses, predictors are simultaneously included in the model and standard errors are clustered at the teacher level to account for repeated observations of the same teacher over time.

Results

Frequency of Within-Year Turnover

In Table 1, we show that an average of 4.64% of teachers turn over during each school year. This within-year turnover includes 1.72% of teachers who moved schools, 2.12% who left teaching, and 0.98% who temporarily exited and returned to the same school. We report measures of turnover that are not mutually exclusive to capture when teacher move schools more than one time during the school year or move and then exit teaching, including temporarily. Overall, the combination of teachers who turn over before October, move multiple times during

the school year, and teachers who temporarily exit and return accounts for the difference in the rate of overall teacher turnover (17.89%) compared to October-to-October measures (15.89%).

The frequency of within-year teacher turnover varies throughout the school year. In Figure 1, we report the percentage of teachers to turn over during each month of the year, separating movers by whether they moved within the same district or to another district in the state. Within-district moves are most common in the first two months of the school year. The rate of within-year within-district movers is noteworthy as teachers are much less likely to move across district lines within the school year compared to the end of the year (26.2% versus 63.5%).³ The rate of within-year leaving is consistent throughout the school year, with the exception of January and February, when teachers leave at higher rate. Our results show no clear relationship between month in the school year and either moving schools within the state or temporary exit and return, except a slight increase in moving out of the school and district in January and February. Next, we present the results from three multinomial logistic regression models that compare within- and end-of-year turnover, moving, and leaving to remaining in the same school.

Teacher Characteristics

In Table 2, we find that early career teachers—those with 0-5 years of experience—are more likely to turn over compared to teachers with 6-10 years of experience. This relationship is strongest for teachers with 0-2 years of experience, whose risk of within-year turnover is 33% greater than teachers with 6-10 years of experience and whose risk of end-of-year turnover is 73% greater, holding all else constant. Although we observe this relationship for within- and

³ Notably, when teachers move schools during the school year, either within the same district or to another district in the state, the school in which they move to has, on average, similar student demographic characteristics. It is only when teachers move schools at the end of the year that they are more likely to move to a school enrolling a smaller concentration of minority or economically disadvantaged students. That being said, even in these instances, the differences in average student characteristics are small, as seen in Table A4.

end-of-year turnover, Wald tests indicate that early career teachers are at greater risk of turning over at the end of school year than within. This pattern is driven by both higher rates of moving schools and leaving teaching at the end of the school year.

Teachers with 20 or more years of experience are slightly more at risk of turning over at the end of the year than teachers with 6-10 years of experience. These teachers have a low risk of moving schools but an elevated risk of leaving teaching within and at the end of the year, which we examined for the relationship to retirement. Among teachers with 20 years of experience or more, 2.27% of teachers not eligible for full retirement benefits left teaching during the school year compared to 5.19% of teachers eligible for full or partial benefits.⁴ The relative risk ratio of those eligible for some retirement benefits is 2.81 for within-year leaving and 3.45 for end-of-year leaving, when controlling for other variables in the model.

Female teachers are at greater risk of turning over during the school year compared to male teachers, holding all else constant. As female teachers' higher rates of within-year turnover may be related to parental leave, in Table A7, we interact gender and five categories of age: 25 years old and younger, 26 to 30 years old, 31 to 40 years old, 41 to 50 years old, 51 to 60 years old, and over 60 years old. The risk of leaving midyear is 13% greater for female teachers who are 26-30 years old compared to male teachers of the same age. While we find no evidence of gender differences in mid-year leaving for ages 31-40, this difference re-emerges for women 51 and older. The latter finding may be driven by the higher rates with which women exit the workforce to care for family members. The evidence of female teachers' exit for parental leave is even stronger when we examine temporary exit and return. Women ages 26 to 40 are roughly

⁴ Supplementary analyses in Tables A5 and A6 examine the extent to which this high rate of leaving is driven by veteran teachers' retirement eligibility. Table A5 indicates that retirement eligible teachers are leaving teaching at high rates both during and at the end of the school year. Table A6 still finds retirement eligible teachers to be at greater risk of leaving teaching at the end of school year than within.

340% more at risk of temporary exit and return than men of the same age but overall annually only approximately 1% of teachers exit and return.

The final teacher characteristic for which we find evidence of differences in the timing of turnover is in terms of entry pathway. Alternate entry teachers are 17% more at risk of turning over at the end of the year than traditionally prepared teachers, with no evidence of differences in terms of within-year turnover. TFA teachers are less at risk of turning over during the school year than traditionally prepared teachers but at greater risk at the end of the year. This pattern is driven by a distinct pattern in the ways in which TFA corps members move schools and leave teaching. Holding all else constant, TFA teachers are 55% less at risk of moving schools during the year and 23% less at risk of moving schools at the end of the year, compared to traditionally prepared teachers. TFA teachers are no more or less at risk of leaving during the school year but are 374% more at risk of end-of-year leaving than traditionally prepared teachers. Although TFA teachers are often characterized by their high turnover rates, our results indicate that these teachers are incredibly stable during the school year, until leaving at the end-of-year that likely occurs at the end of their program commitment. Unlike alternate entry and TFA teachers that have different within- and end-of-year turnover patterns, out-of-state prepared teachers are more likely to turn over than in-state, traditionally prepared teachers, both during and at the end of the school year.

Teacher Quality

Higher value-added and higher rated teachers are less likely to turn over, both during and at the end of the school year (Table 3). For value-added, this relationship is driven by the higher rates of leaving teaching for lower performing teachers. A standard deviation increase in teachers' lagged value-added is associated with a 6% decrease in the risk of leaving teaching

within the school year and a 4% decrease in the risk of leaving teaching at the end of the school year, holding all else constant. We find no evidence of differences in the relationship for within-year versus end-of-year moving.

Compared to teachers with a median score of 1 or 2 on their previous year's summative evaluation, teachers who scored 3 or above had a 40% to 50% decrease in the risk of within-year turnover. Unlike value-added, higher rated teachers are significantly less at risk of turning over during the school year than at the end. This pattern is driven most strongly by within-year leaving, with relative risk ratios that range from 0.35 to 0.48 and significantly different from end-of-year leaving. We find no evidence of a relationship between the average teacher test scores, a measure of teacher human capital, and within-year turnover. Teacher test scores are related to end-of-year turnover, with a standard deviation increase in the average teacher test associated with a 5% increase in the risk of end-of-year turnover.

School Demographics and Working Conditions

The most notable differences between within- and end-of-year turnover for school-level variables are in terms of the underserved school index, school level, and, to a lesser degree, working conditions. The underserved school index is consistently associated with elevated within- and end-of-year turnover, holding all else constant. Wald tests indicate that the magnitude of this relationship is stronger during the school year compared to the end, particularly for leaving teaching.⁵ Teachers are more likely to turn over from middle and high schools compared to elementary school teachers. This relationship is much stronger

⁵ In Table A8, we control for the separate variables that go into this underserved school index and find that when controlling for other school-level variables, the percentage of Black, Hispanic, and other race students is consistently associated with a greater risk of teacher turnover, with a slightly stronger relationship during the school year than at the end of the school year. The estimates for the percentage of economically disadvantaged students are less consistent.

in terms of within-year than end-of-year turnover, with middle school teachers having 114% greater risk of within-year turnover than elementary school teachers and high school teachers having 312% greater risk within year.⁶

In terms of working conditions, higher teacher ratings of school facilities and resources are associated with a reduced risk of within-year moving but a greater risk of moving schools at the end of the school year. An increase in the quality of principal leadership is associated with a lower risk of within- and end-of-year turnover. This relationship is strongest for end-of-year moving. An increase in the quality of distributed leadership is associated with a lower risk of moving schools, both within and at the end of the school year, but not leaving teaching.

Discussion and Conclusion

In this study, we add to the research on teacher turnover by reporting on the rates of within-year turnover and comparing associations of within- and end-of-year turnover. On average, 4.64% of teachers either move schools, leave teaching, or temporarily exit and return during the school year, which comprises a sizable share of the 17.89% of teachers who turn over annually. The rate and type of turnover varies throughout the school year, with district transfers common in the first two months of the school year and leaving most common at the beginning of the spring semester. The elevated rates of intradistrict teacher transfer at the beginning of the year are notable given that they likely indicate districts' proactive role in adequately staffing schools in response to enrollment fluctuations. While this descriptive study does not assess the full range of costs and benefits that within-year teacher turnover raises for schools and districts nor does it reflect on the wisdom of any specific administrative decision to dismiss a teacher,

⁶ With evidence of differences in the within-year turnover rate for elementary, middle, and high schools, we re-estimate our main model separately by level of school in Table A9. Results are generally consistent across school levels, with the exception of female teachers, who have lower odds of within-year turnover than men in elementary schools and greater odds of within-year turnover in high schools.

evidence on the teacher and school characteristics associated with within-year turnover can inform policy and future research in a number of ways.

Although within- and end-of-year turnover are both elevated in schools with higher concentrations of underrepresented minorities and economically disadvantaged student, this relationship is strongest when predicting within-year turnover. The consequences of this finding for school operations are twofold. First, when multiple teachers exit a school during the year, it can become increasingly difficult for teachers to maintain a work environment with a high degree of collaboration (Ronfeldt, Farmer, McQueen, & Grissom, 2015) and sufficient instructional resources to mentor new teachers across different grades and subjects (Simon & Johnson, 2015). Second, the elevated teacher mobility in underserved schools can divert administrator' attention away from managing the schools' instructional culture to hiring replacement teachers midyear. In other words, evidence of within-year turnover situates turnover as an ongoing management problem that teachers and school leaders must contend with at higher rates in these already challenging school environments.

Our analysis also uncovers important differences in the timing of teacher turnover. Female teachers are more likely to leave teaching midyear or temporarily exit and return, a difference that we attribute to differentially higher rates of exit for female teachers for child-rearing. Features of the teacher workforce—the uniform salary schedule and lack of wage penalty for exit and reentry—make teaching an appealing career for individuals who intend to take temporary leave for family considerations (Flyer & Rosen, 1997; Grissom & Reininger, 2012). The high degree of temporary exit and reentry is likely also attributable, in part, to Family and Medical Leave (FMLA) and other family benefits that have been found to increase job continuity, including higher rates of return to the same employer (Baker & Milligan, 2008;

Waldfoegel, Higuchi, & Abe, 1999). Future research would benefit from data that allowed researchers to identify the extent to which male and female teachers' use FMLA and its effect on their longer-term retention in the teacher workforce.

We also find important differences in regards to teacher entry pathways. While previous research has shown alternate entry teachers to turnover at higher rates than traditionally prepared teachers (Redding & Smith, 2016), we show that their higher turnover rates are confined to the end of the school year. More striking, we find TFA corps members to leave teaching at high rates at the end of the school year but to be highly stable during the school year. In comparison, beginning alternate entry and out-of-state prepared teachers leave teaching at the beginning of their careers, including during the school year (Redding & Henry, in press). Future research could leverage this finding to more precisely estimate the effect of different entry pathways on student achievement, taking the differential within- and end-of-year turnover rates and their effectiveness into consideration.

For veteran teachers eligible for retirement benefits, incentives could be introduced for these teachers who become eligible or partially eligible during the school year to discourage the high rates of within-year turnover among this group. Yet, even with evidence of a negative effect of within-year teacher turnover on student achievement (Henry & Redding, in press), this negative effect would have to be weighed against the cost of such an incentive. In one simulation study, Feng (2009) indicates that teachers would require an additional \$10,000 to remain in a school with above-average minority and low-income students. Further, it is possible that veteran teachers would still disengage for their last few months on the job given evidence that teacher productivity levels decline slightly after 28 years of experience (Ladd & Sorenson, 2017).

Lastly, we confirm previous findings about the relationship between teacher effectiveness

and turnover, with higher value-added and higher rated teachers less likely to turn over during and at the end of the school year. We extend this finding by showing that high-rated teachers are even less likely to turn over during the school than at the end of the year compared to the lowest rated teachers. The higher rates of within-year leaving of low-rated teacher may be a result of teacher- or administrator-initiated exits. However, this finding suggests that the timing of when teachers receive their performance evaluations may be consequential. Although administrators share signals of teachers' performance throughout the school year, summative evaluation scores that include value-added scores for many teachers—which are often not available until the subsequent school year (Goldring et al., 2015)—are related to both job satisfaction and retention (Adnot et al., 2017; Cullen et al., 2016; Koedel, Li, Springer, & Tan, 2017). The extent to which the delayed provision of performance ratings spurs within-year turnover is an important topic in understanding how recent changes in educator evaluation systems incentivize teacher turnover in ways that may be disadvantageous for students and if more timely release of evaluation scores may reduce within-year turnover.

References

- Allensworth, E., Ponisciak, S., & Mazzeo, C. (2009). *The schools teachers leave: Teacher mobility in Chicago Public Schools*. Chicago, IL: Consortium on Chicago School Research—University of Chicago.
- Baker, M. & Milligan, K. (2008). How does job-protected maternity leave affect mother's employment? *Journal of Labor Economics*, 26(4), 655-691.
- Borman, G. D., & Dowling, N. M. (2008). Teacher attrition and retention: A meta-analytic and narrative review of the research. *Review of Educational Research*, 78(3), 367–409.
- Boyd, D. Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J. (2008) *Who leaves? Teacher attrition and student achievement*. NBER Working Paper 14022, National Bureau of Economic Research.
- Feng, L. (2009). Opportunity wages, classroom characteristics, and teacher mobility. *Southern Economic Journal*, 75, 1165–1190.
- Flyer, F. & Rosen, S.(1997). The new economics of teachers and education. *Journal of Labor Economics*, 15(1), 104-139.
- Furgeson, J., Strauss, R. P., & Vogt, W. B. (2006). The effects of defined benefit pension incentives and working conditions on teacher retirement decisions. *Education Finance and Policy*, 1(3): 36–48.
- Goldhaber, D., Gross, B., & Player, D. (2011). Teacher career paths, teacher quality, and persistence in the classroom: Are public schools keeping their best? *Journal of Policy Analysis and Management*, 30(1), 57–87.
- Goldhaber, D. and Theobald, R. (2013). Managing the teacher workforce in austere times: The determinants and implications of teacher layoffs. *Education Finance and Policy*, 8(4),

494-527.

- Grissom, J. A., & Reininger, M. (2012). Who comes back? A longitudinal analysis of the re-entry behavior of exiting teachers. *Education Finance and Policy*, 7(4) 425-454.
- Guarino, C., Santibañez, L., & Daley, G. A. (2006). Teacher recruitment and retention: A review of the recent empirical literature. *Review of Educational Research*, 76, 173–208.
- Hanushek, E., Kain, J., & Rivkin, S. (2004). Why public schools lose teachers. *Journal of Human Resources*, 39, 326–254.
- Henry, G. T. & Redding, C. (in press). The consequences of leaving school early: The effects of within-year and end-of-year teacher turnover. *Education Finance and Policy*.
- Ingersoll, R. (2001). Teacher turnover and teacher shortages: An organizational analysis. *American Education Research Journal*, 38(3), 499–534.
- Ingersoll, R. M., Merrill, L., & Stuckey, D. (2014). *Seven trends: The transformation of the teaching force*. CPRE Research Report # RR-80. Philadelphia: Consortium for Policy Research in Education.
- Johnson, S. M., Birkeland, S. E. (2003). Pursuing a “sense of success”: New teachers explain their career decisions. *American Educational Research Journal*, 40(3), 581-617.
- Koedel, C., Podgursky, M., & Shi, S. (2013). Teacher pension systems, the composition of the teaching workforce, and teacher quality. *Journal of Public Analysis and Management*, 32(3), 574-596.
- Koski, W. S., & Horng, E. (2007). Facilitating the teacher quality gap? Collective bargaining agreements, teacher hiring and transfer rules, and teacher assignment among schools in California. *Education Finance and Policy*, 2(3), 262–300.

- Kraft, M. & Papay, J. P. (2014). Can professional environments in schools promote teacher development? Explaining heterogeneity in returns to teaching experience. *Educational Evaluation and Policy Analysis*, 36(4), 476-500.
- Ladd, H. F. (2011). Teachers' perceptions of their working conditions: How predictive of planned and actual teacher movement? *Educational Evaluation and Policy Analysis*, 33(2), 235–261.
- Ladd, H. F. & Sorenson, L. C. (2017). Returns to teacher experience: Student achievement and motivation in middle school. *Education Finance and Policy*, 12(2), 241-279.
- Lankford, H., Loeb, S. & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis*, 24(1), 37-62.
- Papay, J. P., Bacher-Hicks, A., Page, L. A., & Marinell, W. H. (2017). The challenge of teacher retention in urban schools: Evidence in variation from a cross-site analysis. *Educational Researcher*, 46(8), 434-448.
- Redding, C. & Henry, G. T. (in press). Leaving school early: An examination of novice teachers' within- and end-of-year turnover. *American Educational Research Journal*.
- Redding, C. & Smith, T.M. (2016). Easy in, easy out—Are alternatively certified teachers turning over at increased rates? *American Educational Research Journal*. 53(4), 1086-1125.
- Ronfeldt, M., Farmer, S. O., McQueen, K., & Grissom, J. A. (2015). Teacher collaboration in instructional teams and student achievement. *American Educational Research Journal*, 52(3), 475–514.
- Ronfeldt, M., Loeb, S., & Wyckoff, J. (2013). How teacher turnover harms student achievement. *American Educational Research Journal*, 50(1), 4-36.

- Schweig, J. (2013). Cross-level measurement invariance in school and classroom environment surveys: Implications for policy and practice. *Educational Evaluation and Policy Analysis, 36*(3), 259-280.
- Simon, N. S. & Johnson, S. M. (2015) Teacher turnover in high-poverty schools: What we know and can do. *Teachers College Record, 117*(3), 1-36.
- Smith, T. M., & Ingersoll, R. M. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal, 41*(3), 681–714.
- Stinebrickner, T. R. (1998). An empirical investigation of teacher attrition. *Economics of Education Review, 17*(2), 127-136.
- Waldfogel, J., Higuchi, Y., & Abe, M. (1999). Family leave policies and women's retention after childbirth: Evidence from the United States, Britain, and Japan. *Journal of Population Economics, 12*, 523-545.

Figure 1. Monthly Frequency of Within-Year Teacher Turnover

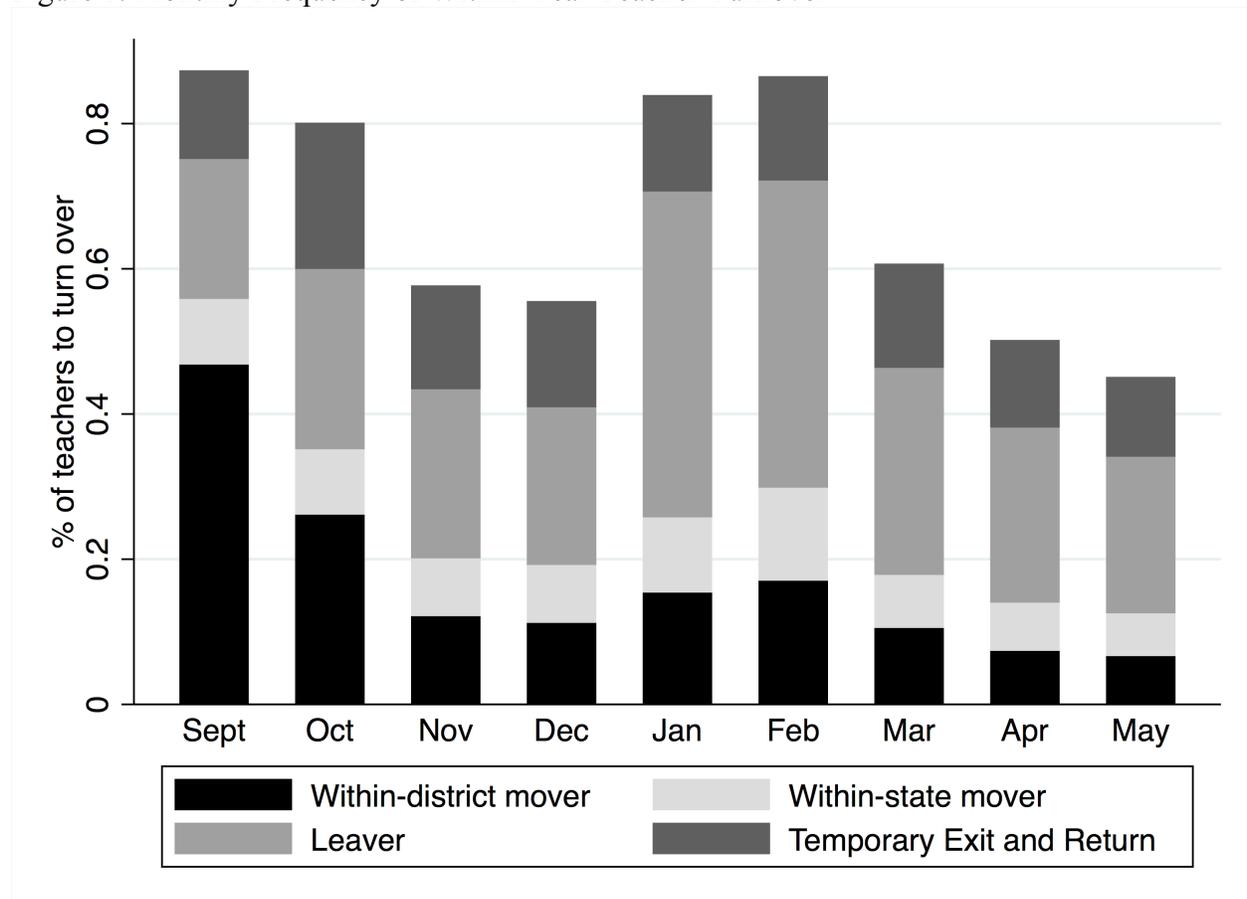


Table 1. Annual Rate of Teacher Turnover

	Overall	Within- year	End- of-year	October-to- October
Total				
Turnover	17.89	4.64	13.41	15.89
Mover	8.80	1.72	7.24	7.60
Leaver	8.29	2.12	6.17	8.29
Temporary Exit and Return	0.98	0.98		

Notes. Observations = 436,945

Table 2. Multinomial Logistic Regression Estimates of Within- and End-of-Year Teacher Turnover, Moving, and Leaving

	Within-year turnover	End-of-year turnover	Within-year mover	End-of-year mover	Within-year leaver	End-of-year leaver
Teacher Characteristics						
0-2 years experience	1.33*** (12.70)	1.73*** (39.92)	1.31*** (7.39)	1.60*** (26.98)	1.58*** (15.07)	1.95*** (33.67)
3-5 years experience	1.24*** (9.39)	1.35*** (20.82)	1.09* (2.22)	1.20*** (10.07)	1.42*** (11.10)	1.57*** (21.68)
11-20 years experience	0.61*** (-22.30)	0.71*** (-25.52)	0.73*** (-9.23)	0.76*** (-16.25)	0.62*** (-15.27)	0.64*** (-21.44)
20+ years experience	1.04 (1.84)	1.16*** (10.82)	0.70*** (-9.21)	0.62*** (-23.01)	1.55*** (15.43)	2.04*** (38.31)
Female	1.29*** (13.75)	1.06*** (4.83)	1.09** (2.95)	1.01 (0.56)	1.25*** (9.54)	1.09*** (5.47)
Black	1.08*** (3.35)	1.07*** (4.81)	1.30*** (7.95)	1.13*** (6.73)	0.92** (-2.92)	0.98 (-0.82)
Hispanic	1.15** (2.80)	1.18*** (4.96)	1.17 (1.84)	1.16*** (3.31)	1.10 (1.40)	1.20*** (4.18)
Other race	1.06 (1.43)	1.01 (0.29)	1.10 (1.35)	0.94 (-1.82)	1.03 (0.56)	1.10** (2.62)
Alternate entry	0.97 (-1.28)	1.17*** (11.18)	1.01 (0.20)	1.11*** (5.84)	0.94 (-1.95)	1.23*** (10.44)
Teach for America	0.83* (-2.05)	2.20*** (20.76)	0.45*** (-4.30)	0.77*** (-3.65)	1.20 (1.66)	4.74*** (35.42)
Out-of-state prepared	1.39*** (19.66)	1.35*** (28.91)	1.12*** (3.88)	1.10*** (6.73)	1.64*** (23.08)	1.69*** (37.98)
Other	1.05 (1.42)	1.13*** (5.82)	0.87* (-2.43)	0.92** (-2.93)	1.24*** (4.91)	1.42*** (13.03)
School Characteristics						
Underserved school index (std)	1.24*** (27.26)	1.21*** (36.77)	1.32*** (23.71)	1.29*** (38.23)	1.23*** (20.46)	1.12*** (15.88)
City	1.15*** (5.61)	1.07*** (4.39)	1.21*** (4.37)	1.08*** (3.49)	1.14*** (3.92)	1.07** (2.97)
Rural	1.02 (0.73)	1.05** (3.06)	1.11* (2.54)	1.11*** (5.06)	1.01 (0.33)	0.99 (-0.35)
Town	0.96 (-1.10)	1.01 (0.71)	1.00 (-0.01)	1.07** (2.69)	0.96 (-0.81)	0.95 (-1.68)
Middle school	2.14*** (35.84)	1.12*** (9.60)	2.15*** (21.50)	1.15*** (9.03)	2.64*** (34.24)	1.09*** (5.11)

High school	4.12*** (74.03)	1.13*** (12.66)	3.83*** (41.24)	1.11*** (8.11)	5.60*** (62.84)	1.14*** (9.71)
School Working Conditions						
Facilities and Resources (std)	1.00 (-0.29)	1.01 (1.76)	0.97 (-1.91)	1.02* (2.21)	1.02 (1.23)	1.00 (0.33)
Distributed leadership (std)	0.99 (-0.74)	0.98** (-2.88)	0.96 (-1.91)	0.97** (-2.73)	1.02 (0.88)	0.99 (-1.44)
Principal leadership (std)	0.96** (-3.28)	0.93*** (-10.11)	0.99 (-0.59)	0.90*** (-10.55)	0.93*** (-4.28)	0.95*** (-4.50)
Constant	0.02*** (-107.68)	0.10*** (-99.22)	0.01*** (-76.45)	0.07*** (-87.86)	0.00*** (-104.68)	0.03*** (-106.10)
Observations	452874	452874	408616	408616	408348	408348

Notes. Estimates reported as relative risk ratios. Model includes wave fixed effects. z-statistics reported in parentheses. * p<0.05; ** p<0.01; *** p<0.001. Wald tests were used to compare differences in the coefficients for within-year and end-of-year moving and within-year and end-of-year leaving. A bold coefficient signifies a difference of at least the 0.05 level between these two respective turnover categories.

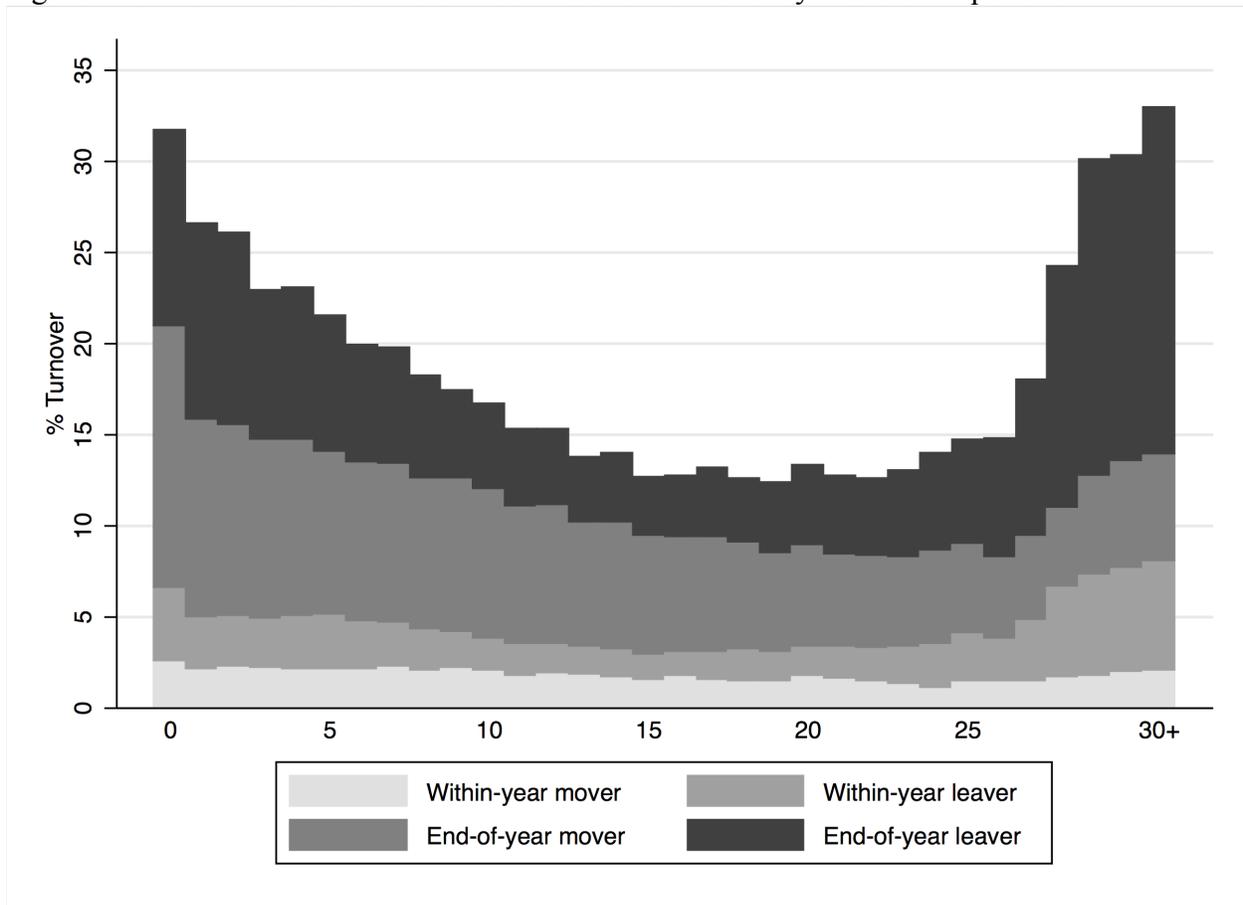
Table 3. Multinomial Logistic Regression Estimates of Within- and End-of-Year Teacher Turnover, Moving and Leaving, Controlling for Teacher Quality

Panel A. Teacher Quality and Turnover						
	Within- year turnover	End-of- year turnover	Within- year turnover	End-of- year turnover	Within- year turnover	End-of-year turnover
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher value-added (lag)	0.97* (-2.36)	0.98* (-2.21)				
Evaluation score = 3			0.58*** (-7.58)	0.72*** (-6.81)		
Evaluation score = 4			0.48*** (-10.10)	0.68*** (-7.77)		
Evaluation score = 5			0.48*** (-8.73)	0.75*** (-5.33)		
Average teacher test					0.99 (-1.14)	1.05*** (6.13)
Observations	27924	27924	182434	182434	388959	388959
Panel B. Teacher Quality and Moving						
	Within- year moving	End-of- year moving	Within- year moving	End-of- year moving	Within- year moving	End-of-year moving
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher value-added (lag)	1.00 (0.25)	1.00 (-0.33)				
Evaluation score = 3			0.77* (-2.06)	0.80*** (-3.59)		
Evaluation score = 4			0.74** (-3.13)	0.76*** (-4.30)		
Evaluation score = 5			0.83* (-1.98)	0.84* (-2.39)		
Average teacher test					1.00 (-0.16)	1.02 (1.55)
Observations	25256	25256	164022	164022	354346	354346
Panel C. Teacher Quality and Leaving						
	Within- year leaving	End-of- year leaving	Within- year leaving	End-of- year leaving	Within- year leaving	End-of-year leaving
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher value-added (lag)	0.94***	0.96***				

Evaluation score = 3	(-3.36)	(-3.32)	0.48***	0.66***		
			(-8.80)	(-6.46)		
Evaluation score = 4			0.38***	0.63***		
			(-11.22)	(-7.07)		
Evaluation score = 5			0.35***	0.68***		
			(-10.07)	(-5.42)		
Average teacher test					0.98	1.08***
					(-1.29)	(7.47)
Observations	25212	25212	165796	165796	351376	351376

Notes. Estimates reported as relative risk ratios. Model includes full controls and year fixed effects. Median evaluation score across 5 standards is compared to scores of 1 and 2. z-statistics reported in parentheses. * p<0.05; ** p<0.01; *** p<0.001. Wald tests were used to compare differences in the coefficients for within-year and end-of-year turnover. A bold coefficient signifies a difference of at least the 0.05 level between these two turnover categories.

Figure A1. Within-Year and End-of-Year Teacher Turnover by Years of Experience



Notes. 445,641 teacher-year observations.

Table A1. Description of Within- and End-of-Year Turnover Variables

1. Teachers are defined using object and purpose codes from the North Carolina Uniform Code of Accounts. These codes are used by North Carolina Department of Public Instruction to identify teachers in their own reporting of teacher turnover. Object codes include Teacher (121), JROTC Teacher (123), Foreign Exchange (VIF) (124), and re-employed retired teachers (128). Purpose codes include Regular Curricular Services (51), Special Populations Services (52), and Alternative Programs and Services (53). Object and purpose codes are linked to pay records.

2. Salary files are used to identify whether and where a teacher worked in a particular month. A long salary file was created by year to identify the school the teacher was employed in during each month of the school year. Summer months, when observed, were dropped from this file. Teachers who worked at multiple schools were dropped from this file. A teacher was defined as a within-year mover if the school identification number was different in two consecutive monthly observations. A teacher was defined as a within-year leaver if no future observations were observed for the duration of the school year.

3. To generate variables for end-of-year moving and leaving, monthly salary files for each year of the analysis were appended. A teacher was defined as an end-of-year mover if the school in which they were employed at the end of year t was different from the school in which they were first employed in year $t + 1$. A teacher was defined as an end-of-year leaver if the teacher was not observed in the data in the subsequent school year. Temporary exit and return (“returner”) was defined as someone who left their school for at least one month before returning to the same school. In cases where a within-year leaver was observed in the next school year, they were re-classified as a returner.

4. To ensure mutual exclusivity for the current analysis, mobility was defined as the first instance that occurred during the school year. For instance, a teacher who moved during the school year and again at the end of the school year was defined as a within-year mover.

Table A2. Covariates used in Regression Analysis

Teacher Characteristics	School Characteristics	School Working Conditions
Teaching experience	Student enrollment	Distributed leadership ($\alpha = 0.86 - 0.88$)
Female	School level	School leadership ($\alpha = 0.87 - 0.93$)
Race/Ethnicity	Elementary	Facilities and resources ($\alpha = 0.84 - 0.85$)
White	Middle	
Black	High	
Hispanic	Urbanicity	
Asian American Indian Multiracial	City	
Age	Suburb	
Entry Portal	Rural	
In-state, traditional	Town	
Alternate entry	% economically disadvantaged	
Teach For America	% Black students	
Out-of-State Prepared	% Hispanic students	
Other (Visiting International Faculty and unclassifiable)	% Other race/ethnicity	
	Teacher salary supplement (\$1000s)	

Note. α = Cronbach's alpha

Table A3. Conditional Means and Frequencies, by Turnover Status

	Stayer	Within-year mover	Within-year leaver	End-of-year mover	End-of-year leaver	Temporary Exit and Return
Teaching experience (years)	12.47	11.02	13.41	9.67	13.43	10.79
0-2 years experience	71.77	2.37	3.27	11.99	9.93	0.67
3-5 years experience	77.09	2.17	2.85	9.39	7.45	1.05
6-10 years experience	81.15	2.13	2.24	8.39	5.12	0.97
11-20 years experience	86.31	1.70	1.56	6.55	3.49	0.39
20+ years experience	78.40	1.66	3.78	5.15	10.44	0.56
Male	79.74	2.06	2.89	8.06	6.96	0.28
Female	79.79	1.80	2.74	7.93	7.03	0.72
White	80.50	1.67	2.73	7.55	6.93	0.62
Black	76.47	2.82	2.88	10.10	7.07	0.64
Hispanic	74.62	2.30	3.57	9.59	9.07	0.86
Other race	77.05	2.19	3.16	8.78	8.10	0.73
In-state, traditional preparation	81.86	1.80	2.26	7.63	5.79	0.66
Alternate entry	78.51	2.64	2.41	9.71	6.04	0.69
Teacher For America	55.37	1.37	3.64	8.69	30.62	0.31
Out-of-state prepared	78.02	1.89	3.28	7.64	8.41	0.76
Other	80.14	1.92	3.03	6.55	7.81	0.55
Age (years)	40.73	39.54	43.71	37.76	42.33	38.42
< 26 years old	73.22	2.04	2.17	12.64	9.50	0.43
26-30 years old	75.50	2.08	3.10	9.76	8.52	1.04
31-40 years old	81.40	2.02	2.26	8.37	5.13	0.82
41-50 years old	85.88	1.65	1.60	7.07	3.51	0.30
51-60 years old	80.39	1.63	3.59	5.70	8.21	0.48
60+ years of age	62.37	1.63	8.52	4.47	22.13	0.63
School size (100s)	7.91	7.75	8.05	7.39	7.89	7.88
City	77.91	2.14	3.08	8.34	7.78	0.75
Rural	80.91	1.85	2.43	7.79	6.41	0.61
Town	80.13	2.06	2.48	8.16	6.52	0.65
Suburb	82.34	1.75	2.25	6.71	6.14	0.81
Elementary school	80.87	1.68	2.21	7.88	6.60	0.76
Middle School	78.84	2.12	2.82	8.57	7.06	0.59
High School	76.83	2.98	4.41	7.81	7.16	0.81
Underserved school index (std)	-0.15	0.18	0.04	0.13	-0.01	-0.11
% economically disadvantaged	56.15	61.42	59.13	61.69	58.50	55.66
% White students	51.99	42.42	45.40	44.46	46.97	49.11
% Black students	26.46	34.93	31.93	32.90	30.72	28.47
% Hispanic students	13.64	14.86	14.62	14.83	14.40	14.53
% other race	7.91	7.79	8.05	7.81	7.91	7.88
Teacher salary supplement	3.35	3.44	3.49	3.34	3.46	3.58
Facilities and Resources (std)	-0.08	-0.24	-0.20	-0.19	-0.16	-0.12
Distributed leadership (std)	-0.13	-0.28	-0.24	-0.26	-0.22	-0.17
Principal leadership (std)	-0.14	-0.33	-0.30	-0.32	-0.25	-0.19

Table A4. Differences in Student Demographic Characteristics Between Schools from which Teachers Moved and their New School

	<u>Intradistrict Transfer</u>				<u>Out-of-District Intrastate Mover</u>			
	Within-Year		End-of-Year		Within-Year		End-of-Year	
	Original	New	Original	New	Original	New	Original	New
% Minority Students	52.7	52.5	53.9	52.7	52.9	52.6	54.2	53.0
% Economically Disadvantaged Students	56.4	56.4	59.2	58.9	58.3	58.5	60.2	58.9

Notes. Restricted to teachers who move schools. Observations = 40,403.

Table A5. Percent of Teachers to Turnover by Retirement Eligibility (Teaching Experience 20+ years)

	Stayer	Within- year mover	Within- year leaver	End- of- year mover	End- of- year leaver	Temporary Exit and Return
Not eligible for retirement benefits	85.86	1.40	2.27	5.00	5.16	0.30
Eligible for full/partial retirement benefits	71.73	1.99	5.19	5.32	14.97	0.53

Notes. Restricted to teachers with over 20 years of experience. Observations = 130,144.

Table A6. Multinomial Logistic Regression Estimates of Within-and End-of-Year Teacher Turnover for Veteran Teachers (Teaching Experience 20+ years)

	Turnover vs. Staying		Moving vs. Staying		Leaving vs. Staying	
	Within-	End-of-	Within-	End-of-	Within-	End-of-
	year	year	year	year	year	year
	(1)	(2)	(3)	(4)	(5)	(6)
Years of teaching experience	1.03*** (6.63)	1.03*** (12.65)	1.00 (0.61)	1.00 (0.50)	1.03*** (6.13)	1.05*** (14.69)
Eligible for either full/partial retirement benefits	2.25*** (17.68)	2.38*** (30.74)	1.35** (3.45)	1.21*** (4.05)	2.81*** (18.95)	3.45*** (35.44)
Observations	102714	102714	88858	88858	95995	95995

Notes. Sample restricted to teachers with 20 years or more of teaching experience. Estimates reported as relative risk ratios. Models include controls for teacher and school characteristics and year fixed effects. *z*-statistics reported in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Notes. Observations = 445,641. Conditional means presented for continuous variables. Conditional frequencies presented for categorical and binary variables.

Table A7. Multinomial Logistic Regression Estimates of Gender and Age Differences for Within- and End-of-Year Teacher Turnover, Moving, Leaving, and Temporary Exit and Return

	Within-year mover	End-of-year mover	Within-year leaver	End-of-year leaver	Temporary Exit and Return
	(1)	(2)	(3)	(4)	(5)
Teacher Characteristics					
Female	1.13*	1.07*	1.16*	0.97	1.46*
	(1.98)	(2.16)	(2.46)	(-0.65)	(2.41)
< 26 years old	0.83	1.32***	0.60***	1.52***	0.61
	(-1.71)	(5.37)	(-5.02)	(7.08)	(-1.51)
26-30 years old	1.08	1.11*	0.84*	1.51***	0.62*
	(0.87)	(2.34)	(-2.16)	(7.98)	(-2.00)
31-40 years old	1.12	1.16***	1.10	1.36***	0.61*
	(1.55)	(4.06)	(1.41)	(6.41)	(-2.31)
51-60 years old	1.05	0.98	2.36***	1.77***	1.77**
	(0.56)	(-0.33)	(12.54)	(11.73)	(2.96)
60+ years of age	1.46**	0.95	6.54***	6.05***	5.40***
	(2.91)	(-0.58)	(24.25)	(32.49)	(7.73)
Female * < 26 years old	1.08	0.91	0.90	0.86*	1.84
	(0.65)	(-1.84)	(-1.03)	(-2.50)	(1.86)
Female * 26-30 years old	0.92	0.98	1.45***	1.13*	4.43***
	(-0.91)	(-0.49)	(4.36)	(2.19)	(6.04)
Female * 31-40 years old	1.01	0.91*	1.21*	1.07	4.43***
	(0.08)	(-2.35)	(2.41)	(1.35)	(6.68)
Female * 51-60 years old	0.99	0.95	1.02	1.39***	0.92
	(-0.10)	(-0.98)	(0.25)	(6.09)	(-0.38)
Female * 60+ years old	0.84	1.05	1.01	1.31***	0.64
	(-1.15)	(0.51)	(0.16)	(4.39)	(-1.81)
0-2 years experience	1.43***	1.46***	2.42***	2.04***	1.02
	(7.86)	(16.88)	(25.51)	(28.83)	(0.22)
3-5 years experience	1.10*	1.17***	1.56***	1.52***	1.04
	(2.31)	(7.94)	(13.18)	(18.39)	(0.69)
11-20 years experience	0.78***	0.79***	0.57***	0.60***	0.47***
	(-7.13)	(-13.02)	(-17.76)	(-22.76)	(-12.56)
20+ years experience	0.80***	0.69***	0.90**	1.19***	0.68***
	(-4.69)	(-14.76)	(-3.02)	(7.09)	(-4.96)
Black	1.31***	1.13***	0.90***	0.98	1.05
	(8.03)	(7.10)	(-3.66)	(-1.15)	(0.75)
Hispanic	1.16	1.17***	1.10	1.27***	1.33*
	(1.69)	(3.59)	(1.45)	(5.32)	(2.17)

Other race	1.08 (1.07)	0.94 (-1.72)	1.03 (0.47)	1.12** (3.09)	1.12 (1.02)
Alternate entry	0.98 (-0.50)	1.11*** (6.12)	0.87*** (-4.52)	1.22*** (9.86)	0.92 (-1.33)
Teach for America	0.48*** (-3.94)	0.72*** (-4.50)	1.61*** (4.26)	4.90*** (35.27)	0.71 (-0.91)
Out-of-state prepared	1.10** (3.25)	1.10*** (6.56)	1.46*** (17.60)	1.57*** (31.78)	1.18*** (3.58)
Other	0.86** (-2.60)	0.93* (-2.30)	1.21*** (4.40)	1.51*** (14.88)	0.86 (-1.46)
School Characteristics					
Underserved schools index (std)	1.32*** (23.53)	1.29*** (38.62)	1.20*** (17.97)	1.10*** (12.97)	1.00 (-0.12)
City	1.20*** (4.28)	1.07** (3.21)	1.15*** (4.00)	1.06* (2.45)	1.10 (1.41)
Rural	1.11* (2.55)	1.10*** (4.83)	1.04 (1.01)	1.01 (0.29)	0.88* (-1.99)
Town	1.01 (0.11)	1.07* (2.57)	0.98 (-0.52)	0.96 (-1.37)	0.93 (-0.82)
Middle school	2.11*** (21.19)	1.15*** (9.16)	2.50*** (32.80)	1.08*** (4.44)	1.13* (2.13)
High school	3.80*** (41.49)	1.12*** (8.52)	5.34*** (62.23)	1.11*** (7.78)	1.88*** (14.29)
School Working Conditions					
Facilities and Resources (std)	0.97 (-1.81)	1.02* (2.13)	1.02 (1.76)	1.01 (0.98)	0.99 (-0.30)
Distributed leadership (std)	0.96* (-2.01)	0.97** (-2.71)	1.01 (0.58)	0.98 (-1.87)	0.98 (-0.49)
Principal leadership (std)	0.99 (-0.54)	0.90*** (-10.29)	0.93*** (-4.63)	0.95*** (-4.68)	0.99 (-0.40)
Constant	0.01*** (-59.17)	0.07*** (-67.01)	0.00*** (-76.15)	0.03*** (-75.76)	0.00*** (-33.80)

Notes. n = 451,493. Estimates reported as relative risk ratios. Models in reference to stayers. Model includes wave fixed effects. z-statistics reported in parentheses. * p<0.05; ** p<0.01; *** p<0.001.

Table A8. Multinomial Logistic Regression Estimates of Within- and End-of-Year Teacher Turnover, Moving, and Leaving

	Turnover vs. Staying		Moving vs. Staying		Leaving vs. Staying	
	Within-	End-of-	Within-	End-of-	Within-	End-of-
	year	year	year	year	year	year
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher Characteristics						
0-2 years experience	1.32*** (12.35)	1.72*** (39.45)	1.29*** (7.03)	1.58*** (26.54)	1.57*** (14.83)	1.94*** (33.31)
3-5 years experience	1.24*** (9.20)	1.35*** (20.55)	1.08* (2.03)	1.20*** (9.81)	1.42*** (10.96)	1.57*** (21.52)
11-20 years experience	0.62*** (-21.89)	0.71*** (-25.34)	0.74*** (-8.87)	0.76*** (-16.05)	0.63*** (-14.98)	0.64*** (-21.35)
20+ years experience	1.05* (2.24)	1.17*** (10.95)	0.70*** (-9.01)	0.62*** (-22.98)	1.56*** (15.73)	2.04*** (38.39)
Female	1.20*** (9.78)	1.03** (2.65)	1.00 (0.01)	0.97 (-1.87)	1.16*** (6.40)	1.08*** (4.77)
Black	1.00 (0.10)	1.02 (1.33)	1.19*** (5.09)	1.07*** (3.59)	0.85*** (-5.21)	0.94** (-3.04)
Hispanic	1.10 (1.83)	1.15*** (4.29)	1.09 (1.01)	1.13** (2.66)	1.05 (0.75)	1.18*** (3.81)
Other race	1.02 (0.52)	1.02 (0.84)	1.06 (0.82)	0.96 (-1.24)	0.97 (-0.56)	1.11** (2.80)
Alternate entry	1.00 (0.05)	1.18*** (11.82)	1.04 (1.18)	1.12*** (6.70)	0.97 (-0.99)	1.23*** (10.48)
Teach for America	0.78** (-2.60)	2.08*** (19.48)	0.42*** (-4.71)	0.72*** (-4.48)	1.14 (1.21)	4.47*** (34.12)
Out-of-state prepared	1.38*** (18.80)	1.34*** (27.74)	1.09** (3.17)	1.09*** (5.87)	1.63*** (22.66)	1.68*** (37.09)
Other	1.05 (1.51)	1.13*** (5.67)	0.87* (-2.42)	0.91** (-3.08)	1.24*** (4.94)	1.42*** (12.86)
School Characteristics						
School size (100s)	0.95*** (-25.35)	0.97*** (-20.72)	0.95*** (-16.43)	0.96*** (-20.89)	0.95*** (-19.09)	0.98*** (-8.89)
City	1.02 (0.81)	0.99 (-0.37)	1.01 (0.17)	0.99 (-0.62)	1.05 (1.40)	1.00 (-0.04)
Rural	1.01 (0.45)	1.01 (0.94)	1.11* (2.47)	1.07** (3.20)	0.98 (-0.46)	0.96 (-1.82)
Town	0.95 (-1.63)	0.98 (-0.95)	0.99 (-0.24)	1.03 (1.19)	0.93 (-1.59)	0.92** (-2.80)

Middle school	2.20*** (37.70)	1.15*** (12.05)	2.23*** (23.23)	1.20*** (11.95)	2.67*** (35.38)	1.10*** (5.89)
High school	4.69*** (80.24)	1.22*** (18.94)	4.47*** (46.68)	1.24*** (15.56)	6.25*** (67.20)	1.18*** (11.31)
% economically disadvantaged	1.00 (-0.16)	1.00** (-2.83)	1.00 (1.77)	1.00 (-0.51)	1.00 (-0.14)	1.00*** (-4.02)
% Black students	1.01*** (17.82)	1.01*** (27.37)	1.01*** (14.11)	1.01*** (25.02)	1.01*** (13.02)	1.01*** (15.85)
% Hispanic students	1.01*** (10.42)	1.00*** (9.68)	1.01*** (8.65)	1.01*** (9.80)	1.01*** (6.51)	1.00*** (4.73)
% Other race students	1.01*** (8.25)	1.00*** (3.42)	1.01*** (4.95)	1.00*** (3.97)	1.01*** (8.11)	1.00 (1.26)
Teacher salary supplement	1.03*** (5.71)	0.99* (-2.17)	1.06*** (6.04)	1.00 (-1.03)	1.01 (1.32)	0.99** (-2.60)
School Working Conditions						
Facilities and Resources (std)	0.98* (-2.46)	1.00 (0.69)	0.95*** (-3.43)	1.01 (0.95)	0.99 (-0.55)	1.00 (0.05)
Distributed leadership (std)	0.98 (-1.83)	0.97*** (-3.43)	0.95** (-2.60)	0.97*** (-3.36)	1.00 (0.23)	0.98 (-1.55)
Principal leadership (std)	0.94*** (-4.74)	0.92*** (-11.39)	0.98 (-1.24)	0.89*** (-11.88)	0.91*** (-5.65)	0.95*** (-4.97)
Constant	0.01*** (-81.07)	0.10*** (-71.24)	0.01*** (-59.64)	0.07*** (-63.73)	0.00*** (-78.73)	0.04*** (-75.42)
Observations	452861	452861	408604	408604	408341	408341

Notes. n = 452,861. Estimates reported as relative risk ratios. Model includes year fixed effects. *t*-statistics reported in parentheses. * p<0.05; ** p<0.01; *** p<0.001. Wald tests were used to compare differences in the coefficients for within-year and end-of-year moving and within-year and end-of-year leaving. A bold coefficient signifies a difference of at least the 0.05 level between these two respective turnover categories.

Table A9. Multinomial Logistic Regression Estimates of Within- and End-of-Year Turnover, by School Level

	Within- year turnover	End-of- year turnover	Within- year turnover	End-of- year turnover	Within- year turnover	End-of- year turnover
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher Characteristics						
0-2 years experience	1.37*** (9.55)	1.70*** (27.80)	1.34*** (5.87)	1.70*** (27.80)	1.37*** (11.09)	1.75*** (27.09)
3-5 years experience	1.32*** (8.60)	1.34*** (14.82)	1.25*** (4.31)	1.34*** (14.82)	1.24*** (7.53)	1.29*** (11.37)
11-20 years experience	0.60*** (-16.31)	0.70*** (-19.15)	0.63*** (-9.39)	0.70*** (-19.15)	0.63*** (-17.28)	0.73*** (-15.72)
20+ years experience	1.04 (1.20)	1.27*** (12.54)	1.03 (0.54)	1.27*** (12.54)	1.10*** (3.46)	1.17*** (7.75)
Female	0.87*** (-3.38)	0.90*** (-4.84)	0.98 (-0.43)	0.90*** (-4.84)	1.27*** (11.06)	1.09*** (5.66)
Black	1.06 (1.63)	1.05** (2.63)	0.99 (-0.31)	1.05** (2.63)	1.12*** (4.31)	1.12*** (5.93)
Hispanic	1.09 (1.04)	1.29*** (5.77)	1.21 (1.52)	1.29*** (5.77)	1.09 (1.44)	1.13** (2.60)
Other race	1.01 (0.11)	0.99 (-0.26)	1.09 (0.85)	0.99 (-0.26)	1.05 (1.00)	1.05 (1.29)
Alternate entry	1.09* (2.09)	1.20*** (7.57)	1.17*** (3.36)	1.20*** (7.57)	0.91*** (-3.52)	1.15*** (7.56)
Teach for America	0.97 (-0.15)	2.45*** (13.24)	0.91 (-0.51)	2.45*** (13.24)	0.87 (-1.26)	2.11*** (13.24)
Out-of-state prepared	1.36*** (13.33)	1.36*** (22.46)	1.40*** (8.75)	1.36*** (22.46)	1.37*** (14.89)	1.32*** (17.54)
Other	1.01 (0.20)	1.23*** (7.11)	1.31** (3.10)	1.23*** (7.11)	1.01 (0.35)	0.97 (-0.90)
School Characteristics						
Underserved school index (std)	1.16*** (11.56)	1.19*** (22.96)	1.27*** (11.32)	1.28*** (19.73)	1.19*** (19.10)	1.18*** (23.30)
City	1.11** (2.89)	1.05* (2.11)	1.31*** (4.62)	1.12*** (3.35)	1.09** (2.89)	1.05* (2.01)
Rural	0.94 (-1.71)	1.00 (0.17)	1.14* (2.29)	1.08* (2.37)	0.99 (-0.35)	1.03 (1.27)
Town	0.91 (-1.94)	1.01 (0.50)	1.16* (1.96)	1.06 (1.30)	0.92* (-2.04)	0.97 (-0.88)
School Working Conditions						

Facilities and Resources (std)	0.96** (-2.76)	1.03** (3.12)	0.92*** (-3.82)	0.99 (-0.96)	1.02 (1.86)	1.01 (0.68)
Distributed leadership (std)	1.01 (0.39)	0.97* (-2.56)	0.99 (-0.29)	1.02 (1.21)	0.99 (-0.58)	0.97** (-2.93)
Principal leadership (std)	0.91*** (-5.15)	0.91*** (-9.48)	0.93** (-2.66)	0.92*** (-5.02)	0.96** (-2.69)	0.95*** (-4.74)
Constant	0.03*** (-61.23)	0.12*** (-63.45)	0.02*** (-48.24)	0.12*** (-46.34)	0.07*** (-64.81)	0.12*** (-66.94)
Elementary	x	x				
Middle			x	x		
High					x	x
Observations	238989	238989	91565	91565	205386	205386

Notes. n = 453034. Estimates reported as relative risk ratios. Models in reference to stayers. Model includes wave fixed effects. z-statistics reported in parentheses. * p<0.05; ** p<0.01; *** p<0.001.