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ABSTRACT

This paper takes advantage of a unique policy change to examine how principals make decisions regarding teacher dismissal. In 2004, the Chicago Public Schools (CPS) and Chicago Teachers Union (CTU) signed a new collective bargaining agreement that gave principals the flexibility to dismiss probationary teachers for any reason and without the documentation and hearing process that is typically required for such dismissals. With the cooperation of the CPS, I matched information on all teachers that were eligible for dismissal with records indicating which teachers were dismissed. With this data, I estimate the relative weight that school administrators place on a variety of teacher characteristics. I find evidence that principals do consider teacher absences and value-added measures, along with several demographic characteristics, in determining which teachers to dismiss.

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I. Introduction

Efforts to improve teacher quality traditionally have focused on the supply side of the teacher labor market. Many studies have documented that both wages and working conditions play important roles in teacher mobility (Dolton & van der Klaauw 1999; Hanushek et al. 2005; Scafidi, Stinebrickner, & Sjoquist 2003; Stinebrickner 1998, 2002; Boyd, Lankford, Loeb, & Wyckoff 2005), and recent evidence suggests that targeted salary bonuses can induce individuals to teach in high-need areas (Clotfelter, Ladd and Vigdor 2005). Similarly, dozens of studies have explored the relative effectiveness of teachers with traditional versus alternative (or no) certification (see, for example, Loeb et al. 2007; Kane, Rockoff and Staiger 2006).

In contrast, there has been remarkably little research on the demand side of the teacher labor market. For example, few studies have examined how principals hire or fire teachers, or how changes in personnel policies might influence teacher quality. One reason is the common but mistaken perception that disadvantaged school districts are in a state of perpetual shortage of certified teachers in all areas.[1]

Neglect of the demand side of the teacher labor market is particularly unfortunate since policies focusing on teacher hiring, promotion and dismissal may be important levers for improving the quality of public schools. For example, there is evidence that principals do not hire the "best" teachers (Ballou, 1996; Ballou & Podgursky, 1997; Pflaum & Abramson, 1990), and the teacher effectiveness literature has found surprisingly little relationship between many commonly used proxies for teacher quality and student outcomes (see, for example, Hanushek 1997). If principals had greater autonomy with regard to hiring and promotion decisions, there

[1] While there are often shortages in certain subjects and grade levels, even some of the most disadvantaged districts in the country have an ample supply of teachers for most positions. For example, the Chicago Public Schools regularly receives 10 applications for each position. In 2005, an alternative certification program, NYC Teaching Fellows, received over 17,500 applications for 2,000 spots in New York CityPersonal communication with Andy Sokatch of the New Teacher Project.

is some evidence that they would be able to distinguish between the most and least effective teachers in their buildings (Jacob and Lefgren 2008).

This void is not unique to education research. There is a vast economics literature on employee compensation, for example, but relatively few empirical studies that examine the factors that employers consider when hiring or dismissing workers. The one notable exception involves discrimination, where there is a large body of work devoted to determining whether, and under what circumstances, employers discriminate against women and racial minorities. Interestingly, this research has *not* provided strong evidence that employers generally consider factors related to productivity in hiring or dismissing employees.

This paper takes advantage of a unique policy change to examine how principals make decisions regarding teacher dismissal. In 2004, the Chicago Public Schools (CPS) and Chicago Teachers Union (CTU) signed a new collective bargaining agreement that gave principals the flexibility to dismiss probationary teachers for any reason and without the documentation and hearing process that is typically required for dismissals in other districts. With the cooperation of the CPS, I matched information on all teachers who were eligible for dismissal with records indicating which teachers were dismissed. By comparing the characteristics of dismissed versus non-dismissed probationary teachers within the same school and year, I estimate the relative weight that school administrators place on a variety of teacher characteristics, including proxies for teacher productivity.

Several factors make the new CPS policy ideal for addressing this question. First, the present analysis relies on actual personnel decisions as opposed to administrator self-reports. Second, unlike past teacher mobility studies, the present analysis is able to distinguish between

voluntary and involuntary separations. Third, the availability of data such as teacher absence rates and student achievement allows one to create excellent measures of teacher productivity.

I find evidence that principals do consider teacher productivity in determining which teachers to dismiss. Principals are significantly more likely to dismiss teachers who are frequently absent and who have received worse evaluations in the past. Elementary teachers who were dismissed had significantly lower value-added with regard to student achievement in prior years compared with their peers who were not dismissed. In addition, principals were significantly less likely to dismiss teachers with stronger educational qualifications as measured by things such as the competitiveness of their undergraduate college, whether they ever failed the teacher certification exam and whether they had a Masters degree. Finally, dismissed teachers who were subsequently re-hired by a different school are substantially more likely to be dismissed again relative to first-year teachers in the school.

These results provide suggestive evidence that reforms along the lines of the Chicago policy might improve student achievement. In a related paper, I find evidence that the introduction of the Chicago policy reduced teacher absenteeism and may have led to higher achievement in elementary schools (Jacob 2010). At the same time, this analysis reveals that many principals – including those in some of the worst performing schools in the district – did not dismiss any teachers despite how easy it was under the new policy. This result is consistent with the fact that existing teacher contracts in many large urban school districts actually provide considerably more flexibility than is commonly believed and yet administrators rarely take advantage of such flexibility (Ballou 2000, Hess and Loup 2008, Price 2009). The apparent reluctance of many Chicago principals to utilize the additional flexibility granted under the new

contract may indicate that issues such as teacher supply and/or social norms governing employment relations are more important factors than policymakers have realized.

I also find evidence that several teacher demographic characteristics are associated with the probability of dismissal. Principals are more likely to dismiss male teachers, even after controlling for other demographics, prior absences, formal evaluations and teacher value-added. Older teachers are more likely to be dismissed, particularly those working in buildings with younger principals.

While these results raise some concerns, it would be incorrect to conclude on the basis of this evidence alone that principals in Chicago were acting in a discriminatory manner. As described in more detail below, the analysis reported here cannot control for any direct measures of teacher qualities that principals could legitimately consider in making a dismissal decision (e.g., energy, enthusiasm, ability to relate to children, familiarity with the best instructional practices). To the extent that these qualities are correlated with characteristics like age or gender, the results presented below may not reflect discriminatory behavior. Moreover, the sample selection introduced by non-random hiring may lead to biased estimates of the relationship between dismissal and any easily observable, pre-determined teacher characteristic such as age or gender. If, for example, male teachers were less productive on average than female teachers (or even if the principal believed this to be the case), then the marginal male teacher who was hired must be more attractive on some other, likely unobservable, dimension relative the marginal female teacher hired. Nonetheless, these results suggest that additional research into the decision-making process of principals may be warranted.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature, and Section 3 provides background on teacher dismissals in the Chicago Public Schools.

Sections 4 and 5 describe the data and methodology, respectively. Section 6 presents the results, and Section 7 concludes.

2. Prior Literature

This section reviews the existing literature in two areas closely related to the current analysis. I first discuss the economics literature on job displacement across a variety of occupations. I then discuss work that focuses specifically on the labor market for teachers, emphasizing work on teacher hiring and dismissal.

2.1 Job Displacement

The economics literature on job displacement – including both terminations as well as layoffs – has focused on several issues, including the determinants of displacement, changes in the incidence of displacement over time, and in the consequences of job displacement on future earnings and employment. Studies that discuss the determinants of displacement focus primarily on factors such as age, education, industry and occupation. For example, a number of studies have found that younger and less educated workers are more likely to be displaced than their peers (Kletzer 1998).

While many studies mention the determinants of job displacement, few studies attempt to carefully explore employer preferences for worker characteristics. One important exception is the literature on employer discrimination. Prior research has documented racial differences in job displacement, with Black and Hispanic workers more likely to be laid off than Whites. In studies that have been able to control for measures of worker quality or actual performance, these race differentials are generally reduced but still significant. Blau and Kahn (1981) used data

from the National Longitudinal Study in 1970 and 1971 to study differential in layoff rates between Blacks and Whites. After controlling for demographic, educational and socioeconomic differences, the authors found that Black males (females) were 29 (45) percent more likely to be laid off than their White counterparts. Using three years of personnel data from a U.S. financial firm and controlling for the performance ratings given to all employees, Elvira and Zatzick (2002) found that African-Americans were 3 to 10 percent more likely to be laid off than the average employee, and that Hispanic employees were found to be laid off more than the average employee in 7 of 10 business units. In a case study of the U.S. Postal Service in a Northeastern city, Zwerling and Silver (1992) found that Blacks were more than twice as likely to be fired compared to white employees. This was found to be significant at even after controlling for personal characteristics such as age, gender, job specification, drug-test results and civil service test scores. Using the Panel Study of Income Dynamics, Wilson (2005) found that African-Americans were 33 percent more likely to experience job dismissal, even after controlling for education, socioeconomic status and job credentials.

The evidence on whether employers consider employee productivity when determining layoffs is less definitive. Elvira and Zatzick (2002) found that employee performance ratings were negatively associated with layoffs, but it is not clear that this really measures productivity. Zwerling and Silver (1992) found that civil service exam scores were not associated with involuntary termination among postal workers, and Wilson (2005) found no relationship between employee absenteeism and job dismissal. Brown (1990) examined employee retention in the context of the military. He found that soldiers with a high school diploma and higher AFQT scores were more likely to be *eligible* for re-enlistment – that is, they were less likely to be "laid off" by the military.

There is evidence that employers prioritize other skills that are generally unobservable to the econometrician. For example, there is evidence that employers value soft-skills (Murnane and Levy 1996). In a survey to 63 employers in Los Angeles and Detroit, Moss and Tilly (1995) found a growing concern among employers of Black employee's "soft skills," skills like customer interaction and motivation. Holzer and Ihlanfeldt (1998) found evidence that some labor market discrimination may be driven, in part, by discrimination on the part of consumers. Specifically, using data from a survey of 800 employers in four major metropolitan areas (Atlanta, Detroit, Boston and Los Angeles), they found that a twenty-percentage point increase in the fraction of customers who are Black increased the probability that the last person hired by the firm was black by 7 to 14 percentage points. A similarly significant result was found for Hispanics, but the magnitude was lower, an increase in the probability hiring Hispanic employees of 2 to 11 percentage points.

2.2 Teacher Hiring

Although research on teacher hiring is limited, there are several important studies in this area. In a comprehensive review article, Harris et al. (2006) conclude that principals prefer teachers who are enthusiastic and have strong communication skills. Some principals also prefer teachers with particular teaching skills or knowledge of specific pedagogy. They also note, however, that both characteristics considered and methodologies used varied considerably across studies, making it difficult to draw conclusions. In their own study of principal preferences, Harris and his colleagues interviewed 30 principals from a Florida school district. Based on an analysis of open-ended responses, they found that principals most often reported strong teaching skills, caring, knowledge of subject, ability to work with others, experience, enthusiasm and

communication skills as the most important characteristics in applicants for teaching positions. Harris et al. (2006) also note that while a number of principals mentioned intelligence as an important characteristic, principals almost always noted that intelligence only mattered if it was coupled with other important characteristics such as enthusiasm. Further, in qualitative interviews principals often noted that they considered how a potential candidate would complement their existing faculty.

Two recent studies explore teacher hiring practices through statewide surveys of administrators, one in New York (Balter and Duncombe 2005a, 2005b, 2005c) and the other in Pennsylvania (Strauss, Bowes, Marks and Plesko 2000). They report that district officials emphasize the importance of a candidate's undergraduate major, prior teaching experience, subject matter knowledge and references but do not focus on factors such as the caliber of the candidate's academic institution in the hiring process.

3. Teacher Dismissals in Chicago

As in many public school districts, teacher layoffs and dismissals in the Chicago Public Schools are highly regulated. In situations where teacher positions must be eliminated due to enrollment changes or a budget shortfall, the collective bargaining agreement outlines a procedure by which the least experienced teachers are let go first. This is typically known as a reduction-in-force (RIF).

In the past, it has been extremely difficult for principals to dismiss teachers outside the auspices of a RIF. Like most other districts, the collective bargaining agreement in Chicago provides considerable protection for tenured teachers that make it very time-consuming and difficult for principals to dismiss these teachers for cause. Unlike many smaller, suburban

districts in Illinois, however, the collective bargaining agreement in Chicago also made it very difficult for principals to dismiss non-tenured teachers. Perhaps for this reason, formal principal evaluations in Chicago are remarkably generous. In 2007, for example, only 15 out of the 11,621 teachers who were evaluated in 2007 received a rating of unsatisfactory, and only 641 out of 11,621 (roughly 5.5 percent) received a rating of satisfactory. The remaining teachers were rated excellent or superior.

The adoption of a new collective bargaining agreement on July 1, 2004 made substantial changes to the tenure system in Chicago that, for the first time in the 2004-05 school year, provided principals with the ability to easily dismiss non-tenured teachers. So, in the analysis that follows, the academic years 2001-02 through 2003-04 constitute the "pre-policy" period and the academic years 2004-05 through 2006-07 constitute the "post-policy" period. The July 2004 contract created a new three-tiered classification system for Chicago teachers: (1) Temporarily Assigned Teachers (TATs), e.g. individuals who are in a temporary placement (such as a long-term substitute who is filling in for a teacher on leave) and are not earning tenure; (2) Probationary Appointed Teachers (PATs), e.g. individuals who have been regularly appointed to a position but have been teaching for fewer than five consecutive years (i.e., during this period, Chicago teachers received tenure *after* four years of service) and; (3) tenured teachers.

Non-renewal works in the following way. Each February, principals are able to log into a district computer system that has a list of all of the PATs in their school. The principal can then check one of two boxes: renew or non-renew.[2] The administrative ease with which

[2] If the principal checks the "non-renewal" box, he or she must check indicate at least one of the following five reasons for the non-renewal: deficiencies with instruction (e.g., planning, methods, subject matter knowledge), deficiencies with environment (e.g., classroom management, teacher-pupil relationships), deficiencies with professional and personal responsibilities (e.g., attendance, tardiness, professional judgment), deficiencies with communication (e.g., parent conference skills, relations with staff), or deficiencies with attitude (e.g., lack of cooperation, lack of respect for others).

administrators can dismiss a probationary teacher – with a simple "click" of a button – is noteworthy. In essence, the collective bargaining agreement adopted in July 2004 dramatically reduced the costs of firing a probationary teacher in the district. This policy change made Chicago the only large, public school district in the country to provide principals with this type of flexibility over personnel decisions.[3]

Teachers are notified by formal letter of non-renewal sometime in late April or early May. If a principal chooses to non-renew a teacher, the teacher is guaranteed health benefits through August 31st of the current year, and is allowed to reapply to positions in other Chicago public schools. Moreover, the teacher is eligible for unemployment benefits as non-renewal is viewed as a layoff rather than a dismissal for cause.[4] However, non-renewed teachers are not guaranteed another job in the CPS.[5] Although principals are required to provide district officials with at least one reason for the non-renewal decision, they are not required to justify or explain their decision and they do not need to provide teachers with this reason.[6]

4. Data

The data for this study comes from several sources. Teacher personnel files provide information on teacher background, current assignment and, for probationary teachers, whether

[3] Principals are not *required* to make any decision for a particular teacher. If a principal either chooses to renew a PAT or takes no action, then the teacher is still eligible to be laid off through the standard RIF process.
[4] PATs who are rehired by November 1st will not experience a break in service for tenure purposes.
[5] PATs who are displaced through the standard RIF process are also guaranteed health benefits through August 31st and eligible for unemployment insurance. However, they are also guaranteed a position as a cadre teacher, which means that they are guaranteed work as a substitute every day and receive a higher rate of pay and better benefits than a day-to-day substitute. In contrast, non-renewed teachers have to apply to be a cadre teacher, and are accepted on a case-by-case basis after displaced PATs. Tenured teachers who are displaced through the RIF process receive even more benefits. Personal communication with Nancy Slavin, Director of Teacher Recruitment, Chicago Public Schools, June 22, 2007.
[6] If a principal chooses to non-renew a PAT in his or her fourth year (that is, immediately prior to tenure), the principal is required to inform the teacher which reason(s) were listed, but is not required to further justify or explain the decision.

they were renewed or not. We supplement this teacher-level data with information on school demographics, principal characteristics from personnel files, and student test score information (which is used to construct value-added measures of teacher effectiveness).

The initial sample includes probationary teachers in the Chicago Public Schools in three consecutive years: 2004-05, 2005-06 and 2006-07. I exclude individuals who were employed by the central office, including speech pathologists, nurses, counselors and teachers working in administrative or professional development capacities. Moreover, I exclude teachers in a handful of "alternative" schools that serve severely disabled students or other special populations as well as teachers on leave or who were employed less than half time. For a small number of teachers who taught subjects such as art or music in multiple schools, I include only the observation in the school that is listed as their "primary" appointment.[7]

The final sample consists of 16,246 elementary school teachers and 7,764 high school teachers spread across 588 schools. Table 1 presents summary statistics for the sample. Women comprise roughly 85 percent of the sample in elementary schools, and 60 percent of high school teachers. About 50 percent of teachers are White, compared with 28 and 16 percent for Black and Hispanic teachers respectively. Roughly 25 percent of teachers in this sample are less than 28 years old, and 14 percent are over 50 years of age. Interestingly, there are a number of teachers with more than four years of experience in the CPS who were nonetheless classified as probationary teachers during this period. The reason for this is that prior to the 2004 contract, the CPS frequently hired teachers but did not appoint them to tenure-track positions. As part of the new collective bargaining agreement, these teachers were moved to the tenure-track, and thus became probationary teachers regardless of their level of experience.[8]

[7] Including all observations for these teachers does not change our results.
[8] Moving forward, all fully certified teachers are immediately placed on the tenure track.

Roughly 45 percent of teachers received a BA in education, and about 28 percent attended colleges or universities that were rated "non-competitive" (or were unrated) by Barron's Guide to Colleges. On the other hand, roughly 11 percent of the teachers attended colleges rated highly competitive or most competitive. According to Illinois state certification information, about 23 percent of teachers in the sample had failed at least one certification exam in the past, and 5 percent had never passed a certification exam. This later group consists of older teachers who entered the system before such exams were mandatory.

4.1 Measures of Teacher Quality

The analysis incorporates three proxies for teacher quality. First, I use teacher absences because they are measured extremely well, they are easily interpretable, and they impose substantial financial and non-financials costs on the school, which has to arrange for and pay substitutes. Moreover, several recent studies have documented that teacher absences have a strong, negative association with student achievement, providing evidence that this association is causal (Clotfelter et al. 2007, Miller et al. forthcoming).[9] Indeed, in other work using Chicago data from a similar time period, I show that a teacher's absences are negatively associated with principal evaluations of the teacher and with a teacher's value-added contribution to student achievement (Jacob and Walsh 2009). Finally, there is considerable evidence that absences are at least partly discretionary. Research suggests that teacher absences are more frequent on Mondays and Fridays (ERS 1980), higher among temporary teachers and correlated with more

[9] Using North Carolina data, Clotfelter et al. (2007) employ teacher fixed effects and find that each 10 days of teacher absences decrease student achievement by 2.6 percent of a standard deviation. Miller et al. (2007, forthcoming) focus on one disadvantaged urban district and also use teacher fixed effects. They find that each 10 days of teacher absences reduce students' mathematics achievement by 3.3 percent of a standard deviation. In the context of a developing economy, Duflo and Hanna (2006) provide experimental evidence that teacher absences reduce student performance.

general shirking in the workplace (Bradley et al. 2007) and negatively associated with buy-back provisions that allow teachers to receive payment for unused absences (Ehrenberg et al. 1991). Hansen (2009a) finds that teacher absences in NC correspond to experience, tenure in a school, the presence of a new principal and proximity to retirement in ways that would suggest absences are a good proxy for discretionary effort.

Teachers in Chicago are allotted 10-12 paid sick or personal days per year. Teachers can accumulate unused sick days across years, up to a maximum of 315 days. These days can be cashed in upon leaving the district at a rate of 100% for those teachers retiring with at least 40 years of experience and at a 90% rate for teachers with 20-40 years of experience. In addition, teachers get 3 personal days per year, which can be used for emergencies, religious holidays or personal business. There are some restrictions regarding the use of personal days (e.g., teachers cannot use all three days in succession and they cannot be used in the first or last week of school, or on a day before or after a holiday), although unused personal days get banked as sick days.[10]

Using daily level teacher attendance data from payroll records, I calculated the total number of days that each teacher was absent between September 1st and March 1st during the academic year in which the dismissal decision was made, excluding "excused absences" for professional development or other sanctioned activities.[11] For new hires, I count absences accrued only after the teachers' date of hire.

[10] Information on teacher absence policy comes from a review of the recent CPS teacher collective bargaining agreements. Teachers with 13+ years of experience are entitled to 11 paid sick/personal days per year and (as of 2008) teachers with 18+ years of experience are entitled to 12 paid days. Starting in 2009, teachers were allowed to accumulate up to 320 days of sick leave across years. Teachers who retire at age 65 or older they would get to cash in 85% of their sick days. Teachers who retire before 65 years of age with less than 20 years of experience cannot cash in any of their sick days. For leaves due to illness over 10 days, teachers must apply for a personal illness leave.

[11] Unfortunately, I do not have additional detail such as whether the teacher notified the principal ahead of time, or simply did not show up in school.

The second measure is the formal performance rating that the principal gave the teacher in prior years. Traditionally principals rate teachers every one to three years (depending on the tenure status of the teacher) on a four-point scale that includes superior, excellent, satisfactory and unsatisfactory.[12]These ratings do not determine promotion or compensation, with the exception of an unsatisfactory rating, which is necessary to proceed with a dismissal for cause. Many principals and district administrators believe that these ratings are inflated, and not terribly informative. Indeed, only a handful of teachers in our sample received an unsatisfactory rating in the past. However, there does still appear to be variation in this measure, with 21, 20 and 3 percent of teachers receiving superior, excellent and satisfactory ratings respectively. Of course, principal ratings are not an objective measure of teaching effectiveness, although prior work suggests that they may be highly predictive of teacher value-added at the tails (Jacob and Lefgren 2008).

The third measure is a value-added indicator of teacher effectiveness. This measure is meant to capture the extent to which each teacher contributes to student achievement growth, as measured by the standardized tests taken by students in the CPS. While this is an objective and direct measure of one important dimension of teacher effectiveness, value-added indicators have several important limitations. First, only a modest fraction of teachers work in grades and subjects in which students take standardized tests. Hence, it is not possible to calculate value-added measures for a large fraction of the teachers in our sample, including teachers in grade two or below, most teachers in grades 10 or above and any teacher in a non-core subject. Second, it is not clear that one should consider the value-added measures from the year in which the non-

[12] Over 95 percent of efficiency ratings were given to teachers between April and June with the rest assigned between January and March. When available, we use the April-June rating. In practice, less than 3 percent of teachers with ratings are assigned multiple ratings in a single academic year. For these teachers, we use the latest rating. For teachers with no ratings in the immediately prior year, we assign them the ratings received in the most recent prior year available.

renewal decision was made. Non-renewal decisions are made in late February or early March, and the standardized tests are not administered until May. To the extent that the decision to non-renew a teacher influences his or her performance in the final months of school, one might be worried that the current year value-added measures would systematically understate the effectiveness of non-renewed teachers, and thus introduce a mechanical negative association between value-added and non-renewal. If one chooses to focus on value-added from prior years, this means that it is not possible to consider the value-added for first-year teachers. Finally, value-added indicators capture only one (albeit important) dimension of teacher effectiveness.

With these caveats in mind, I attempt to construct value-added indicators for as many teachers in the sample as possible. Unlike some school districts, Chicago traditionally has *not* maintained reliable data linking teachers to classrooms, particularly at the elementary level. Working with CPS officials, however, I was able to obtain such links for a limited sample, thus allowing me to create value-added measures for some, but not all, teachers in the analysis file. Appendix A provides more detail on the construction of the value-added measures used in this analysis.

5. Empirical Strategy

The goal of this analysis is to determine whether any teacher, principal or school characteristics are associated with the likelihood that a teacher will be dismissed. To do so, I estimate discrete-choice models of principal decisions. The model utilized here follows the general structure of a discrete-time hazard model. The dependent variable is a binary indicator, y_{ijt}, that takes on a value of one if teacher *i* in school *j* in year *t* was dismissed, and zero

otherwise. The explanatory variables in this model include teacher characteristics, *X*, and principal and/or school characteristics, *Z*.

(1) $$y_{ijt} = X_{it}\beta + Z_{jt}\Gamma + X_{it}Z_{jt}\Pi + \alpha_{jt} + \varepsilon_{ijt}$$

Note that the sample includes teachers "at risk" of being dismissed in the given year – that is, all probationary teachers. If a teacher is dismissed and not rehired, leaves the district voluntarily or receives tenure, she is no longer in the risk set, and is thus excluded from the analysis. The vector *X* includes an indicator of the teacher's probation year to capture the effect of "surviving" dismissal in year t on the likelihood of being dismissed in year t+1.

To examine the influence of specific school-level characteristics, we estimate specifications that include a set of observable school and/or principal characteristics. However, when I estimate the influence of teacher characteristics on the likelihood of dismissal, I include a complete set of school x year fixed effects (α_{jt}) to account for unobserved school-level factors that might be correlated with teacher characteristics and the probability of dismissal. Finally, in some specifications, I include interactions between teacher and school characteristics, which can be identified even if school x year fixed effects are included in the model.

Following the standard approach for discrete-time hazard models, I initially estimate equation (1) using a conditional Logit specification, conditioning on the teacher's school x year. I then re-estimate equation (1) as a linear probability model (LPM) with school x year fixed effects. While the use of linear models for binary outcomes has several well-known limitations (e.g., a potential reduction in efficiency, predictions outside the unit interval, heteroskedastic error terms), in this case the estimated effects from the LPM are virtually identical to those one obtains from a conditional Logit. Given the equivalence of results, I present marginal effects from the LPM for ease of interpretation. In all models, I report standard errors clustered by

school to account for arbitrary heteroskedasticity within a school x year as well as serial correlation within a school across years.

With several reasonable assumptions, the coefficients estimated from the model above can be interpreted as reflecting the principal preferences for particular teacher attributes (see below for a discussion of these assumptions). The first assumption is that principals are aware of the policy and observe the teacher characteristics included in the model. The second assumption involves the standard concern with omitted variables. If the model does not include a teacher characteristic that principals consider in the dismissal decision and that is also correlated with one of the included variables, the estimate for the included characteristic may be biased.

One potentially important variant of this omitted variables concern involves the supply of teachers. If it is more difficult to find qualified teachers in certain subjects or grade levels, then the principal may be less likely to dismiss teachers in these areas. To the extent that teachers in harder-to-staff areas are concentrated among particular demographic groups, or tend to graduate from particular institutions, one might be concerned that estimated coefficients on these teacher characteristics are biased. As a control for the supply of teachers in particular areas, all regressions include a series of variables that indicate the teacher's program area including, for example, regular education grades 1-3, regular education grades 4-8, secondary math, secondary science, bilingual education, vocational education, etc. Schools fund teachers from a variety of revenue streams and according to discussions with school administrators it is often difficult for principals to reallocate positions across funds. For this reason, if a school experiences a decline in a particular revenue fund, the principal may be more inclined to dismiss teachers funded by this revenue source. To control for these factors, all regressions also include a series of binary variables that indicate the revenue source from which each teacher position is funded.

Another potentially important form of selection bias is introduced through the hiring process itself. For example, if a principal has a strong preference for female teachers, then a male teacher hired by the principal must have some unobservable asset relative to an observationally equivalent female teacher hired by the principal. Because we do not observe this quality, it may lead us to understate the principal's preference for female teachers. This selection will be particularly important for very easily observable characteristics such as teacher race, gender and age. In theory, one could circumvent this concern by focusing on teachers who were not hired by the current principal, although even in this case one might be concerned about correlation of preferences across principals within the same school, particularly if certain views are commonly held in the profession (e.g., male teachers are not as effective as female teachers). In practice, there are not sufficient numbers of cases in which principals switched schools or were newly hired to obtain precise estimates from this approach.

Fortunately, this type of selection will not bias the primary teacher productivity measures – i.e., absences, value-added and principal ratings – because these factors only become known after hiring. To the extent that the principal was not aware of an individual's educational background or prior failure of the state certification exam, estimates of these coefficients would not suffer from this type of bias either.

Of course, it is still possible that the estimates of these characteristics suffer from a more standard omitted variable bias. For example, it may be the case that high rates of absenteeism are associated with a bad attitude or shirking in other dimensions, and it is these factors – rather than the absences per se – that the principal is reacting to in dismissing teachers with more absences. In this case, one may not be able to say something definitive about teacher views

regarding teacher absenteeism per se, but rather about behaviors/characteristics associated with absenteeism, all of which presumably speak to productivity in some form or another.

6. Results

This section presents the main findings of the analysis. Section 6.1 presents some basic facts about teacher dismissals under this policy. Section 6.2 examines how school, principal and teacher characteristics are associated with the likelihood of dismissal. Section 6.3 reports a variety of sensitivity analyses. Section 6.4 examines how the effects vary by school and principal characteristics. Section 6.5 presents results on the relationship between teacher value-added and the probability of dismissal. Section 6.6 explores interactions between teacher and school (or principal) characteristics.

6.1 Some Basic Facts about Teacher Dismissals in Chicago

Table 2 provides summary statistics on the prevalence of teacher dismissal under this new policy. Several interesting facts stand out. First, while roughly 9-13 percent of probationary teachers were dismissed each year under the new policy, 30-40 of schools did not dismiss *any* teachers. This did not change dramatically between 2005 and 2007. Younger probationary teachers were substantially more likely to be dismissed than others, consistent with the idea that principals learn the most about a new teacher in his or her first year. The total fraction of teachers dismissed declined somewhat from 2005 to 2007, but not as dramatically as one might have expected, particularly for elementary schools.

These statistics seem to suggest that the introduction of the dismissal policy had a large impact on job separations in the district. However, the numbers of teachers who were non-

renewed in any given year likely overstates the impact of the policy because a number of young teachers would likely have left the CPS in the absence of the policy, either voluntarily or due to subtle "encouragement" on the part of the principals. If the dismissal policy merely formalized previously informal dismissals, then one would not necessarily expect to find a substantial change in separations. Even in this case, however, the policy may have influenced teacher productivity if it changed the expectation or transparency of the dismissal process. In other work, I document that the dismissal did have an impact on overall teacher separations, although not as large as the overall nonrenewal numbers would suggest (Jacob 2010). For example, the fraction of first-year teachers leaving the CPS rose from about 10 percent in 2004 to roughly 19 percent in 2005 and 2006.

While there was a positive correlation between low student performance and the prevalence of teacher dismissal in a school, it was not merely high-performing schools that failed to dismiss any of their teachers. In 2005, 65 percent of schools in the lowest quartile of student achievement in the district dismissed at least one teacher compared with 46 percent of the highest-achieving schools in the district. Splits using school value-added measures yield comparable results.

As part of the dismissal process, principals were asked to indicate one or more of the following pre-specified reasons for the dismissal: deficiencies with instruction (i.e., planning, subject matter knowledge), classroom environment (i.e., classroom management, teacher-pupil relationships), professional and personal responsibilities (i.e., attendance, tardiness, professional judgement), communication (i.e., parent conference skills, relations with staff) or attitude (lack of cooperation, lack of respect for others). The most common reason cited for dismissal involved classroom environment, which principals cited in 50 to 60 percent of cases. The next

most common reasons were instruction (45-55 percent of cases), followed by professional responsibility (35-45 percent of cases).

Finally, it is worth noting that in any given year, over half of the dismissed teachers were rehired the following year by another school in the district. For example, 50.6% of first-year probationary teachers who were dismissed in Spring 2005 were rehired by a CPS school in Fall 2005. Among third- and fourth-year probationary teachers who were dismissed, the rate was over 60%. Given the fact that at least some of the dismissals under the policy were the result of position cuts, in which case the teacher's former principal may have provided the teacher with a good recommendation, it is not surprising that some fraction of dismissed teachers were rehired. However, it is also likely that some fraction of teachers dismissed due to poor performance were also rehired by other CPS schools. It is not clear why principals would rehire teachers who had been dismissed from a different school for performance reasons. Non-renewal decisions are not made public to all principals in the district, but a hiring principal could almost certainly get this information by contacting the candidate's former principal.

6.2 The Relationship between School, Principal, Teacher Characteristics and Teacher Dismissal

Table 3 examines the relationship between school-level characteristics and teacher dismissal. Each column represents a separate OLS regression where the dependent variable is a binary indicator that takes on a value of one if the teacher was dismissed. School fixed effects are not included, but the standard errors are adjusted for clustering at the school level.

In both elementary and secondary schools, principals in larger schools dismissed a smaller fraction of probationary teachers. In elementary schools, higher student achievement is associated with a smaller fraction of probationary teachers while the opposite pattern occurred at

the secondary level. Principals who attended more competitive colleges and principals who were older dismissed a smaller proportion of teachers in both elementary and high schools. However, male high school principals dismissed a significantly smaller percentage of their teachers while principal gender did not play as important a role at the elementary level. Finally, principals new to the building dismissed a substantially larger fraction of teachers in elementary schools, but not in high schools.

Table 4 explores the association between teacher characteristics and the likelihood of dismissal, relying solely on variation within school x years to identify the effects. The estimates shown in column 1 indicate that two proxies for teacher quality – prior year principal evaluations and current year teacher absences – both influence the likelihood of dismissal. Teachers who were rated satisfactory in the prior academic year were roughly 22 percentage points more likely to be non-renewed relative to teachers who were rate superior. Teachers rated excellent were 4 percentage points more likely to be dismissed. Given an average dismissal rate of roughly 11 percent, these results suggest that teacher performance as measured in prior evaluations is strongly associated with dismissal. In this way, the policy facilitated principals' ability to dismiss teachers with relatively poor performance in the past.

Teachers who were absent more than 10 times between September and March of the current year were 11-13 percentage points more likely to be non-renewed than their colleagues who were never absent. Teachers absent 6-10 days were 3 percentage points more likely to be dismissed. In analyses not presented here, I confirm that these results are robust to the inclusion of personal days and to normalizations that account for differential employment length during the current school year.

The specification shown in column 2 includes several other potential proxies for teacher quality. The results indicate that principals value teachers with stronger educational backgrounds as measured by college quality, certification test scores and advanced degrees. For example, the coefficient of -0.009 on Barron's rating means that, all else equal, a teacher who attended a highly competitive college (ranking=4) is nearly 3 percentage points (roughly 15 percent) less likely to be dismissed than a teacher who attended a least competitive (or unrated) college (ranking=1).[13] On the other hand, on average principals do not seem to value certification exam performance or advanced degrees, at least after conditioning on the other proxies of quality.

The specification in column 3 includes a host of teacher demographics along with the proxies for relative supply in a teacher's field (i.e., certification area, funding source, etc.). Perhaps the most important thing to note is that the inclusion of these other characteristics does not materially change the coefficients on the teacher quality indicators. Prior evaluations, ratings and undergraduate college quality remain significant predictors of non-renewal.

However, it is also worth noting that several teacher demographics – including age, gender and race – are associated with the likelihood of dismissal, even after conditioning on the measures of teacher productivity and qualifications described above. Principals are roughly 3 percentage points more likely to dismiss male teachers than female teachers, an effect of over 25 percent given the baseline dismissal rate of 10-12 percent. Principals are considerably more

[13] Barron's rating can be thought of as both a proxy for the cognitive ability of the individual teacher as well as a measure of the quality of the individual's undergraduate education. In preliminary analyses, we explored several different ways to measure the quality of the teacher's undergraduate college, including the ACT/SAT scores of students in the school and the Barron's rating of the school's competitiveness. All of these measures produced qualitatively similar results. For the sake of simplicity, and because a non-trivial fraction of schools were missing ACT/SAT information, we chose to focus on a linear measure of the college's competitiveness ranging from 1 (noncompetitive or unrated) to 5 (most competitive) taken from the Barron's Guide to Colleges. The Barron's rankings are highly correlated with the average ACT/SAT scores of incoming students and with more informal perceptions of the "quality" of the institution.

likely to dismiss older teachers. For example, teachers 36 to 50 years of age are roughly 4 percentage points (33 percent) more likely to be dismissed relative to teachers age 22 to 28. Teachers over 50 are 10 percentage points (nearly 100 percent) more likely to face dismissal than their youngest counterparts.[14] And Black teachers are roughly 2 percentage points less likely to be dismissed than their colleagues.

The bottom panel shows estimates for several indicators of teacher status. We see that principals are significantly more likely to dismiss teachers who were in the system in other positions prior to starting on the tenure track. For the most part, this includes individuals who started as temporary (i.e., uncertified) teachers, teacher's aides or certified teachers who were not assigned to the tenure track. Probationary teachers in years 2-4 who worked at the same school in the previous year are substantially less likely to be dismissed than first-year probationary teachers. This is consistent with principals learning the most about teachers in their first year on the job.[15]

Interestingly, probationary teachers who were dismissed from another school in the prior year, and re-hired by the current school, are substantially more likely to be dismissed. For example, elementary school teachers who were dismissed from another school in the prior year were 5 percentage points (about 45 percent) more likely to be dismissed relative to first-year teachers in the school. In high school, previously dismissed teachers were over 13 percentage points (more than 130 percent) more likely to be dismissed than first-year teachers. These results suggest that many of the initial non-renewal decision were not idiosyncratic, stemming from a particularly bad match, or based on temporary difficulties experienced by the teacher.

[14] Note that the models shown in Table 4 include a quadratic in experience as well as the off-track indicator to account for the correlation between teacher age and prior (non-teaching) experience in the CPS.
[15] In most specifications, there are no significant differences between second through fourth year teachers in dismissal likelihood.

Rather, this suggests that, at least in many cases, the initial non-renewal decision reflected a concern with the teacher's general productivity.

The results in columns 4 and 5 show the full set of results separately for elementary and high schools. With only a few exceptions, the determinants of teacher dismissal are roughly equivalent across the two school levels.

6.3 Sensitivity Analyses

Table 5 presents the estimates from a variety of alternative specifications to test the robustness of the main results. The baseline model shown in column 1 is a replication of the estimates shown in Table 4, column 4. Column 2 presents odds ratios from a conditional Logit specification to test whether the imposition of a linear functional form is biasing the results. As mentioned earlier, the linear model appears to yield inferences essentially equivalent to the non-linear model.

Columns 3-7 report specifications with alternate samples and/or alternate definitions of the dependent variable. The specification in column 3 uses a measure of teacher dismissal that considers teachers who were non-renewed and *not* rehired at the same school as never dismissed, since principals have indicated that a non-trivial fraction of non-renewal decisions in the first year or two of the policy were driven by potential budget concerns and many of these teachers were later rehired. Column 4 drops all observations in which the principal did not make an active decision to renew or non-renew the teacher. Column 5 sets the principal rating measures to missing if the teacher or the principal were not in the same school in the previous year, under the assumption that in such cases the principal may not be as aware of the teacher's past performance. Column 6 limits the sample to schools in which at least one teacher was dismissed

since it is possible that some principals were not fully aware of the non-renewal policy, particularly in 2005. Column 7 combines the restrictions imposed in columns 4 and 6. In each of these cases, the main findings described above remain consistent.

Column 8 reports results for a sample of probationary teachers who "survived" dismissal in prior years – specifically, teachers in the 2006 and 2007 cohorts who were not dismissed in the prior year and who remained in the same school. Given that principals had an opportunity to dismiss these teachers, one might expect that time-varying performance measures (e.g., absences) or less easily observable characteristics (e.g., quality of teacher's college) might be more salient, and easily observable permanent characteristics (i.e., age, gender, race) might be less salient, in the principal's dismissal decision for this set of teachers. In contrast, the results for this group are roughly equivalent to those for the full sample.

Columns 9-10 report results for schools that indicated budget cuts did and did not play an important role in teacher dismissals. Principals are not required to provide any justification for dismissing probationary teachers under the new policy. Specifically, principals were permitted to non-renew a teacher even in the absence of any necessary reduction-in-force. However, informal conversations with school officials suggest that some principals used dismissal primarily in response to budget cuts while others made dismissal decisions independent of budget considerations. In both cases, one would expect principals to dismiss teachers with the lowest perceived value to the school. However, if those principals who non-renew teachers on the basis of budget considerations focus explicitly on program area, revenue source or seniority, the inclusion of these schools will attenuate the coefficients on the teacher productivity measures.

Using a survey administered to principals in Spring 2007, I explore this possibility.[16] Column 9 presents results for schools where the principal indicated that anticipated position closings were very important to some or all of his or her non-renewal decisions. Column 10 shows the results for schools where the principal indicated that these factors were very minor or not at all important to his or her non-renewal decisions. The two sets of schools appear to value many teacher characteristics similarly, including teacher age, gender, educational background and performance as measured by absences and prior rating. However, schools making non-renewal decisions in light of budget cuts were significantly less likely to dismiss Black and Hispanic teachers (relative to white teachers) than schools not facing cuts. Similarly, schools facing cuts were significantly more likely to dismiss teachers with prior non-teaching experience in the district.

Finally, in results not shown here, I find that the determinants of teacher dismissal were quite stable across the three cohort years in this sample.

6.4 Heterogeneity of Effects across Schools

Table 6 explores whether principal responses varied across schools. Preliminary analyses indicated that the relationships were comparable for elementary and high schools, so the results presented here include all schools. Columns 2 and 3 present results for schools in the top and

[16] The survey was administered to principals who registered their schools to attend CPS job fairs in May or June 2007, which included 320 of the 584 schools in our sample. The survey asked about non-renewal decisions in the 2005-2006 and 2006-2007 school years. As part of the survey, principals were asked "What level of importance did anticipated position closings have on your non-renewal decisions (in past years)?" Principals responding "Very important to all of my non-renewal decisions" or "Very important to some of my non-renewal decisions" were categorized as making at least some non-renewal decisions because of anticipated budget cuts. Roughly 29 percent of responses fell into this category. Principals responding "Very minor to my non-renewal decisions" or "Not at all important to my non-renewal decisions" were categorized as not making non-renewal decisions on the basis of anticipated budget cuts. Roughly 44 percent of responses fell into this category.

bottom half of Chicago school achievement distribution.[17] Perhaps most importantly, principals across school types appear to place similar weight on many of the teacher productivity measures, including absences and prior ratings. However, principals in higher-achieving schools are less likely to dismiss teachers with a MA degree and more likely to dismiss teachers that failed a certification whereas these characteristics are not significant predictors of dismiss in lower-achieving schools.

Several other interesting differences appear with respect to the demographics. Most notably, the higher dismissal rates among male teachers appear to be driven largely by low-achieving schools. In low-achieving schools, male teachers are 6.7 percentage points more likely to be dismissed than female teachers. Conversely, the lower dismissal likelihood for Black and Hispanic teachers appears to be driven by low-achieving schools. I explore this finding in more detail below.

One might also imagine that principal decisions would differ based on the competence of the principal. On the one hand, one might suspect that more effective principals would be better able and/or more inclined to use non-renewal to remove low-quality teachers, in which case one would expect the coefficients on the productivity measures to be larger. On the other hand, it is also possible that highly effective principals do a better job of screening applicants during the hiring practice and a better job of encouraging poor teachers to leave, in which case the relationship between observed productivity measures and dismissal might be lower. To explore this possibility, I estimated the baseline model for schools with value-added measures above and

[17] For elementary schools, school achievement is the enrollment weighted fraction of third, fifth, and eighth grade students in the school-year testing at or above proficiency on the ISAT averaged across math and reading. For high schools, school achievement is the fraction of students in the school-year testing at or above national norms on the PSAE. Data from the years 2002-2004 (prior to the implementation of the new policy) is used to determine school achievement.

below district median respectively.[18] Overall, the pattern of results appears remarkably similar across these groups (results available upon request).

Given that a principal's age and college quality appear to be at least somewhat predictive of dismissal propensity (Table 3), columns 4-9 in Table 6 examine whether a principal's age and/or educational background influence the weight that she places on different teacher characteristics. While there is no striking difference across principal college quality categories in terms of their valuation of teacher prior ratings or absences, principals who attended the most competitive colleges (similar to principals from high-achieving schools) seem to be place more emphasis on teachers' educational background than their peers from less competitive colleges.[19] There is no clear pattern of effects by principal age with respect to valuation of teacher prior ratings, current absences or educational background. Interestingly, however, there appears to be some evidence of an interaction between principal and teacher age – namely, younger principals appear to be slightly more likely to dismiss older teachers compared with older principals. I explore this finding in more detail below.

6.5 Teacher Value-Added and Dismissal

The results in Table 4 provide evidence that principals consider some measures of teacher qualifications and/or performance (e.g., absences, educational background, prior evaluations) in making their dismissal decisions. There is some evidence that subjective principal ratings (Jacob and Lefgren 2008) and teacher absences (Miller et al. forthcoming, Clotfelter et al. 2006) are associated with student learning. However, to the extent that one views student achievement as

[18] School value-added measures are calculated by regressing student-level achievement scores on prior student achievement and a vector of standard student demographics (e.g., race, gender, free-lunch eligibility, etc.) and then aggregating the residuals to the school level.

[19] This is due in part (but not entirely) to the fact that principals from the most competitive colleges are more likely to work in high-achieving than low-achieving schools.

the primary outcome of interest, one should directly assess how a teacher's ability to improve student achievement influences the likelihood of dismissal.

Table 7 presents some evidence on this issue by focusing on the relationship between teacher value-added and dismissal. Unfortunately, as mentioned above, it is only possible to calculate teacher value-added for a limited number of teachers in our sample. For elementary schools, we have value-added indicators on (virtually) all math and reading teachers in grades 2-5 in a set of 327 schools, which is roughly two-thirds of the elementary schools in the district.[20] For high schools, the data includes value-added measures for all core-subject 9th grade teachers.

To examine the relationship between the other teacher characteristics and dismissal in the value-added sample, columns 1 and 4 in Table 7 replicate columns 4 and 5 from Table 4. The estimates for this sub-sample are much less precise than those for the full sample, and many of the estimates are not statistically different than zero. However, if one examines the magnitude of the point estimates, most results appear comparable across the two samples. Interestingly, the mean dismissal rate in this sample is considerably lower than among all probationary teachers. Only 6.2 percent of elementary teachers in the value-added sample are dismissed relative to 11.4 percent in the full elementary sample.

Given the limited student achievement data available, the estimated teacher value-added indicators that we use as predictors likely will be measured with considerable error. Hence, in order to correct for this attenuation bias, I use an instrumental variables strategy in which I split the data sample used to calculate the value-added measures and use the value-added measures calculated from one half of the sample as an instrument for the value-added measures calculated

[20] These schools are roughly comparable to all CPS schools on standard observable measures.

from the other half of the sample.[21] This strategy will not help correct any inconsistency in the estimates arising from non-random sorting of students and teachers, nor will it correct for classroom-year sources of error arising (e.g., a dog barking in the parking lot during the end-of-the-year test), but will correct for the attenuation bias stemming from the measurement error in the value-added indicators associated with sampling variability.

Columns 2 and 5 present the main estimates from dismissal models that include value-added measures of teacher effectiveness, along with teacher demographics and school x year fixed effects but no other teacher qualification/performance characteristics. The value-added measures have been normalized to mean zero and standard deviation one. For elementary schools, the point estimate of -.071 indicates that a one standard deviation increase in teacher value-added is associated with a 7.1 percentage point (over 100 percent) decrease in the likelihood of dismissal. The inclusion of other teacher performance measures in column 3 (e.g., teacher absences and prior principal rating) does not change the coefficient on the value-added measure, suggesting that the other quality measures are only weakly correlated with value-added in this sample.

In contrast to the results for elementary schools, I find that teacher value-added has zero association with dismissal among the sample of 9th grade core subject teachers in high schools. One potential reason for the difference across grade levels is that the outcome measure for the 9th grade value-added measures is the PLAN test, which is given in the Fall of a student's 10th grade year. PLAN is developed by ACT to test knowledge and skills in math, science and language arts, resembles the ACT in that it is not tightly linked to any particular curriculum. Hence, because of both the timing of the exam (in the Fall of the following year) and the content of the

[21] For example, if teacher A had 26 students in her class during a particular year, I would calculate two value-added measures for the teacher, each of which would use a randomly selected 13 students. These two measures are highly correlated with each other, and thus provide powerful instruments.

exam, the 10th grade value-added measures may not capture teacher effectiveness as well as the elementary value-added measures.

6.6 Principal-Teacher Interactions and Dismissal

To this point, we have seen evidence that principals do consider some measures of teacher qualifications, effort and productivity when making non-renewal decisions. This suggests that this policy might improve student achievement in the long run. However, one of the primary concerns with this and other similar policies is that principals will dismiss teachers capriciously and/or on the basis of illegitimate (i.e., non-productivity related) criteria.

In the results presented earlier (Table 4), we saw that principals were substantially more likely to dismiss male teachers and older teachers, even after controlling for background and productivity measures. Similarly, we saw that principals were somewhat less likely to dismiss Black teachers after controlling for other factors.

While these results raise some potential concerns, it would be incorrect to conclude on the basis of this evidence alone that principals in Chicago were acting in a discriminatory manner. First, while the models above include some proxies for teacher effectiveness, they undoubtedly cannot capture many of the individual teacher qualities that principals consider essential. For example, if older teachers are less adept with technology, have a more difficult time relating to children, or are less aware of recent innovations in curriculum and pedagogy, principals who are concerned solely with teacher productivity may legitimately dismiss a larger fraction of senior teachers. Second, as discussed in the previous section, selection generated through the hiring process makes it difficult to interpret the results for characteristics like age, race and gender, which were clearly known by the principal ex-ante.

In order to shed additional light on the issue of principal discrimination, Table 8 examines whether interactions between teacher and principal characteristics are significant predictors of dismissal. Note that the inclusion of school x year fixed effects ensures that these interactions are identified by differences in principal behavior across teachers *within* the same school.

As a point of comparison, column 1 reproduces the baseline model with one change that will facilitate interpretation of the subsequent results – i.e., teacher age is specified as a linear term instead of grouped into discrete categories. Consistent with the results shown in Table 4, older teachers are more likely to be dismissed even after controlling for other demographic, educational and productivity measures. Specifically, coefficient of .003 indicates that the average principal would be 3 percentage points (about 27 percent) more likely to dismiss a 50-year-old teacher relative to a 40-year-old teacher, all else equal. (Note that all of the other predictors shown in the baseline model are included in the specification, though they are not presented in the table for the sake of parsimony.)

Column 2 includes interactions between principal and teacher race, gender and age. There is no significant interaction between principal-teacher gender, though the analogous interactions for principal-teacher race and age are statistically significant. The negative coefficient on the principal-teacher age interaction indicates that older principals are less concerned with a teacher's age than younger principals. For example, a 65-year-old principal would only be 2 percentage points (about 18 percent) more likely to dismiss the 50- versus 40-year-old teacher, relative to the 55-year-old principal above.

Column 3 explores whether teacher dismissal is associated with the characteristics of the student population. Given the widespread belief that same-race role models are crucial for low-

income students, it would not be surprising if principals took into account the composition of their student body when making dismissal decisions. Indeed, insofar as prior research has demonstrated that, all else equal, students learn more when taught by a teacher of the same race (Dee 2004, Hanushek et al. 2005), this might be a legitimate determination on the part of the principal.

The estimate of -.025 indicates that as the fraction of students in the school that share the race of the teacher rises, the likelihood that the teacher will be dismissed declines. Specifically, an increase of 50 percentage points in the fraction of students who share the teacher's race decreases the likelihood that the teacher will be dismissed by slightly more than 1 percentage point, or 10 percent.[22] This result is consistent with the model of "customer discrimination" highlighted in Holzer and Ihlanfeldt (1998).

Column 4 examines whether desegregation mandates may have influenced principal dismissal decisions. According to the consent decree that the CPS signed with the U.S. Department of Justice in September 1980, the district committed to developing a comprehensive student desegregation plan (CPS 1994). The plan stipulated that the racial/ethnic composition and experience level of teachers in each school faculty should be between plus or minus 10 percent of the district-wide proportion of such teachers. Under the plan, the district was supposed to the extent possible follow teacher assignment and transfer practices to facilitate this goal.[23] To account for this, we include a quadratic term in the difference between the fraction of teachers in the district of a certain race and the fraction of teacher's in the school of the same

[22] Additional analyses not presented here confirmed that the linear specification of the same-race variable provides the best fit for the data. In results not reported here, we find that this phenomenon applies to white, Black, and Hispanic teachers, though the standard errors increase considerably. I also confirm that this result is not driven by an interaction between student poverty and/or student achievement and teacher race.

[23] The consent decree was lifted in 2006, however, and did not apply to schools during the 2006-07 school year. It is possible that principals and district officials may have maintained some of the procedures/systems for at least some time afterwards.

race. This variable will be negative if a teacher race group is overrepresented in the school, relative to the district. In this case, a principal might be more likely to dismiss the teacher. Conversely, when a teacher race group is underrepresented in the school relative to the district the variable will be positive and the principal may be less likely to dismiss the teacher. While the estimates are imprecise, the point estimates are consistent with this phenomenon.

Column 5 includes the student-teacher, principal-teacher and relative teacher racial composition variables in the same model. The coefficients on both the teacher-student race and principal-teacher race interactions decrease (in absolute value) and are no longer statistically significant. The principal-teacher age interaction remains significant.

Columns 6-9 replicate the specifications in columns 2-5, but allow the key interactions to vary by the race of the teacher. In general, we find that the effects described above are driven largely by decisions regarding Black teachers. Interestingly, relative teacher racial composition is a significant predictor of dismissal decisions for white and Black, but not Hispanic, teachers. On the other hand, the principal-teacher and student-teacher interactions are still not statistically significant.

7. Conclusions

This paper examines a new policy that provided Chicago Public School principals the flexibility to dismiss probationary teachers for any reason and without the documentation and hearing process that is typically required for dismissals in other districts. By comparing the characteristics of dismissed versus non-dismissed probationary teachers within the same school and year, the analysis aims to learn which teacher characteristics principals value most highly,

and whether there are any important interactions between school or principal characteristics and the dismissal decision.

I find evidence that principals do consider teacher productivity in determining which teachers to dismiss. Principals are significantly more likely to dismiss teachers who are frequently absent and who have received worse evaluations in the past. Elementary teachers who were dismissed had significantly lower value-added with regard to student achievement in prior years compared with their peers who were not dismissed. In addition, principals were significantly less likely to dismiss teachers with stronger educational qualifications as measured by things such as the competitiveness of their undergraduate college, whether they ever failed the teacher certification exam and whether they had a Masters degree. Finally, dismissed teachers who were subsequently re-hired by a different school are substantially more likely to be dismissed again relative to first-year teachers in the school.

These results provide suggestive evidence that reforms along the lines of the Chicago policy might improve student achievement, consistent with results from a related paper (Jacob 2010). At the same time, this analysis reveals that many principals – including those in some of the worst performing schools in the district – did not dismiss any teachers despite how easy it was under the new policy. This result is consistent with the fact that existing teacher contracts in many large urban school districts actually provide considerably more flexibility than is commonly believed and yet administrators rarely take advantage of such flexibility (Ballou 2000, Hess and Loup 2008, Price 2009). The apparent reluctance of many Chicago principals to utilize the additional flexibility granted under the new contract may indicate that issues such as teacher supply and/or social norms governing employment relations are more important factors than policymakers have realized.

I also find evidence that several teacher demographic characteristics are associated with the probability of dismissal. Principals are more likely to dismiss male teachers, even after controlling for other demographics, prior absences, formal evaluations and teacher value-added. Older teachers are more likely to be dismissed, particularly those working in buildings with younger principals. While these results do not necessarily indicate that principals are acting in a discriminatory manner, they suggest that additional research into the decision-making process of principals is warranted.

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Appendix A: Construction of Teacher Value-Added Measures

For elementary schools, I was able to obtain teacher-student links for core-subject classroom teachers in the 2004-05 and 2005-06 school years. This allows me to calculate value-added measures in the non-renewal year for the 2005 and 2006 cohorts, and in the year prior to non-renewal for the 2006 and 2007 cohorts. Preliminary analyses and conversations with CPS officials concluded that these links were only reliable for teachers in grades 2-5 in roughly three-quarters of the schools. Given the limited data, I estimated relatively simple models in which the dependent variable, y, is the math or reading achievement score of student i with teacher j in school k in year t.

$$y_{ijkt} = f(y_{ijkt-1}) + X_{it}b + q_{jt} + g_k + e_{ijkt} \quad \text{(A1)}$$

I control for prior student achievement flexibly using polynomials of both prior math and reading scores y_{ijkt-1}. I also control for a standard set of student demographics, X, including age, gender, race, special education status, free-lunch eligibility, etc. Finally, I include school-fixed effects, γ_k, which insure that the value-added measures are identified by comparisons of teachers *within* the same school. Standard errors are corrected to account for clustering of students within classroom.[24]

For secondary schools, it is only possible to reliably calculate value-added measures for individuals who teach ninth grade math, reading or science. During the years covered in this study, high schools students in Chicago took a series of standardized tests developed by the makers of the ACT exam. In preparation for the ACT, which Chicago students typically take in 11th grade, students take the EXPLORE and PLAN exams in the fall of the 9th and 10th grades

[24] Because I estimate each of the two years separately, there is only one teacher observation per sample and I thus cannot separately identify classroom-level covariates, or distinguish between idiosyncratic teacher-year effects and true value-added.

respectively. These exams are developed by ACT to test knowledge and skills in math, science and language arts. Working with CPS officials, I obtained achievement scores for 9th and 10th grade students along with course files and teacher records that allow me to link students to teachers. Unlike elementary school, I have such data on all teachers who taught a 9th grade math, science or language arts course. Using this data, I create value-added measures for 9th grade teachers using the Fall 10th grade score (on the PLAN exam) as the post-test and the Fall 9th grade score (on the EXPLORE exam) as the pre-test.

Specifically, I estimated models in which the dependent variable, y, is the math or reading achievement score of student i with teacher j in school k in year t.

(A2) $$PLAN_{ijkt} = f(EXPLORE_{ijkt-1}) + X_{it}b + q_{jt} + g_k + e_{ijkt}$$

As with the elementary models, I control for prior student achievement flexibly using polynomials of prior math, reading and science scores along with a standard set of student demographics, classroom demographics such as race composition, fraction male, class size, semester and class period, and school fixed effects. Using this data, I am able to calculate value-added measures for the 2003-04, 2004-05 and 2005-06 school years, which means that I will have a measure of teacher effectiveness prior to the non-renewal year for all cohorts, and a measure in the actual non-renewal year for the 2005 and 2006 (but not 2007) cohort.

Table 1 – Summary Statistics

	Elementary Schools		High Schools	
	All Probationary Teachers	Probationary teachers who were dismissed	All Probationary Teachers	Probationary teachers who were dismissed
Number of observations	16246	1858	7764	822
Fraction Non-Renewed	0.114	1	0.106	1
Demographics				
Male	0.163	0.222	0.399	0.501
Black	0.282	0.314	0.260	0.294
Hispanic	0.184	0.148	0.104	0.112
White	0.485	0.496	0.561	0.533
Asian	0.048	0.043	0.074	0.061
1st year probationary teacher	0.303	0.407	0.327	0.408
2nd year probationary teacher	0.292	0.291	0.297	0.270
3rd year probationary teacher	0.230	0.178	0.224	0.167
4th year probationary teacher	0.174	0.124	0.152	0.156
Years of experience	5.290	5.519	4.944	5.903
Worked in CPS prior to starting as a tenure track teacher	0.327	0.388	0.277	0.394
Age <=27	0.260	0.223	0.231	0.137
Age 28-35	0.339	0.279	0.327	0.232
Age 35-50	0.276	0.305	0.285	0.355
Age 50+	0.125	0.193	0.157	0.277
Education				
MA+	0.453	0.459	0.516	0.522
Education Major	0.546	0.495	0.230	0.242
Math/Science Major	0.085	0.087	0.207	0.242
Social Science/Humanities Major	0.163	0.164	0.368	0.330
Art Major	0.051	0.064	0.069	0.049
Other Major	0.064	0.067	0.055	0.057
Vocational Major	0.045	0.051	0.047	0.050
Barron's Rating (1=not competitive or unrated to 5=most competitive)	2.124	2.053	2.301	2.147
Failed at least one test	0.227	0.245	0.225	0.262
Has not passed any tests	0.047	0.067	0.062	0.086
Other Teacher Background				
Teacher new to school	0.300	0.425	0.304	0.391
In multiple schools	0.006	0.010	0.001	0.000
Part time	0.073	0.088	0.005	0.004
School Characteristics				

Predominantly Minority	0.143	0.135	0.244	0.266
Predominantly Black	0.396	0.491	0.389	0.477
Predominantly Hispanic	0.233	0.192	0.062	0.061
Mixed/Integrated	0.228	0.182	0.306	0.196
Achievement level (% meeting national norms or achieving proficiency)	56.925	52.679	25.439	21.961
Enrollment/100	7.735	7.122	16.826	14.680
Magnet school	0.083	0.074	0.192	0.118
Principal Characteristics				
Principal new to school	0.130	0.194	0.161	0.168
Principal male	0.311	0.276	0.509	0.416
Principal Black	0.480	0.582	0.506	0.590
Principal White	0.319	0.231	0.323	0.207
Principal Hispanic	0.184	0.172	0.163	0.187
Principal age	53.594	52.698	54.346	53.357
Principal B.A. in Education	0.690	0.698	0.405	0.434
Barron's Rating (1=not competitive or unrated to 5=most competitive)	2.011	1.920	2.174	2.119
Effectiveness				
Prior year rating = none	0.637	0.731	0.696	0.774
Prior year rating = satisfactory	0.096	0.301	0.103	0.349
Prior year rating = excellent	0.449	0.477	0.474	0.489
Prior year rating = superior	0.455	0.222	0.423	0.161
0 current year absences (Sept. – Mar.)	0.111	0.097	0.110	0.098
1-5 current year absences (Sept. – Mar.)	0.551	0.463	0.525	0.400
6-10 current year absences (Sept. – Mar.)	0.252	0.285	0.272	0.306
11-20 current year absences (Sept. – Mar.)	0.068	0.124	0.082	0.163
21+ current year absences (Sept. – Mar.)	0.019	0.031	0.011	0.033
Prior year value added estimate = none	0.937	0.966	0.791	0.815
Estimated prior year value-added	0.022	-0.398	-0.022	-0.065

Notes: The sample includes probationary teachers in the 2004-2005, 2005-2006, and 2006-2007 school years. We exclude individuals employed in positions other than teachers, teachers in specialized "alternative" schools, teachers on leave or who are employed at under half time. For the small number of teachers employed in multiple schools we keep only the observation listed as their "primary" appointment.

Table 2 – Basic Statistics on Teacher Dismissal in Chicago

	Elementary Schools			High Schools		
	2005	2006	2007	2005	2006	2007
Number of teachers per school	35.7	34.5	33.6	68.1	65.6	66.7
Number of probationary teachers per school	12.3	11.6	10.3	26.6	25.6	23.4
Among schools with any probationary teachers, fraction that dismissed at least one probationary teacher	0.581	0.612	0.538	0.660	0.695	0.720
Overall fraction of probationary teachers who were dismissed	0.116	0.125	0.100	0.123	0.103	0.088
Fraction of probationary teachers who were dismissed						
1 year experience	0.161	0.163	0.143	0.163	0.111	0.083
2 years experience	0.082	0.137	0.105	0.061	0.115	0.090
3 years experience	0.090	0.089	0.087	0.088	0.058	0.088
4 years experience	0.074	0.100	0.073	0.120	0.109	0.100
Among probationary teachers who were dismissed, fraction who were rehired as a teacher in the district						
1 year experience	0.506	0.507	0.547	0.564	0.449	0.455
2 years experience	0.513	0.521	0.518	0.441	0.507	0.490
3 years experience	0.640	0.573	0.561	0.585	0.607	0.549
4 years experience	0.622	0.674	0.561	0.619	0.682	0.458

Notes: Based on author's calculations using CPS administrative data.

Table 3 – The Relationship between School Characteristics and Teacher Dismissal

	Elementary Schools		High Schools	
Dependent Variable = Non-Renewed	(1)	(2)	(3)	(4)
School Characteristics				
School achievement (percent meeting national norms or achieving proficiency)	-0.151**	-0.094**	0.001	0.001**
	(0.033)	(0.033)	(0.001)	(0.001)
Predominantly minority	-0.006	-0.002	-0.020	-0.013
	(0.015)	(0.015)	(0.016)	(0.017)
Predominantly hispanic	0.014	0.012	-0.040	-0.042
	(0.018)	(0.018)	(0.028)	(0.029)
Mixed/Integrated	0.027	0.020	-0.052**	-0.051**
	(0.020)	(0.019)	(0.024)	(0.023)
Enrollment/100	-0.004**	-0.003**	-0.002**	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Magnet school	0.018	0.010	-0.058**	-0.058**
	(0.015)	(0.016)	(0.020)	(0.018)
Multiple schools in building	0.029	0.025	-0.035**	-0.046**
	(0.017)	(0.017)	(0.014)	(0.013)
Year 2006	0.028**	0.020**	-0.020	-0.026**
	(0.009)	(0.010)	(0.013)	(0.013)
Year 2007	0.009	0.007	-0.036**	-0.024**
	(0.010)	(0.010)	(0.012)	(0.011)
Principal Characteristics				
Principal new to school	0.057**	0.054**	0.002	-0.004
	(0.012)	(0.012)	(0.013)	(0.013)
Principal male	-0.007	-0.005	-0.025**	-0.024**
	(0.008)	(0.008)	(0.011)	(0.011)
Principal black	0.022	0.011	0.025	0.009
	(0.017)	(0.017)	(0.019)	(0.018)
Principal hispanic	0.004	-0.003	0.030	0.033*
	(0.010)	(0.011)	(0.021)	(0.020)
Principal age	-0.001**	-0.001**	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Principal B.A. in Education	0.002	-0.002	-0.005	-0.005
	(0.009)	(0.009)	(0.011)	(0.012)
Principal's Barron’s rating (1=not competitive or unrated to 5=most competitive)	-0.015**	-0.014**	-0.017**	-0.012*
	(0.005)	(0.005)	(0.008)	(0.007)
Controls for teacher characteristics	No	Yes	No	Yes
Mean of dependent variable	0.114	0.114	0.106	0.106
Number of observations	16246	16246	7764	7764
Number of teachers	8700	8700	4117	4117

Number of schools	480	480	108	108
R-Squared	0.020	0.063	0.022	0.093

Notes: Each column is an OLS regression with standard errors clustered by school in parentheses. All specifications include missing value indicators for principal demographics, and school achievement. Specifications with teacher characteristics include controls for teacher effectiveness, teacher education, teacher demographics, teacher experience and status, and a set of teacher fund and certification area indicators. For elementary schools school achievement is the enrollment weighted fraction of third, fifth, and eighth grade students in the school-year testing at or above proficiency on the ISAT averaged across math and reading. For high schools school achievement is the fraction of students in the school-year testing at or above national norms on the PSAE.

Table 4 – The Relationship between Teacher Characteristics and Dismissal

	All Schools			Elementary Schools	High Schools
Dependent Variable = Non-Renewed	(1)	(2)	(3)	(4)	(5)
Teacher Effectiveness					
Satisfactory prior year rating relative to superior	0.221**	0.221**	0.185**	0.190**	0.169**
	(0.018)	(0.018)	(0.018)	(0.021)	(0.033)
Excellent prior year rating relative to superior	0.043**	0.044**	0.037**	0.045**	0.017
	(0.007)	(0.007)	(0.007)	(0.008)	(0.011)
1-5 current year absences (Sept. – Mar.)	0.002	0.002	0.018**	0.019**	0.016
	(0.006)	(0.006)	(0.006)	(0.008)	(0.010)
6-10 current year absences (Sept. – Mar.)	0.035**	0.036**	0.057**	0.058**	0.056**
	(0.007)	(0.007)	(0.008)	(0.009)	(0.014)
11-20 current year absences (Sept. – Mar.)	0.113**	0.113**	0.131**	0.130**	0.128**
	(0.011)	(0.011)	(0.011)	(0.013)	(0.020)
21+ current year absences (Sept. – Mar.)	0.129**	0.129**	0.152**	0.127**	0.232**
	(0.021)	(0.021)	(0.021)	(0.022)	(0.049)
Teacher Education					
MA+		0.007	-0.007	-0.006	-0.010
		(0.004)	(0.004)	(0.006)	(0.007)
Barron's rating (1=not competitive or unrated to 5=most competitive)		-0.009**	-0.005**	-0.005*	-0.005
		(0.002)	(0.002)	(0.003)	(0.003)
Failed at least one test		0.003	0.007	0.004	0.012
		(0.005)	(0.005)	(0.006)	(0.009)
Teacher Demographics					
Age 28-35			0.005	0.002	0.011
			(0.005)	(0.007)	(0.009)
Age 35-50			0.040**	0.032**	0.057**
			(0.007)	(0.008)	(0.014)
Age 50+			0.100**	0.092**	0.115**
			(0.010)	(0.012)	(0.019)
Black			-0.021**	-0.023**	-0.019**
			(0.006)	(0.008)	(0.009)
Hispanic			-0.004	-0.010	0.014
			(0.006)	(0.007)	(0.010)
Male			0.038**	0.041**	0.034**
			(0.006)	(0.008)	(0.008)
Part time teacher			0.013	0.014	-0.004

			(0.011)	(0.012)	(0.043)
Teacher in multiple schools			0.006	0.023	-0.193*
			(0.040)	(0.042)	(0.107)
Teacher Status					
Worked in CPS prior to starting as a tenure track teacher			0.026**	0.029**	0.023
			(0.008)	(0.010)	(0.014)
PAT 2-4 and dismissed in prior year			0.080**	0.049**	0.134**
			(0.019)	(0.021)	(0.035)
PAT 2-4, in same school and not dismissed in prior year			-0.045**	-0.049**	-0.038**
			(0.007)	(0.008)	(0.012)
PAT 2-4, in different school and not dismissed in prior year			-0.021	-0.020	-0.026
			(0.013)	(0.017)	(0.021)
Mean of dependent variable	0.112	0.112	0.112	0.114	0.106
Number of observations	24010	24010	24010	16246	7764
Number of teachers	12670	12670	12670	8700	4117
Number of schools	588	588	588	480	108
R-Squared	0.173	0.174	0.195	0.209	0.168

Notes: Each column is an OLS regression with school-year fixed effects and standard errors clustered by school in parentheses. All specifications include a set of teacher fund and certification area indicators, a quadratic in years of experience, and missing value indicators for efficiency ratings, absences, and age.

Table 5 – Sensitivity of Results to Alternative Samples and Specifications

	Baseline	Conditional Logit	Dependent Variable = non-renewed and not rehired	Sample = excludes no decision	Rating set to missing if not in same school last year	Sample = schools where 1+ fired	Sample = schools where 1+ fired, excluding no decision	Sample = teachers who were not dismissed in the prior year and who remained in the same school	Sample = schools that indicated they did not make non-renewal decisions in response to anticipated cuts	Sample = schools that indicated they made at least some non-renewal decisions in response to anticipated cuts
Dependent Variable = Non-Renewed	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Teacher Effectiveness										
Satisfactory prior year rating relative to superior	0.185**	8.090**	0.015**	0.181**	0.227**	0.253**	0.241**	0.207**	0.258**	0.172**
	(0.018)	(1.295)	(0.007)	(0.019)	(0.024)	(0.023)	(0.024)	(0.030)	(0.042)	(0.071)
Excellent prior year rating relative to superior	0.037**	2.345**	0.000	0.045**	0.039**	0.058**	0.068**	0.049**	0.040**	0.028
	(0.007)	(0.292)	(0.003)	(0.008)	(0.007)	(0.009)	(0.010)	(0.010)	(0.020)	(0.030)
1-5 current year absences (Sept. – Mar.)	0.018**	1.208**	0.010**	0.020**	0.017**	0.023**	0.025**	0.009	0.017	0.065**
	(0.006)	(0.097)	(0.004)	(0.007)	(0.006)	(0.009)	(0.010)	(0.010)	(0.016)	(0.025)
6-10 current year absences (Sept. – Mar.)	0.057**	1.931**	0.025**	0.065**	0.057**	0.078**	0.085**	0.041**	0.076**	0.139**
	(0.008)	(0.176)	(0.004)	(0.009)	(0.008)	(0.011)	(0.012)	(0.012)	(0.021)	(0.032)
11-20 current year absences (Sept. – Mar.)	0.131**	3.773**	0.060**	0.143**	0.131**	0.179**	0.185**	0.103**	0.174**	0.230**
	(0.011)	(0.404)	(0.008)	(0.013)	(0.011)	(0.015)	(0.016)	(0.017)	(0.030)	(0.042)
21+ current year absences (Sept. – Mar.)	0.152**	4.209**	0.081**	0.157**	0.152**	0.205**	0.199**	0.097**	0.293**	0.148**
	(0.021)	(0.734)	(0.015)	(0.024)	(0.021)	(0.028)	(0.031)	(0.028)	(0.059)	(0.073)
Teacher Education										
MA+	-0.007	0.931	-0.001	-0.007	-0.006	-0.008	-0.008	-0.013*	-0.004	-0.006
	(0.004)	(0.048)	(0.003)	(0.005)	(0.004)	(0.006)	(0.007)	(0.007)	(0.011)	(0.018)
Barron's rating (1=not competitive or unrated to 5=most competitive)	-0.005**	0.926**	-0.002*	-0.007**	-0.005**	-0.008**	-0.009**	-0.001	-0.008	-0.007
	(0.002)	(0.024)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.010)
Failed at least one test	0.007	1.081	-0.003	0.009	0.007	0.008	0.013	0.001	-0.020	0.018
	(0.005)	(0.064)	(0.003)	(0.006)	(0.005)	(0.007)	(0.008)	(0.008)	(0.014)	(0.019)
Teacher Demographics										
Age 28-35	0.005	1.032	0.002	0.004	0.004	0.006	0.005	0.004	-0.009	0.028
	(0.005)	(0.077)	(0.003)	(0.006)	(0.005)	(0.007)	(0.008)	(0.008)	(0.014)	(0.019)
Age 35-50	0.040**	1.601**	0.008*	0.040**	0.039**	0.054**	0.052**	0.028**	0.065**	0.081**
	(0.007)	(0.138)	(0.004)	(0.008)	(0.007)	(0.010)	(0.011)	(0.010)	(0.020)	(0.027)
Age 50+	0.100**	2.884**	0.041**	0.115**	0.100**	0.136**	0.150**	0.071**	0.127**	0.165**
	(0.010)	(0.284)	(0.006)	(0.012)	(0.010)	(0.013)	(0.015)	(0.014)	(0.026)	(0.039)
Black	-0.021**	0.796**	-0.022**	-0.018**	-0.021**	-0.028**	-0.024**	0.001	0.006	-0.075**
	(0.006)	(0.050)	(0.004)	(0.007)	(0.006)	(0.008)	(0.009)	(0.008)	(0.013)	(0.027)
Hispanic	-0.004	0.941	-0.009**	-0.009	-0.005	-0.006	-0.012	-0.009	0.015	-0.057**

	(0.006)	(0.073)	(0.004)	(0.006)	(0.006)	(0.008)	(0.009)	(0.009)	(0.018)	(0.023)
Male	0.038**	1.521**	0.011**	0.038**	0.038**	0.050**	0.048**	0.028**	0.039**	0.049**
	(0.006)	(0.092)	(0.003)	(0.007)	(0.006)	(0.007)	(0.008)	(0.009)	(0.013)	(0.024)
Part time teacher	0.013	1.194	0.014*	0.020	0.011	0.025	0.033*	-0.007	0.033	0.008
	(0.011)	(0.142)	(0.007)	(0.013)	(0.011)	(0.017)	(0.018)	(0.014)	(0.034)	(0.033)
Teacher in multiple schools	0.006	0.878	-0.019	-0.002	0.005	0.004	-0.015	0.047	-0.067	0.135
	(0.040)	(0.320)	(0.018)	(0.049)	(0.040)	(0.060)	(0.068)	(0.066)	(0.088)	(0.152)
Teacher Status										
Worked in CPS prior to starting as a tenure track teacher	0.026**	1.434**	0.012**	0.035**	0.026**	0.037**	0.045**	0.034**	0.001	0.093**
	(0.008)	(0.128)	(0.005)	(0.009)	(0.008)	(0.011)	(0.012)	(0.011)	(0.023)	(0.035)
PAT 2-4 and dismissed in prior year	0.080**	1.642**	0.020**	0.073**	0.090**	0.100**	0.093**		0.095**	0.060
	(0.019)	(0.220)	(0.010)	(0.021)	(0.018)	(0.024)	(0.025)		(0.037)	(0.060)
PAT 2-4, in same school and not dismissed in prior year	-0.045**	0.611**	-0.011**	-0.046**	-0.047**	-0.061**	-0.059**		-0.044**	-0.075**
	(0.007)	(0.042)	(0.004)	(0.008)	(0.006)	(0.009)	(0.010)		(0.019)	(0.024)
PAT 2-4, in different school and not dismissed in prior year	-0.021	0.788	-0.003	-0.020	-0.033**	-0.025	-0.023		-0.054*	0.002
	(0.013)	(0.116)	(0.007)	(0.016)	(0.013)	(0.019)	(0.021)		(0.029)	(0.045)
Mean of dependent variable	0.112	0.157	0.035	0.143	0.112	0.159	0.193	0.080	0.134	0.162
Number of observations	24010	16848	24010	18711	24010	16877	13868	8862	3923	2105
Number of teachers	12670	10687	10687	11167	12670	10703	9451	6750	3210	1672
Number of schools	588	519	519	582	588	521	521	554	173	103
R-Squared	0.195		0.135	0.316	0.195	0.168	0.288	0.205	0.172	0.192

Notes: Each column is an OLS regression with school-year fixed effects and standard errors clustered by school in parentheses, except column 2, which presents odds ratios from a conditional logit. All specifications include a set of teacher fund and certification area indicators, a quadratic in years of experience, and missing value indicators for efficiency ratings, absences, and age.

Table 6 – Heterogeneity of Teacher Dismissal Effects

	Baseline	High-achieving Schools	Low-achieving schools	Principal's Barron's rating not competitive or unrated	Principal's Barron's rating less competitive	Principal's Barron's rating competitive, very competitive, or most competitive	Principal's age <50	Principal's age 50-57	Principal's age 58+
Dependent Variable = Non-Renewed	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Teacher Effectiveness									
Satisfactory prior year rating relative to superior	0.185**	0.182**	0.195**	0.282**	0.170**	0.152**	0.195**	0.177**	0.187**
	(0.019)	(0.028)	(0.026)	(0.046)	(0.023)	(0.038)	(0.039)	(0.026)	(0.034)
Excellent prior year rating relative to superior	0.037**	0.037**	0.043**	0.091**	0.023**	0.038**	0.039**	0.035**	0.039**
	(0.007)	(0.009)	(0.012)	(0.022)	(0.009)	(0.012)	(0.015)	(0.010)	(0.013)
1-5 current year absences (Sept. – Mar.)	0.018**	0.005	0.029**	0.011	0.016*	0.023**	0.030**	0.021**	-0.001
	(0.007)	(0.008)	(0.012)	(0.016)	(0.010)	(0.011)	(0.014)	(0.010)	(0.011)
6-10 current year absences (Sept. – Mar.)	0.057**	0.036**	0.079**	0.077**	0.058**	0.047**	0.075**	0.056**	0.041**
	(0.008)	(0.010)	(0.014)	(0.019)	(0.012)	(0.013)	(0.016)	(0.012)	(0.015)
11-20 current year absences (Sept. – Mar.)	0.131**	0.082**	0.174**	0.154**	0.121**	0.140**	0.180**	0.128**	0.098**
	(0.012)	(0.014)	(0.019)	(0.032)	(0.017)	(0.020)	(0.027)	(0.018)	(0.019)
21+ current year absences (Sept. – Mar.)	0.152**	0.079**	0.223**	0.106**	0.159**	0.165**	0.183**	0.134**	0.147**
	(0.021)	(0.027)	(0.033)	(0.051)	(0.031)	(0.035)	(0.043)	(0.031)	(0.035)
Teacher Education									
MA+	-0.007	-0.011**	-0.002	0.002	-0.004	-0.014*	-0.025**	-0.005	0.003
	(0.005)	(0.005)	(0.008)	(0.013)	(0.006)	(0.008)	(0.010)	(0.006)	(0.008)
Barron's rating (1=not competitive or unrated to 5=most competitive)	-0.005**	-0.006**	-0.004	-0.007	-0.002	-0.010**	-0.003	-0.004	-0.009**
	(0.002)	(0.002)	(0.004)	(0.007)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)
Failed at least one test	0.007	0.013*	0.003	-0.012	0.007	0.018**	-0.001	0.011	0.004
	(0.005)	(0.007)	(0.009)	(0.014)	(0.007)	(0.009)	(0.013)	(0.008)	(0.009)
Teacher Demographics									
Age 28-35	0.005	0.012*	-0.001	-0.010	0.009	0.005	0.003	0.014*	-0.005
	(0.006)	(0.007)	(0.010)	(0.017)	(0.008)	(0.008)	(0.012)	(0.008)	(0.009)
Age 35-50	0.040**	0.035**	0.045**	0.032	0.046**	0.035**	0.063**	0.043**	0.020
	(0.007)	(0.009)	(0.013)	(0.021)	(0.010)	(0.012)	(0.017)	(0.010)	(0.013)
Age 50+	0.100**	0.089**	0.111**	0.124**	0.101**	0.089**	0.117**	0.110**	0.074**
	(0.010)	(0.015)	(0.015)	(0.031)	(0.014)	(0.016)	(0.023)	(0.015)	(0.017)
Black	-0.021**	-0.010	-0.028**	0.010	-0.036**	-0.003	-0.014	-0.021**	-0.023**
	(0.006)	(0.007)	(0.009)	(0.018)	(0.008)	(0.011)	(0.013)	(0.009)	(0.010)

Hispanic	-0.004	0.003	-0.026**	-0.020	0.002	-0.005	-0.007	-0.001	-0.006
	(0.006)	(0.007)	(0.012)	(0.016)	(0.008)	(0.010)	(0.014)	(0.008)	(0.011)
Male	0.038**	0.020**	0.067**	0.007	0.043**	0.041**	0.044**	0.036**	0.035**
	(0.006)	(0.007)	(0.011)	(0.016)	(0.009)	(0.009)	(0.013)	(0.009)	(0.010)
Part time teacher	0.013	0.019	0.006	0.015	0.012	0.008	0.015	0.014	0.013
	(0.011)	(0.014)	(0.019)	(0.035)	(0.015)	(0.020)	(0.023)	(0.015)	(0.025)
Teacher in multiple schools	0.006	-0.019	0.052	0.077	0.026	-0.044	0.033	0.014	-0.016
	(0.041)	(0.048)	(0.078)	(0.172)	(0.052)	(0.070)	(0.114)	(0.059)	(0.067)
Teacher Status									
Worked in CPS prior to starting as a tenure track teacher	0.026**	0.027**	0.031**	0.050**	0.044**	-0.014	0.011	0.035**	0.023
	(0.008)	(0.011)	(0.013)	(0.025)	(0.012)	(0.013)	(0.019)	(0.013)	(0.015)
PAT 2-4 and dismissed in prior year	0.080**	0.050*	0.097**	0.051	0.070**	0.121**	0.108**	0.078**	0.039
	(0.020)	(0.028)	(0.028)	(0.041)	(0.026)	(0.041)	(0.034)	(0.034)	(0.032)
PAT 2-4, in same school and not dismissed in prior year	-0.045**	-0.039**	-0.051**	-0.065**	-0.042**	-0.039**	-0.031**	-0.033**	-0.075**
	(0.007)	(0.009)	(0.011)	(0.017)	(0.010)	(0.012)	(0.015)	(0.010)	(0.013)
PAT 2-4, in different school and not dismissed in prior year	-0.021	-0.016	-0.017	-0.018	-0.030*	-0.010	-0.031	0.005	-0.051**
	(0.014)	(0.018)	(0.023)	(0.038)	(0.018)	(0.026)	(0.028)	(0.022)	(0.024)
Mean of dependent variable	0.112	0.089	0.140	0.134	0.112	0.100	0.134	0.107	0.101
Number of observations	24010	13334	10084	3791	12566	7653	5468	11346	7042
Number of teachers	12670	7314	5617	2395	7340	4655	3683	7124	4634
Number of schools	588	291	273	121	345	220	197	363	229
R-Squared	0.195	0.170	0.214	0.209	0.189	0.210	0.196	0.194	0.193

Notes: Each column is an OLS regression with school-year fixed effects and standard errors clustered by school in parentheses. All specifications include a set of teacher fund and certification area indicators, a quadratic in years of experience, and missing value indicators for efficiency ratings, absences, and age. High achieving schools are schools with above median mean proficiency rates (or fraction at national norms in high schools) across the 2001-2002, 2002-2003 and 2003-2004 school years.

Table 7 – The Relationship between Teacher Value-Added and Dismissal

	Elementary Schools			High Schools		
Dependent Variable = Non-Renewed	(1)	(2)	(3)	(4)	(5)	(6)
Value added in prior year		-0.071**	-0.070**		-0.004	-0.010
		(0.021)	(0.021)		(0.022)	(0.022)
Teacher Effectiveness						
Satisfactory prior year rating relative to superior	0.148*		0.117*	0.081		0.082*
	(0.080)		(0.061)	(0.067)		(0.045)
Excellent prior year rating relative to superior	0.059		0.044	-0.003		-0.002
	(0.037)		(0.037)	(0.030)		(0.030)
1-5 current year absences (Sept. – Mar.)	-0.010		-0.014	0.022		0.022
	(0.027)		(0.031)	(0.022)		(0.029)
6-10 current year absences (Sept. – Mar.)	0.003		-0.005	0.051*		0.051*
	(0.032)		(0.036)	(0.027)		(0.031)
11-20 current year absences (Sept. – Mar.)	-0.034		-0.039	0.094**		0.095**
	(0.052)		(0.055)	(0.038)		(0.037)
21+ current year absences (Sept. – Mar.)	0.026		0.070	0.351**		0.353**
	(0.035)		(0.102)	(0.118)		(0.083)
Teacher Education						
MA+	-0.005		-0.004	-0.021		-0.021
	(0.022)		(0.023)	(0.015)		(0.016)
Barron's rating (1=not competitive or unrated to 5=most competitive)	-0.014		-0.018*	0.001		0.001
	(0.010)		(0.011)	(0.007)		(0.007)
Failed at least one test	0.012		0.008	0.037*		0.036*
	(0.026)		(0.026)	(0.021)		(0.019)
Teacher Demographics						
Age 28-35	-0.033	-0.023	-0.026	-0.007	-0.013	-0.007
	(0.028)	(0.026)	(0.027)	(0.022)	(0.019)	(0.020)
Age 35-50	-0.041	-0.034	-0.042	0.018	0.006	0.018
	(0.028)	(0.030)	(0.032)	(0.028)	(0.022)	(0.023)
Age 50+	0.032	0.034	0.015	0.087**	0.078**	0.085**
	(0.056)	(0.046)	(0.048)	(0.033)	(0.031)	(0.032)
Black	0.027	0.040	0.027	0.010	0.030	0.010
	(0.031)	(0.028)	(0.029)	(0.021)	(0.020)	(0.021)
Hispanic	-0.006	-0.002	-0.011	0.025	0.030	0.025
	(0.017)	(0.032)	(0.032)	(0.024)	(0.027)	(0.027)
Male	0.046	0.034	0.028	0.013	0.006	0.013
	(0.034)	(0.029)	(0.029)	(0.018)	(0.015)	(0.016)

Part time teacher	-0.051	-0.060	-0.063	-0.089*	-0.096	-0.092
	(0.046)	(0.052)	(0.053)	(0.051)	(0.215)	(0.213)
Teacher Status						
Worked in CPS prior to starting as a tenure track teacher	-0.008	-0.020	-0.026	0.007	0.010	0.006
	(0.038)	(0.042)	(0.043)	(0.030)	(0.029)	(0.029)
PAT 2-4 and dismissed in prior year	0.119	0.164**	0.148**	0.202**	0.229**	0.203**
	(0.114)	(0.073)	(0.076)	(0.078)	(0.052)	(0.052)
PAT 2-4, in same school and not dismissed in prior year	-0.053	-0.053	-0.039	-0.081**	-0.092**	-0.082**
	(0.041)	(0.033)	(0.036)	(0.021)	(0.024)	(0.024)
PAT 2-4, in different school and not dismissed in prior year	-0.042	-0.059	-0.033	-0.083	-0.095	-0.085
	(0.067)	(0.061)	(0.063)	(0.058)	(0.059)	(0.058)
Mean of dependent variable	0.062	0.062	0.062	0.094	0.094	0.094
Number of observations	1017	1017	1017	1621	1621	1621
Number of teachers	803	803	803	1134	1134	1134
Number of schools	327	327	327	100	100	100
R-Squared	0.546			0.344		

Notes: All columns restrict the sample to teachers with value added scores and include school-year fixed effects. See appendix for details on value added estimation. Value added scores are standardized at the teacher level within year to have a mean of zero and a standard deviation of one. Columns 1 and 5 are OLS regressions with standard errors clustered by school in parentheses. All other columns are 2SLS regressions using one half-classroom sample estimate of value added as an instrument for the other half-classroom sample estimate with heteroskedasticity robust standard errors in parentheses. The sample in columns 4 and 8 is limited to school-years with principals who fired at least one teacher in the value added sample.

Table 8 – The Relationship between Teacher Value-Added and Dismissal

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Black	-0.022**	-0.014**	-0.005	-0.006	-0.006	-0.022	-0.000	-0.008	-0.007
	(0.006)	(0.006)	(0.007)	(0.008)	(0.008)	(0.015)	(0.014)	(0.009)	(0.030)
Hispanic	-0.004	-0.005	0.010	0.005	0.005	-0.002	-0.000	-0.013	-0.025
	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.017)	(0.017)	(0.010)	(0.035)
Male	0.036**	0.035**	0.036**	0.035**	0.035**	0.035**	0.036**	0.036**	0.035**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Age	0.003**	0.003**	0.003**	0.003**	0.003**	0.003**	0.003**	0.003**	0.003**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Percent of students in school same race as teacher			-0.026**		-0.009				
			(0.008)		(0.012)				
Teacher and principal different race		0.014**			0.007				
		(0.005)			(0.006)				
Teacher and principal different gender		0.005			0.005	0.005			0.005
		(0.006)			(0.006)	(0.006)			(0.006)
Principal age x teacher age/100 (both demeaned)		-0.010**			-0.010**	-0.010**			-0.009**
		(0.003)			(0.003)	(0.003)			(0.003)
Teacher Racial Composition Relative to the District (fraction teachers in district same race as teacher - fraction teachers in the school same race as teacher)				0.024	0.003				
				(0.019)	(0.027)				
Teacher Racial Composition Relative to the District Squared				-0.130	-0.125				
				(0.103)	(0.104)				
Percent of students in school white or asian and teacher white or asian							-0.029		0.008
							(0.026)		(0.044)
Percent of students in school black and teacher black							-0.033*		-0.021
							(0.017)		(0.040)
Percent of students in school hispanic and teacher hispanic							-0.010		0.017
							(0.020)		(0.036)
Teacher and principal different race x teacher white						0.009			-0.001
						(0.014)			(0.017)
Teacher and principal different race x teacher black						0.029*			0.029
						(0.017)			(0.023)
Teacher and principal different race x teacher hispanic						0.007			0.007
						(0.015)			(0.018)
White x (fraction teachers in district white- fraction of teachers in school white)								-0.021	-0.014
								(0.052)	(0.075)
White x (fraction teachers in district white- fraction of teachers in school white) squared								-0.599**	-0.585**
								(0.240)	(0.260)
Black x (fraction teachers in district black- fraction of teachers in school black)								0.038	-0.054
								(0.043)	(0.101)
Black x (fraction teachers in district black- fraction of teachers in school black) squared								-0.424**	-0.513**
								(0.200)	(0.222)
Hispanic x (fraction teachers in district hispanic- fraction of teachers in school hispanic)								-0.014	0.030
								(0.086)	(0.122)
Hispanic x (fraction teachers in district hispanic- fraction of teachers in school hispanic) squared								-0.135	-0.056
								(0.218)	(0.218)
Mean of dependent variable	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
Number of observations	24010	24010	24010	24010	24010	24010	24010	24010	24010
Number of teachers	12670	12670	12670	12670	12670	12670	12670	12670	12670
Number of schools	588	588	588	588	588	588	588	588	588

Notes: Each column is an OLS regression with school-year fixed effects and standard errors clustered by school in parentheses. All specifications include controls for teacher effectiveness, teacher education, teacher demographics, teacher experience and status, and a set of teacher fund and certification area indicators. Specifications with principal and teacher race or gender interactions also include principal demographic missing value indicators interacted with teacher male, black and hispanic.