# The Impact of Year-Round Schooling on Teacher Turnover and Quality

Jennifer Graves[a,1], Steven McMullen[b], Kathryn Rouse[c]

**PRELIMINARY DRAFT. PLEASE DO NOT CITE.**

[a] *Universidad Autónoma de Madrid, Cuidad Universitaria de Cantoblanco, 28049 Madrid, Spain*

[b] *Calvin College, Department of Economics, 3201 Burton St., Grand Rapids, MI 49546, United States*

[c] *Elon University, Department of Economics, 2075 Campus Box, Elon, NC 27244, United States*

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**Abstract**

In this paper, we evaluate the extent to which year-round school (YRS) calendars impact teacher turnover and quality. To the extent that YRS calendars are received positively (or negatively) by teachers, they may affect the ability of schools to recruit and retain high quality teachers. Additionally, we focus on a particular type of YRS, multi-track, which may affect the number of teachers needed. Depending on who leaves or who is hired, this can also impact the quality of the teacher pool. Understanding this relationship is important for policymakers given high rates of teacher turnover, particularly in schools serving disadvantaged populations, and evidence that such turnover can impact student outcomes. As the literature thus far on the academic impacts of YRS has found largely heterogeneous effects along a number of dimensions, it is likely that teacher effects may exhibit such heterogeneity as well. In our study, we make use of detailed data from two locations: California and Wake County, North Carolina. Both locations have widely implemented YRS due to school crowding, but have differing student demographics, and have been found to have differing academic impacts of YRS calendars. We find that schools in both locations hire additional teachers to accommodate the multi-track YRS model. However, in California, where YRS is implemented in particularly disadvantaged populations, the teacher quality is diminished, while in North Carolina, where YRS has been implemented in more affluent areas, teacher quality does not suffer. This is consistent with previous literature on YRS calendars indicating that the context in which YRS is implemented is particularly important.

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[1] Corresponding author. US Tel.:206-618-0748, Spain Tel: 626 20 28 39. Email: jennifer.graves@uam.es

## 1. Introduction

Education policymakers in the United States have for decades attempted to use policy to improve student achievement and to narrow persistent achievement gaps. With the exception of policies specifically aimed at teachers, however, many of these initiatives overlook potential impacts related to teachers, such as teacher preferences or adequate supply of quality teachers for the policy change. This can have many unintended consequences, such as increased teacher turnover rates and changes in teacher quality. Understanding the relationship between school policy and teacher turnover is particularly important for policymakers given high rates of teacher turnover, especially in schools serving disadvantaged populations (Ingersoll, 2001; Hanushek, Kain and Rivkin, 2004). While some turnover has been associated with positive student outcomes, especially when less-effective teachers leave, high levels of turnover have been associated with organizational disruption (Bryk and Schneider 2002, Guin 2004) and can be very costly (Barnes, Crowe and Schaefer 2007).

In this paper, we estimate the effect of a policy change that has recently grown in popularity - the switch from a traditional to a year-round academic calendar – on teacher retention, turnover and quality. From 1986 to 2007, the number of students attending a year-round school (YRS) in the United States increased from 360,000 (0.7 percent of all U.S. students) to over two million (4% of all U.S. students).[2] Despite a growing literature on the academic impact of YRS calendars (Graves 2010, 2011; McMullen and Rouse 2012a,b), research examining its impact on teachers is notably absent.

[2] 2007 data from http://www.nayre.org. (accessed February 3, 2011). 1986 data comes from "Year-Round Schooling," Education Week, September 10, 2004. http://www.edweek.org/ew/issues/year-round-schooling/ (accessed February 10, 2011).

YRS calendars spread the 180 day traditional school calendar across the full year, creating shorter periods of learning and more frequent breaks.[3] Because this policy change has a direct impact on teachers by altering their work schedules, teacher impacts are a particularly relevant aspect of the policy to take into consideration. This is even more so because the traditional summer break is often touted as a desirable benefit for teachers.[4] Teachers may either have a preference or distaste for the alternative calendar. Moreover, because teacher preferences for these attributes are likely to be heterogeneous, it is also important to consider how mobility in response to the calendar varies based on teacher demographics and quality. To the extent that teachers perceive YRS calendars negatively or positively, the YRS calendar may affect the ability of schools to recruit and retain high quality teachers.

We primarily focus our study on a particular type of YRS, multi-track, which may also affect the number of teachers needed. This is because a multi-track calendar, in addition to allocating school days more evenly across the calendar year, also divides the student body into separate tracks that rotate on and off of break, allowing the school to serve a larger student body by making continual use of the school facility. Because of this feature of the calendar, multi-track YRS is primarily implemented to address school crowding concerns. However, a rarely discussed result of this rotating-yet-continuous teaching schedule is that multi-track YRS must either require current teachers to take on more days of teaching or hire additional teachers. If the teacher labor market exhibits diminishing returns in teacher quality, as more teachers are hired one would expect to see lesser equipped teachers hired. Depending on who leaves or who is hired, this can also impact the quality of the teacher pool under a YRS calendar.

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[3] This type of year-round calendar is different from the "extended year" calendar, where the number of instructional days is increased.

[4] For example, see: www.teach.com/why-teach/teacher-salary-benefits, www.educationnext.org/fringebenefits, www.heritage.org/research/reports/2011/10/assessing-the-compensation-of-public-school-teachers, http://online.wsj.com/news/articles/SB10001424052970203687504576655352353046120, (each viewed 2/26/2014).

There is limited research available on year-round school calendars and teacher turnover. Much of the research is based on the examination of teacher attitudes towards the calendar (Worthern and Zsiray, 1994; Shields and Oberg, 2000, Kneese, 2000). The studies of turnover that do exist provide some helpful evidence (Loeb, Darling-Hammond and Luczak, 2005; Stuit and Smith, 2012), but the extent to which these benefits and challenges of YRS that are outlined in the research actually cause teachers to leave, stay or search out a YRS is not clear. Because YRS calendars are often non-randomly placed, it is difficult to separately identify the impact of the school calendar from other measures of school quality. If, for instance, YRS tend to be high quality schools with high achieving students, resources, and facilities, the reports may be reflective of these characteristics which are related to both the adoption of the year-round school and to teacher satisfaction and therefore retention of high-quality teachers.

In this project, we use detailed data from the North Carolina Education Research Data Center (NCERDC) and a mandatory calendar conversion in Wake County, NC as well as administrative school and teacher level data from the state of California to study the impact of YRS on teacher turnover and quality. We use data on these two very different locations for two main reasons. First, prior research on YRS suggests the estimated academic effects differ by level of school crowding and by the demographics of the student population (Graves, McMullen and Rouse 2013). It is likely that teacher effects may exhibit such heterogeneity as well. Using both California, where YRS is implemented in particularly disadvantaged populations, and North Carolina, where YRS has been implemented in more affluent areas, allows us to explore this possibility, providing a more complete look at teacher turnover effects.

Second, while YRS has been growing in popularity as a policy option, it has traditionally been implemented in high concentration in the locations where adopted. Both California and North Carolina are ideal for studying impacts of YRS calendars because of their high incidence of YRS calendar adoption. Additionally, YRS calendars have been in place in both locations for long enough to observe useful variation in calendar type over time. The panel design of the two datasets allows us to include teacher, year and school fixed effects in our estimation, as well as follow teacher transitions over time.

To our knowledge, this paper is the first to estimate the impact of YRS on teacher retention, turnover and quality in a large-scale longitudinal setting, addressing the important selection concerns inherent to the estimation. In addition to informing the larger literature on how school policy changes affect teacher turnover, our results can also provide additional evidence on the effects of a major education policy change and insight into why academic results of YRS have differed across different contexts in the past.

The remainder of the paper is organized as follows: Section 2 provides background on both the teacher turnover literature and on year-round schools in both of our locations; Section 3 provides data details and descriptive statistics from both of our datasets; Section 4 describes our empirical strategies; Section 5 presents regression results, Section 6 provides checks for robustness of results, and Section 7 concludes.

## 2. Background

### *2.1 Teacher Turnover*

There has been a rarely-tested consensus in the literature regarding YRS that the more frequent breaks of this calendar would result in lower teacher turnover. The main mechanism proposed is a lower rate of burnout. Glass and Kreitzer (1993) suggest this hypothesis, as do Worthen and Zsiray (1994). Until recently, these studies on the topic focused on limited data analysis or case studies. For example, Haser and Nasser (2003) examine three school settings in detailed case studies, and argue that teacher retention can be improved by a switch to a year round calendar. Only very recently have rich administrative datasets been used to examine these questions with panel data techniques. Using North Carolina data, Smith (2011) finds higher teacher retention in year-round schools, whereas Loeb, Darling-Hammond, and Luczak (2005), using data from California, find higher turnover in multi-track year round schools, finding also that vacancies in these schools were harder to fill.

In these studies, there is little effort, beyond multivariate techniques, to consider ways in which the policies, demographics, or variables of interest are correlated with other unobserved school or student characteristics. As a result, it is difficult to know whether the observed impacts of year-round schooling are capturing teachers response to the calendar policy, or teachers' response to possibly unobserved demographic and policy changes that drive the adoption of year-round calendars. It has been well documented that YRS policy adoption, both in North Carolina and California, is not done in a random or exogenous manner, so these unobserved differences between schools may considerably impact the estimated effects (Graves, 2010; McMullen and Rouse 2012b).

Because a teacher's working schedule and classroom control may be altered dramatically in a year-round school, it is worth examining the impact of teaching conditions and turnover more broadly. While salaries and benefits are easy to measure, most aspects of teachers' working conditions are unobserved in administrative data, and so researchers have focused on the demographic composition of the student body and class size (Hanusheck, Kain, and Rivkin, 2004; Falch and Strom 2005; Falch and Ronning, 2007). These studies document the pattern of teachers leaving schools with high proportions of low performing, low-income, and minority students. To the extent that researchers are able to observe working conditions, they usually find that the impacts are substantial. Loeb, Darling-Hammond, and Luczack, (2005) show that part of the observed teacher movement that is attributed to student characteristics is explained by differential teaching conditions that are correlated with student characteristics. Moreover, Ost and Schiman (2013) document that the observed teacher experience-turnover relationship is strongly dependent on the number of grade-reassignments, which they argue is a signal of workload.

In studies of teacher turnover, there is some consensus on the main determinants of teacher's employment choices. Compensation has a noticeable impact (Hanushek, Rivkin, and Kain, 1999; Murnane and Olesen, 1990; Stinebrickner, 1998). As do the previously noted demographics and job conditions. Because working conditions, wages, student demographics, and other policies are correlated with each other and with other unobserved factors, the challenge in these studies is to identify exogenous variation in teachers' job characteristics.

For this reason, in our study we pay particular attention to disentangling the effects of job characteristics that would have occurred anyway and those driven by our policy change. For Wake County North Carolina, we identify a natural experiment in which a number of schools were switched to a year round calendar. Because the teachers and school characteristics can be controlled in this experiment, and because we have a natural control group of teachers in the district in unaffected schools, we can examine the impacts of the policy on teacher decision-making separate from unobserved job-related influences. Similarly, we can examine the California case in greater depth than previously done by using school-specific fixed effects as well as school-specific time trends to control for unobserved differences between schools that would have occurred regardless of calendar type.

*2.2 YRS Policy Details*

California has traditionally been the state with the most schools on a year-round calendar, totaling about half of all year-round schools in the nation (NAYRE 2006, 2007). From the mid-1990s to mid-2000s, California experienced a boom in adoption of YRS calendars. This is likely in part due to school crowding concerns, which made the multi-track model popular. Multi-track YRS calendars have been shown to provide cost savings under high levels of school crowding (Merino, 1983; Cooper et al., 2003; Daneshvary and Clauretie, 2001; CDE, 2013). In addition to the lure of potential costs savings in the face of the difficult issue of school crowding, beliefs about potentially beneficial academic impacts of the calendar helped to motivate the large-scale implementation of YRS calendars in California (CDE, 2013). Another potential reason for the surge in year-round calendars in California at the time, as suggested by Mitchell and Mitchell (2005), is California's class size reduction initiative that took place in the 1990s, which by requiring smaller classes in schools that may not have had the capacity, provided motivation to switch to a multi-track year-round calendar.

The Wake County Public School System (WCPSS) currently serves over 150,000 students, making it the largest district in the state of North Carolina and the 16$^{th}$ largest in the United States. Enrollment in the WCPSS has grown substantially over the last few decades and is expected to increase by 40,000 students by 2022.[5] Use of the year-round calendar was first implemented in the WCPSS in 1989. Since its adoption, use of the year-round calendar slowly increased in prevalence until 2007 when the school system converted 22 schools from traditional to year-round calendars and ordered that all new schools be opened on a year-round calendar. This one-time large-scale calendar conversion more than doubled the number of schools using the calendar in a single academic year. Similar to California, the YRS policy change was

[5] http://www.wcpss.net/about-us/our-students/demographics/ (accessed February 24, 2014).

implemented largely as a response to overcrowding created by a high level of population growth in the county. Because it was imposed mandatorily upon the selected schools, this change was met with strong opposition from parents and was eventually contested at the State Supreme Court where the court upheld the school system's decision to enforce the mandatory calendar conversions. The policy environment surrounding the WCPSS and the mandatory nature of the calendar assignments makes Wake County a good place to study the effects of YRS because the calendar conversions create a natural experiment.

In both locations, there are some differences and similarities in how the YRS calendar was implemented. In California, the most popular models of year-round calendar schedules are either the 45-15 or 60-20 calendars, referring to days in school and days out of school respectively. Wake County, NC uses only the 45-15 multi-track model of year-round education. In Wake County, NC, YRS calendars are all of the multi-track type, where each school has four tracks of students, at least one of which is "tracked-out" at any point in time. Both the California Department of Education and the WCPSS claim that use of the multi-track year-round calendar model allows a school to accommodate 20 to 33 more students than its traditional calendar counterpart.[6] California, on the other hand, has both single-track and multi-track YRS calendars. The single-track calendar maintains the same in-school and vacation days for the entire student body, while the multi-track model incorporates the previously-mentioned rotation of students on and off of break to serve a larger student body. Both the single-track and multi-track YRS calendar similarly distribute the 180 school days more evenly over the calendar year. In our analysis, we focus primarily on the multi-track YRS calendar, where comparisons between both locations are most easily drawn.

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[6] http://www.wcpss.net/year-round/capacity_gain.html (accessed February 10, 2011).
http://www.cde.ca.gov/ls/fa/yr/guide.asp (accessed February 26, 2014)

In a Year-Round Education Program Guide, the California Department of Education discusses some of the proposed advantages and disadvantages of the YRS calendar that can apply to both the California and North Carolina use of YRS calendars.[7] They note disadvantages such as scheduling and maintenance difficulties under a multi-track calendar due to the facility being in use all year, as well as difficulties with faculty communication and organization of teaching and extracurricular activities on a rotating basis. For instance, under the multi-track calendar, four different teachers may be required to share three classrooms on a rotating basis during the school year. While these disadvantages are primarily organizational concerns, the listed advantages sound much more promising, including many cost savings, academic benefits to students (especially disadvantaged students) and possible family preferences due to lifestyles and work schedules.[8] Regarding teachers, they note a possible reduction in teacher stress and burnout due to more frequent breaks, more frequent planning periods and the ability for teachers to earn more money by opting to teach extra sessions or substitute.

Unfortunately, such beliefs regarding the advantages of the YRS calendar have since have been found to be largely inconsistent with later research for the state of California and North Carolina. Graves (2010 and 2011) finds clear negative academic impacts of YRS on academic outcomes for the state of California, especially among traditionally disadvantage student populations and Graves (2013a, 2013b) finds that the year-round calendar is more disruptive to work schedules resulting in reductions in maternal employment, with a larger burden among lower income families. Recent research on the academic impacts of the YRS

[7] These listed advantages and disadvantages of year-round schools are quite commonly listed in other sources as well. See for example: Kneese (2000). See http://www.cde.ca.gov/ls/fa/yr/guide.asp for the California Department of Education's Year Round Education Program Guide (accessed February 26, 2014)

[8] YRS has been primarily touted as an effective way to address the loss of learning during the traditionally long summer break, or "summer learning loss." Graves 2010, 2011, and McMullen and Rouse 2012a and 2012b explain why the existence of summer learning loss does not actually predict positive academic student outcomes.

schedule in Wake County is less discouraging. McMullen and Rouse (2012b) find the YRS calendar has little impact on achievement for the average student or for any racial sub-group. While McMullen and Rouse (2012a) find the calendar has little impact on average, they also find that it may help to partially offset the negative impacts of crowding in highly crowded schools. While the effects for Wake County are not supportive of wide-spread large positive impacts on achievement, a finding of a null academic impact may offer support for the use of the calendar as a cost-effective way to handle school crowding.

Similar to the discussion of other advantages and disadvantages, without empirical evidence, effects on teachers remain unclear. In the case of multi-track YRS, teachers may find the frequent breaks stress relieving or may find them too short relative to the traditional summer break. Likewise, teachers may welcome opportunities for additional teaching or may find them a source of teacher burn-out. Additionally, these preferences may play a smaller or larger role in teacher mobility decisions depending on how the teacher already views the teaching conditions at their school or district of employment. The largest difference between the context of YRS implementation in California and North Carolina is the student demographics, California serving more disadvantaged populations in YRS than Wake County, North Carolina. Given that previous research has shown differential teacher turnover rates by student demographics, it is possible that the policy change of YRS calendar implementation may have differing effects along these lines as well.

Alternatively, if new teachers are hired to meet the additional teaching need on a multi-track YRS calendar, then one must consider the possibility of diminishing returns in teacher quality in the teacher labor market. In this case, as more teachers are hired, one would expect to see reductions in the quality of the teacher pool under a YRS calendar. An example of this in the teacher labor market can be taken from Jepsen and Rivkin (2009), who showed that in the case of California's class size reduction program in the early 1990s, benefits from class size reduction were offset (sometimes fully) by the deterioration of teacher quality that accompanied the large expansion in California's teacher force.

## 3. Data & Descriptive Evidence

We use two panel datasets to identify the impact of YRS on teacher turnover. The first is longitudinal data from the state of California from 1998 to 2012. In our second analysis, we use data from the NCERDC, which has student-level panel data from 2006 to 2010. To estimate the effects, we rely on both school level and teacher level analysis, using fixed effects approaches to account for the unobserved heterogeneity across YRS and traditional calendar schools.

### 3.1 California Data

Our first dataset is compiled from a variety of files made publicly available through the California Department of Education. The primary data sources are California Basic Educational Data System (CBEDS) data files by year for the years 1998-2007, combined with data from the updated Online Public Update for Schools (OPUS) and Online Reporting Application (ORA) files for the years 2008-2012. This data combines school-level variables such as school calendar, school programs, technology use, staffing variables, teacher variables, enrollment and student characteristics, such as racial composition and percent of students on the free and reduced price meals program. The combined longitudinal school-level data is used in our initial specifications.

To further explore teacher turnover, we also make use of teacher-level data collected from the Professional Assignment Information Forms (PAIF) that contain detailed information on all teachers within schools in the California public school system. This data contains individual teacher demographics such as race and gender, teacher qualifications such as education, experience and credentials, as well as teacher assignment data indicating subjects of courses taught. We use this longitudinal data on all public school teachers within California public schools to more directly estimate teacher turnover effects as well.

While teacher-level data available through the California Department of Education is quite detailed and follows teachers within schools across years, the unique identifier for each teacher available in the data is not longitudinal. To use the individual teacher-level data over time, one must match teacher observations over years using various descriptive variables that either do not change over time, such as race and gender, or change in a predictable way, such as experience (increases by one each year) or education (can increase, but should not decrease). A limitation of this necessary matching, however, is that one can only observe who is retained and who is new within a school across years. One cannot however, observe where the new teacher came from prior to arriving (within the district, outside the district but within the state, or from out-of state) or whether a teacher has left and later returned.

[This matching process is still in progress. Details of both the matching, as well as estimation using teacher-level analysis for the state of California will be incorporated in a later draft].

Our California data provides useful variation in school calendar changes overtime to take advantage of in estimation. In Table 1, we present the percent of schools that are on a traditional calendar, single-track year-round and multi-track year-round calendar across the years 1998-2012. One can see that the percentage of schools that are on a traditional calendar increase from roughly 80% to 95% over the years in our sample. YRS calendars decrease as a percentage of total public schools over this same time period, but not in exactly the same way for single-track and multi-track calendars. Single-track calendars first increase in use then decrease, while multi-track consistently decreases in use over the sample period studied. Graves (2010) uses the same data source as used here for the years 1998 through 2005 and shows that over this time period, there is considerable switching between all combinations of these three calendar types and that most schools that try out a multi-track calendar eventually switch back to either a traditional or a single-track calendar. This is not surprising as multi-track calendars were primarily used as a means of addressing school overcrowding issues in California at the time and were seen from the start as a temporary solution.[9][10]

Because multi-track year-round calendars were often implemented in overcrowding situations, it is also not surprising to find that schools that adopt different calendar types differ along a number of dimensions. In Table 2, we present a number of school and student characteristics broken out by traditional, single-track and multi-track year-round calendar status. One can see that, as expected, multi-track YRS has larger enrollment than either single-track YRS or traditional calendars. Even when adjusted for the total number of students expected to be in-school at a given moment, we can see that daily enrollment is higher (see adjusted daily enrollment). Multi-track YRS calendars in California also have notably different student demographics, with a higher percent of minority students, especially Hispanic students, and a

[9] Section 42269(a) was added to California Education Code in 1999 as part of Senate bill 1068. This section discusses the phasing out of year-round schools after receiving grant money to implement them in overcrowded schools. For example, part of this text reads: "The State Department of Education shall… conduct a study of the grant program… to develop an equitable method of phasing out the program over a multiyear period." This code can be found at: http://www.oclaw.org/research/code/ca/EDC/42269./content.html#.UxBgofldXng (last viewed: 2/28/2014).

[10] Additionally, a particular type of YRS calendar, the Concept 6 multi-track calendar, was widely believed to have negative impacts on students, even prompting a lawsuit (*Williams vs. California*) that resulted in the complete phasing out of these calendars from the California public school system. Concept 6 multi-track schools reduced the number of school days to 163 in order to fit more students in the same school facility. In this study, we do not include schools that have adopted the Concept 6 model in our estimation and only focus on year-round schools that maintain the same 180 total number of school days. However, it is likely that the association of Concept 6 year-round calendars, which alter the number of school days, with other types of year-round calendars that do not, prompted much of the decrease in numbers of regular YRS calendars over the same general period of time.

larger percent of students on a free and reduced price meals program. As previously noted and evidenced in the data, multi-track YRS calendars are more likely to be in place in overcrowded schools. Regarding teacher characteristics, multi-track YRS have more teachers (which is not surprising, given that they serve a notably larger student body), but also have fewer teachers with degrees above a bachelor's degree relative to traditional or single-track YRS calendars and have teachers with less experience on average. Single-track YRS calendars also differ somewhat from a traditional calendar, but to a much lesser degree and in a much less systematic way.[11]

### 3.2 North Carolina Data

Our second dataset comes from the NCERDC, a data center that was created in 2000 and was a collaborative effort with the North Carolina Department of Public Instruction. The center collects and maintains data on NC public school students, teachers, schools, and districts. We focus our attention on Wake County, NC where the large policy change in 2007-2008 forced 22 schools to convert from a traditional to a year-round academic calendar. We combine this data with publically available data provided by the WCPSS. The school system makes available school-level data on demographics, achievement, and crowding.[12] We merge the WCPSS data with the NCERDC using the unique school code and year. Because the YRS calendars are only used in elementary and middle schools in Wake County, we eliminate high schools from our analysis.

In Table 3, we illustrate the growth in use of the YRS calendar in Wake County over the time period of study. Each year corresponds to the spring of the academic year. In 2006, 15 of

[11] These differences remain notable when characteristics are summarized by whether a school has ever been year-round, is currently year-round or is currently not year-round but adopts a year-round calendar in another year (results not shown here, available upon request from the authors).

[12] This data is available at http://www.wcpss.net/about-us/our-students/demographics/school-data.html (accessed February 25, 2014.

117, or only about 13 percent of Wake's elementary and middle schools operated on a YRS calendar. In 2007, five new schools were opened on the calendar. The largest change occurred the year of the mandatory calendar conversions in 2007-2008, when the number of year-round schools increased from 20 to 46 or from roughly 16 to 36 percent of the schools. Since 2008, the number of schools operating on the schedule has increased slightly. However, it is clear from the table that use of the calendar has varied greatly over the time period. From 2006 to 2010, the percent of schools operating on the calendar increased from just fewer than 13 percent to just over 38 percent.

Similar to California, because the calendar conversions in 2007-2008 were largely implemented to counteract the high levels of crowding in Wake schools, year-round schools tend to differ from traditional counterparts along other dimensions. In Table 4, we present descriptive statistics of student, school and teacher characteristics by calendar type. In contrast to California, multi-track year-round schools in Wake have a higher percent of white students and a lower percent of students on a free and reduced price meals program. Average reading achievement scores suggest there is little difference across calendar types, however there is a slightly higher passage rate for math exams in year-round schools. There are also a lower number of crimes and long-term suspensions at year-round calendar schools. Not surprisingly given the reason for implementation, the year-round schools are less crowded than their traditional calendar counterparts and there are more teachers, on average, in year-round schools. We also see a slightly lower teacher turnover rate and a higher number of national board certified teachers in year-round schools. However, compared to what we see in the descriptive statistics for California, there is less of a difference in observed teacher characteristics across calendar types in Wake County, NC.

Our teacher level analysis includes individual teacher data for those teachers who are observed teaching in the WCPSS during the time period of study and for whom we are able to observe all of the relevant control variables. The final sample includes 6,019 teachers for a total of 21,538 teacher-year observations. In addition to the student, school and average teacher characteristics summarized in Table 4, we are able to observe an individual teacher's salary, years of experience and highest level of education. Because our dataset includes data on all North Carolina public schools, we are also able to observe whether the teacher stays in their current school, leaves for a new public school within the district, moves to a new public school in North Carolina outside of WCPSS or if they exit the sample entirely.[13] We use this information to construct these teacher-level measures of their mobility decision. Table 5 summarizes the additional teacher-level characteristics by calendar type. The table shows teachers in year-round WCPSS schools earn roughly 2,000 more than their traditional calendar counterparts, though this likely reflects the fact that the number of year-round schools increased in later years when the salaries would be higher. This is particularly likely given that there is little difference in the number of years of experience or in the education measures across the teachers in the two calendar types. The mobility statistics suggest turnover is slightly lower in year-round schools. This pattern persists across all of the mobility measures.

## 4. Empirical Strategies

The empirical challenge when estimating the impact of YRS on teachers is that the YRS calendars are generally not randomly placed into schools. If the calendar placements occur in

[13] Unfortunately, because our dataset only includes NC public school teachers, we are unable to ascertain the destination of those who exit our sample. These decisions would therefore include exit from the labor market entirely (retirement and otherwise), moves to a new school in a different state, moves to a private school, and moves to a new occupation.

schools that are either lower or higher in quality in terms of other attributes that affect teachers, then it is crucial to account for these differences in order to separately identify the impact of the school calendar from simply the types of schools in which they are implemented. We address this issue by exploiting the longitudinal nature of our datasets using multi-level fixed effects models. We begin with school level analyses to see how the academic calendar impacts several measures of teacher quality. We then move to a teacher-level analysis to estimate directly the impact of the year-round calendar on teacher turnover. We discuss these methods in turn.

*School level analysis*

To examine the impact of year-round schooling on teacher quality and retention, we begin by estimating the following general linear function at the school level:

$$Y_{st} = \alpha YR_{st} + \delta S_{st} + \phi_s + \gamma_t + \varepsilon_{st}$$

where $Y_{st}$ is the outcome of interest (i.e. percent of licensed teachers, percent of highly experienced teachers, percent teacher turnover), $YR_{st}$ is an indicator variable that is set equal to one if school s operates on a year-round schedule at time t, $S_{st}$ is a vector of school level characteristics of school s at time t, $\phi_S$ is a school fixed effect, $\gamma_t$ is year fixed effect, and $\varepsilon_{st}$ is an error term. This estimation will give us an idea of the impact of YRS calendars on the composition of the stock of teachers in schools. In the case of California, $YR_{st}$ is broken into multi-track YRS, $MT_{st}$, and single-track YRS, $ST_{st}$, to separately account for the two very different models of YRS calendars implemented. Since the YRS calendars implemented in North Carolina were the multi-track YRS model, the coefficient on $YR_{st}$ in the North Carolina regressions is most directly comparable to the coefficient on $MT_{st}$ in California regressions.

As previously discussed, Wake County, North Carolina provides a nice combination of longitudinal data and a natural experiment that mandated calendar conversions. For this reason, specifications including year and school fixed effect are likely to address selection concerns and allow for estimation of a causal effect of YRS calendars on teacher outcomes. For the case of California, schools had considerably more choice in their school calendar adoption. For this reason, one may be concerned, even with school fixed effects, that time-varying selection may still occur. For example, if the school demographics were changing over time in a way that was not preferred by teachers, one might observe teacher mobility regardless of a calendar change.

For this reason, for California we also estimate specifications comparable to those with school fixed effects and school-specific time trends, which can be represented by the following equation:

$$Y_{st} = \alpha YR_{st} + \delta S_{st} + \varphi_s + \gamma_t + \varphi_s t + \varepsilon_{st}$$

As there are on average around 8,000 schools included in each of the 12 years of our data, for computational reasons, this specification cannot be directly estimated. This is because when school specific time trends are included, specifications include a full set of school dummies and these dummies interacted with a time trend, which cannot be estimated using methods designed for large dummy variable sets. We therefore present estimation using a differenced version of this specification (resulting in differenced models with school fixed effects).[14] Just like a specification with school fixed effects and school-specific time trends directly included, this modified model controls for both time-invariant and linearly changing school characteristics that

[14] For estimation with the large set of school dummy variables, we make use of Stata's areg command. The areg command uses a computational shortcut that only requires estimation of the coefficients on all variables except the dummy variables corresponding to the categorical variable that is absorbed. The resulting coefficients, standard errors, *t* statistics, significance levels, confidence intervals and R2 are all unaffected by use of this method. For a more compete explanation of the method, refer to the Stata Manual for the ''areg" command. When the equation is differenced, the school fixed effects fall out of the specification and school-specific time trends become school-specific dummies, allowing for the use of areg again.

could potentially bias results. Identifying variation is therefore limited to only deviations from the trajectory that a school was already on.

*Teacher level analysis*

We also separately analyze teacher turnover with teacher-level data using a linear probability model with multi-level fixed effects where

$$Y_{ist} = \beta_1 YR_{st} + \beta_2 S_{st} + \beta_3 T_{ist} + \phi_s + \gamma_t + \varphi_i + \varepsilon_{ist}$$

Here, $Y_{ist}$ is an indicator variable that is set equal to one if teacher i leaves school s at time *t* and is zero otherwise, $T_{ist}$ is a vector of time-varying teacher level characteristics of teacher i in school s at time t, $\varphi_i$ is a teacher fixed effects and, as in the school-level specifications above, $S_{st}$ is a vector of school level characteristics of school s at time t, $\phi_S$ is a school fixed effect, $\gamma_t$ is year fixed effect, and $\varepsilon_{st}$ is an error term.

It is important to note that YRS could have a differential impact on mobility according to the destination to which the teacher is moving. For example, we might reasonably assume that distaste for a YRS calendar might make it more likely that a teacher would make an in-district move than an out-of-district move, because the cost of making an in-district move would be lower. While a YRS calendar could conceivably cause a teacher to move to another North Carolina public school outside of Wake County, this decision might more likely be driven by something like a household move to another part of the state. Similarly, the impact of YRS on the decision to exit public school teaching – whether due to retirement or for some other reason (e.g. new career, move to another state, etc) – is likely to be different than its impact on the decisions to move to another Wake school or to another school within North Carolina. To address this possibility, similar to Goldhaber, Gross and Player (2011)[15] we also estimate this model with a separate regression on each of three potential transitions: moving to a new school in the district, moving to a school outside of the district, or leaving the NC system entirely.

[Because preparation of teacher-level California data is still in progress, teacher-level discussion of estimation results for the state of California will be incorporated in a later draft].

## 5. Results

### 5.1 California

Table 6 presents school level regression results for California. Each specification in Table 6 includes a full set of school level controls, including total enrollment, student racial composition, percent of students eligible for free and reduced price meals, computer and internet connectivity, non-teaching staff to student ratios, and whether the school is a charter school. Also included in each specification are year and school fixed effects. The only difference between the specifications in the different columns of Table 6 are the dependent variables used. Column 1 presents results using the total number of teachers. In this column, we can see that multi-track YRS calendars increase the number of teachers at the school, consistent with the idea that multi-track YRS may need additional teachers to cover the continuous teaching schedule. We know that multi-track YRS calendars are often implemented due to school crowding issues. If a school is at or over capacity when new teachers are hired, with students unlikely to be moved to the school in any systematic way after the calendar change, then this is likely to reflect a reduction in student to teacher ratios as well. The results from Column 2 confirm this, finding a negative and significant drop in student-teacher ratios after a school has become multi-track.

[15] Goldhaber, Gross and Player (2011) use a discrete hazard model to estimate teacher turnover in North Carolina.

Columns 3-6 present results using the following education measures: the percent of teachers with a doctorate degree, the percent teachers with a master's degree, the percent of teachers with a bachelor's degree, and the percent of teachers with less than a bachelor's degree. One can see that there are negative and significant effects on the percent of teachers with a doctorate or master's degree and a positive effect on the percent of teachers with a bachelor's degree. It appears that in hiring additional teachers, schools either do not seek out or cannot find teachers with higher degrees than a bachelors, lowering the overall education level of the stock of teachers. Average experience level of teachers also falls, as evidenced by the negative and significant effects found in Columns 7 and 8 for the average years teachers have been teaching in the school and the average years teachers at the school have been teaching in the district. Additionally, from Columns 9 and 10, we can see a significant drop in the percent of fully credentialed teachers on average, as well as an increase in the percent of teachers hired on special conditions. Special conditions included in this measure are teachers hired under emergency permits or short-term staff permits requested by employers when fully credentialed teachers cannot be found, waivers requested when neither certified teachers nor teachers qualifying for emergency permits can be found, or when the teacher is serving as an intern teacher while pursuing their credentials.

Turning to Column 11, one can see that the percent of teachers that are certified to teach special education also falls. This is likely to be detrimental to meeting students' needs, unless multi-track YRS calendars also see a drop in the number of students with special education needs at the same time as calendar implementation. While student transfers are greatly limited in the California public school system, it is possible that this is granted at a higher rate for those students with special needs (we cannot observe this in the data).[16] An additional need that is more prominent in California than in many other states is language services. This is due to high immigrant populations, especially Hispanics in California. We therefore also present results using one such measure in Column 12. There is a positive and significant increase in the percent of teachers that are certified for bilingual education. This could be explained by the schools considering their special need for this in their new hiring decision.[17]

By comparing results from multi-track YRS calendars to single-track YRS calendar, we can also learn something about where these effects may be coming from. For instance, single-track YRS calendars do not see significant changes in teacher numbers, which is expected since, just like traditional school calendars, all of the teachers are either in school or on break at the same time and there is no reason to suspect an increased need for teachers under a single-track YRS calendar. Similar to the multi-track YRS effects, single-track YRS appears to also see a drop in experience level, as evidenced by a negative and significant effect on average years teaching and average years in the school district. However, this appears to be paired with no significant changes in education levels, an increased percent of fully credentialed teachers and a decreased use of teachers hired under special conditions. It appears that single-track YRSs do not have the same troubles finding credentialed and highly educated teachers as multi-track YRSs do. Some of this may be driven by multi-track YRS calendars larger need for hiring. It may also be that the year-round schedule itself is not an undesirable trait for teachers, but that the organizational burdens imposed by a multi-track YRS are viewed by teachers as a particularly negative aspect of the teaching environment.

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[16] In California, selection on the part of students is greatly limited by restrictions on within-district transferring in the public school system. District restrictions on student transfers are the same regardless of calendar type.
[17] Alternatively, this could reflect newly hired teachers being a higher concentration of minority themselves and therefore more able to meet this criteria.

In California and Wake County, North Carolina, the primary concern for estimation is addressing the non-random adoption of calendar type by schools. This is apparent in the descriptive statistics presented in Table 1 and Table 4. School fixed effects limit the identifying variation to within-school changes in calendar type. In Wake County, NC, where a natural experiment that mandated conversion is also present, school fixed effects are likely to address this concern. In California, however, where no such mandate was put in place, schools have more freedom to choose their calendar type. Therefore, one might still worry about time-varying school characteristics that could drive a school's choice to adopt a specific calendar type. As previously mentioned, we address this possibility in California by also presenting the same results as presented in Table 6 only repeated including specifications similar to adding school-specific time trends into our estimation (see Section 4 for details). In Table 7 we present these specifications (differenced models with fixed effects) that control for both time-invariant and linearly changing school characteristics that could potentially bias results.[18]

Results from Table 7 are largely consistent with results from Table 6. In these more rigorous specifications, we also see an increased number of teachers corresponding with a decrease in education levels (columns 3-6) and reductions in teaching experience (columns 7 and 8). Multi-track YRS calendars no longer appear as negative regarding credentials, with the percent of teachers with full credentials no longer significant and the percent hired under special conditions actually significantly dropping. Additionally, there no longer appear to be significant differences based on the percent certified for special education or bilingual education. These

[18] Because measurement error can lead to different results depending on the length of the difference used (Griliches and Hausman, 1986), we have run these models using 1-year, 2-year and 3-year differences to ensure that the results found are not specific to the difference used. Because findings are very similar across the three sets of specifications, for brevity sake we only report the 2-year differenced results in this paper. The 2-year differenced results mostly fall between the 1-year and 3-year differenced results in magnitude. The other results are available from the authors upon request.

differences between estimates in Tables 6 and 7 indicate that multi-track YRS calendars cause an increase in the number of teachers, creating a lower educated stock of teachers. However, changes in credentials and certifications observed in YRS were likely reflective of pre-existing trends. The comparison of single-track to multi-track YRS calendars in Table 7 tells a similar story as in Table 6, that single-track calendars do not appear to increase their overall number of teachers, but relative to both the multi-track and traditional calendars appear to have an easier time attracting credentialed teachers.

[Teacher-level analysis for California to be added in a later draft]

## 5.2 Wake County, NC

School level regression results for Wake County are presented in Table 8. Each specification in Table 8 includes a full set of school level controls, including the number of students per instructional computer, average daily attendance, number of books per students, number of crimes per 100 students, number of long-term suspensions, percent crowding, percent poverty, percent black, and percent Hispanic.  Also included in each specification are year fixed effects. The differences between the specifications 1-7 in the different columns of Table 8 are the dependent variables used. For dependent variable, the models are estimated with and without school fixed effects.

Column 1 shows the results from a model where the school level percent of turnover is the dependent variable. The models without school fixed effects imply year-round schools have a roughly two percent lower rate of turnover than their traditional calendar counterparts. This result is suggestive of positive teacher reaction to the calendar change as argued by those who tout the benefits of the year-round schedule.[19] However, this effect is eliminated once school fixed effects are added to the model in column 1b. Models without school fixed effects suggest year-round school calendars have a lower percentage of teachers with fewer than four years of experience (column 2a) and a higher proportion of teachers with between four and ten years of experience (column 4a), but no significant impact on teachers with 11 or more years of experience. This result would suggest year-round schools in Wake County attract teachers with mid-range levels of experience and that traditional calendar schools use a slightly higher proportion of new teachers. However, similar to the turnover results, once school fixed effects are added to the models, these effects disappear. These results suggest the correlations between the school calendar and teacher outcomes are more likely due to differences in underlying school quality that are unaccounted for by the school control variables included in the models without fixed effects. These results reflect the importance of properly controlling for non-random calendar placements. Results regarding the percent of teachers with higher degrees also suggest the calendar has little impact on this outcome.

Turning to column 5, we see a result similar to that in California – one which is not surprising- the number of teachers is significantly higher in year-round schools and this difference is reflected both in models without and with school fixed effects included. Finally, turning to column 7, we see that compared to traditional calendar schools, year-round schools have a higher proportion of fully licensed teachers, though the magnitude of this effect is quite small compared to the size the negative effects we see for California.

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[19] This is noted by organizations that directly promote YRS implementation, such as the National Association for Year Round Education. For example: http://www.nayre.org/Louisville CJ July 17.pdf (last viewed 2/28/2014). It is also often listed as a benefit of YRS on sites that are trying to present a balanced description of advantages and disadvantages of YRS (CDE, 2012). Similarly, it is sometimes reported in descriptive studies, such as Haser and Ilham (2003).

Teacher level results for Wake County are presented in Table 9. This table includes four separate measures of the decision to leave. The first row has as the dependent variable an indicator variable set equal to one if the teacher leaves school s in year *t* to go anywhere. Then, we separate the decision to leave into the three possible destinations we can observe: (1) a new Wake school, (2) a new school outside of WCPSS but inside NC and (3) exit from the sample. We estimate these models with four specifications. First, we present a baseline model without any controls to illustrate the baseline correlation between year-round school and the mobility outcomes. Then, we add observed school and teacher characteristics and year effects in column 2. In addition to the school variables included in our school level regressions, these controls also include school-level average teacher characteristics to capture the impact of peer teacher quality on an individual teacher's decision to stay in the school. Additionally, we include our observed individual teacher characteristics of annual salary, years of experience and education. School fixed effects are added in column 3 to capture permanent school characteristics we don't observe and finally, teacher fixed effects are added in column 4 to control for permanent teacher characteristics that we are unable to observe in our dataset.

First looking at the results in column 1, the raw correlations imply there is a negative correlation between YRS and turnover. However, once controls and fixed effects are added to the model in columns 2-4, the negative impact on overall turnover (shown in row 1) implies the calendar has little impact on the decision to leave a school. However, when we separate the mobility decision into the three potential destinations we can observe, our results support the assertion that a YRS effect might be more likely with within-district moves. The estimate from our preferred model with both teacher and school level fixed effects (column 4) suggests the YRS calendar decreases the probability of moving to a different WCPSS school by roughly 2.5

percent. This result suggests that while the calendar may have little impact on mobility decisions overall, it does have a small impact on the decision to move to a different school within the Wake County school district. The results in the last two rows of the table, however, suggest the YRS calendar has little impact on the probability of moving to a different NC school outside of Wake County or on the decision to exit the NC public school system.

Taken as a whole, the results for Wake County, NC contrast those we see in California and suggest the year-round calendar does not negatively impact teacher quality or have a detrimental impact on turnover. As expected, similar to California, we do see a measurable increase in the number of teachers at multi-track year-round schools; however, the increased number of teachers does not appear to alter the composition of the teaching stock. If anything, we see a slight positive impact on the proportion of fully licensed teachers in year-round schools and our results suggest the probability of moving to a different school within the WCPSS is slightly lower under a YRS calendar than under a traditional calendar.

## 6. Robustness of Results

One concern in both the school and teacher level analysis presented thus far is that results could be biased if teachers' moves to or from a school happen before the actual calendar change. This could occur if an announcement of the calendar change precedes the actual change. Teachers who have a preference for teaching in a YRS may move before the actual change is implemented and teachers with a preference for traditional calendars may leave a school before the actual calendar implementation. If this is the case, we would be attributing changes that are actually due to YRS to the traditional calendar type. In such a case where some YRS-related changes occur just before the YRS calendar implementation and others after, this would bias results toward finding no effect. To address this possibility, we present a number of checks corresponding to our main specifications presented and discussed in the previous section.

Our main specifications for school-level analysis for California are presented in Table 7 which includes school fixed effects and school-specific time trends. In Table 10, we present regression results similar to those presented in Table 7, only with three variations. In Panel A, we present the same specifications with three dummy variables added to estimation: a dummy for the change year, a dummy for 1 year prior to the calendar change year and a dummy for 2 years prior to the calendar year. These dummies account for any lasting effects specific to the time just before a calendar change. Alternatively, in Panel B, we present specifications where these years are excluded from the sample. Instead of simply controlling for effects prior to the calendar change, this specification directly ensures that post-change teacher movements are only compared to "clean" pre-change teacher movements occurring enough years prior to the calendar change that they cannot contain any pre-emptive moves associated with the announcement of the change. In both Panels A and B of Table 10, main results are largely consistent with the findings from Table 7.

As a third check for pre-emptive teacher movements, in Panel C of Table 10, we present the main specifications from Table 7, adding a dummy for changing to a YRS calendar in the following year. In Table 10, because we are using California data, we break this out to be multi-track and single-track YRS. The coefficient for multi-track YRS therefore gives the effect of multi-track YRS status in time $t$ on teacher outcomes in time $t$, while the dummy for a change to multi-track YRS next year gives the effect of the policy change happening soon (year $t+1$) on current teacher movements (year $t$). This specification allows for direct comparison of pre-emptive and reactionary teacher movements. One can see from Panel C of Table 10 that main effects are mostly consistent with the main effects of Table 7.[20] Looking at the coefficients on a change to multi-track YRS next year, we can see that there does appear to be some pre-emptive hiring of teachers before the calendar change and that these teachers bring down the average years spent teaching in the district, but that they are not brought in on special conditions. Despite rather large pre-emptive hiring, however, there are no significant changes in education levels, credentials or overall years teaching experience with the pre-emptive hires. For California, this differs from the estimates on multi-track YRS status which indicate that years after the calendar change do see these reductions in teacher quality measures.

Turning to results for North Carolina, because we have fewer years of data, we restrict our robustness check to a specification similar to that used in the panel C of Table 10 for California. We re-estimate the school level fixed effects models from the WCPSS results in Table 8 but add in a dummy variable that is set equal to one in time $t$ for a change to a YRS schedule in time $t+1$. Similar to our specification for California, the coefficient for multi-track YRS therefore gives the effect of multi-track YRS status in time $t$ on teacher outcomes in time $t$, while the dummy for a change to multi-track YRS next year gives the effect of the policy change happening soon (year $t+1$) on current teacher movements (year $t$). This specification allows for direct comparison of pre-emptive and reactionary teacher movements. These results are presented in Table 11. Similar to what we find with California, the main results on multi-track YRS are consistent with the results presented in Table 8. Also similar to what we find for California, these results suggest there is some pre-emptive hiring the year before the calendar

[20] The key differences between the coefficients on multi-track YRS in Tables 5 and 6 are that in Table 6 we can see that there is still a reduction in the percent of teachers with a PhD, but that this appears to result in a switch to those with a master's degree instead of bachelor's degree and we now see a significant negative effect on fully credentialed teachers that was insignificant before.

change. However, there are no other significant changes in the quality of the teacher stock caused by the increased hires nor is turnover significantly impacted.

[Additional teacher-level robustness checks to be added once California teacher-level analysis is incorporated]

## 7. Concluding Remarks

In this paper, we generally find that schools in both locations hire additional teachers to accommodate the multi-track YRS model. However, in California, where multi-track YRS is implemented in particularly disadvantaged populations, the teacher quality is diminished, while in North Carolina, where multi-track YRS has been implemented in more affluent areas, teacher quality does not suffer. This is consistent with previous literature on YRS calendars indicating that the context in which YRS is implemented is particularly important. There are two parts to that context that are likely to contribute to our differing results in terms of teacher quality between California and Wake County, NC.

The first possibility is a story of teacher preferences. Both locations have widely implemented YRS due to school crowding, but have very different student demographics and previous studies have found that turnover is worse in disadvantaged areas (Ingersoll, 2001; Hanushek, Kain and Rivkin, 2004). While selection concerns are addressed in the estimation methods used for both California and North Carolina, they do serve different student populations, meaning that the results are specific to those sample populations. It is possible that multi-track YRS is viewed negatively in most cases, but that this is not enough to initiate turnover or recruitment problems on its own. However, when paired with conditions that are already viewed unfavorably by teachers (as found for disadvantaged student populations), this is enough to hinder efforts to obtain high quality teachers. In other words, it is possible that in places with desirable student populations, school policies are less likely to drive a teacher away, even if undesirable themselves, while in areas that already have problems holding on to good teachers, undesirable school policies can exacerbate the problem. This theory is consistent with the differences in estimates found for California and North Carolina.

A second possible explanation is based on the supply of quality teachers in the teacher labor market. California had already implemented programs like class size reduction that required expanded teacher hiring in the years prior to those studied here. It is possible that NC had not dipped as far into its teacher supply to see decreased quality become an issue. This would be a classic story of diminishing return in the labor market.

Regardless of the extent that these described reasons explain the teacher effects found in this study, the results are informative for discussing the differences in academic results previously found for North Carolina and California. Research has found worse academic effects of YRS for California than for North Carolina, implying that the context in which YRS calendars are implemented matters (Graves, McMullen and Rouse, 2013). However, the precise mechanisms through which these academic effects occur are currently only conjectures and empirically still unknown. The evidence presented in this paper is at least consistent with teacher effects potentially driving the differences in academic impacts between the two locations. Alternatively, it is also possible that in locations in which YRS calendars impact student outcomes, that these student achievement changes affect teacher preferences for a school and could lead to teacher turnover. Although, given the abundance of literature that finds teachers to be a crucially important input in student learning (e.g. Rivkin, Hanushek and Kain, 2005; Rockoff, 2004; Sanders and Rivers, 1996), we believe that the first case is more likely. Teacher effects of YRS calendars are likely to play a significant role in determining whether YRS calendars are beneficial, neutral or detrimental to student learning.

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Table 1: Percent of California public schools on each calendar type by year
(means with standard deviations in parenthesis)

| Year | Calendar type | | | Observations |
|---|---|---|---|---|
| | Traditional | Single-Track YR | Multi-Track YR | |
| 1998 | 80.57 | 6.02 | 13.41 | 7380 |
| | (39.57) | (23.78) | (34.08) | |
| 1999 | 80.77 | 6.16 | 13.12 | 7737 |
| | (39.41) | (24.04) | (33.77) | |
| 2000 | 80.82 | 6.13 | 13.05 | 7765 |
| | (39.37) | (23.99) | (33.68) | |
| 2001 | 81.88 | 6.78 | 11.34 | 8630 |
| | (38.52) | (25.14) | (31.72) | |
| 2002 | 81.87 | 7.84 | 10.28 | 8898 |
| | (38.53) | (26.89) | (30.38) | |
| 2003 | 82.82 | 8.12 | 9.06 | 9057 |
| | (37.72) | (27.31) | (28.71) | |
| 2004 | 83.76 | 8.04 | 8.2 | 9318 |
| | (36.88) | (27.19) | (27.44) | |
| 2005 | 84.27 | 8.38 | 7.35 | 9512 |
| | (36.41) | (27.71) | (26.09) | |
| 2006 | 85.72 | 8.14 | 6.14 | 9635 |
| | (34.99) | (27.34) | (24.02) | |
| 2007 | 86.97 | 8.38 | 4.65 | 9825 |
| | (33.66) | (27.71) | (21.06) | |
| 2008 | 89.27 | 7.5 | 3.24 | 9884 |
| | (30.96) | (26.34) | (17.7) | |
| 2009 | 92.31 | 6.9 | 0.8 | 8034 |
| | (26.65) | (25.34) | (8.89) | |
| 2010 | 93 | 5.86 | 1.14 | 8038 |
| | (25.52) | (23.49) | (10.64) | |
| 2011 | 93.44 | 5.73 | 0.82 | 8005 |
| | (24.76) | (23.25) | (9.04) | |
| 2012 | 94.43 | 4.65 | 0.93 | 7338 |
| | (22.94) | (21.05) | (9.58) | |

Table 2: Student, School and Teacher Characteristics summarized separately by Calendar Type

| | Calendar Type | | | | | |
|---|---|---|---|---|---|---|
| | Traditional | | Multi-track YR | | Single-track YR | |
| | mean (SD) | observations | mean (SD) | observations | mean (SD) | observations |
| *A. Student Variables* | | | | | | |
| total enrolled | 653.18 | 111059 | 1015.31 | 8854 | 610.17 | 9133 |
| | (600.93) | | (656.62) | | (452.69) | |
| adjusted daily enrollment | 653.18 | 111059 | 793.31 | 8854 | 610.17 | 9133 |
| | (600.93) | | (492.47) | | (452.69) | |
| percent students, Asian | 0.07 | 111063 | 0.05 | 8854 | 0.05 | 9133 |
| | (0.12) | | (0.08) | | (0.08) | |
| percent students, black | 0.07 | 111063 | 0.09 | 8854 | 0.1 | 9133 |
| | (0.12) | | (0.1) | | (0.14) | |
| percent students, white | 0.38 | 111063 | 0.19 | 8854 | 0.26 | 9133 |
| | (0.29) | | (0.21) | | (0.26) | |
| percent students, hispanic | 0.41 | 111063 | 0.63 | 8854 | 0.52 | 9133 |
| | (0.29) | | (0.27) | | (0.29) | |
| percent students, other race | 0.07 | 111063 | 0.04 | 8854 | 0.07 | 9133 |
| | (0.09) | | (0.05) | | (0.09) | |
| percent students, male | 0.53 | 111063 | 0.51 | 8854 | 0.54 | 9133 |
| | (0.09) | | (0.04) | | (0.1) | |
| percent students, FRPM | 12.79 | 100459 | 22.83 | 8584 | 15.42 | 8460 |
| | (26.02) | | (35.61) | | (29.78) | |
| *B. School Variables* | | | | | | |
| years on current calendar | 9.82 | 100002 | 7.04 | 8675 | 6.16 | 8367 |
| | (4.83) | | (3.69) | | (4.52) | |
| computers/student | 0.26 | 110813 | 0.21 | 8835 | 0.29 | 9124 |
| | (0.59) | | (0.58) | | (0.45) | |
| internet connected device/student | 0.07 | 110796 | 0.04 | 8834 | 0.07 | 9122 |
| | (0.17) | | (0.05) | | (0.09) | |
| full time staff | 5.81 | 111063 | 10.55 | 8854 | 5.84 | 9133 |
| | (10.42) | | (11.66) | | (14.74) | |
| charter school | 0.07 | 110885 | 0.04 | 8835 | 0.11 | 9105 |
| | (0.25) | | (0.19) | | (0.31) | |
| overcrowded school 2001[a] | 0.06 | 111063 | 0.37 | 8854 | 0.1 | 9133 |
| | (0.23) | | (0.48) | | (0.3) | |
| in district with overcrowded school 2001[a] | 0.2 | 111063 | 0.52 | 8854 | 0.31 | 9133 |
| | (0.4) | | (0.5) | | (0.46) | |
| *C. Teacher Variables* | | | | | | |
| number of teachers | 28.39 | 98089 | 49.07 | 8660 | 28.32 | 8476 |
| | (25.97) | | (28.39) | | (22.11) | |
| percent of teachers, male | 26.57 | 90561 | 20.05 | 8595 | 23.94 | 7913 |
| | (22.26) | | (13.28) | | (19.88) | |
| percent of teachers with a PhD | 0.82 | 90516 | 0.73 | 8595 | 0.81 | 7893 |
| | (3.95) | | (2.7) | | (3.3) | |
| percent of teachers with a masters | 32.26 | 90516 | 27.76 | 8595 | 34.84 | 7893 |
| | (21.08) | | (15.25) | | (19.75) | |
| percent of teachers with a BA | 66.57 | 90516 | 71.2 | 8595 | 63.98 | 7893 |
| | (21.41) | | (15.61) | | (20.06) | |
| percent of teachers with less than a BA | 0.35 | 90516 | 0.31 | 8595 | 0.38 | 7893 |
| | (2.59) | | (1.74) | | (2.55) | |
| school average year teaching | 13.27 | 90555 | 11.08 | 8595 | 12.09 | 7911 |
| | (4.58) | | (2.95) | | (4.53) | |
| school average years teaching in the district | 10.73 | 90519 | 9.23 | 8595 | 9.77 | 7894 |
| | (4.33) | | (2.81) | | (4.35) | |
| percent of teachers working overtime | 1.28 | 90561 | 1.06 | 8595 | 1.22 | 7913 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (6.78) | | (8.09) | | (7.51) | |
| percent of teachers tenured | 69.38 | 90561 | 60.76 | 8595 | 67.88 | 7913 |
| | (28.01) | | (24.71) | | (28.75) | |
| percent of teachers fully credentialed | 77.39 | 90561 | 85.37 | 8595 | 80.51 | 7913 |
| | (36.01) | | (18.33) | | (32.43) | |
| percent of teachers hired, special conditions[b] | 7.63 | 90561 | 14.7 | 8595 | 8.83 | 7913 |
| | (12.9) | | (14.87) | | (14.34) | |
| percent of teachers certified, special ed | 7.92 | 90561 | 6.78 | 8595 | 8.6 | 7913 |
| | (12.39) | | (8.2) | | (12.77) | |
| percent of teachers certified, bilingual | 6.28 | 90561 | 15.01 | 8595 | 9.06 | 7913 |
| | (13.57) | | (20.32) | | (15.92) | |
| student to teacher ratio | 19.81 | 90557 | 20.68 | 8595 | 19.92 | 7913 |
| | (10.09) | | (11.58) | | (6.95) | |
| adjusted student to teacher ratio | 19.81 | 90557 | 16.24 | 8595 | 19.92 | 7913 |
| | (10.09) | | (9.20) | | (6.95) | |

Notes:

a. The California Department of Education makes available a one-time list of schools in its Critically Overcrowded School Facilities Program. This list was made available in 2003, using 2001 data.

b. This variable gives the percent of teachers hired under special conditions. Special conditions include teachers hired under emergency permits or short-term staff permits requested by employers when fully credentialed teachers cannot be found, waivers requested when neither certified teachers or teacher qualifying for emergency permits can be found, or when the teacher is serving as an intern teacher while pursuing credentials.

**Table 3. Number of Wake County Public Schools on each calendar type by year**

| Calendar Type | Year | | | | |
|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 |
| Traditional | 102 | 102 | 81 | 80 | 82 |
| *Percent* | *87.18* | *83.61* | *63.78* | *62.02* | *61.65* |
| Multi-Track YR | 15 | 20 | 46 | 49 | 51 |
| *Percent* | *12.82* | *16.39* | *36.22* | *37.98* | *38.35* |
| Total | 117 | 122 | 127 | 129 | 133 |

**Table 4. Student, School and Teacher Characteristics summarized separately by calendar type**

| | Traditional | | | Multi-Track YR | | |
|---|---|---|---|---|---|---|
| | Mean | SD | observations | Mean | SD | observations |
| ***A. Student Variables*** | | | | | | |
| Percent students, FR | 0.361 | 0.144 | 445 | 0.266 | 0.158 | 181 |
| Percent ESL | 0.066 | 0.049 | 411 | 0.066 | 0.049 | 179 |
| Percent LEP | 0.111 | 0.069 | 344 | 0.107 | 0.068 | 166 |
| Percent Black | 0.294 | 0.142 | 446 | 0.199 | 0.141 | 181 |
| Percent Hispanic | 0.128 | 0.074 | 446 | 0.126 | 0.082 | 181 |
| Percent White | 0.473 | 0.162 | 446 | 0.565 | 0.188 | 181 |
| %students who pass end-of-grade reading tests | 0.775 | 0.137 | 447 | 0.774 | 0.131 | 181 |
| %students who pass end-of-grade math tests | 0.767 | 0.105 | 447 | 0.840 | 0.090 | 181 |
| ***B. School Variables*** | | | | | | |
| #Students per instructional computer | 3.165 | 1.017 | 447 | 3.633 | 0.943 | 181 |
| Annual Yearly Progress | 0.421 | 0.494 | 444 | 0.530 | 0.500 | 181 |
| Average daily attendance | 0.954 | 0.011 | 447 | 0.957 | 0.006 | 181 |
| # books per students | 17.734 | 8.192 | 447 | 17.060 | 5.205 | 181 |
| Crimes per 100 students | 0.609 | 1.292 | 447 | 0.260 | 0.640 | 177 |
| Number of long term suspensions | 0.364 | 1.083 | 445 | 0.107 | 0.390 | 178 |
| Percent Crowding, includes mobile classrooms | 101.736 | 15.394 | 444 | 88.772 | 14.988 | 181 |
| Percent poverty | 0.419 | 0.170 | 447 | 0.302 | 0.172 | 181 |
| ***C. Teacher Variables*** | | | | | | |
| % Turnover | 0.228 | 0.092 | 447 | 0.183 | 0.078 | 181 |
| Number of Teachers | 51.826 | 13.704 | 447 | 56.724 | 12.261 | 181 |
| % Lateral entry | 0.019 | 0.028 | 349 | 0.011 | 0.020 | 103 |
| % Classes taught by highly qualified teachers | 0.980 | 0.044 | 447 | 0.989 | 0.032 | 181 |
| % Teachers fully licensed | 0.964 | 0.044 | 447 | 0.981 | 0.031 | 181 |
| %teacher 0-4 years experience | 0.231 | 0.094 | 447 | 0.215 | 0.082 | 181 |
| %teachers 4-10 years experience | 0.323 | 0.082 | 447 | 0.356 | 0.072 | 181 |
| %teachers with 11+ years | 0.446 | 0.112 | 447 | 0.429 | 0.105 | 181 |
| %teachers with advanced degrees | 0.298 | 0.081 | 447 | 0.302 | 0.082 | 181 |
| Number of national board certified teachers | 5.852 | 3.716 | 440 | 9.481 | 6.015 | 181 |

**Table 5. Wake County teacher characteristics summarized separately by calendar type**

| | Traditional | | | Multi-Track YR | | |
|---|---|---|---|---|---|---|
| | Mean | SD | Observations | Mean | SD | Observations |
| *A. Teacher Characteristics* | | | | | | |
| Annual Salary | 37,881 | (9783) | 14479 | 39,890 | (10441) | 7059 |
| Years of Experience | 12.519 | (8.689) | 14479 | 12.104 | (8.412) | 7059 |
| Masters Degree | 0.344 | (0.475) | 14479 | 0.337 | (0.473) | 7059 |
| Advanced Degree or Phd | 0.006 | (0.079) | 14479 | 0.006 | (0.076) | 7059 |
| | | | | | | |
| *B. Teacher Mobility* | | | | | | |
| Stay in current school | 0.864 | (0.343) | 14479 | 0.890 | (0.312) | 7059 |
| Leave for new Wake school | 0.075 | (0.264) | 14479 | 0.061 | (0.240) | 7059 |
| Leave for new NC school outside of Wake | 0.012 | (0.110) | 14479 | 0.007 | (0.086) | 7059 |
| Exit Sample | 0.049 | (0.216) | 14479 | 0.041 | (0.198) | 7059 |

**Table 6: School-level estimation for California, fixed effects specifications**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dependant variables: | number of teachers | student-teacher ratio | percent with PhD | percent with masters | percent with BA | percent with less than BA |
| *Calendar measures:* | | | | | | |
| Multi-track YRS calendar | 2.849*** | -1.156*** | -0.102* | -3.039*** | 3.232*** | -0.0913* |
| | (0.149) | (0.232) | (0.0605) | (0.418) | (0.421) | (0.0495) |
| Single-track YRS calendar | -0.152 | 0.00322 | -0.0147 | -0.594 | 0.655 | -0.0466 |
| | (0.190) | (0.199) | (0.111) | (0.558) | (0.548) | (0.0915) |
| Observations | 106,131 | 99,243 | 99,185 | 99,185 | 99,185 | 99,185 |
| R-squared | 0.942 | 0.368 | 0.461 | 0.708 | 0.705 | 0.415 |

| | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Dependant variables: | average years teaching | average years in district | percent full credentials | percent special conditions | percent cert. special educ. | percent cert. bilingual educ. |
| *Calendar measures:* | | | | | | |
| Multi-track YRS calendar | -1.307*** | -1.327*** | -1.237*** | 1.335*** | -0.437*** | 1.087*** |
| | (0.0846) | (0.0769) | (0.335) | (0.338) | (0.155) | (0.333) |
| Single-track YRS calendar | -0.296*** | -0.305*** | 2.447*** | -1.986*** | 0.236 | 0.0670 |
| | (0.113) | (0.0983) | (0.471) | (0.453) | (0.296) | (0.467) |
| Observations | 99,238 | 99,187 | 99,243 | 99,243 | 99,243 | 99,243 |
| R-squared | 0.681 | 0.712 | 0.940 | 0.586 | 0.642 | 0.564 |

Robust standard errors in parentheses. Errors are clustered at the school level.

*** p<0.01, ** p<0.05, * p<0.1

Notes: all specifications include school fixed effects and year effects, as well as school control variables. School control variables include: total enrollment, student racial composition, percent of students eligible for free and reduced price meals, computers and internet connected devices per student, non-teaching staff to student ratios, district expenditures and whether the school is a charter school.

**Table 7: School-level estimation for California, differenced specifications (fixed effects and school-specific time trends)**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Dependant variables: | number of teachers | student-teacher ratio | percent with PhD | percent with masters | percent with BA | percent with less than BA |
| *Calendar measures:* | | | | | | |
| Multi-track YRS calendar | 3.501*** | -0.456*** | -0.176* | -0.919*** | 1.146*** | -0.0522 |
| | (0.341) | (0.170) | (0.107) | (0.355) | (0.365) | (0.0798) |
| Single-track YRS calendar | 0.274 | -0.00734 | -0.0467 | -0.243 | 0.385 | -0.0954 |
| | (0.479) | (0.135) | (0.131) | (0.440) | (0.429) | (0.172) |
| Observations | 85,844 | 73,266 | 73,178 | 73,178 | 73,178 | 73,178 |
| R-squared | 0.111 | 0.242 | 0.112 | 0.136 | 0.135 | 0.097 |

| | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Dependant variables: | average years teaching | average years in district | percent full credentials | percent special conditions | percent cert. special educ. | percent cert. bilingual educ. |
| *Calendar measures:* | | | | | | |
| Multi-track YRS calendar | -0.363*** | -0.330*** | -0.0305 | -1.330*** | -0.235 | 0.916 |
| | (0.0636) | (0.0545) | (0.765) | (0.304) | (0.261) | (0.642) |
| Single-track YRS calendar | -0.0188 | -0.124* | 6.035*** | -1.687*** | 1.046*** | 1.419* |
| | (0.0907) | (0.0730) | (1.123) | (0.412) | (0.378) | (0.855) |
| Observations | 73,266 | 73,175 | 73,266 | 73,266 | 73,266 | 73,266 |
| R-squared | 0.160 | 0.173 | 0.252 | 0.155 | 0.185 | 0.157 |

Robust standard errors in parentheses. Errors are clustered at the school level.

*** p<0.01, ** p<0.05, * p<0.1

Notes: All specifications are differenced models that include school fixed effects. This approximates specifications including school fixed effects and school specific time trends, which cannot be run for computational reasons. All specifications include school control variables (see table notes for Table 5). Due to potential errors introduced in differences models, each specification presented here has been run using 1 year, 2-year and 3-year differences. Because findings are very similar across the three sets of specifications, we only report the 2-year differenced results. 2-year differenced results mostly fall between 1-year and 3-year differenced results.

**Table 8. School-Level estimation for WCPSS**

| | **1** | | **2** | | **3** | | **4** | |
|---|---|---|---|---|---|---|---|---|
| Dependent variables: | % Teacher Turnover | | %Teachers with 0 to 3 years of experience | | %Teachers with 4 to 10 years of experience | | %Teachers with 11+ years of experience | |
| | 1a | 1b | 2a | 2b | 3a | 3b | 4a | 4b |
| Multi-track YRS calendar | -0.0208** | 0.004 | -0.0165* | -0.0149 | 0.0416*** | 0.0171 | -0.0251 | -0.00229 |
| | (0.009) | (0.019) | (0.015) | (0.014) | (0.012) | (0.015) | (0.020) | (0.014) |
| School fixed effects | No | Yes | No | Yes | No | Yes | No | Yes |
| Observations | 617 | 617 | 617 | 617 | 617 | 617 | 617 | 617 |

| | **5** | | **6** | | **7** | |
|---|---|---|---|---|---|---|
| Dependent variables: | Number of Teachers | | %Teachers with advanced degrees | | %Teachers Fully Licensed | |
| | 5a | 5b | 6a | 6b | 7a | 7b |
| Multi-track YRS calendar | 5.054*** | 4.636*** | 0.00875 | -<br>0.0000939 | 0.00194 | 0.0122* |
| | (1.388) | (1.180) | (0.013) | (0.010) | (0.003) | (0.006) |
| School fixed effects | No | Yes | No | Yes | No | Yes |
| Observations | 617 | 617 | 617 | 617 | 617 | 617 |

Robust standard errors in parentheses. Errors are clustered at the school level.

***p<0.01, **p<0.05,*p<0.1

Notes: All specifications include year fixed effects and school control variables. School control variables include: students per instructional computer, average daily attendance, # books per students crimes per 100 students, number of long term suspensions, percent crowding, percent poverty, percent black and percent Hispanic.

**Table 9. Teacher-level estimations for WCPSS**

| **Dependent variable:** | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Leave school | -0.0267*** | -0.0068 | 0.0057 | -0.0285 |
| | (0.0048) | (0.0087) | (0.0186) | (0.0193) |
| Leave school for new Wake school | -0.0137*** | -0.0111 | -0.0055 | -0.0246* |
| | (0.0037) | (0.0074) | (0.0157) | (0.0146) |
| Leave for non-Wake school in NC | -0.00486*** | -0.0004 | -0.0030 | 0.0007 |
| | (0.0015) | (0.0020) | (0.0029) | (0.0026) |
| Exit sample | -0.00810*** | 0.0047 | 0.0143 | -0.0046 |
| | (0.0031) | (0.0046) | (0.0087) | (0.0088) |
| Number of teachers | 6019 | 6019 | 6019 | 6019 |
| Number of teacher-year observations | 21538 | 21538 | 21538 | 21538 |
| Controls for School & Teacher Characteristics | No | Yes | Yes | Yes |
| School Fixed Effects | No | No | Yes | Yes |
| Teacher Fixed Effects | No | No | No | Yes |
| Year Fixed Effects | No | Yes | Yes | Yes |

Robust standard errors in parentheses. Errors are clustered at the school level.

***p<0.01, **p<0.05,*p<0.1

Notes: School control variables include:

Students per instructional computer, average daily attendance, # books per students, crimes per 100 students, number of long term suspensions, percent crowding, percent poverty, percent black, percent Hispanic, number of teachers, %lateral entry, %classes taught by highly qualified teachers, %teachers highly licensed, %teachers 0-3 years experience, %teachers 4-10 years experience, %teachers with advanced degree, number of National Board Certified teachers

Teacher control variables include:

Annual salary, years of experience, masters degree, advanced or Phd degree

**Table 10: Specifications in Table 4, repeated using 3 variations to test for pre-emptive teacher moves**

Panel A: including dummy variables for the year of the calendar change, 1 year and 2 years prior to a calendar change

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependant variables: | number of teachers | student-teacher ratio | percent with PhD | percent with masters | percent with BA | percent with less than BA | average years teaching | average years in district | percent full credentials | percent special conditions | percent cert. special educ. | percent cert. bilingual educ. |
| Multi-track YRS calendar | 2.592*** | -0.320 | -0.218* | -1.046*** | 1.329*** | -0.0657 | -0.411*** | -0.407*** | -1.308 | -1.178*** | -0.0368 | 0.796 |
| | (0.441) | (0.236) | (0.117) | (0.386) | (0.395) | (0.0862) | (0.0769) | (0.0669) | (0.875) | (0.347) | (0.321) | (0.653) |
| Single-track YRS calendar | 0.136 | 0.0135 | -0.0771 | -0.297 | 0.479 | -0.105 | -0.0405 | -0.164** | 5.100*** | -1.641*** | 1.086*** | 1.303 |
| | (0.493) | (0.206) | (0.143) | (0.448) | (0.437) | (0.175) | (0.0913) | (0.0747) | (1.109) | (0.419) | (0.388) | (0.868) |
| Observations | 85,844 | 73,178 | 73,178 | 73,178 | 73,178 | 73,266 | 73,175 | 73,266 | 73,266 | 73,266 | 73,266 | 73,266 |
| R-squared | 0.112 | 0.112 | 0.136 | 0.135 | 0.097 | 0.160 | 0.173 | 0.253 | 0.155 | 0.185 | 0.157 | 0.242 |

Panel B: excluding from the sample the year of the calendar change, 1 year and 2 years prior to a calendar change

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multi-track YRS calendar | 3.929*** | -0.185 | -0.741* | 0.972** | -0.0463 | -0.419*** | -0.366*** | 0.488 | -0.804** | 0.372 | 2.010*** | -0.454* |
| | (0.467) | (0.136) | (0.405) | (0.424) | (0.0799) | (0.0865) | (0.0751) | (1.143) | (0.402) | (0.327) | (0.766) | (0.273) |
| Single-track YRS calendar | 0.892 | -0.0139 | -1.016* | 1.168** | -0.138 | -0.0563 | -0.154 | 8.916*** | -0.946 | 1.649*** | 1.788 | 0.319 |
| | (0.669) | (0.181) | (0.555) | (0.555) | (0.192) | (0.119) | (0.102) | (1.732) | (0.583) | (0.493) | (1.125) | (0.215) |
| Observations | 79,702 | 67,677 | 67,677 | 67,677 | 67,677 | 67,753 | 67,671 | 67,753 | 67,753 | 67,753 | 67,753 | 67,753 |
| R-squared | 0.106 | 0.142 | 0.143 | 0.144 | 0.116 | 0.167 | 0.180 | 0.260 | 0.163 | 0.194 | 0.170 | 0.131 |

Panel C: include variables for next year change to multi-track or single-track YRS calendar

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Multi-track YRS calendar | 3.851*** | -0.229* | -1.141*** | 1.389*** | -0.0184 | -0.363*** | -0.355*** | -1.353* | -1.408*** | -0.525* | 1.186 | -0.118 |
| | (0.386) | (0.132) | (0.391) | (0.403) | (0.105) | (0.0696) | (0.0606) | (0.820) | (0.348) | (0.283) | (0.723) | (0.497) |
| Single-track YRS calendar | 0.161 | 0.0117 | -0.253 | 0.334 | -0.0935 | 0.0238 | -0.0529 | 6.862*** | -1.973*** | 0.916** | 2.002** | -0.0323 |
| | (0.527) | (0.141) | (0.474) | (0.469) | (0.172) | (0.0984) | (0.0792) | (1.180) | (0.443) | (0.400) | (0.938) | (0.141) |
| Change to multi-track next year | 3.206*** | -0.110 | -0.216 | 0.0381 | 0.287 | -0.158 | -0.0888 | -3.203** | 0.251 | -1.319** | -0.571 | 2.623 |
| | (0.562) | (0.108) | (0.774) | (0.771) | (0.176) | (0.145) | (0.139) | (1.386) | (0.962) | (0.647) | (0.765) | (2.834) |
| Change to single-track next year | -0.627 | 0.236 | -0.125 | -0.118 | 0.00742 | 0.00147 | 0.178** | 5.091*** | -0.00319 | 0.276 | 0.295 | -0.101 |
| | (0.549) | (0.212) | (0.425) | (0.469) | (0.103) | (0.0878) | (0.0794) | (0.877) | (0.371) | (0.313) | (0.561) | (0.148) |
| Observations | 81,808 | 69,991 | 69,991 | 69,991 | 69,991 | 70,074 | 69,985 | 70,074 | 70,074 | 70,074 | 70,074 | 70,074 |
| R-squared | 0.111 | 0.129 | 0.141 | 0.142 | 0.098 | 0.166 | 0.184 | 0.252 | 0.161 | 0.194 | 0.162 | 0.222 |

Robust standard errors in parentheses. Errors are clustered at the school level.

*** p<0.01, ** p<0.05, * p<0.1

Notes: All specifications are differenced models that include school fixed effects. This approximates specifications including school fixed effects and school specific time trends, which cannot be run for computational reasons. All specifications include school control variables (see table notes for Table 5). Due to potential errors introduced in differences models, each specification presented here has been run using 1 year, 2-year and 3-year differences. Because findings are very similar across the three sets of specifications, we only report the 2-year differenced results. 2-year differenced results mostly fall between 1-year and 3-year differenced results.

**Table 11. School Fixed Effects Specifications in Table 7, including variables for next year change to YRS**

| | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Dependent variables: | % Teacher Turnover | %Teachers with 0 to 3 years of experience | %Teachers with 4 to 10 years of experience | %Teachers with 11+ years of experience |
| | 1 | 2 | 3 | 4 |
| Multi-track YRS calendar | -0.00204 | -0.00488 | 0.0112 | -0.00642 |
| | (0.0240) | (0.0152) | (0.0175) | (0.0169) |
| Change to YRS next year | -0.0316 | 0.00915 | -0.00235 | -0.00686 |
| | (0.0225) | (0.0123) | (0.0137) | (0.0120) |
| Observations | 536 | 536 | 536 | 536 |

| | **5** | **6** | **7** |
|---|---|---|---|
| Dependent variables: | Number of Teachers | %Teachers with advanced degrees | %Teachers Fully Licensed |
| | 5 | 6 | 7 |
| Multi-track YRS calendar | 5.709*** | 0.00254 | 0.0169 |
| | (1.5300) | (0.0114) | (0.0108) |
| Change to YRS next year | 3.609*** | 0.000671 | 0.0139 |
| | (1.0010) | (0.0077) | (0.0106) |
| Observations | 536 | 536 | 536 |

Robust standard errors in parentheses. Errors are clustered at the school level.

***p<0.01, **p<0.05,*p<0.1

Notes: All specifications include year fixed effects and school fixed effects and school control variables.

School control variables include: students per instructional computer, average daily attendance, # books per students crimes per 100 students, number of long term suspensions, percent crowding, percent poverty, percent black, and percent Hispanic.