Career Concerns Incentives and Teacher Effort

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Abstract

I present a generalization to the standard career concerns model and apply it to the public teacher labor market. In particular, this model provides three testable hypotheses: optimal teacher effort levels decline with experience all things equal, optimal effort declines with tenure at a particular school, and teachers shirk as incentives collapse at the end of a teacher's career or tenure. Using administrative data from North Carolina spanning 13 school years through 2007, I find significant changes in teacher absenteeism consistent with the generalized career concerns model. These findings are robust to various empirical specifications, showing consistent within-teacher behavioral changes. By exploiting exogenous variation in career concerns in the form of principal turnover, I find results consistent with the model's predictions. I also investigate the effects of career concerns incentives breaking down, and find evidence suggestive of teacher shirking. While the career concerns effect is compounded with a learning curve early in a teacher's career, I find shirking among exiting teachers is significantly predictive of negative outcomes in student testing.

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I. Introduction

Teachers matter. Decades of education research have established a strong consensus about the critical role they play in education production. No other schooling input is as critical or effective at raising student achievement, making this a relevant policy issue (James S. Coleman, 1966, Eric A. Hanushek, 1986). Yet, teacher quality varies greatly from teacher to teacher, and proves elusive to researchers and policymakers alike (Daniel Aaronson et al., 2007, Steven G. Rivkin et al., 2005).

Some speculate the reason for the considerable variance in quality is due to the lack of explicit incentives in education, which create a moral hazard (Michael H. Casson, 2007, Michael K. Judiesch and Frank L. Schmidt, 2000). Compensation in the market for public school teachers is generally an input-based salary completely determined by a teacher's level of experience and credential, and not dependent on a teacher's output. Various education policies, notably the No Child Left Behind Act, prescribe accountability for schools and teachers in an effort to raise educational outcomes (Robert L. Linn et al., 2002). Merit pay and other proposed pay-for-performance plans are prominent examples of accountability policies aimed specifically at linking teachers' wages to their classroom performance (Dan Goldhaber, 2006).

Proponents for performance incentives argue such reforms to the compensation structure would professionalize teaching and align compensation with desired outcomes (Julia Koppich, 2008). Underlying the debate over incentives is the position that schools could raise achievement overall if only teachers could be induced to exert more effort. Whether incentives actually succeed in changing teachers' behavior and, more importantly, whether student learning improves is an empirical question that has not been satisfactorily answered (David N. Figlio and Lawrence W. Kenny, 2007). The model and results presented in this paper directly address the issue of how teachers respond to incentives, which are at the heart of the public debate on pay-for-performance reforms to teacher compensation. While the incentive I analyze here are not explicit incentives, the fundamental question of how teachers respond to incentives is shared with either type of incentive system, explicit or not.

In this paper, I offer some evidence on both how teachers respond to incentives and how students are affected by these responses. First, I present a generalization of the standard career concerns model and apply it to the public teacher labor market, asserting that it manipulates teachers' implicit incentives and behavior. In lay terms, this model shows that because teachers receive benefits from their reputations as workers over the course of their careers and tenure at a particular school, teachers are induced to higher levels of effort to enhance their reputations in predictable and observable ways. The model provides three testable hypotheses: optimal effort declines with a teacher's experience *ceteris paribus*, effort declines with tenure at a given school, and teachers shirk as incentives collapse at the end of a teacher's career or tenure. Using data covering the universe of public school teachers in North Carolina spanning 13 school years, I find evidence that teachers' absence behavior is related to these career concerns incentives. Second, I link changes in these career concerns incentives to changes in student outcomes. While higher effort levels in teachers' early careers are compounded with a learning curve (offering no separable effect), I find significantly negative outcomes among students whose teachers' career concerns incentives have collapsed prior to making some type of exit from the school. In summary, this paper finds teachers' behaviors responding in ways consistent with career concerns incentives, and these behaviors do affect student learning.

In the following section, I offer a background on the relevant literature and demonstrate this study's contributions. In Section III, I derive the conditions of these career concerns incentives. Specifically, I present a generalized career concerns model that predicts varying levels of optimal effort for teachers over time. Section IV presents the data and methodology I use to test for teachers' responses to these implicit incentives. In these tests, I utilize two important measures—teacher absences and student achievement—to estimate how both teacher inputs and student outcomes correlate with these incentives. In Section V, I argue the teacher labor market meets the assumptions necessary for the application of this career concerns model and present evidence to support this assertion. Section VI presents the main findings of this investigation and Section VII shows the results are consistent with logical variations in the model. In Section VIII, I address threats to the model and present the results of exogenous variation in teachers' career concerns incentives: changes in a school's administration. In Section IX, I report the estimated impacts of responses to career concerns incentives on student achievement, which is the policy-relevant outcome. Section X concludes with a discussion of the results and their policy implications.

II. Relevant Literature and Contributions

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 literatures to inform debates surrounding teacher incentives and compensation reform.

The lack of explicit incentives in teacher labor contracts does not necessarily indicate teachers are withholding effort from production, as is sometimes assumed (Michael H. Casson, 2007). Rather, participation in the labor market can be considered a multi-period game, where the outcome of the current game impacts the outcomes of future games. Because teachers participate in the labor market over the span of their careers and future job prospects are influenced by past performance, teachers' concerns over their own career paths provide implicit incentives for effort input and performance in the classroom. This reasoning embodies the essence of the career concerns model. Eugene 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. Bengt 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 managers and the market are learning of managers' unknown ability over time.

A considerable theoretical literature has developed around the properties of this type of incentive system. For instance, Robert Gibbons and Kevin J. Murphy (1992) derive the optimal explicit incentives over time to complement those diminishing from career concerns decreasing with time. Mathias Dewatripont et al. (1999a, b) discuss the role of information systems in this model, and apply it to government agencies. While the standard model prescribes symmetric imperfect information, I present a generalization in which agents, firms, and the market may potentially have different information about a worker's ability—Michael Waldman (1984) and Arijit Mukherjee (2008) analyze career concerns under similar scenarios. These authors, however, analyze how the market learns of an agent's ability, and do not specifically focus on changes in effort levels as agents transfer between firms as I do here. In contrast to the breadth of the theoretical literature, the empirical evidence supporting career concerns is scant (Judith Chevalier and Glenn Ellison, 1999, Robert Gibbons and Kevin J. Murphy, 1992, Harrison Hong et al., 2000), and to my knowledge has only been applied in business and managerial settings.

In my application of the career concerns model to the teacher labor market, I propose to use discretionary absences as a proxy for effort. Admittedly, teacher absences can only approximate effort input. One could easily imagine false positives and negatives—for instance, a teacher who expends little effort on classroom preparation but has perfect attendance; likewise, a teacher may routinely spend several hours after school preparing future lessons but fall sick for several weeks during the flu season. However, the evidence on teacher absences has shown absences in teachers are markedly higher than other industries in the U.S. (Michael Podgursky, 2003), appear to be sensitive to the generosity of leave provisions (Ronald G. Ehrenberg et al., 1991), are most frequent on Mondays and Fridays (Educational Research Service, 1980), and have been shown to be correlated with overall shirking in the workplace (Steve Bradley et al., 2007). In summary, absences appear to be at least partially discretionary. Further, recent studies have shown teacher absences have a significantly negative impact on student outcomes, and the evidence appears to suggest a causal relationship (Charles T. Clotfelter et al., 2007, Raegen T. Miller et al., 2007). Thus, because absences are both discretionary and correlated with student outcomes, this measure of teacher absences is the best variable available to approximate effort in the data.

Finally, my paper addresses the issue of how teachers respond to incentives.[2] Though individual performance incentives for teachers have been implemented in some form or another for decades in the United States, surprisingly little evidence has shown whether incentives actually raise achievement (David N. Figlio and Lawrence W. Kenny, 2007). Several studies have shown significant causal increases in achievement from incentive programs (Paul Glewwe

[2] I wish to clarify the incentives I'm addressing here are those awarded to individual teachers for raising student performance in some way. Various proposals for compensation reform include providing incentives for difficult-to-staff subjects, teaching in high-needs schools, or additional career-ladder steps. While these incentives are of policy interest, they are beyond the scope of this paper.

et al., 2008, Victor Lavy, 2004, Karthik Muralidharan and Venkatesh Sundararaman, 2008), but these are all implemented in foreign countries and may not be applicable to the education system in the U.S. Further, not all outcomes are positive: both Paul Glewwe, et al. (2008) and Randall Eberts et al. (2002) report responses that, while consistent with the incentives, were not consistent with policy intentions, suggesting multi-task moral hazard could pose a barrier to successful implementation (Bengt Holmström and Paul Milgrom, 1991).

Importantly, while all empirical studies on teacher incentive programs analyze outcomes, few analyze changes in teacher behavior. In particular, because of the multi-task moral hazard problem, an unanswered question is whether teachers actually increase effort levels to qualify for incentives or simply re-allocate their efforts to those tasks on which they are being rewarded. This point is of considerable interest, as policymakers seek to reward good teaching overall, not simply "teaching to the test" or worse, outright cheating, which maximize teachers' private benefit while other dimensions of student learning are neglected (Brian A. Jacob and Steven D. Levitt, 2003). Of the studies above, only Paul Glewwe, et al. (2008) and Victor Lavy (2004) find evidence suggestive of teachers inducing higher levels of effort (as opposed to re-distributing effort), but these were based on self-reported results. Further, Paul Glewwe, et al. (2008) find the gains in student achievement resulting from the incentives did not persist beyond the incentive year, suggesting any gains were short-term or perhaps the product of re-distributing effort rather than increasing effort overall. In short, the evidence on exactly how individual teachers respond to incentives is not definitive, and whether these responses result in changes in student outcomes in the American education context is an unanswered question.

This paper contributes to these literatures in several ways. First, I propose a more readily testable career concerns model and apply it to an education setting. This paper contributes to the small literature of empirical evidence supporting the career concerns model, and is the first empirical paper applied outside of a business setting. Further, this paper documents how teacher effort levels change (within a teacher) in response to changes in career concerns incentives, in addition to addressing the impact on student achievement. This is the first paper to do this in an American education setting. Finally, I present evidence suggestive of teachers shirking when their career concerns incentives collapse, and link this shirking to negative student outcomes. To my knowledge, only one paper has shown empirical evidence of shirking behavior among teachers (Steve Bradley, et al., 2007); this paper confirms those findings and further estimates how shirking impacts student achievement.

III. 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: a teacher's ultimate productivity is dependent on teacher quality that varies considerably across the workforce, effort levels that are difficult to monitor, and random inputs. Also, outcomes are quantifiable to some extent and can be isolated to individual teachers (i.e. no reliance on team productivity). Additionally, with the available data I can observe teachers throughout their careers, greatly enhancing my ability to detect changes within a teacher over time.

In one critical aspect, though, the teacher labor market is not well suited to this model: teachers' monetary compensation is insensitive to changes in performance and thus principals or the market cannot readily manipulate teachers' compensation to reflect their expected output (Allan Odden et al., 2001). In spite of this inability to reward teachers with different levels of monetary pay, research has shown teachers with higher seniority and credentials tend to sort both across and within schools to students with higher tests scores and higher measures of socioeconomic status (e.g. Eric A. Hanushek et al., 2004). While seniority and credentials do not guarantee quality teaching, this sorting tendency suggests higher-performing teachers may be rewarded through non-monetary means where the standard salary schedule cannot distinguish between teachers on expectations of ability. For this application, I take principals' ability to compensate teachers through non-monetary means as a given, and it is this non-monetary compensation that differentiates teachers according to expected outcomes.[3] As such, precisely because teachers' reputations are rewarded through non-monetary means, deviations from the single salary schedule are not guaranteed, but are implied rewards (or punishments, as the case may be) to past performance. Thus, in the present application I interpret "wages" as the sum of monetary and non-monetary compensation to teachers.

I propose a generalization of Bengt Holmström's (1982) basic career concerns model, adjusting two of the assumptions to match plausible scenarios in my application to the teacher labor market. 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: employees and firms know more about their employees than the labor market is expected to (due to the costliness of disseminating this information across the market) (Michael Waldman, 1984); moreover, a firm's unrestricted ability to compensate managers neglects the budget-driven reality of modern organizations. The generalization I present here explicitly models these informational and budgetary constraints, and as a result predicts additional testable hypotheses not present in the original model. As will

[3] 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.

become clear, Holmström's original model is a limiting case of the generalized model I present here.

First, I present Holmström's original model applied to the teacher case, then develop the generalized framework. The characters the original model portrays are the labor market, the hiring firm, and the manager; the analogous entities for my discussion here are the labor market, the school, and the teacher. Holmström proceeds assuming output is determined through the following production function:

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

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 (the inverse of the variance) given by h_1.

Teachers are risk neutral, with a shared utility function given by:[4]

(2) $$U(c,a) = \sum_{t=1}^{\infty} \beta^{t-1}[w_t - g(e_t)]$$

where $g(e_t)$ denotes the increasing disutility of effort. The competitive labor market offers a wage reflecting the expected output of the teacher, conditional on past performance:[5]

(3) $$w_t(y^{t-1}) = E[y_t \mid y^{t-1}] = E[\theta \mid y^{t-1}] + e_t(y^{t-1})$$

[4] The assumption of risk neutrality is Holmström's, but is likely violated in the present application to the public teacher labor market. Allowing for teachers to have risk-averse utility functions does change the resulting optimal effort path—it induces higher levels of effort from teachers. Because all teachers' decisions are all affected in the same way, however, changing the form of the utility function has no substantive effect on the predictions of the model. Thus, the assumption of risk neutrality imposes no loss of generality and is employed here for convenience.

[5] I wish to remind the reader that in the present application to the teacher labor market, wage differences off of the pre-determined salary schedule are non-monetary benefits. I interpret "wages" here as the sum of monetary and non-monetary compensation.

here y^{t-1} represents the history of observed outputs ($y_1, y_2, \ldots y_t$) to time t-1. Effort is determined in equilibrium simultaneously by maximizing the first equation, given the competitive wage rate detailed in the second.

Even though the market may not directly observe the teacher's effort, it can be deduced given the optimization rule above. Thus, observing output provides information to the market about a manager's ability through the relationship $y_t - e_t^*(y^{t-1}) = \theta + \varepsilon_t$. This information is implemented into the market's assessment of the teacher's ability, where the posterior distributions of θ, conditional on y^t are estimated through the following means and precisions:

(4)
$$m_{t+1} = \frac{h_t m_t + h_\varepsilon (y_t - e_t^*)}{h_t + h_\varepsilon} = \frac{h_1 m_1 + h_\varepsilon \sum_{j=1}^{t} (y_j - e_j^*)}{h_1 + t h_\varepsilon},$$

$$h_{t+1} = h_t + h_\varepsilon = h_1 + t h_\varepsilon$$

Because this posterior mean is the market's best estimate of a manager's ability, it is incorporated into the wage rule. Teachers now have a means to compute their expected future wages:

(5)
$$E[w_t \mid y^{t-1}] = \frac{h_1 m_1}{h_t} + \frac{h_\varepsilon}{h_t} \sum_{j=t}^{\infty} (m_1 + e_j - e_j^*(y^{j-1})) + e_j^*(y^{j-1})$$

An important conclusion implied in this equation is that the greatest changes in wage over time are most likely early in a teacher's career (when the precision of a teacher's ability is small, and the variance of performance large). Note also that current effort (as a component of current output) can influence the market's assessment of ability only if it deviates from the equilibrium effort level. Maximizing this function with respect to e_t over all future wages determines the equilibrium path of effort over time by equating it to the marginal disutility of effort.

(6)
$$\sum_{j=t}^{\infty} \beta^{j-t} \frac{h_\varepsilon}{h_t} = g'(e_t^*)$$

Thus, all teachers choose to put in the optimizing level of effort in every period, not deviating from the equilibrium path. Additional effort beyond that point is too costly (the marginal impact on wages is less than the marginal disutility associated with the additional effort), while effort below the equilibrium biases the market's learning process against the teacher. Also, note effort declines with time (the fraction of the precision terms converges to zero) as the market develops a better estimate of ability.

Asymmetric Information

I propose to re-specify this model in two distinct ways. First, I propose output (y_t), as defined above, is observed by the teacher and her school only. The market observes partial information on output (z_t), and its deviation from real output is random:

(1')
$$y_t = \theta + e_t + \varepsilon_t$$
$$z_t = \theta + e_t + \varepsilon_t + \eta_t$$

In this framework, y_t is a sufficient statistic for z_t, and because information loss is random, the teacher has no incentive to try influencing z_t independent of y_t. Thus, 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. $Var(\eta_t) = 0$). The most important difference due to this informational barrier between the school and the labor market is that the market and school now maintain separate estimates of a given teacher's ability, where the means and precisions of the posterior distributions are

(4'a)
$$m_{t+1}^p = \frac{h_t^p m_t^p + h_\varepsilon (y_t - e_t^*)}{h_t^p + h_\varepsilon} = \frac{h_1 m_1 + h_\varepsilon \sum_{j=1}^{t} (y_j - e_j^*)}{h_1 + t h_\varepsilon}$$

$$h_{t+1}^p = h_t^p + h_\varepsilon = h_1 + t h_\varepsilon$$

and

(4'b)
$$m_{t+1}^m = \frac{h_t^m m_t^m + h_{(\varepsilon+\eta)} (z_t - e_t^*)}{h_t^m + h_{(\varepsilon+\eta)}} = \frac{h_1 m_1 + h_{(\varepsilon+\eta)} \sum_{j=1}^{t} (z_j - e_j^*)}{h_1 + t h_{(\varepsilon+\eta)}}$$

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

for the school and market, respectively. Note both the school and the market share the same original estimate of the distribution of ability (hence the superscripts at *t=1* are omitted above), but these estimates differ with time as different information is incorporated into each. Also, because a school only observes y_t when employing a teacher, and observes z_t just as the market does otherwise, any subsequent school (notated with the superscript *sp*) will use both the directly observed y_t and the generally known z_t (for those periods prior to the principal's direct supervision, when y_t was not observed) in assessing a teacher's ability:

(4'c) $$m_{t+1}^{sp} = \frac{h_t^{sp} m_t^{sp} + h_\varepsilon (y_t - e_t^*)}{h_t^{sp} + h_\varepsilon} = \frac{h_1 m_1 + h_{(\varepsilon+\eta)} \sum_{j=1}^{s-1} (z_j - e_j^*) + h_\varepsilon \sum_{j=s}^{t} (y_j - e_j^*)}{h_1 + (s-1)h_{(\varepsilon+\eta)} + (t-s)h_\varepsilon}$$

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

Note that a subsequent school will weight the directly observed performance more heavily than past performance that was not directly supervised, because $h_{(\varepsilon+\eta)} \leq h_\varepsilon$ as asserted above. Also, note a clear asymmetry in the information each has access to: a school who has directly observed a teacher's performance for her whole career is the upper bound of precision on estimating teacher ability, while the market is a lower bound by virtue of incorporating noisy information only. A subsequent school incorporates both public and private information, thus the precision of its estimate will fall somewhere between the upper and lower bounds.

(7) $$h_t^{p} \leq h_t^{sp} \leq h_t^{m}$$
$$\text{for all } t = 1,2,\ldots\infty$$

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

Because each school has her own private estimate of a teacher's effectiveness, the expected wage for teachers hinges on the tenure of the teacher-school relationship through the precision term in the denominator:

(5')
$$E[w_t \mid y^{t-1}] = \frac{h_1 m_1}{h_t^p} + \frac{h_\varepsilon}{h_t^p} \sum_{j=t}^{\infty} (m_1 + e_j - e_j^*(y^{j-1})) + e_j^*(y^{j-1})$$

Equation (5') presents the expected wage in the case of a principal who has observed the full history of y_t. In cases where the subsequent school pays an expected wage using a less complete history of y_t, that school's precision substitutes the original hiring school's in the denominator presented above (ie. h^{sp} rather than h^p).

Importantly, a teacher optimally choosing her effort level over time, given these expected wages will arrive at different levels depending on her length of time at that specific school:

(6')
$$\sum_{j=t}^{\infty} \beta^{j-t} \frac{h_\varepsilon}{h_j^p} = g'(e_j^* \mid tenure, y^{j-1})$$
$$\sum_{j=t}^{\infty} \beta^{j-t} \frac{h_\varepsilon}{h_j^{sp}} = g'(e_j^* \mid tenure, y_{j-1}, y_{j-2}, \ldots y_s, z^{s-1})$$

The first optimal path is for working with the same school throughout one's career; the second is based on working with a subsequent school (where the subsequent principal begins direct observation at time $t=s$). Since $h_t^{sp} \leq h_t^p$ (equality in the case of no information loss between the school and market), a teacher working at a subsequent school will put in higher levels of effort at each point in time, compared to the teacher who has worked at the same school for the duration. The first equilibrium effort path is the lower bound of effort, given a teacher's time in the profession, the second path represents an upper bound when the precision of the subsequent school equals the precision of the market (ie. before the subsequent school has directly observed any output).

Note that every agent's optimal effort level is fully determined, given her time in the profession and her tenure at her current school. As a result, even though the teacher's precision of her own ability will always be greater than or equal to her school's, this does not change her equilibrium effort (the teacher's estimate of her own ability does not enter the equilibrium effort functions). Thus, even in an extreme case where a teacher knew her own ability with perfect clarity, because her pay is dependent on her school's valuation of her ability and independent of her own knowledge, the equilibrium path remains the same.

Limited Compensation

The second variation I propose to Holmström's original model is the firm's ability to compensate a manager (or in the present application, the school's ability to compensate a teacher). Holmström's framework does not limit this compensation, but sets it equal to expected productivity; however, such a framework makes the model less applicable to real-world settings, particularly in the present application to teachers where working conditions between schools vary considerably (Eric A. Hanushek, et al., 2004).

I propose the alternative wage-setting rule:

(3')
$$w_t(tenure, y^{t-1}) = E[y_t \mid tenure, y^{t-1}] = E[\theta \mid tenure, y^{t-1}] + e_t^*(tenure, y^{t-1})$$
$$\text{subject to } w_t \leq \psi^p$$

This is essentially the same competitive wage-setting rule (now conditioning on both time in profession and tenure at school to determine expected productivity). The substantive change is the addition of the wage constraint, where any teacher's expected wages may not exceed the individual school's ability to pay (ψ^p), which is known to all parties and determined exogenously to the model.[6] This extension does not distort the fundamental outcomes of the original model—Holmström's model can still be obtained in the special case where $\psi^p=\infty$.

This extension to the model not only enhances its applicability to real-world scenarios but also introduces a necessary exogenous source of variation inducing teachers to transfer between schools. 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, then any teacher attempting to move would send an implicit signal of her lower quality, thus unraveling the market (George A. Akerlof, 1970). Exogenously determined limits on schools' ability to compensate teachers ensures teachers from both ends of the ability distribution will have incentives to transfer schools; thus, seeking to transfer does not provide any new information to the market.

Summary

The model as proposed extends Holmström's model in two ways: first, I propose asymmetric information between the teacher, principal, and the market; second, I propose principals are exogenously constrained in their ability to compensate teachers. As illustrated, Holmström's original model can be obtained as a limiting case of the model derived here. As a result, the hypotheses of Holmström's model are unchanged: optimal effort generally 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.

My enhanced model also provides other refutable hypotheses not present in Holmström's original model. Importantly, effort additionally decreases as tenure at a given school increases

[6] 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 restrict total compensation to all teachers in the organization rather than limit compensation to individual teachers. 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.

(all else constant); thus, newly transferred teachers should exhibit higher levels of effort over other teachers at the same school *ceteris paribus*. A corollary to this hypothesis is that a discrete jump in effort (within a teacher) is predicted when a teacher moves from one school to another. Additionally, this model rests on a teacher's concerns about her future career path—if a teacher's career comes to a premature end, these incentives can collapse. A similar situation may arise when a teacher decides to end tenure at a specific school. In this case, where future wages are no longer dependent on current effort inputs, teachers are predicted to shirk relative to other teachers and relative to their own past behavior. I investigate this assertion in the data.

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 VIII is that these predicted changes in effort levels are not due to teachers' tenure at the school specifically, but rather tenure with a principal; thus, an exogenous change in principal (separate from the school) should cause an increase in optimal teacher effort among all teachers at the school generally. This test provides an important exogenous check on the model's predictions.

IV. Data and Methodology

For this analysis, I utilize an administrative dataset that covers the universe of teachers in the North Carolina Department of Public Instruction (NCDPI) spanning 13 school years, from 1994-1995 through 2006-2007. 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.

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 other background variables. Because my study primarily deals with changes in teachers' behavior in response to incentives, I restrict the sample to full-time teachers for whom I can observe at least three years of observations. A unique feature of this dataset is my ability to observe the same teachers in different schools as they progress through their careers, and identifying these moves within the school system will be key to identifying any behaviors due to career concerns. Also, I can use administrative personnel files to determine when schools change principals, which will provide an alternative method to test the generalized model's predictions through exogenous variation.

Importantly, a supplemental data file on teacher absenteeism, indicating both the pay period, type, and length (in half-day increments) for each teacher absence, can be merged with the data and will serve as a proxy measure of teacher effort for this study. To my knowledge only one paper (Charles T. Clotfelter, et al., 2007) has specifically addressed teacher absences in North Carolina using this same dataset. I adopt their methodology in classifying all recorded teacher absences as one of four types: sick leave, personal leave, administrative leave, or vacation.[7]

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 (i.e. unused vacation time rolls over into the next contract year), but vacation time

[7] Charles T. Clotfelter, et al. (2007) document the classification method for the NCERDC data in considerable detail, and I apply this method here. 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 four general absence categories. I refer the reader to their work for more detail.

must be approved with the principal well in advance of actually utilizing it; hence, the interruption to student learning in these cases should be minimal. Neither administrative leave nor vacation are used in this analysis.

For the paper, I focus on the two types of absences that are discretionary for teachers—sick and personal leave. Teachers accumulate one day of sick leave per month, and teachers may accumulate unused sick leave indefinitely; thus, experienced teachers may cash in extended periods of sick leave without any detrimental effect on their pay. However, using sick leave carries a cost: any unused leave at the time of a teacher's retirement can be converted to additional months of service, increasing a teacher's pension benefit.[8] Personal leave is any other day of voluntary leave beyond the three categories listed above, and entails a deduction in salary as a result of its use—either a deduction of $50 or a full day's pay. Generally, teachers do not use personal leave until they've expended their allotted sick leave—the median teacher in the data takes no personal leave at all.

Both of these types of leave are truly discretionary to teachers—they can be cashed in without prior approval and with little notice. Note, however, most schools have policies in place that would prevent leave from being abused, such as requirements for a doctor's note on the third sick day, etc. Also, when a teacher calls in sick, the duty of finding an acceptable substitute falls to the school; thus, the most meaningful cost of taking leave is the inability to somehow use it in the future (except in the case of personal leave, where pay is also deducted). For this study, in which I attempt to explain variation in absences with career concerns incentives, I assume teachers who have high career concerns incentives face a relatively higher cost of taking a day of

[8] 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.

leave than a teacher with low incentives, all else equal, reflecting the opportunity costs associated with the decision to use leave.

In Table 1, I report descriptive statistics for the restricted sample of teachers that I will be utilizing for this study. Column 1 reports the measures among the full sample I will be using (which by construct includes a minimum of three observations per teacher), and Column 2 reports these same measures for teachers observed in 2004 only (only one observation per teacher). Because inclusion in this sample is conditional on a minimum of three years of valid observations, this sample is not representative of the labor market as a whole, but is conditional on staying in the profession for a minimum of three years. As shown in the tables, the teachers in the data are predominantly white, female, and have over 10 years of teaching experience.

The table also reports over 9 absence days for each teacher per year, on average. This number is slightly misleading, however, as the distribution of teacher absences is strongly skewed; the median of the entire dataset is 7 days of absence. In Figure 1, I show the estimated kernel densities of the distribution of absences in the data, by absence type. As can be seen in the data, the largest share of combined absences comes from sick leave, and only a small amount comes from personal leave.[9] Also, while the computed variance of the combined distribution is over 9, the bulk of absences fall in a small range: the middle 50 percent of the distribution is contained between 4 and 11.5 days.

In the scope of this study, I also wish to assess whether these implicit incentives affect student learning in classrooms. To do this, I utilize a subset of teachers in the dataset, those teaching grades 4 through 5, with whom I can link their students' outcomes on end-of-grade tests. These end-of-grade tests are standardized tests in math and reading, as mandated by the

[9] Negative absence values are observed in the data, as some schools have policies of buying back leave from teachers, but these account for less than 100 teacher-year observations in the full data sample.

North Carolina Standard Course of Study. The vertical alignment design of these criterion-referenced tests ensure each marginal point on the test score represents a constant level of student learning across all grades.[10] For convenience in estimating effects across multiple years of data, I standardize test scores to have a mean of zero and unit variance in the third grade (the earliest year of observation); this same standardization is applied to all subsequent test scores as students progress through grades. The test data also include background information on students, including race and ethnicity, gender, parental education, learning disabilities, and eligibility for the free or reduced-price lunch (the best available indicator of household poverty).

I cannot link students to teachers directly; rather, the data documents the exam proctor for each student. In elementary grades, the exam proctor is generally the student's teacher as well, but this cannot be validated externally. To avoid mistakenly linking students to a non-teacher proctor, I perform a series of checks to ensure that the available information from personnel files on a given proctor is consistent with that proctor being the regular teacher for that particular class of students. For instance, only proctors that are not teaching honors or special education classes, teaching the same grade level of students whose exams they proctored for, and teaching self-contained classrooms are included in the analysis. Also, I restrict the class size to those with 10-29 students to reflect standard elementary classes; the lower limit of 10 students is for reasonable inference of teacher effectiveness, and the upper limit of 29 is the maximum regular class size for elementary grades in North Carolina. By applying these restrictions, I isolate the data in which I am highly confident of representing true student-teacher linkages in the most common classroom settings.

[10] For further documentation on the competencies tested, please see the Standard Course of Study, available online at http://www.dpi.state.nc.us/curriculum/ncscos. Additional information on the end-of-grade tests North Carolina uses to measure student learning can be found at http://www.dpi.state.nc.us/accountability/testing/eog/.

In Panel B of Table 1, I compare the restricted sample I use here against the unrestricted data from the universe of 4th and 5th graders in the NCERDC data. As shown, students in my sample are slightly more likely to be white, are less likely to be eligible for the free-lunch program, and have higher percentages of parents with a college education. They also score higher on standardized tests; thus, while this sample is not a random sample of the population of 4th and 5th grade students, it is the sample of which I am most confident that I can link students to teachers.

With this data, I proceed to test for evidence supporting the predictions of the generalized career concerns model. I primarily focus on whether discretionary teacher absences (the sum of personal and sick leave days in a year) respond to career concerns incentives as the model predicts. The basic model estimates the following equation:

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

Here, I use 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) to explain the variation in the number of days a teacher is absent in a given year. The vector of teacher characteristics includes a teacher's race, gender, credential, age, fertility, retirement eligibility, and other explanatory variables.[11] The career concerns variables are those indicating a teacher's experience level and tenure at a specific school. Alternatively, instead of entering experience and tenure into the model directly, some models include indicator variables on the year of experience and tenure, which allows for

[11] Age and fertility have been shown to be significant predictors of absence behavior (Charles T. 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 *2008 Statistical Abstract of the United States*, Table 88. The 2000 birth rate was applied to observations prior to 2003, the 2006 birth rate was applied to teachers from 2003 and on. 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); thus, the tables presented throughout the paper include these imputed measures.

non-linearities in the estimates of career concerns over time. The year fixed effect captures any systemic changes in absence behavior over time (i.e. changes to collective bargaining arrangements or administrative practices).

The model in Equation (11) ignores the panel structure of the data and pools estimates across all observations. Straightforward estimation on this pooled data could potentially bias our estimates, however, as a teacher's tenure at a specific school may be correlated with the absence policy at the school.[12] Also, this approach 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:

(12) $$Absences_{i,t} = \alpha + X_{i,t}\beta_1 + CC_{i,t}\beta_2 + \delta_{s,t} + \varepsilon_{i,t}$$

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

These models are identical to Equation (11) with the exception of the school-year ($\delta_{s,t}$) and teacher (α_i) fixed effects in Equations (12) and (13) 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 (Steve Bradley, et al., 2007, Raegen T. Miller, et al., 2007). Failing to estimate within-school changes in behavior could compound responses to career concerns with a shared propensity for absenteeism. If high- or low-absenteeism schools were correlated with

[12] A debate has ensued in the literature on returns to experience concerning the bias in estimates on the return to tenure (or job seniority) separate from a worker's experience levels (see Joseph G. Altonji and Nicolas Williams, 2005) for a concise review of the relevant bias and literature). Using an approach like the OLS specification in Equation 11 has been shown in that literature to bias tenure estimates due to unobserved heterogeneity across individuals, firms, and job difficulties. Though my dependent variable captures absences instead of wages, the bias problem may still apply. My strategy of employing teacher and school-year fixed effects should effectively control for the first two sources of heterogeneity. I cannot directly address heterogeneity in job difficulties with my data, but because I apply this to public school teachers in a single state, I presume the variance of job difficulty in my application is considerably smaller than other studies in that literature (which use population surveys across multiple industries and states), if not zero. I thus cannot assert the resulting estimates in this study are causal, but any remaining bias is likely very small.

indicators for various career concerns, pooled least squares estimates would be biased; thus, I pursue an identification strategy robust to this school-level variation. 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.

For some sections of the paper, I analyze changes in student learning coinciding with the career concerns model. In these sections, I estimate a basic value-added model of student achievement with the following equation:

(14) $$SA_{i,j,s,t} = \alpha + X_{j,t}\beta_1 + X_{i,t}\beta_2 + CC_{i,t}\beta_3 + SA_{j,history}\beta_4 + \phi_t + \varepsilon_{i,t}$$

This model explains variation in current student achievement in a given subject ($SA_{i,j,s,t}$), as a linear function of a vector of student characteristics ($X_{j,t}$), a vector of observable characteristics and career concerns variables from the teacher ($X_{i,t}$, $CC_{i,t}$), a vector of the full history of test scores in both subjects ($SA_{j,history}$), and a fixed year effect (ϕ_t). Note the *j* subscript above indicates individual students, *i* represents individual teachers, and *s* represents subjects. As in the case of analyzing absence behavior above, I will also estimate this model with school-year and teacher fixed effects (separately) to analyze the within-teacher and within-school changes that result from these career concerns incentives.

Additionally, as a corollary inspection into teachers' sorting on expected ability, I employ the following model to produce an estimate of teachers' value-added input into student achievement:[13]

(15) $$SA_{i,j,s,t} = \alpha_{j,t} + X_{j,t}\beta_1 + SA_{i,history}\beta_2 + \phi_t + \varepsilon_{i,j,s,t}$$

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[13] I estimate these value-added inputs for teachers in 5^{th} grade only, to remove as much bias from the estimates as possible through the inclusion of two years' history of prior test scores.

This approach substitutes the vector of teacher characteristics and the career concerns variables into a single teacher-specific intercept. I estimate this intercept using a rolling window on two years of classroom performance; thus a teacher's estimated intercept is not constant over time. This value-added approach is common in the education literature; and models using the full history of past student learning, as I do here, show the least propensity for bias compared to other alternative value-added specifications (Jesse Rothstein, 2008).[14] Beginning in the next section, I discuss the application of the career concerns model to the teacher labor market.

V. Career Concerns, Turnover, and Public Teachers

The career concerns model is not theoretically constrained to applications in private industry; however, previous studies of career concerns behavior have almost exclusively been applied in that setting. The only paper I know of that applies the career concerns model to a non-business setting is Mathias Dewatripont, et al. (1999b), where the authors discuss theoretical implications on organizational missions within government departments; no empirical work has applied this model outside of a business setting. Additionally, the inflexibility of the single salary schedule, ubiquitous in public schools, violates a primary assumption of the model—that of teachers being compensated according to expected ability. These reasons compel me to provide some evidence to support the application of this model here.

As described above, the teacher labor market is an ideal setting for the application of this model. The model assumes output is a function of effort, ability, and random inputs; none of which are fully observable. Education research supports the importance of teacher quality (Steven G. Rivkin, et al., 2005, Jonah E. Rockoff, 2004), and shows that the variance in quality

[14] My use of these value-added estimates in this study is very limited, so I omit discussion of potential biases, alternative models, and other important issues in the estimation of these measures. Please see (Daniel F. McCaffrey et al., 2004) for a detailed discussion of various models employed in the literature and the issues surrounding this method.

is largely unobservable (Daniel Aaronson, et al., 2007). My proxy of teacher effort, discretionary absences, shows a significant correlation with student outcomes (Raegen T. Miller, et al., 2007), but true effort cannot be observed, consistent with the model's assumptions. Additionally, teacher inputs are only one of several components in the education production function (Eric A. Hanushek, 1986). Finally, the model's premise is founded on non-contractible output, a prominent feature of education. In summary, the primary assumptions of the model are fully met in the teacher labor market.

The unique feature of the generalized career concerns model presented here relates to my ability to observe teachers as they move between schools over the course of their careers. My model predicts tenure with a school, like experience in the labor market, has an impact on teachers' career concerns. In Panel A of Table 2, I present a snapshot of the length of tenure, by type, for all teachers in 2004 (the same teachers described in Panel A of Table 1). I identify teacher tenure separately, depending on where teachers transferred from: another school within the district (labeled 'School'), another district within the state school system ('District'), or outside of the NC Public School system ('State'). The data shows many teachers along the full range of tenure in each type, which provides the variation necessary to identify the tenure effect separately from experience.

To get a picture of the frequency of transfers observed in the data, I can identify which of these teachers will be moving at the end of 2004, those moving in 2005, and those not moving either of these years. I present these tabulations in Panel B of Table 2 (the column labels now indicate the next teaching assignment for those leaving). Within-state transfers (both school and district transfers) are common—approximately 9 percent of these teachers made one of these moves in 2004. In total, nearly 17 percent of the observed teachers in 2004 will make some kind of transition, whether it be leaving the school, district, state, or going on leave. The level of turnover among teachers demonstrated in this snapshot is similar to that observed in other years of the data also. This ability to observe teachers' careers start and stop over time across multiple worksites is quite unique, and suits the application of this career concerns model to public school teachers.

The most problematic feature of the current application, however, is the single salary schedule, which predetermines a teacher's wage, inhibiting the model's assumption of compensating teachers according to expected productivity. In Section III above, I take the ability of principals and schools to compensate through non-pecuniary means off of the salary schedule as a given, an assumption on which I intend to provide some support. Several studies have supported the mobility of teachers sorting between and within schools on observable characteristics. For instance, Eric A. Hanushek, et al. (2004) find teachers' career paths on average lead to schools with higher test scores and lower levels of poverty and minority students, causing experienced teachers to be disproportionately concentrated in those schools.[15] Further, even within schools, studies have shown clear patterns of non-random sorting among students, showing within-school differences in classroom compositions and teaching assignments when comparing across teacher credentials, experience levels, and race (Charles T. Clotfelter et al., 2005, Daniel Player, 2006).[16] Other studies have also shown teachers certified through the National Board of Professional Teaching Standards are also disproportionately sorted across and

[15] Benjamin Scafidi et al. (2007) present evidence suggesting teachers' sorting preferences are driven primarily by preferences for the racial composition of the student body, rather than the level of poverty or test scores

[16] While the evidence of sorting within schools is strong, another study shows not all schools are sorted this way (Charles T. Clotfelter et al., 2006). Even if schools do not sort classrooms as a method of teacher compensation, this does not prevent them from rewarding teachers through other means unobservable to the analyst such as additional prep time, differential pay for extra-curricular activities, etc.

within schools as a result of obtaining the certification (Dan Goldhaber et al., 2007, Dan Goldhaber and Michael Hansen, 2007).

While seniority, degrees, or credentials do not guarantee a teacher's ability, these are commonly perceived as signals of teacher quality; thus, sorting on these observable variables is relevant to the career concerns model, though not exactly the compensation mechanism the model requires. Perhaps a more convincing evidence of sorting as prescribed by the career concerns model is that demonstrated on past performance measures themselves. In Table 3, I present transition matrices that illustrate the distribution of teacher quality across schools for transferring teachers. For those teachers observed beginning to teach in a new school after making some kind of transfer within North Carolina Public Schools (changing either schools or districts), I rank relevant characteristics of their prior school and new school into quintiles. For past performance measures, I take teachers' estimates of value-added effectiveness in math (from Equation 15) based on the two years of teaching just prior to transferring, and rank them into quintiles.[17] Both schools and teachers are ranked within the year of observation, and then aggregated across all years. I analyze the distribution of teachers using the percentage of minority students in a school (the top two tables) and using prior-year math scores (the bottom two tables). The tables on the left show the distribution of teacher quality across schools in the year prior to transferring (note, the performance estimates are based on the final two years prior to moving). The tables on the right show the distribution of teachers across schools in the year immediately after the transfer takes place. To be specific, the only thing changing in these tables

[17] Note, because I only use value-added estimates on 5th grade teachers, and I only isolate transferring teachers observed for two years previously, my sample size for this analysis is only a small fraction of the teacher population. The results of this investigation, however, are illuminating in spite of the small sample. Also, because quintile rankings for the school characteristics are based on all transferring teachers within each year (not just those for whom performance is estimated), the numbers of teachers in each quintile are not uniform.

is the ranking of prior schools versus new schools—the past performance rankings and the sample of teachers are constant across comparisons.

Below each table, I also report the correlation on school rankings against rankings of past teacher performance as well as the results of a chi-squared test on the null hypothesis of random sorting across schools. Inspecting the distribution of teachers prior to exiting (the tables on the left), in both the percentage of minority students and prior-year math scores, these tests fail to reject the null of random sorting. In fact, the distribution of teachers under the percentage of minority students appears marginally positive—schools with high levels of minority students may have slightly more high-performing teachers than expected. Moving now to the tables on the distribution of teachers after transferring (the tables on the right), this relationship is reversed in the case of the minority student population—now teacher quality is sorted negatively across schools (this is significant at the 10% level). In the case of prior-year math scores, teachers after transferring are distributed across schools positively in relation to prior-year test scores. In both cases, the sorting across schools, given past value-added performance, is consistent with prior evidence of sorting on readily observable teacher traits. I replicated this investigation using the percentage of students eligible for free and reduced-price lunch and prior-year reading scores, and found qualitatively similar results (see the Appendix for details).

VI. Changes in Teacher Absence Behavior

The generalized career concern model predicts effort responses on two different levels. First, effort decreases with experience generally, as the market learns a teacher's type. 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. I look for supporting evidence primarily using variables indicating teachers' experience levels and tenure with an employer.

Before including these career concerns variables in the model, I first wish to report the significance of the included control variables. I find 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. Charles T. Clotfelter, et al., 2007). Further documentation of these supporting regressions is detailed in the Appendix.

Next I move to Equation (11) in which I predict absence behavior with career concerns variables. I first include experience and tenure variables directly in the equation (along with squared and cubed terms for any potential non-linear relationship). In Panel A of Table 4, I present the results of this specification. In column 1, I omit all other controlling variables, column 2 includes teacher-level controls, column 3 adds on school-year fixed effects, and column 4 substitutes teacher fixed effects in place of the school-level effect. Consistent with the model's predictions, all specifications predict increasing absences in response to a one-year change in tenure or experience. As predicted in the model, the coefficients on both experience and tenure are positive and significant. Keep in mind the dependent variable here is the number of discretionary teacher absences, where I interpret higher values to be equivalent to lower levels of effort. All four specifications support the model's predictions. 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 regresses to the overall mean considerably 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. Recall 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. Figure 2 shows a graphical representation of the estimated relationship between tenure and experience.[18] The lower line depicts the expected absences when tenure is zero, but experience is positive, at different points along the experience level (along the x-axis). This line represents expected absence behavior when career concerns incentives are highest (given experience only), and the graph supports the prediction by showing absences are significantly lower than the upper line. The upper line depicts the estimate where a teacher's school tenure is equivalent to her experience. This represents the point where career concerns incentives are lowest, given her experience level. Again, the curve supports the model's predictions, predicting significantly higher absences among teachers when career concerns are lowest.

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 omitted). These results are presented in Panel B of Table 4. 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

[18] The coefficient estimates used to generate Figure 1 are those in column 4 of Appendix Table 3. All estimates in this table illustrate a similar relationship, and the graphical representation is somewhat invariant to the choice of model. While many teachers in the data have more than 10 years' experience, very few are observed with longer lengths of tenure (the maximum is 11 as I've constructed the variable); thus, I only project the estimates over the first 10 years.

the largest differences are observed moving from years 1 (omitted) to 2, and then years 2 to 3. Tenure also showed a similar pattern—my within-teacher estimates here indicate a teacher takes approximately one additional day absence in the second year of tenure at a new school compared the first year, *ceteris paribus*. In the third year of tenure, the difference is still significant, though marginally smaller. Beyond the third year of tenure, however, results appear to converge a mean. Thus, the tenure effect appears relatively short lived, and is most relevant over the first few years.

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. Rather, teachers may prefer (and hence stay longer) at schools with lax absence policies, which could bias my estimates of responses to changes in tenure. This is a consequential issue, and I will address this specifically in Section VIII through exploiting exogenous variation from principal turnover, but defer the issue for the present.

VII. Systematic Variations in the Career Concerns of Teachers

My findings support the predictions of the generalized career concerns model, however, not all teachers may have a uniform response to these incentives, which is an implicit assumption of the results presented above. In this section, I investigate three ways in which career concerns incentives vary among teachers systematically—by gender, by tenure type, and those exiting.

Different Career Concerns by Gender

The career concerns model predicts effort levels vary in response to the expected benefit of good performance over the lifetime of a teacher's career. Truly, the most sensible variation in career concerns (after controlling for experience and tenure) would come from the expected length of each teacher's career at each point in my data; however, I have no way to determine this *a priori*. Some teachers, however, may systematically have higher levels of dependence on their career paths, which could increase career concerns at all points in those teachers' careers. I investigate these career concerns responses by gender on the presumption that female teachers are more likely to have a higher additional income from a spouse; male teachers would have a tendency for lower incomes from a spouse.[19] Thus, the lifetime earnings of a male teacher may be more consequential to the household than those of females, on average. If this were true empirically, I would expect to see male teachers responding to changes in career concerns incentives differently—specifically, I expect males to exert higher levels of effort (lower absences) when career concerns are highest.

To analyze these differences, I interact the career concerns variables on experience and tenure with gender, and I find male teachers respond to career concerns more dramatically. In Table 5, I present the results of this test. 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). Please note the overall and male interaction estimates are from the same regression, I've placed them side-by-side in the table for convenience in reading them. These estimates show male teachers are absent due to tenure less on average, and males' absence behavior takes longer to reach the level of what is predicted for female teachers in the second year of tenure (where female teachers converge to the mean almost entirely after the first year of tenure). Figure 3 depicts the male tenure estimates vis-à-vis the female tenure estimates. As shown, males show lower levels of absence (higher effort) at every point along a teacher's tenure. The same is true of the path estimated path on experience.

[19] While wives' proportions of household incomes have increased significantly over time, husbands, on average, earn more than wives (Anne E. Winkler, 1998).

Different Career Concerns by Tenure Type

Next, I investigate variations in career concerns by tenure type. In both the model and the empirical predictions above, I treat a teacher's tenure at a school uniformly, implying any principal looking to hire any teacher knows only as much as the market knows. In reality, as principals hire teachers from the market they may feasibly collect information about a specific teacher's ability that may not be public knowledge; thus, even prior to formally hiring and supervising a teacher, a principal may have a better estimate of a teacher's ability than that held by the market.[20] Further, the amount of private information gathered on a new hire need not be uniform across all teachers a principal 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 principal knows of a teacher's ability, the more the teacher wishes to exert effort to mold the principal's perception (i.e. career concerns incentives are stronger).

In the current analysis, I have no way to observe the information a principal has when deciding whom to hire; thus, I cannot test the predictions of this model directly. However, I propose an alternative approach that may be able to tease out these differences. Recall Equation (1') in which I proposed information was transmitted from the employer to the market with random noise η, where $\mathrm{Var}(\eta) > 0$. Suppose now that $\mathrm{Var}(\eta)$ varies depending on the level of private information collected in the hiring process. On one extreme, a principal could diligently inquire with former supervisors and colleagues on a teacher's ability, shrinking $\mathrm{Var}(\eta)$ to zero in the process; on the other extreme, a principal could use publicly available information only to make a hiring decision, in which case $\mathrm{Var}(\eta)$ retains its original magnitude. I assume private information about a candidate is relatively costly to gather the further a teacher is removed from

[20] A principal may not be the only person at a school involved in hiring teachers, and in some cases, may not directly hire teachers at all. The principal here is representative of the person making the hiring decision.

her new school. For instance, a principal 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. 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.

If the principal's information structures in fact varied by organizational distance as I suggest, this implies varying equilibrium effort levels—teachers from out of state put in more effort than those from another district who in turn exert more effort than those transferring from another school within the district. I thus predict different responses among teachers in variables indicating tenure by transfer type. 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).

Table 6 presents the results of this investigation; as in Table 5 above, I report the results of the overall estimates (columns 1 and 3) and male interaction terms (columns 2 and 4) for the school-year fixed effects and teacher fixed effects models. The estimates on these separate indicators are consistent with these predictions, supporting the validity of the information assumption and the generalized career concerns model. I find evidence of absence levels monotonically increasing (suggesting effort is decreasing) with proximity to a new school assignment. Notably, those transferring from another school within the district display little variation in their absence behavior between years one and two but the year one estimate is significantly larger than the omitted category of teachers entering the school system altogether.

The consequential finding is on those teachers entering the state system—only in their third year of teaching do they exceed the absence levels observed among teachers transferring from within the state school system, suggesting they exert considerably more effort in these first two years. The significance of these findings is robust across specifications, suggesting our estimates are picking up real behavioral differences.

Different Career Concerns by Exiting Teachers

Finally, I investigate variation in career concerns among exiting teachers. The evidence presented thus far supports the notion of career concerns incentives playing a role in predicting a teacher's effort level in a particular teaching assignment. In particular, the evidence suggests teachers exert higher levels of effort than what would otherwise be expected due to concerns over their reputation. The responses to these incentives are largest early in a teacher's career, and early in a teacher's tenure at a given school.

In a way, these findings offer some consolation to those who worry about moral hazard in the teacher labor market—my findings showing increased effort in response to these incentives indicates any moral hazard is at least mitigated with these career concerns (whether any moral hazard remains after this correction is an unanswered empirical question). On the flip side, these findings also suggest moral hazard may arise when these career concerns break down. As the name suggests, a teacher's career concerns induce effort when teachers are concerned about the effect of their own reputations on their careers. If teachers for any reason, however, foresee a premature ending to their careers, these effort-inducing incentives could disappear.

A teacher's career could end abruptly for any number of reasons—an attractive job opportunity in a different industry, relocating to accommodate a spouse's career, or changes in the family environment could all cause teachers to leave teaching sooner than expected. Once a teacher knows her teaching career will be ending soon, she will no longer exert additional effort in the hopes of altering her potential career path. 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 when output is realized at the end of the year it will not change the terms of her subsequent employment agreement. Thus, we have reason to worry about adverse behavior arising when career concerns incentives break down. Conversely, teachers' decisions to exit may be endogenous with their absence behavior (i.e. principals may encourage those with excess absences to exit), so high absences among exiting teachers may not necessarily be indicative of shirking. I will address the shirking hypothesis vis-à-vis the endogenous exiting hypothesis in an auxiliary investigation.

To empirically test for the possibility of adverse behavior arising from this collapse in incentives, I include a vector of indicator variables on the last year of a teacher's tenure, prior to exiting. As above, I categorize exits to another school, another district, and out of the public school system altogether separately to allow for different impacts.[21] In Table 7 I present the outcomes of these models. As predicted, I find evidence consistent with shirking in the final year of a teacher's tenure at a particular school. Please note these models include a full vector of controls on tenure and experience already, so these are significant changes in behavior at the tail end of a teacher's tenure (or career, as the case may be). When transferring to another school, the estimated level of shirking is modest: approximately one additional day of absence. When exiting the school system altogether, though, the estimate is large: approximately five additional days of discretionary absence. I include the estimates on the next to last year for each type of

[21] 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 setting or in another state) or leaving teaching altogether. This distinction 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.

move as well, indicating a basis of comparison for each of the estimates. In all cases, absences basically double the marginal effects of the second-year tenure indicators.

My interpretation of these estimates above could potentially be misleading—these absences may not be a shirking response to the last year of a teacher's tenure. Rather, the causality of this association may be reversed: perhaps principals are wary of high levels of absences and encourage excessively delinquent teachers to exit or perhaps events arise in a teacher's life for which absence is needed and causes the exit decision. I propose a method to make a distinction between these two conflicting scenarios: I propose to analyze the time dependence of observed teacher absences. If the causality were from excessive absences causing teachers to exit, I would expect to see teacher absences uniformly distributed across the school year. If the causality flowed from a teacher knowing the current year is the last at a particular school, and this information was revealed to the teacher sometime during the course of the school year, I would expect teacher absences (indicative of shirking) to increase after this information is revealed—skewing teacher absences toward the latter end of the school year.

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 final half and final quarter of the last year of tenure at a particular school.[22] The results of this specification, presented in Table 8, indicate absences are concentrated in the latter half of the last year of tenure. Please note the last half indicator is additive, thus the total effect is the sum of the last half and the last year indicators; thus, I predict absences in the last half of the last year are generally 50 percent higher that they are in the first half (which was already significantly higher than the null hypothesis). While not causal, this

[22] For computational feasibility with the large number of observations, I isolate teachers in the 2001-2002 school year and after. Early pass regressions with fewer explanatory variables suggest my results here are not sensitive to this shift in the analysis sample.

evidence supports the hypothesis that the collapse of incentives from career concerns plays a key role in the level of shirking among departing teachers.

VIII. Robustness Checks: Novice Teachers, New Principal Tenure Effects

The results presented thus far support the predictions of the career concerns model; however, I wish to be careful of competing explanations for these behavioral changes. A common debate in the literature on teacher mobility centers on losing the most capable teachers to non-teaching jobs (Donald J. Boyd et al., 2005, Richard J. Murnane et al., 1988). This non-random attrition from the workforce could potentially bias my estimates to reflect behavioral responses among those teachers who stay, but not among all teachers generally. However, more recent studies show the loss of high-quality teachers through non-random attrition is not as severe as previously feared (e.g. Dan Goldhaber et al., 2008). Also, the results presented to this point control for experience levels and other characteristics, both within school-years and within teachers over time, and all are consistent in the sign and significance of these career concerns variables, so my estimates do not likely suffer this bias problem.

In spite of this, however, I employ an additional test robust to this possibility of biasing influence from senior teachers. Specifically, I isolate the teachers in my data with less than four years of experience (this is prior to the tenure decision in North Carolina) and re-estimate the models on this sub-sample. These results are presented in Table 9. Among these novice teachers, I still find large and significant differences in absence behavior consistent with the career concerns predictions. Thus, I conclude these career concerns responses are not an artifact of the teachers who stay only.

Second, while the evidence presented to this point supports the career concerns model, I am not entirely satisfied that my career concerns variables are exogenous. Essentially, each of these variables indicates a choice made by teachers—how long of a relationship to maintain with a particular employer, when to move, and where to move to are all choices the teacher ultimately decides herself. These decisions around tenure may be endogenous to a teacher's decisions on her use of discretionary absences. Thus, I worry that the evidence presented thus far in support of the career concerns model may be a relic of an endogenous relationship between absences and a teacher's tenure. The endogeneity of these leave decisions 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. 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 may be transferred between principals, but some information will be lost in the process. This information loss implies teachers have an incentive to induce higher levels of effort with the arrival of an incoming principal to sway the principal's perception of teacher ability. Changes in principal administration, I assume, 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.[23]

[23] The research on principals' actions as a determinant of student outcomes is very small (see, for instance Sherrilyn M. Billger, (2007) and Dominic J. Brewer (1993)). According to these studies, principals' managerial skills do make a significant difference on the operation of the school and the outcome of students. This is a growing area of research in education policy.

I use administrative files in the NCERDC data to identify principals at each school, and paneling these data files over time, I can track when new principals took over.[24] I create variables on the length of a teacher's tenure with an incoming principal and use this variable to detect whether absence levels were generally lower in response. In Table 10, I present the results of these specifications. As predicted, teachers respond with significantly more absences as tenure with the incoming principal increases, supporting the prediction of higher effort levels when the principal first arrives and falling again as more is learned of teacher ability. While not all variables are significant in the first two OLS specifications, the responses are significant in the latter two.

Because school-year effects are collinear with new principal tenure at a school, I cannot estimate using the school-year effects model; however, I can isolate the within-principal response via principal fixed effects (in column 4). 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 4 suggest managerial style embodied within a principal is not causing this change because even within principals, tenure under the principal significantly increases a teacher's likelihood of being absent.

Comparing the estimates of each year of new-principal tenure versus those indicating teacher-school tenure (discussed in Section V), the new-principal tenure effects have a considerably smaller magnitude than the original tenure estimates presented in Panel B of Table 4. This smaller effect is reasonable—a new principal to a school has many ways to conveniently

[24] 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.

gather information about employees. This incoming principal could relatively costlessly inquire with other teacher colleagues or administrative staff about past teacher performance and behavior, thus sharpening the precision of his estimate of teacher ability generally. A principal does not have this same luxury in gathering information about an incoming teacher because he must inquire with others outside of the school to verify a teacher's ability, which is more costly (recall the argument for varying information structures in the previous section). For this reason, I expect incoming principals to be at an informational advantage compared to the case of a principal with an incoming teacher, and as a result of better information, the jump in teacher effort is smaller in the case of an incoming principal.

IX. Career Concerns Effects on Student Learning

Behavioral responses to career concerns incentives are relevant to policymakers only to the extent that they impact the educational outcome of interest: student learning. To this point, though the responses in teachers to these incentives are largely significant, the magnitudes of the estimated changes are modest: generally less than two days of discretionary absences separate the higher effort levels of incoming teachers from the baseline effort levels we would expect given experience levels only. The most notable exceptions to this differential are incoming teachers from out of state and outgoing teachers leaving the state school system, but even in these cases, the maximum estimated differential is approximately five additional days of discretionary absence. Two recent studies have estimated the impact of teacher absences on student achievement—Charles T. Clotfelter, et al. (2007) estimate 10 additional days of absence decreases student learning by one percent of a standard deviation, and Raegen T. Miller, et al. (2007) in an urban setting estimate 10 additional days decreases achievement by 3.3 percent of a standard deviation. Using these estimates as a guide, I would expect career concerns, at best, to make only a small impact on learning: for instance, a difference of two days of teacher absence would make considerably less than one percent of a standard deviation in learning outcomes.

To verify whether these estimates are born out empirically, I link a subset of these teachers to students in grades 4 and 5 and test whether career concerns make a difference. In particular, I am curious whether higher effort levels (as teachers transfer) or lower effort levels (from shirking before leaving a school) partially explain the variance of student outcomes in the data. Table 11 presents the findings from these models.

The indicator terms at the beginning of a teacher's experience indicate a significant negative impact on student learning in spite of the additional effort exerted early on in a teacher's career. This negative estimate, however, is consistent with many studies on returns to experience among teachers (e.g. Jonah E. Rockoff, 2004). I highlight this to point out two effects at work in these estimates: career concerns effects of higher effort (pushing student learning upward) and a learning curve as teachers develop their ability to teach (pushing student learning downward). The results show the learning curve dominates any additional effort from career concerns as far as a teacher's experience level.

Moving to the variables on tenure, most of these variables still indicate negative impacts on student learning again, though not as large as the magnitude of those early in a teacher's career. Because teachers likely have to become accustomed to a new school environment, and may be teaching students with different backgrounds as well, I would expect a learning curve to be present in this case also.

The variables indicating the end of a teacher's tenure, in contrast to those indicating the beginning of tenure, are not generally subject to a learning curve (except in the rare cases where a teacher's tenure at a particular school only lasts one year). Thus, our estimates of student learning should show the impact of shirking due to decreasing incentives from career concerns, with no counteracting effect. In this case, I find student achievement is significantly negative in the final year before teachers end their tenure at a school. The magnitude of these differences is also considerably higher than anticipated—well over 1 percent of a standard deviation in reading and greater than 2 percent in math (in most specifications). While this effect seems small, consider average yearly gains in reading are approximately 40-50 percent of a standard deviation, and those in math are usually 60-70 percent of a standard deviation (computed means of the NCERDC data). Thus, shirking among teachers is significantly negative, accounting for student yearly gains some 2.5-5 percent lower than what we would otherwise expect (depending on the model estimate and subject).

In contrast to our findings of changes in absence behavior, where the differences in the magnitudes of the absence estimates were significant, most of these models arrive at estimates that are statistically equivalent. This may suggest different types of shirking among teachers. A returning teacher faces a cost in using discretionary absences; namely, she cannot roll them over into the future. A teacher leaving the state school system does not bear this cost, and so may use absences less discriminately. However, both types of exiting teachers show strongly negative outcomes in response to these incentives, well in excess of the expected differentials given the impacts estimated from previous studies. This findings suggests teachers may shirk in other ways, aside from excess absences; and because absences are relatively costly to the teacher remaining in the state, she shirks primarily through other means.

As an alternative perspective, the magnitude of this finding may be reconciled with previous literature by viewing discretionary absences as a measure of effort with noise. My findings have been largely consistent throughout the study in finding significant predictions on absence behavior using these career concerns incentives; however, even in the best-case scenarios with the most saturated models, I cannot predict more than 10 percent of the variation in absences. This does not surprise me, given that teachers mostly use absences as unforeseen events arise (i.e. sickness, death in the family, etc.). This suggests absences are mostly noise with a small component reflecting effort. Viewed this way, my career concerns estimates may suffer an attenuation bias and under-estimate the true magnitude of changes in true (unobservable) effort. In reality true effort may collapse considerably more than what I have predicted, which could cause the unexpectedly large decrease in student achievement.

These results suggest teachers making any kind of exit from a school-tenure relationship likely make an impact significantly lower than what we would expect otherwise. While the magnitude of these estimates alone is somewhat minor, the total effect of this finding is substantial. For instance, these negative outcomes are aggregated across all students in an exiting teacher's classroom, not just a subset of those students. Further, approximately 17-18 percent of the teachers in my data from North Carolina are in their last year of tenure prior to making some kind of exit (either school, district, or state) in any given year. Thus, approximately one sixth of the student population is consistently underperforming at levels 2-5 percent lower than what we would otherwise expect.

X. 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 motivated by two questions: 1) do teachers change their behavior in ways consistent with the model's predictions? and if so, 2) what sort of effect does this make on student outcomes?

In response to the first question, the evidence I find using data from North Carolina public school teachers is consistent with the model, and the findings are robust to various empirical specifications including teacher and school-year fixed effects. The predictions also hold up to sensible variations in the model, and I find different responses by gender and transfer type, in addition to collapsing incentives among exiting teachers. Finally, I find the model's predictions are robust to exogenous changes in the school's administration, a strong test of the robustness of the model. Within-principal estimates show the principal response is not due to managerial differences alone. In short, all of the evidence points to actual changes in teacher absence behavior and not simply variation across a cross-section of teachers.

In response to the second question, I find the impact on student achievement is both significant and large enough to be of policy interest. In particular, I find teachers ending their tenure with an employer have a significantly negative correlation with student outcomes. The point estimate on this impact (approximately 1 percent of a standard deviation in reading and over 2 percent in math) is significantly higher than what I would expect given the absence differential alone, and supports the hypothesis of teacher shirking as a likely cause for the negative outcomes.

These results suggest teachers' shirking behavior at the end of tenure or a career may be curbed through sensible changes to policies governing absence use. For instance, Charles T. Clotfelter, et al. (2007) suggest paying all teachers in a cash bonus for unused days of absence. They argue this policy would raise income levels for teachers, while lowering costs of finding substitutes. Such a policy has the potential to be a pareto improvement over the current scenario. The results presented here, however, also suggest the negative learning impacts of having a teacher in the final year of tenure goes beyond what would be expected, given the difference in absences alone. Because teachers whose career concerns incentives have collapsed do not receive any benefit from their marginal effort, explicit performance incentives could have a hand in mitigating shirking behavior among this group, as proposed in Robert Gibbons and Kevin J. Murphy (1992). In summary, implicit incentives through career concerns play a significant role in determining teacher behavior. While this cannot speak directly to the outcomes under explicit incentives, it establishes a benchmark for future expectations and research.

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Appendix

In Section V of the text, I report transition tables of the distribution of teachers across schools, where schools are ranked according to the percentage of minority students and prior-year test scores. In Appendix Table 1, I present complementary tables, where schools are ranked by the percentage of free and reduced-price lunch eligible students in the student body and prior-year reading scores. The results are consistent with those reported in the text. Notably, the distribution of teachers across schools prior to teachers transferring fails to reject the null hypothesis of random sorting using either metric. After the transfer takes place, the hypothesis of random sorting in both cases is rejected.

In Section VI, I allude to regressions on the determinants of teacher absences, independent of the career concerns variables. In Appendix Table 2, 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.

Table 1. Descriptive Statistics for NCERDC Data

Panel A. Teachers, Full Sample vs. 2004 Only			Panel B. Students, Unrestricted vs. Restricted Sample		
	Full sample	2004		Unrestricted	Restricted
Discretionary absences	9.387	9.663	Female	0.493	0.497
	(9.726)	(9.914)		(0.500)	(0.500)
Experience	13.875	14.100	White	0.625	0.639
	(9.496)	(9.568)		(0.484)	(0.480)
Female	0.806	0.802	Free lunch eligible	0.329	0.322
	(0.396)	(0.399)		(0.470)	(0.467)
White	0.844	0.843	Parent holds bachelor's degree or higher	0.141	0.148
	(0.363)	(0.364)		(0.348)	(0.355)
Highest degree is BA	0.691	0.722	Standardized Reading Score	0.022	0.065
	(0.462)	(0.448)		(0.993)	(0.975)
NBPTS certified	0.038	0.078	Standardized Math Score	0.027	0.081
	(0.191)	(0.267)		(0.995)	(0.979)
Elementary teacher	0.554	0.537	Class Size	23.447	23.527
	(0.497)	(0.499)		(3.700)	(3.515)
Mean SAT at undergraduate college	891.302	893.377	Observations (students)	1,453,588	1,108,370
	(109.863)	(109.380)			
Age	41.108	41.508			
	(10.673)	(10.958)			
Observations (teachers)	740,743	64,270			

Table 2. Descriptive Tables on Observed Tenure and Turnover

Panel A. Year of Tenure, by Type, for all Teachers in 2004

Tenure	School	District	State	Missing Tenure	Total
Year 1	3,300	2,775	681	0	6,756
Year 2	3,218	1,907	4,265	0	9,390
Year 3	2,555	1,496	3,416	0	7,467
Year 4	2,201	1,284	3,094	0	6,579
Year 5	1,765	927	2,499	0	5,191
Year 6 or higher	4,184	1,974	6,032	16,697	28,887
Total	17,223	10,363	19,987	16,697	64,270

Panel B. Teachers Exiting, by Type, for all Teachers in 2004

Tenure	School	District	State	Leave	Staying	Total
Exiting in 2004	2,897	2,906	4,192	617	0	10,612
Exiting in 2005	2,221	1,531	4,626	443	0	8,821
Staying beyond 2005	0	0	0	0	44,837	44,837
Total	5,118	4,437	8,818	1,060	44,837	64,270

Table 3. Transition Matrices of School Sorting on Past Performance

Percentage of Minority Students at School

Year immediately prior to move							Year immediately following move						
School rankings	Value-added estimates (quintiles)						School rankings	Value-added estimates (quintiles)					
(quintiles)	1	2	3	4	5	Total	(quintiles)	1	2	3	4	5	Total
1	24	23	17	26	20	110	1	20	28	19	30	23	120
2	33	27	20	30	16	126	2	28	28	22	28	23	129
3	23	27	25	23	19	117	3	29	16	24	29	23	121
4	26	26	20	23	12	107	4	20	29	27	17	12	105
5	22	15	22	20	34	113	5	31	17	12	18	20	98
Total	128	118	104	122	101	573	Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						0.06	Correlation of School, Past Performance Rankings:						-0.07
Chi-Square Statistic (16 d.f.):						23.30	Chi-Square Statistic (16 d.f.):						24.62
P-value:						0.11	P-value:						0.08

Prior-year Test Scores in Math

Year immediately prior to move							Year immediately following move						
School rankings	Value-added estimates (quintiles)						School rankings	Value-added estimates (quintiles)					
(quintiles)	1	2	3	4	5	Total	(quintiles)	1	2	3	4	5	Total
1	2	3	2	2	0	9	1	12	16	5	11	3	47
2	6	6	11	5	8	36	2	11	9	8	8	12	48
3	29	13	17	18	22	99	3	20	16	16	19	15	86
4	49	44	38	44	33	208	4	52	35	28	33	20	168
5	42	52	36	53	38	221	5	33	42	47	51	51	224
Total	128	118	104	122	101	573	Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						0.02	Correlation of School, Past Performance Rankings:						0.11
Chi-Square Statistic (16 d.f.):						17.85	Chi-Square Statistic (16 d.f.):						31.49
P-value:						0.33	P-value:						0.01

Table 4. Career Concerns Incentives and Teacher Absence Behavior

Panel A. Tenure and Experience Entered Directly with Polynomial Expansion

	1	2	3	4
Experience	0.502**	0.558**	0.563**	0.972**
	(0.019)	(0.020)	(0.013)	(0.031)
Experience squared	-0.038**	-0.033**	-0.033**	-0.049**
	(0.002)	(0.001)	(0.001)	(0.002)
Experience cubed	0.001**	0.001**	0.001**	0.001**
	0.000	0.000	0.000	0.000
Tenure	1.709**	1.558**	1.560**	1.901**
	(0.063)	(0.062)	(0.067)	(0.060)
Tenure squared	-0.296**	-0.274**	-0.270**	-0.306**
	(0.015)	(0.015)	(0.016)	(0.014)
Tenure cubed	0.015**	0.014**	0.013**	0.015**
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	740,743	740,743	740,743	740,743
R-squared	0.01	0.03	0.02	0.02

Panel B. Tenure and Experience Entered as Indicator Variables

	1	2	3	4
Omitted category is teacher in year 1 of both experience and tenure				
Year 2 of experience	1.670**	1.518**	1.536**	1.528**
	(0.063)	(0.063)	(0.070)	(0.066)
Year 3 of experience	2.738**	2.486**	2.518**	2.452**
	(0.067)	(0.070)	(0.075)	(0.077)
Year 4 of experience	3.559**	3.226**	3.275**	3.215**
	(0.071)	(0.076)	(0.078)	(0.089)
Year 5 of experience	4.043**	3.676**	3.742**	3.603**
	(0.075)	(0.083)	(0.082)	(0.100)
Year 2 of school tenure	0.952**	0.907**	0.889**	1.164**
	(0.044)	(0.044)	(0.050)	(0.044)
Year 3 of school tenure	1.118**	1.077**	1.071**	1.664**
	(0.052)	(0.052)	(0.057)	(0.052)
Year 4 of school tenure	0.937**	0.887**	0.904**	1.710**
	(0.059)	(0.058)	(0.062)	(0.060)
Year 5 of school tenure	1.062**	1.001**	1.001**	1.958**
	(0.068)	(0.067)	(0.071)	(0.071)
Indicator variables for experience and tenure after year 5, including missing tenure variables, are included in regression but omitted in output				
Observations	740,743	740,743	740,743	740,743
R-squared	0.01	0.03	0.03	0.02
Teacher controls		√	√	√
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators.

Table 5. Career Concerns Interacted with Gender

	Overall	Male Interaction	Overall	Male Interaction
Omitted category is female teacher in year 1 of both experience and tenure				
Year 2 of experience	1.714**	-0.733**	1.676**	-0.547**
	(0.083)	(0.137)	(0.079)	(0.120)
Year 3 of experience	2.847**	-1.436**	2.757**	-1.232**
	(0.089)	(0.140)	(0.092)	(0.132)
Year 4 of experience	3.664**	-1.729**	3.601**	-1.577**
	(0.092)	(0.147)	(0.104)	(0.140)
Year 5 of experience	4.255**	-2.338**	4.111**	-2.150**
	(0.097)	(0.147)	(0.116)	(0.144)
Year 2 of school tenure	0.987**	-0.519**	1.269**	-0.549**
	(0.057)	(0.093)	(0.051)	(0.084)
Year 3 of school tenure	1.166**	-0.518**	1.784**	-0.635**
	(0.064)	(0.110)	(0.060)	(0.103)
Year 4 of school tenure	1.016**	-0.610**	1.846**	-0.704**
	(0.070)	(0.114)	(0.069)	(0.111)
Year 5 of school tenure	1.119**	-0.625**	2.110**	-0.760**
	(0.081)	(0.130)	(0.081)	(0.128)
Indicator variables for experience and tenure after year 5, including missing tenure variables, are included in regression but omitted in output				
Observations	740,743		740,743	
R-squared	0.03		0.02	
Teacher controls	√		√	
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators.

Table 6. Different Information Structures for Principals

	Overall	Male Interaction	Overall	Male Interaction
Omitted category is female teacher in year 1 in NC Public Schools				
Year 1 after school move	2.571**	0.376*	1.071**	0.405**
	-0.086	-0.148	-0.099	-0.152
Year 2 after school move	3.203**	-0.299	2.036**	-0.214
	(0.097)	(0.158)	(0.112)	(0.166)
Year 3 after school move	3.118**	0.000	2.165**	0.000
	(0.107)	(0.198)	(0.122)	(0.199)
Year 1 after district move	2.054**	0.399**	0.246*	0.490**
	(0.091)	(0.136)	(0.106)	(0.151)
Year 2 after district move	3.082**	-0.335*	1.580**	-0.31
	(0.113)	(0.166)	(0.127)	(0.176)
Year 3 after district move	3.482**	-0.405	2.144**	(0.445)
	-0.133	-0.232	-0.149	(0.233)
Year 2 in NC Public Schools	1.759**	-0.389**	1.798**	-0.553**
	(0.086)	(0.129)	(0.081)	(0.124)
Year 3 in NC Public Schools	2.476**	-0.575**	2.745**	-0.893**
	(0.097)	(0.144)	(0.096)	(0.143)
Indicator variables tenure after year 3, including missing tenure variables, are included in regression but omitted in output				
Observations	740,743		740,743	
R-squared	0.03		0.02	
Teacher controls	√		√	
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators. Regressions also include full vector of experience indicators by year (with male interaction terms).

Table 7. Incentive Collapse Among Exiting Teachers

	Overall	Male Interaction	Overall	Male Interaction
Omitted category is female teacher in year 1 of both experience and tenure				
Next to last year in school	1.112**	-0.239	0.401**	-0.039
	-0.069	-(0.124)	-0.069	-0.126
Last year in school	2.050**	-0.294**	1.196**	-0.159
	(0.062)	(0.112)	(0.067)	(0.125)
Next to last year in district	1.167**	0.098	0.331**	0.429**
	(0.084)	(0.132)	(0.090)	(0.136)
Last year in district	2.784**	-0.174	1.769**	0.197
	(0.077)	(0.128)	(0.087)	(0.138)
Next to last year in NC Public Schools	1.421**	0.455**	0.847**	0.197
	-0.066	-0.139	-0.067	(0.139)
Last year in NC Public Schools	5.696**	-0.454*	4.979**	-0.725**
	(0.094)	(0.203)	(0.095)	(0.207)
Observations	740,743		740,743	
R-squared	0.05		0.04	
Teacher controls	√		√	
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators.

Table 8. Incentive Collapse by Pay Period, 2002-2006

	Overall	Male Interaction	Overall	Male Interaction
Omitted category is female teacher in year 1 of both experience and tenure				
Last year in school	0.772**	0.153	0.230**	0.191
	-0.06	-(0.132)	-0.065	-0.145
Last half in school	0.512**	-0.494**	0.512**	-0.494**
	(0.082)	(0.180)	(0.076)	(0.168)
Last year in district	1.115**	0.133	0.524**	0.261
	(0.072)	(0.144)	(0.078)	(0.158)
Last half in district	0.551**	-0.395*	0.551**	-0.395*
	(0.099)	(0.197)	(0.092)	(0.184)
Last year in NC Public Schools	1.995**	0.102	1.237**	0.165
	-0.049	-0.111	-0.06	(0.136)
Last half in NC Public Schools	1.582**	-0.660**	1.582**	-0.660**
	(0.067)	(0.150)	(0.063)	(0.140)
Observations	622,790		622,790	
R-squared	0.06		0.05	
Teacher controls	√		√	
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators.

Table 9. Career Concerns Among Novice Teachers Only

	Overall	Male Interaction	Overall	Male Interaction
Omitted category is female teacher in year 1 of both experience and tenure				
Year 2 of experience	1.883**	-0.611**	2.129**	-0.713**
	(0.101)	(0.162)	(0.150)	(0.147)
Year 3 of experience	2.977**	-1.257**	3.622**	-1.258**
	(0.113)	(0.174)	(0.252)	(0.191)
Year 4 of experience	3.724**	-1.511**	4.802**	-1.554**
	(0.122)	(0.184)	(0.358)	(0.232)
Year 2 of school tenure	0.963**	-0.662**	1.464**	-0.953**
	(0.104)	(0.164)	(0.101)	(0.145)
Year 3 of school tenure	1.277**	-0.788**	2.224**	-1.273**
	(0.130)	(0.196)	(0.148)	(0.212)
Year 4 of school tenure	1.065**	-0.835**	2.370**	-1.339**
	(0.173)	(0.252)	(0.208)	(0.288)
Indicator variables for experience and tenure after year 5, including missing tenure variables, are included in regression but omitted in output				
Observations	125,411		125,411	
R-squared	0.06		0.08	
Teacher controls	√		√	
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility indicators.

Table 10. Test Against Endogeneity: New Principal Tenure

	1	2	3	4
Omitted category is year 1 of both experience and principal tenure				
Year 2 of principal tenure	0.130** (0.045)	0.109* (0.044)	0.149** (0.050)	0.241** (0.043)
Year 3 of principal tenure	0.070 (0.055)	0.030 (0.055)	0.159* (0.066)	0.287** (0.054)
Year 4 of principal tenure	0.110 (0.070)	0.047 (0.070)	0.171* (0.086)	0.399** (0.068)
Year 5 of principal tenure	0.298** (0.094)	0.206* (0.093)	0.296* (0.115)	0.533** (0.092)
Indicator variables for experience and principal tenure after year 5, including missing tenure variables, are included in regression but omitted in output				
Observations	631,211	631,211	631,211	631,211
R-squared	0.01	0.03	0.03	0.02
Teacher controls		√	√	√
Year fixed effects	√	√	√	√
Principal 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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, fertility, and retirement eligibility. A full vector of experience indicators and missing tenure variables are also included.

Table 11. Career Concerns Effects on Student Achievement

	Reading					
	Grade 4			Grade 5		
Year 1 in state	-0.057** (0.006)	-0.049** (0.006)	-0.038** (0.007)	-0.048** (0.005)	-0.040** (0.005)	-0.044** (0.006)
Year 1 in district	-0.018** (0.006)	-0.027** (0.007)	0.006 (0.008)	-0.018** (0.006)	-0.014* (0.006)	-0.015* (0.007)
Year 1 in school	-0.013* (0.005)	-0.011 (0.006)	0.001 (0.006)	-0.022** (0.004)	-0.029** (0.005)	-0.008 (0.005)
Year 2 in state	-0.014** (0.005)	-0.018** (0.006)	-0.011 (0.006)	-0.014** (0.005)	-0.011* (0.005)	-0.010* (0.005)
Year 2 in district	-0.007 (0.007)	-0.009 (0.007)	-0.004 (0.008)	-0.008 (0.006)	-0.006 (0.006)	-0.004 (0.007)
Year 2 in school	-0.011* (0.005)	-0.012 (0.007)	0.003 (0.006)	-0.005 (0.004)	-0.008 (0.005)	0.006 (0.005)
Final year in state	-0.013** (0.005)	-0.014** (0.005)	-0.016** (0.005)	-0.009* (0.004)	-0.006 (0.004)	-0.010* (0.004)
Final year in district	-0.018** (0.007)	-0.013 (0.007)	-0.015* (0.008)	-0.017** (0.006)	-0.011 (0.007)	-0.013 (0.007)
Final year in school	-0.017** (0.005)	-0.016** (0.006)	-0.001 (0.006)	-0.016** (0.004)	-0.007 (0.005)	-0.012* (0.005)
Experience	0.003 (0.001)	0.001 (0.001)	0.011** (0.004)	0.001 (0.001)	0.000 (0.001)	0.002 (0.003)
Observations	573,271	573,271	573,271	472,331	472,331	472,331
R-squared	0.97	0.63	0.97	0.99	0.68	0.99
Teacher controls	√	√	√	√	√	√
Year fixed effects	√		√	√		√
School-year fixed effects		√			√	
Teacher fixed effects			√			√
	Math					
	Grade 4			Grade 5		
Year 1 in state	-0.077** (0.008)	-0.076** (0.008)	-0.038** (0.009)	-0.077** (0.009)	-0.060** (0.008)	-0.072** (0.010)
Year 1 in district	-0.036** (0.009)	-0.050** (0.009)	-0.009 (0.010)	-0.027** (0.009)	-0.031** (0.009)	-0.018 (0.011)
Year 1 in school	-0.022** (0.008)	-0.023** (0.008)	0.005 (0.008)	-0.040** (0.008)	-0.046** (0.008)	-0.014 (0.008)
Year 2 in state	-0.030** (0.007)	-0.036** (0.007)	-0.014 (0.007)	-0.021** (0.007)	-0.014* (0.007)	-0.016* (0.007)
Year 2 in district	-0.013 (0.010)	-0.025* (0.011)	-0.006 (0.010)	-0.004 (0.010)	-0.018 (0.010)	0.004 (0.010)
Year 2 in school	-0.022** (0.008)	-0.030** (0.009)	-0.003 (0.008)	-0.025** (0.008)	-0.027** (0.009)	-0.008 (0.008)
Final year in state	-0.025** (0.007)	-0.023** (0.008)	-0.023** (0.007)	-0.016* (0.007)	-0.002 (0.007)	-0.013 (0.007)
Final year in district	-0.029** (0.009)	-0.026* (0.010)	-0.011 (0.010)	-0.029** (0.010)	-0.034** (0.010)	-0.031** (0.011)
Final year in school	-0.008 (0.007)	0.000 (0.008)	0.01 (0.008)	-0.015* (0.007)	-0.012 (0.007)	-0.011 (0.008)
Experience	0.000 (0.002)	-0.001 (0.002)	0.008 (0.005)	-0.004 (0.002)	-0.001 (0.002)	-0.011* (0.005)
Observations	573,271	573,271	573,271	472,331	472,331	472,331
R-squared	0.98	0.61	0.98	0.99	0.67	0.99
Teacher controls	√	√	√	√	√	√
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, college selectivity, NBPTS certification, school level (elementary vs. secondary), age, missing tenure, and fertility. Experience squared and cubed variables also included for non-linearities.

Figure 1.

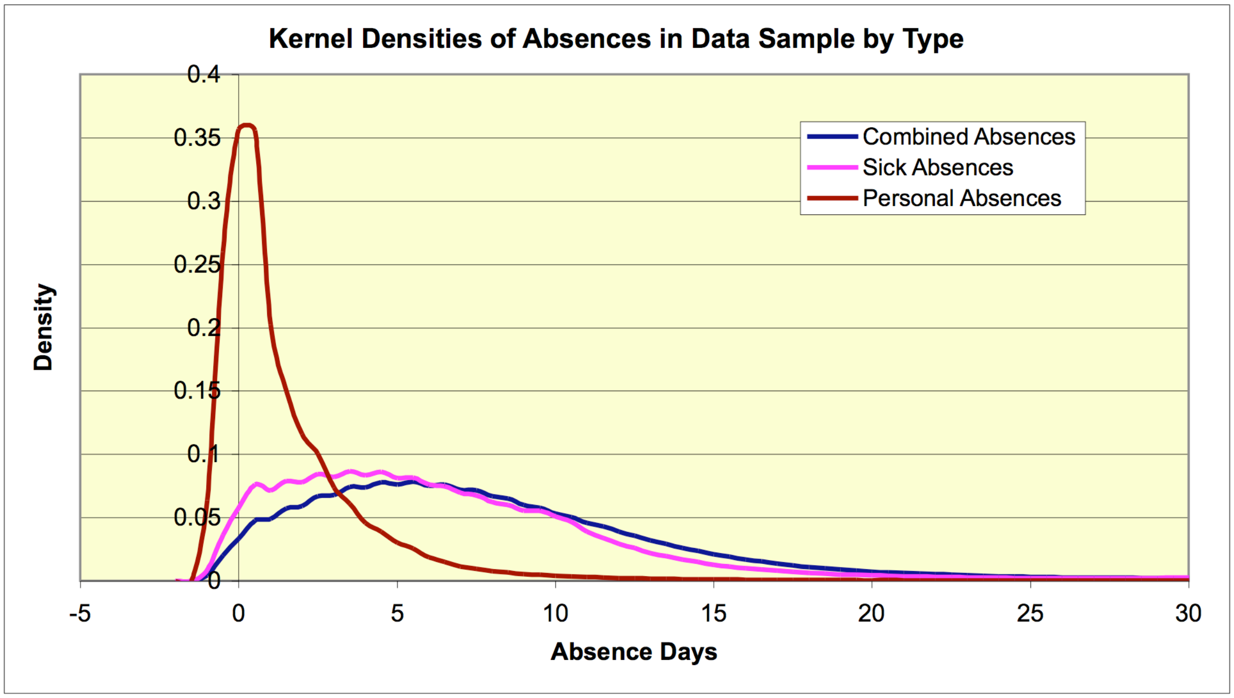

Kernel Densities of Absences in Data Sample by Type
Density
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-5
0
5
10
15
20
25
30
Absence Days
Combined Absences
Sick Absences
Personal Absences

Figure 2.

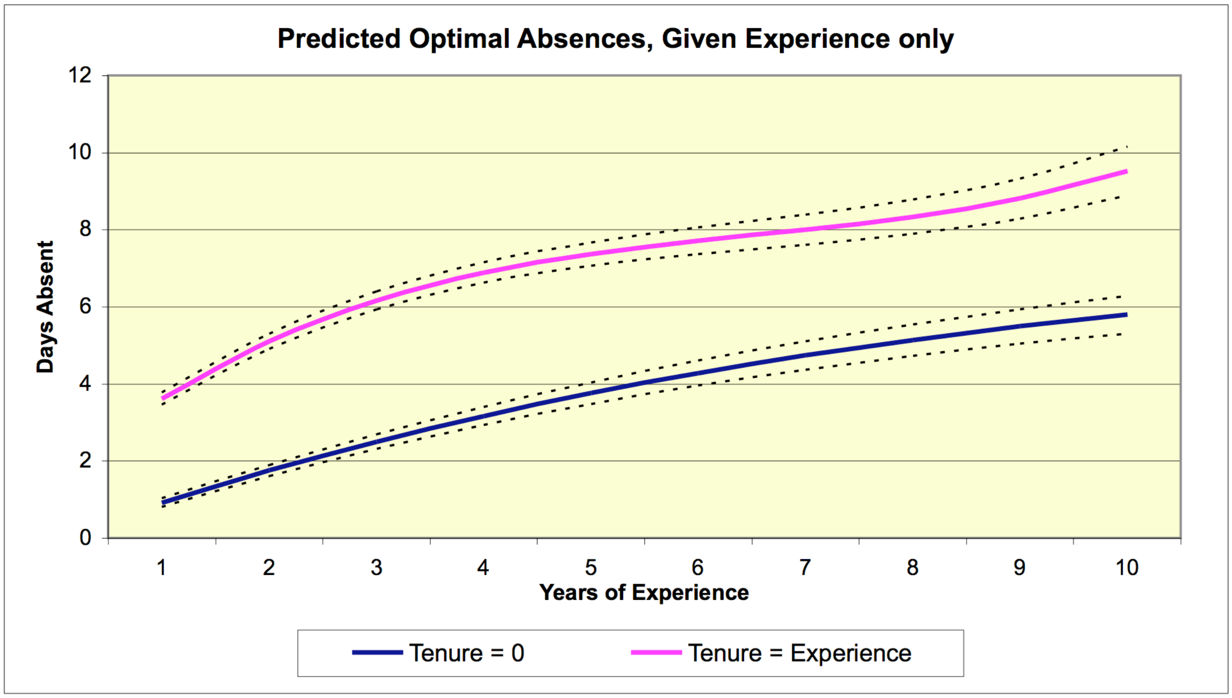
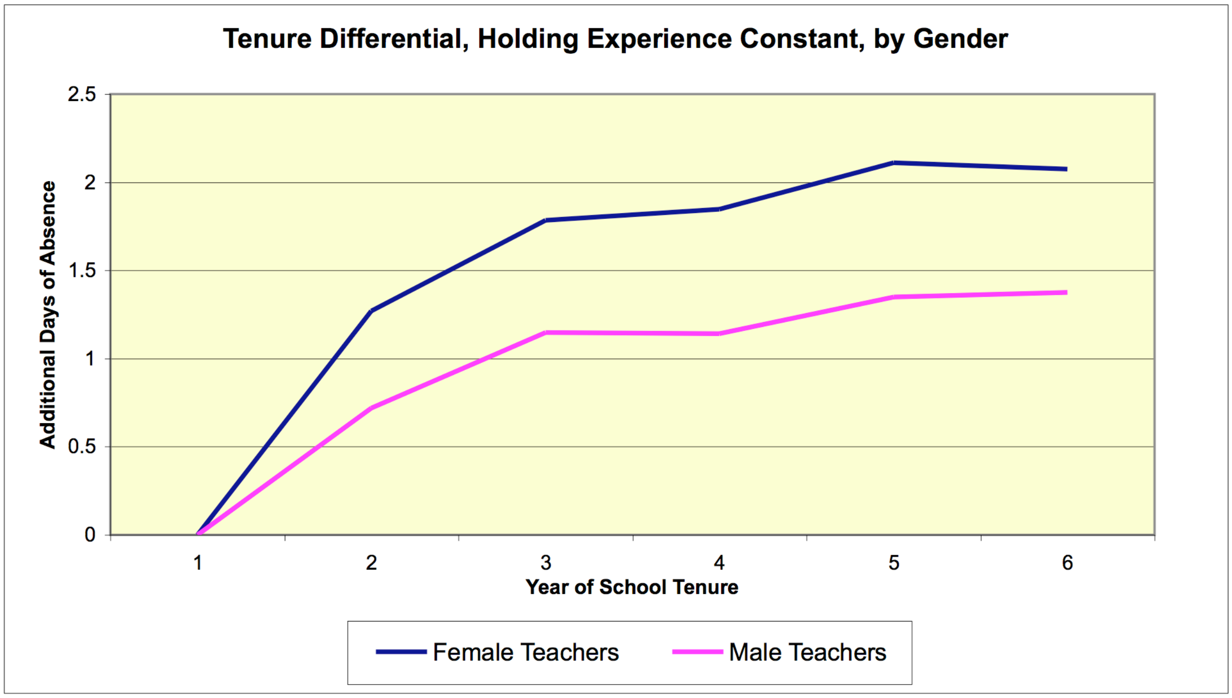

Predicted Optimal Absences, Given Experience only
Days Absent
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
9
10
Years of Experience
Tenure = 0
Tenure = Experience

Figure 3.


Tenure Differential, Holding Experience Constant, by Gender
Additional Days of Absence
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
Year of School Tenure
Female Teachers
Male Teachers

Appendix Table 1. Transition Matrices of School Sorting on Past Performance

Percentage of Minority Students at School

Year immediately prior to move

School rankings (quintiles)	Value-added estimates (quintiles) 1	2	3	4	5	Total
1	32	34	42	42	29	179
2	22	22	15	25	16	100
3	27	30	15	16	17	105
4	29	19	14	20	19	101
5	18	13	18	19	20	88
Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						-0.01
Chi-Square Statistic (16 d.f.):						19.57
P-value:						0.24

Year immediately following move

School rankings (quintiles)	Value-added estimates (quintiles) 1	2	3	4	5	Total
1	18	25	29	36	28	136
2	20	25	21	28	21	115
3	28	30	27	21	22	128
4	30	23	18	20	19	110
5	32	15	9	17	11	84
Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						-0.16
Chi-Square Statistic (16 d.f.):						28.08
P-value:						0.03

Prior-year Test Scores in Reading

Year immediately prior to move

School rankings (quintiles)	Value-added estimates (quintiles) 1	2	3	4	5	Total
1	9	9	8	7	9	42
2	16	14	10	14	12	66
3	19	20	21	24	18	102
4	57	34	31	26	27	175
5	27	41	34	51	35	188
Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						0.03
Chi-Square Statistic (16 d.f.):						23.35
P-value:						0.10

Year immediately following move

School rankings (quintiles)	Value-added estimates (quintiles) 1	2	3	4	5	Total
1	15	18	4	12	6	55
2	22	12	15	15	13	77
3	23	17	16	20	21	97
4	40	33	27	24	22	146
5	28	38	42	51	39	198
Total	128	118	104	122	101	573
Correlation of School, Past Performance Rankings:						0.11
Chi-Square Statistic (16 d.f.):						27.24
P-value:						0.04

Appendix Table 2. Predictors of Teacher Absence Independent of Career Concerns

	1	2	3	4	5	6
Female	2.503** (0.042)	0.883** (0.058)	2.474** (0.028)	0.886** (0.038)		
African-American	0.000 (0.059)	0.013 (0.059)	-0.119** (0.042)	-0.121** (0.042)		
Age		1.074** (0.025)		1.032** (0.019)		1.857** (0.137)
Age squared		-0.017** 0.000		-0.016** 0.000		-0.037** (0.003)
Age cubed		0.000** 0.000		0.000** 0.000		0.000** 0.000
Fertility		0.040** (0.001)		0.039** (0.001)		0.050** (0.001)
Observations	740,743	740,743	740,743	740,743	740,743	740,743
R-squared	0.01	0.02	0.01	0.02	0.01	0.01
Teacher controls	√	√	√	√	√	√
Year fixed effects	√	√			√	√
School-year fixed effects			√	√		
Teacher fixed effects					√	√

Note: * significant at 5%; ** significant at 1%. Robust standard errors in parentheses. Teacher controls also include the following: highest degree, college selectivity, NBPTS certification, and school level (elementary vs. secondary).