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Inconvenient Truth? Do Collective Bargaining Agreements Help Explain the Mobility of Teachers Within School Districts?

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Contents

Acknowledgements....ii

Abstract....iii

I. Introduction....1

II. Background....4

III. Theoretical Framework and Hypotheses....7

IV. Data....13

V. Analytic Models....18

VI. Primary Results....21

VII. Simulation study....27

VIII. Mobility, by Teacher Effectiveness....31

IX. Extensions and Falsification Tests....34

X. Conclusions....38

References....41

Tables....45

Figures....52

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Abstract

We investigate patterns of teacher mobility in districts with different collective bargaining agreement (CBA) transfer provisions. We use detailed teacher-level longitudinal data from Washington State to estimate the probability that teachers of varying experience and effectiveness levels transfer out of their schools to other schools in the district, to other districts, or out of Washington kindergarten through 12th grade (K–12) public schools. We find consistent evidence that within-district transfer probabilities increase for veteran teachers with the proportion of disadvantaged students in a school but decrease for novice teachers with the proportion of disadvantaged students, and that the strength of these relationships is associated with the strength of seniority transfer provisions in CBAs. Specifically, the pattern of veteran teachers' leaving disadvantaged schools and novice teachers' staying in disadvantaged schools is more pronounced in districts with strong CBA seniority transfer protections. CBA transfer provisions do not, however, appear to be an important factor in teacher transfers out of school districts or the K–12 public school workforce in Washington. Finally, we find some evidence that more effective teachers are more likely to stay in advantaged schools when seniority is not a factor in transfer decisions.

I. Introduction

Over the past decade, federal, state, and district policy makers have experimented with a variety of interventions aimed at addressing concerns about the inequitable distribution of teacher talent in U.S. public schools.[1] Considerable evidence suggests that, despite such efforts, teachers throughout the United States remain inequitably distributed across student subgroups (racial, income, and achievement categorizations) by experience, qualifications, and value-added measures of performance.[2] Washington State, the setting of this study, is no exception. Disadvantaged (eligible for free or reduced-price lunch [FRL], underrepresented minority [URM], or low-performing) students are far more likely to be taught by novice and less qualified teachers than are other students in the state.[3]

There is a good deal of speculation (e.g., Snell, 2014) and some empirical evidence (discussed below) that transfer protections in teacher collective bargaining agreements (CBAs) contribute to inequities in the distribution of teachers by influencing patterns in within-district teacher transfers.[4] Many districts—including about 70% of the largest districts in the country (National Council on Teacher Quality (NCTQ, 2014)[5]—have teacher CBAs with provisions that protect senior teachers from involuntary transfers and grant senior teachers advantages over junior teachers when it comes to obtaining a job in

[1] For instance, the federal government helps college students planning to teach in high-need fields in low-income areas to finance their educations (Federal Student Aid, June 11, 2014: https://studentaid.ed.gov/types/grants-scholarships/teach), and various states and localities have offered pay differentials for teachers wiling to serve in disadvantaged schools (Clotfelter et al., 2004; Guarino et al., 2006).

[2] See, for instance, Clotfelter et al. (2005, 2007), Kalogrides and Loeb (2013), Kalogrides et al. (2013), Lankford et al. (2002) on the distribution of teacher experience and qualifications, and Isenberg et al. (2013) and Sass et al. (2010) on the distribution of value added.

[3] In a related paper (Goldhaber et al., 2014), we demonstrate that, in Washington State, teacher quality (measured in a variety of ways) is inequitably distributed across a variety of indicators of student disadvantage.

[4] Collective bargaining provisions have recently been under the policy microscope. The issues over which districts in several midwestern states are allowed to bargain was recently limited (Greenhouse, 2011), and in Washington State, the setting for this study, seniority transfer provisions became a key point of contention in a teachers' strike in the Tacoma School District (Murphy, 2011). Seniority layoff provisions were also a major factor in a recent high-profile court case in Los Angeles (*Vergara v. California*, 2014).

[5] About 25% of districts in the NCTQ database use seniority as the *only* factor in these decisions (National Council on Teacher Quality, 2014).

another district school that has an opening. To the extent that more senior teachers choose to teach more advantaged students, these seniority transfer protections may help these teachers move out of less desirable schools (as identified by student poverty or minority composition) and stay in more choice placements, and may therefore contribute to the inequitable distribution of teacher experience within school districts.

Policy debates have spurred and been spurred by a flurry of recent research about collective bargaining and the distribution of teacher quality. Some empirical evidence in Moe (2005) and Anzia and Moe (2014a) suggests that teacher transfer provisions in CBAs influence the inequitable sorting of teachers. But these findings are far from conclusive as other recent studies (Cohen-Vogel et al., 2013; Koski & Horng, 2007) find little relationship between seniority transfer protections and the extent of the teacher experience gap between more and less disadvantaged schools.[6] One reason that it is so difficult to know what to make of these conflicting findings is that, while these authors carefully investigate the potential *consequences* of a mechanism (within-district teacher transfers), none of these authors scrutinize the mechanism itself. That is, the static school-level distributions of teacher experience modeled in the existing empirical literature may partially be a function of within-district transfers but may also be influenced by patterns of teacher hiring, attrition, layoffs, and transfers into and out of the district. Therefore, it is not clear whether the findings in the existing literature—significant or otherwise—are capturing the influence of CBA transfer provisions or of other confounding factors.

With this in mind, we use longitudinal data on all teachers from Washington State to investigate the only outcome that CBA transfer provisions would be expected to influence directly: within-district teacher transfers. Specifically, we estimate teacher-level logistic regression models predicting within-

[6] One argument for this nonfinding, supported by anecdotal evidence in California, is that "the text of the transfer rules in CBAs does not matter—all school districts may simply honor the assignment preferences of teachers with seniority because the professional culture and practice in California rewards senior teachers with the teaching assignment of their choice" (Koski & Horng, 2007). Stated another way, school district administrators fail to exercise the discretion that they may have (Hess & Kelly, 2006).

district teacher transfer decisions as a function of teacher, school, and district characteristics. We observe very different mobility patterns for teachers of different experience levels. All else being equal, the probability that a novice teacher will transfer from one school to another school in a district *decreases* as the percentage of economically disadvantaged and/or URM[7] students in the school increases, while the same probability *increases* for a veteran teacher.

To determine whether these patterns of teacher mobility vary in districts with different CBA teacher transfer protections, we estimate models that allow the relationship between the percentage of economically disadvantaged or URM students in a teacher's school and the probability that a teacher will transfer to another school in the district to vary between districts with different CBA transfer protections. We find consistent evidence that differences in mobility patterns by teacher experience vary depending on the CBA transfer provisions that govern such moves. In particular, the interaction between teacher experience and school disadvantage in teacher transfer decisions is *more extreme* in districts with strong seniority transfer protections; novice teachers are *even more likely* to stay in disadvantaged schools, and veteran teachers are *even more likely* to leave disadvantaged schools. These findings are robust to the measure of student disadvantage we use (URM or FRL) and to different specifications of our teacher transfer model,[8] and thus provide preliminary but compelling evidence that seniority transfer provisions in CBAs matter in terms of the movement of teachers within districts.

This paper proceeds as follows. Section II includes a review and critique of prior work on CBA seniority transfer protections and teacher mobility. In section III, we outline our theoretical framework and hypotheses. We describe our data in section IV, present empirical models and primary results in sections V and VI, and discuss a simulation study in section VII. We then explore patterns in teacher mobility by estimated effectiveness, rather than experience, in section VIII, investigate a number of

[7] We define underrepresented minority as Black, Hispanic, or American Indian.
[8] We describe all specifications in greater details in section V.

extensions and falsification tests in section IX, and offer some policy implications and conclusions in section X.

II. Background

Teacher CBAs regulate school district policies on issues from teacher hiring and transfers, association rights, and workload to evaluation, grievance, benefits and leave, and layoffs and recall.[9] There is a large body of literature that documents the considerable variation in the language of CBAs and describes the potential consequences of collective bargaining for school and district finances, staffing, and operations.[10]

Four recent papers (Anzia & Moe, 2014a; Cohen-Vogel et al., 2013; Koski & Horng, 2007; Moe, 2005) have investigated the potential influence of seniority transfer protections on the distribution of teacher experience within school districts. We discuss these papers as a group because their analytic approaches are quite similar. In each paper, the authors estimate some variant of a model that predicts the percentage of experienced teachers in a school (e.g., the percentage of teachers with 2 or more years of experience) as a function of four school characteristics: enrollment, growth, average class size, and percentage of disadvantaged students (i.e., minority or eligible for FRL).[11] Each paper finds that, independent of seniority transfer provisions and controlling for variability across districts and the other three school-level variables, the percentage of experienced teachers in a school decreases as the percentage of disadvantaged students in the school increases.

[9] In many states, CBAs also regulate teacher salaries, but almost all districts in Washington use the state's salary schedule.

[10] For a review of these issues, see Goldhaber (2006), Hannaway and Rotherham (2006), Hess and Kelly (2006), Riley et al. (2002), Strunk (2011), and Strunk and Grissom (2010).

[11] The model these authors estimate also includes a district effect—either a fixed effect within an ordinary least squares (OLS) model (Anzia & Moe, 2014a; Cohen-Vogel, 2013; Moe, 2005) or a random effect within a Hierarchical Linear Model (Anzia & Moe, 2014a; Cohen-Vogel, 2013; Koski & Horng, 2007)—that controls for variability in teacher experience across districts.

To quantify seniority transfer provisions, each set of authors creates a district-level CBA-based index that increases as the number and strength of the seniority transfer protections in a district's CBA increase,[12] and estimates models that include interactions between this district-level index and the four school-level variables (enrollment, growth, average class size, and percentage of disadvantaged students). This allows them to estimate how the relationship between each school variable and the percentage of experienced teachers in the school *changes* as the strength of the seniority transfer protections in a district's CBA increases. Moe (2005) and Anzia and Moe (2014a) find that the interaction between the seniority transfer index and the percentage of disadvantaged students in a school is statistically significant and negative; that is, the relationship between the percentage of disadvantaged students in a school and the percentage of experienced teachers in a school becomes *more negative* as the strength of the seniority transfer provisions in a district's contract increases. On the other hand, Koski and Horng (2007) and Cohen-Vogel et al. (2013) do not find evidence of such a relationship.

These mixed findings could be the result of different study settings (California or Florida), different estimation strategies (discussed extensively in Anzia & Moe, 2014a), different CBA coding indexes (see footnote 12), or just sampling error. However, both sets of authors interpret their findings (or lack thereof) quite broadly. For example, Anzia and Moe (2014a) conclude that "seniority-based transfer rules do have consequences for the distribution of teachers and for the plight of disadvantaged schools," while Koski and Horng (2007) reach a very different conclusion: "Merely changing the language of the rules of teacher assignment in CBAs will do little to close the teacher quality gap."[13]

[12] The specific coding varies across papers, but the index in each paper is designed to quantify the extent to which seniority plays a role in both voluntary and involuntary teacher transfer provisions, defined below, in each district's contract. The indexes in Moe (2005) and Anzia and Moe (2014a) are solely the function of the role of seniority in voluntary and involuntary transfer provisions. The indexes in Koski and Horng (2007) and Cohen-Vogel et al. (2013) also include information about consideration of outside applicants versus inside applicants and long-term leave policies.

[13] This debate recently continued in a published response to Anzia and Moe (2014a) by Koski and Horng (2014), and a response to Koski and Horng's response by Anzia and Moe (2014b).

Our view is that the evidence from this emerging literature does not yet justify such broad conclusions. The implied assumption underlying these conclusions is that, if the negative relationship between the percentage of disadvantaged students in a school and the percentage of experienced teachers in a school is more extreme in districts with CBA seniority transfer protections, then seniority transfer protections must be *causing* this inequity (or alternatively, that seniority transfer protections have no effect if this relationship does not exist). This assumption is problematic for several reasons. First, the distribution of teacher experience in a district is a function of many factors—patterns of teacher hiring, attrition, layoffs, transfers into and out of the district, and so forth—that are not accounted for in any of the models described above.[14] Second, while it is true that seniority transfer protections in CBAs may have an indirect effect on the distribution of teacher experience in a district, this indirect effect should operate primarily through the influence of seniority transfer protections on within-district teacher transfers.[15] In the absence of evidence connecting seniority transfer protections to the only process they are designed to influence—within-district teacher transfers—it is a leap to conclude that these protections have an effect on the overall distribution of teacher experience in a district.

With these considerations in mind, we ground our analysis in the literature on teacher mobility (e.g., Goldhaber et al., 2010; Hanushek et al., 2004; Scafidi et al., 2007), which has demonstrated that teachers are far more likely to leave disadvantaged schools, particularly schools with a high percentage of minority students. Our contribution to this literature is to investigate the role that seniority transfer protections in CBAs play in this process. Specifically, we ask whether teachers (and particularly

[14] For example, if districts with strong seniority transfer provisions are also more likely to hire novice teachers into disadvantaged schools than districts that do not use seniority in transfer decisions, then the distribution of teacher experience will be more inequitable in districts with strong seniority transfer provisions even if these provisions have *no effect* on teacher transfer decisions.

[15] As we discuss in section VII, there are also reasons to believe that CBA transfer provisions could have an indirect effect on teacher attrition from the district or teaching profession if (for example) teachers view transfer provisions as restricting their in-district job options.

experienced teachers) are *even more likely* to transfer from disadvantaged schools in districts with CBAs containing strong seniority transfer protections than are comparable teachers in districts without such strong protections. There is currently no empirical evidence on this topic, which is surprising, given the prominent battles over these provisions in districts across the country (see Moe, 2011) and concern in policy circles that seniority transfer provisions undermine the ability of disadvantaged schools to retain highly qualified teachers (Levin et al., 2005). Moreover, recent evidence (Barnes et al., 2014; Hanushek & Rivkin, 2013; Ronfeldt et al., 2013) suggests the "churn" (i.e., within-district mobility) of teachers within and across school districts creates "disruption costs" to student learning that are independent of the quality of the incoming and outgoing teachers. This implies that seniority transfer provisions could have ramifications beyond the distribution of teacher experience within districts.

III. Theoretical Framework and Hypotheses

Before discussing our data and analytic models, we first present our theoretical expectations of the relationships between CBA transfer provisions and within-district teacher mobility. These relationships can be captured by interactions among three variables: the level of disadvantage in a teacher's school, the teacher's experience level, and the transfer provisions in the district's CBA.[16] Because the nature of the relationships among these variables is complex, we have set up a conceptual model to clarify our expectations about how seniority transfer provisions might differentially influence the mobility of teachers with different levels of seniority at schools serving different types of students.

Before introducing the specifics of our conceptual model, we draw attention to another important factor that distinguishes our study from existing empirical work on CBA transfer provisions (Anzia & Moe, 2014a; Cohen-Vogel et al., 2013; Koski and Horng, 2007; Moe, 2005). Here and

[16] In this section, we ignore other variables that influence teacher transfer decisions but introduce these when describing our empirical strategy.

throughout the paper, we separately consider the CBA provisions that govern voluntary and involuntary transfers. We view this distinction as essential because voluntary and involuntary provisions inform different personnel decisions. Voluntary transfer provisions are important when there is an open teaching position and more than one teacher from the district wants to voluntarily transfer into the position. In districts with CBAs that identify seniority as the only factor in voluntary teacher transfer decisions, for example, the teacher with the *most* seniority who wants to transfer into a position gets priority.[17] Involuntary transfer protections, on the other hand, are important when a position must be moved to another school.[18] In districts with CBAs that identify seniority as the only factor in involuntary teacher transfer decisions, the teacher with the *least* seniority is selected to be involuntarily transferred if more senior teachers elect not to move. Below we describe a conceptual model of *voluntary* transfers in terms of *teacher* preferences.[19]

We define p_{ijkt} as the probability that teacher *i* in school *j*, district *k*, and year *t* transfers to another school in the district the following year (relative to staying in the same school). We will use the log odds of this probability, $\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right)$, as our outcome variable in all of our primary models. We

[17] Voluntary transfer provisions often read like the following example from 2002-04 CBA from the Clover Park School District: "An employee interested in a transfer of assignment will submit a written request to the Human Resources Office as early as practicable, stating as specifically as possible the desired transfer, including preferred subject(s), building(s), and grade level(s). Requests for transfer will be kept on file for consideration until the beginning of the next school year." Most then go on to specify how experience factors into voluntary transfer decisions.

[18] Although a majority of contracts with involuntary transfer provisions stipulate that such transfers will occur when changes in enrollment necessitate movement, a significant minority of contracts also specify that teachers may be involuntarily relocated in the case of irresolvable conflicts between coworkers. The Puyallup 2008-10 CBA provides a typical example of contract language stipulating the necessity for involuntary transfer because of changing enrollments: "An involuntary transfer shall mean a transfer necessitated by an elimination or reduction in program, declining student enrollment, closure of schools, changes in school boundaries or reduction in staffing ratio." The University Place 2007-08 CBA illustrates contract language designed to address conflict: "The exception to the least senior employee being involuntarily transferred is in the case of an irresolvable conflict between co-workers which has a substantial negative impact on the learning or work environment of the site. In such a case, a more senior employee may be involuntarily transferred provided that the employee is accorded a process including interest based problem solving, mediation assistance, and formal direction by the district in a timely manner."

[19] See Boyd et al. (2013) for a more detailed discussion about disentangling teacher and administrator preferences in the context of a two-sided matching model for teacher hiring.

further define DVG_{jt} as the percentage of "disadvantaged" students in school *j* and year *t*. In what follows, we can think about DVG_{jt} being standardized to have mean 0 and standard deviation 1, meaning that $DVG_{jt} = 0$ for an "average" school and that a 1-unit change in DVG_{jt} represents a 1 standard deviation change in the percentage of disadvantaged students in the school. As a starting point, consider the following conceptual model of the relationship between DVG_{jt} and p_{ijkt}:

$$\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = \alpha_0^* + \alpha_1^* DVG_{jt} + \varepsilon^{\alpha*}{}_{ijkt} \quad (1)$$

Figure 1 illustrates the interpretation of the coefficients in equation 1 and our hypothesized results. The intercept α_0^* is the expected log odds that a teacher in an "average" school will transfer to another school in the district, while the coefficient α_1^* is the expected change in this outcome for each standard deviation increase in the percentage of disadvantaged students in the school. As noted above, the existing literature on teacher mobility (e.g., Goldhaber et al., 2010; Hanushek et al., 2004; Scafidi et al., 2007) has shown that teachers are more likely to transfer from disadvantaged schools (shown on the right of Figure 1) than advantaged schools (shown on the left of Figure 1). We therefore expect that $\alpha_1^* > 0.$

But the relationship between the level of disadvantage in a school and the probability of teacher transfer is likely to be different for novice and veteran teachers (Koski & Horng, 2007; Hess & Kelly, 2006). Therefore, for the purposes of our theoretical model, we introduce VET_{it} as a binary indicator for whether teacher *i* in year *t* is a "veteran" teacher.[20] Now consider the following two-way interaction model with DVG_{jt} and VET_{it}:

$$\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = \beta_0^* + \beta_1^* DVG_{jt} + \beta_2^* VET_{jt} + \beta_3^* DVG_{jt} \times VET_{jt} + \varepsilon^{\beta*}{}_{ijkt} \quad (2)$$

[20] We will allow teacher experience to be continuous in the next section.

Figure 2 illustrates the interpretation of the coefficients in equation 2 and our hypothesized results. The coefficient β_1^* represents the relationship between the percentage of disadvantaged students in the school and the log odds of teacher transfer *for novice (nonveteran) teachers*, while β_2^* is the expected difference in the log odds of teacher transfer between veteran teachers and novice teachers *in an average school ($DVG_{jt} = 0$)*. Finally, the coefficient on the two-way interaction, β_3^*, is the expected *change* in the relationship between the percentage of disadvantaged students in the school and the log odds of teacher transfer *for veteran teachers relative to novice teachers*.

We expect that teachers of all experience levels (including novice teachers) seek to move out of disadvantaged schools, so our expectation is that $\beta_1^* > 0$. The existing literature on teacher mobility (discussed in section II) has also shown that novice teachers tend to transfer more often than do veteran teachers; so we expect that $\beta_2^* < 0$. Finally, existing evidence on district policies and culture suggests that, regardless of specific CBA transfer provisions, veteran teachers have considerably more ability to pursue "desirable" teaching positions—by remaining in advantaged schools or transferring out of disadvantaged schools—than novice teachers (see Koski & Horng, 2007). The consequence is that the relationship between the percentage of disadvantaged students in a school and probability of transfer should be *more positive* for veteran teachers than novice teachers. We therefore hypothesize that $\beta_3^* > 0$ (the resulting relationships are shown in Figure 2).

The goal of our analysis is to examine the role of CBA transfer provisions in this process. Therefore, in our final conceptual model we introduce a binary variable SEN_{kt}, which indicates whether the CBA provisions regulating teacher transfers in district *k* and year *t* specify that more senior teachers have a contractual advantage in transferring to a school in the case of a job opening for which they are qualified. Here, again, we are focused on voluntary transfer provisions. The reference category is CBAs

that do not address seniority in voluntary transfer decisions.[21] We present a three-way interaction model with DVG_{jt}, VET_{it}, and SEN_{kt}:

$$\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = \gamma_0^* + \gamma_1^* DVG_{jt} + \gamma_2^* VET_{jt} + \gamma_3^* DVG_{jt} \times VET_{jt} + \gamma_4^* SEN_{kt} + \gamma_5^* DVG_{jt} \times SEN_{kt} + \gamma_6^* VET_{jt} \times SEN_{kt} + \gamma_7^* DVG_{jt} \times VET_{jt} \times SEN_{kt} + \varepsilon^{\gamma^*}{}_{ijkt} \quad (3)$$

Figure 3 provides the graphical interpretation of the coefficients of interest in equation 3. We focus specifically on the coefficients γ_5^* and γ_7^*. The coefficient γ_5^* describes how the relationship between the percentage of disadvantaged students in a school and probability of transfer changes *for novice teachers* between districts that either consider or do not use seniority in transfer decisions. In districts with CBAs that use seniority in voluntary transfer decisions, we hypothesize that novice teachers should have *less* "leverage" to leave undesirable teaching positions (i.e., disadvantaged schools). We therefore hypothesize that $\gamma_5^* < 0$.

Finally, the three-way interaction coefficient γ_7^* describes how the interaction between teacher experience and percentage of disadvantaged students (i.e., β_3^* in equation 2) changes between districts that do and do not use seniority in teacher transfer decisions. We have already hypothesized that, across all districts, this interaction is positive; that is, the relationship between the percentage of disadvantaged students in a school and probability of transfer will be more positive for more veteran teachers than for novice teachers. However, we further hypothesize that this relationship will be *even more positive* in districts that use seniority in teacher transfer provisions than in districts that do not. In other words, in districts with CBAs that use seniority in voluntary transfer decisions, we hypothesize that veteran teachers should have *more* leverage to transfer out of disadvantaged schools, $\gamma_7^* > 0$.

[21] We will elaborate on the more specific ways that CBAs might create advantages for teacher seniority in the next section.

Our discussion to this point has focused solely on *voluntary* transfers, but we argue that the relationships in Figures 1 through 3 should hold for *involuntary* transfers, as well. Involuntary transfers are *not initiated* by teacher preference; instead, they occur for administrative reasons like position reductions. However, in districts that use seniority in involuntary transfer decisions, teacher preferences still play an important role. That is, when a position must be eliminated, teachers with the least seniority are selected to be transferred *only if more senior teachers opt not to move*. Because of the well-documented teacher preferences discussed above, we hypothesize that this is more likely to happen in advantaged schools than in disadvantaged schools. Therefore, we argue that, in districts with CBAs that use seniority in involuntary transfer decisions, novice teachers should have *less* leverage to stay in advantaged schools (i.e., the left side of Figure 3), while veteran teachers should have *more* leverage.

Teacher effectiveness

Transfer provisions in CBAs are designed to operate through teacher experience; so the conceptual models above focus on experience as the teacher characteristic of interest. The distribution of teacher effectiveness, however, may be just as important. We might expect the relationships among teacher effectiveness, CBA transfer provisions, and the patterns of within-district teacher transfers to reflect the findings on teacher experience, given the well-documented correlation between teacher experience and effectiveness, particularly early in a teaching career (e.g., Rice, 2013; Rivkin et al., 2005; Rockoff, 2004). On the other hand, while correlated, teacher experience and effectiveness are certainly not synonymous (Atteberry et al., 2013), and effective teachers in districts that do *not* use seniority in teacher transfer decisions may have more leverage to pursue "desirable" teaching positions than effective teachers in districts in which all transfer decisions must defer to seniority.[22] If true, this would suggest a relationship among effectiveness, transfer decisions, and seniority transfer provisions that

[22] Similarly, administrators may have more ability to protect effective teachers from involuntary transfers when seniority is *not* used in transfer decisions.

differs from what we see when experience is the teacher characteristic of interest. Because of our unclear expectations about the interaction between effectiveness and transfer provisions in teacher mobility decisions, we investigate these relationships in the first extension to our main analyses—section VIII. We discuss potential policy implications of these results in our concluding remarks.

IV. Data

To test the theoretical expectations set forth in section III, we utilize data on teachers and contracts in Washington State, compiled from two sources: administrative data on individual teachers, schools, and districts maintained by the Washington State Office of the Superintendent of Public Instruction; and contract data from the teacher CBAs from all 270 school districts in Washington that have collective bargaining agreements.[23] Our combined data set includes information on all public schools and teachers in Washington State from the 2005 to 2006 school year through the 2012 to 2013 school year, linked to the CBA transfer provisions that regulated teacher transfers in that district and school year. We discuss each source of data below and then provide some descriptive statistics for our data before proceeding to our primary analysis.

Longitudinal teacher and school data

Washington State's S-275 database provides annual demographic information, such as the gender, race, experience, and degree level (of each teacher), for every public school employee in the state, linked to the school(s) and district(s) where each employee worked. These data are linked to teacher certification and endorsements data that include every endorsement that each teacher has on his or her credential (i.e., the subjects that each teacher is endorsed to teach).[24] We limit this data set to

[23] Only 270 of the state's 295 school districts have CBAs. The remaining 25 districts in the state are generally extremely small (the average enrollment of the 25 districts is 100 students).

[24] The state's Professional Educator Standards Board also supplied comprehensive data on individual teacher layoff notices, which allowed us to include an indicator of whether each teacher received a layoff notice during the school

one observation per public school teacher per year, keeping only individuals with a teaching assignment of greater than half-time (and the location of that teaching assignment). For our teacher-level analysis, we create indicators for whether each teacher in the state stayed in the same school, transferred to a different school within the same district, transferred to a different school outside of the district, or left the Washington State teaching workforce the following year.[25] Unfortunately, it is not possible to determine from our data whether a within-district transfer is voluntary or involuntary. We address this shortcoming in our data in the next section.

We link the above teacher information from the S-275 to data on a number of variables about each teacher's school, reported in Washington State's School Report Card. We collect data on the total enrollment, annual growth, and percentage of disadvantaged students—eligible for FRL or URMs—in the teacher's school, as these variables have been shown to influence the likelihood of a teacher's transferring out of schools (Goldhaber et al., 2010; Hanushek et al., 2004; Scafidi et al., 2007).[26] We also consider the level of the teacher's school (elementary, middle, or high), since research suggests that teacher mobility patterns differ across different types of schools (Goldhaber et al., 2011).

Finally, we calculate three district-level variables intended to measure school disadvantage: the district log enrollment; the percentage of disadvantaged (URM or FRL) students in the district; and as a measure of the "heterogeneity of disadvantage" in a district, the standard deviation of the percentage of disadvantaged (URM or FRL) students across the schools in each district. This last measure is potentially important because a teacher's desire to transfer out of a disadvantaged school may depend on the extent to which there are more advantaged schools in the same district.

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year—clearly an important variable that can influence teacher transfer decisions. For more background on teacher layoffs in Washington State, see Goldhaber and Theobald (2013).

[25] A small percentage (less than 1%) of teachers move into nonteaching positions the following year; so we have dropped these teachers from the analysis.

[26] We stress that these variables are only proxies for workplace conditions, as many disadvantaged schools may have strong administrators, school cultures, and district support that make them desirable workplaces, and many advantaged schools may present other undesirable working conditions.

Collective bargaining agreements

The CBA variables are derived from a multiyear collection of 471 CBAs, which includes at least one CBA from each of the 270 districts subject to collective bargaining in Washington State (our data set includes multiple CBAs for 76 districts).[27] Because some CBAs are active for more years than others and we have multiple CBAs for some districts in the sample, our data set is imbalanced with some school years and districts better represented than others. We explain in detail how we account for this imbalance in section V.[28] It is important to note that CBAs are linked to the teacher, school, and district data *only for the years that the CBA was active;* so teacher transfer decisions from year *t* to *t*+1 are modeled as the function of the CBA provisions governing transfers in year *t*.

We use these CBAs to create separate variables that describe the rules that govern voluntary and involuntary transfers in the district.[29] As we discuss in section III, our separation of voluntary and involuntary provisions is a departure from the existing literature on CBA transfer provisions (Anzia & Moe, 2014a; Cohen-Vogel et al., 2013; Koski & Horng, 2007; Moe, 2005) but, in our view, is essential, given differences in how these provisions may influence teacher mobility.

Slightly fewer than half of the 471 CBAs in our collection address seniority as a factor in voluntary transfer decisions, and slightly more than half address seniority as a factor in involuntary transfer decisions (see Table 1).[30] For CBAs that address seniority as a factor in teacher transfer decisions, we organize seniority language into one of four categories.[31] First, some districts explicitly state that seniority *is prohibited from use* in transfer decisions. Second, some districts identify seniority

[27] See Goldhaber et al. (2013; in press) for more information about our broader CBA data set.
[28] For example, we include district-by-year fixed effects in some models.
[29] Only 6% of CBAs in our sample allow district Human Resources to "fly" an open position outside of the district before offering it to teachers in the district.
[30] Most CBAs in Washington State define seniority as in-state teaching experience (as used in the state salary schedule). However, some districts define seniority (for the purposes of teacher transfer protections) as within-district teaching experience. Since state and district teaching experience are highly collinear (r = 0.71), we only include state experience in our analyses but see little difference in our results when we use district experience.
[31] Unlike Koski and Horng (2007), we do not observe any CBAs in Washington State that grant "bumping" privileges, which allow senior teachers to bump a less senior one from a position without administrative need.

as *one of several factors* in transfer decisions. Third, some districts state that seniority will be a *tiebreaker* in transfer decisions; that is, if all else is equal between two teachers, then seniority becomes the deciding factor. Finally, some districts identify seniority as the *only factor* in teacher transfer decisions.[32] In another departure from the published literature on CBA transfer protections (Anzia & Moe, 2014a; Cohen-Vogel et al., 2013; Koski & Horng, 2007; Moe, 2005), we do not attempt to aggregate these categories into a single index for each district.[33]

Descriptive picture of our data set

Our teacher-level data set (used in all our primary analyses) consists of 190,469 teacher/year observations, and 61,102 unique teachers.[34] The first three columns of Table 1 contain summary statistics for the variables in this data set (which will serve as control variables in the teacher transfer models described in section IV), calculated at the teacher, school, and district levels. The distribution of seniority transfer provisions across CBAs is summarized in the final column of Table 1. It is relatively rare for seniority to be the only factor in voluntary transfer decisions (4.9% of CBAs) but it is more common for seniority to be the only factor in involuntary transfer decisions (12.3% of CBAs). Table 2 summarizes the percentage of CBAs with each *combination* of voluntary and involuntary transfer protections. Perhaps surprisingly, 38% of the CBAs in our collection do not address the role of seniority for either voluntary or involuntary transfer decisions. On the other end of the spectrum, 1.3% of CBAs address seniority as the only factor for both voluntary and involuntary transfers.[35]

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[32] There are gray areas in this coding scheme; so two individuals coded each CBA independently, and then the coders worked together with the authors to reconcile their coding decisions. The average inter-rater reliability in the first round of coding was 0.62, which is generally considered "good" agreement (Altman, 1991). For more information about the coding process, see Goldhaber et al. (2013)

[33] Although these categories are ordinal, and thus represent increasing roles of seniority in transfer decisions, there is no theoretical reason to believe that they have a linear relationship to transfers.

[34] 4.80% of the teachers in our data set transfer to another school in the same district the following year, which is a considerably lower percentage than the figure reported for North Carolina (11.88%) in Goldhaber et al. (2010).

[35] There are also other combinations of protections that are relatively rare (for example, no CBA in our collection specifies seniority as the only factor in voluntary transfer decisions but prohibits the use of seniority in involuntary transfer decisions).

Descriptive picture of teacher moves by CBA transfer protections

Before describing our analytic models, we take a closer look at patterns in teacher transfers across two categorical variables: teacher experience levels (0–2 years, 2–5 years, 5–10 years, and 10+ years) and our coding of CBA transfer provisions (described in the previous subsection).[36] Table 3 presents rates of teacher transfers for each combination of these variables. Across all districts, the probability that a teacher will stay in the same school the following year increases with teacher experience. In fact, regardless of the text of the district's seniority transfer provisions, novice teachers are more likely than teachers with greater experience to transfer to another school in the same district, transfer to a school in a different district, and leave the in-state teaching workforce.

The characteristics of the "sending" and "receiving" schools for within-district transfers may also influence the relationship between within-district teacher transfers and the distribution of teacher experience within a district. That is, the pattern of teacher transfers that we hypothesize in section III will only influence the distribution of teacher experience within a district if, on average, teachers who choose to transfer tend to go to more advantaged schools. Table 4 gives the average standardized percentage of URM (standardized across all schools in the state each year) of the sending and receiving schools *of teachers who transfer to another school within the district* (our findings are qualitatively similar if we use FRL instead of URM). The first panel shows these averages by experience level across all districts. The first point to note is that the average standardized percentage of URM students of the sending schools is positive for each experience level; teachers who transfer within districts tend to transfer from schools with higher percentages of URM students than the average school in the state. Second, the difference in standardized percentage of URM students between the receiving and sending schools is negative and significant for each experience level, indicating that teachers who transfer to another school in the same district tend to transfer to a school with a *lower* percentage of URM

[36] We use categories of experience in Tables 3 and 4 to provide a descriptive look at transfers, but transition to a continuous measure of teacher experience in the next section.

students; this is consistent with the existing empirical literature on flow of teachers and distribution of teacher credentials (e.g., Hanushek et al., 2004; Lankford et al., 2002; Scafidi et al., 2007).

The remaining two panels of Table 4 break down the average standardized percentage URM of the sending and receiving schools for within-district transfers by CBA seniority transfer protection categories, for voluntary and involuntary transfers. Consistent with the above findings, the differential in standardized percentage of URM students is generally negative across different types of protections. However, just as our theoretical framework does not consider the characteristics of receiving schools, the analytic models we describe in the next section only consider the characteristics of sending schools as predictors of teacher mobility. Modeling the characteristics of both sending and receiving schools would require a two-sided matching model (e.g., Boyd et al., 2013), which is beyond the scope of this paper. Therefore, the patterns in Table 4 simply help us quantify the extent to which teacher transfers might influence the distribution of teacher experience (see section VII).

V. Analytic Models

We now extend the theoretical models described in section III to take advantage of the detailed, longitudinal data we describe in section IV.[37] For our primary teacher transfer models, we limit the teacher-level data set to teachers who return to the same school district the following school year.[38] We also introduce a vector of control variables CON_{ijkt} that includes the other variables summarized in Table 1, as well as indicators for the contract year of the district's CBA (i.e., the first year the contract was in place, the second year the CBA was active, etc.) and each individual school year. There are good reasons

[37] Ideally, we would like to exploit *changes* in CBA seniority transfer provisions within a district to estimate the impact of these provisions. However, not enough districts modified the transfer language in their CBAs during the years of our study to justify this approach.

[38] This drops teachers who transfer to another district or who leave the in-state teaching workforce, but we also estimate separate models for these outcomes and report these results in section VI.

to believe that each of these variables may influence teacher transfer decisions (and may be correlated with our variables of interest); so we include them in all models to reduce confounding.

Because transfer rates vary so widely for teachers of different experience levels (shown in Table 3), we also control for teacher experience in all our models. We consider a number of parameterizations of teacher experience, including a linear term and indicators for teacher experience levels (i.e., the four experience levels used in Table 3).[39] However, we find that the best logistic regression model fit results from using the natural log of teacher experience at the end of the year (so first-year teachers have a value of 0). We therefore include the natural log of the experience of teacher *i* at the end of year *t*, $\ln(EXP_{it})$, in all models.

Our first teacher transfer model, then, is analogous to the theoretical model described in equation 1, but with a number of additional control variables:

$$\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = \alpha_0 + \alpha_1 DVG_{jt} + \alpha_2 \ln(EXP_{ij}) + \alpha_3 CON_{ijkt} + \alpha_t + \varepsilon^{\alpha}_{ijkt} \quad (4)$$

The coefficient of interest in equation 4, α_1, describes the expected change in the log odds of a within-district transfer for each standard deviation increase in the percentage of disadvantaged students in the teacher's school, *controlling for* variation by year and observable teacher, school, and district characteristics.[40]

When we allow this relationship to vary for teachers of different experience levels by including a two-way interaction, as in the theoretical model described in equation 2, we also allow the relationships for all the other variables in the model to vary by experience level:

[39] Results that use other parameterizations of teacher experience are qualitatively similar and available from the authors on request.

[40] There are good reasons to believe that the relationship between school disadvantage and probability of transfer is nonlinear. For example, this relationship may be more extreme for more disadvantaged schools (i.e., beyond a "tipping point": see Clotfelter [1976]). We test this possibility by estimating a model that includes quintiles of the percentage of URM distribution and interactions between these quintiles and the continuous measure of percentage of URM students. None of the quintiles or interactions is statistically significant—meaning that there is little evidence of discontinuities or nonlinearities in the relationship between school disadvantage and probability of transfer.

$$\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = \beta_0 + \beta_1 DVG_{jt} + \beta_2 \ln(EXP_{ij}) + \beta_3 DVG_{jt} \times \ln(EXP_{ij}) + \beta_4 CON_{ijkt} + \beta_5 CON_{ijkt} \times \ln(EXP_{ij}) + \beta_t + \varepsilon^{\beta}_{ijkt} \quad (5)$$

The coefficients of interest in equation 5 are β_1, which describes the relationship between the percentage of disadvantaged students in a teacher's school and the log odds of within-district transfer for *first-year teachers*, and β_3, which describes how this relationship changes as teacher experience increases, *controlling for* interactions with other variables in the model.

Finally, when we incorporate CBA transfer provisions into this model—as in the theoretical model described in equation 3—we consider all five categories of CBA transfer provisions discussed in section IV. We define CBA_{kt} as a vector of indicators for the category of CBA transfer provision in district *k* and year *t*, leaving "seniority not addressed" as the reference category. The resulting three-way interaction model is as follows[41]:

$$\begin{aligned}\ln\left(\frac{p_{ijkt}}{1-p_{ijkt}}\right) = {} & \gamma_0 + \gamma_1 DVG_{jt} + \gamma_2 \ln(EXP_{ij}) + \gamma_3 DVG_{jt} \times \ln(EXP_{ij}) \\ & + \gamma_4 CBA_{kt} + \gamma_5 DVG_{jt} \times CBA_{kt} + \gamma_6 \ln(EXP_{ij}) \times CBA_{kt} \\ & + \gamma_7 DVG_{jt} \times \ln(EXP_{ij}) \times CBA_{kt} \\ & + \gamma_8 CON_{ijkt} + \gamma_9 CON_{ijkt} \times \ln(EXP_{ij}) + \gamma_{10} CON_{ijkt} \times CBA_{kt} + \gamma_t + \varepsilon^{\gamma}_{ijkt}\end{aligned} \quad (6)$$

In equation 6, γ_5 and γ_7, are now vectors of coefficients (since CBA_{kt} is a vector), but they are still analogous to the corresponding coefficients in the theoretical model described in equation 3. The coefficients in γ_5 describe how the coefficient β_1 in equation 5—the relationship between the percentage of disadvantaged students in a school and probability of transfer changes for novice teachers (i.e., teachers with 1 year of experience at the end of the year)—changes among districts with different CBA transfer provisions. In a similar manner, the coefficients in γ_7 describe how the interaction between

[41] Following the existing literature on CBA transfer provisions (Anzia & Moe, 2014a; Cohen-Vogel et al., 2013; Koski & Horng, 2007; Moe, 2005), we also allow the coefficients on the school-level variables in CON_{ijkt} to vary by CBA transfer provision (see the footnote of Table 5).

teacher experience and percentage of disadvantaged students (i.e., β_3 in equation 5) changes among districts with different CBA transfer provisions. It is important to note that we estimate and present results from the model in equation 6 *separately* for voluntary and involuntary CBA transfer provisions (i.e., one specification with CBA_{kt} containing indicators for CBA voluntary transfer provisions and another specification with CBA_{kt} containing indicators for CBA involuntary transfer provisions).

The estimates of the coefficients in γ_5 and γ_7 in equation 6 are identified by differences in the probability of within-district transfers for teachers of the same experience level in schools and districts that are similar in every way except for their CBA transfer provisions. However, it is possible that the district-level controls in CON_{ijkt} fail to adequately account for district-level factors that influence the likelihood that teachers will transfer between schools. Therefore, we also estimate specifications in which the district control variables (including the CBA provisions themselves) and year fixed effects in equations 4 through 6 are replaced by district-by-year fixed effects.[42] In these specifications, CBA provisions enter the model *only* in the interactions terms, and the effect of CBA seniority provisions is identified by *within-district and within-year differences* in the probability of within-district transfers. The district-by-year fixed effects in this model account for the fact that our data set is unbalanced and more representative of some school years and districts than others. However, this model also makes the strong assumption that—in the absence of CBA transfer provisions—the within-district relationships among teacher experience, school disadvantage, and relative probability of transfer would be the same across different districts. As a robustness check, then, we present estimates from both specifications throughout section VI.

VI. Primary Results

[42] It is well known that the maximum-likelihood estimations of parameters in a fixed-effects logistic regression model are biased when sample sizes within each level of the fixed effect are small (e.g., Chamberlain, 1980). However, the average school district and year combination has more than 130 teachers in our data set; so we do not view this as a substantial problem in our application.

Table 5 presents estimated coefficients from our primary models: Columns 1 and 2 are estimated from the model in equation 4; columns 3 and 4 are estimated from the model in equation 5; columns 5 and 6 are estimated from the model in equation 6, using the CBA provisions governing *voluntary* teacher transfers; and columns 7 and 8 are estimated from the model in equation 6, using the CBA provisions governing *involuntary* teacher transfers. Within each set of results, the first column presents estimates from a model that includes a vector of district control variables and year/contract year effects, while the second column presents estimates from a model that substitutes a district-by-year fixed effect for these control variables.

Columns 1 and 2 of Table 5 demonstrate that, as we hypothesized in section III and consistent with prior empirical evidence, the probability that a teacher will transfer to another school in the district *decreases* as teacher experience increases and *increases* as the percentage of URM students in the school increases, all else being equal.[43] Figure 4 shows the estimated relationship between standardized school percentage of URM students and probability of within-district transfer from the model with district control variables (that are similar to the estimates from the model with district-by-year fixed effects) for an *average* teacher.[44] The point estimate for standardized percentage of URM students from this model suggests, for example, that an increase in the school percentage of URM students from the state average to 1 standard deviation above the state average is correlated with a .006 increase in the probability that an average teacher will transfer to another school in the district. This represents more than a 10% increase in the probability, since it is relative to a baseline probability of within-district transfer of .053.

The estimates in columns 3 and 4 of Table 5 are from the two-way interaction model (equation 5 in section V) that allows the relationship between the percentage of URM students in a school and the

[43] These findings are quite consistent with findings from the existing teacher mobility literature (Goldhaber et al., 2010; Hanushek et al., 2004; Scafidi et al., 2007).
[44] In Figures 4 through 7, we transform the log odds of within-district transfer to the probability scale (shown on the y-axis) to make the estimates easier to interpret.

probability of within-district transfer to vary for teachers of different experience levels. Most of the results are very consistent with the hypotheses developed in section III. The relationship between the percentage of URM students in a school and the probability of within-district transfer becomes increasingly positive as teacher experience increases ($\hat{\beta}_3$ from equation 5), suggesting that district policies and culture give veteran teachers more leverage than novice teachers to move out of undesirable teaching positions or stay in desirable teaching positions. Figure 5 illustrates how the estimated relationship between the percentage of URM students in a school and the predicted probability of within-district transfer varies for teachers of different experience levels (holding other variables in the model constant).

One relationship that does deviate from the hypotheses described in section III is the relationship between school disadvantage and the probability of within-district transfer for novice teachers ($\hat{\beta}_1$ from equation 5). We find the relationship is *negative;* so, for instance, the probability that a first-year teacher serving in a very disadvantaged school (2 standard deviations above the mean percentage of URM students) will transfer to another school in the district is actually .105 *lower* than in an average school, all else being equal. One possible explanation for this finding is that novice teachers have different preferences from those of veteran teachers in terms of teaching in disadvantaged schools. Idealistic younger teachers, for instance, may seek out disadvantaged schools early in their careers but learn over time that these schools are difficult places in which to teach (Chester & Beaudin, 1996).

Another possible explanation is that district rules (including CBA transfer protections) serve to "trap" novice teachers in disadvantaged schools. We explore this possibility in columns 5 through 8 of Table 5, which include estimates from the three-way interaction model (equation 6 in section V) that allows the relationships between teacher experience and the percentage of URM students in the school to vary across districts with different CBA transfer provisions. Before turning our attention to the coefficients of interest, it is worth noting that we do *not* find evidence (from the main effects of CBA

provisions in models with district controls) that the *overall rates* of teacher transfers vary across districts with different CBA transfer provisions. This is important for two reasons. First, this justifies the district-by-year fixed effects models reported in columns 6 and 8. Specifically, since there is no evidence that teachers in districts with different CBA transfer provisions are any more or less likely to transfer to another school in the district (all else being equal), it is reasonable to drop these main effects and include district-by-year effects that capture all variation in within-district transfer rates between districts.

This finding is also important because of the research (Barnes et al., 2014; Hanushek & Rivkin, 2013; Ronfeldt et al., 2013) showing that the churn of teachers affects student achievement. The fact that we do not find evidence that provisions affect teacher churn suggests that these provisions do not have an impact on achievement that is associated solely with teacher turnover. Of course, that does not mean that provisions do not affect teacher distribution. As we describe below, there is in fact evidence that they do.

The other reported estimates in columns 5 through 8 of Table 5 are for the primary coefficients of interest, $\hat{\gamma}_5$ and $\hat{\gamma}_7$, from equation 6. Recall that the coefficients in $\hat{g}_5$ describe how the relationship between the percentage of disadvantaged students in a school and the probability of transfer changes for novice teachers between districts with different CBA transfer provisions (the reference category is districts with CBAs that do not address seniority in transfer decisions), and the coefficients in $\hat{g}_7$ describe how the interaction between teacher experience and percentage of disadvantaged students changes among districts with different CBA transfer provisions.

When we consider CBA *voluntary* transfer provisions (columns 5 and 6 of Table 5), the coefficients on two interaction terms are statistically significant under both parameterizations of the three-way interaction model (i.e., with district controls and with district-by-year fixed effects).[45] The

[45] One explanation for the nonfindings for districts in which seniority is the only factor in voluntary transfer decisions is that there are relatively few of these districts (fewer than 5% of our sample).

negative two-way interaction "School %URM * Seniority is a tiebreaker" (one of the coefficients in $\hat{g}_5$) means that, relative to districts with CBAs that do not address seniority in voluntary transfer decisions, the relationship between percentage of URM students and the probability that a novice teacher will transfer to another school in the district is *more negative* in districts with CBAs that specify that seniority is a tiebreaker in voluntary transfer decisions. This is consistent with the hypothesis, described in section III, that novice teachers in these districts have less leverage to transfer out of disadvantaged schools. This is illustrated in Figure 6, as novice teachers in disadvantaged schools (i.e., *high* values of standardized school %URM) are more likely to transfer in districts with CBAs that do not address seniority in voluntary transfer decisions than they are in districts with CBAs that specify that seniority is a tiebreaker in voluntary transfer decisions. In particularly disadvantaged schools (2 standard deviations above the mean of %URM), novice teachers are 50% more likely to transfer, all else being equal, if they teach in districts with CBAs that do not address seniority in voluntary transfer decisions than if they would be if they taught in districts with CBAs specifying that seniority is a tiebreaker in voluntary transfer decisions.

Further, the positive three-way interaction "School %URM * log experience * Seniority is tiebreaker" (one of the coefficients in $\hat{\gamma}_7$) means that, relative to districts with CBAs that do not address seniority in voluntary transfer decisions, the interaction between percentage of URM students and teacher experience is *more positive* in districts with CBAs that specify that seniority is a tiebreaker in voluntary transfer decisions. While this is directionally consistent with the hypothesis we described in section III, there is little difference between the predicted probabilities of within-district transfer for veteran teachers (20 years of experience) in the two different types of districts in Figure 7; that is, in both types of districts, the probability that a veteran teacher will transfer to another school in the district increases with the percentage of URM students in the school—and at about the same rate. This,

combined with the findings for novice teachers, suggests that that seniority voluntary transfer protections may be more important for more junior teachers than for veteran teachers.

When we consider CBA *involuntary* transfer provisions in columns 7 and 8 of Table 5, we see consistent relationships for districts with CBAs that specify seniority as a tiebreaker or the only factor in involuntary transfer decisions. In these districts, the relationship between percentage of URM students and the probability that a novice teacher will transfer to another school in the district is *more negative* than in districts with CBAs that do not address seniority in involuntary transfer decisions. This is also consistent with the hypotheses described in section III: Novice teachers in these districts have less leverage to keep their positions in advantaged schools when there is a reduction in staffing at a school and a position needs to be eliminated. This is illustrated in Figure 7, as novice teachers in advantaged schools (i.e., *low* values of school %URM) are more likely to transfer (about 60% more likely in particularly advantaged schools, all else being equal) in districts with CBAs that specify seniority as the only factor in involuntary transfer decisions than in districts with CBAs that do not address seniority in involuntary transfer decisions.

Finally, the three-way interactions among school percentage of URM students, teacher experience, and the indicators for seniority being a tiebreaker or the only factor in involuntary transfer decisions are also positive and statistically significant. This means that, relative to districts with CBAs that do not address seniority in involuntary transfer decisions, the interaction between the percentage of URM students and teacher experience is *more positive* in districts with CBAs that specify that seniority is a tiebreaker or the only factor in involuntary transfer decisions. Figure 7 illustrates that this is quite consistent with the hypothesis we described in section III: Veteran teachers in districts with CBAs that specify seniority as the only factor in involuntary transfer decisions are *less likely* to transfer out of advantaged schools than are veteran teachers in districts with CBAs that do not address seniority in involuntary transfer decisions. The relationships in Figure 7 are extremely consistent with our

hypotheses about how seniority transfer protections in CBAs might influence teacher transfer decisions (see Figure 3), and we therefore conclude that seniority involuntary transfer protections are an important factor in within-district teacher transfer decisions.[46]

In sum, the above findings paint a consistent picture of how within-district teacher mobility patterns vary depending on the CBA transfer provisions that govern such moves; the interaction between teacher experience and school disadvantage in teacher transfer decisions is consistently *more extreme* (i.e., veteran teachers are even more likely to leave disadvantaged schools, and novice teachers are even more likely to stay in disadvantaged schools) in districts with strong seniority transfer protections.[47]

VII. Simulation study

The patterns that we describe in section VI matter because they may contribute to the inequitable distribution of teacher experience across advantaged and disadvantaged schools. But these results address only one variable (CBA transfer provisions) that influences one factor (within-district teacher transfers) in a dynamic process that ultimately determines the distribution of teacher experience. So, how important are these results in the grand scheme of things?

[46] There is still reason to worry that—despite the district controls or district-by-year fixed effects in each of our models—we do not adequately control for differences between teachers in districts with different contract provisions. There are some teachers who have switched districts during our years of data, and there are some districts that negotiate different transfer provisions during these years. This allows us to estimate teacher fixed-effects models and produce estimates identified by *within-teacher* variation in school composition and CBA contract provisions. The estimates from these models are directionally consistent with our primary results, but are not statistically significant, presumably because there is far less variation to inform these estimates. Thus, we view these results as supporting our primary results (full results are available from the authors on request).

[47] These findings are robust to a number of additional checks. We estimate our models separately by school year (e.g., 2009–2010 only, 2010–2011 only) to ensure that our findings are robust across different school years and see few differences over time. We also estimate our models separately for each contract year (e.g., the first year the contract was in effect and the last year the contract is in effect) in case teachers are more likely to respond to CBA provisions in a contract's first or last year. Again, we see few differences in our results. Finally, we estimate our primary models, using different measures of teacher experience (e.g., experience in the district, experience relative to other teachers with the same endorsement in the district), and once again, our results change very little.

To provide a more concrete context for the relative importance of our primary findings, we perform a speculative simulation that considers just one measure of the inequitable distribution of teacher experience: the distribution of novice teachers (i.e., with less than 2 years of experience) across schools in the bottom and top quartile of the statewide distribution of the percentage of URM students (i.e., advantaged and disadvantaged schools, respectively).[48] It is well documented (e.g., Goldhaber et al., in press) that disadvantaged schools are far more likely than advantaged schools to have novice teachers and less likely to have veteran teachers, but as we discuss in section II, patterns in within-district transfer, cross-district transfer, attrition, and hiring can all influence this distribution. Therefore, our simulation has two goals: (1) assess the relative importance of patterns in within-district transfers, cross-district transfers, attrition, and hiring in determining the distribution of novice teachers across advantaged and disadvantaged schools and (2) quantify the relative importance of CBA transfer provisions in this process.

We make a number of simplifications and simplifying assumptions to make our calculations tractable. The first simplification is to assume that the initial distribution of first-year teachers in the first year of our simulation is equitable between advantaged and disadvantaged schools; that is, that students are equally likely to be initially assigned to a novice teacher in each type of school. This assumption is far from realistic—from 2006 through 2013, the percentage of first-year teachers in disadvantaged schools (7.4%) is far higher than in advantaged schools (5.1%)—but this simplification allows us to isolate the impact of the four factors described above from the impact of the many factors that have contributed to the *existing* inequitable distribution of teacher experience.

Our simulation makes three additional simplifying assumptions: (1) Rates of within-district transfer, cross-district transfer, and attrition for teachers of different experience levels are independent of one another and the existing distribution of teacher experience; (2) rates of hiring of novice teachers

[48] For the purposes of the simulation, we define a veteran teacher to be any teacher with more than 2 years of experience.

are independent of the existing distribution of teacher experience and the experience level of departing teachers; and (3) students do not transfer between schools because of the teacher to whom they are assigned. These assumptions are not particularly realistic—for example, we might expect a principal's hiring decisions to depend, in part, on the experience level of departing teachers and the existing experience level in the school—so we stress that our simulation results do not permit a causal interpretation.

In our simulation, we assign students to teachers in school *s* and year *t* via the following two-step process: Sstudents are first assigned to a teacher who was already in school *s* in year *t-1*, and then students are assigned to that teacher's replacement if the teacher transfers from the school. In this process, there are two ways a student could get a novice teacher in year *t*: (1) the student is initially assigned to a first-year teacher, who then stays in the school for her second year, or (2) the student is initially assigned to a teacher who leaves and is then replaced by a novice teacher. In turn, the probability of each of these events depends on patterns of within-district transfer and teacher hiring (e.g., the probability that a veteran teacher will transfer to another school in the district and will then be replaced by a novice). These probabilities vary across different school settings; so we can estimate the probability that a student will be assigned to a novice teacher in different types of schools (i.e., advantaged and disadvantaged) by imputing rates of within-district transfers, cross-district transfers, attrition, and hiring that are either calculated from our observed data or, in the case of within-district transfers, fitted probabilities from our teacher transfer models.

Our simulation proceeds in two parts. In the first part, we ignore CBA transfer provisions and simply quantify how much each factor—within-district transfers, cross-district transfers, attrition, and hiring—contributes to inequitable distribution of novice teachers across advantaged and disadvantaged schools. For each factor, we impute the observed rates for advantaged and disadvantaged schools but then hold rates of all other factors at their observed rates across *all schools* (i.e., assuming that patterns

are equitable in advantaged and disadvantaged schools). For example, to isolate the impact of within-district transfers, we assume that rates of cross-district transfer, attrition, and hiring are the same in advantaged and disadvantaged schools but allow rates of within-district transfer to vary in the two types of schools (using observed rates of within-district transfer in the two types of schools from our data from 2006–2013). Overall, we estimate that within-district transfers are responsible for about 20% of the inequitable distribution of novice teachers across advantaged and disadvantaged schools. This makes within-district transfers the second most important source of inequity; we estimate that patterns of cross-district transfer are responsible for about 7%, attrition is responsible for about 18%, and hiring is responsible for about 55% of the "novice teacher gap" in year *t*. This is a lower bound estimate of the importance of within-district transfers, because one could argue that the inequities in within-district transfers that we document (e.g., veteran teachers' leaving disadvantaged schools at higher rates) are problematic precisely *because* disadvantaged schools have a harder time recruiting experienced teachers (and thus hire novice teachers at much higher rates).

For the second part of our simulation, we manipulate the rates of within-district transfer on the basis of the fitted values from our within-district teacher transfer models to provide intuition about the magnitudes of our results about different CBA transfer provisions. Table 6 summarizes simulation results that address our most consistent finding: Patterns of within-district transfer are more inequitable in districts with CBAs that specify seniority as the only factor in involuntary transfer decisions than in districts with CBAs that do not address seniority at all. Under different assumptions (summarized in column 1 of Table 6), we run our simulation, using fitted probabilities of within-district transfer in districts with CBAs that do not address seniority in involuntary transfer decisions, and again in districts with CBAs that specify seniority as the only factor in involuntary transfer decisions. The third column shows the percentage of students in disadvantaged schools who are assigned to a novice teacher in year *t*, while the fourth column shows the percentage for students in advantaged schools. Finally, the fifth

column shows the resulting "novice teacher gap" between disadvantaged schools and advantaged schools. Under each set of assumptions, the difference in this gap between districts with different CBA provisions is about 0.35 percentage points, or a little less than 20% of the overall gap between advantaged and disadvantaged schools in the average district.

We believe there are three main takeaways from this exercise. The first is that within-district transfers are important but only explain a fraction (about one fifth) of the inequitable distribution of novice teachers across advantaged and disadvantaged schools. We view this as additional motivation for our analysis—which isolates the impact of CBA transfer provisions on within-district teacher mobility—relative to prior analyses that conflate the impacts of all four factors that can contribute to the inequitable distribution of teacher experience.

The second takeaway, shown in Table 6, is that patterns in teacher transfers can result in an inequitable distribution of teacher experience in districts *regardless of their CBA transfer provisions*. This is an important point: Our findings about CBA involuntary transfer provisions do *not* imply that the distribution of teacher experience will be "equitable" in districts with CBAs that do not address the role of seniority in involuntary transfer decisions. However, our third takeaway is that there *is* evidence that the distribution of seniority will be *more* inequitable (almost 20% more) in districts with CBAs that specify seniority as the only factor in involuntary transfer decisions. Our broad conclusion from this simulation, therefore, is that the impact of CBA transfer provisions on the distribution of teacher experience is likely to be small but meaningful.

VIII. Mobility, by Teacher Effectiveness

Before considering a number of important extensions and robustness checks to the models and results discussed in sections V and VI, we take a short but important detour to examine the relationship between teacher *effectiveness* and seniority transfer protections. We again stress the importance of this

analysis because of findings showing the connection between teacher effectiveness and later student outcomes (e.g., Chetty et al., 2011).

For the focus on teacher effectiveness, we rely on a subset of teachers in our sample—elementary school teachers in Grades 4 through 6 and middle school math and reading teachers—who can be linked to demographic information and both prior and current state test scores of students in their classes.[49] For this subset of teachers, we estimate value-added models (VAMs) to identify the contribution of these teachers toward student learning gains. The value-added estimate for teacher *j* in subject *s* in year *t* is calculated from the following VAM:

$$Y_{ijst} = \lambda_0 + \lambda_1 Y_{i(t-1)} + \lambda_2 X_{it} + \tau_{jst} + \varepsilon^{\lambda}_{ijst} \quad (7)$$

In equation 7, Y_{ijst} is the state test score for each student *i* with teacher *j* in subject *s* (math or reading) and year *t,* normalized within grade and year; $Y_{i(t-1)}$ is a vector of the student's scores the previous year in both math and reading, also normalized within grade and year; X_{it} is a vector of student attributes in year *t* (gender, race, eligibility for FRL, English-language-learner status, gifted status, special education status, learning disability status); and τ_{jst} is a fixed effect that captures the contribution of teacher *j* to student test scores in subject *s* and year *t*. We adjust all teacher-effect estimates using empirical Bayes methods.[50] For elementary teachers, we use the mean of the teacher's estimates in

[49] These data come from Washington State's Core Student Record System (CSRS, prior to 2009–2010) and Comprehensive Education Data and Research System (CEDARS, since 2009–2010). The proctor of the state assessment was used as the teacher–student link in the CSRS data system.The "proctor" variable was not intended to be a link between students and their classroom teachers; so this link may not accurately identify those classroom teachers. The CEDARS data includes fields designed to link students to their individual teachers, based on reported schedules. However, limitations of reporting standards and practices across the state may result in ambiguities or inaccuracies around these links. See Goldhaber et al. (2013) for more information about these data. This generates value-added estimates for 19,224 different teachers from 2006 through 2013, estimated from about 1.9 million student/year/subject observations.

[50] The standard empirical Bayes method shrinks estimates back to the grand mean of the population. Note, however, that standard empirical Bayes adjustment does not properly account for the uncertainty in the grand mean; this suggests that the estimates are shrunk too much (McCaffrey et al., 2009). However, recent evidence (Herrmann et al., 2013) also suggests that shrinkage improves the estimates for teachers of "hard to predict" students. We use the standard approach estimated in the literature (an appendix on empirical Bayes shrinkage is available from the authors on request).

math and reading as our measure of effectiveness, while for middle school teachers, we use the estimate for the subject each teacher teaches (math or reading).[51]

We use these value-added estimates to investigate the patterns of teacher mobility for teachers of different levels of estimated effectiveness across districts with different CBA transfer provisions. Specifically, we estimate variants of the models in equations 4 through 6, in which we replace log teacher experience, $\ln(EXP_{it})$, with an estimate of the teacher's value-added performance VAM_{it}[52] (we include $\ln(EXP_{it})$ in the vector of control variables CON_{ijkt}).[53] Columns 1 and 2 of Table 7 demonstrate that, all else being equal, the probability that a teacher will transfer to another school in the district *decreases* as estimated teacher effectiveness increases. This is directionally consistent with findings from Goldhaber et al. (2010) and Feng and Sass (2012).[54] In columns 3 through 4 of Table 7, when we allow the relationship between teacher value added and probability of transfer to vary by school percentage of URM students, we do not find significant differences in this relationship by school percentage of URM students. Similarly, we see few consistent patterns when we allow these relationships to vary by CBA voluntary transfer provisions (columns 5 and 6).

However, very clear patterns emerge when we allow these relationships to vary by CBA involuntary transfer provisions (columns 7 and 8 of Table 7). The positive coefficient on the interaction "School %URM * teacher VAM" shows that, in districts with CBAs that do not address seniority in involuntary teacher transfers, the relative likelihood that a teacher will leave a disadvantaged school actually *increases* with teacher effectiveness. Further, the two sets of significant three-way interactions imply that, relative to districts with CBAs that do not address seniority in involuntary transfer decisions, the interaction between school percentage of URM students and teacher value added is *less positive* in

[51] We are not able to account for student tracking at the middle school level (e.g., Jackson, 2012) because we do not have reliable section IDs that distinguish between students with the same teacher but in different sections.
[52] We standardize our value-added estimates across all teachers, so $VAM_{it} = 0$ represents a teacher of average effectiveness.
[53] We also estimate models that do not control for teacher experience, and the results are qualitatively similar.
[54] The magnitude of this coefficient is larger than the estimates in Feng and Sass (2012).

districts with CBAs that specify seniority as a tiebreaker or the only factor in involuntary transfer decisions than in districts with CBAs that do not address seniority.

To help interpret these coefficients, we replace the continuous measure of effectiveness with indicators for whether each teacher is in the top quartile or bottom quartile of the distribution of estimated effectiveness.[55] The results from this model suggest that the mobility patterns of effective teachers are driving this result; that is, effective teachers are, relatively speaking, far *less likely* to leave disadvantaged schools in districts that *do* use seniority in involuntary transfer decisions. This provides an interesting corollary to our primary results, as it suggests that—despite the early-career correlation between experience and effectiveness (e.g., Boyd et al., 2006; Rivkin et al., 2005; Rockoff, 2004)[56]—seniority protections for involuntary transfers in CBAs could actually *decrease* the inequitable distribution of teacher quality, since they may give effective novice teachers less leverage when a position in a school has to be moved. In other words, effective teachers may have more leverage to stay in advantaged schools in districts where seniority is *not* used in transfer decisions (or alternatively, administrators are more able to protect their effective teachers from involuntary transfer when seniority transfer rules are in place).[57]

IX. Extensions and Falsification Tests

To further bolster the results reported in section VI, we now return to our main models and present several important modifications. We first estimate the models in equations 4 through 6, using the percentage of students in the school eligible for FRL as the measure of school disadvantage, DVG_{jt}. We then consider other types of teacher transfers—out of the district and out of the state workforce—

[55] Results are available from authors on request.
[56] Recent research (e.g., Ladd & Sorenson, 2014) suggests that the returns to experience may extend out to as much as year 12 of a teacher's career.
[57] See Jacob and Lefgren (2008) for evidence that principals can identify high value-added teachers.

to see if patterns in within-district transfers hold for other types of transfers. Finally, we conclude the section by discussing a number of falsification tests of our primary results.

Teacher mobility, by school poverty level

Table 8 presents estimates from the models in equations 4 through 6, in which the measure of school disadvantage, DVG_{jt}, is the percentage of students in the school eligible for FRL. The estimates in columns 1 through 4 of Table 8 are very similar to our primary results in columns 1 through 4 of Table 5 (i.e., when the measure of school disadvantage is the percentage of URM students in the school); in particular, the relationship between the percentage of FRL students in a school and the probability of within-district transfer is *negative* for novice teachers but becomes increasingly positive as teacher experience increases.

When we allow the relationships among school percentage of FRL students, teacher experience, and log-odds of within-district transfer to vary across districts with different CBA voluntary (columns 5–6) and involuntary (columns 7–8) transfer provisions, we also see similar patterns to those in Table 5. The results for voluntary transfer provisions are directionally consistent with the results in Table 5 but not statistically significant, suggesting perhaps that teachers are more attuned to the racial composition of a school than the level of poverty, in terms of their mobility decisions (Scafidi et al., 2007). The findings for involuntary transfer provisions in columns 7 through 8 of Table 8 are perfectly consistent with the results from Table 5, from which we conclude that our estimates of the impact of involuntary transfer provisions are robust to the measure of school disadvantage that we consider.

Other types of teacher moves (out of district and workforce)

In Table 5, the outcome variable is the log odds of p_{ijkt}, the probability that teacher *i* in school *j*, district *k*, and year *t* will transfer to another school in the district the following year (relative to staying in the same school). In Tables 9 and 10, we consider two other outcome variables: in Table 9, the outcome

variable is the log odds that a teacher will transfer to a school *in another district* (relative to staying in the same school); and in Table 10, the outcome variable is the log odds that a teacher *will leave the in-state teaching workforce* (relative to staying in the same school).[58] As we discuss in section II, the only outcome that CBA transfer provisions should be expected to influence *directly* is within-district transfer decisions. But transfer provisions may also indirectly affect the decisions of teachers to stay in their districts because of the role these provisions play in influencing teachers' within-district job options. For example, junior teachers who may be frustrated by an inability to transfer out of less desirable schools, in part because of strong CBA seniority transfer provisions, might be more inclined to leave their districts for other job opportunities in or outside of public schools. For this reason, we also consider other types of teacher moves.

The results in columns 1 through 4 of Tables 9 and 10 are consistent with results from the existing literature on teacher mobility (Goldhaber et al., 2010; Hanushek et al., 2004; Scafidi et al., 2007): The probability that a teacher will leave the district or workforce increases with the percentage of URM students in the school, and this relationship is stronger for veteran teachers than novice teachers. However, when we allow these relationships to vary across districts with different CBA transfer provisions (columns 5–8 of Tables 9 and 10), no consistent patterns emerge. In fact, in the models with district control variables (columns 5 and 7 of Tables 9 and 10), only 3 of the 36 interaction terms are statistically significant at the .05 significance level, which is only slightly more than we would expect by random chance. Our conclusion is that CBA transfer provisions are not an important factor in teacher transfers out of the school district or profession.

Falsification Tests

A significant shortcoming of our analysis is that we cannot distinguish between voluntary and involuntary teacher transfers; we only observe whether a teacher switches schools. However, as we

[58] This category includes teachers who retire, switch professions, or leave for a teaching job in another state.

discuss in section III, involuntary and voluntary transfers are more likely in some situations than others. Specifically, involuntary transfers should be more likely when a school experiences a sharp decrease in enrollment and staffing, while voluntary transfers should be more likely in districts with expanding enrollments and staffs (and therefore more jobs to transfer into). As falsification tests, therefore, we estimate our models separately for teachers in different types of schools: (a) teachers in schools that will experience a sharp drop in enrollment or staffing the following year and (b) teachers in districts that will experience a sharp increase in enrollment or staffing the next year. We hypothesize that involuntary transfer provisions should be more important for teachers in group (a), while voluntary transfer provisions should be more important for teachers in group (b).

Our findings largely support this conclusion. Namely, when we limit the data set to the subset of teachers in schools that we know will experience sharp decreases in enrollment the following year (we use two cutoffs: at least a 10% decrease and at least a 25% decrease), the results are directionally consistent with the results in section VI for involuntary transfer provisions (and the coefficients on involuntary transfer provisions are larger than the coefficients on voluntary transfer provisions). This is also true when we consider changes in staffing; the coefficients on involuntary transfer provisions are *larger* in schools that will experience a decrease in teaching positions the following year but *not statistically significant* in schools with staffing levels that will stay the same or increase the following year.

Our findings for districts that expanded are also consistent with our hypothesis that *voluntary* transfer provisions should be more important in these districts. For example, the estimated coefficient on the interaction between the percentage of URM students and seniority's being the only factor in voluntary transfer decisions is 0.433 (SE = 0.157) for all teachers, 0.519 (SE = 0.190) for teachers in districts that grew at all, and 0.646 (SE = 0.168) for teachers in districts that grew by at least 2%. Taken together, these falsification tests give little reason to question our primary results.

X. Conclusions

This paper represents the first attempt to connect CBA transfer provisions to patterns of teacher mobility within school districts. Our empirical findings are remarkably consistent with the hypothesized ways in which transfer provisions in CBAs might affect the mobility of teachers of varying seniority: The pattern of veteran teachers' leaving disadvantaged schools and novice teachers' staying in disadvantaged schools is more pronounced in districts with strong CBA seniority transfer protections. In short, seniority transfer protections appear to matter in terms of the movement of teachers within school districts. Coupled with evidence that teachers tend to transfer to more advantaged schools, this suggests that CBA transfer provisions could be one of the factors that contribute to the inequitable distribution of teacher experience within districts in Washington State (see Goldhaber et al., 2014). Further, our simulation study (described in section VII) suggests that the contribution of CBA transfer provisions to this inequity is likely to be small but meaningful.

A legitimate question, however, is whether we should consider these patterns to be a problem. From a teacher's perspective, the provisions in teacher CBAs *should* be a reflection of teacher preferences, and empirical evidence suggests that many teachers prefer to have the option to leave disadvantaged schools as they advance in their careers. From a policy perspective, however, the resulting inequities in the distribution of teacher experience only exacerbate well-documented achievement gaps between advantaged and disadvantaged students. These two perspectives are likely brought to the table by teachers unions and districts, respectively. Therefore, this paper provides some empirical evidence to inform negotiations between these groups, as well as legislation by state and federal policy makers with greater power to determine the scope of bargaining (Cohen et al., 2008).

Moreover, the findings from our models that include estimates of teacher effectiveness suggest one way that CBA seniority transfer protections could actually *mitigate* the inequitable distribution of teacher quality. If a position in an advantaged school must be moved to a disadvantaged school, a

principal in a district where seniority plays no role in transfer decisions may be able to protect her effective, less experienced teachers from involuntary transfer. However, our results suggest that this is not the case in a district where seniority is the only factor in this decision.[59]

It is also important to acknowledge the drawbacks of this analysis and suggest directions for future study. A significant shortcoming of our analysis (discussed in section IX) is our inability to distinguish between voluntary and involuntary teacher transfers. However, two recent papers suggest future directions for research on CBA transfer provisions; Boyd et al. (2011) collect data from New York City on teachers' transfer applications (allowing them to distinguish between transfers initiated by teacher and administrator preference), while Grissom et al. (2014) collect data on involuntary transfers within one district (Miami-Dade County) with a CBA that gives administrators the ability to transfer teachers to another school "when deemed in the best interest of the school system." If similar data were collected across multiple districts *with different CBA transfer provisions*, they could be used to further explore the relationship between these provisions and teacher mobility, potentially strengthening the conclusions from this analysis.

Both litigation (e.g., *Vergara v. California*, 2014) and policy changes (e.g., Greenhouse, 2011) are altering the extent to which seniority is being used to drive teacher personnel decisions. This should allow for better inferences about the role such provisions play in influencing the distribution of teachers and, through this, student outcomes. In particular, time will tell whether districts continue to operate by preferencing seniority even when no longer contractually required to do so (as suggested by Koski & Horng, 2007 and Cohen-Vogel et al. 2013), or whether elimination of CBA seniority transfer protections contributes to a more equitable distribution of teacher talent (as suggested by Moe, 2005 and Anzia & Moe, 2014a). Until these natural experiments have run their course, we view our results as the most convincing evidence that CBA seniority transfer provisions represent an important policy lever with the

[59] We caution that only about 25% of our sample taught in a school with at least a 3% drop in enrollment the following year, so this likely only explains part of this result.

potential to influence the distribution of teachers.

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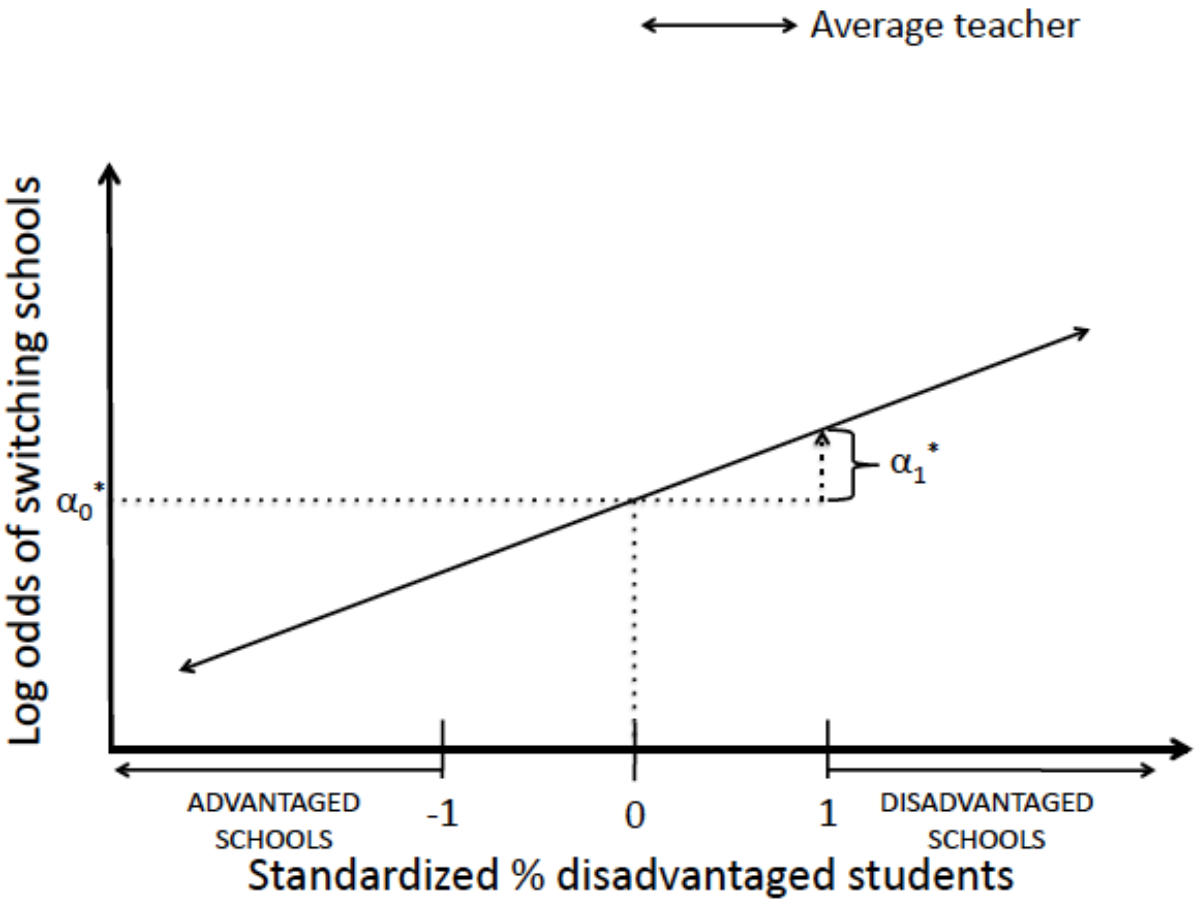
Figures

Figure 1. Conceptual figure of relationship between school disadvantage and within-district transfers (equation 1)

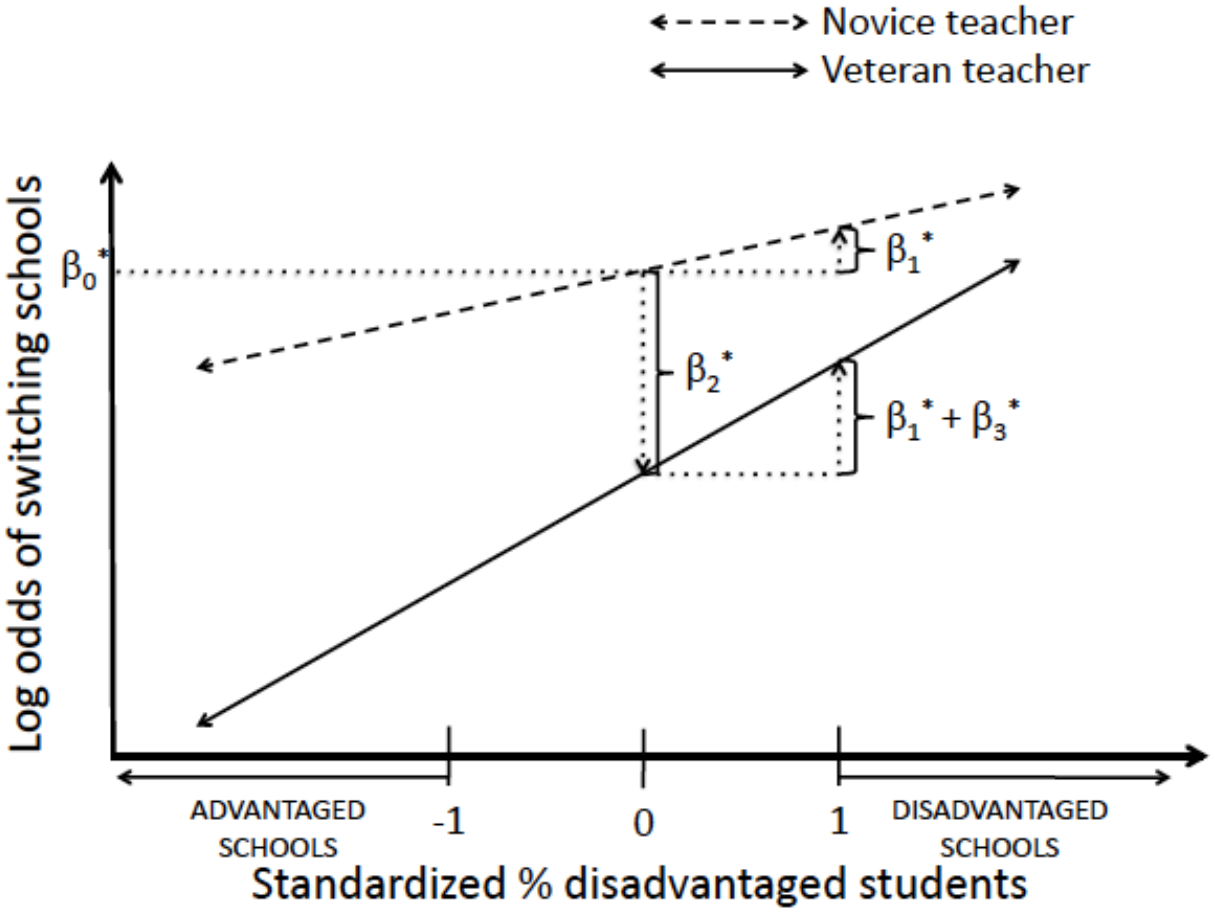


Coefficients of Interest in Figure 1

α_0^* = expected log odds of switching schools for teacher in "average" school

α_1^* = expected change in log odds of switching schools for each standard deviation increase in % disadvantaged students

Figure 2. Conceptual figure of two-way interaction teacher transfer model (equation 2)



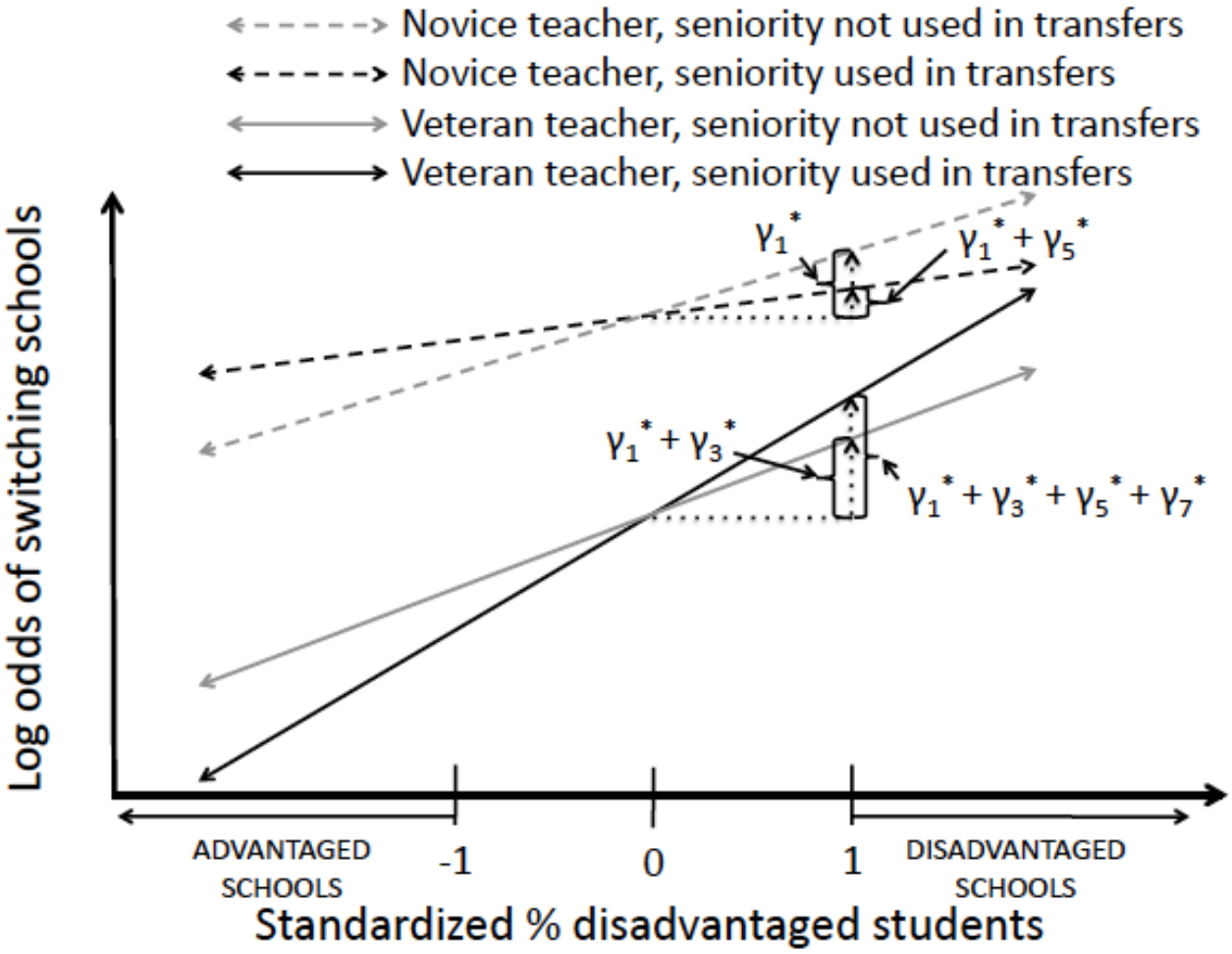
Coefficients of Interest in Figure 2

β_1^* = expected change in log odds of switching schools for each standard deviation increase in % disadvantaged students *for novice teachers*

β_2^* = expected difference in the log odds of teacher transfer between veteran teachers and novice teachers *in an average school*

β_3^* = expected *change* in the relationship between % disadvantaged students in the school and the log odds of teacher transfer *for veteran teachers relative to novice teachers*

Figure 3. Conceptual figure of three-way interaction teacher transfer model (equation 3)

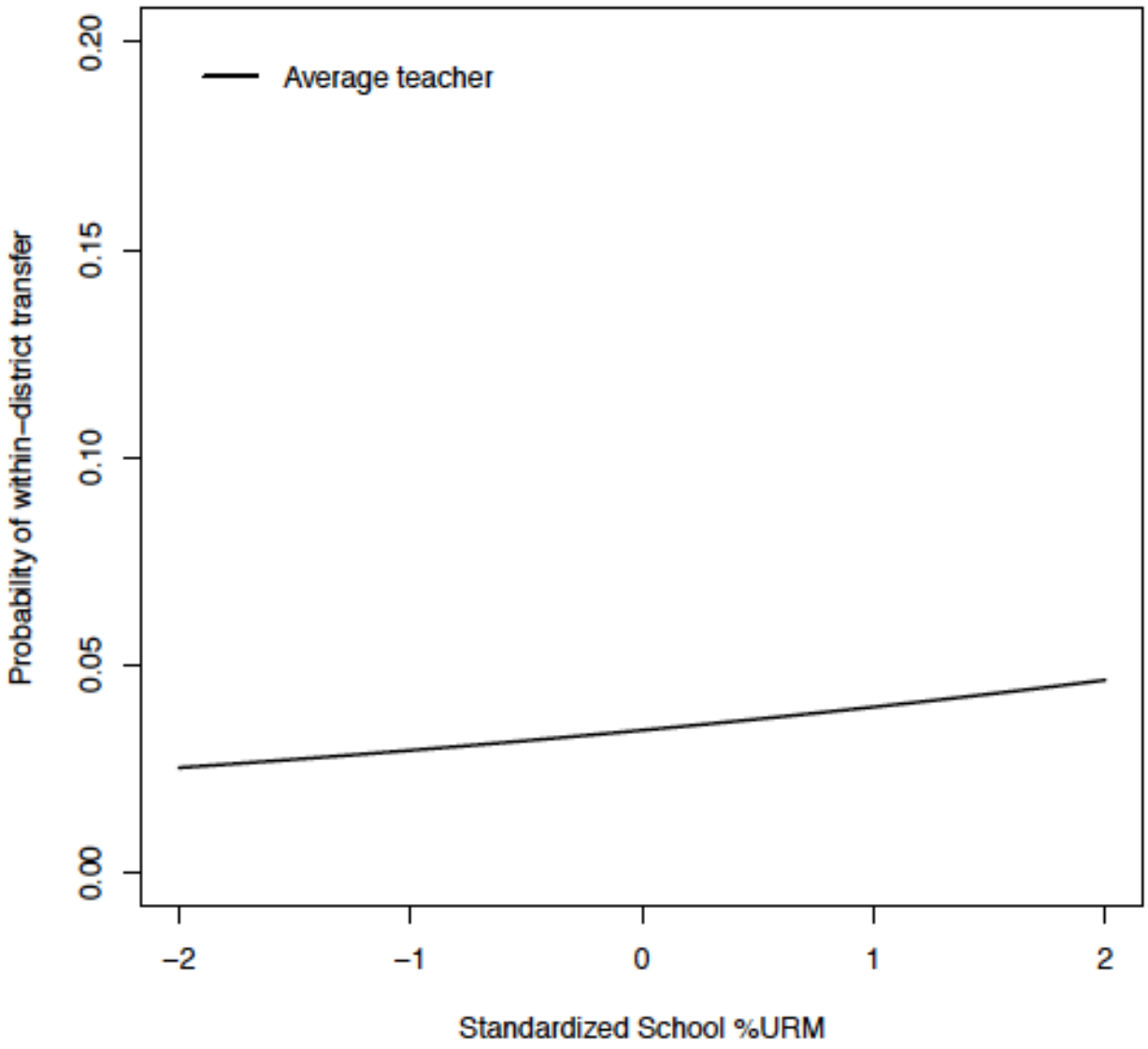


Coefficients of Interest in Figure 3

γ_5^* = expected change in the relationship between % disadvantaged students in a school and probability of transfer *for novice teachers* between districts that either consider or do not use seniority in transfer decisions.

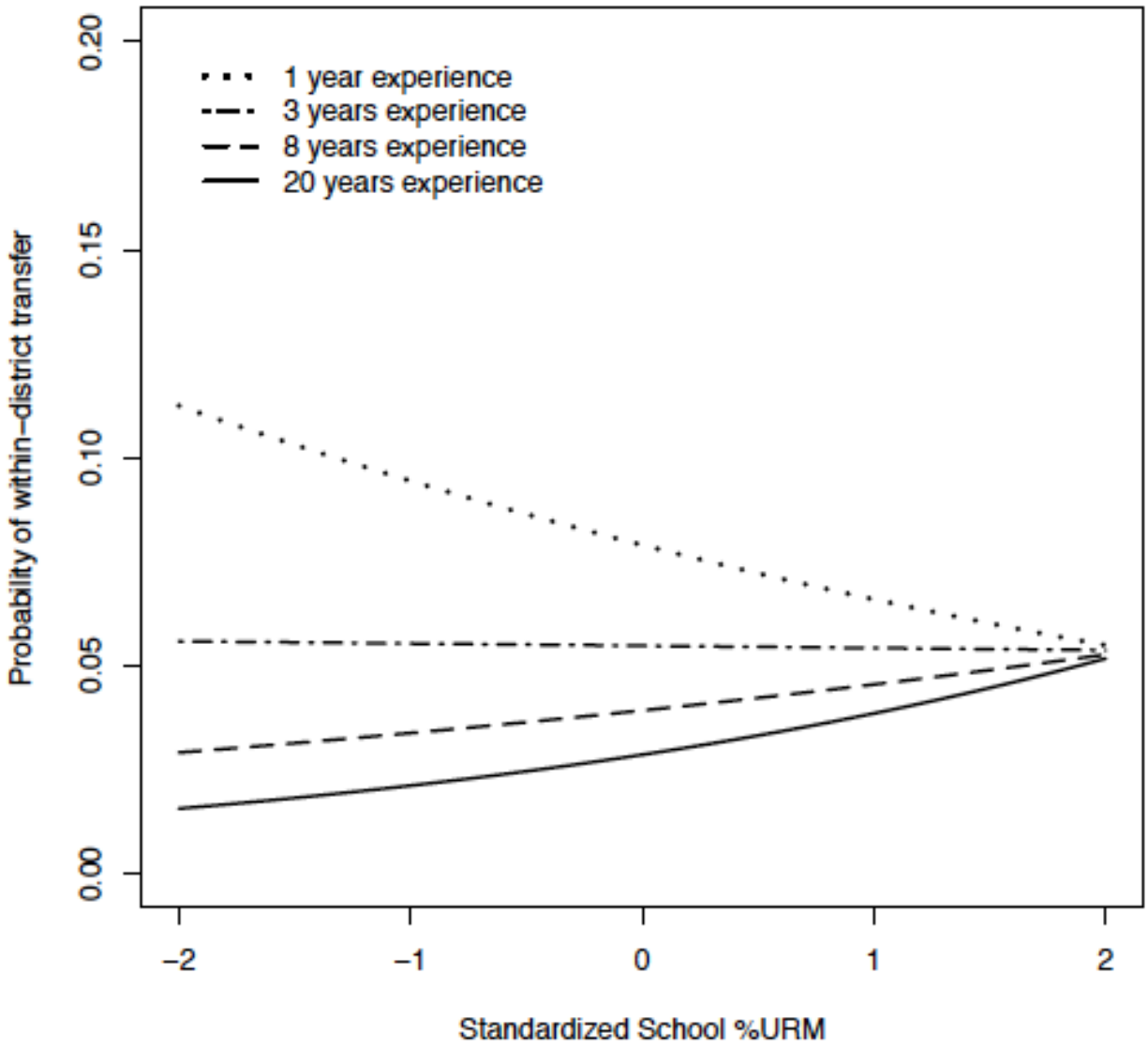
γ_7^* = expected change in interaction between teacher experience and % disadvantaged students between districts that do and do not use seniority in teacher transfer decisions.

Figure 4. Estimated relationship between percentage of URM students in school and probability of within-district transfer



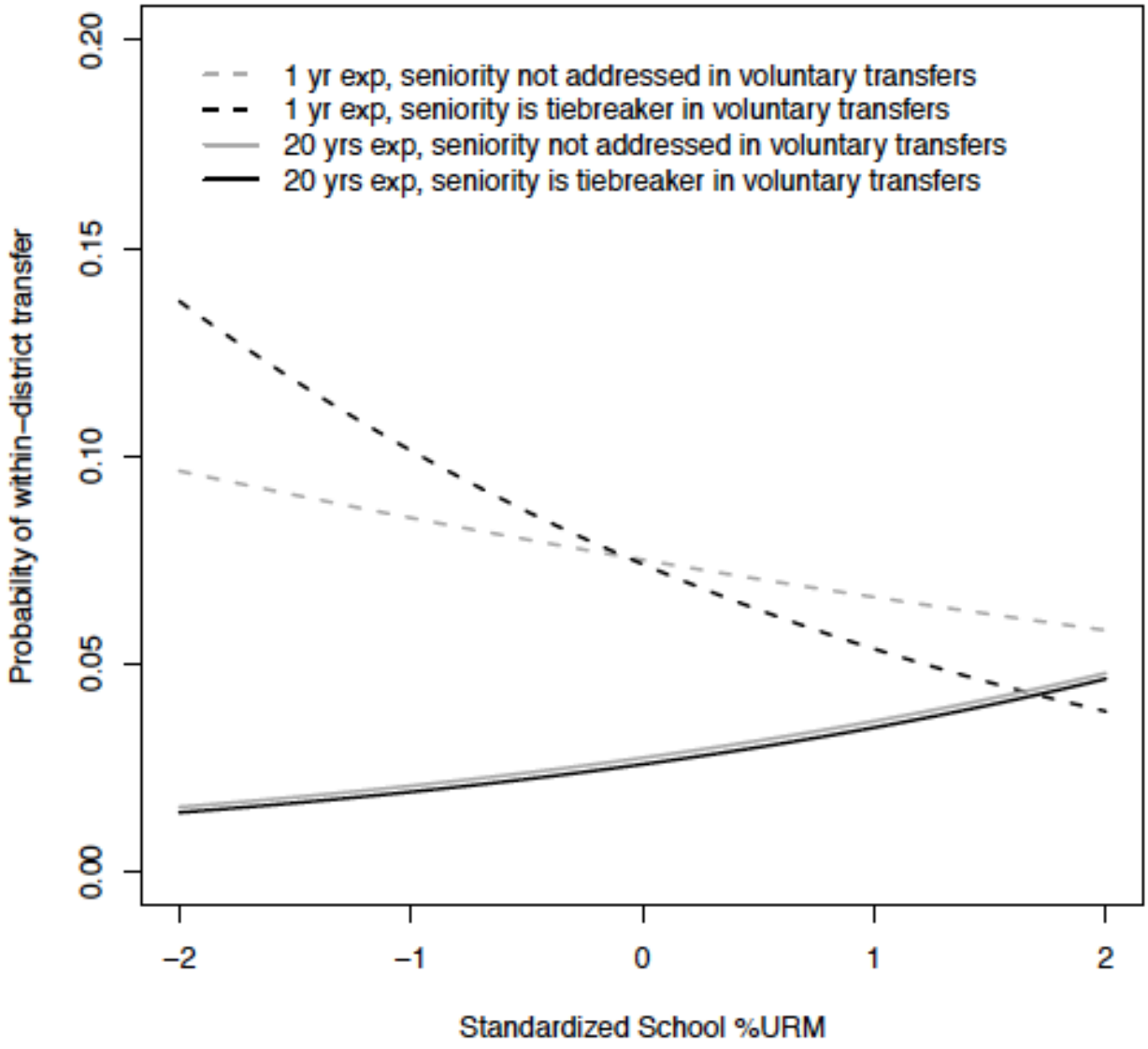
*NOTE: Predicted probabilities of within-district transfer (relative to staying in the same school) are from the model reported in Column 1 of Table 5 with all other covariates set to zero (i.e., average values for continuous variables and reference category for categorical variables).

Figure 5. Estimated relationship between percentage of URM students in school and probability of within-district transfer for teachers of different experience levels



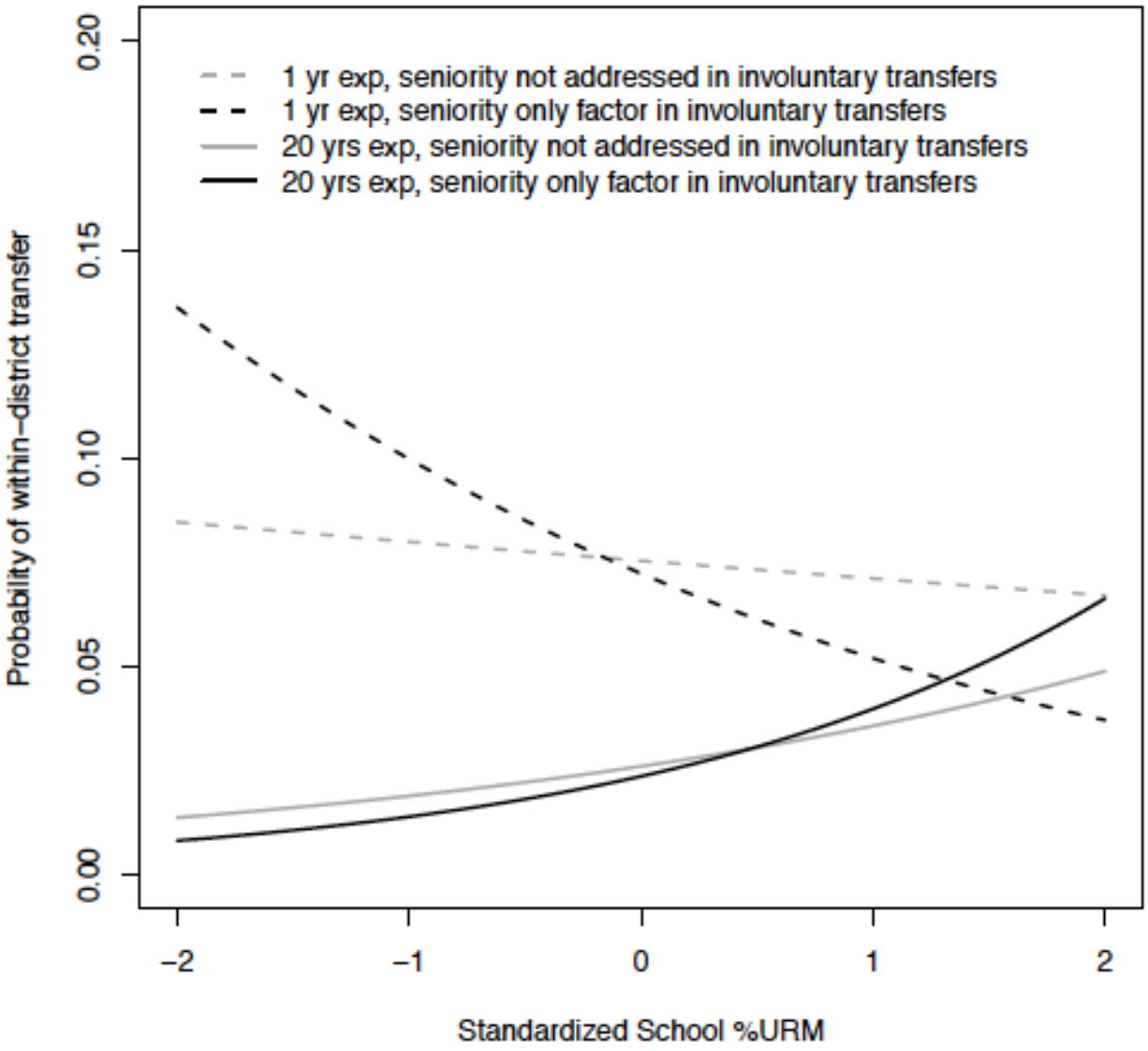
*NOTE: Predicted probabilities of within-district transfer (relative to staying in the same school) are from the model reported in Column 3 of Table 5 with all other covariates set to zero (i.e., average values for continuous variables and reference category for categorical variables).

Figure 6. Estimated relationship between percentage of URM students in school and probability of within-district transfer for teachers of different experience levels in districts with different CBA voluntary transfer provisions



*NOTE: Predicted probabilities of within-district transfer (relative to staying in the same school) are from the model reported in Column 5 of Table 5 with all other covariates set to zero (i.e., average values for continuous variables and reference category for categorical variables).

Figure 7. Estimated relationship between percentage of URM students in school and probability of within-district transfer for teachers of different experience levels in districts with different CBA involuntary transfer provisions



*NOTE: Predicted probabilities of within-district transfer (relative to staying in the same school) are from the model reported in Column 7 of Table 5 with all other covariates set to zero (i.e., average values for continuous variables and reference category for categorical variables).

Tables

Table 1. Summary statistics (2005–2006 through 2011–2012 school years)

Level	Teacher years	School years	District years	CBAs
Sample size	**N = 190469**	**N = 7159**	**N = 944**	**N = 471**
Teacher variables				
Experience	13.274 (9.282)			
Male	27.4%			
Nonwhite teacher	8.0%			
Master's degree	66.0%			
STEM endorsement	17.9%			
SPED endorsement	17.8%			
Elem endorsement	57.7%			
ELL endorsement	4.8%			
RIF Notice	1.1%			
School variables				
Elementary school	53.6%	61.8%		
Middle school	19.6%	16.8%		
High school	26.8%	21.4%		
School enrollment (standardized)	0.583 (0.926)	0.110 (0.974)		
School growth (standardized)	-0.025 (0.726)	0.015 (1.116)		
School %URM (standardized)	0.001 (0.943)	-0.004 (0.974)		
District variables				
District log enrollment (standardized)	1.234 (0.604)	1.059 (0.750)	0.220 (0.882)	
District %URM (standardized)	0.045 (0.773)	0.040 (0.801)	0.016 (0.973)	
District SD %URM (standardized)	0.389 (0.961)	0.346 (0.979)	0.004 (0.981)	
CBA variables				
Seniority prohibited from use (voluntary)	12.4%	11.9%	9.3%	8.1%
Seniority not addressed (voluntary)	31.5%	35.7%	52.0%	51.2%
Seniority one of several factors (voluntary)	24.1%	22.6%	18.0%	18.5%
Seniority is tiebreaker (voluntary)	25.8%	23.5%	16.1%	17.4%
Seniority only factor (voluntary)	6.3%	6.3%	4.6%	4.9%
Seniority prohibited from use (involuntary)	6.9%	6.7%	6.4%	6.2%
Seniority not addressed (involuntary)	25.6%	29.7%	49.4%	48.5%
Seniority one of several factors (involuntary)	15.3%	15.0%	15.4%	15.1%
Seniority is tiebreaker (involuntary)	27.4%	25.6%	18.2%	17.9%
Seniority only factor (involuntary)	24.7%	23.1%	10.6%	12.3%

Table 2. Percentage of CBAs with combinations of seniority transfer provisions (voluntary and involuntary)

CBA variables	Seniority prohibited from use (involuntary)	Seniority not addressed (involuntary)	Seniority one of several factors (involuntary)	Seniority is tiebreaker (involuntary)	Seniority only factor (involuntary)
Seniority prohibited from use (voluntary)	4.5%	1.7%	1.1%	0.4%	0.4%
Seniority not addressed (voluntary)	0.2%	37.8%	5.1%	4.0%	4.0%
Seniority one of several factors (voluntary)	1.1%	3.4%	8.3%	3.8%	1.9%
Seniority is tiebreaker (voluntary)	0.4%	4.0%	0.2%	8.1%	4.7%
Seniority only factor (voluntary)	0.0%	1.7%	0.4%	1.5%	1.3%

Table 3. Transfer rates by experience level and CBA transfer provision

	Experience level	Same school	Different school, same district	Different district	Leaves teaching workforce
All Districts	0–2 years	75.7%	8.8%	4.6%	10.9%
	2–5 years	84.4%	5.7%	2.0%	7.9%
	5–10 years	87.2%	4.9%	1.2%	6.6%
	10+ years	88.8%	3.8%	0.6%	6.9%
BY CBA VOLUNTARY transfer provision	**Experience level**	**Same school**	**Different school, same district**	**Different district**	**Leaves teaching workforce**
Seniority prohibited from use (8.1% of CBAs)	0–2 years	75.3%	8.2%	4.5%	12.0%
	2–5 years	83.4%	5.8%	1.6%	9.2%
	5–10 years	85.5%	5.6%	1.2%	7.8%
	10+ years	88.1%	3.9%	0.7%	7.3%
Seniority not addressed (47.4% of CBAs)	0–2 years	74.0%	9.2%	5.6%	11.3%
	2–5 years	83.9%	5.7%	2.4%	8.1%
	5–10 years	86.9%	5.2%	1.5%	6.5%
	10+ years	88.3%	4.1%	0.7%	6.9%
Seniority one of several factors (19.3% of CBAs)	0–2 years	78.1%	7.9%	3.6%	10.4%
	2–5 years	85.7%	5.3%	1.7%	7.3%
	5–10 years	87.9%	4.2%	1.2%	6.7%
	10+ years	88.9%	3.6%	0.7%	6.8%
Seniority is tiebreaker (19.3% of CBAs)	0–2 years	76.0%	9.4%	4.4%	10.2%
	2–5 years	84.3%	6.1%	1.9%	7.8%
	5–10 years	87.7%	5.1%	1.2%	6.0%
	10+ years	89.3%	3.5%	0.4%	6.7%
Seniority only factor (5.6% of CBAs)	0–2 years	72.9%	10.8%	4.7%	11.6%
	2–5 years	83.7%	6.4%	2.4%	7.5%
	5–10 years	87.6%	4.2%	0.8%	7.3%
	10+ years	89.4%	3.5%	0.6%	6.5%
BY CBA INVOLUNTARY transfer provision	**Experience level**	**Same school**	**Different school, same district**	**Different district**	**Leaves teaching workforce**
Seniority prohibited from use (6.1% of CBAs)	0–2 years	77.2%	6.5%	4.8%	11.4%
	2–5 years	87.0%	3.6%	1.8%	7.6%
	5–10 years	87.9%	3.8%	1.4%	7.0%
	10+ years	88.1%	3.8%	0.8%	7.3%
Seniority not addressed (44.4% of CBAs)	0–2 years	74.8%	8.8%	5.1%	11.3%
	2–5 years	84.7%	5.2%	2.2%	8.0%
	5–10 years	86.8%	5.4%	1.4%	6.5%
	10+ years	88.4%	3.9%	0.8%	6.9%
Seniority one of several factors (15.4% of CBAs)	0–2 years	75.2%	8.1%	5.6%	11.2%
	2–5 years	83.9%	6.0%	2.1%	8.0%
	5–10 years	87.3%	4.7%	1.5%	6.5%
	10+ years	88.9%	3.9%	0.7%	6.5%
Seniority is tiebreaker (20.1% of CBAs)	0–2 years	76.2%	8.9%	3.9%	11.0%
	2–5 years	84.3%	5.9%	1.9%	7.9%
	5–10 years	87.7%	4.5%	1.1%	6.6%
	10+ years	88.9%	3.7%	0.5%	6.9%
Seniority only factor (13.9% of CBAs)	0–2 years	75.9%	9.9%	4.0%	10.1%
	2–5 years	83.7%	6.5%	1.8%	8.0%
	5–10 years	86.9%	5.3%	1.1%	6.8%
	10+ years	89.1%	3.6%	0.5%	6.9%

Table 4. Average standardized %URM at sending and receiving schools for *within-district* transfers

	Experience level	**Receiving school**	**Sending school**	**Difference**
All Districts	0–2 years	0.054	0.070	–0.016*
	2–5 years	0.103	0.125	–0.022*
	5–10 years	0.093	0.116	–0.023*
	10+ years	0.078	0.089	-0.011*
BY CBA *VOLUNTARY* transfer provision	**Experience level**	**Receiving school**	**Sending school**	**Difference**
Seniority prohibited from use	0–2 years	0.001	0.044	–0.043*
	2–5 years	0.042	0.078	–0.036*
	5–10 years	-0.013	0.026	-0.039*
	10+ years	-0.102	-0.061	-0.040*
Seniority not addressed	0-2 years	-0.030	0.015	-0.045*
	2-5 years	-0.030	0.018	-0.049*
	5-10 years	-0.015	0.031	-0.045*
	10+ years	-0.066	-0.038	-0.028*
Seniority one of several factors	0-2 years	0.235	0.245	-0.010
	2-5 years	0.213	0.238	-0.025*
	5-10 years	0.306	0.332	-0.026*
	10+ years	0.242	0.264	-0.021*
Seniority is tiebreaker	0-2 years	0.028	-0.007	0.035*
	2-5 years	0.185	0.169	0.016
	5-10 years	0.115	0.098	0.017*
	10+ years	0.286	0.246	0.040*
Seniority only factor	0–2 years	-0.005	0.024	-0.029*
	2–5 years	0.109	0.123	-0.013
	5–10 years	0.099	0.138	-0.040*
	10+ years	-0.196	-0.172	-0.024*
BY CBA *INVOLUNTARY* transfer provision	**Experience level**	**Receiving school**	**Sending school**	**Difference**
Seniority prohibited from use	0-2 years	0.094	0.100	-0.006
	2–5 years	-0.081	-0.098	0.017
	5–10 years	0.104	0.109	-0.005
	10+ years	0.099	0.135	-0.036
Seniority not addressed	0–2 years	0.155	0.156	-0.001
	2–5 years	0.149	0.159	-0.010
	5–10 years	0.067	0.093	-0.026*
	10+ years	-0.039	-0.028	-0.010*
Seniority one of several factors	0–2 years	-0.027	-0.021	-0.005
	2–5 years	-0.107	-0.075	-0.032*
	5–10 years	-0.021	-0.021	0.000
	10+ years	-0.082	-0.080	-0.002
Seniority is tiebreaker	0–2 years	0.102	0.091	0.011
	2–5 years	0.310	0.308	0.002
	5–10 years	0.290	0.299	-0.009
	10+ years	0.307	0.282	0.024*
Seniority only factor	0–2 years	-0.060	0.007	-0.067*
	2–5 years	0.005	0.062	-0.058*
	5–10 years	-0.007	0.044	-0.050*
	10+ years	0.048	0.098	-0.050*

NOTE: Significance levels from two-sided *t*-test: *p <.05.

Table 5. Relationships between teacher *experience*, school percentage of *URM students*, CBA transfer provisions, and probability of *within-district* transfer

	Logistic regression outcome: Teacher transfers to another school in district (relative to stays in school)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Type of CBA transfer provisions	**NONE**				**VOLUNTARY**		**INVOLUNTARY**	
Log experience	-0.397*** (0.019)	-0.428*** (0.014)	-0.357*** (0.078)	-0.503*** (0.051)	-0.353*** (0.082)	-0.505*** (0.053)	-0.372*** (0.084)	-0.529*** (0.053)
School %URM (standardized)	0.157*** (0.034)	0.140*** (0.025)	-0.195** (0.070)	-0.092* (0.037)	-0.137 (0.149)	-0.235 (0.139)	-0.063 (0.155)	-0.250 (0.138)
School %URM * log experience			0.168*** (0.030)	0.112*** (0.013)	0.142* (0.059)	0.068 (0.043)	0.130* (0.062)	0.056 (0.044)
Seniority prohibited from use					-0.106 (0.136)		-0.331 (0.172)	
Seniority one of several factors					-0.106 (0.115)		0.024 (0.123)	
Seniority is tiebreaker					-0.015 (0.128)		-0.054 (0.119)	
Seniority only factor					0.132 (0.191)		-0.045 (0.133)	
School %URM * Seniority prohibited from use					0.117 (0.108)	0.124 (0.130)	-0.338* (0.146)	-0.231 (0.187)
School %URM * Seniority one of several factors					-0.081 (0.100)	-0.099 (0.104)	-0.067 (0.149)	-0.013 (0.151)
School %URM * Seniority is tiebreaker					-0.207* (0.099)	-0.303** (0.104)	-0.266* (0.105)	-0.365*** (0.106)
School %URM * Seniority only factor					0.443** (0.157)	0.153 (0.165)	-0.289* (0.141)	-0.356** (0.118)
School %URM * log experience * Seniority prohibited from use					-0.117* (0.047)	-0.091 (0.049)	0.124** (0.048)	0.109 (0.058)
School %URM * log experience * Seniority one of several factors					-0.028 (0.035)	-0.004 (0.036)	-0.043 (0.060)	0.001 (0.056)
School %URM * log experience * Seniority is tiebreaker					0.074* (0.037)	0.079* (0.036)	0.109** (0.038)	0.078* (0.037)
School %URM * log experience * Seniority only factor					-0.021 (0.043)	0.034 (0.056)	0.167*** (0.046)	0.140** (0.045)
District controls	YES	NO	YES	NO	YES	NO	YES	NO
Year/contract year fixed effects	YES	NO	YES	NO	YES	NO	YES	NO
District-by-year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Teacher/year observations	172535	172535	172535	172535	172535	172535	172535	172535

NOTES: Significance levels from two-sided *t*-test: *$p < .05$; **$p < .01$; ***$p < .001$. All coefficients are on the log odds scale. All models control for teacher gender, teacher race, teacher degree level, teacher endorsement area, teacher RIF notice receipt, school level, school enrollment, school growth, and interactions between district controls and school-level variables (enrollment and growth). District controls include district enrollment, percentage URM, school-level heterogeneity of percentage URM, and (in models that include CBA transfer provisions) CBA provision indicators. In models with teacher experience interactions, *all* control variables are interacted with teacher experience levels. Standard errors are clustered at the district/year level.

Table 6. Novice teacher gaps from simulation

Assumption	CBA Provision Governing Involuntary Transfers	%Novice in Disadvantaged Schools	%Novice in Advantaged Schools	Gap
Within-district transfers are the only source of inequity	Seniority not addressed	9.68%	9.11%	0.58%
	Seniority only factor	9.92%	9.00%	0.93%
Within-district transfers and hiring are both sources of inequity	Seniority not addressed	10.12%	8.64%	1.48%
	Seniority only factor	10.38%	8.53%	1.84%
All types of transfers and hiring are sources of inequity	Seniority not addressed	10.34%	8.42%	1.92%
	Seniority only factor	10.60%	8.32%	2.28%

*NOTE: See section V for full description of simulation.

Table 7. Relationships between teacher *value added*, school *%URMs,* CBA transfer provisions, and probability of *within-district* transfer

	Logistic regression outcome: Teacher transfers to another school in district (relative to stays in school)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Type of CBA transfer provisions	**NONE**				**VOLUNTARY**		**INVOLUNTARY**	
Teacher VAM	-0.151*** (0.031)	-0.137*** (0.031)	-0.201 (0.135)	-0.248* (0.105)	-0.115 (0.168)	-0.137 (0.110)	-0.152 (0.176)	-0.148 (0.110)
School %URM (standardized)	0.203** (0.077)	0.196** (0.063)	0.203** (0.077)	0.202** (0.063)	0.241 (0.176)	0.121 (0.331)	0.313 (0.173)	0.214 (0.328)
School %URM * teacher VAM			0.000 (0.061)	0.017 (0.028)	0.180 (0.121)	0.311* (0.130)	0.167 (0.131)	0.315* (0.131)
Seniority prohibited from use					0.097 (0.165)		-0.514 (0.285)	
Seniority one of several factors					-0.120 (0.137)		0.019 (0.154)	
Seniority is tiebreaker					0.076 (0.142)		0.027 (0.142)	
Seniority only factor					0.251 (0.198)		0.131 (0.150)	
School %URM * Seniority prohibited from use					0.040 (0.150)	-0.248 (0.234)	-0.096 (0.223)	0.727 (0.674)
School %URM * Seniority one of several factors					0.014 (0.118)	-0.284 (0.212)	-0.203 (0.146)	-0.175 (0.274)
School %URM * Seniority is tiebreaker					0.102 (0.104)	-0.096 (0.179)	0.146 (0.114)	-0.023 (0.201)
School %URM * Seniority only factor					0.403 (0.211)	-0.175 (0.339)	0.177 (0.133)	0.156 (0.192)
School %URM * teacher VAM * Seniority prohibited from use					-0.060 (0.092)	-0.101 (0.129)	-0.223 (0.190)	-0.225 (0.330)
School %URM * teacher VAM * Seniority one of several factors					-0.160 (0.093)	-0.176 (0.090)	-0.066 (0.117)	-0.118 (0.136)
School %URM * teacher VAM * Seniority is tiebreaker					-0.100 (0.061)	-0.117 (0.073)	-0.272*** (0.081)	-0.270** (0.090)
School %URM * teacher VAM * Seniority only factor					0.256 (0.131)	0.131 (0.141)	-0.231** (0.086)	-0.207* (0.100)
District controls	YES	NO	YES	NO	YES	NO	YES	NO
Year/contract year fixed effects	YES	NO	YES	NO	YES	NO	YES	NO
District-by-year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Teacher/year observations	27329	27329	27329	27329	27329	27329	27329	27329

NOTES: Significance levels from two-sided t-test: *p<.05; **p<.01; ***p<.001. All coefficients are on the log odds scale. All models control for teacher log experience, teacher gender, teacher race, teacher degree level, teacher endorsement area, teacher RIF notice receipt, school level, school enrollment, school growth, and interactions between district controls and school-level variables (enrollment and growth). District controls include district enrollment, percentage URM, school-level heterogeneity of percentage URM, and (in models that include CBA transfer provisions) CBA provision indicators. In models with teacher experience interactions, *all* control variables are interacted with teacher experience levels. Standard errors are clustered at the district/year level.

Table 8. Relationships between teacher *experience*, school percentage of *FRLs*, CBA transfer provisions, and probability of *within-district* transfer

	Logistic regression outcome: Teacher transfers to another school in district (relative to stays in school)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Type of CBA transfer provisions	**NONE**				**VOLUNTARY**		**INVOLUNTARY**	
Log experience	-0.400***	-0.428***	-0.304**	-0.486***	-0.345**	-0.549***	-0.383**	-0.557***
	(0.019)	(0.014)	(0.107)	(0.051)	(0.122)	(0.053)	(0.122)	(0.053)
School %FRL (standardized)	0.084**	0.080***	-0.141*	-0.134***	0.316	0.316	0.450*	0.328*
	(0.027)	(0.019)	(0.057)	(0.034)	(0.185)	(0.165)	(0.185)	(0.162)
School %FRL * log experience			0.106***	0.102***	-0.113	-0.167**	-0.160*	-0.171**
			(0.023)	(0.014)	(0.068)	(0.063)	(0.070)	(0.063)
Seniority prohibited from use					-0.111		-0.342*	
					(0.135)		(0.166)	
Seniority one of several factors					-0.099		-0.057	
					(0.114)		(0.124)	
Seniority is tiebreaker					-0.011		-0.076	
					(0.133)		(0.121)	
Seniority only factor					0.360		0.007	
					(0.243)		(0.138)	
School %FRL					0.048	0.134	-0.468**	-0.212
* Seniority prohibited from use					(0.112)	(0.118)	(0.154)	(0.179)
School %FRL					-0.205	-0.148	-0.134	-0.008
* Seniority one of several factors					(0.111)	(0.099)	(0.143)	(0.132)
School %FRL					-0.135	-0.117	-0.224*	-0.218*
* Seniority is tiebreaker					(0.113)	(0.096)	(0.097)	(0.097)
School %FRL					0.283	0.024	-0.194	-0.147
* Seniority only factor					(0.151)	(0.141)	(0.117)	(0.104)
School %FRL * log experience					-0.087	-0.078	0.159**	0.146*
* Seniority prohibited from use					(0.045)	(0.048)	(0.054)	(0.067)
School %FRL * log experience					0.042	0.047	0.056	0.066
* Seniority one of several factors					(0.040)	(0.039)	(0.061)	(0.053)
School %FRL * log experience					0.049	0.038	0.112**	0.098*
* Seniority is tiebreaker					(0.043)	(0.038)	(0.040)	(0.039)
School %FRL * log experience					-0.065	-0.001	0.138**	0.121**
* Seniority only factor					(0.056)	(0.056)	(0.048)	(0.042)
District controls	YES	NO	YES	NO	YES	NO	YES	NO
Year/contract year fixed effects	YES	NO	YES	NO	YES	NO	YES	NO
District-by-year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Teacher/year observations	172535	172535	172535	172535	172535	172535	172535	172535

NOTES: Significance levels from two-sided *t*-test: *$p < .05$; **$p < .01$; ***$p < .001$. All coefficients are on the log odds scale. All models control for teacher gender, teacher race, teacher degree level, teacher endorsement area, teacher RIF notice receipt, school level, school enrollment, school growth, and interactions between district controls and school-level variables (enrollment and growth). District controls include district enrollment, percentage FRL, school-level heterogeneity of percentage FRL, and (in models that include CBA transfer provisions) CBA provision indicators. In models with teacher experience interactions, all control variables are interacted with teacher experience levels. Standard errors are clustered at the district/year level.

Table 9. Relationships between teacher *experience*, school percentage of *URM students*, CBA transfer provisions, and probability of *cross-district* transfer

	Logistic regression outcome: Teacher transfers to a school in another district (relative to stays in school)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Type of CBA transfer provisions	**NONE**				**VOLUNTARY**		**INVOLUNTARY**	
Log experience	-0.917*** (0.028)	-0.910*** (0.023)	-1.068*** (0.105)	-0.981*** (0.097)	-1.104*** (0.109)	-0.952*** (0.101)	-0.991*** (0.106)	-0.951*** (0.101)
School %URM (standardized)	0.160*** (0.048)	0.191*** (0.053)	-0.076 (0.087)	0.013 (0.062)	-0.126 (0.170)	-0.141 (0.228)	-0.015 (0.178)	-0.232 (0.235)
School %URM * log experience			0.140** (0.050)	0.106*** (0.020)	0.094 (0.087)	0.144* (0.065)	0.031 (0.091)	0.122 (0.068)
Seniority prohibited from use					-0.093 (0.186)		0.090 (0.204)	
Seniority one of several factors					-0.341* (0.160)		0.286 (0.160)	
Seniority is tiebreaker					-0.059 (0.153)		0.161 (0.166)	
Seniority only factor					0.203 (0.177)		0.064 (0.164)	
School %URM * Seniority prohibited from use					0.104 (0.122)	0.213 (0.216)	0.144 (0.113)	0.430 (0.273)
School %URM * Seniority one of several factors					0.115 (0.096)	-0.009 (0.173)	0.050 (0.153)	0.248 (0.229)
School %URM * Seniority is tiebreaker					-0.126 (0.093)	-0.186 (0.184)	-0.180 (0.096)	-0.069 (0.180)
School %URM * Seniority only factor					0.023 (0.142)	-0.115 (0.306)	-0.277 (0.147)	-0.372 (0.203)
School %URM * log experience * Seniority prohibited from use					-0.053 (0.061)	-0.066 (0.071)	-0.167* (0.080)	-0.125 (0.074)
School %URM * log experience * Seniority one of several factors					-0.092 (0.054)	-0.038 (0.055)	-0.055 (0.082)	-0.013 (0.085)
School %URM * log experience * Seniority is tiebreaker					0.031 (0.049)	0.041 (0.059)	0.018 (0.053)	0.027 (0.055)
School %URM * log experience * Seniority only factor					0.094 (0.057)	0.068 (0.092)	0.058 (0.074)	0.110 (0.079)
District controls	YES	NO	YES	NO	YES	NO	YES	NO
Year/contract year fixed effects	YES	NO	YES	NO	YES	NO	YES	NO
District-by-year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Teacher/year observations	165923	165923	165923	165923	165923	165923	165923	165923

NOTES: Significance levels from two-sided *t*-test: *$p < .05$; **$p < .01$; ***$p < .001$. All coefficients are on the log odds scale. All models control for teacher gender, teacher race, teacher degree level, teacher endorsement area, teacher RIF notice receipt, school level, school enrollment, school growth, and interactions between district controls and school-level variables (enrollment and growth). District controls include district enrollment, percentage URM, school-level heterogeneity of percentage URM, and (in models that include CBA transfer provisions) CBA provision indicators. In models with teacher experience interactions, *all* control variables are interacted with teacher experience levels. Standard errors are clustered at the district/year level.

Table 10. Relationships between teacher *experience*, school percentage of *URM students*, CBA transfer provisions, and probability of *exiting* the state workforce

	Logistic regression outcome: Teacher leaves the in-state teaching workforce (relative to stays in school)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Type of CBA transfer provisions	**NONE**				**VOLUNTARY**		**INVOLUNTARY**	
Log experience	-0.114***	-0.092***	-0.352***	-0.340***	-0.358***	-0.334***	-0.312***	-0.317***
	(0.018)	(0.011)	(0.062)	(0.040)	(0.068)	(0.042)	(0.070)	(0.042)
School %URM (standardized)	0.124**	0.133***	-0.003	-0.022	0.270	0.049	0.235	-0.073
	(0.039)	(0.021)	(0.099)	(0.033)	(0.224)	(0.117)	(0.217)	(0.118)
School %URM * log experience			0.056	0.069***	-0.044	0.021	-0.021	0.049
			(0.031)	(0.011)	(0.069)	(0.034)	(0.068)	(0.036)
Seniority prohibited from use					0.148		-0.039	
					(0.156)		(0.215)	
Seniority one of several factors					-0.063		0.067	
					(0.121)		(0.126)	
Seniority is tiebreaker					-0.289		-0.040	
					(0.156)		(0.130)	
Seniority only factor					0.043		0.042	
					(0.160)		(0.149)	
School %URM					0.111	0.221	0.021	0.191
* Seniority prohibited from use					(0.116)	(0.118)	(0.151)	(0.146)
School %URM					0.124	0.195*	0.266*	0.317*
* Seniority one of several factors					(0.100)	(0.094)	(0.130)	(0.134)
School %URM					0.041	0.232*	-0.011	0.047
* Seniority is tiebreaker					(0.128)	(0.095)	(0.094)	(0.094)
School %URM					0.058	0.010	0.092	0.185
* Seniority only factor					(0.149)	(0.157)	(0.161)	(0.107)
School %URM * log experience					-0.007	-0.025	-0.018	0.007
* Seniority prohibited from use					(0.048)	(0.041)	(0.051)	(0.045)
School %URM * log experience					-0.063	-0.065*	-0.119*	-0.110*
* Seniority one of several factors					(0.039)	(0.032)	(0.050)	(0.047)
School %URM * log experience					-0.022	-0.014	0.015	0.021
* Seniority is tiebreaker					(0.046)	(0.032)	(0.035)	(0.031)
School %URM * log experience					0.037	0.061	-0.026	0.001
* Seniority only factor					(0.054)	(0.056)	(0.052)	(0.040)
District controls	YES	NO	YES	NO	YES	NO	YES	NO
Year/contract year fixed effects	YES	NO	YES	NO	YES	NO	YES	NO
District-by-year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Teacher/year observations	177532	177532	177532	177532	177532	177532	177532	177532

NOTES: Significance levels from two-sided *t*-test: *$p < .05$; **$p < .01$; ***$p < .001$. All coefficients are on the log odds scale. All models control for teacher gender, teacher race, teacher degree level, teacher endorsement area, teacher RIF notice receipt, school level, school enrollment, school growth, and interactions between district controls and school-level variables (enrollment and growth). District controls include district enrollment, percentage URM, school-level heterogeneity of percentage URM, and (in models that include CBA transfer provisions) CBA provision indicators. In models with teacher experience interactions, *all* control variables are interacted with teacher experience levels. Standard errors are clustered at the district/year level.