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Teacher Stability and Turnover in Los Angeles: The Influence of Teacher and School Characteristics

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The Influence of Teacher and School Characteristics

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Abstract

In this paper, we investigate the effects of teacher characteristics and school context on the timing of teachers' decisions to exit schools where they teach. The two-level discrete-time survival analysis framework allows for simultaneous examinations of who exits, when, and under what conditions. Our results for a large sample of teachers in the Los Angeles Unified School District observed from 2002-03 to 2008-09 affirm the importance of school context such as type of school (e.g., charter) and school organizational characteristics (e.g., teacher-students racial match in some context), above and beyond individual teacher characteristics and qualifications. In addition, differences in the relationship between some factors and teacher turnover are observed between elementary and secondary teachers.

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Introduction

In this paper, we investigate the effects of teacher characteristics and school social context on the timing of teachers' decisions to exit schools where they teach. Understanding who leaves, when, and under what conditions is important for policy formulations that target teacher retention, especially of teachers in inner city schools and shortage specialty areas (e.g., mathematics, sciences, and special education).

Research shows that the quality of the teacher is the single most important factor within the control of schools that contributes directly to pupil learning and achievement (Darling-Hammond, 2002; Hanushek,1992; Loucks-Horsley, 1999; Rockoff, 2004; Sanders,1998; Sanders & Rivers, 1996; Wright, Horn, & Sanders, 1997). However, we also know that high quality teachers are disproportionally found in better-off suburban schools, compared with poor urban schools (Darling-Hammond, 2003; EdSource, 2008). This shortage of high quality teacher in poor urban schools is partly a supply and partly a retention problem (EdSource, 2008; Guarino, Santibañez, and Daley, 2006). Our investigation focuses on the retention issue at the school level.

Research on teacher turnover and retention is vast and diverse in their theoretical and methodological perspectives. Empirical studies of teacher retention in general fall along the line of economical (i.e., economics) and sociological camps (i.e., sociology) and have explored a variety of factors that may influence teacher retention. These factors

range from teacher demographic characteristics and academic preparations (e.g., Guarino et al 2004), teacher compensation (e.g., Murnane and Olsen, 1989, 1990; Dolton and van der Klaluw, 1995, 1999; Hanushek, Kain and Rivkin, 2002; Ingersoll, 2001; and Loeb & Page, 2000), district hiring practices (e.g., McCarthy and Guiney, 2004), working conditions such as facilities (e.g., Bukley, Shneider, and Shang, 2005), teaching assignments (e.g., Johnson et al., 2004), and curriculum, standards, and accountability pressures (e.g., Grossman and Thompson, 2004), as well as school community factors such as school administrators (e.g., Boyd et al., 2006), and student population that teachers serve (e.g., Boyd et al, 2007; De Angelis and Presley, 2007; Lankford et al., 2002; Hanushek et. al., 2002; Scafidi et al 2007; and Theobald, 1990). These studies have provided valuable insights into the factors that shape teacher turnover, allowing researchers and policymakers to hypothesize what policy levers might contribute to teacher stability, especially in urban schools.

However, there are several limitations to the existing empirical research base. To begin with, most studies conceptualize the outcome of interest (i.e., exit or not) statically rather than dynamically. In other words, the focus is on whether or not a teacher exits, instead of both whether or not AND when a teacher exits. Part of this shortcoming might be due to the limited access to panel data that track teachers' movements in and out of schools or the teaching profession. Secondly, studies that have focused on the dynamic nature of teacher retention (i.e., both whether or not AND when) almost exclusively focus on individual teachers as an analytic level, ignoring the effect of social context on individual teachers' behaviors (i.e., decision to exit). Thirdly, studies that do focus on school context tend to model teachers' behaviors statically (i.e., exit or not) rather than

dynamically. To overcome these three shortcomings of existing empirical base, we need statistical models that combine multilevel modeling framework and event-history analysis framework (i.e., survival analysis). To the best of our knowledge, we are not aware of any study that has used this innovative methodology to examine teacher turnover (i.e., who exits, when, and under what conditions). Finally, existing studies tend to focus on either elementary or secondary teachers, or when both schooling levels are present, the analysis tends not to separate the two groups, This separate (i.e., the former) and the combined approach (i.e., the latter) prevent us from investigating both similarities and differences with respect to the relationship between teacher characteristics, school contextual factors and teacher exit at the elementary versus secondary level, in the same district.

Our research builds on and extends the existing knowledge base by overcoming the four limitations identified previously. Using two-level discrete-time survival analysis framework, we model how teacher characteristics and school social context may impact the timing of teachers' decision to exit schools where they teach on a large sample of elementary and secondary teacher panel data (from 2002-03 to 2008-09) from the Los Angeles Unified School District (LAUSD).

The LAUSD provides a unique opportunity to examine the teacher retention issue for a variety reasons. To begin with, the LAUSD is the second largest urban school district in the U.S. that serves over 670,000 K-12 students of diverse social economical, cultural, and ethnic backgrounds.[1] These students attend over 1,000 schools that are located in diverse neighborhoods, ranging from the economically disadvantaged areas in

[1] The most updated district information, LAUSD Finger Facts 2010-2011, is available at the district web: http://notebook.lausd.net/pls/ptl/docs/PAGE/CA_LAUSD/LAUSDNET/OFFICES/COMMUNICATIONS/COMMUNICATIONS_FACTS/10-11FINGERTIPFACTS_FINAL.PDF.

inner city South Central and East LA to relatively wealthy areas such as West Hollywood, West LA, Beverly Hills, and Pacific Palisades. Secondly, the LAUSD also employs one of the largest K-12 teaching forces, totaling 31,656. The size, the diversity, and the policy context of the LAUSD make it an excellent setting to studying teacher mobility issues in urban schools. While the LAUSD may have its own challenges, we believe our findings from studying the LAUSD have implications for dealing with similar issues in other large urban school contexts (e.g., New York, Chicago, and so on).

Our paper is structured as follows. In the next section, we briefly outline our conceptual framework (i.e., theoretically and methodologically). We then review and highlight relevant empirical work on teacher turnover and retention, which serves as a starting point of our own empirical inquiry. After the literature review, we describe the data and our analytic models. Next, we present our findings. In the final section, we discuss the implications and conclude.

Conceptual Framework

Theoretical Perspectives

The theoretical framework of this study is rooted in two disciplines. The first theoretical underpinning is based on the economic labor market theory of supply and demand. In this framework, teachers are treated as rationale actors who make decisions about their career choices (i.e., whether to become a teacher) and trajectories (i.e., whether to exit the current teaching assignment for better opportunities and rewards) based on whether teaching represents the most attractive occupation compared to alternatives that are available to them (Brewer, 1996; Strunk & Robinson, 2006). Under the supply and demand framework, research on teacher retention focuses on identifying

factors influencing teacher attrition (Guarino, Santibanez, & Daley, 2006). These factors include both monetary (e.g., salaries, benefits, bonuses, earning potentials, etc.) and non pecuniary ones (e.g., job satisfaction, working conditions, etc.).

Apart from considering teachers as individual rationale actors, we are also mindful of the fact that teachers are grouped in schools of different types and with different organizational characteristics. We therefore draw relevant theoretical perspectives from sociology to guide our empirical analysis of factors influencing teacher turnover as well. The benefits of a sociological perspective are nicely summarized by Ingersoll (2001) in his organizational analysis of teacher turnover:

> The theoretical perspective…, drawn from the sociology of organizations, occupations, and work, holds that teacher turnover and, in turn, school staffing problems cannot be fully understood without closely examining the characteristics of the organizations that employ teachers and also examining turnover at the level of the organization (Ingersoll, pp.500 – 501).

Schools therefore are an important organizational level in our analysis. Combining the economical and sociological perspectives, our theoretical premise is that in order to fully understand teachers' behaviors in school organizations, we need to examine the characteristics of both the teacher and the school. We discuss these teacher and school characteristics in the literature review section.

Methodological Perspectives

The objective of our study is to understand how individual teachers' behaviors such as decisions to exit current teaching position are a joint function of both who they are (an economical perspective) and what kinds of school organizational context they find

themselves in (a sociological perspective). Additionally, the phenomenon of our study emphasizes the dynamic nature of teacher exit, namely, we are interested in examining when teachers are at the greatest risk of exiting schools. This dynamic focus marks a departure from the typical teacher turnover analysis where exit is conceptualized as a status (i.e., exit or not). The theoretical perspectives and the focus of the study require both multilevel modeling and event-history analysis. The combined use of this innovative methodology is another unique feature of our study. To the best of our knowledge, we are not aware of its application in studying teacher turnover to date.

We conducted multilevel (in this context, 2-level) discrete-time survival analysis (Barber et al., 2000; Hedeker et al., 2000; Rabe-Hesketh and Skrondal, 2008), with the outcome focusing on the timing of a teacher's decision to exit the school where he or she works (i.e., the propensity of a teacher leaving a school at a time point given that he or she has not left). The multilevel modeling aspect of our analytic technique reflects our theoretical perspective, which conceptualizes that organizational dynamics and contextual factors are likely to condition the decision process made at the individual level and thereby influence individual behaviors (e.g., decision to leave a school). Toward this end, we made a deliberate effort at modeling the relationship between macro-level contextual factors and micro-level behaviors. In addition to this theoretical motivation, a multilevel modeling framework is consistent with the nested structure of the data (i.e., teachers within different schools) and is a methodologically sound choice.

Literature Review

Research on teacher turnover and retention is vast and diverse in their theoretical and methodological perspectives. Empirical studies of teacher retention in general fall

along the line of economical (i.e., economics) and sociological camps (i.e., sociology) and have explored a wide variety of factors that may influence teacher retention. Given the limited space, we strategically focus on studies that are relevant to our own empirical inquiry and briefly describe the existing knowledge base on factors influencing teacher retention that are of interest to our research. Furthermore, we do not intend to give a comprehensive review of these studies, instead we highlight the key findings. Readers who are interested in a comprehensive review should refer to review articles focusing on comprehensive literature review of teacher turnover studies (e.g., Guarino et al., 2006). In general, factors can be grouped into two categories: teacher characteristics and school characteristics.

Teacher Characteristics

We focus on the following three types of teacher characteristics variables: (1) teacher demographic backgrounds (gender, ethnicity, and age), (2) proxy measures of teacher quality and qualification (years of teaching experiences, degrees, credential, and internship status), and (3) teacher specialty areas. Teachers of different demographic backgrounds may have different preferences for working conditions. It is also plausible they have different priorities when faced with the conflict between the family and teaching obligations. Teacher quality, qualification, and specialty, on the other hand, signal different alternative opportunities compared to teaching that teachers may have depending on their levels of attractiveness defined by these measures.

Gender, race/ethnicity, and age. Prior studies on the relationship between gender and teacher turnover have produced mixed results. Some studies find that women had higher turnover rates (migration or attrition) than men (e.g., Gritz & Theobald, 1996;

Ingersoll, 2001; Kirby, Berends, & Naftel, 1999); whereas other studies suggest that men are more likely to quit teaching or transfer schools than women (e.g., Boyd et al., 2005; Ingersoll, 2001). Additionally, some research has found no gender differences in teacher turnover rates (e.g., Strunk & Robinson, 2006), while some scholars (e.g., Rees, 1991) argue that men and women have similar exit behaviors before marriage but diverge after marriage due to childrearing and family obligations. It is possible, therefore, that patterns of exit behaviors may differ among men and women of different ages. We test this hypothesis in our model by incorporating interaction terms between gender and age indicators.

In contrast, the finding on the relationship between race/ethnicity, age and teacher turnover is fairly consistent (Guarino et al., 2006). Studies in general observe that minority teachers tend to have lower turnover rates than white teachers (Adams, 1996; Ingersoll, 2001; Kirby et. al., 1999). Similarly, younger teachers have higher attrition rates than older teachers until they reach retirement eligible age (Hanushek, Kain, & Rivkin, 2002; Ingersoll, 2001; Kirby et a.., 1999).

Years of teaching experience. A U-shaped pattern of teaching experience and teacher turnover has been observed in various studies (Hanushek et al., 2002; Ingersoll, 2001). For instance, using data on more than 300,000 Texas elementary teachers between 1993-96, Hanushek et al. (2002) found that teachers who exited Texas public schools were either young with fewer than two years of teaching experience (i.e., 0-2 years) or very experienced and near retirement (30+ years). Similar findings are also observed in additional studies (e.g., Ingersoll, 2001; Murnane & Olsen, 1989a; Rees, 1991). These studies typically break years of teaching experience into different

categories (e.g., 0-2, 3-5, 6-10, 11-30, and 30+) and include them in the model. One limitation of this approach is that by collapsing years of teaching experience into a limited numbers of categories, we run the risk of masking the true relationship between experience, teacher quality, and teachers' propensity to exit a school (Wiswall, 2011). We model years of teaching experience using a quadratic function.

Degrees, credential, and internship status. In general, research has found that better qualified teachers have higher turnover rates than less qualified teachers. Qualification has been typically measured by teachers' test scores on standardized examinations (e.g., ACT) (e.g., Henke et al., 2000; Lankford, Loeb, & Wyckoff, 2002; Pdgursky, Monroe, & Watson, 2004). In our study, we use three proxy measures to signal teachers' quality and qualifications, namely, teachers' degrees, credential, and internship status, in addition to years of teaching experience discussed earlier.

Evidence regarding the relationship between degrees and teacher turnover has been mixed. Strunk and Robinson (2006) found no statistically significant relationship between teachers having advanced degrees and their propensity to leave. Kirby et al. (1999) observed that teachers entering teaching with advanced degrees were more likely to leave than those entering teaching with bachelor's degrees or less. Adams (1996), however, showed that elementary teachers with a bachelor's degree were more likely to exit than those with graduate degrees, using data from a large district in Texas. It is possible that the relationship between degrees and teacher turnover vary by the schooling level (i.e., elementary vs. secondary). We test this plausibility by modeling the relationship between various factors and teacher turnover, separately, for elementary and secondary teachers.

Teachers' credential and internship status have been used to approximate teacher quality. While we make no claim about the relationship between these variables and teacher effectiveness measured by students' standardized test scores, we include these variables in our model, to partly account for teacher qualification and partly for potential unobserved differences between teachers who have earned their credentials versus those who are still in the intern programs. Empirical studies of the relationship between credential, internship status, and teacher turnover are rather thin. Strunk and Robinson (2006) examined the relationship between the certification type (e.g., probationary, emergency, regular, etc.) and teacher turnover. They found no statistically significant difference in exit rates between regular teachers and emergency teachers. However, probationary teachers had slightly higher probability of attrition than regular teachers.

Specialty areas. Empirical studies have consistently shown that teacher subject specialty matters when considering teacher turnover rates. Specifically, research suggests that secondary science and math teachers are more likely to leave than elementary (Henke et al., 2001; Kirby et al., 1999) or other subject areas teachers (Ingersoll, 2001; Murnane & Olson, 1989a, 1989b, 1990). In addition, research finds that special education teachers are more likely to leave than other subject teachers (e.g., Ingersoll, 2001). An exception is the study by Strunk and Robinson (2006) who did not find strong relationships between subject specialty and teacher turnover in any subject areas except for foreign language, controlling for teachers having certifications in their main areas of teaching.

Elementary teachers in the United States are typically trained as generalists (mostly with humanity major), whereas secondary teachers normally need to have a

major or equivalent amount of course work in the subject area they teach. Teachers entering teaching with majors in mathematics, physical sciences, and engineering are typically placed at the secondary level and they have better alternative opportunities than most elementary teachers. Except for special education teachers (because there is a shortage of such teachers), the potential opportunity alternatives likely differ for elementary and secondary teachers. We therefore run the models separately for elementary and secondary teachers.

School Characteristics

In addition to the focus on individual teachers' characteristics, we also examine the school conditions in which teachers work. Understanding school conditions is important, as Ingersoll (2001) pointed out, "…research has shown overall conditions of workplace and job sites significantly affect the attachment of employees to the organization" (p. 506). School working conditions encompass a wide variety of facets, ranging from the compensation structure (e.g., salary, bonuses, pension plans, etc.), physical conditions (e.g., space, plants, bathrooms, etc.), school climate (e.g., principal leadership, student composition, etc.), to policies that govern the day-to-day teaching experiences (e.g., curricular mandates, standardized testing and accountability system, etc.).

Our study focuses on the set of school characteristics that have the most direct implications for teaching and learning and that have been empirically examined by different scholars in the past. These school factors characterizes different aspects of the working condition that have implications for teacher satisfactions and quit behaviors, including (1) students' social economical and demographic backgrounds (proportion of

Title I students, proportions of Hispanic, proportion of African American students), (2) academic climate approximated through students' achievement level (proportion of students who scored below and far below basic on the accountability tests), (3) the ethnic composition of teachers (proportion of Hispanic teachers, and proportion of African American teachers), (4) quality of the teaching force (average years of teaching experiences), (5) physical space (over crowdedness), and (6) school type which indicates different management and governance styles from traditional public schools (i.e., new school, charter, and magnet).

Students' social economical and demographic backgrounds. Research has consistently revealed that teachers have higher turnover rates in schools with higher proportions of low income and minority students than teachers in schools with higher income and fewer minority students (Boyd et al., 2005; Carroll, Reichardt, & Guarino, 2000; Hanushek et al., 2002; Scafidi, Stinebrickner, & Sjoquist, 2003; Shen, 1997; Smith & Ingersoll, 2004). This finding is common across studies that examined data from Georgina, New York, Texas, and Washington (Strunk & Robinson, 2006) and is consistent with the labor market theory (Guarino et al., 2006). The more difficult the working conditions, the less attractive the schools are for teachers, which leads to higher teacher turnover rates. In our study, we use proportions of title I, Hispanic, and African American students to index the types of students schools serve which signal challenging conditions that schools serving high-income and white students do not normally face.

Academic climate: students' achievement level. We use proportion of students who scored below and far below basic on the accountability tests as a proxy for general school academic climate for two reasons. First, research has found a direct relationship

between the level of students' performance at a school and teacher turnover rates. Schools with low-performing students tend to have higher teacher turnover than schools with high-performing students (Hanushek et al., 2002; Murnane et al., 1991; Rees, 1991). Second, students' achievement levels may signal their intrinsic motivation and learning habits. Students with very low academic achievement might have low intrinsic motivation to learn and unproductive disciplinary behaviors, which makes teaching less satisfactory for some teachers. Whitener et al., (1997) found that student discipline problems and poor student motivation to learn accounted for about 35% of the public school teachers who left teaching in their study sample (they used a national sample from the 1994-1995 Teacher Follow-up to the 1993-94 Schools and Staff Survey). Given the current accountability system that pushes for tying teacher evaluation with students' performance, we think it important to include students' performance level in the model of teacher turnover rates. Teachers in schools with high proportion of far below and below basic students face challenges that teachers in higher performing schools do not have, which makes the teaching condition less attractive than otherwise.

Ethnic composition of teachers. We include the ethnic composition of teachers at a school for several reasons. First, urban schools tend to have a high concentration of minority students. In contrast, the teaching force in the US mostly consists of teachers from white, middle class background (Cochran-Smith & Zeichner, 2005). Racial mismatch between students and teachers is common and has implication for teacher satisfaction. Satisfaction, in turn, has been found to be connected to subsequent teacher turnover (Renzulli et al., 2011; Whitener et al., 1997). Renzulli et al., (2011) showed that teaching in racially mismatched schools led to low levels of satisfaction, in particular,

among white teachers. This finding is similar to what was found in earlier studies (e.g., Boyd et al., 2005; Dworkin, 1980; Imazeki, 2004; Hanushek et. al., 2002; Scafidi et al., 2003). These studies suggest that white teachers tend to leave schools with higher proportion of minorities for schools with higher proportion of non-minorities. In contrast, African American teachers seem to prefer teaching in schools with high proportion of African American and minority students.

Secondly, apart from the racial match or mismatch between students and teachers, we are also interested in testing how the racial match or mismatch between an individual teacher's racial identity with that of the teaching staff where the teacher works. As Strunk and Robinson (2006) argued in their study, the social identity theory holds that "…individuals may choose employment opportunities where they can serve and work side by side with people of their own race/ethnicity" (p. 73). The empirical evidence on the racial match between teacher and teaching staff is few and has mixed findings. For instance, Bryk and Schneider (2002, cited by Strunk and Robinson) showed through a case study in a Chicago elementary school where Hispanic and white have low level of trust with each other. Though it was unclear whether the mistrust has led to teacher turnover, it is plausible that mistrust among staff could result in less commitment to the school and subsequent turnover. Strunk and Robinson's own study (2006), in contrast, found that an increase in the proportion of one's own race resulted in an increase in the likelihood of turnover for Asian and Hispanic teachers. We intend to test how this theory holds in the Los Angeles schools so as to add to the empirical knowledge base.

Quality of the teaching force. We calculated the mean years of teaching experiences of teachers at a school and included it in our model to account for two

aspects of the work condition, namely the overall teacher quality and the school's ability to retain experienced teachers. Previous research has found that teacher efficacy (measured by students' standardized test scores) increases after the first two years of struggle and then reaches a plateau around 7 to 10 years (Hanushek, 1972; Hanushek et al., 2002). This finding, however, is challenged by Wiswall (2011). Allowing a flexible non-parametric relationship between experience and teacher quality, Wiswall (2011) found that

> "teaching experience has a substantial and statistically significant impact on mathematics achievement…a teacher with 30 years of experience has over 1 standard deviation higher measured mathematics effectiveness than new, inexperienced teachers, and about 0.75 standard deviations higher measured mathematics effectiveness than a teacher with 5 years of experience" (p. 2)

Research has also found that most teachers leave during their first two years of teaching (Hanushek et al., 2004; Ingersoll, 2001; Murnane & Olson, 1989a). Furthermore, teachers tend to stay teaching in the same schools with fewer inexperienced teachers (Shen, 1997). These findings on the relationship between experience, teacher quality, and teacher retention have implications for teacher sorting across schools and for policies that aim to achieve a balanced distribution of high quality teachers across schools. It is important, therefore, to examine how the overall teaching quality at a school impact individual behaviors.

Physical space: over-crowdedness. Some research (e.g., Buckley, Schneider, and Yang, 2005) shows that the physical environment of schools (i.e., school facility quality) is an important determinant in teachers' decision to leave, even after taking into

account other factors such as salary satisfaction. School facility quality covers a range of conditions (e.g., lighting, clean bathroom, etc.), we focus on physical space as signaled by "still overcrowded" index because school crowdedness is a unique challenging problem in the LAUSD. In fact, this problem has led to the new school construction program in an effort to address the overcrowded and dilapidated facility conditions. Our finding on the relationship between the crowdedness and teacher turnover has implications for the district's construction program.

School type. Research has suggested that school type is one of the school factors that appear to play a role in teacher turnover (Guarino et al., 2006). For instance, Smith and Ingersoll (2004) found that charter schools had high attrition rates, with about a quarter of beginning charter teachers leaving after the first year. Other researchers (e.g., Lankford et al., 2002) showed that large urban schools tended to have higher turnover rates than suburban schools. Ingersoll (2001) found that large schools had lower turnover rates than small schools, based on data from a national sample. Furthermore, some research has found school type as an important mediating factor in teacher satisfactions and decisions to leave (Renzulli et al., 2011). All this research points to the important role school type plays in teacher turnover. In our study, we include three types of schools in comparison to traditional public schools. The three school types are new school, charter, and magnet.

In summary, research to date has explored a variety of factors that may influence teacher retention, which provides a platform for our own empirical inquiry. We intend to extend the existing knowledge base and make a contribution to the teacher turnover literature in several ways. First, we conceptualize teacher turnover as a dynamic process

rather than as a status. In other words, we ask "whether or not AND when a teacher leaves" instead of just "whether or not a teacher leaves" questions. Secondly, we base the theoretical framework on theories from both economics and sociology, as opposed to one or the other. The economic labor market theory draws our attention to factors that rationale actors such as teachers may consider when comparing the utility or attractiveness of teaching compared to alternative activities that they can pursue. The sociological theories of organizations, occupations, and work, on the other hand, requires that we examine school conditions within which teachers work in order to fully understand teacher turnover. Our theoretical perspective therefore conceptualizes that organizational dynamics and contextual factors are likely to condition the decision process made at the individual level and thereby influence individual behaviors (e.g., decision to leave a school). Toward this end, we make a deliberate effort at modeling the relationship between macro-level contextual factors and micro-level behaviors. Thirdly, we utilize an innovative statistical model that combines multilevel modeling framework and even-history analysis framework (i.e., survival analysis) in our investigation of how teacher and school characteristics influence turnover. This methodological framework is perfectly in-sync with the theoretical framework underlying our study. In addition to this theoretical motivation, a multilevel modeling framework is consistent with the nested structure of the data (i.e., teachers within different schools) and is a methodologically sound choice. Finally, we have access to large samples of both elementary and secondary teachers in the second largest urban school district in the country. This sampling advantage allows us to conduct analyses separately by the schooling level in order to

compare and contrast similarities of and differences in elementary and secondary teachers' behaviors within the same district.

Specifically, the following research questions guide our analyses:

1. When is a teacher at the highest risk of exiting the first assigned school[2] in the LAUSD?
2. What individual teacher and school contextual factors are associated with the risk of a teacher exiting the first assigned school in the LAUSD?

Methods

Data Sources and Sample

Our study utilizes data collected for a larger project led by a group of researchers at the University of California Berkeley to explore the long-term effects of the Los Angeles Unified School District's new school construction program (NSCP), a $27 billion initiative to build 130 new schools and improve the working conditions of countless other schools. The NSCP was initiated in the late 90s and was intended to address the overcrowded and dilapidated facility conditions. Various student, teacher, school and neighborhood data information collected by the Berkeley Policy Analysis for California Education (PACE) and the Center for Cities & Schools formed the primary data sources for this study (See Appendix A for the description of the data merging process).

Outcome

We follow Ingersoll's (2001) definition of turnover as teachers' exit from their teaching jobs in schools. Their exit may be due to various reasons, including leaving

[2] By first assigned we meant "first assigned" during our observation period (i.e., 2002-03 and 2008-09).

teaching for good, moving across the district to another school, retiring, being fired, and so on. While we acknowledge that differentiating different types of exit may matter in certain context (e.g., comparing teaching versus other professions), these reasons matter little from the perspective of the school (i.e., where a teacher left), because the school must deal with the loss of a teacher regardless of the reason for his or her exit. From an organizational-level perspective, teacher migration is as relevant as teacher attrition, because regardless of whether teachers leave for another school or another profession, their departure impact and are impacted by schools (Ingersoll, 2001). This perspective has been used in various empirical studies of teacher turnover (e.g., Ingersoll, 2001; Kelly, 2004; Strunk & Robinson, 2006).

Specifically, our analysis focused on *whether and when* a teacher exits the first assigned school in the LAUSD. In other words, for teachers whom we observed being hired by all schools in the LAUSD between years 2002-03 and 2008-09, we ask the question of how long a teacher stays teaching in the first assigned school before he or she exits. So the central outcome of our analysis focuses on the duration of time to event, with event defined as teacher exiting the first assigned school.

One point worth mentioning is that for teachers who were present in the data during the 2002-03 year (i.e., the first year of our observation period), the beginning of the observation period does not necessarily coincide with when a teacher is at risk for exit a school for some of the teachers. This creates a potential left-censoring problem, in the sense that some of the teachers were already at risk of exiting before our observation started (i.e., 2002-03). To remove the impact of potential left-censoring problem, we run the models with a restricted teacher sample by excluding all 2002-03 teachers whose

years of teaching experience in the LAUSD were greater than one at the time. This ensures that teachers who were kept in our sample were most likely teaching in their first assigned LAUSD schools during 2002-03.

In addition, we conducted demographic analysis for teachers who left (i.e., uncensored cases) versus those who stayed when our data observation period ended (i.e., right-censored cases). The descriptive statistics suggest no systematic demographic differences in most key demographic variables (e.g., gender, ethnicity, age, years of teaching experiences, educational level, and subject areas) between uncensored and censored cases. The three variables where close to 10% differences exist (i.e., full credential, the proportion of Hispanic, and other subject area for secondary teachers) are consistent with the literature. In other words, fully credentialed or minority (in this case, Hispanic) teachers are less likely to quit than non-credentialed or white. Furthermore, right-censoring occurs because our data collection period ended, not because of actions taken by teachers in our study sample. Taken together, we can be confident that censoring is non-informative. Therefore, we assume that teachers who stayed after the censoring date are representative of those "who *would have remained in the study* had censoring not occurred" (Singer & Willet, 2003, p. 318).

Explanatory Variables

Table 1 lists the explanatory variables along with the descriptive statistics (i.e., means and standard deviations) used in our analysis. We arrange the variables by teacher and school characteristics.

Table 1: Variable Definitions and Sample Values (Means and Standard Deviations)

Variable	Elementary		Secondary	
	Mean	St.Dev	Mean	St.Dev
Overall Teacher Turnover	0.190	0.392	0.210	0.407
Baseline Hazard Indicator Variables				
D1 - Interval 1-2	0.253	0.435	0.264	0.441
D2 - Interval 2-3	0.173	0.378	0.158	0.365
D3 - Interval 3-4	0.111	0.314	0.090	0.286
D4 - Interval 4-5	0.064	0.246	0.050	0.218
D5 - Interval 5-6	0.025	0.156	0.015	0.122
Individual Teacher Characteristics				
Female - Teacher is female	0.858	0.349	0.615	0.487
Ethnicity variables (reference group: white)				
Hispanic - Teacher is Hispanic	0.355	0.478	0.278	0.448
Afro American - Teacher is Afro American	0.085	0.278	0.115	0.319
Other ethnicity - Teacher is another ethnicity	0.168	0.374	0.153	0.360
Age variables (reference group: teacher between 30 and 50 years)				
Young - Teacher is younger than 30 years	0.573	0.495	0.458	0.498
Old - Teacher is older than 50 years	0.050	0.218	0.099	0.298
Experience- Teacher experience	2.359	1.592	2.162	1.457
Experience squared - Teacher experience squared	8.101	24.512	6.798	18.037
Degree variables (reference group: bachelor degree)				
Less than Bachelor - Teacher does not have a bachelor degree	0.004	0.060	0.005	0.073
Bachelor plus extra 30 hours units - Teacher degree is bachelor plus extra 30 hours units	0.250	0.433	0.200	0.400
Master - Teacher holds a master degree	0.103	0.304	0.106	0.308
Master plus extra 30 hours units - Teacher holds a master degree plus extra 30 hours units.	0.111	0.314	0.109	0.312
Doctorate - Teacher holds a doctorate	0.008	0.089	0.018	0.135
Full credential - Teacher has full credential	0.847	0.360	0.656	0.475
Intern - Teacher is an intern	0.159	0.365	0.287	0.452
Teacher subject assignment variables (reference group for elementary is non-special education and for secondary is english)				
Math - Math teachers			0.131	0.337
Science - Science teachers			0.114	0.317
Social Science - Social science teachers			0.062	0.312
Special Education - Special education teachers	0.124	0.330	0.155	0.362
Other subjects			0.605	0.489
School Context and Characteristics				
% Title 1 - Proportion of Title 1 students	0.860	0.256	0.667	0.323
% Hispanic students - Proportion of Hispanic students	0.725	0.264	0.708	0.246
% African American students - Proportion of African American students	0.143	0.191	0.137	0.174
Student achievement - Proportion of students basic and below basic	0.353	0.142	0.437	0.141
Mean Teacher experience	11.17	2.376	10.86	2.254
Mean Teacher experience squared	130.5	54.6	123.0	49.1
Still overcrowded - Teacher teaches in an still overcrowded school	0.057	0.233	0.078	0.268
New school - Teacher teaches in a new school	0.031	0.173	0.063	0.244
Charter - Teacher teaches in a charter school	0.034	0.182	0.021	0.145
Magnet - - Teacher teaches in a magnet school	0.019	0.137	0.021	0.144

Statistical Model: Two-Level Discrete-Time Survival Analysis

The key statistical technique was two-level discrete-time survival models (Barber et al., 2000; Hedeker et al., 2000; Rabe-Hesketh and Skrondal, 2008; Reardon, Brenna, & Buka, 2002), with the outcome focusing on whether and when a teacher experiences an event (i.e., the propensity of a teacher leaving a school at a time point given that he or she has not left). In order to describe the two-level discrete-time survival analysis, we first explain the three key concepts in discrete-time framework that characterize the distribution of discrete-time event occurrence data. We then present the statistical model of the discrete-time framework for non-clustering data (i.e., units of observations are not grouped in some kind of organizations such as schools), before extending it to the two-level context (i.e., different teachers located in different schools).

Key concepts in discrete-time framework that characterize the distributions of discrete-time event occurrence data. Discrete-time survival analysis relies on three statistics to summarize data about even occurrence over time (Singer & Willet, 2003). These three statistical summaries are: the hazard function, the survival function, and the median lifetime. Table 2 lists the definitions of these three concepts (Singer & Willet, 1993; 2003).

Table 2: Definitions of Key Statistical Concepts in Discrete-Time Survival Analysis

Key Concepts	Definitions
Hazard Function	Hazard function is the chronological pattern of the hazard probabilities over time, where the hazard probability in discrete-time survival framework is defined as the conditional probability

	that an individual will experience the event in time period *j*, given that he or she has not experienced it in earlier time periods.
Survival Function	Survival function is the chronological pattern of the survival probabilities over time, where the survival probability is defined as the probability that an individual will survive past time period *j*.
Median Lifetime	The value of T (time) for which the value of the estimated survival function is .5. In other words, the median lifetime refers to the time period when half of the sample has experienced the event, while the other half has survived.

Discrete-time framework. Our discrete-time survival analysis examines the hazard function that a teacher exiting the first assigned school in the LAUSD in a given year conditional on not having left the school before that year. Equation (1) represents Singer and Willet's (2003) proposed framework for investigating event occurrence. In this framework, discrete-time hazard, *hij*, is defined as the conditional probability that individual *i,* as distinguished by their values of specific predictors Z, will experience the target event in time period *j*, given that he or she did not experience the event prior to *j*:

$$h_{ij} = \Pr(T_i = j / T_i \geq j, Z_{1ij} = z_{1ij}, Z_{2ij} = z_{2ij}, \ldots, Z_{pij} = z_{pij}) \qquad (1)$$

The probabilities, h_{ij}, as Cox (1972) proposed, can be re-parameterized so that they have a logistic dependence on the predictors and the time periods, as shown in equation (2). The parameters of the time periods (i.e., the α's) represent a baseline profile of risk (i.e., baseline hazard function), and the parameters of the predictors (i.e., the β's) capture any shift in the risk associated with the predictors.

$$h_{tij} = \frac{1}{1 + e^{-[(\alpha_{1}D_{1tij} + \alpha_{2}D_{2tij} + \cdots + \alpha_{j}D_{j(t)ij}) + (\beta_{1}Z_{1ij} + \beta_{2}Z_{2ij} + \cdots + \beta_{j}Z_{j(t)i})]}} \quad (2)$$

Finally, equation (2) can be re-written as the population discrete-time hazard model shown in equation (3). This model represents the log-odds of event occurrence as a function of the baseline hazard profile and a shift in the baseline hazard as a function of different predictors.

$$\log\left(\frac{h_{tij}}{1-h_{tij}}\right) = \alpha_{1}D_{1tij} + \alpha_{2}D_{2tij} + \cdots + \alpha_{j}D_{j(t)ij} + (\beta_{1}Z_{1ij} + \beta_{2}Z_{2ij} + \cdots + \beta_{j}Z_{j(t)i}) \quad (3)$$

In other words, in Equation (3), vector D is a sequence of dummy variables, with values indexing time periods. Therefore, the conditional log-odds that the event will occur in each time period (given that it did not occur before) is a linear function of the α parameters, capturing the baseline level of hazard in each time period, and the slope parameters describing the effects of the predictors on the baseline hazard function.

Two-level discrete-time statistical equations. Following the multilevel modeling framework of Raudenbush and Bryk (2002), we write the equations in multilevel format (see also Barber et al., 2000). For simplicity, we included only one predictor at each level, though they could easily represent vectors of predictors at each level. In addition, we model the hazard by the logic link (Singer and Willet, 1993; Barber et al., 2000; Reardon et al., 2002).

Level 1 equation: teacher level.

$$\text{Logit}\,(p_{tjk}) = \beta_{0k} + \beta_{1k}\,(X_{j}) + \beta_{2}\,(\text{Time Period Indicators}_{tj}) \quad (4)$$

Where

p_{tjk} represents the hazard of leaving for teacher *j* in school *k* during year *t* (given that he or she has not left);

β_{0k} represents the average hazard of leaving in school *k*;

X_j is a teacher level predictor (e.g., educational level);

β_{1k} is the regression coefficient that captures the relationship between a teacher level predictor variable, X_j, and outcome (i.e., logit hazard of leaving); and

β_2 so on represents the effects of Time (i.e., Time indicator variable is used to capture the baseline hazard function of leaving).

Note that we use a general specification to describe the effect of time (i.e., a system of dummy predictors). In theory, we could also use other polynomial functions (e.g., linear, quadratic, cubic, etc.) to capture the dependence of logit-hazard on Time. Our decision to use a general formulation is due to the following two considerations: (1) we do not need to use many dummy variables because the time series were relatively not too long (e.g., 100); and (2) As Singer and Willet (2003) pointed out, "as the best fitting model, the completely general specification of TIME provides an invaluable anchor on the continuum of goodness-of-fit" (p. 411).

Level 2 equation: school level.

$$\beta_{0k} = \gamma_{00} + \gamma_{01}(W1)_k + u_{0k} \quad (5)$$

$$\beta_{1k} = \gamma_{10} + \gamma_{11}(W1)_k \quad (6)$$

$$\beta_2 = \gamma_{20} \quad (7)$$

and so on

Where

β_{0k}, β_{1k} are the intercept and slope from the level-1 model; note here we allow the intercept to randomly vary across schools (see the random effect term: u_{0k});

γ_{00}, γ_{10} represent the mean of intercept and slope respectively;

$(W1)_k$ is a school level variable (e.g., type of schools)

γ_{01} are regression coefficients that capture the effects of school-level variables (i.e., type of schools) on hazard;

γ_{11} are regression coefficients that capture the cross-level interaction between school-level variables (i.e., type of schools) and the teacher level predictor (X_j) effect on hazard;

u_{0k} represent the residual or variability in β_{0k} after taking school characteristics variables into consideration.

We conducted all two-level discrete-time survival analysis using the STATA software, using the xtlogit procedure.

Variable Centering

Variable centering is important in quantitative analysis in general but becomes especially critical in multilevel models, because choice of location for level-1 predictors affect the meaning of level-1 intercept in two-level models and the estimation of regression coefficients of level-1 predictors (Raudenbush & Bryk, 2002). We use group-mean centering for all teacher level predictors (i.e., Level-1). The group-mean centering defines the intercept as the hazard for an average teacher in an average school. In addition, group mean centering produces unbiased estimators of the effect of teacher characteristics (For a technical discussion of why so, see Raudenbush & Bryk, 2002, pp.

134-141). The choice of level-2 centering (i.e., school level predictors) is not as critical as for the level-1 predictors. Following Raudenbush and Bryk (2002), we use grand-mean centering for all school level continuous predictors (e.g., proportion of African American students) but not for school type dummy indicators (e.g., whether the school is charter or not).

Analytic Approach

Prior to estimating multilevel survival models, we begin by fitting a model ignoring school clustering and estimating a one-level discrete-time survival model that includes a set of time period dummy variables and teacher characteristics variables. Note that teacher characteristics variables are group mean centered in order to compare this model with more sophisticated models that we subsequently fit to the same data. We call this Model 1 (see column one in Tables 5 and 6).

Next, we estimate a conditional logit survival model in order to evaluate whether ignoring school clustering biases the estimates of the effects of teacher characteristics variables on the logit hazard of exit. We label this as Model 2 (see column 2 in Tables 5 and 6).

We then extend the one-level discrete-time survival model (i.e., Model 1) to the two-level case. We begin with a simplest two-level discrete-time survival model with only the time period dummy variables and refer to this as Model 3 (see column 3 in Tables 5 and 6). We then add teacher level characteristics variables to Model 3 and call it Model 4 (see column 4 in Tables 5 and 6). Following this, we add school characteristics variables to Model 4 and refer to this as Model 5 (see column 5 in Tables 5 and 6). Finally, we add interaction terms (teacher level interaction terms and teacher-school

interaction terms) to Model 5 to arrive at our final model, which is Model 6 (see column 6 in Tables 5 and 6).

Though we ran six models, we focus on the final model (i.e., the last column in Tables 5 and 6) when presenting the results. The one-level survival model ignores the clustering feature of the data (i.e., teachers are nested in schools). This may lead to biased estimates of standard errors and the coefficients of predictors in some cases. The conditional survival model is an improvement over the one-level survival model by using only the within-school variation and thereby controlling for all the observable and unobservable. However, the conditional survival model does not allow researchers to model how school characteristics influence teacher turnover. In addition, the conditional survival model assumes that the shapes of the baseline logit-hazard curves (after controlling for teacher variables) are parallel across all schools. In light of differences in school characteristics in the LAUSD, this assumption is unlikely. Multilevel survival models overcome these limitations, especially when the chi-square test suggests significant random effect.

Results

This section presents the results of our analysis. We begin with a general picture of teacher turnover across the schools in the LAUSD with some descriptive statistics. We then present the findings based on the 2-level survival analysis.

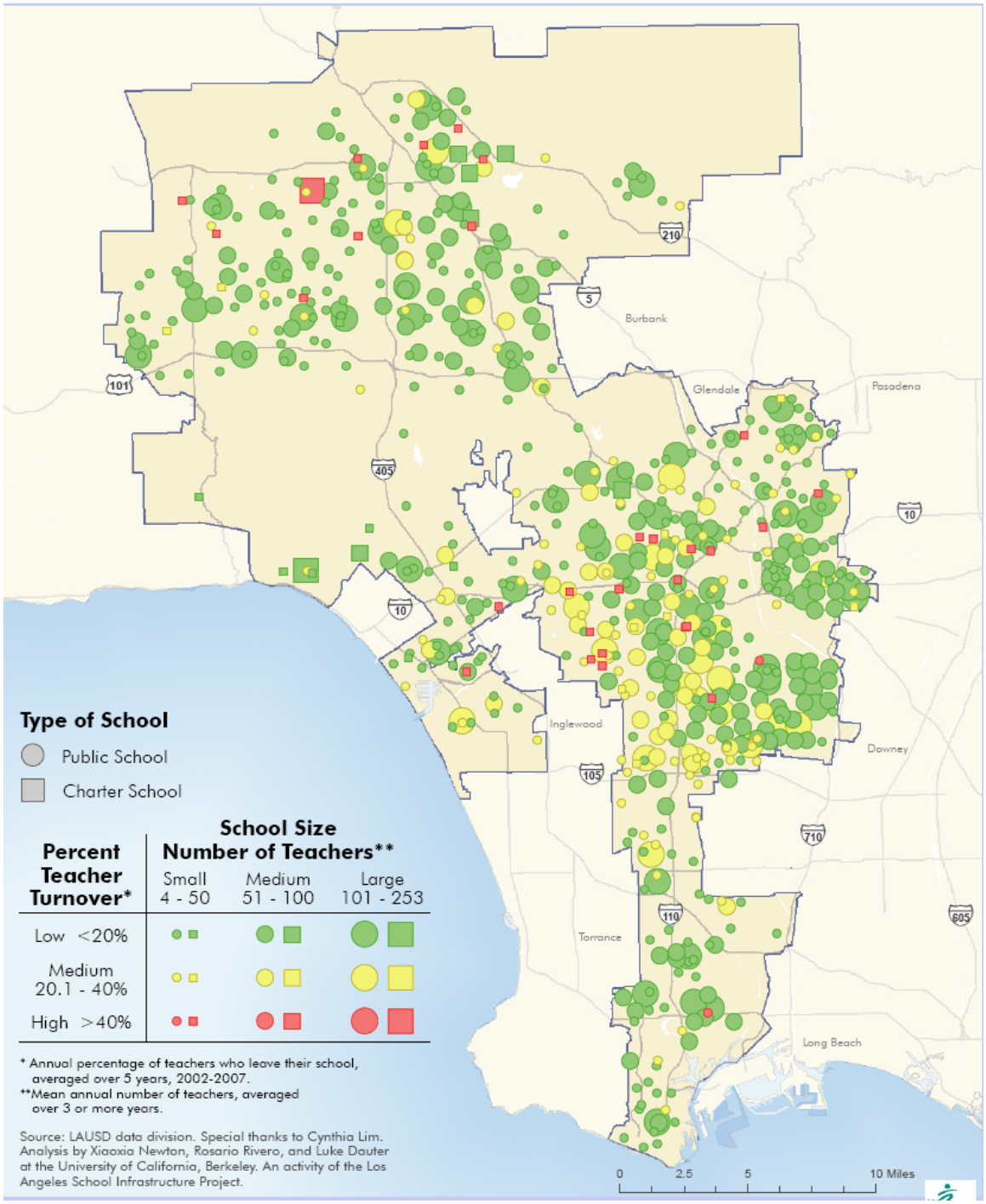
Teacher Turnover in LAUSD Schools: Mapping the Terrain

Figure 1 maps the average annual teacher turnover rates across schools in the LAUSD between 2002-02 and 2007-08 by the size of schools (in terms of the mean

number of teachers per year) and types of schools (whether public or charter). The data display scheme is as follows: (1) Circle stands for charter while square stands for public; (2) Size of the object (i.e., circle or square) is based on the average annual numbers of teachers; and (3) The color green signals small average annual teacher turnover; whereas yellow stands for medium turnover and pink red for high average annual teacher turnover.

Figure 1 shows the following patterns of average annual teacher turnover across schools in the LAUSD: (1) Schools with high average annual turnover rates predominantly tended to be small, charter schools; (2) There was only one small public school with high average annual turnover rate; (3) Public schools, regardless of size in terms of numbers of teachers per year, tended to have low to medium average annual turn over rates; and (4) There was one large charter school with high average annual turnover rate. In general, Figure 1 shows that there existed some variation in the average annual teacher turnover rates across schools in the LAUSD.

Figure 1: Mean Annual Turnover in the LAUSD Schools: 2002-2008



Click here for a larger version of this figure.

Hazard, Survival, and Median Lifetime: Descriptive Statistics

Tables 3 and 4 present data describing the career survival at their first assigned schools of 4,788 elementary and 8,467 secondary teachers hired by the LAUSD and who were observed between 2002-03 and 2008-09. The numbers indicate whether and if so, when these teachers exited the first assigned schools between the first year of observation period and 2008-09, which was the last year of observation period. The first column, *year*, in Tables 1 and 2 refers not to the calendar year (e.g., 2002, 2003, etc.); rather *year* refers to the year of teaching at the first assigned schools during the data collection period. For instance, *year* 1 is 2002 for those *first* observed in 2002, 2003 for those hired in 2003, and so on.

Table 3: Descriptive Statistics of Elementary Teacher Hazard

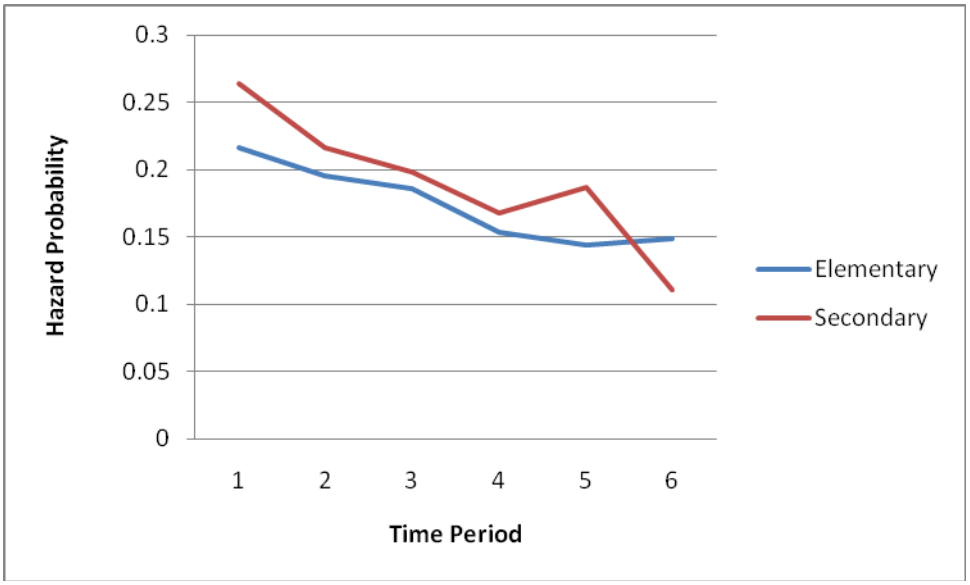
Year	Total	Move	Lost	Stay	Hazard
1	4,788	1,033	519	3,236	0.216
2	3,236	631	365	2,240	0.195
3	2,240	417	373	1,450	0.186
4	1,450	222	376	852	0.153
5	852	123	401	328	0.144
6	328	49	279	-	0.149

Table 4: Descriptive Statistics of Secondary Teacher Hazard

Year	Total	Move	Lost	Stay	Hazard
1	8,467	2,239	1,223	5,005	0.264
2	5,005	1,083	954	2,968	0.216
3	2,968	587	728	1,653	0.198
4	1,653	278	469	906	0.168
5	906	169	466	271	0.187
6	271	30	241	-	0.111

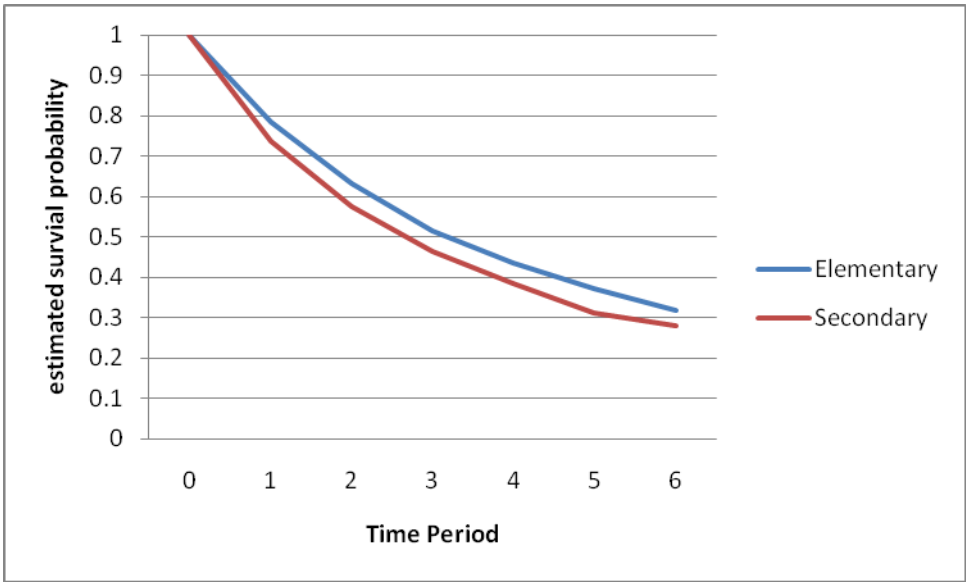
As shown by the numbers under "hazard" column in Tables 3 and 4, both elementary and secondary school teachers were at the highest risk of leaving their initially assigned schools during the first year of teaching at those schools. This risk of exit in general decreases over time for both elementary and secondary teachers. In addition, the risk (i.e., the hazard probabilities) was slightly higher among secondary teachers than the risk for elementary teachers. Figure 2 graphs the hazard function for both elementary and secondary teachers.

Figure 2: Hazard Function



Based on the sample hazard probabilities, we could estimate the sample survival probabilities under the assumption of independent censoring (i.e., non-informative). [3] Figure 3 displays the estimated survival function based on the sample hazard function for both elementary and secondary teachers.

Figure 3: Survival Function



As can be seen in Figure 3, secondary teachers' survival probabilities were slightly but consistently lower than those of elementary teachers. This is not surprising, because secondary teachers had higher hazards than elementary teachers as shown previously. Consequently, for the sampled teachers we observed between 2002-03 and 2008-09, the estimated median survival lifetime for secondary teachers was roughly two and half years, which was slightly shorter than the estimated median survival lifetime for elementary teachers (i.e., slightly over 3 years).

[3] The estimated survival probabilities are calculated based on the hazard probabilities, where $S(t_j)=[1-h(t_j)][1-h(t_{j-1})]\ldots[1-h(t_1)]$ (Singer & Willet, p. 337)

Factors Predicting Teacher Turnover: Two-level Discrete-Time Survival Analysis

The descriptive statistics provide a glimpse of the variation in turnover across the LAUSD schools, the sample estimates of the hazard probabilities, the survival probabilities, and the median survival lifetime at a school. The primary goal of our analysis is to focus on investigating two intertwined aspects of teacher turnover and retention in the LAUSD schools. These two aspects include: (1) how long a teacher stays teaching in the first assigned school in the LAUSD before the teacher exits that school; and (2) how this propensity for the length of survival might be related individual teacher characteristics and school contextual factors.

This section presents the results from our two-level discrete-time survival analysis. We organize the results around teacher and school predictors of the hazard function for exiting the first assigned schools.

Teacher characteristics

Teacher demographic background: Gender, ethnicity, and age. As shown in Table 5 (see results under model 6), there was no statistically significant difference between elementary male and female teachers in the timing of their propensity for leaving a school; however, female secondary teachers exhibited slightly lower propensity for leaving a school than their male counterparts (see results under model 6 in Table 6). Specifically, the odds of leaving for female secondary teachers were about 11.4% lower than that for male secondary teachers (odds ratio: .896; *p* value: .027).

Table 5: Discrete-Time Survival Analysis Results—Elementary Schools

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	(n=12,652)	(n=12,652)	(n=12,652)	(n=12,652)	(n=12,652)	(n=12,652)
Baseline Hazard						
D1 - Interval 1-2	0.78*** (0.04)	0.98 (0.06)	0.90* (0.05)	0.93 (0.06)	0.90 (0.07)	0.79***(0.05)
D2 - Interval 2-3	0.73*** (0.05)	1.03 (0.08)	0.87** (0.06)	0.95 (0.07)	0.89 (0.10)	0.70***(0.05)
D3 - Interval 3-4	0.54***(0.05)	0.83* (0.08)	0.69***(0.06)	0.75***(0.07)	0.68***(0.10)	0.48***(0.04)
D4 - Interval 4-5	0.47***(0.05)	0.78* (0.10)	0.65***(0.07)	0.70***(0.08)	0.62** (0.12)	0.39***(0.04)
D5 - Interval 5-6	0.41***(0.05)	0.75 (0.14)	0.61***(0.04)	0.67** (0.12)	0.57** (0.15)	0.32***(0.06)
Individual Teacher Characteristics						
Female	0.96 (0.06)	0.99 (0.07)		0.97 (0.07)	0.97 (0.07)	0.91 (0.08)
Hispanic	0.66*** (0.04)	0.64*** (0.04)		0.63*** (0.04)	0.65*** (0.04)	0.76*** (0.07)
African American	0.79*** (0.07)	0.77*** (0.07)		0.75*** (0.07)	0.79*** (0.07)	0.94 (0.12)
Other ethnicity	0.78*** (0.05)	0.76*** (0.06)		0.76*** (0.05)	0.81*** (0.05)	0.99 (0.10)
Young	1.05 (0.05)	1.09 (0.06)		1.10* (0.06)	1.11* (0.06)	1.09 (0.13)
Old	1.06 (0.11)	1.04 (0.12)		1.13 (0.12)	1.14 (0.12)	1.31** (0.16)
Experience	1.27*** (0.02)	1.03 (0.02)		1.02 (0.02)	1.03 (0.03)	1.08*** (0.02)
Experience squared	1.01*** (0.00)	1.00 (0.00)		1.00* (0.00)	1.00 (0.00)	1.00*** (0.00)
Degree: less than Bachelor	4.52*** (1.40)	5.45*** (1.76)		5.02*** (1.59)	5.01*** (1.58)	4.82*** (1.52)
Degree: Bachelor plus extra 30 hours units	1.01 (0.06)	0.96 (0.06)		0.97 (0.06)	0.96 (0.06)	0.96 (0.06)
Degree: Master	1.32*** (0.10)	1.32*** (0.11)		1.30*** (0.10)	1.30*** (0.10)	1.32*** (0.11)
Degree: Master plus extra 30 hours units	1.19** (0.10)	1.18* (0.10)		1.15* (0.10)	1.14 (0.09)	1.13 (0.09)
Degree: Doctorate	1.01 (0.27)	1.03 (0.30)		0.97 (0.27)	0.96 (0.26)	0.87 (0.24)
Full credential	0.68*** (0.06)	0.68*** (0.07)		0.65*** (0.06)	0.66*** (0.06)	0.66*** (0.06)
Intern	0.79** (0.07)	0.79** (0.08)		0.77*** (0.07)	0.78*** (0.07)	0.77*** (0.07)
Special Education	1.47*** (0.10)	1.48*** (0.11)		1.49*** (0.10)	1.51*** (0.11)	1.52*** (0.11)

* < .10
**<.05
***<0.01

Click here for a larger version of this table.

Table 5 (continued): Discrete-Time Survival Analysis Results—Elementary Schools

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
School Context and Characteristics						
% Title 1					0.95 (0.16)	0.95 (0.16)
% of Hispanic students					0.79 (0.20)	0.75 (0.19)
% of African American students					1.16 (0.31)	1.08 (0.30)
Student achievement					2.50*** (0.87)	2.40** (0.83)
Mean Teacher experience					1.07 (0.22)	1.23*** (0.02)
Mean Teacher experience squared					1.01 (0.00)	1.01** (0.16)
Still overcrowded					1.10 (0.13)	1.09 (0.13)
New school					0.79 (0.14)	0.80 (0.14)
Charter					1.27 (0.19)	1.33* (0.22)
Magnet					0.82 (0.18)	0.82 (0.18)
Teacher Level Interactions						
Hispanic* Young						0.81* (0.10)
African American * Young						0.68** (0.12)
Other ethnicity * Young						0.78* (0.10)
Hispanic * Old						1.44 (0.41)
African American * Old						0.94 (0.31)
Other ethnicity * Old						1.57 (0.44)
Female* Young						0.96 (0.14)
Female* Old						0.70 (0.19)
Teacher School Level Interactions						
Hispanic* % of Hispanic students						1.07 (0.27)
African American* % of African American students						0.78 (0.27)
Charter*young						0.54** (0.14)

* < .10
**<.05
***<0.01

Click here for a larger version of this table.

Table 6: Discrete-Time Survival Analysis Results—Secondary Schools

Variables	Model 1 (n=18,878)	Model 2 (n=18,878)	Model 3 (n=18,878)	Model 4 (n=18,878)	Model 5 (n=18,878)	Model 6 (n=18,878)
Baseline Hazard						
D1 - Interval 1-2	0.86*** (0.04)	1.01 (0.05)	0.83***(0.04)	0.86*** (0.04)	0.84*** (0.04)	0.84*** (0.04)
D2 - Interval 2-3	0.79*** (0.04)	1.03 (0.08)	0.78***(0.04)	0.80*** (0.04)	0.74*** (0.05)	0.74*** (0.05)
D3 - Interval 3-4	0.61*** (0.04)	0.89 (0.09)	0.66***(0.05)	0.62*** (0.05)	0.55*** (0.05)	0.56*** (0.05)
D4 - Interval 4-5	0.60*** (0.06)	0.99 (0.13)	0.74***(0.07)	0.61*** (0.06)	0.53*** (0.05)	0.53*** (0.05)
D5 - Interval 5-6	0.33*** (0.06)	0.62** (0.14)	0.46***(0.09)	0.34*** (0.06)	0.30*** (0.06)	0.30*** (0.06)
Individual Teacher Characteristics						
Female	0.92** (0.06)	0.91** (0.04)		0.92** (0.04)	0.92** (0.04)	0.90** (0.04)
Hispanic	0.67*** (0.03)	0.67*** (0.03)		0.68*** (0.03)	0.68*** (0.03)	0.77*** (0.06)
African American	0.79*** (0.05)	0.88** (0.06)		0.86** (0.05)	0.87** (0.05)	0.99 (0.08)
Other ethnicity	0.74*** (0.04)	0.88** (0.05)		0.83*** (0.05)	0.86*** (0.05)	0.86* (0.06)
Young	1.11** (0.05)	1.12** (0.05)		1.11** (0.05)	1.11** (0.05)	1.10** (0.05)
Old	0.96 (0.06)	1.02 (0.07)		1.00 (0.07)	1.03 (0.07)	1.07 (0.08)
Experience	1.25*** (0.01)	1.04 (0.02)		1.22*** (0.02)	1.17*** (0.02)	1.17*** (0.02)
Experience squared	1.01*** (0.00)	1.00 (0.00)		1.01*** (0.00)	1.00 (0.00)	1.00 (0.00)
Degree: less than Bachelor	1.96*** (0.43)	2.01*** (0.45)		2.04*** (0.46)	2.03*** (0.46)	1.99*** (0.45)
Degree: Bachelor plus extra 30 hours units	0.81*** (0.05)	0.75*** (0.04)		0.78*** (0.04)	0.77*** (0.04)	0.78*** (0.04)
Degree: Master	1.06 (0.06)	1.03 (0.06)		1.05 (0.07)	1.04 (0.06)	1.05 (0.07)
Degree: Master plus extra 30 hours units	1.02 (0.07)	1.00 (0.07)		1.00 (0.07)	1.01 (0.07)	1.02 (0.07)
Degree: Doctorate	1.04 (0.14)	1.10 (0.15)		1.07 (0.15)	1.04 (0.14)	1.05 (0.15)
Full credential	0.65*** (0.04)	0.62*** (0.04)		0.64*** (0.04)	0.65*** (0.04)	0.65*** (0.04)
Intern	0.69*** (0.04)	0.67*** (0.04)		0.68*** (0.04)	0.70*** (0.04)	0.70*** (0.04)
Math	1.05 (0.06)	1.02 (0.06)		1.01 (0.06)	1.01 (0.06)	1.01 (0.06)
Science	1.27*** (0.07)	1.25*** (0.07)		1.24*** (0.07)	1.23*** (0.07)	1.23*** (0.07)
Social Science	0.83*** (0.05)	0.83*** (0.06)		0.82*** (0.05)	0.82*** (0.05)	0.83*** (0.05)
Special Education	1.03 (0.06)	1.01 (0.06)		1.02 (0.06)	1.01 (0.06)	1.01 (0.06)
Other subjects	0.85*** (0.04)	0.82*** (0.04)		0.83*** (0.04)	0.81*** (0.04)	0.81*** (0.04)

* < .10
**<.05
***<0.01

Click here for a larger version of this table.

Table 6 (continued): Discrete-Time Survival Analysis Results—Secondary Schools

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
School Context and Characteristics						
% Title 1					1.17** (0.09)	1.17** (0.09)
% of Hispanic students					1.04 (0.19)	1.04 (0.19)
% of African American students					2.10*** (0.50)	1.97*** (0.48)
Student achievement					2.11*** (0.54)	2.10*** (0.54)
Mean Teacher experience					1.09*** (0.02)	1.09*** (0.02)
Mean Teacher experience squared					0.99*** (0.00)	0.99*** (0.00)
Still overcrowded					0.88 (0.08)	0.87 (0.08)
New school					1.22* (0.14)	1.22* (0.14)
Charter					3.82*** (0.56)	3.89*** (0.62)
Magnet					1.08 (0.19)	1.08 (0.19)
Teacher Level Interactions						
Hispanic* Young						0.88 (0.09)
African American * Young						0.84 (0.11)
Other ethnicity * Young						1.00 (0.10)
Hispanic * Old						1.24 (0.24)
African American * Old						1.18 (0.24)
Other ethnicity * Old						1.06 (0.20)
Female* Young						1.15* (0.10)
Female* Old						1.06 (0.14)
Teacher School Level Interactions						
Hispanic* % of Hispanic students						0.71* (0.14)
African American* % of African American						0.65 (0.17)
Charter*young						0.95 (0.23)

* < .10
**<.05
***<0.01

Click here for a larger version of this table.

In terms of ethnicity, elementary Hispanic teachers had lower propensity for leaving their schools than white. The odds of leaving for Hispanic teachers were 25.3% lower than that for white (odds ratio: .757; *p* value: .004). African American or teachers of other ethnic backgrounds elementary teachers did not differ significantly in their propensity for leaving a school from their white colleagues. These patterns of relationship observed at the elementary level between a teacher's ethnic background and his or her propensity for leaving a school hold for the most part at the secondary level (odds ratios: .775, .987,; *p* values: .001, .87- respectively; see Table 6). The odds of leaving for secondary teachers of other ethnic backgrounds, however, were about 13.5% lower than the odds of leaving for white teachers (odds ratio, .865, *p* value: .051).

With respect to age, Table 5 indicates that at the elementary school level, older teachers (odds ratio: 1.31; *p* value: .024) were more likely to exit schools than middle-range-aged teachers, possibly due to retirement. There was no statistically significant difference between younger and middle-range-aged teachers in their propensity for leaving a school. At the secondary level, however, a reverse pattern of relationship between age and teacher exit was observed. The odds of leaving for younger teachers were roughly 10% higher than that of middle-aged teachers (odds ratios: 1.10,; *p* values: .037; see Table 6). In contrast, the odds of leaving for older secondary teachers were not statistically different from that for middle-aged teachers.

Finally, we found several interaction effects between ethnicity and age, and between gender and age. This implies that the propensity for exiting a school among teachers of different ethnic background, gender, or age groups is not necessarily linear

additive. As shown in Table 5, there was a statistically significant interaction effect between Hispanic and Young indicator variables (odds ratio: .81; *p* value: .09). This interaction suggests that while younger teachers on average may not differ in terms of propensity for exiting a school from middle-range-aged teachers, the relationship between age and exit is moderated by a teacher's ethnic background. Specifically in this instance, the odds of leaving among younger teachers of Hispanic background were about 19% lower than that of their white counterparts (i.e., young white teachers). The same interaction effect was also observed for African American (odds ratio: .68; *p* value: .035) and other ethnicity indicator variables (odds ratio: .78; *p* value: .06). Therefore, although younger teachers in general might not exit higher propensity to exit a school than middle-range-aged teachers, younger teachers of non-white background tended to stay in the same schools longer than their white peers. For older teachers, we observed no statistically significant interaction effect between race/ethnicity and age indicator variables. In addition, we observed no interaction effect between gender and age at the elementary level.

Among the secondary teachers (see model 6 under Table 6), we observed no interaction effect between race/ethnicity and age indicator variables. However, there was a significant interaction effect between gender and age. Specifically, female younger teachers had about 15% higher odds of leaving than middle-aged female teachers (odds ratio, 1.15; *p* value, .09) at the secondary level.

Teacher quality and qualifications: years of teaching experiences, degrees, credential and intern status. Table 5 show that, as teachers accumulate years of teaching experiences, the odds of leaving also increases, and there is an acceleration in

the rate of change as years go by (odds ratio for the linear term: 1.08; *p* value: .000; odds ratio for the quadratic terms: .995; *p* value: .001). For secondary teachers (see Table 6), as years of teaching experiences increase, the odds of leaving also increase, though there is no acceleration in the rate of change (odds ratio for the linear term: 1.17; *p* value: .000; odds ratio for the quadratic terms: 1.000; *p* value: .293).

In terms of educational background, compared to teachers who had a bachelor's degree, elementary teachers who had less than a bachelor's degree had close to five times odds of leaving (odds ratio, 4.82; *p* value: .000). Similarly, teachers with a master's degree had higher propensity for leaving a school than teachers with a bachelor's degree. Specifically, the odds of leaving for the former group were 32% higher than that for the latter group (odds ratio: 1.32; *p* value: .000). No other statistically significant differences were observed between teachers with different degrees (including doctorate) and teachers with a bachelor's degree. The same patterns of relationship held for secondary teachers (see Table 6) between the educational background of a teacher and his or her propensity for exiting a school with one exception. The odds of leaving for teachers with a bachelor's degree plus 30 hours of additional credit were approximately 22% lower than that for teachers with a bachelor's degree (odds ratio, .78; *p* value: .000).

With respect to credential and intern status, as Table 5 indicate, among elementary school teachers, fully credentialed teachers had about 34% lower odds of leaving (i.e., lower propensity for leaving a school) than non-credentialed teachers (odds ratio: .66; *p* value: .000). Interestingly, interns also had lower propensity for leaving a school (odds ratio: .77; *p* value: .007). In other words, the odds of leaving for interns were about 23% lower than that for non-intern teachers. These relationships held for

secondary school teachers as well (odds ratios: .65 and .70 respectively; *p* values: .000; see Table 6).

Teacher specialty areas. Because elementary teachers in the U.S. are trained as generalists and teach every subject at the elementary level, we could only compare one assignment group with others, namely, the special education teachers with everyone else. As shown Table 5, special education teachers had higher propensity to exit a school than other teachers (odds ratio: 1.52; *p* value: .000). In other words, the odds of leaving for special education teachers were about 52% higher than typical elementary teachers.

At the secondary level, teachers are subject specific. In our analysis, we focused on the following subject assignment areas: English, social sciences, physical sciences, mathematics, special education, and other subjects. English Language Arts (i.e., ELA) teachers were the reference group. Results in Table 6 indicated that compared to ELA teachers, physical sciences teachers had higher propensity for exiting schools (odds ratio: 1.23; *p* value: .000). Specifically, the odds of leaving for physical sciences teachers were 23% higher than that for ELA teachers. This is not surprising, since based on the utility maximization theory, physical sciences teachers have wider career options than ELA teachers. In contrast, social sciences and other subject assignments teachers tended to have lower odds of leaving, about 17% and 19% lower than ELA teachers (odds ratios for social sciences and other subjects: .83, and .81 respectively; *p* values: ..000). Surprisingly, no statistically significant difference was observed in odds of leaving between mathematics, special education, and ELA teachers at the secondary level (see Table 6).

School Characteristics and Contextual Factors

We examined several aspects of the school context in our attempt to understand how school context might be related to a teacher's behavior (i.e., exiting a school). Results in Tables 5 and 6 suggest both similar and different relationships between school contextual factors and the propensity of teacher exit at the elementary versus secondary level.

Students' social economical and demographic backgrounds. We examined school demographic characteristics in terms of poverty level (i.e., proportion of title-1 students) and demographic populations (i.e., proportion of Hispanic and African American students). Results in Table 5 (column 6) show these three aspects of the social economical and demographic backgrounds of students at a school were not related to teacher turn over at the elementary level. In contrast, two of the three school demographic characteristics were statistically significant predictors of teacher turnover at the secondary level (see Table 6). Specifically, teachers in schools with 1-unit higher proportion of title-1 students had about 17% higher odds of leaving than teachers in schools with average proportion of title-1 students, holding constant other factors (odds ratio, 1.17; *p* value, .038). Schools with higher proportion of African American students also saw higher teacher turnover than those with lower proportion of African American students. The odds of teachers leaving in schools with 1-unit higher proportion of African American students were as close to two times as the odds of teachers leaving in schools with average proportion of African American students, other things being equal (odds ratio, 1.97; *p* value, .005).

Academic climate: Students' achievement level. We use proportion of students' who scored far below and below on the California reading standards tests as a

proxy for the academic climate at a school. Results in Tables 5 and 6 (column 6) suggest that the achievement level of students at a school is a statistically significant predictor of teacher turnover at both elementary and secondary level. Specifically, the odds of teacher leaving in schools with 1-unit higher proportion of students who scored far below or below basic were over twice that of teacher leaving in schools with average proportion of students who scored far below or below basic on the state standards tests (odds ratios, 2.40 and 2.10 respectively; *p* values .011 and .004 respectively).

Racial match. Building on the existing theory and empirical studies, we also tested the potential impact of the racial match or mismatch both in terms of the teacher-to-student and the teacher-to-teacher racial match at a school. Specifically, we tested the interaction terms between a teacher's ethnic background and the following four school composition variables: (1) the proportion of Hispanic students, (2) the proportion of African American students, (3) the proportion of Hispanic teachers, and (4) the proportion of African American teachers. To avoid the collinearity problems caused by high correlations among the four variables, we tested each interaction term individually and dropped the interaction that was not statistically significant. Tables 5 and 6 display the final model with two cross-level interaction terms that test the racial match between teachers and students they serve. Table 5 shows that the proportion of Hispanic or African American students did not have any impact on the teacher turnover among Hispanic and African American teachers at the elementary level. At the secondary level, however, the odds of Hispanic teachers leaving in schools with 1-unit higher proportion of Hispanic students were about 29% lower than in schools with the average proportion

of Hispanic students (odds ratio, .71; *p* value, .09). The proportion of African American students at a secondary school did not affect teacher turnover.

Experience of teachers at a school. While it makes sense that teachers with more years of experience have better opportunities and therefore are more likely to leave than their peers with less experience (Hanushek et al., 2002), we have expected that the average experiences of teachers at a school would help to slow down teacher turnover given there are more experienced teachers at the school. Our results, however, did not support this hypothesis. As shown in Tables 5 and 6, the average experience of teachers at a school actually accelerate teacher turnover. In other words, the odds of teacher leaving increase by 23% and 9% at the elementary and secondary level respectively, with 1-unit increase in average teacher experience (odds ratios, 1.23 and 1.09 respectively; *p* values, .000), holding constant other factors. There is also acceleration in the odds of leaving as suggested by the quadratic term of teacher experience, which is statistically significant.

Physical space. We focus on the crowdedness aspect of a school's physical environment, because over crowdedness is a unique change in the LAUSD. Results indicate that schools that are still overcrowded do not see higher teacher turnover than schools that are not. This result is true for both elementary and secondary schools.

School type. Research has pointed to the important role of school type plays in teacher turnover. In our study, we focus on three types of schools and compare them to the traditional public schools in the district. They are new schools, charter, and magnet.

At the elementary level (see Table 5), we observed two interesting statistically significant results, which were the main effect of charter and the cross-level interaction

effect between charter and teacher age (specifically, the young indicator variable) (odds ratios: 1.33 and .54 respectively; *p* values: .08 and .02 respectively). This means that charter school teachers had approximately 33% higher odds of leaving than public schools teachers. In terms of the cross-level interaction effect between charter and young, recall results presented earlier indicated that younger teachers in general did not have a higher propensity for exiting a school than middle-range-aged teachers. However, the interaction effect means that younger teachers in charter schools had lower propensity for exiting than younger teachers in public schools. Specifically, the odds of younger charter school teachers leaving were about 46% less than that of younger public school teachers. To some extent, this result is plausible, given that some research has found (e.g., Stinebrickner, 1998) that the reality of the job demand in small charter schools is such that, younger teachers who may not have family responsibilities (e.g., not yet married with children) may be able to handle the intense teaching demands more than those who have family responsibilities.

The charter school effect on teacher turnover was also observed at the secondary level (odds ratio, 3.89; *p* value, .000). Charter school teachers at the secondary level had close to four times odds of leaving than public school teachers. In addition, we also found that teachers in new schools had higher odds of leaving than teachers in public schools (odds ratio, 1.22; *p* value, .089). Specifically, the odds of teachers leaving new schools were 22% higher than that of teachers leaving public schools.

Other school type such as magnet had no statistically significant effect on teacher turnover, regardless of the schooling level (see Tables 5 and 6).

Finally, the intra-class correlations suggested that the predictors we included in the model did not fully exhaust all the variation in teacher turnover across elementary or secondary schools as the chi-square tests of the random effects after predictors were added were still statistically significant. To some extent, this may reflect the fact that schools in the LAUSD are complex organizations. Further research could attempt to capture additional aspects of the school characteristics that are not highly correlated to the predictors we have focused on.

Summary of Findings

Table 7 highlights our key findings in the broad context of existing empirical research on teacher turnover. We discuss these findings in details in the first part of the next section.

Table 7. Click here for our Key Findings and Existing Empirical Research on Teacher Turnover.

Summary and Discussion

Teacher turnover and retention have attracted increasing attention in the research and policy community. Understanding who leaves, when, and under what conditions is important for policy formulations that target teacher retention, especially of teachers in inner city schools and shortage specialty areas (e.g., mathematics, sciences, and special education).

Our study provides an opportunity to explore these issues through two-level discrete-time survival analyses, taking advantage of a longitudinal data gathered from the

LAUSD. As the second largest urban school district in the U.S., the LAUSD context provides a unique and excellent opportunity to examine how various individual and school organizational characteristics influence teacher turnover at both elementary and secondary schools in the same district. In particular, our study focuses on investigating the effects of teacher characteristics and school context on the timing of teachers' decision to exit schools where they teach.

When are teachers at risk of leaving?

Our analysis shows that both elementary and secondary school teachers are at the highest risk of leaving their initially assigned schools during the first year of teaching at those schools. However, the risk (i.e., the hazard probabilities) of leaving among secondary teachers is slightly higher than the risk of leaving among elementary teachers. We find that for the sampled teachers observed between 2002-03 and 2008-09, the estimated median survival lifetime for secondary teachers at a school is roughly two and half years, which is shorter than the estimated median survival lifetime for elementary teachers (i.e., a little over 3 years). Both are lower than the reported five-year median lifetime of teacher retention in the teaching force. Given the rise in charter schools and new schools in the LAUSD, it is possible that teachers (especially younger ones) who enter the LAUSD teaching force through non-conventional routes such as Teach for America exit schools after serving their two-year commitment and therefore lowering the median lifetime of teaching in their first assigned schools. Involuntary exits (e.g., firing or forced transfers) may be less likely in the LAUSD context given the strong union presence in the district.

Who is likely to leave?

Gender, race/ethnicity, and age. In terms of gender, while no statistically significant difference exists between female and male teachers at the elementary level, female teachers are less likely than their male counterparts to exit a school at the secondary level. With respect to race and ethnicity, Hispanic teachers are less likely to leave than white at both the elementary and secondary level. In contrast, no difference in the turnover rate is observed between African American and white teachers at both the elementary and secondary level. Teachers of other ethnicities are less likely to exit their schools than white at the secondary level, but no difference is found at the elementary level.. As far as age is concerned, older elementary teachers are more likely to leave than their middle-range-aged colleagues,, probably due to retirement. No difference exits between younger elementary teachers and middle-range-aged teachers.

The pattern of relationship between age and turnover is reversed at the secondary level. Younger secondary teachers are less likely to leave than their middle-range-aged teachers, while no difference in the attrition is found between older and middle-range-aged teachers. Interestingly, we also find several interaction effects between ethnicity and age, and between gender and age. Specifically, we find that while younger elementary teachers in general do not exhibit higher propensity for leaving a school, non-white younger elementary teachers tend to stay teaching at the school longer than their white peers. This interaction effect is not observed at the secondary level. For secondary teachers, though female teachers as a group are less likely to leave, younger female teachers are more likely to leave. This gender by age interaction effect is not found at the elementary level.

Years of teaching experience. We find that as teachers accumulate years of teaching experiences, the odds of leaving also increases. There is also an acceleration in the rate of change for elementary teachers though not for secondary teachers. This finding is consistent with the existing literature which shows that the attrition rate is highest in the beginning years of teaching, but decreases over time, and then picks up again as teachers are near retirement stage.

Degrees, credential, and intern status. We find that teachers with less than bachelor's degrees have higher turnover rate than those with bachelor's degrees. This is true at both elementary and secondary level. In addition, at the elementary level, teachers with master's degrees are more likely to leave than those with only bachelor's degrees. In contrast, secondary teachers with bachelor's degrees plus 30 hours-units are less likely to leave. It is possible that these additional units contribute to the salary increase and therefore reducing the likelihood of leaving.

With regards to credential and intern status, fully credentialed elementary teachers have lower propensity for leaving a school than non-credentialed teachers. Interestingly, interns also have lower propensity for leaving a school. The same pattern of relationships holds for secondary school teachers as well. The finding of interns being less likely to exit schools is interesting in light of the recent ruling by the Ninth U.S. Circuit Court of Appeals in San Francisco, which ruled that California has violated federal law by classifying interns as highly qualified and assigning them to schools with heavily low-income and minority students.

Specialty areas. We find that elementary special education teachers showed higher risks for leaving, but not secondary special education teachers. One thing to bear

in mind is that the reference group is different in the two cases. At the elementary level, we compare special education teachers with general teachers; whereas at the secondary level, we compare special education teachers with English language arts (ELA) teachers. Though the research literature in general portraits special education teachers as having higher turnover rates than general teachers, our finding shows that it matters what reference group we use. For secondary teachers, we also observe that physical sciences teachers are more likely to leave, possibly due to the fact that these teachers have wider career choices than teachers of other subjects (e.g., English language arts, social sciences, etc.). Contrary to most literature, our study does not show that mathematics teachers have higher turnover rates than ELA teachers.

Under What School Context Are Teacher Likely to Leave?

We find both similar and somewhat different relationships between school contextual factors and the propensity of teacher exit at the elementary versus secondary level.

Poverty, minority, and achievement level. Similar to existing research, we find that at both the elementary and secondary level, teachers tend to have higher hazard to exit schools that have higher proportion of low achieving students. Though the research literature seems consistent in stating that teachers in schools with higher proportion of students from poverty and of minority backgrounds have higher turnover rates, our research shows these relationships vary depending on the schooling level and students' race/ethnicity backgrounds. In particular, we find that poverty increases the likelihood of teacher turnover at the secondary level, but not at the elementary level. In terms of minority status, we observe an association between the proportion of African

American students and teacher turnover at the secondary level, but not at the elementary level.

Racial match. The research literature on teacher-student racial match and teacher turnover shows that both Hispanic and African American teachers are less likely to leave schools with higher proportion of Hispanic and African American students respectively. In contrast, we only find one result that is consistent with the existing literature. Specifically, Hispanic teachers are less likely to leave schools with higher proportion of Hispanic students, but only at the secondary level. No other differences are found in support of racial match theory. Further, we tested the potential teacher-to-teacher racial match theory, but found no difference in teachers' preference of the match between their own and their colleagues' ethnic backgrounds.

Experience of the teaching force at a school. Though existing research suggests that teachers tend to stay in schools with fewer inexperienced teachers, our research shows the opposite which is counterintuitive. We find that the higher the average teaching experience of teachers at a school, the more likely a teacher in that school is to exit. This is true at both the elementary and secondary level.

Physical space: overcrowded. We find no difference in the relationship between school being overcrowded and teacher turnover, taking into account other teacher and school characteristics factors.

School type. At the elementary level, we find charter school teachers have higher turnover rates than traditional public school teachers. In addition, we note one interesting significant cross-level interaction effect between charter and teacher age (specifically, the young indicator variable). While younger teachers in general have a

similar propensity for exiting a school as middle-range-aged teachers, younger teachers in charter schools have lower propensity for leaving than younger teachers in traditional public schools. To some extent, this result is consistent with some literature which finds that the reality of the job demand in small charter schools, where younger teachers who may not have family responsibilities (e.g., not yet married with children) may be able to handle the intense teaching demands than those who have family responsibilities (Reis, 1991; Stinebrickner, 1998). Though charter schools are becoming an increasingly popular solution to the problem of public schools, the potential unintended consequence of teacher burnout needs to be addressed. Similarly, results for secondary schools suggest that teachers in new or charter schools have significantly higher propensity for exiting the school than teachers in traditional public schools.

Implications of the Findings

There are several ways to think about the implications of these empirical findings. Conceptually and theoretically, we may need to broaden our policy formulations in terms of what works for whom and in what context and stay away from a one size fits all mindset. With respect to the policy target population, our findings offer some insights on differences in propensity for leaving among teachers of different demographic backgrounds. For instance, we find that while younger teachers on average may (i.e., secondary) or may not (i.e., elementary) have higher exit rates, non-white younger teachers are less likely to exit schools than their white peers. This finding provides data information that researchers can use to probe further (e.g., through qualitative in-depth studies) the motivation and reasons behind the different decision-making process, the

understanding of which could lead to better policy formulation for these teachers than otherwise.

In a similar manner, teachers of different ethnic backgrounds may have different motivations in their choices of teaching in urban schools, which in turn, may affect their decisions regarding how long to stay teaching in urban schools before exit. Our analysis shows that non-white teachers differed from their white colleagues in terms of propensity for exiting their first assigned urban schools. While incentives such as high salaries may help, they might not be the motivating factor for a teacher to enter or exit the teaching force in the first place.

In terms of the timing (i.e., when to intervene), our results show that the hazard or risk for exiting schools is highest during the earlier stage of teaching career (and higher for secondary teachers than for elementary teachers). The implication of this finding is that interventions for teacher retention should pay particular attention to early career teachers. To some extent, our finding supports teacher educators' push for beginning teacher support as a way to address teacher retention problem, especially those teaching in urban schools.

Our finding that the district's initiative to address the crowdedness problem through creating new schools has led to different results for elementary and secondary schools, in particular, the results that teachers in new schools at the secondary level did not slow down their exit rate, calls for further examinations of why the difference exits.

In addition, our finding that teachers in charter schools have significantly higher propensity for exiting has implications for the push for value added accountability in the LAUSD. With teachers exiting these schools at a more frequent rate, it would be difficult

if not at all impossible to come up with reliable value added estimates of teacher quality in charter schools. Depending on where these teachers wind up, it also has implication for calculating value-added estimates of teachers in other schools, since value-added estimates are relative (i.e., relative to which teachers were present during any given year, at which school, and teaching which students).

Finally, some may argue that teacher mobility among urban schools might not be a bad thing, because competition is good. This argument has merit only if all teachers who exit a school are "bad" teachers and thereby only high quality teachers are retained in a school. While the argument makes sense, it is not an easy matter to define "high quality" and verify empirically, though increasing volumes of empirical studies have examined teachers' effect on raising students' test scores as a proxy for teacher quality (e.g., Aaronson, Barrow, & Sander, 2007; Boyd et al., 2005; Clotfelter, Glennie, et al., 2006; Clotfelter et al., 2006, 2007; Hanushek & Rivkin, 2006; Harris & Sass, 2010; Kane, Rockoff, & Staiger, 2008; Murnane et al., 1991; Nye, Konstantopoulos, & Hedges, 2004; Rockoff, 2004; Wayne & Youngs, 2003).

Overly relying on students' test scores to define teacher quality may be problematic, however. For instance, the first author of this report has directed a five-year longitudinal evaluation of a math initiative in the LAUSD, which followed a same group of 160 teachers over a five-year period, to the extent possible. Classroom observations of the same teachers over the five-year period showed that quality of mathematics teaching and learning (i.e., in terms of how teachers engage students around substantive mathematics) did not change (Newton, 2004; Newton, 2005). Furthermore, from the cost-benefit perspective, the gain of having a more mobile teaching force at urban schools

benefits students only if high quality teachers come and STAY teaching in those schools. In the absence of such empirical evidence, we consider frequent teacher exits at urban schools, especially those serving high proportion of minority and low achieving students, as less of a blessing but more of a curse.

Limitations and Further Research

Our proxy measures of teacher quality and qualifications may be imperfect in light of the recent debate surrounding teacher evaluation and accountability. If we had a valid and reliable measure of teacher quality in terms of students' achievement, we would have been able to include such a measure in our model and see if teachers who are effective at raising students' achievement tend to stay or leave urban schools. Unfortunately, the recently popularized but highly controversial value-added measure of teacher quality in the LAUSD is restricted to grades 3 to 5 teachers only, which makes its use limited in our analysis. A different study may confine teacher populations to reading or English language arts (ELA) and mathematics teachers at grade levels where value-added estimates may be calculated (i.e., third through eleventh), though the drawback is lack of external validity (i.e., the extent to which we are able to generalize findings from such a study).

A second limitation of our study is that among the teacher characteristics and factors we examined, teacher salary is not one of them. Our decision is mostly attributable to the lack of access to such information for each individual teacher. But given that the LAUSD follows a standard salary schedule largely based on teacher education backgrounds and years of teaching experience, we have incorporated these two

pieces of information in our model to partly account for earning differences among teachers.

Finally, the reform and accountability climate may have led to different financial incentive initiatives in the district (e.g., bonuses for teaching in hard to staff schools, especially for math, science, special education, and ELL certification teachers). At the same time, the economic crisis the district faces has led to teachers receiving pink slips (most likely based on seniority). Whether these financial incentives or budget deficits have an impact on teacher turnover and equitable distribution of high quality teachers across schools or not is beyond the scope of our current study. However, we agree that studies focusing on evaluating these impacts rigorously are worth the effort.

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Appendix A

Data Merging Process

1. We started with the school level data. The school level data has information on grade type, magnet, new school, pre-overcrowded, still overcrowded schools, and charter. The school level data set identify each school by year using the following ID variables: locn, cdscode and year.
2. Then, we merged the school level data with the student level data. The student level data was transformed before merging with the school level data. We created two composite variables based on individual student information, namely, proportion of Hispanic students and proportion of title I students in the school by year. Each school is identified using the following ID variables: locn, cdscode, and year. This step of the merging process was based on locn and year.
3. Then we merged the school and student data with the test data. The test data was transformed before merging with the school and student data. Based on the individual student test information, we created proportion of student with low performance in the school by year. Each school was identified by the following ID variables: cdscode and year. This step of the merging process was based on cdscode and year.
4. Then we merged the school_student_test data with the teacher data. The teacher data contain all the teachers who have worked in LAUSD between 2002-03 and 2008-09. From this teacher data we obtained all the teacher characteristics and the school characteristics in terms of mean annual school teacher turnover. This step of the merging process was based on cdscode and year.

5. We finally had a teacher data file where each row represents a teacher in a specific calendar year. Each teacher has his or her own characteristics and the school characteristics where he or she works.
6. Based on the teacher data file (step 5), we generated and formatted the data so as to run discrete-time survival analysis. In this data, the outcome for a teacher takes on a value of "0" and remains in the data until he or she exited the school (i.e., the teacher experienced the event). Once a teacher has experienced the event, he or she is not longer in the data.