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How Career Concerns Influence Public Workers' Effort:

Evidence from the Teacher Labor Market

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ABSTRACT

This study presents a generalization to the standard career concerns model and applies it to the public teacher labor market. The model predicts optimal teacher effort levels decline with both tenure at a school and experience, all things being equal. Using administrative data from North Carolina spanning 14 school years through 2008, the author finds significant changes in teacher sick leave consistent with the generalized career concerns model. By exploiting exogenous variation in career concerns in the form of principal turnover, the author shows the observed behaviors cannot be due to the endogeneity of teacher mobility decisions alone. Also examined are the effects of career concerns incentives breaking down. The author finds evidence suggestive of teacher shirking, and presents evidence on an unobservable measure of effort taken from the Schools and Staffing Survey that corroborates findings from observable teacher absence behavior. In sum, these findings show teachers exert considerable discretion over their own effort levels in response to these incentives, with important policy implications.

I. INTRODUCTION

Public-sector employees generally work under a fixed-wage contract, where compensation is not contingent on output. The combination of professionalism, organizational missions, and the length of careers common in public occupations has led some to speculate these workers likely respond to career concerns incentives (Dixit 2002, Dewatripont et al. 1999b, Tirole 1994). Until now, however, no empirical evidence has been presented to either confirm or refute this hypothesis. This paper presents evidence showing public-sector workers respond to changes in their career concerns incentives, which vary naturally over the course of their careers. This evidence shows these incentives play a role in influencing changes in effort *within* public workers in non-trivial ways.

This study primarily uses administrative data from the public teacher labor market to investigate teachers' absence behavior (to proxy for effort) over the course of their careers. Generalizing Holmström's (1982) career concerns model and applying it to the data shows teachers take significantly fewer sick days when their career concerns incentives are high. The evidence also suggests teachers shirk by taking significantly more sick days when these incentives break down. To detect the causal effect of career concerns on teacher absences, I exploit the exogenous variation in teachers' career concerns arising from principal turnover. The results presented here shows the observed changes in teacher absence cannot be solely attributable to the endogeneity of teacher mobility alone. I also present evidence on an unobservable measure of teacher effort taken from nationally representative survey data that corroborates the observed patterns detected in teachers' absence behavior. Taken together, these findings show teachers exert considerable discretion over their own effort levels in response to career concerns incentives, which has meaningful implications for the ongoing policy debate on teacher compensation.

The organization of this paper is as follows: Section II provides institutional background on the teacher labor market, Section III briefly reviews the relevant literature on career concerns and teacher incentives, Section IV presents the generalized model of career concerns, Section V describes the data and methods used for this study, Section VI presents the primary empirical findings that show teachers' effort change in response to career concerns, Section VII supports the findings with a series of robustness checks on the dependent variable used in the study, and Section VIII offers a brief concluding discussion.

II. TEACHERS, QUALITY, AND THE LABOR MARKET

Consider cognitive learning as the output of education. The inputs into the productive process include social, family, and schooling factors. Of these factors, schooling is the only input that policymakers can directly manipulate, and of the components of schooling, teachers have shown to be the most productive (Hanushek 1986). The hard part with managing teachers' labor as a productive input, however, arises from two key findings: 1) teacher quality appears to vary considerably across the labor market, and 2) much of its variation is unobservable (Rivkin et al. 2005; Aaronson et al. 2007; Koedel and Betts 2007). These findings have resulted in calls for reforming the way in which public teachers are compensated. Currently, public school teachers are (almost) universally paid on an input-based salary schedule that fully determines a teacher's wage, given a teacher's education and experience (Podgursky and Springer 2007). Most schedules in place across the country reward teacher inputs that are only weakly correlated with the outcome of interest: student learning (Vigdor 2008a). Such a compensation scheme fails to appropriately reward or sanction on output, therefore creating an environment conducive to adverse selection and moral hazard.

The problem of adverse selection in the teacher labor market arises from low-quality teachers being attracted to and retained in the teaching profession because wages fail to distinguish along this dimension. Hoxby and Leigh (2004), Murnane et al. (1988), and Corcoran et al. (2004) all document a deterioration of quality among teachers as competing wages and women's accessibility to alternative careers have increased, though reach different conclusions about how the market forces work. Adverse selection appears to also happen within the profession as well: teacher mobility within the profession is well correlated with signals of teacher quality (Hanushek et al. 2004; Goldhaber and Hansen 2009).[1]

In contrast to the breadth of literature on adverse selection, the moral hazard problem in the teacher workforce is not nearly as well documented or, in many cases, even acknowledged.[2] Moral hazard arises in the market because teachers, if shielded from the uncertainty inherent in their students' output, may systematically withhold effort from production. In the principal-agent model, the choice to withhold effort under a fixed-wage contract is the utility-maximizing choice; thus, one might reasonably predict teachers systematically undersupply effort on the job. Koppich (2008) states reasons for compensation reforms that align wages with outcomes, arguing that teachers will shift their effort levels accordingly. On the contrary, teachers' intrinsic motivation may be sufficient to guarantee an appropriate level of effort on the job, and the extrinsic reward may be unable to yield different results (Johnson 1986). Little empirical evidence has been presented on either side of the argument.

[1] Not all of the research presented on the adverse selection problem is negative: recent findings suggest that teachers exiting the workforce are not generally the most effective ones (Hanushek et al. 2005; Boyd et al. 2008; Goldhaber et al. 2008).

[2] As evidence of this, in Podgursky and Springer's (2007) review of teacher performance pay, the authors present two theoretical motives for linking compensation to output, which are essentially two nuanced versions of adverse selection. They do not identify moral hazard (systematically withholding effort) as a problem in the workforce that can be remedied through output-based compensation; rather, they identify the multitask moral hazard (discussed below) as a theoretical case against reform without acknowledging the potential of performance incentives to increase effort levels among teachers.

III. CAREER CONCERNS, EFFORT, AND INCENTIVES

In this study I address three different literatures on some level—career concerns, teacher absences, and teachers' behavioral responses to incentives. This paper attempts to link these somewhat disparate lines of research. The lack of explicit incentives in teacher compensation does not necessarily indicate teachers withhold effort from production, as sometimes assumed (Casson 2007). Rather, participation in the labor market can be considered a multi-period game, where the outcome of the current game influences potential payouts in future games.

Because teachers participate in the labor market repeatedly over their careers and future job prospects are likely influenced by past performance, teachers' concerns over their own career paths induce teachers to exert effort. This reasoning embodies the essence of the career concerns model. Fama (1980) proposed that the managerial labor market, through observing and incorporating managers' past performance to estimate unknown ability, induces managers to higher levels of effort than would be expected in the absence of the market with this learning process. Holmström (1982) formalizes this model of career concerns in a theoretical framework and derives the assumptions and optimality conditions that obtain this labor market result. The standard model is one of symmetric imperfect information, where both workers and the market are learning of workers' unknown ability over time.

A considerable theoretical literature has developed around the properties of these naturally occurring incentives (Prendergast 1999). For instance, Gibbons and Murphy (1992) derive the optimal explicit incentives over time to complement those diminishing from career concerns that decrease with time, and Dewatripont et al. (1999a) discuss the role of information systems in determining incentives in this model. While the standard model prescribes symmetric imperfect information, this study proposes a generalization in which agents, firms, and the market may potentially have different information about a worker's ability. Waldman (1984), Gibbons and Waldman (1999) and Mukherjee (2008) all analyze career concerns under similar scenarios. These studies, however, analyze how the market learns of an agent's ability (focusing on strategic actions for the employing firm), and do not specifically address the implied changes in effort levels as agents transfer between firms. An identification problem inherent in the standard career concerns model is that experience in an industry is not exogenous and is compounded with human capital accumulation and age. Accordingly, the empirical evidence supporting career concerns is scant, and to my knowledge has only been applied in business settings (Gibbons and Murphy 1992; Chevalier and Ellison 1999; Hong et al. 2000) and experimental settings (Koch et al. 2009).

This study applies the career concerns model to a public setting, though this is not the first to do so. Tirole (1994) and Dewatripont et al. (1999b), noting the complexities of offering explicit incentives in the public sector, predict incentives from career concerns should induce larger effort responses in public-sector workers than for those in private industries. Levy (2005) presents a theoretical model of court judges who make appeals decisions based, in part, on a Bayesian learning process of ability derived from judges' career concerns. Lastly, Dixit (2002) presents an argument suggesting public school teachers in particular should be motivated by career concerns, but does not provide any empirical evidence supporting this claim. None of these studies, however, present empirical evidence supporting the presence of career concerns in the public sector; this paper addresses this gap in the literature.

In the current application of career concerns, I propose to use teachers' discretionary absences as a proxy for withholding effort. Admittedly, absences can only approximate shirking: presumably the primary reason for most observed absences is not shirking but due to some legitimate reason. The evidence on teacher absences, however, has shown absences in teachers are markedly higher than other industries in the U.S. (Podgursky 2003), appear to be sensitive to more liberal leave provisions (Ehrenberg et al. 1991), are more common on Mondays and Fridays (Educational Research Service 1980), and have been shown to be correlated with overall shirking in the workplace (Bradley et al. 2007). In summary, the evidence suggests absences appear at least partially discretionary for teachers. Further, recent studies have shown teacher absences have a significantly negative impact on student outcomes, and the evidence appears to suggest a causal relationship (Clotfelter et al. 2009; Miller et al. 2007). Thus, because absences are both discretionary and negatively correlated with student learning, this measure is the best measure available to approximate shirking in the data.

Finally, my paper addresses the issue of how teachers respond to incentives.[3] Though performance incentives for teachers (both individuals and groups) have been implemented in some form or another for decades in the United States, surprisingly few studies have evaluated these programs (see Podgursky and Springer 2007 for a thorough review). Several studies have shown significant causal increases in achievement from incentive programs outside of the U.S. (Glewwe et al. 2003; Lavy 2009; Muralidharan and Sundararaman 2008), while others in the U.S. have shown outcomes positively correlated with incentive systems (Ladd 1999; Figlio and Kenny 2007). The evidence on school-based (group) incentives also suggests outcomes respond favorably (Lavy 2002), though complicated with the free-rider problem (Vigdor 2008b). Not all findings in this literature are positive: both Glewwe et al. (2003) and Eberts et al. (2002) report outcomes that were consistent with the incentives but misaligned with the program's objectives—suggesting "you get what you pay for."

Importantly, all of these empirical studies on teacher incentive programs analyze outcomes, but few analyze changes in teacher behavior (or more explicitly, effort). Of particular concern here is the

[3] For clarification, this study focuses on output-based incentives. Various proposals for teacher compensation reform include providing additional compensation for difficult-to-staff subjects, teaching in high-needs schools, or mastering teacher competencies. While of policy interest, these proposals are beyond the scope of this paper.

complicating multitask moral hazard problem (Holmström and Milgrom 1991), which arises when agents produce output along multiple dimensions that vary in their precision of measurement. The authors show a fixed-wage contract can maximize output by minimizing inefficient distortions in the allocation of effort among tasks to align with external incentives. The mere presence of a multi-task moral hazard problem, however, does not necessarily mean educational outcomes are bounded within a finite space. For instance, Lazear (2006) shows when both test instruments and dimensions of learning are diffuse, announcing the content of tests and rewarding results can result in a higher level of learning than what would be expected under diffuse test monitoring. Alternatively, if an incentive's objective is to increase total outcomes, one can ensure higher levels of output by simply monitoring effort inputs (assuming some elements of effort are observable). Increasing overall effort is the necessary condition to guarantee unambiguously better student outcomes.[4] Thus, the unanswered question in this literature is whether incentives induce teachers to *increase* or *re-allocate* effort.

Importantly, policymakers seek to reward good teaching overall, not simply "teaching to the test," which maximizes teachers' private benefit while other (unmeasured) dimensions of student learning bear the cost. Worse yet, teachers could respond perversely by cheating (Jacob and Levitt 2003). Of the studies on teacher incentives above, only Lavy (2009) finds evidence suggesting incentives induce higher levels of effort (not a simple re-allocation) using self-reported surveys. Glewwe et al. (2003) also investigate changes in effort, and find evidence suggesting teachers shifted effort to short-term test preparation. None of the other empirical studies above addressed changes in effort in light of the multi-task moral hazard problem. In short, the evidence on exactly how teachers' behaviors respond to incentives—distinct from an output response—is mixed.

[4] The sufficient condition in the multitask moral hazard is that the level of productive effort along each dimension is greater than or equal to the baseline case.

This paper contributes to these literatures in several ways. First, the generalized model presented here facilitates empirical identification of career concerns by using two dimensions jointly. Second, this is the first study to show career concerns induce responses in public-sector workers. Finally, this paper shows teachers increase effort in response to these incentives, which is the first paper to document this in an American education setting.

IV. A GENERALIZED MODEL OF CAREER CONCERNS

The teacher labor market is an ideal case for the application of the career concerns model in some respects: teacher quality varies considerably across the market, monitoring effort is costly, outcomes depend on some random inputs, and the unit of production is an individual (not a team). In one critical aspect, though, the teacher labor market is not well suited to this model: the single salary schedule dictating teachers' monetary compensation is not contingent on past performance (Odden et al. 2001). Principals or the market cannot readily manipulate teachers' compensation to reflect their expected output.

In spite of this, research has shown teachers with signals of quality tend to sort both across and within schools to students with higher tests scores and higher measures of socio-economic status (e.g. Hanushek et al. 2004). This sorting mechanism implies teachers may be rewarded on past performance through non-monetary means even though the salary schedule fails to do so. Further, having a reputation as a productive worker with your supervisor imaginably provides many unobservable benefits over your career (e.g. continued employment, better working relationships), which is not specific to teaching. For this study, I assume principals have the ability to compensate teachers through non-monetary means; it is this non-monetary compensation that differentiates teachers according to expected outcomes.[5] Thus, in the present application I interpret "wages" as the sum of monetary and non-monetary compensation to teachers.

I propose a generalization of Holmström's (1982) career concerns model, adjusting two of the assumptions to match plausible scenarios in my application. Specifically, Holmström's model assumes the labor market, the firm, and the manager all share the same beliefs of a manager's ability; second, the original model is unrestricted in the firm's ability to compensate managers for demonstrated performance. These assertions are not readily applicable to a real-world setting: firms know more about their employees than the labor market (Waldman 1984), and firms are almost universally somehow constrained in their ability to pay workers. The generalization I present here explicitly models these informational and budgetary constraints; as a result, additional testable hypotheses emerge that were not present in the original model.

The set-up of Holmström's model is straightforward: teachers, schools, and the labor market[6] are all equally uninformed of a teacher's ability; teachers maximize their expected career wages; and the labor market learns of a teacher's ability through repeated observation over time to set future wages accordingly. I employ a similar framework. To begin, output is determined through the following production function:

$$(1) \qquad y_t = \theta + e_t + \varepsilon_t$$

Output at time t is dependent on a teacher's time-invariant ability (θ), the effort expended in the time period (e_t, *where* $e_t \in [0,\infty]$), and a random error with mean zero and precision h_ε. Ability is assumed unknown to all parties, but its distribution is known, with mean m_1 and precision given by h_1. Where I

[5] In Section V below, I address the notion of teacher working conditions responding to past performance in greater detail, I present evidence from my data that supports this assertion, and discuss the application of the career concerns model to the teacher labor market generally.

[6] Holmström's original model portrays the actors as the labor market, the hiring firm, and the manager; I use analogous labels from the education setting for my discussion: the labor market, the school, and the teacher.

diverge from Holmström is in my assumption of who observes output: Holmström assumes y_t is known publicly, but I maintain this is observed by a teacher and her school only and observed publicly with error, as below.

$$(2) \qquad z_t = \theta + e_t + \varepsilon_t + \eta_t$$

In Equation 2, z_t is the public's noisy observation of a teacher's true output. In this framework, y_t is a sufficient statistic for z_t.[7] The precision associated with z_t is given by $h_{(\varepsilon+\eta)}$ where $h_{(\varepsilon+\eta)} \leq h_\varepsilon$ with equality holding only in the case where $z_t = y_t$ (i.e. $Var(\eta_t) = 0$).

Without loss of generality, teachers are risk neutral, with a shared utility function:[8]

$$(3) \qquad U(w,e) = \sum_{t=1}^{\infty} \beta^{t-1}[w_t - g(e_t)]$$

where utility increases in wages and decreases in effort; $g(e_t)$ denotes the increasing disutility of effort. The competitive labor market offers a wage to the teacher reflecting her expected output, which is conditioned on past performance:

$$(4) \qquad w_t^m(z^{t-1}) = E[y_t \mid z^{t-1}] = E[\theta \mid z^{t-1}] + e_t(z^{t-1})$$

Here z^{t-1} represents the history of publicly observed outputs ($z_1, z_2, \ldots z_{t-1}$) to time $t-1$ (the superscript m denotes the market). Effort is determined in equilibrium simultaneously by maximizing utility, given the competitive wage rate.

Even though the market may not directly observe the teacher's effort, it can be deduced given the teacher's utility optimization above through the relationship $z_t - e^*(z^{t-1}) = \theta + \varepsilon_t + \eta_t$. This

[7] Because information loss is random, the teacher has no incentive to influence z_t independently of y_t

[8] The assumption of risk neutrality is Holmström's, but is likely violated in the case of teachers. Allowing for teachers to have risk-averse utility functions changes the resulting optimal effort path inducing higher levels of effort from teachers at all points of the path. Because all teachers' decisions are all affected in the same way, however, the assumption makes no substantive change on the model's predictions.

information is implemented into the market's assessment of the teacher's ability, where the posterior distributions of θ, now conditioned on z^t, are estimated through the following means and precisions:

$$(5) \qquad m_{t+1}^{m} = \frac{h_t^m m_t^m + h_{(\varepsilon+\eta)}(z_t - e_t^*)}{h_t^m + h_{(\varepsilon+\eta)}} = \frac{h_1 m_1 + h_{(\varepsilon+\eta)} \sum_{j=1}^{t} (z_j - e_j^*)}{h_1 + t h_{(\varepsilon+\eta)}}$$

$$h_{t+1}^{m} = h_t^m + h_{(\varepsilon+\eta)} = h_1 + t h_{(\varepsilon+\eta)}$$

Note, however, that not all parties in the problem observe the same output; thus, not all parties have the same expectation of a teacher's ability. A teacher, for instance, observes y_t directly for her career; thus, her expectation of her own ability is given by:

$$(6) \qquad m_{t+1}^{t} = \frac{h_t^t m_t^t + h_{\varepsilon}(y_t - e_t^*)}{h_t^t + h_{\varepsilon}} = \frac{h_1 m_1 + h_{\varepsilon} \sum_{j=1}^{t} (y_j - e_j^*)}{h_1 + t h_{\varepsilon}}$$

The precision on the teacher's estimate of her own ability is $h_{t+1}^{t} = h_t^t + h_{\varepsilon} = h_1 + t h_{\varepsilon}$, which is more precise than that of the market (the superscript t denotes the teacher).

As indicated previously, schools employing teachers also observe output directly; thus, if a teacher is employed at the same school throughout her career, her school is equally well informed of her ability. If a teacher changes schools during the course of her career, the school uses directly observed output (y_t) to estimate ability, but uses publicly observed output (z_t) to supplement observations that were not directly observed. Accordingly, such a school estimates teacher ability using both outputs in a hybridized learning model:

$$(7) \qquad m_{t+1}^{s} = \frac{h_t^s m_t^s + h_{\varepsilon}(y_t - e_t^*)}{h_t^s + h_{\varepsilon}} = \frac{h_1 m_1 + h_{(\varepsilon+\eta)} \sum_{j=1}^{s-1} (z_j - e_j^*) + h_{\varepsilon} \sum_{j=s}^{t} (y_j - e_j^*)}{h_1 + (s-1) h_{(\varepsilon+\eta)} + (t-s) h_{\varepsilon}}$$

Note that a school using this hybrid learning model will weight the directly observed performance more heavily than performance that was not directly supervised, because $h_{(\varepsilon+\eta)} \leq h_{\varepsilon}$ (the superscript s denotes the school). Also, note a clear asymmetry in the information each party of the model has access to: a teacher who directly observes performance for her whole career obtains the upper bound of precision on estimating her own ability over all times, while the market is a lower bound by virtue of incorporating noisy information only. The precision of the employing school's estimate (indicated in the denominator of Equation 7) will fall somewhere between the upper and lower bounds.

$$(8)\qquad \begin{aligned} &h_t^m \le h_t^s \le h_t^t \\ &\text{for all } t = 1,2,\ldots\infty \end{aligned}$$

Equality holds on both relational signs at the outset of a teacher's career, but does not bind afterwards (so long as the $Var(\eta_t) > 0$). The precision of the school is equal to the market's precision when the school has not privately observed any output; however, after the first observation, the inequality no longer binds.

Because the posterior means derived above are the market's and school's best estimate of a teacher's ability, they incorporate this information into wages offered to a teacher. Both parties offer wages conditional on observed information, and these offers vary according to information observed to either party. Because teachers know both the market's learning process (from Equation 5) and wage setting rule (Equation 4), teachers have the means to compute their expected future wages conditional on these estimates of ability:

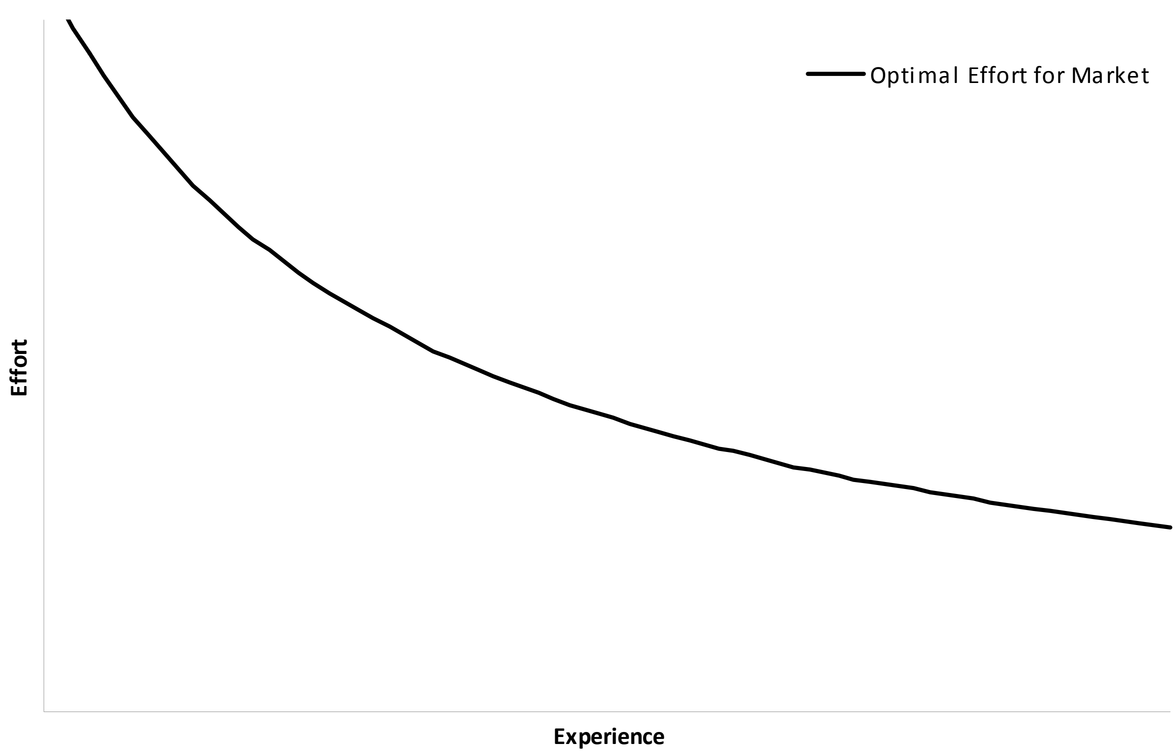
$$(9)\qquad E[w_t^m \mid z^{t-1}] = \frac{h_1 m_1}{h_t^m} + \frac{h_{(\varepsilon+\eta)}}{h_t^m}\sum_{j=1}^{t-1}(m_1 + e_j - e_j^*(z^{j-1})) + e_j^*(z^{j-1})$$

Equation 9 states the wage rule for the labor market generally. A teacher's marginal increase in expected market wages for additional effort in the current period is equal to $h_{(\varepsilon+\eta)}/h_t^m$. A utility-maximizing teacher will set this marginal benefit equal to the marginal disutility of effort in the current period, as in Equation 10 below.

$$(10) \qquad \sum_{j=t}^{\infty} \beta^{j-t} \frac{h_{(\varepsilon+\eta)}}{h_j^m} = g'(e_t^*)$$

This function now defines the optimal effort path for a teacher, given the market's assessment of ability. An important prediction of this function is that increasing the precision on the estimate of ability (h_t^m) lowers the benefit of expending effort, and therefore predicts optimal effort will decline as more is learned of a teacher's ability (i.e. over the course of her career). Figure 1a depicts a stylized optimal effort path, with experience on the x-axis and effort on the y-axis, in which optimal effort declines with experience. This relationship is also one of the key predictions of Holmström's original career concerns model.

Figure 1a. Optimal Effort Path Given Experience Only



An important extension here, however, is the school's ability to hold its own estimate of teacher ability, which is separate (and more precise) than that held by the market. Moreover, the market does not hire teachers, but schools do. As a result of this, once a teacher is hired, directly observed performance is a stronger signal of teacher ability to the school and teachers are rewarded accordingly. This increases the marginal reward to h_ε / h_t^s, and a maximizing teacher sets this equal to the marginal cost of effort.

$$(11) \qquad \sum_{j=t}^{\infty} \beta^{j-t} \frac{h_\varepsilon}{h_j^s} = g'(e_t^*)$$

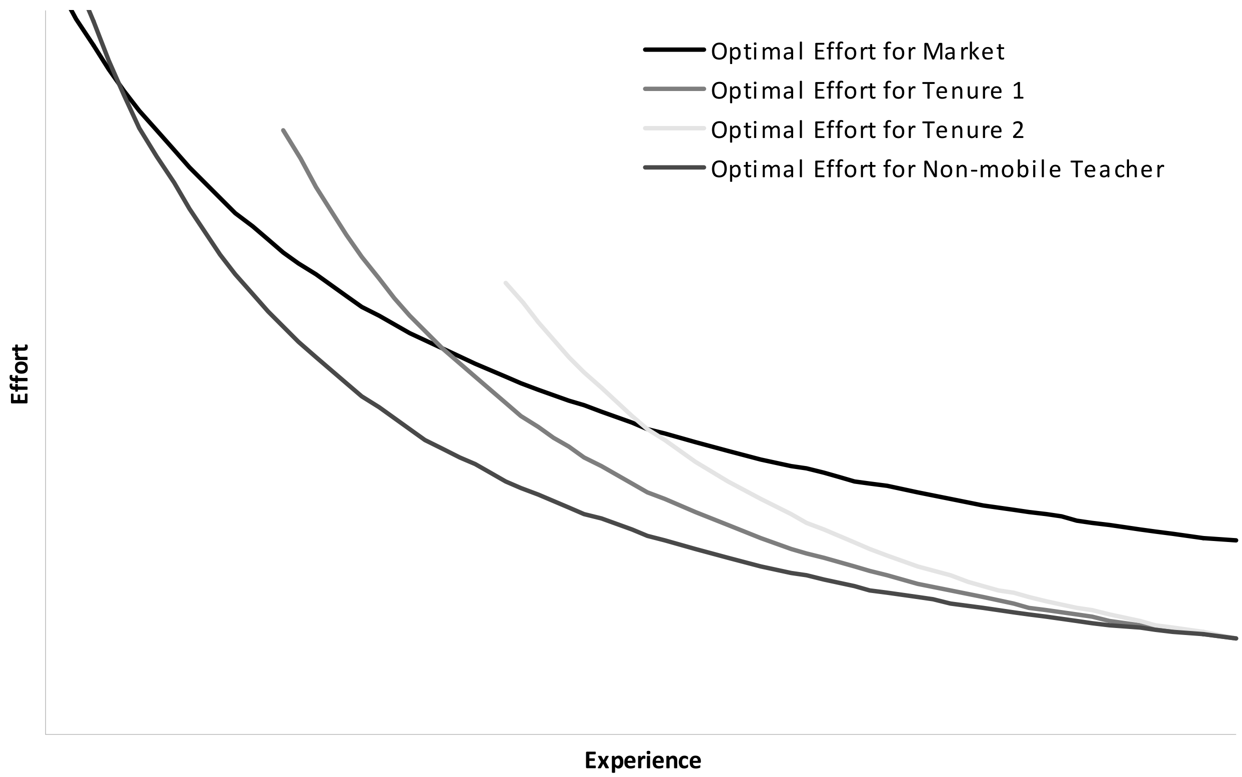
Initially, when a teacher begins her tenure at a new school, the school's precision (in the denominator) is the same as the market's precision; however, the numerator increases because output is now less noisy (compare Equation 11 with Equation 10). This creates a strong incentive to increase effort in the short run because doing so influences the school's perception of ability more powerfully than any single observation from the past could. A corollary to this result is that effort converges to an even lower level after this initial jump compared to that predicted by the market only (because more is revealed of a teacher's ability). Because a teacher's career concerns incentives operate along two dimensions—experience in career and length of tenure at a school—a teacher's optimal effort at any given point in her career is characterized with these two variables (which are publicly observed).[9]

Figure 1b graphically depicts the two-dimensional interplay between tenure and experience and its influence on optimal effort. The original effort path (optimizing on the market's information) is shown, but now has several overlaid curves. These curves depict the optimal effort for a teacher who starts at a new school, given the experience level at the line's origin. For instance, the non-mobile teacher line begins when the teacher is new in her career and enters a school but never transfers. Because the school's estimate of that teacher's ability obtains the upper bound precision at all points in time, this

[9] The model presented here allows the teacher to have the best estimate of her own ability, while the school (market) has a less precise estimate from the additional noisiness of public information, contrary to Hölmstrom's approach. Note that a teacher's estimate of her own ability does not enter the equilibrium effort functions and thus does not alter her behavior.

teacher's effort level is the lower bound of optimal effort. The other two overlaid lines represent mobile teachers.

Figure 1b. Optimal Effort Path Given Experience and Tenure



When a teacher is new to a school, the optimizing teacher will increase effort immediately to enhance her reputation. As more performance is revealed, however, the teacher's optimal effort level declines to a level below that predicted using the market optimization only. The *Optimal Effort for Tenure 1* and *2* lines[10] show that whenever a teacher changes schools after some time in the profession, optimal effort will temporarily increase, followed by a decline below the market's optimizing level of effort, which over time converges with the optimal effort of the non-mobile teacher.

[10] The numbers in the figure labels here are ordinal, and are not intended to be equated to units along the x-axis.

Recall in this model that optimal effort is conditional on both experience and tenure; thus, the market line captures an average decline due to experience, but teachers do not optimize on the market line. Rather, teachers' career paths follow the appropriate tenure line at all times, as they are always under direct observation (tenure may vary given a level of experience, hence the duplicity of tenure lines given a level of experience).

The second variation I propose to Holmström's original model is the school's ability to compensate a teacher, which assumes schools face no constraint in their ability to reward. This assumption certainly fails to hold in the current application to the teacher labor market. Instead, I propose the alternative wage-setting rule:

$$(12)\qquad \begin{aligned} &w_t^s(y^{t-s}, z^{s-1}) = E[y_t \mid y^{t-s}, z^{s-1}] = E[\theta \mid y^{t-s}, z^{s-1}] + e_t^*(z^{t-1}) \\ &\text{subject to } w_t \le \psi^s \qquad \psi^s \sim N(0, \sigma^2) \end{aligned}$$

This is essentially the same competitive wage-setting rule as Equation 4, conditioning on both experience and tenure to determine expected productivity. The substantive change is the addition of the wage constraint, where any teacher's expected wages may not exceed the employing school's ability to pay (ψ^s), which is known to all parties and determined exogenously to the model.[11] This extension to the model not only aligns better with the teacher labor market but also introduces a necessary exogenous condition inducing a teacher to transfer between schools when her current school cannot compensate her up to her full perceived ability. As laid out here, an arbitrage opportunity exists for a teacher whose market-estimated ability is significantly higher than her own estimate of ability. If this were the only reason to transfer, any teacher attempting to transfer would send an implicit signal of her lower quality, thus

[11] Here, I model the school's ability to pay as a wage ceiling for each individual teacher. In reality, individual wages may not be subject to individual ceilings; rather, were an institutional budget restricting wages, the restriction may limit total compensation to all teachers in the organization rather than limit individual teacher compensation. Ultimately, how the school applies the restriction has no effect on the teacher's behavior in this model; as long as a teacher may only be compensated up to an exogenous limit, the outcome in the model will still be the same.

unraveling the market (Akerlof 1970). These limits ensure teachers from both ends of the ability distribution will have incentives to transfer schools; thus, closing the model.

The model I've sketched here extends Holmström's in two ways: noise in publicly observed output and schools are constrained in their ability to pay teachers. Holmström's original model is a limiting case of the model derived here when no noise arises in transmitting a worker's performance to the labor market ($Var(\eta_t) = 0$) and when management is unconstrained in their ability to pay workers ($\psi^s = \infty$). As a result, the hypotheses of Holmström's model are unchanged: a teacher's optimal effort path decreases with time as the market learns more of a teacher's ability and optimal effort increases with the noisiness of the market's (or school's) learning process.

This generalization also provides other refutable hypotheses not present in Holmström's original model, which enable identification of career concerns responses independently of experience. Importantly, effort additionally decreases as tenure at a given school increases and newly transferred teachers exert higher levels of effort over other teachers at the same school *ceteris paribus*. Thus, the primary feature I look for in the data is evidence of a discrete jump in effort coincident with teachers transferring between schools.

Empirical observation of these predicted behavioral changes does not definitively support the career concerns model; rather, teachers' absence behavior may be endogenously related to their experience and tenure levels. I propose an alternative strategy to exogenously identify responses to career concerns incentives: changes in the school's administration. An important nuance that I address further in Section VI is that these predicted changes in effort levels are not due to teachers' tenure at the school specifically, but rather length of tenure with a principal. An exogenous change in principal (separate from the school) renews teachers' career concerns; thus principal turnover will have a causal impact on teacher effort arising from career concerns.

V. DATA AND METHODOLOGY

For this analysis, I use an administrative dataset that covers the universe of teachers in the North Carolina Department of Public Instruction spanning 14 school years, from 1994-95 through 2007-08.[12] This dataset includes information on all teachers in the public school system, including details such as class assignment, experience level, credentials, licensure status, salary, demographic characteristics, and absence data. The administrative personnel files in the data are used to determine when schools change principals.[13] To identify changes in effort within teachers over time, I restrict the sample to full-time teachers employed in the same school for the entire 10-month school year for whom at least three years of absence data are observed.

The data captures the entire public teacher labor market in North Carolina, enabling observation of teachers in different schools as they progress through their careers. Because the study focuses on the length of a teacher's tenure at a particular school, I use the data from the first six school years to calculate teachers' school-specific tenure, but omit it from the analysis sample. Teachers who are not mobile for these six years thus have a minimum of seven years of tenure in a school at the beginning of the analysis, and all school tenure beyond seven years is aggregated with a single indicator variable. Part of the analysis focuses on exit behavior, so I use the final year of data to determine teacher exits. The data in the sample used for analysis are drawn exclusively from the 2000-01 to 2006-07 school years.

[12] This data is collected and maintained by the North Carolina Education Research Data Center (NCERDC), housed at Duke University's Center for Child and Family Policy.

[13] Principal assignments were coded differently in the first two school years of the data, and are omitted from the study. Accordingly, I code principal tenure with five or more years with an indicator variable.

The data on teacher absences documents the pay period, type, and length of each teacher absence event. Generally speaking, all absences can be coded as one of four types: administrative leave, vacation, sick leave, and personal leave.[14] Administrative leave is generally determined by the school or district, and is therefore outside of the teachers' decision on expending effort in the classroom. Vacation time is accrued according to a teacher's level of seniority in the school system and accumulated to a teacher indefinitely, but vacation time must be approved with the principal well in advance of actually utilizing it. Sick leave is uniformly granted to all teachers in the state public school system: teachers accumulate one day of sick leave per month, and teachers may accumulate unused sick leave indefinitely. Using sick leave, though, carries a cost as any unused leave at retirement can be converted to additional months of service, increasing a teacher's pension benefit.[15] Personal leave is any other day of voluntary leave beyond the three categories listed above, and generally entails a deduction in salary as a result of its use. Commonly, teachers do not use personal leave until their allotted sick leave is exhausted—the median teacher in the data takes no personal leave at all. All accumulated leave benefits are portable across districts within the state.

For the paper, I focus on leave that is readily available for use at a teacher's own discretion—sick leave. Sick leaved can be used without prior approval and with little notice (though many schools have policies in place designed to prevent sick leave from being abused, such as requirements for a doctor's note on the third sick day, etc). Moreover, when a teacher calls in sick, the duty of finding a substitute

[14] Clotfelter et al. (2007) document the their classification method for the NCERDC data in considerable detail. The original data has 28 unique absence code types used for payroll purposes, indicating the appropriate budget to which each day of leave is to be charged. The unique codes are mapped into the four general absence categories. I refer the reader to their work for more detail.

[15] Annual pension benefits in North Carolina are calculated using the following formula: (average salary of four highest paid years) x 0.0182 x (creditable service in years). Unused sick leave can be credited towards a teacher's length of creditable service (20 days of sick leave = 1 month of service), increasing the benefit. Unused sick leave, however, cannot be used to meet retirement eligibility requirements ahead of time. Additional information on the North Carolina pension system is available online at http://www.nctreasurer.com/dsthome/RetirementSystems.

falls to the school; thus, the most meaningful cost of taking leave is the inability to somehow use it in the future.

Teachers' use of sick leave is (on the margin) dictated by the strength of teachers' own incentives; thus, it provides a reasonable proxy measure of shirking. Because I use days of sick leave to proxy teacher shirking, I seek to remove those absences that are clearly not due to shirking. While direct observation of shirking independent of sick leave is not possible, I omit sick leave that is coded with some qualifying condition (i.e. extended sick leave and sick bank leave). Thus the absences of interest are days of ordinary sick leave.[16]

Table 1 reports descriptive statistics for the teacher data used in this study. Column 1 reports the statistics for observations that meet all of the criteria described for inclusion above. This column, however, includes observations that are clearly problematic: some observations report negative sick leave while others report sick leave in excess of 100 days. I wish to eliminate those observations with extreme values in a way that is consistent with using sick leave as a proxy for shirking. Accordingly, I drop all observations for which more than seven days of sick leave are used within a single month.[17] A teacher who misses more than seven days of work in a month presumably does so out of extenuating circumstances and is not likely due to shirking. Moreover, Chow tests decidedly reject the null hypothesis of no difference in the coefficients for these two groups within the data. Column 2 presents the data sample after dropping these problematic observations, which amounted to approximately 5 percent of all observations in Column 1.

[16] These are absence codes 01 and 11 in the NCERDC data.

[17] I also drop observations with less than -7 days of sick leave taken in a month. I do not drop all negative observations altogether because some districts appear to use them to adjust absence records across pay periods.

Table 1. Descriptive Statistics of Teachers in Data

	All sick data	Sample	2005 Sample
Sick absences	7.190	6.173	6.370
	(6.937)	(4.268)	(4.297)
Experience	13.736	13.719	13.252
	(9.468)	(9.469)	(9.643)
Female	0.799	0.794	0.792
	(0.401)	(0.404)	(0.406)
White	0.845	0.846	0.845
	(0.362)	(0.361)	(0.362)
Highest degree is BA	0.701	0.701	0.707
	(0.458)	(0.458)	(0.455)
NBPTS certified	0.077	0.076	0.085
	(0.267)	(0.266)	(0.280)
Elementary teacher	0.527	0.526	0.523
	(0.499)	(0.499)	(0.499)
Age	41.150	41.161	40.761
	(10.941)	(10.937)	(11.206)
Observations (teachers)	425,282	403,331	63,479

Comparing Column 1 with Column 2 shows the mean absences dropped significantly, but other observable characteristics show no detectable change. Thus, dropping these observations does not appear to have introduced any bias into the sample. Column 2 includes multiple observations per teacher, and Column 3 reports these same measures for teachers observed in 2005 only (only one observation per teacher). Teachers in the data are predominantly white, female, and have over 10 years of teaching experience.

This table shows the average teacher takes just over 6 days of sick leave per year; however, the distribution of this variable is slightly skewed right and the median teacher takes 5.5 days of sick leave per year. Though sick leave is most commonly used in whole days, partial-day uses of sick leave are also regularly observed in the data. The middle 50 percent of the distribution lies between 3 and 9 days of sick leave, and the middle 90 percent lies between 0 and 13.5 days of sick leave.

The length of a teacher's tenure at a particular school plays a prominent role in empirical identification of the career concerns response. Table 2 provides a descriptive look at the tenure and turnover in the data for unique teachers in the 2004-05 school year. Panel A shows teacher tenure by type (whether a teacher entered from a different school, district, or out of the state school system).

Table 2. Descriptive Tables on Observed Tenure and Turnover

Panel A. Year of Tenure, by Type, for all Teachers in 2005

Tenure	School	District	State	Missing Tenure	Total
Year 1	2,551	2,388	4,008	0	8,947
Year 2	2,334	1,969	4,196	0	8,499
Year 3	2,385	1,456	3,595	0	7,436
Year 4	1,984	1,177	2,863	0	6,024
Year 5	1,658	1,072	2,372	0	5,102
Year 6 or higher	3,276	4,206	5,881	14,108	27,471
Total	**14,188**	**12,268**	**22,915**	**14,108**	**63,479**

Panel B. Teachers Exiting, by Type, for all Teachers in 2005

Tenure	School	District	State	Leave	Staying	Total
Exiting in 2005	2,849	2,094	3,132	544	0	8,619
Exiting in 2006	2,602	1,644	4,019	359	0	8,624
Staying beyond 2006	0	0	0	0	46,236	46,236
Total	**5,451**	**3,738**	**7,151**	**903**	**46,236**	**63,479**

As shown, approximately half of the teacher-year observations show teachers have 5 or fewer years of tenure at a school. Panel B shows exiting behavior among the same teachers: more than two-thirds stay in their current school for at least two years, while the remainder exits in either the 2004-05 or 2005-06 school year to another school within the district, another district within the state, or out of the state entirely. A relatively small number of teachers go on leave (returning to the same school after a year of absence).

With this data, I focus on whether teachers' use of sick leave responds to career concerns incentives as the model predicts. The basic model estimates the following equation:

$$(13) \quad Absences_{i,t} = \beta_0 + X_{i,t}\beta_1 + CC_{i,t}\beta_2 + \phi_t + \varepsilon_{i,t}$$

A vector of teacher characteristics ($X_{i,t}$), a vector of variables on career concerns incentives ($CC_{i,t}$), and a year fixed effect (ϕ_t) are used to explain the variation in the amount of sick leave a teacher uses in a year. The vector of teacher characteristics includes a teacher's race, gender, credential, age, fertility, and retirement eligibility.[18] The career concerns variables are those indicating a teacher's experience level and tenure at a specific school. The year fixed effect captures any systemic changes in absence behavior over time.

The model in Equation 13 ignores the panel structure of the data and pools estimates across all observations. A teacher's tenure at a specific school, however, may be correlated with the absence practices at the school, which could bias these estimates (I address this further below). Also, this approach

[18] Age and fertility have been shown to be significant predictors of absence behavior (Clotfelter et al. 2007). Unfortunately, age is not directly observed in the NCERDC dataset, and I impute this internally by assuming a teacher is 23 at the time of college graduation, which is observed. The fertility variable represents the birth rate per thousand women conditional on age only, extracted from the *2009 Statistical Abstract of the United States*, Table 79. This imputed age variable and the observed experience values, were used to create variables on retirement and early-retirement eligibility. Because these four variables (age, fertility, retirement eligible, and early-retirement eligible) were imputed, I also fit models that excluded these variables and the significance of the estimates were generally unchanged for other variables (see Appendix for more details). The tables presented throughout the paper include these imputed measures.

fails to account for previously observed behavior within teachers. To counter this, I also estimate the models using a fixed effects specification for schools and teachers, respectively:

$$(14) \quad Absences_{i,t} = \alpha + X_{i,t}\beta_1 + CC_{i,t}\beta_2 + \delta_s\phi_t + \varepsilon_{i,t}$$

$$(15) \quad Absences_{i,t} = \alpha_i + X_{i,t}\beta_1 + CC_{i,t}\beta_2 + \phi_t + \varepsilon_{i,t}$$

These models are identical to Equation 13 with the exception of the school-year ($\delta_s\phi_t$) and teacher (α_i) fixed effects in Equations 14 and 15, respectively. Analyzing teacher behavior within schools is critical: several studies show teacher absence policies vary considerably from school to school, leading to a considerable level of variation in observed absences across schools (Bradley et al. 2007; Miller et al. 2007). Failing to estimate within-school changes in behavior could compound responses to career concerns with a shared propensity for absenteeism. Moreover, my analysis of career concerns is relevant to the level at which it alters teachers' behavior, and analyzing the career concerns model with teacher fixed effects allows me to identify changes in behavior within teachers in response to these incentives.

Threats to Validity

The empirical approach sketched above faces three primary threats to obtaining valid estimates. First, estimating tenure and experience together with a standard OLS approach conflates these variables with typically unobserved heterogeneities in other dimensions. Second, the length of a teacher's tenure at a given school is ultimately an endogenous variable that teachers choose and may confound any changes in effort with different preferences. Finally, sick leave is a noisy measure of shirking. I address each of these threats and describe my attempts to counter them below.

First, a debate has ensued in the literature on returns to experience concerning the bias in estimates on the returns to tenure (or job seniority) separate from a worker's experience levels (see Altonji and Williams (2005) for a concise review of the relevant bias and literature). Using an approach like the

OLS specification in Equation 13 has been shown to bias tenure estimates due to unobserved heterogeneity across individuals (different productivities), firms (different policies for rewarding tenure), and job difficulties (different compensating differentials). The resulting estimates could be biased in either direction away from the true values. Though the dependent variable in the present analysis captures absences instead of wages, the bias still applies. The studies in that literature, however, typically use data from cross-sectional population surveys that sample workers across multiple industries and/or states.

In contrast, the panel data used here permits control for some of these unobserved heterogeneities through fixed effects estimation—teacher fixed effects remove variation across individuals and school-year fixed effects remove the variation across worksites. Further, by using data from workers who all hold the same professional position in the public school system within a single state, the variance of job difficulty in this application is minimal. While I cannot assert causality for any estimates from an equation that directly control for a teacher's tenure and experience jointly, I am confident any residual bias in my estimates is likely small.

As a counter to these potential biases, I instead use an exogenous variable uncorrelated with a teacher's tenure at a school, but correlated with a teacher's career concerns: a principal's tenure at the school. When a new principal enters a school (which occurs beyond the teacher's control), they come in with a relatively uninformed prior on a teacher's ability, thus exogenously renewing a teacher's career concerns incentives. Exploiting this natural experiment that arises in the data allows me to assert a causal relationship between teachers' career concerns and changes in their absence behavior. I present this evidence in Section VI below.

Next, tenure is an endogenous variable that compounds the career concerns effect on effort with a teacher's preferences that may be revealed through Tiebout sorting. A teacher's choice to stay at a school may be correlated with a jointly held preference for any other dimension across worksites (e.g. a preference for working closer to home, etc.), and these preferences may drive changes in the tenure variable separately from a teacher's career concerns. The teacher-level fixed effects approach I employ effectively counters any bias from simultaneous Tiebout sorting across teachers by analyzing changes within teachers.

Finally, teacher absences are an admittedly noisy level of effort, and whether real effort is correlated with days of sick leave is assumed but not tested. This is particularly relevant at the beginning or ending of a teacher's tenure at a given school, when teachers may adjust observable behaviors without adjusting underlying effort (Holmström 1979). I first address this potential problem by re-estimating the models with alternative measures of teacher absence as dependent variables to ensure the results are not sensitive to the use of ordinary sick leave as the dependent variable. Second, I present analysis from the Schools and Staffing Survey showing teachers' self-reported work hours outside of the classroom (an unobservable measure of effort) shows a pattern similar to that observed in sick leave. These results suggest the potential for bias from using sick leave as the dependent variable is small. This analysis is presented in Section VII.

VI. CAREER CONCERNS RESPONSES IN TEACHER ABSENCE BEHAVIOR

Estimates from Teacher Tenure

The generalized career concern model presented in Section IV predicts effort responses on two different levels. First, effort decreases with experience generally, as the market learns a teacher's ability. Second, effort decreases as tenure with a particular employer lengthens because direct supervision reveals better information of a teacher's ability. While the first effect is shared across the entire cohort of teachers entering the labor market simultaneously, the second is separable and may show up at any point in a teacher's career, discretely increasing teachers' effort levels when teachers switch schools. I look for changes in teachers' use of sick leave along these two dimensions as supporting evidence of the generalized model.

Before analyzing the career concerns response, I first wish to note the significance of other explanatory variables in the model, separate from the career concerns variables. Gender, age, and fertility are all significant predictors of absence behavior. Other control variables include race and ethnicity variables, credentials, and college selectivity, which were considerably less profound in magnitude and significance. These results are consistent with other published papers on the determinants of teacher absence (eg. Clotfelter et al. 2009). Further documentation of these supporting regressions is detailed in the Appendix.

Next I predict sick leave using career concerns variables. First, experience and tenure variables are included directly in the regression (along with squared and cubed terms for any potential non-linear relationship), which is presented in Panel A of Table 3. Column 1 is the OLS approach (estimating Equation 13 above), column 2 adds on school-year fixed effects (Equation 14), and column 3 uses a teacher fixed effect (Equation 15). Recall the dependent variable here is days of sick leave, where higher values imply lower levels of effort. Consistent with the model's predictions, all specifications predict increasing absences (lower effort) in response to a one-year change in tenure or experience.

Table 3. Career Concerns and Teacher Absence Behavior

Panel A. Tenure and Experience Entered Directly

	1	2	3
Experience	0.325**	0.319**	0.350**
	(0.012)	(0.008)	(0.021)
Experience squared	-0.016**	-0.016**	-0.022**
	(0.001)	0.000	(0.001)
Experience cubed	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
Tenure	0.987**	0.983**	1.134**
	(0.027)	(0.030)	(0.024)
Tenure squared	-0.170**	-0.169**	-0.179**
	(0.006)	(0.006)	(0.005)
Tenure cubed	0.008**	0.008**	0.009**
	(0.000)	(0.000)	(0.000)
Observations	403,331	403,331	403,331
R-squared	0.04	0.03	0.04

Panel B. Tenure and Experience Entered as Indicator Variables

	1	2	3
Year 2 of experience	1.366**	1.380**	1.430**
	(0.041)	(0.049)	(0.041)
Year 3 of experience	1.833**	1.848**	1.808**
	(0.043)	(0.048)	(0.046)
Year 4 of experience	2.019**	2.046**	1.939**
	(0.047)	(0.049)	(0.054)
Year 5 of experience	2.159**	2.188**	2.015**
	(0.051)	(0.050)	(0.062)
Year 2 of school tenure	0.693**	0.678**	0.760**
	(0.022)	(0.029)	(0.021)
Year 3 of school tenure	0.733**	0.718**	0.973**
	(0.025)	(0.030)	(0.023)
Year 4 of school tenure	0.695**	0.675**	1.040**
	(0.028)	(0.031)	(0.026)
Year 5 of school tenure	0.702**	0.690**	1.134**
	(0.031)	(0.034)	(0.029)
Observations	403,331	403,331	403,331
R-squared	0.05	0.04	0.05
Year fixed effects	√		√
School-year fixed effects		√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, imputed age, fertility, and retirement eligibility. A full vector of experience indicators also included in Panel B regressions. Omitted category is teacher in year 1 of tenure and experience. Indicator variables for experience and tenure after year 5 are included in regression but omitted in output.

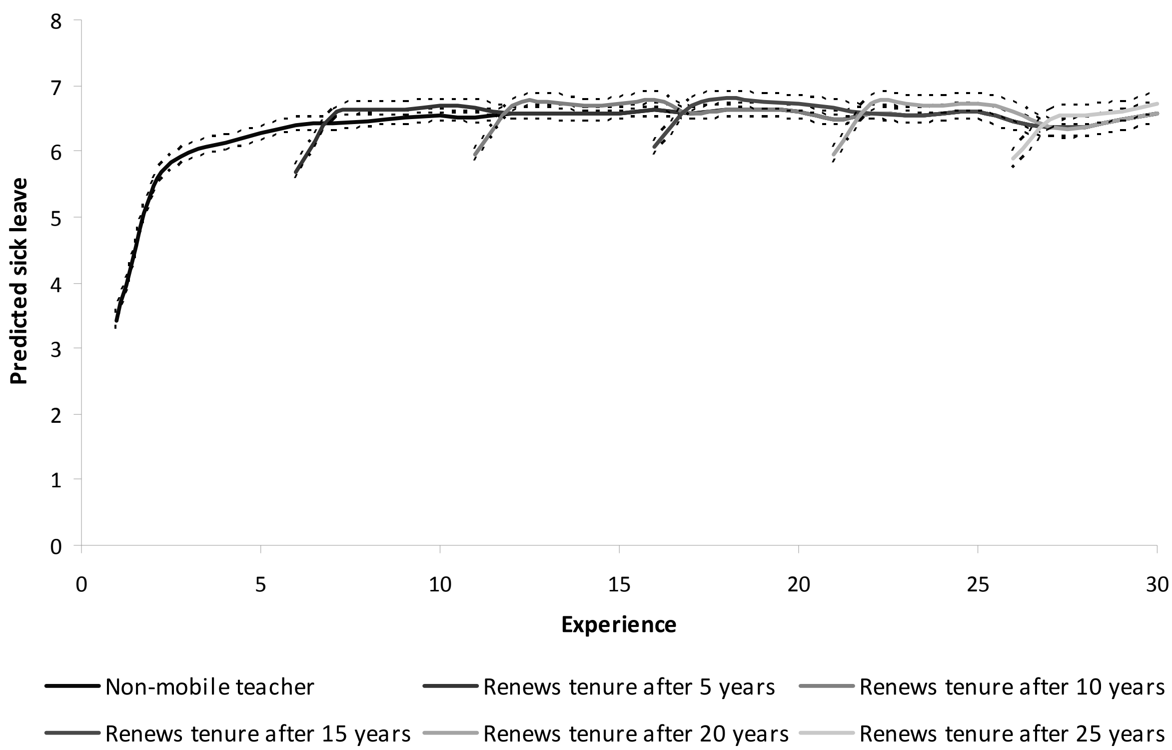
Notably, a one-year increase in employer tenure has a considerably higher magnitude than a one-year increase in experience, suggesting the implied variance of the noise between the market's observation of teacher quality and a direct supervisor's observation is large (effort under tenure converges to the overall mean faster than that of experience alone). Additionally, the squared terms indicate decreasing marginal absences as both experience and tenure increase, which is also consistent with the nature of the learning process: a teacher has a greater ability to sway the market's (or employer's) assessment of ability early on, and additional years of information are marginally less informative with time.

To verify this relationship is not sensitive to the direct inclusion of the experience and tenure variables, I re-estimated these models including a full vector of indicator variables on experience and tenure (by year, year 1 of tenure and experience are the omitted groups). These results are presented in Panel B of Table 3. Using indicator variables for each specific year allows more flexibility in the estimated response. The significance and direction of the estimates were robust to this specification change. As experience increases, teachers are absent significantly more, but the largest differences are observed moving from years 1 (omitted) to 2, and then years 2 to 3. Tenure also showed a similar pattern—the within-teacher estimates indicate a teacher takes roughly 0.7 additional days of sick leave in the second year of tenure at a new school compared to the first year, *ceteris paribus*. In the third year of tenure, the additional increase in sick leave is still significant (marginally in the case of Columns 1 and 2), though much smaller in magnitude. Beyond the third year of tenure, however, results appear to converge to a mean level. Thus, the tenure effect appears relatively short-lived, and is most relevant over the first 1-2 years.[19] Figure 2 shows a graphical representation of the estimated relationship between sick

[19] I also estimated sick leave with a spell fixed effect model (teacher-school interacted effect), and the results were generally consistent with the teacher fixed effects models presented in Column 3. I omit these results for brevity.

leave, experience, and tenure.[20] Experience increases along the x-axis, and sick leave increases in the y-axis. The general trend shows sick leave increases considerably over the first five years of a teacher's experience in the profession, but then flattens. When a teacher changes schools (renewing tenure) at various points in her career, however, sick leave is predicted to be significantly lower for a brief period before converging back to the mean level observed across the labor market generally. These estimates are reasonably consistent with the model's predictions, depicted in Figure 1b.

Figure 2. Predicted Sick Leave by Experience and Tenure



[20] The coefficient estimates used to generate Figure 2 are those in column 1 of Table 3 Panel B. All estimates in this table illustrate a similar relationship, and the graphical representation is invariant to the choice of model.

Causal Estimates from Principal Tenure

While these findings support the model's predictions, I cannot say with certainty that various aspects of career concerns, notably tenure at a school, are endogenous to a teacher's absence behavior. Essentially, each of these variables indicates a choice made by teachers—how long of a relationship to maintain with a particular school, when to move, and where to move are all choices the teacher ultimately decides herself. This endogeneity is the most severe threat to the validity of this model and its application here.

To counter this potential endogeneity, I propose identifying career concerns responses through an alternative, exogenous method—principal turnover. The generalized model I propose posits each school has a private information set about teachers, and teachers respond according to their schools' perceptions of their ability. When a school changes to a new principal administration, however, the former principal's information set will not likely transfer perfectly to the incoming principal. Rather, some information will be lost in the process. This 'clean slate' implies teachers have an incentive to induce higher levels of effort with the arrival of an incoming principal to sway the new principal's perception of teacher ability. Changes in principal administration are totally exogenous to the teacher's decision for tenure; but, according to the model, this exogenous change predicts an observable response in teacher behavior.[21] Thus, the arrival of a new principal at a school provides a natural experiment to test the causality of career concerns on absence behavior among teachers.

I use administrative files in the NCERDC data to identify principals at each school, permitting me to observe when new principals took over.[22] I create variables on the length of a principal's tenure at a school and use this variable to detect whether absence levels decreased in response to the administrative

[21] The research on principals' actions as a determinant of student outcomes is a small but rapidly expanding field (see, for instance Brewer 1993; Billger 2007; Clark et al. 2009; and Horng et al. 2009). According to these studies, principals' managerial skills appear to make a significant difference on the operation of the school and the outcome of students.

[22] The NCERDC data is inconsistent in coding principals prior to the 1996-97 school year; thus, I omit all observations prior to this school year for this analysis. Principals with more than five years of tenure are aggregated together.

change and then increase with time. Table 4 presents the results of these specifications.

Table 4. Causal Test of Career Concerns: Principal Tenure

	1	2	3
Year 2 of principal tenure	0.073**	0.090**	0.177**
	(0.018)	(0.022)	(0.016)
Year 3 of principal tenure	0.047*	0.090**	0.199**
	(0.023)	(0.028)	(0.020)
Year 4 of principal tenure	0.060*	0.105**	0.237**
	(0.029)	(0.036)	(0.025)
Year 5 or more of principal tenure	0.019	0.090*	0.192**
	(0.029)	(0.041)	(0.024)
Observations	402,713	402,713	402,713
R-squared	0.05	0.04	0.05
Year fixed effects	√	√	√
Principal-school fixed effects		√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), tenure in school (when less than principal's), and imputed age, fertility, and retirement eligibility.

As predicted, teachers' sick leave significantly increases as tenure with the new principal increases, lending support to the prediction of higher effort levels when the principal first arrives and falling again as more is learned of teacher ability. Consistent with the evidence in Table 3, the largest response occurs between the first and second year of principal tenure, and changes beyond year 2 are not significant.

Because school-year effects are collinear with a principal's tenure at a school, the school-year effects model is not identified; however, the within-principal response is isolated via principal-school fixed effects (in Column 2). The results of this model are important, since principals may turnover because of poor performance under the old principal. If this were the case, the new principal would be expected to raise school performance generally (possibly by being more strict on teacher absences) due to new management and not due to career concerns. The estimates of Column 2 suggest managerial style embodied within a principal is not driving this change because even within principals, tenure under the principal significantly increases a teacher's likelihood of taking sick leave.

Comparing these new-principal tenure estimates against those indicating teacher-school tenure (in Panel B of Table 3), the new-principal tenure effects have a considerably smaller magnitude than the original tenure estimates. This smaller effect is reasonable—a new principal to a school potentially has many ways to gather information about employees (i.e. inquiring with school administrators who survived the change in leadership), thus sharpening the precision of the principal's estimate of teacher ability. A school may not have such ready access to information about a new incoming teacher. For this reason, new principals may be at an informational advantage compared to the case of a school with a new teacher. As a result of the more precise information, the jump in teacher effort could feasibly be smaller, as observed here.

In summary, by exploiting the natural experiment that arises through administrative turnover in the data, I find teachers' absence behavior changes significantly in response to the arrival of a new principal at a school. Because principal turnover is purely exogenous to teachers' absence behavior, I assert the estimates presented here are causal estimates of behavioral changes due to career concerns.

Exploring Systematic Variations in Career Concerns

The findings above support the predictions of the generalized career concerns model, however, not all teachers may have a uniform response to these incentives. In this section, I investigate three ways in which career concerns incentives may vary among teachers systematically—by tenure type, by gender, and by experience level.

Different Career Concerns by Tenure Type

In both the model and the empirical predictions above, a teacher's tenure at a school is treated uniformly, implying any school looking to hire any teacher knows only as much as the market knows. In reality, as schools hire teachers from the market they may feasibly collect information about a specific teacher's ability that may not be public knowledge, and the amount of private information gathered on a new hire need not be uniform across all teachers a school hires. These varying levels of information on a new hire have important implications on a teacher's career concerns incentives and their optimal effort levels—specifically, the less a school knows of a teacher's ability, the more the teacher wishes to exert effort to mold the school's perception (i.e. career concerns incentives are stronger).

In the current analysis, I have no way to observe the information a school has when deciding whom to hire. An alternative approach, however, may be able to tease out these differences. Recall Equation 2 in which information was transmitted from the school to the market with random noise η, where $Var(\eta) > 0$. Suppose now that $Var(\eta)$ varies depending on the level of private information collected in the hiring process. Assume private information about a candidate is relatively costly to gather the further a teacher is removed (organizationally) from her new school.[23] Thus, I assume $Var(\eta_{state}) > Var(\eta_{district}) > Var(\eta_{school}) \geq 0$, where the subscripts indicate teachers coming from another state, district, and school; these would imply sick leave should decrease as this error increases. To test this empirically, I categorize tenure variables as tenure after a school move, tenure after a district move, and tenure after a state move (the linear sum of these categories is identically the original tenure-year indicator).

[23] For instance, a school can gather private information about a teacher moving in from out of the state public school system, but gathering this information is costly. On the other hand, gathering information about a teacher transferring from a neighboring school within the same district is relatively cheap—the principals from both schools are likely to be on familiar terms and calling other teacher colleagues as references is easy and reliable.

Table 5 presents the results of this investigation. The relative magnitudes of these estimates are generally consistent with this predicted pattern. I find evidence of absence levels monotonically increasing (effort is decreasing) with proximity to a new school assignment (year 1 in NC public schools is the omitted category).

Table 5. Different Information Structures for Principals

	1	2	3
Year 1 after school move	0.167** -0.039	0.371** -0.036	0.215** -0.047
Year 2 after school move	0.541** (0.041)	0.640** (0.038)	0.660** (0.051)
Year 3 after school move	0.588** (0.043)	0.654** (0.040)	0.735** (0.055)
Year 1 after district move	0.140** (0.043)	0.210** (0.038)	-0.053 (0.051)
Year 2 after district move	0.608** (0.045)	0.636** (0.040)	0.519** (0.055)
Year 3 after district move	0.686** (0.049)	0.725** (0.045)	0.686** (0.060)
Year 2 in NC Public Schools	-0.037 (0.043)	0.022 (0.039)	1.044** (0.040)
Year 3 in NC Public Schools	0.142** (0.042)	0.188** (0.036)	1.370** (0.043)
Observations	403,331	403,331	403,331
R-squared	0.05	0.04	0.05
Year fixed effects	√		√
School-year fixed effects		√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Omitted category is year 1 in NC Public Schools. Indicator variables on path-specific tenure after year 3 are included in regression but omitted in output

A consequential finding is on those teachers entering the state system—only in their third year of teaching do they reach the absence levels observed among teachers transferring from within the state school system, suggesting they may exert considerably more effort in these first two years of tenure relative to within-state transfers.

Different Career Concerns by Gender

In describing general determinants of teacher absence, I noted gender is a significant predictor. I wish to also investigate whether teachers respond to career concerns differently by gender, to ensure the estimated career concerns response is not due to biological differences alone. To analyze these differences, I interact the career concerns variables on experience and tenure with gender; results are presented in Table 6. Columns 1 and 3 present the overall career concerns estimates, Columns 2 and 4 present the interaction terms for male teachers. I report the results from the school-year fixed effects specification (Columns 1 and 2) and the teacher fixed effects specification (Columns 3 and 4). Note the overall and male interaction estimates are from the same regression, they are positioned side-by-side in the table for presentation. These estimates show male teachers exhibit a significantly lower profile of sick leave as experience increases.[24] The interacted estimates on tenure, however, are all insignificant across both specifications, suggesting the renewal of career concerns after a teacher has accumulated some experience does not appear to be isolated to a single gender.

[24] Ichino and Moretti (2009) present evidence suggesting different women's absence behavior appears to be strongly correlated with a woman's menstrual cycle and as a result, find a smaller negative effect on wages from absenteeism (compared with men, whose wage effect is significantly larger in magnitude). The estimated lower absence profile among male teachers here is consistent with their results.

Table 6. Career Concerns Interacted with Gender

	Overall	Male Interaction	Overall	Male Interaction
Year 1 of experience	—	-1.884**	—	0.144
	—	(0.223)	—	(0.346)
Year 2 of experience	1.443**	-1.939**	1.524**	-0.259
	(0.055)	(0.231)	(0.046)	(0.344)
Year 3 of experience	1.884**	-1.799**	1.868**	-0.099
	(0.054)	(0.228)	(0.051)	(0.341)
Year 4 of experience	2.101**	-1.869**	2.009**	-0.141
	(0.056)	(0.229)	(0.060)	(0.338)
Year 5 of experience	2.238**	-1.828**	2.075**	-0.096
	(0.057)	(0.226)	(0.067)	(0.335)
Year 1 of school tenure	—	0.163	—	-0.124
	—	(0.085)	—	(0.364)
Year 2 of school tenure	0.693**	0.034	0.767**	-0.153
	(0.032)	(0.085)	(0.024)	(0.364)
Year 3 of school tenure	0.750**	-0.052	0.991**	-0.207
	(0.033)	(0.085)	(0.026)	(0.362)
Year 4 of school tenure	0.699**	-0.02	1.045**	-0.138
	(0.034)	(0.087)	(0.029)	(0.361)
Year 5 of school tenure	0.716**	-0.048	1.143**	-0.151
	(0.037)	(0.090)	(0.032)	(0.360)
Observations	403,331		403,331	
R-squared	0.04		0.05	
Year fixed effects			√	
School-year fixed effects	√			
Teacher fixed effects			√	

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Indicator variables for experience and tenure (and male interactions) after year 5 are included in regression but omitted in output.

Different Career Concerns by Experience Levels

Finally, I investigate variation in career concerns at different points in teachers' careers. Imaginably, the estimated response may be concentrated among teachers who are relatively early in their careers (who happen to be the most mobile teachers also). I wish to investigate whether the estimated career concerns response is driven by teachers at a particular point in their careers, or whether career concerns influence all teachers in some way.

To investigate different responses by experience levels, I interact tenure with indicators on whether a teacher has less than 7 years of experience, 7-12 years of experience, or 13 or more years of experience. These results are presented in Table 7 (year 1 of tenure for a teacher with less than 7 years of experience is the omitted group).

Table 7. Career Concerns Interacted with Experience

	1	2	3
Year 2 of school tenure	0.761**	0.739**	0.790**
	(0.031)	(0.038)	(0.030)
Year 3 of school tenure	0.766**	0.747**	1.020**
	(0.036)	(0.040)	(0.035)
Year 1 of school tenure x 7-12 years of experience	0.116	0.134*	0.178**
	-(0.061)	-(0.056)	-(0.058)
Year 2 of school tenure x 7-12 years of experience	-0.043	-0.013	0.077
	(0.059)	(0.055)	(0.054)
Year 3 of school tenure x 7-12 years of experience	0.014	0.019	0.058
	(0.057)	(0.057)	(0.051)
Year 1 of school tenure x 13 or more years of experience	0.101	0.027	0.086
	-(0.059)	-(0.053)	-(0.056)
Year 2 of school tenure x 13 or more years of experience	-0.01	-0.075	0.082
	(0.056)	(0.053)	(0.052)
Year 3 of school tenure x 13 or more years of experience	0.082	0.021	0.053
	(0.054)	(0.054)	(0.047)
Observations	403,331	403,331	403,331
R-squared	0.05	0.04	0.05
Year fixed effects	√		√
School-year fixed effects		√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Omitted category is teacher in year 1 of tenure. Indicator variables for tenure (and experience interactions) after year 3 are included in regression but omitted in output.

By and large, virtually all of the tenure-experience interaction terms are not significantly different, indicating that the response is shared by teachers across the distribution of experience. Note that Columns 2 and 3 show a significant increase in sick leave for year 1 of tenure in teachers with 7-12 years of experience; in spite of this difference, a large predicted jump between years 1 and 2 persists for all experience levels.

Investigating the Collapse of Career Concerns Incentives

In a way, these findings offer some consolation to those who worry about moral hazard in the teacher labor market—increased effort in response to these incentives indicates any moral hazard is at least mitigated with these career concerns incentives (whether any moral hazard remains after this correction is an unanswered empirical question). On the flip side, these findings also suggest moral hazard may play a more prominent role when teachers' career concerns break down. If teachers for any reason foresee a premature ending to their careers, these effort-inducing incentives could disappear. A similar line of reasoning could be applied to a teacher who intends to transfer to another school—if the transfer is determined ahead of time, a teacher may shirk in her current assignment because she knows it will not change the terms of her subsequent employment agreement. Thus, one might worry about adverse behavior (shirking) arising when career concerns incentives break down before teachers exit a school.

To empirically test for the possibility of adverse behavior arising from this collapse in career concerns incentives, I include a vector of indicator variables on the last and second-to-lest year of a teacher's tenure, prior to exiting. As above, exits to another school, another district, and out of the public school system altogether are categorized separately to allow for different impacts.[25] Table 8

[25] I have no way to verify whether a teacher leaving the North Carolina public school system is staying in the teaching profession (ie. teaching in a private school or in another state) or leaving the teaching profession altogether. This distinction

presents the outcomes of these models. As predicted, the evidence is consistent with shirking in the final year of a teacher's tenure at a particular school. I include the estimates on the next to last year for each type of move as well, indicating a basis of comparison for each of the estimates. In all cases, sick leave increases in the final year relative to the next-to-last year. The estimated difference is largest for those exiting the district or NC public school system—over 0.5 additional days of sick leave are predicted for these teachers.

Table 8. Incentive Collapse Among Exiting Teachers

	1	2	3
Next to last year in school	0.455**	0.465**	0.025
	(0.036)	(0.037)	(0.033)
Last year in school	0.731**	0.753**	0.258**
	(0.032)	(0.033)	(0.031)
Next to last year in district	0.733**	0.739**	0.164**
	(0.044)	(0.045)	(0.040)
Last year in district	1.325**	1.364**	0.777**
	(0.039)	(0.039)	(0.037)
Next to last year in NC Public Schools	0.662**	0.675**	0.272**
	(0.034)	(0.035)	(0.030)
Last year in NC Public Schools	1.077**	1.118**	0.701**
	(0.039)	(0.039)	(0.036)
Observations	403,331	403,331	403,331
R-squared	0.06	0.05	0.05
Year fixed effects	√		√
School-year fixed effects	√	√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Omitted category is teacher in year 1 of tenure.

could make a considerable difference on a teacher's behavior as they exit—those staying in the profession may not shirk in the hopes of retaining positive referrals to help secure future teaching positions.

My interpretation of these estimates above could potentially be misleading—these absences may not be a shirking response in the last year of a teacher's tenure. Rather, the causality of this association may be reversed: principals may be wary of high levels of absences and encourage excessively delinquent teachers to exit, or events may arise in a teacher's life for which absence is needed and provokes the exit decision. To distinguish between these two conflicting hypotheses, I propose to analyze the time dependence of observed teacher absences. If the causality flowed from a teacher learning the current year is the last at a particular school, teacher absences (indicative of shirking) would likely increase after this information is revealed—skewing teacher absences toward the latter end of the school year. If the causality were from excessive absences causing teachers to exit, there is no reason to believe absences would be skewed over time.

As mentioned in the data description, the teacher absence data indicates the pay period in which an absence occurred. I aggregate this information into halves and re-estimate the model, now including indicator variables on the fall and spring halves of the last year of tenure at a particular school (along with pay-period indicator variables). The results of this specification, presented in Table 9, indicate absences are disproportionately concentrated in the latter half of the last year of tenure. Comparing the spring estimates with the analogous fall estimate shows spring absences are approximately twice as large (and this difference is significant in each case). While not causal, this evidence supports the hypothesis that the collapse of incentives from career concerns plays a role in the level of shirking among exiting teachers.

Table 9. Timing of Exiting Teachers' Absences

	1	2	3
Fall of last year in school	0.262**	0.273**	0.026
	(0.017)	(0.018)	(0.017)
Spring of last year in school	0.469**	0.479**	0.232**
	(0.023)	(0.023)	(0.021)
Fall of last year in district	0.471**	0.491**	0.197**
	(0.021)	(0.021)	(0.021)
Spring of last year in district	0.854**	0.873**	0.580**
	(0.028)	(0.028)	(0.027)
Fall of last year in NC Public Schools	0.308**	0.328**	0.119**
	(0.020)	(0.020)	(0.019)
Spring of last year in NC Public Schools	0.770**	0.790**	0.582**
	(0.028)	(0.028)	(0.026)
Observations	806,662	806,662	806,662
R-squared	0.11	0.11	0.14
Year fixed effects	√		√
School-year fixed effects	√	√	
Teacher fixed effects			√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Omitted category is teacher in year 1 of tenure.

VII. ALTERNATE DEPENDENT VARIABLES

The empirical results presented in Section VI show teachers' absence behavior is well correlated with career concerns incentives, and causality is established in the case of principal turnover. As described previously, however, days of sick leave are most likely utilized for cases unrelated to teacher shirking, resulting in a very noisy proxy measure of shirking. I wish to investigate several alternate dependent variables to ensure that the results presented here are not unique to the choice of variable.

First, the results above used days of ordinary sick leave as the dependent variable, because I argue this is most likely to isolate shirking. However, I could've also used other aggregations of the absence data. Clotfelter et al. (2009) use sick and personal leave to predict student outcomes, because they argue both sick and personal leave are left to teachers' discretion. I also could have used all sick leave which would include extended sick leave and uses of leave in a pooled sick bank. The results presented here are generally insensitive to the choice of dependent variable, as shown in Table 10.

Table 10. Alternate Dependent Variables to Proxy Effort

Panel A. Career Concerns and Absence Behavior

	Sick & Personal Leave		All Sick Leave	
Year 2 of school tenure	0.741**	0.919**	0.685**	0.806**
	(0.045)	(0.033)	(0.035)	(0.026)
Year 3 of school tenure	0.740**	1.183**	0.720**	1.039**
	(0.045)	(0.036)	(0.036)	(0.028)
Year 4 of school tenure	0.674**	1.289**	0.643**	1.101**
	(0.047)	(0.040)	(0.037)	(0.031)
Year 5 of school tenure	0.683**	1.427**	0.666**	1.212**
	(0.051)	(0.043)	(0.040)	(0.034)
Observations	403,331	403,331	403,331	403,331
R-squared	0.03	0.04	0.03	0.04
Year fixed effects		√		√
School-year fixed effects	√		√	
Teacher fixed effects		√		√

Panel B. Career Concerns Responses Caused by Principal Turnover

	Sick & Personal Leave		All Sick Leave	
Year 2 of principal tenure	0.066*	0.213**	0.086**	0.192**
	(0.031)	(0.023)	(0.025)	(0.019)
Year 3 of principal tenure	0.027	0.197**	0.064*	0.199**
	(0.041)	(0.028)	(0.032)	(0.023)
Year 4 of principal tenure	0.077	0.266**	0.078	0.238**
	(0.050)	(0.034)	(0.040)	(0.028)
Year 5 or more of principal tenure	0.060	0.217**	0.058	0.195**
	(0.057)	(0.032)	(0.046)	(0.026)
Observations	402,713	402,713	402,713	402,713
R-squared	0.03	0.04	0.04	0.04
Year fixed effects	√	√	√	√
Principal-school fixed effects	√		√	
Teacher fixed effects		√		√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls include the following: gender, race and ethnicity, highest degree, NBPTS certification, elementary teacher, experience (entered as vector of indicators), and imputed age, fertility, and retirement eligibility. Panel B additionally includes tenure in school (when less than principal's). Omitted category is year 1 of school tenure. Indicator variables for tenure after year 5 are included in regression but omitted in output.

Columns 1 and 2 present the estimates using the sum of sick and personal leave as the dependent variable, and Columns 3 and 4 use all sick leave as the dependent variable. Aside from the change in dependent variable, Panel A of Table 10 is otherwise equivalent to Panel B of Table 3, and Panel B of Table 10 is equivalent to Table 4. As shown, the parameter estimates change slightly depending on the choice of dependent variable, but the primary results stay intact. All measures of absence increase significantly with both teacher tenure in a school, and new principal tenure in the school, and this increase is largest between years 1 and 2 of tenure.

The larger concern with the dependent variable used, however, concerns the correlation between absence levels and effort, which is assumed but untested above. Teacher absences are fully observable to supervisors; therefore, teachers may strategically use absence days over time so that their reputations are enhanced without actually changing their underlying effort input (Holmström 1979). Because of this, absences could potentially be uncorrelated or even positively correlated with teacher effort, undermining the assumption that absence behavior proxies teachers' shirking in the classroom. To test the validity of this assumption, I present evidence from an alternative data source that provides an independent measure of teacher effort that is unobservable to a supervisor.

For this analysis, I use data from the Schools and Staffing Survey (SASS), which is administered every four years by the National Center for Education Statistics.[26] The nationally representative survey is administered to districts, schools, principals, and teachers nationwide in public and private schools. I use the 1999-2000 wave of the SASS, as Section VI of this wave's Public School Teacher Questionnaire inquires about the number of hours a teacher works outside of the classroom (specifically focusing on

[26] More detailed information on the SASS data can be viewed online at http://nces.ed.gov/surveys/sass/.

work that does not involve student interaction).[27] This is the measure Stoddard and Kuhn (2008) use in their study to proxy effort, which they argue should be well correlated with the strength of the performance incentives in the employment contract. More importantly, this proxy of effort is unobservable to a teacher's supervisor, and thus not subject to the strategic use as described above.

If this unobservable measure of effort responds to career concerns in ways that are consistent with the response in absence behavior, this is evidence that the assumed relationship between absences and effort is valid. Evidence that contradicts this pattern undermines this claim. The empirical test proceeds using the same estimation strategy described in Equations 13 and 14 using extra work hours as the dependent variable.[28] The teacher fixed effects strategy (Equation 15) is not possible with this data because of the cross-sectional nature of the data. Finally, because extra work hours are reported as non-negative integers, I use a negative binomial regression approach, which appropriately models the support of the dependent variable. Results of this analysis are presented in Table 11.

The estimates reported here are incident-rate ratios, where a variable with no effect has an estimated ratio of 1; estimates greater (less) than 1 indicate an increased (decreased) propensity for reporting higher levels of work hours. The estimates presented here show teachers' reported work hours outside of the classroom decrease with experience and tenure, and the largest jump is observed from year 1 to year 2 in both dimensions. This is consistent with the parameters reported in Panel B of Table 3. The estimates suggest going from year 1 to year 2 of tenure at a school (*ceteris paribus*) decreases the predicted number of work hours by approximately 4 percent (using the estimates in Column 2). Further analysis presented in Hansen (2009) shows this estimated jump in work hours is robust to controls for

[27] I restrict the data to include observations on full-time teachers only, to avoid excessive variation in work hours among part-time employees that are likely poorly aligned with the assumptions of the career concerns model.
[28] Because of limited within-school sample size, I use a district fixed effect rather than school-year fixed effects in Equation 14.

class size, competing time use measures, the number of classes and preps, and variation in principal tenure.

Table 11. Teachers' Self-reported Work Hours

	1	2
Year 2 of experience	0.909* (0.037)	0.939** (0.021)
Year 3 of experience	0.883** (0.037)	0.905** (0.021)
Year 4 of experience	0.875** (0.035)	0.916** (0.022)
Year 5 of experience	0.852** (0.033)	0.912** (0.022)
Year 2 of school tenure	0.980 (0.026)	0.961* (0.015)
Year 3 of school tenure	0.930* (0.028)	0.944** (0.016)
Year 4 of school tenure	0.927* (0.029)	0.911** (0.017)
Year 5 of school tenure	0.910** (0.028)	0.928** (0.019)
Observations	38,375	38,095
District Conditional Fixed Effects		√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Source: 1999-2000 Schools and Staffing Survey. Coefficients are estimated incidence rate ratios from negative binomial regression. Teacher controls include the following: race, class organization, degree, outside income level, school enrollment, month of survey completion and cubic polynomial on age. Omitted categories are year 1 of tenure and experience. Indicator variables for experience and tenure after year 5 are included in regression but omitted in output.

In summary, the dependent variable primarily used in this study (ordinary sick leave) does not capture an anomalous result. Rather, using other absence measures in the data and an unobservable measure of effort from an entirely separate data source as dependent variables, I find evidence of behavioral responses that corroborate the career concerns evidence presented throughout Section VI above. Taken together, these results strongly support the hypothesis that teachers' effort levels are actually changing in response to these career concerns incentives, not just absence behaviors alone.

VIII. CONCLUSION AND DISCUSSION

This paper presents a generalization of the standard career concerns model and applies it to the public teacher labor market. This application is primarily motivated by one question: Do teachers' effort levels increase in response to incentives? The evidence presented is consistent with teachers increasing effort in response to career concerns incentives. Using exogenous changes in the school's administration, I show the relationship between career concerns and sick leave is causal. Using an alternative, unobservable measure of effort from survey data shows corroborating results. In short, all of the evidence points to actual changes in teacher effort in response to career concerns incentives.

With these results, I return to the multi-task moral hazard problem presented in Section III, which is pivotal to the debate on the feasibility of teacher performance incentives. By and large, policymakers do not simply want to "get what they pay for" by shifting teachers' efforts away from other (unrewarded) aspects of education just to get better outcomes on paper. While such a result may appear positive in the short run, policymakers worry those neglected aspects of education may incur a larger cost on society in the long run. Do teachers respond to incentives with higher effort overall or with a simple redistribution of prior effort levels? The evidence presented here strongly supports the hypothesis of increasing effort levels. The results also suggest that these behavioral responses are reasonably large in magnitude—for instance, 0.75 fewer days of sick leave where the median level is 5.5 days constitutes a reduction approaching 15 percent and suggest teachers exhibit considerable variation in the amount of sick leave (and presumably, effort) they exert over the course of their careers.[29]

This study has its limitations. Most notably, I assume a learning process in which the labor market and schools learn of a teacher's ability, but do not investigate the particular avenues of this learning process. "Output" in this model may not necessarily be restricted to student test scores, but may also be conveyed through principal or peer evaluations, input from a parent's group, or various other measures of student outcomes. Because "output" may be observed and rewarded on several dimensions, these career concerns incentives may potentially be more encompassing than incentives based on objectives in a single dimension. Thus, the evidence presented here shows teachers respond to incentives, but does not say how broad explicit incentives must be to obtain this same level of response. Also, policymakers would do well to design any explicit incentive structure in conjunction with these naturally occurring career concerns incentives to sustain effort levels in the labor force (Gibbons and Murphy 1992).

A particularly noteworthy finding shows teachers exiting their teaching assignment (to another school or out of the school system entirely) take significantly higher levels of sick leave. This response is consistent with career concerns incentives collapsing prior to exiting, and the evidence suggests teachers may be shirking. These results suggest such shirking behavior at the end of tenure or a career may be curbed through sensible changes to policies governing absence use. For instance, Clotfelter et al. (2009) suggest paying all teachers in a cash bonus for unused days of absence at the end of each year. They argue this policy would raise income levels for teachers, while lowering the district's costs of finding substitutes, showing the potential for a pareto improvement over the current scenario.

[29] Related to effort, but beyond the scope of this analysis, is an investigation into what the "optimal" level of effort for teachers is (which could be defined in a number of different ways). The model presented predicts effort varies substantially over time; thus, effort levels can be both greater than and less than optimal levels at various points in career concerns framework.

In sum, implicit incentives through career concerns appear to play a significant role in determining teacher behavior and influencing student outcomes. These findings establish an important benchmark for understanding how teachers themselves respond to incentives in an American educational environment.

REFERENCES

Aaronson, Daniel, Lisa Barrow, and William Sander. 2007. "Teachers and Student Achievement in the Chicago Public High Schools." *Journal of Labor Economics* 25: 95–135.

Akerlof, George A. 1970. "The Market for "Lemons": Quality Uncertainty and the Market Mechanism." *Quarterly Journal of Economics* 84: 488 –500.

Altonji, Joseph G. and Nicolas Williams. 2005. "Do Wages Rise with Job Seniority? A Reassessment." *Industrial and Labor Relations Review* 58: 370–397.

Billger, Sherrilyn M. 2007. "Principals as Agents? Investigating Accountability in the Compensation and Performance of School Principals." IZA Discussion Paper No. 2662.

Boyd, Donald, Pam Grossman, Hamilton Lankford, Susanna Loeb, and James Wyckoff. 2008. "Who Leaves? Teacher Attrition and Student Achievement." NBER Working Paper #14022. Cambridge, MA: National Bureau of Economic Research.

Bradley, Steve, Colin Green, and Gareth Leeves. 2007. "Worker Absence and Shirking: Evidence from Matched Teacher-School Data." *Labour Economics* 14: 319-334.

Brewer, Dominic J. 1993. "Principals and Student Outcomes: Evidence from U.S. High Schools." *Economics of Education Review* 12: 281-92.

Casson, Michael H. 2007. "Reducing Teacher Moral Hazard in the U.S. Elementary and Secondary Educational System through Merit-Pay: An Application of the Principal-Agency Theory." *Forum for Social Economics* 36: 87-95.

Chevalier, Judith and Glenn Ellison. 1999. "Career Concerns of Mutual Fund Managers." *Quarterly Journal of Economics* 114: 389-432.

Clark, Damon, Paco Martorell, and Jonah Rockoff. 2009. "School Principals and School Performance." CALDER Working Paper #38. Washington, DC: The Urban Institute.

Clotfelter, Charles T., Helen F. Ladd, and Jacob L. Vigdor. 2009. "Are Teacher Absences Worth Worrying About in the United States?" *Education Finance and Policy* 4: 115-149.

Corcoran, Sean P., William N. Evans, and Robert M. Schwab. 2004. "Women, the Labor Market, and the Declining Relative Quality of Teachers." *Journal of Policy Analysis and Management* 23: 449-470.

Dewatripont, Mathias, Ian Jewitt, and Jean Tirole. 1999a. "The Economics of Career Concerns, Part I: Comparing Information Structures." *Review of Economic Studies* 66: 183-198.

Dewatripont, Mathias, Ian Jewitt, and Jean Tirole. 1999b. "The Economics of Career Concerns, Part II: Application to Missions and Accountability of Government Agencies." *Review of Economic Studies* 66: 199-217.

Dixit, Avinash. 2002. "Incentives and Organizations in the Public Sector: An Interpretative Review." *Journal of Human Resources* 37: 696-727.

Eberts, Randall, Kevin Hollenbeck, and Joe Stone. 2002. "Teacher Performance Incentives and Student Outcomes." *Journal of Human Resources* 37: 913-927.

Educational Research Service. 1980. "Employee Absenteeism: A Summary of Research." Arlington, VA: Educational Research Service.

Ehrenberg, Ronald G., Randy A. Ehrenberg, Daniel I. Rees, and Eric L. Ehrenberg. 1991. "School District Leave Policies, Teacher Absenteeism, and Student Achievement." *Journal of Human Resources* 26: 72-105.

Fama, Eugene. 1980. "Agency Problems and the Theory of the Firm." *Journal of Political Economics* 88: 288-307.

Figlio, David N. and Lawrence W. Kenny. 2007. "Individual Teacher Incentives and Student Performance." *Journal of Public Economics* 91: 901-914.

Gibbons, Robert and Kevin J. Murphy. 1992. "Optimal Incentive Contracts in the Presence of Career Concerns: Theory and Evidence." *Journal of Political Economics* 100: 468-505.

Gibbons, Robert and Michael Waldman. 1999. "A Theory of Wage and Promotion Dynamics Inside Firms." *Quarterly Journal of Economics* 114: 1321-1358.

Glewwe, Paul, Nauman Ilias, and Michael Kremer. 2003. "Teacher Incentives." NBER Working Paper #9671. Cambridge, MA: National Bureau of Economic Research.

Goldhaber, Dan, Betheny Gross, and Daniel Player. 2008. "Are Public Schools Really Losing Their 'Best'? Assessing the Career Transitions of Teachers and Their Implications for the Quality of the Teacher Workforce." CRPE Working Paper #2007_2.

Goldhaber, Dan and Michael Hansen. 2009. "National Board Certification and Teachers' Career Paths: Does NBPTS Certification Influence how Long Teachers Remain in the Profession and Where They Teach?" *Education Finance and Policy* 4: 229-262.

Hansen, Michael. 2009. "Teachers' Discretionary Effort and Incentives: Evidence from the Schools and Staffing Survey." University of Washington Working Paper.

Hanushek, Eric A. 1986. "The Economics of Schooling - Production and Efficiency in Public Schools." *Journal of Economics Literature* 24: 1141-1177.

Hanushek, Eric A., John F. Kain, and Steven G. Rivkin. 2004. "Why Public Schools Lose Teachers." *Journal of Human Resources* 39: 326-354.

Hanushek, Eric, John F. Kain, Daniel M. O'Brien, and Steven G. Rivkin. 2005. "The Market for Teacher Quality." NBER Working Paper #11154. Cambridge, MA: National Bureau of Economic Research.

Holmström, Bengt. 1979. "Moral Hazard and Observability." *Bell Journal of Economics* 10: 74-91.

Holmström, Bengt. 1982. "Managerial Incentive Problems: A dynamic Perspective." In *Essays in Economics and Management in Honor of Lars Wahlbeck*. Helsinki: Swedish School of Economics. Reprinted in *Review of Economic Studies* 66: 169-182.

Holmström, Bengt and Paul Milgrom. 1991. "Multitask Principal-Agent Analyses: Incentive contracts, asset ownership, and job design." *Journal of Law, Economics, and Organization* 7: 24-52.

Hong, Harrison, Jeffrey D. Kubik, and Amit Solomon. 2000. "Security Analysts' Career Concerns and Herding of Earnings Forecasts." *RAND Journal of Economics* 31: 121-144.

Horng, Eileen Lai, Daniel Klasik and Susanna Loeb. 2009. “Principal Time Use and School Effectiveness.” CALDER Working Paper #34. Washington, DC: The Urban Institute.

Hoxby, Caroline M. and Andrew Leigh. 2004. “Pulled Away or Pushed Out? Explaining the Decline of Teacher Aptitude in the United States.” *American Economic Review* 94: 236-240.

Ichino, Andrea and Enrico Moretti. 2009. “Biological Gender Differences, Absenteeism, and the Earnings Gap.” *American Economic Journal: Applied Economics* 1: 183-218.

Jacob, Brian A. and Steven D. Levitt. 2003. “Rotten Apples: An Investigation of the Prevalence and Predictors of Teacher Cheating.” *Quarterly Journal of Economics* 118: 843-877.

Johnson, Susan Moore. 1986. “Incentives for Teachers: What Motivates, what Matters.” *Education Administration Quarterly* 22: 54-79.

Koch, Alexander K., Albrecht Morgenstern, and Philippe Raab. 2009. “Career Concerns Incentives: An Experimental Test.” University of Aarhus Working Paper.

Koedel, Cory and Julian R. Betts. 2007. “Re-examining the Role of Teacher Quality in the Educational Production Function.” University of Missouri Working Paper.

Koppich, Julia. 2008. “Toward a More Comprehensive Model of Teacher Pay.” National Center on Performance Incentives Working Paper #2008-06.

Ladd, Helen F. 1999. “The Dallas School Accountability and Incentive Program: An Evaluation of its Impacts on Student Outcomes.” *Economics of Education Review* 18: 1-16.

Lavy, Victor. 2009. "Performance Pay and Teachers' Effort, Productivity, and Grading Ethics." *American Economic Review* 99: 1979–2011.

Lavy, Victor. 2002. “Evaluating the Effect of Teachers’ Group Performance Incentives on Pupil Achievement” *Journal of Political Economics* 110: 1286-1317.

Lazear, Edward P. 2006. “Speeding, Terrorism, and Teaching to the Test.” *Quarterly Journal of Economics* 121: 1029-1061.

Levy, Gilat. 2005. “Careerist Judges and the Appeals Process.” *RAND Journal of Economics* 36: 275-297.

Miller, Raegen T., Richard J. Murnane, and John B. Willett. 2007. “Do Teacher Absences Impact Student Achievement? Longitudinal Evidence from One Urban School District.” NBER Working Paper #13356. Cambridge, MA: National Bureau of Economic Research.

Mukherjee, Arijit. 2008. “Sustaining Implicit Contracts when Agents Have Career Concerns: The Role of Information Disclosure.” *RAND Journal of Economics* 39: 469-490.

Muralidharan, Karthik and Venkatesh Sundararaman. 2008. “Teacher Incentives in Developing Countries: Experimental Evidence from India.” University of California - San Diego Working Paper.

Murnane, Richard J., Judith D. Singer, and John B. Willett. 1988. “The Career Paths of Teachers: Implications for Teacher Supply and Methodological Lessons for Research.” *Educational Researcher* 17: 22-30.

Odden, Allan, Dale Ballou, and Michael Podgursky. 2001. “Defining Merit.” *Education Matters* 1: 16-25.

Podgursky, Michael. 2003. "Fringe Benefits." *Education Next* 3: 71-76.

Podgursky, Michael J. and Matthew G. Springer. 2007. "Teacher Performance Pay: A Review." *Journal of Policy Analysis and Management* 26: 909-949.

Prendergast, Canice. 1999. "The Provision of Incentives in Firms." *Journal of Economic Literature* 37: 7-63.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain. 2005. "Teachers, Schools, and Academic Achievement." *Econometrica* 73: 417-458.

Stoddard, Christiana and Peter Kuhn. 2008. "Incentives and Effort in the Public Sector: Have US Education Reforms Increased Teachers' Work Hours?" *Economics of Education Review* 27: 1-13.

Tirole, Jean. 1994. "The Internal Organization of Government." *Oxford Economic Papers* 46: 1-29.

Vigdor, Jacob. 2008a. "Teacher Salary Bonuses in North Carolina." CALDER Working Paper #15. Washington, DC: The Urban Institute.

Vigdor, Jacob. 2008b. "Scrap the Sacrosanct Salary Schedule." *Education Next* 8: 36-42.

Waldman, Michael. 1984. "Job Assignments, Signaling, and Efficiency." *RAND Journal of Economics* 15: 255-267.

APPENDIX

In Section VI, I allude to regressions on the determinants of teacher absences, independent of the career concerns variables. In Appendix Table 1, I report these regressions. Of concern is my imputation technique on taking a teacher's college graduation date as an indicator of age. Inclusion of this variable, along with the computed fertility and retirement eligibility variables based on this imputed variable, makes an improvement in my ability to predict teacher absences and only makes a minor difference on the other estimates. Because of the joint significance of these variables, I use them throughout my analysis here.

Appendix Table 1. Predictors of Teacher Absence Independent of Career Concerns

	1	2	3	4	5	6
	-1.056**	-0.934**	-1.005**	-0.891**		
Male	-0.03	-0.041	-0.019	-0.025		
	0.624**	0.581**	0.300**	0.224**		
African-American	-0.035	-0.035	-0.024	-0.024		
	0.475**	0.493**	0.469**	0.451**		
Hispanic	-0.127	-0.125	-0.081	-0.08		
	0.516**	0.505**	-0.356**	-0.345**		
Other Ethnicity	-0.108	-0.107	-0.071	-0.07		
	-0.269**	-0.380**	-0.201**	-0.307**	0.416**	0.121**
Highest Degree: MA	-0.026	-0.026	-0.015	-0.016	-0.045	-0.045
	-0.152	-0.195	-0.097	-0.116	-0.286	-0.577
Highest Degree: MA+	-0.19	-0.191	-0.108	-0.108	-0.507	-0.504
	-0.830**	-0.700**	-0.678**	-0.560**	-0.103	-0.306
Highest Degree: PhD	-0.204	-0.209	-0.112	-0.114	-0.505	-0.517
	0.06	-0.108**	0.160**	-0.001	-0.03	-0.034
National Board Certified	-0.041	-0.041	-0.026	-0.026	-0.039	-0.039
	0.287**	0.289**	0.151**	0.071**	0.158**	0.154**
Elementary	-0.023	-0.023	-0.027	-0.027	-0.039	-0.039
		0.899**		0.864**		1.270**
Age		-0.02		-0.013		-0.083
		-0.016**		-0.015**		-0.026**
Age squared		0		0		-0.002
		0.000**		0.000**		0.000**
Age cubed		0		0		0
		0.004**		0.003**		0.013**
Fertility		0		0		-0.001
		0.493**		0.419**		0.209**
Retirement eligible		-0.052		-0.037		-0.051
		0.493**		0.489**		0.128**
Early retirement eligible		-0.04		-0.028		-0.036
Observations	403,331	403,331	403,331	403,331	403,331	403,331
R-squared	0.02	0.03	0.01	0.02	0.02	0.03
Year fixed effects	√	√			√	√
School-year fixed effects			√	√		
Teacher fixed effects					√	√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses.

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