Teachers' Unions and School Performance: Evidence from California Charter Schools

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[☆] We thank Ron Ehrenberg for valuable comments and suggestions, and Cassandra Hart and Aaron Sojourner for sharing their data on unionization dates and productive discussions that helped reconcile the differences between our results and those in their paper. All errors are our own.

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Abstract. We examine the impact of unions on the quality of educational production by studying a wave of unionization among California charter schools and administrative data on student achievement. We first present new data showing that unions are much more prevalent among charter schools than suggested by previous studies. Using a difference-in-differences identification strategy, we find that unionization increases achievement in mathematics and has no statistically significant impact on English test scores.

1. Introduction

Teachers' unions have been described as the "preeminent power in American education" (Moe 2001) and there is growing sentiment among academics and the public that their power is not being used for good. For example, in the 2011 Phi Delta Kappa/Gallup poll, 47 percent of respondents believed that unionization has hurt the quality of American education, compared to just 26 percent who held that unionization has helped (Bushaw and Lopez 2011). Across the nation, several state legislatures—such as those in Idaho, Ohio, Tennessee, and Wisconsin—have acted to curtail the power of teachers' unions by limiting the scope of their collective bargaining rights.

Teachers' unions may be a bellwether of public sector unionism more broadly, which now includes 20 million workers employed by federal, state, and local governments in the United States. Private sector unionization rates have declined precipi-

tously over the past 40 years to below 7 percent, and this decline has been linked to increased wage inequality and lower earnings growth for less-educated workers (see, e.g., Western and Rosenfeld (2011) or DiNardo, Fortin and Lemieux (1996)). In contrast, unionization in the public sector has increased and nearly 40 percent of all public sector workers are represented by unions.[1] The recent push to curtail union power may limit wage growth in this sector, a change that would especially affect women and African-American workers, who are disproportionately employed in the public sector. Critics argue that limiting union-driven wage growth is desirable, since unions push wages above market levels and raise the cost of public service provision. This sentiment is especially strong in education, where teachers' unions have been roundly criticized for blocking reforms that do not serve the financial interests of teachers (Hess and West 2006).

At least since Freeman and Medoff (1979), however, economists and other social scientists have recognized that unions can improve productivity in the public sector. For example, unions might give workers more voice in management and in so doing improve the flow of information within the institution or reduce worker turnover and associated costs, or by negotiating higher wages that attract more productive workers. There is little solid evidence of the impact that unions have on the quality of public education in the United States. To wit, two of the best papers on the subject come to differing conclusions. Hoxby (1996) studies the impact of changes in district unionization status induced by state laws permitting public sector workers to collectively bargain in the 1960s and 1970s. She concludes that while unions raise per-pupil spending and other inputs, they have an adverse effect on the district dropout rate suggesting a decline in quality. Lovenheim (2009), however, revisits the question

[1]Source: Bureau of Labor Statistics News Release Jan 23, 2015 http://www.bls.gov/news.release/union2.t03.htm accessed January 11, 2016.

using better data on district unionization for Iowa, Indiana, and Minnesota and finds no impact on high school dropout rates. Other studies reach differing conclusions including Eberts and Stone (1987), Kleiner and Petree (1988), and Peltzman (1996).

A major challenge confronted by all of these studies is the lack of useful outcome data available to measure changes in the quality of education production. This is largely due to the fact that changes in unionization status of districts or schools are rarely observed today. Most districts and schools unionized in the 1960s and 1970s following changes to state laws allowing public sector workers to unionize (Freeman 1988). Unfortunately, consistent data on student achievement from that era are not available and researchers have had to rely on high school graduation or dropout rates as the only measures of the quality of public schools.

This paper adds fresh evidence on the impact of unions in elementary and secondary education by examining a recent wave of charter school unionizations in California. This setting offers a chance to examine the role of teachers' unions in public education, and in particular to assess their impact on the quality of education using student test-score performance data. In this paper, we use administrative school-level data coupled with data on the timing of unionization collected via public records requests (PRR) we sent to each charter school in California and records of union recognition from the state Public Employment Relations Board (PERB) to estimate the impact of teacher unionization on student outcomes. California is a promising place to begin studying the impact of charter unionization because it has the most charter schools in the nation. Of course, there are a variety of reasons why the impacts of unions on school performance among charter schools may differ from their impacts in traditional public schools. But the growing share of students in the charter sector and the fact that some view the lack of teachers' unions as an important factor behind the promising results of some charters makes studying the impact of unions in this

sector interesting in its own right.

Our study builds on work by Hart and Sojourner (2015) (hereafter "HS"), who also investigate the effects of unions on school performance in California charter schools in a study similar to ours. Aided by our new data collection effort and several differences in methodological approach, we make several contributions. First is an improved estimate of the prevalence of teachers' unions in charter schools, finding significantly higher rates of unionization than have been previously documented. In particular, we find that in 2013 there were at least 277 unionized charters in California, about one-quarter of the 1,127 charter schools in operation in the state in that year. Prior studies estimated the unionization rate to be around 15 percent (Price 2011, Hart and Sojourner 2015).[2]

How do teachers' unions affect charter school performance? In addition to presenting descriptive results showing differences in school performance between unionized and non-unionized schools, we use a difference-in-differences research design to estimate the impact of unionization on student test scores. The crux of this analysis is to compare changes in outcomes for schools that do and do not unionize. This identifies the causal impact of unionization to the extent that the changes in outcomes in schools that do not unionize provide a suitable approximation to the counterfactual change in outcomes that unionized schools would have experienced had they not unionized–an assumption we are able to provide support for with the information available. The data include a variety of school-grade level characteristics, including racial composition, English-learner status, parent education levels, etc. that allow for some control to mitigate concerns of bias due to changing composition of the student body that might be correlated with changes in union status.

[2]While prior studies estimated the prevalence in 2011 and 2012, the earlier period of measurement accounts for only a small portion of the difference with our prevalence estimate.

In contrast to the predominant public opinion about school unionizations (Bushaw and Lopez 2011), we find that unionization has a positive and statically significant impact on student math performance and no statistically significant impact on English performance. In our preferred estimates, we find that unions increase average grade-level math test scores by .19 to .20 standard deviations (SD) and English scores by .05 to .06 SD (not statistically significant). For both subjects, the results of our analyses rule out even moderate negative effects. Our results differ from those of Hart and Sojourner (2015), who find no statistically significant impact of unions on test scores. We show the differences between our studies are driven by methodological choices, involving whether weights are used in our analyses and whether math and English test score outcomes are examined separately or pooled together. We argue the methodological choices made in the present paper are better justified in this setting, and discuss how the differences between our results raise new questions about heterogeneity in the impacts of unionization on students that future work should aim to resolve.

The paper next provides an overview of the literature on union impacts on schools, and then discusses the wave of charter school unionizations in California and the institutional details relevant for the study. Section 3 describes the data sources used, with particular attention to our data on teacher unionizations, and section 4 discusses descriptive statistics about unionized and non-unionized charter schools in California. Finally, section 5 presents the results of our analysis and section 6 concludes.

2. Background

The primary role of teachers' unions in the United states is to negotiate pay, benefits, working conditions, and employment security for teachers through collective bargaining practices (Eberts 2007). Although the role of teachers' unions is well un-

derstood, there is no theoretical or empirical consensus on how unions impact student outcomes. From a theoretical perspective, teachers' unions may improve student outcomes by attracting high quality teachers with higher average wages, or improving the effectiveness of existing teachers by decreasing turnover, and increasing communication, skill development, and coordination within the institution (Freeman and Medoff 1979). In contrast, teachers' unions may harm student outcomes if unions limit administrators' ability to pursue strategies that might boost student achievement such as compensating teachers for high performance or terminating underperforming teachers (Hanushek 2011) or if unions engage in rent seeking behavior that diverts resources away from uses that promote student learning (Hoxby 1996).

Empirical evidence on the impact of unionization on student outcomes is mixed.[3] Early studies such as Eberts (1987) and Kleiner and Petree (1988) find a positive relationship between unionization and student standardized test scores, but rely on strong assumptions about unobserved differences in students and districts in unionized relative to non-unionized settings that are unlikely to hold. Work by Hoxby (1996) and Lovenheim (2009) provide more reliable estimates by taking advantage of plausibly exogenous variation in district unionizations driven by changes in state unionization laws in the 1960s and 1970s. However these studies provide limited evidence on the subject for several reasons. First, these studies find contrasting results: Hoxby (1996) finds that unionization increases dropout rates while Lovenheim (2009) using narrower (i.e., for a smaller set of states), albeit higher quality, data finds no evidence that unionization increases dropout rates. A more recent study by Lovenheim and Willen (2016) studies the long-range impacts of this same wave of unionization and finds that unionization reduced long-run earnings for students attending unionized schools.

[3]See Cowen and Strunk (2015) for a recent and thorough review of the literature.

Second, these studies face significant data limitations and are unable to investigate the impact of unions on finer measures of academic performance like student test scores.

With limited academic outcome data available from the era of public school unionizations, the recent wave of charter school unionizations in places like California and Illinois provide a new opportunity to investigate the impact of teacher unionization on student outcomes in an empirically rigorous way. In this study, we take advantage of these recent unionizations to estimate the impact of unionization on student academic performance using data from California.

An important caveat in thinking about the generalizability of the results of our study is that the teacher unions that form in charter schools may differ from those in traditional public schools in important ways. Although we attempted to collect the collective bargaining agreements of unionized charters through our public records request (described below), we received too few responses to our request to systematically document the differences in the nature and strength of contracts across sectors (e.g., using methods proposed by Strunk and Reardon (2010)). There are both theoretical arguments and anecdotal evidence, however, suggesting that unions' strenght and hence the impact of unionization may be different in charters than in traditional public schools. Rose and Sonstelie (2010) develop a public choice model predicting that teachers' unions bargaining power will be greater in large schools or districts due to free-rider problems limiting the influence of parents. Moreover, there is evidence that union impacts on productivity are more negative where firms operate in less competitive product markets (Hirsch and Addison 1986). Though the analogy to these results is imperfect (e.g., charter school policies are not made through locally elected school boards), the facts that charter schools tend to be smaller than traditional public schools and must compete for student enrollment with other charters

and traditional public schools suggest that teachers' unions might have less power relative to parents and other stakeholders in charter schools (all else equal), and thus have different impacts on school governance and performance. A concrete example is provided by Green Dot Schools, a group of about 20 unionized charter schools in California, who adopted a pay-for-performance provision in a recent collective bargaining agreement.[4] Although charter schools and their collective bargaining agreements may differ in important ways from traditional schools, understanding how charter unions impact academic outcomes is important, given that so little is known about the impact of teachers' unions on students' education. Additionally, with the growth of charter school enrollment in the United States, understanding the impact of unionizations on charter school students is important in its own right.

While the recent charter school unionizations in the United States have generated new opportunities to investigate the impact of unionizations in education, to date there has been little research on their prevalence or their impact. One exception is a recent study by Hart and Sojourner (2015). Similar to our approach, Hart and Sojourner (2015) use a difference-in-difference research design based on data on charter schools in California. Our study differs from their work in several ways that lead to different conclusions about the impact of unions on educational production. First, we collect a large body of data on school unionizations via public records requests (PRR) that identifies significantly more charter schools that unionized in California. This additional data allows us to better characterize the prevalence of unionization of charter schools in California—we find nearly twice as many unionized schools overall. We also believe our categorization to be more accurate: of the 42 charter schools classified as switching from non-union to union in Hart and Sojourner (2015), our

[4]See, for example, http://www.dailynews.com/social-affairs/20120706/green-dot-charter-schools-move-toward-merit-pay-instead-of-seniority-for-teachers.

PRR request suggests that five never unionized and two had unionized prior to the start of the period.[5] Second, while Hart and Sojourner (2015) find no significant impact of unionizations on test scores, we find that unionization significantly improves math test score performance. We show the difference in results is driven primarily by differences in methodology involving whether achievement scores across subjects are combined into a single outcome index, and whether sample weights are used in the regression analyses in our paper. We argue the choices we have made are more appropriate and shed a more positive light on the impact of teacher unions in charter schools, but discuss the implications of the lack of robustness of results for future research. We also investigate the impact of unions on several school inputs often associated with quality to explore potential mechanisms through which unions might influence school productivity.

3. Data and Research Design

We combine data from multiple sources to identify which California charters have teachers' unions and the dates when unions were formed or dissolved, and to measure these schools' characteristics and performance. One primary source of data on schools' union status is a dataset of all representation decisions for cases filed with the California Public Employment Relations Board (PERB) between May 2001 and May 2012. In California, when a school applies for a charter it chooses whether the school or the chartering entity (i.e., the district granting a charter) is the employer for collective bargaining purposes.[6] Many (but not all) charter operators choose to be the

[5]It is possible that our data better reflect whether teachers were covered by a collective bargaining agreement, whereas Hart and Sojourner's PERB capture union recognition. While we asked both about union recognition and the presence of a contract in our PRR, in practice respondents nearly always reported the same answer for each question.

[6]This is not true in other states: in Wisconsin, for example, all charters are covered by district collective bargaining agreements whereas in other states some charters are required be covered

employer to avoid being folded into existing district collective bargaining agreements (EdSource 2004). Public service workers in California—including teachers—can organize through a "card check" procedure: if a majority of teachers in a school sign authorization cards stating their desire to be represented by a union, then the school management is required by the PERB to recognize and bargain in good faith with the union. It is fairly unusual for an employer to attempt to block unionization at this stage, but some do, usually on technical grounds such as contesting whether the proposed class of workers is appropriate, or whether votes were counted correctly in determining whether a majority of the class has in fact signed cards. More common is that upon presentation of the cards to management, the employer "voluntarily" recognizes the union and this is simply recorded by the state PERB. The data include information on 90 recognition request actions for 142 schools, with a union being recognized in 106 unique school cases (though some of these schools are recategorized as non-unionized based on our additional data collection or lack outcome data and so are not used in our analyses).[7]

Motivated by discrepancies between the PERB data and list of unionized schools from a previous study (Price 2011), in the Fall of 2013 we contacted each of the 1,127 charter schools identified by the 2013 California Public Schools Database and requested that they provide us with information about their teacher unionization and collective bargaining history.[8] In total 939 (83.3%) of these schools responded to our

(conversion schools authorized by a unionized district, for example) and others are not. Again, this makes California a favorable setting for the research question posed here since many other states with large numbers of unionized charters do not have charters switching their union status, which is necessary to employ the difference in difference research design described above.

[7]Of these 106 schools, we were unable to match 1 school to a California school identification number and we re-categorized 22 as having never unionized based on our PRR results. Of the remaining 83 schools identified as unionized by the PERB, 9 never report CST test scores and 4 schools have no reported CST scores after unionization. This leads to 70 unionized schools being identified by the PERB in our analysis sample.

[8]Initial requests for information were sent by e-mail around the week of October 9, 2013. Two

request, with 265 of these schools indicating that teachers had recognized a teacher's union since the school was formed. Combining data from the PERB and our Public Records Requests (PRR), we find that teachers at at least 291 charter schools—more than one quarter of all charters schools in operation in the state—unionized at some point prior to 2013.[9]

We define a charter school as being unionized in the following way. In most cases, we assign unionized status to schools following the year in which a union is recognized in the PERB data, or reports first recognizing a union in our public records request. In 6 cases, an individual school appears to have a union recognition granted multiple times. We use the earliest unionization decision for these schools. In the 15 cases where a union is recognized for a charter organization with multiple schools, we assume that all of the schools (47 total) in these charter organizations become unionized at that point. In some cases, the PRR and PERB data conflict. For example, in a few cases our PRR records provide a different unionization year than that listed in the PERB records. Additionally, our PRR identifies 17 schools that indicated they had never unionized in spite of having an applicable union recognition decision from the PERB. Because our PRR relies on direct responses from school administrators, we defer to the PRR in both situations.

Our principal source of data on schools and student achievement outcomes is the Standardized Testing and Reporting (STAR) program which is maintained by the

subsequent follow-up e-mail requests were sent between October 29, 2013 and December 12, 2013.

[9]To identify potential distinctions between union recognition and whether workers were covered by collective bargaining contracts, our PRR requested separate information be provided about the dates of union recognition and the dates of the first collective bargaining agreement. While the differences in these measures may have been interesting to investigate, as some unions that are recognized may fail to negotiate a contract, PRR respondents appeared to treat the questions as equivalent with very few differences reported. Only 3 schools indicated having ever recognized a union without signing a collective bargaining agreement, and no schools indicated being covered by a collective bargaining agreement without having recognized a union.

California Department of Education. In particular, we use reports from the annual California Standards Tests (CST), which are the primary tests administered in the STAR program.[10] The CST reports summarize grade-level performance levels in Math and English Language Arts (ELA) for each school in California between 2003 and 2013.[11] The STAR data also contain important input-based quality metrics, including average class-size and teacher experience. The data also include information about student characteristics, including racial and ethnic composition, the fraction of English Language Learners (ELL), parents' education level, free and reduced-price lunch eligibility, and so on. We supplement the STAR data with school level measures from the National Center on Education Statistics' (NCES) Common Core database, which provides alternative measures of staffing and teacher-pupil ratios.

For our main analyses, we use data on the 1,266 charter schools that were active between 2003 and 2013, have valid CST scores, and that report key school demographic data including student population and racial composition. We define the key treatment of interest as an indicator variable equal to one if the school has recognized a teachers' union as of the previous school year, as identified either in the PERB

[10]Other tests in the star program include California Alternate Performance Assessment (CAPA), California Modified Assessment (CMA) and alternate language tests such as the Standards-based Tests in Spanish (STS). The CAPA was introduced in 2003 and is a test for students with significant cognitive disabilities as determined by Individualized Education Program (IEP) team members, and cannot participate in the CST or CMA tests. The CMA tests were introduced in 2007 and are intended for special education students whose disabilities preclude them from receiving proficient levels on the CST test. The CMA tests the same grade level content as the CST but is less challenging. Between 1998 and 2013 a number of STAR tests have been administered in Spanish to students who either take all classes in Spanish or have spent less than 12 months in United States schools. These tests include The Spanish Assessment of Basic Education (SABE/2, 1998-2005), Aprenda 3 (2006), and STS (2007-2013).

[11]The CST were administered in earlier years beginning in 1999, but significant changes between 1999-2002 make comparisons before and after 2003 problematic. Performance levels were not reported for both ELA and Mathematics tests until 2002. Additionally, separate CAPA tests were not administered until 2003. For these reasons, we focus on CST tests from 2003-2013. The STAR system was replaced in July 2013 by the California Assessment of Student Performance and Progress (CAASPP) system.

or PRR data. In supplementary analyses we find similar results if we use a definition based on whether the teachers at a school are covered by a collective bargaining agreement, based on our PRR data, in the academic year. To measure the quality of education at each school, we employ several indicators of school and student academic performance. First are the CST Math and ELA grade level scale scores for students in grades 2-7 and 2-11, respectively. While our analysis focuses on charter schools, we use the universe of California public school CST scores to construct z-scores (normalized to mean=0, standard deviation=1) for each school-grade-year observation.[12] We use this larger group of schools to create z-score measures in order to avoid potential bias generated by significant fluctuations in the composition of charter schools over our sample period.[13] In order to assess whether unions might have differential effects on students in different parts of the achievement distribution, we also examine impacts on the percent of students who receive mathematics and ELA scores that are categorized by the state as being at "advanced", "basic", or "below basic and lower" levels of proficiency in each grade level. We also examine whether unionization effects vary by grade levels. In addition to these outcome measures, we also examine potential outcome measures such as class size and teacher composition.

As alluded to above, this paper leverages a wave of unionization in California charter schools from 2001 to 2013 to study the effect of teacher unions on student outcomes. Charter schools were first allowed in California by the 1992 Charter School Act, and by 2000[14] there were 235 charter schools in operation. Charters expanded

[12]Note that these scores are normalized by the standard deviation of average test scores across schools in each grade, rather than by the student-level standard deviation of test scores. In our discussion of the results we use published statistics on the student level variation in test-scores to construct effect sizes based on student-level standard deviations, to faciliate comparison with the literature.

[13]In practice, creating z-scores using only charter schools yields qualitatively similar results in each of our estimates.

[14]We refer to school years by the year in which they end. So 2000 refers to the school year from

dramatically over the next 15 years, with 502 schools operating in 2005, 809 in 2010, and 1,182 schools in 2015.[15]

At the same time, the number of charter schools where teachers were represented by a union also increased. Evidence from our data collection efforts shows that the number of unionized charters increased over this period from approximately 142 in 2003 to at least 277 charter schools in 2013. Part of the increase was driven by conversions of traditional public schools with a union contract already in place into a charter school. But a significant number of operating charter schools newly unionized over this period, and they constitute the focus of the causal analyses in this paper. After limiting our sample to schools for which the necessary test score outcomes and school demographic information is available, we identify 46 charter schools that switch their union status over the period, with two schools out of that total electing to disband a preexisting union. To illustrate when these schools switched their union status during our sample window, Table 1 shows data on the flow and stock of unionized charter schools between 2003 and 2013. The Table shows that in 2003 there were already 123 unionized charter schools (that pass our criteria for inclusion in the analysis sample, described below), and that number grew by between 9 and 17 schools in each year afterwards until 2013 when there were 4 net new additions. Unionized charter schools can come into existence in three ways. Most commonly, traditional public schools that operated under a union convert to a charter school. These schools are less useful for our main analysis since their union status is not changing. Second, in a small number of cases new charter schools are created with union representation for teachers from the start, a situation that also does not lend

the fall of 1999 to the Spring of 2000.

[15]The reported number of charter schools in operation differs slightly across sources. These figures are "official" counts from the California Charter Association (http://www.ccsa.org/understanding/numbers/ accessed on December 29, 2015).

itself to our research design due to the lack of outcome data prior to unionization. Finally, some charter schools unionize after already operating as a charter. We refer to these schools as "switchers," and they provide the identification of our estimates of the effect of unions on students' outcomes.[16]

As shown below (Table 2), the linked data reveal that unionized charter schools appear to be higher performing than non-unionized charters: on average, their students have substantially higher Math and English test scores. These raw differences in achievement, however, may in part reflect other differences between unionized and non-unionized schools that mask the true causal effect of the union. We attempt to isolate the causal effect of unions on education quality by estimating difference-in-difference models[17] of the following form:

$$Y_{st} = \alpha + U_{st}\beta + \mu_s + \tau_t + X_{st}\Gamma + \epsilon_{st}, \tag{1}$$

where Y_{st} represents some measure of school quality like average test scores for school s in year t; U_{st} is an indicator for whether teachers are represented by a union; μ_s is a vector of school fixed-effects; τ_t is a vector of year fixed-effects; X_{st} is a vector of time-varying school-level determinants of outcomes including parents' education, students' race and ethnic composition, the fraction of students receiving free and reduced price lunch, etc.; and ϵ_{st} represents unobserved determinants of school outcomes.

[16]We identify 46 switchers, whereas HS identify 42. Of the 42 switchers identified in HS's study, our data agree in 32 cases. In 7 of the 10 schools where we identify the school as not unionizing, the difference is due to our PRR data indicating the school was either never (5 schools) or always (2) unionized.

[17]In other contexts (e.g., DiNardo and Lee (2004)), this selection problem has been addressed by employing a regression discontinuity design based on data from union representation elections. While some states may have such elections that influence whether teachers are represented by unions in charter schools, this is not the case in California where a 'card-check' procedure is sufficient to establish a union.

In the statistical model above, the causal impact of a teachers' union on education quality is estimated by the difference in the *change* in the outcome Y_{st} for schools that unionize relative to the change in that outcome for schools that do not unionize. The internal validity of this estimate rests on an assumption that no other determinants of Y_{st} (conditional on X_{st}) are changing differentially for schools that do and do not unionize. This is a strong assumption in the context of teacher unionization: it is likely that schools that unionize differ from those that do not on a number of dimensions. One possibility is that schools that unionize do so because teachers are unsatisfied or seeking more voice in management in response to declining school-level performance (relative to some prior trend). If that is the case then teachers' unions may appear to adversely affect school performance, when in fact the causality runs in the opposite direction.

We will test for such threats to validity in a number of ways. First, the model above can be estimated with and without the vector of control variables X_{st}. If estimates of the effect of unionization (β) are insensitive to these controls, it is more plausible that changes in related but unobserved determinants of outcomes are uncorrelated with changes in union status (Gelbach 2016). We also estimate event study models that enable further tests of the key identification assumption. In particular, we estimate the parameters of the equation:

$$Y_{st} = \sum_{k=-t_{pre}}^{t_{post}} 1\{t = t_s^* + k\}\theta_k + \mu_s + \tau_t + X_{st}\Gamma + \epsilon_{st}, \tag{2}$$

where $1\{t = t_s^* + k\}$ represents a series of event-time indicator variables with associated coefficients θ_k covering a period from t_{pre} years prior to the school's unionization event (in year t_s^*) to t_{post} years afterwards. We exclude these terms for $k = -1$ so the coefficients θ_k capture the difference in the average outcome Y_{st} between schools that

do and do not unionize in each year relative to the year before the unionization year. Testing whether the coefficients $\theta_k = 0$ for $k < -1$ is an important validity check on the identification assumption that the trends in outcomes between unionizing schools and non-unionizing schools do not diverge prior to unionization. This specification is also useful because the event time coefficients capture dynamic impacts of unionization on school outcomes, which might occur if the longer term impacts of unionization differ from short-run effects as unions become more demanding in contract negotiations over time. In practice, the lack of a long time-series for most school outcomes relative to when schools' unionize limits the scope of analyses along these lines, as discussed below.

4. Descriptive Overview of Charter School Unionization in California

Through our collection of administrative recognition data and our public records request, we identified 291 charter schools represented by a union at any time between 2003 and 2013, of which 247 are included in our analysis sample.[18] In 2013, the last year in our sample, 277 of the 1,127 (24.5 percent) operating charters report that teachers are represented by a union, enrolling 32.4 percent of all charter school students. This prevalence figure is significantly larger than has been reported in previous studies, and suggests teachers unions are a more prevalent feature of charter schools than has been previously understood—at least in California. For example, Hart and Sojourner (2015) report 141 unionized charter schools (12.5 percent of all charters) in 2012, only slightly higher than the 12 percent reported by Price (2011) for 2010. Most of the additional schools we identify are due to our public records request

[18] Our analysis sample excludes 26 unionized schools for which we are unable to identify the date of unionization, 17 unionized schools that are missing test score data, and 1 unionized school that does not report student demographic data.

(PRR) that identify a large number of schools that maintained their unionization status when they converted from traditional public schools to charter schools, and so did not file for union recognition with the PERB. Particularly important to our analysis are the 46 schools that we identify that have CST score reports both before and after a switch in unionization status. Among these schools 45 gained union representation (39 identified by the PERB[19] and 6 identified (only) through our PRR) and 1 lost union representation (identified in the PRR request).

Table 2 uses these data to summarize the characteristics of charter schools operating in California in 2013 by their union status. The first column presents averages across all charter schools that report Math or English CST test scores, whereas the second two columns present these statistics separately by whether or not the school was unionized in 2013. The fourth column presents results for schools only identified through the PERB data, omitting the schools we identify only through our public records request. The fifth column presents summary statistics for the "switcher" schools that provide identification for our estimates of the effects of unionization on school performance.

The data reveal several interesting differences between schools that do and do not have a teachers' union. On average, the unionized charters are larger, with higher student enrollment and more teachers. This is related to the fact that slightly more than three-quarters of unionized charters are "conversion charters": charter schools that were traditional public schools where teachers were likely represented by a teachers' union already before the school converted to a charter school. While the differences

[19]In the case of charter school organizations with more than 1 school, the PERB records list the larger organization instead of the individual schools. In some cases, the same organization has multiple decisions, and for 11 schools we are unable to identify which decision is applicable. While it is likely that the earlier decision applies to the schools, we present the more conservative estimates that use the most recent decision as the point of unionization. Our results are not sensitive to this decision.

are not dramatic, on average students in unionized schools have characteristics associated with higher academic performance than their counterparts in nonunionized schools. For example, students in unionized schools are more likely to be Asian, less likely to be Black, less likely to be on free or reduced priced lunch, and a greater share of their parents have a college degree or more.

Both input- and output-based measures of quality differ greatly between unionized and non-unionized charters. Teachers in unionized charter schools have about four more years of experience on average than their counterparts in non-unionized charters. Several studies suggest that the returns to teacher experience are small beyond the first several years (Kane, Rockoff and Staiger 2008), but two recent studies have found these returns remain significant at higher levels of experience as well (Wiswall 2013, Papay and Kraft 2015). They are also much more likely to be covered by tenure or to be tenure track: about 80 percent of teachers at unionized charters are tenure track, compared to about 30 percent at non-unionized charters, and about 70 percent of teachers at schools with a union have tenure compared to about 20 percent at schools without. Student outcomes on both math and reading achievement tests differ greatly, with unionized charter school students scoring about .5 standard deviations higher on math, and .3 standard deviations higher in reading than students in non-unionized charter schools.

While overall unionized charter schools are higher performing and serve less disadvantage students than non-unionized charters, the opposite is true for charter schools that we observe switching their union status between 2003 and 2013. For example, relative to non-unionized charters "switchers" have substantially lower math achievement scores and serve higher fractions of minority, English Language Learner, and low-parental education students. This reflects the fact that switchers tend to be concentrated in large urban school districts, with nearly half located in Los Angeles,

Oakland, or San Diego.

5. Results

How do unions affect the learning outcomes of students? This section first shows our analyses of the impact of teachers' unions on student test scores, and finds that unions appear to increase student achievement in math but have little impact on English test scores. We then explore heterogeneity in these impacts for different types of students, and whether these effects may be mediated by impacts on the educational environment in schools. As noted above, Hart and Sojourner (2015) find no evidence that teachers' unions affected student achievement in the same setting.[20] We show that an analysis of heterogeneous effects by subject and slightly different methodology leads us to substantively different conclusions. While more work is necessary to satisfactorily characterize the impact of unions on student learning in charter schools, we argue that our results shift the weight of the evidence in favor of the view that unions positively affect education production, at least in this setting.

5.1. Effects on student achievement

Table 3 presents estimates of the impact of charter school unionization on math achievement for students in grades 2 through 7. The first column of Table 3 shows that when all school by grade by year observations are pooled together, math test scores are about .67 standard deviations higher[21] when a school is unionized, echoing

[20]More precisely, HS find a temporary decline in student achievement in the years just prior to unionization but no sustained effect. We began this project approximately contemporaneously with Hart and Sojourner, but their manuscript was finalized before ours while we incorporated additional data from our PRR. We decided on the methodology for the main results presented below before seeing their manuscript, but implemented the additional analyses in the Appendix to reconcile our results with those described in their paper.

[21]Recall this is the standard deviation of average school-grade test scores in each year, rather than of the student-level test score distribution. We convert our preferred estimates of the union effects on

the descriptive results in Table 2 showing that unionized schools have higher average achievement scores. In column two, a variety of controls for student and school characteristics as well as grade by year fixed effects are added to the regression model to control for the differences between unionized and non-unionized schools described in Table 2. These controls reduce the estimated effect of unionization to about .47 standard deviations of the distribution of average test scores across schools. It is still likely that unobserved differences between unionized and non-unionized schools contribute to this apparent positive "effect" of unions, so we next implement the difference-in-differences design to control for potential biases due to time-invariant but unobserved influences on school performance.

In columns 3 through 6 in the table, we present estimates of the impact of unionization based on equation (1) above, successively adding additional variables to the vector X_{st}. In the base model with school and grade-by-year fixed effects, the estimated impact of unions is .200 standard deviations, statistically significantly different than zero at the .05 level.[22] As we control for the size of the school, its number of years in operation, and the percent of its students tested the estimated effect is nearly unchanged at .193 standard deviations. Adding controls for student racial composition and socioeconomic background in columns 5 and 6, respectively, results in estimated effects that are nearly identical. Together the stability of results suggests that our results are not confounded by changes in enrollment or the composition of students. To facilitate comparison of our estimated effects with the broader literature on the

achievement to student-level standard deviation equivalents below to facilitate comparisons with the literature. This is done by first estimating effects on 'scale' scores–reported in Appendix Tables A1 and A2, and then comparing those estimates to published data on student-level standard deviations of test scores in each subject-grade-year.

[22]We calculate standard errors clustered at the school level. Clustering instead at the charter management organization level produces near identical results. For example, standard error estimates on the unionization coefficient are at most .6 percent larger than those in Table 3 when clustering at the charter management organization level instead of the school level.

effects of various educational interventions, the Appendix shows estimates using scale scores on the CST as the outcome variable. Using estimates of the student level standard deviation of test scores suggests that our preferred estimate in Table 3–a .191 standard deviation of school-level average test scores–is equivalent to approximately .17 standard deviations of the student-level test score distribution.[23]

Table 4 presents a similar set of analyses of the impact of unions on English test scores. Using the pooled data, columns 1 and 2 again shows that unionized charters have average test scores that are about one-third of a (school-level) standard deviation higher than non-unionized charters, and this difference shrinks by about one-third when we control for school characteristics and student demographics. In the difference-in-differences specifications in columns three to six the estimated effects of unionization are between .050 and .056 standard deviations (s.e. of about .044). Again using estimates of effects on scale scores and the student-level standard deviation of scores, this effect is equal to about .06 standard deviations of the student-level test score distribution.

The main threat to identification in the difference-in-differences estimates presented above is that schools that change unionization status may experience different underlying trends in test scores than schools that do not change unionization status for reasons unrelated to unions. The fact that adding covariates does not influence these estimates (i.e., estimates in columns 6 are similar to those in column 3 in Tables 3 and 4) strengthens our faith that unobserved determinants of achievement are not changing differentially for unionizing schools relative to non-unionizing schools in a way that biases our estimates of the effect of unionization. We can more directly

[23]Weighted by the number of test-takers overall years and grade levels, the student level standard deviation of Math test scores is about 36.1, and the standard deviation of English test scores is about 30.0.

assess whether our "common trends" assumption is reasonable by testing for the presence of different trends in test scores prior to the year in which schools unionized by estimating the event study model defined in equation (2) described above.

The results of this analysis are presented in Figure 1 (and the corresponding coefficient estimates and standard errors are presented in Appendix Table A3), which shows the differences in student achievement levels in unionized schools relative to non-unionized schools, normalizing the difference in the year prior to the unionization event (i.e., -1 on the x-axis of the Figure) to zero. The results from the event study lend credence to the common trends assumption. In particular, in the pre-period when neither group of schools have unionized, there is no evidence in either panel that test scores are changing differentially in schools that unionize. The top panel shows, however, that unionized schools see math scores increase in relative terms in the year after unionization, and that this effect persists with roughly the same magnitude at least 3 years after the unionization event. A similar pattern is evident for English achievement, though the increase in test scores in the post-period appears delayed by one year and the magnitude of the effect is substantially smaller as already shown by the analyses in Tables 3 and 4. In analyses not shown, we also estimated the event study for subsets of schools that form balanced panels in 'event time'[24] to prevent composition effects from biasing results, and found very similar results.

The main results of our analyses are thus that unionization in charter schools positively affects student achievement in math, but has a smaller and statistically insignificant impact on English achievement. In analyses presented in the Appendix, we attempt to replicate the results of Hart and Sojourner (2015) (hereafter HS), and show our results differ primarily due to two differences in our methodological

[24]For example, restricting the panel to schools for which data on the key variables exist for at least 3 years before and after the unionization event.

approach. First, HS combine math, English, and other test scores to form a single school-grade index of performance. While we had no *a priori* expectation that impacts on math would be higher than impacts on English, we followed common practice in the economics of education literature in assessing education interventions, where differential impacts by subject are commonplace if not necessarily well-understood. Since estimated impacts on English are much smaller in magnitude than those on math, and English is tested in 10 grades compared to only six for math, combining the two subjects leads to estimates that are smaller in magnitude.

A more subtle methodological difference is that HS estimate their model using weighted least squares, using the number of test-takers in each school-grade as weights. This difference matters also: we show that estimating HS's specification without weights yields a positive and significant estimated impact of unions on student achievement driven by a difference in the estimated impact on English achievement. We argue in the Appendix that the justification for using weights in this context is weak, following arguments by Solon, Haider and Wooldridge (2015), and investigate potential heterogeneity in the impact of unions on achievement by school size implied by the differences across weighted and unweighted results. Though statistically imprecise, the point estimates are consistent with a less positive effect of unions on English achievement in larger schools, echoing previous studies arguing that rent-seeking behavior on the part of unions may be more likely to harm students in larger districts where parents may find it harder to coordinate to advocate for their children's interests (Rose and Sonstelie 2010).

5.2. Heterogenity in unionization impacts, and impacts on inputs

Previous studies have suggested that union effects on educational outcomes may be concentrated among high- or low-achieving students, or amongst students in partic-

ular grade levels. In Table 5 we estimate the impact of unionization on the proportion of students achieving "Advanced", "Basic", "Below Basic" levels of achievement in math and English.[25] Our results suggest that unionization benefits the learning of students with low levels of achievement the most. In math, unions reduce the fraction of students scoring "Below Basic" levels by about 3.3 percentage points, and in English unions reduce the fraction of students scoring "Below Basic" by about 1.1 percentage points. Estimates of movement into "Advanced" levels are positive for both math (1.7 percentage points) and English (.5 percentage points), but are not statistically significant, suggesting less impact on students in the upper part of the achievement distribution.

In Table 6 we examine whether the impact of unionization on student achievement varies by grade level. We aggregate scores from typical elementary grades (2-5), middle school grades (6-8) and high school grades (9-11) and call these elementary, middle and high school. Since charter schools span grades that cross traditional grade-span boundaries, some schools contribute to analyses in multiple groupings, but we use only the relevant grade-level's test score results in the analyses here. The Table shows that point estimates for the estimated effects of unionization on achievement are larger for younger students in both math and English. The estimates are not sufficiently precise, however, to rule out the hypothesis of equal impacts across grades so these results should only be taken as suggestive. One further dimension

[25]California categorizes each test score into one of five categories: Advanced, Proficient, Basic, Below Basic, and Far Below Basic. In general, an "Advanced" rating signals grade level mastery, "Proficient" signals grade level competency, "Basic" represents a partial or rudimentary understanding, and both "Below Basic" and "Far Below Basic", represents limited or no understanding of grade level subject material. Our below "Below Basic" measure includes "Far Below Basic" whereas our other categorizations are mutually exclusive. We omit results on the fraction proficient from the Table, since in each case the coefficient is approximately the (negative of) the sum of the coefficients shown. Full descriptions of categorizations can be found on the California Department of Education website: http://www.cde.ca.gov/ta/tg/sr/documents/pldreport.pdf .

of heterogeneity we explored was whether unionization impacts differed for unions that were recognized voluntarily by school management, or through a card-check procedure. While the point estimates positive and significant impacts for both types of unionization events, these analyses are also too imprecise to draw firm conclusions since very few 'switchers' (between 3 and 9) unionize via card-check.[26]

As noted above, there are many potential mechanisms through which unionization could alter school performance. Unfortunately our data allow only an assessment of how unionization impacts a small set of inputs that have been associated with school quality. Table 7 shows that unionization leads to a decline in average teacher experience (of about .8 years), but no statistically significant effect on the share of teachers with a master's degree or the fraction of teachers in a non-tenure track position. Moreover, unionization appears to have no statistically significant impact on class-size. Overall, the only significant result—the negative impact on teacher experience—in the limited analyses in Table 7 is suggestive of a negative impact of unionization. Further work is needed to explore other channels through which unions affect educational production, perhaps including effects on teacher morale or school governance through better coordination and information exchange between teachers and school leadership.

6. Discussion

The results presented above yield some interesting new insights about the role of unionization in a growing sector of American education. First, our data suggest that unionization is far more prevalent in charter schools—at least in California—

[26]For these analyses, we estimate the effects for voluntary recognition schools by dropping the switchers where unions are recognized through a card-check procedure (and vice versa). There are three schools that unionize via card-check and six schools where we cannot tell whether they unionized via voluntary recognition or card-check.

than is commonly appreciated, with teachers in nearly one in four charter schools being represented by a union, and nearly one in three students attending a unionized charter school. More importantly, comparing the performance of these charter schools before and after they unionize with the evolution of test scores in a group of non-unionizing schools suggests that unions have a positive impact on math achievement, and no detectable effect on English achievement in California charter schools. We show how slight methodological differences lead us to different conclusions from prior work on unionization in California charters. In concluding, we briefly highlight some limitations of the study and suggest future directions for work in this area.

First, while California provides perhaps the best case in terms of the available data and number of schools unionizing, a variety of factors conspire to limit the internal and statistical validity of our study. In particular, relatively few charter schools switch their union status and we have a short window of test score data over which to observe changes in performance. Unfortunately California discontinued use of the CST testing instrument at the end of 2013, so further analyses of the California case will have to contend with a change in the outcome measure across testing regimes. This lack of data post 2013 limits our ability to learn from the large number of schools that unionized in the most recent years, and of course limits the precision of our estimated impacts and thus our ability to detect smaller but potentially meaningful union impacts, such as those found for English, and heterogeneity in those effects across different types of schools or unions.

More broadly, it is important to note that the effect of unions could differ across contexts, for example, depending on the degree of competition a school faces, the details of the contract negotiated between the charter operator and the union, or the organizational structure of the charter school. Moe (2009) and Strunk (2011) suggest that contract provisions affect school and student performance, and there is emerging

evidence that these provisions vary substantially across schools in both the charter and non-charter sector. While there is little systematic evidence available on charter school contracts, in a review of the contracts at 24 charter schools Price (2011) suggests that the contracts at those schools that were unionized had more flexible contract provisions relative to the nearest traditional public school district. For example, unionized charter schools tend to have contracts specifying faster grievance processes, more discretion for principals to determine layoff criteria, and more flexible workdays and length of year provisions. Additionally, it is possible that the impact of unions depend on specific attributes of the charter schools. For example, charter schools with disorganized administrations may benefit from the order and communication that unionization imposes whereas high performing "no excuses" charters may be hindered by the restrictions unions place on administrators.

These concerns notwithstanding, our findings that charter unionizations lead to improvements in academic performance provides important new evidence in the growing literature on the impact of unions on productivity in education. Future research on how unions impact the operating procedures of schools—that is, on what unions actually do—would be especially valuable to better understand the mechanisms through which unions affect schooling. And direct measures of whether teacher performance, such as their value-added, is affected by unionization may also help inform the debate over unions' role. The growing number of unionized charter schools in areas like Illinois or New York, where richer teacher personnel and student level data are available, should facilitate richer studies in the near future.

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Table 1: Flows of Unionizations in Charter Schools 2003-2013

	Net Flows		Switchers		Stock	
	PERB-NAPCS	PRR Only	Analysis Samp.	Total	Analysis Samp.	Total
2003	13	2	–	2	123	142
2004	6	3	1	1	132	151
2005	6	2	5	6	144	162
2006	7	3	8	10	153	173
2007	12	6	1	3	167	191
2008	9	0	1	2	176	201
2009	3	6	6	8	190	224
2010	8	4	13	13	201	236
2011	14	7	4	7	218	258
2012	7	8	5	5	234	273
2013	0	3	1	1	238	277
Unique Schools	118	147	46	58	247	291

Notes: The table shows the net flows of unionized charter schools by data source, the number of switchers, and the stock unionized charter schools in operation between the 2003 and 2013 test years. Schools in the analysis sample have known unionization dates, valid CST scores and information about enrollment, and school demographic variables. Our analysis sample excludes 26 unionized schools for which we are unable to identify the date of unionization, 17 unionized schools that are missing test score data, and 1 unionized school that does not report student demographic data. Columns do not add to the last row total due to the presence of schools open prior to 2003, closures, and schools where a union disbands. "Switchers" refer to schools that are observed unionizing after already existing as a charter school for at least 1 year. Switchers in analysis sample have at least one year of test scores recorded in pre-unionization and post-unionization years.

Table 2: Summary Statistics for Selected Charter School Characteristics in 2013 by Union Status

	All Charters	Non-Union	Unionized	Unionized PRR Only	Switchers
Size and demographics					
Years charter open	6.371	6.279	6.664	5.717	10.05
	(5.128)	(4.850)	(5.928)	(5.825)	(4.922)
Rural location	0.0814	0.0806	0.0840	0.110	0.0455
	(0.274)	(0.272)	(0.278)	(0.314)	(0.211)
Large unified district	0.311	0.289	0.378	0.306	0.523
	(0.463)	(0.454)	(0.486)	(0.462)	(0.505)
# Students	466.9	427.9	591.1	567.5	796.2
	(498.1)	(461.8)	(583.0)	(540.4)	(937.1)
FTE teachers	20.00	18.26	25.22	23.74	33.45
	(19.95)	(18.58)	(22.82)	(20.20)	(36.32)
Asian	0.0547	0.0501	0.0694	0.0863	0.0436
	(0.0850)	(0.0865)	(0.0787)	(0.0816)	(0.0605)
Hispanic	0.462	0.466	0.448	0.377	0.567
	(0.302)	(0.306)	(0.290)	(0.251)	(0.307)
Black	0.108	0.120	0.0693	0.0519	0.118
	(0.180)	(0.195)	(0.116)	(0.0800)	(0.186)
% Free-reduced lunch	0.546	0.560	0.506	0.423	0.662
	(0.311)	(0.314)	(0.302)	(0.266)	(0.312)
% ELL students	0.163	0.157	0.181	0.152	0.222
	(0.183)	(0.183)	(0.184)	(0.166)	(0.215)
Parents-HS dropout	0.170	0.170	0.169	0.119	0.238
	(0.185)	(0.185)	(0.184)	(0.145)	(0.217)
Parents-Bachelors +	0.350	0.340	0.378	0.442	0.272
	(0.246)	(0.242)	(0.255)	(0.239)	(0.244)
School Inputs					
Avg Teacher Experience	9.195	8.168	12.26	14.00	8.318
	(4.682)	(4.171)	(4.792)	(3.893)	(3.418)
Teachers with advanced degree	0.392	0.397	0.376	0.347	0.446
	(0.196)	(0.199)	(0.184)	(0.177)	(0.184)
Non-tenure track	0.595	0.731	0.192	0.0381	0.521
	(0.463)	(0.411)	(0.364)	(0.144)	(0.441)
Student Achievement					
Math Z-score	-0.129	-0.258	0.277	0.427	-0.301
	(1.006)	(0.994)	(0.935)	(0.920)	(0.774)
% Advanced-math	0.282	0.255	0.369	0.404	0.244
	(0.184)	(0.173)	(0.190)	(0.185)	(0.133)
% Basic or below-math	0.466	0.500	0.361	0.326	0.484
	(0.260)	(0.264)	(0.219)	(0.211)	(0.198)
English Z-score	0.0886	0.00709	0.348	0.554	0.0676
	(0.900)	(0.880)	(0.913)	(0.882)	(0.705)
% Advanced-English	0.248	0.233	0.293	0.336	0.214
	(0.155)	(0.147)	(0.171)	(0.166)	(0.130)
%Basic or below-English	0.527	0.548	0.459	0.395	0.541
	(0.271)	(0.272)	(0.258)	(0.230)	(0.197)
Observations	995	757	238	173	44

Notes: Standard deviations are in parentheses. "Rural" denotes whether a school is located in a county defined as rural by the Census Bureau. "Large unified SD" indicates either Los Angeles Unified School District (LAUSD), Oakland Unified School District (OUSD), or San Diego Unified School District (SDUSD). School input measures including FTE teachers, teacher experience, teacher degree and teacher tenure status come from 2012 whereas all other data are from 2013.

Table 3: The Impact of Unions on Math Achievement

	(1)	(2)	(3)	(4)	(5)	(6)
Unionized	0.667***	0.465***	0.200**	0.193**	0.196**	0.191**
	(0.0762)	(0.0605)	(0.0951)	(0.0967)	(0.0950)	(0.0954)
Percent tested		0.0219***		0.00491***	0.00497***	0.00480***
		(0.00227)		(0.00168)	(0.00168)	(0.00168)
Total students		-0.000208***		-4.41e-05	-2.28e-05	-2.03e-05
		(3.94e-05)		(6.35e-05)	(6.01e-05)	(5.88e-05)
Years charter open		0.00587		0.0152	0.0140	0.00993
		(0.00571)		(0.00943)	(0.00913)	(0.00872)
AI - NA		-3.742***			-1.299	-1.440
		(1.255)			(0.995)	(0.959)
Asian		3.428***			0.359	0.525
		(0.464)			(0.418)	(0.407)
Hispanic		-0.0192			-0.572***	-0.564***
		(0.139)			(0.148)	(0.143)
Black		-0.480***			-1.391***	-1.274***
		(0.148)			(0.304)	(0.286)
Free-reduced lunch		0.0537				0.144**
		(0.123)				(0.0615)
Parents-HS dropout		-0.505***				-0.158
		(0.173)				(0.112)
Parents-Some college		-0.699***				0.00770
		(0.211)				(0.114)
Parents-Bachelors +		0.975***				-0.0304
		(0.155)				(0.0783)
Observations	22,608	22,608	22,608	22,608	22,608	22,608
R-squared	0.082	0.280	0.687	0.688	0.691	0.693
School FE	no	no	yes	yes	yes	yes
School time trend	no	no	no	no	no	yes
Number of schools	969	969	969	969	969	969

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1. Observations are at the school-grade-year level, with a total of 5,906 school-year observations. All specifications include year and grade-by-year fixed effects.

Table 4: The Impact of Unions on English Achievement

	(1)	(2)	(3)	(4)	(5)	(6)
Unionized	0.326***	0.194***	0.0523	0.0504	0.0560	0.0555
	(0.0688)	(0.0436)	(0.0448)	(0.0450)	(0.0442)	(0.0441)
Percent tested		0.0189***		-0.00142	-0.00141	-0.00153
		(0.00225)		(0.00106)	(0.00104)	(0.00104)
Total students		-4.97e-05**		-1.76e-06	2.05e-05	2.39e-05
		(2.26e-05)		(4.73e-05)	(4.58e-05)	(4.52e-05)
Years charter open		0.00375		0.00188	0.00279	0.00163
		(0.00428)		(0.00751)	(0.00707)	(0.00691)
AI - NA		-3.205***			-1.115***	-1.128***
		(0.672)			(0.389)	(0.387)
Asian		2.301***			0.382	0.433
		(0.347)			(0.285)	(0.284)
Hispanic		-0.813***			-0.744***	-0.718***
		(0.104)			(0.112)	(0.110)
Black		-0.996***			-0.914***	-0.869***
		(0.119)			(0.215)	(0.212)
Free-reduced Lunch		-0.0149				0.0490
		(0.0868)				(0.0344)
Parents-HS dropout		-0.394***				-0.132**
		(0.127)				(0.0648)
Parents-Some college		-0.282**				0.0284
		(0.143)				(0.0722)
Parents-Bachelors +		1.252***				0.0498
		(0.116)				(0.0474)
Observations	34,611	34,611	34,611	34,611	34,611	34,611
R-squared	0.026	0.424	0.750	0.750	0.753	0.754
School FE	no	no	yes	yes	yes	yes
School time trend	no	no	no	no	no	yes
Number of schools	1,266	1,266	1,266	1,266	1,266	1,266

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1. Observations are at the school-grade-year level, with a total of 7,689 school-year observations. All specifications include year and grade-by-year fixed effects.

Table 5: Unionization Impact on Students Across the Achievement Distribution

	Math: Fraction scoring			English: Fraction scoring		
	advanced	basic	below basic	advanced	basic	below basic
Unionized	0.0172	-0.00419	-0.0327***	0.00510	-0.00206	-0.0108**
	(0.0153)	(0.0106)	(0.0108)	(0.00677)	(0.00681)	(0.00488)
Percent tested	0.00124***	-0.000412**	9.38e-06	-0.000154	0.000221	0.000248**
	(0.000314)	(0.000204)	(0.000178)	(0.000159)	(0.000166)	(0.000120)
Total students	-5.97e-06	-2.71e-06	7.37e-06	3.02e-06	-4.50e-06	-1.46e-06
	(7.90e-06)	(5.05e-06)	(7.39e-06)	(7.15e-06)	(5.88e-06)	(3.91e-06)
Years charter open	0.000576	-0.00155	-0.00320***	-0.00132	0.000380	-0.00162**
	(0.00153)	(0.000964)	(0.00105)	(0.00123)	(0.000948)	(0.000645)
AI - NA	-0.221	0.132	0.135	-0.165*	0.179***	0.0370
	(0.183)	(0.117)	(0.0915)	(0.0957)	(0.0675)	(0.0420)
Asian	0.139*	-0.0241	0.0358	0.157***	-0.0653	0.0132
	(0.0807)	(0.0408)	(0.0375)	(0.0607)	(0.0420)	(0.0267)
Hispanic	-0.0848***	0.0609***	0.0482***	-0.130***	0.0986***	0.0515***
	(0.0230)	(0.0154)	(0.0182)	(0.0171)	(0.0151)	(0.0129)
Black	-0.178***	0.113***	0.134***	-0.123***	0.115***	0.0771***
	(0.0440)	(0.0276)	(0.0348)	(0.0322)	(0.0275)	(0.0205)
Free-reduced lunch	0.00446	-0.00431	-0.0247***	-0.00652	-0.00150	-0.0131***
Parents-HS dropout	-0.0229	0.0100	0.0215	-0.00445	0.0146	0.0192**
	(0.0166)	(0.0117)	(0.0140)	(0.00869)	(0.00896)	(0.00873)
Parents-Some college	0.00380	-0.00523	0.00819	0.0193	-0.00312	-0.00853
	(0.0185)	(0.0128)	(0.0143)	(0.0117)	(0.0110)	(0.00876)
Parents-Bachelors +	-0.00142	0.00236	0.0166*	0.0295***	-0.00273	0.00349
	(0.0128)	(0.00906)	(0.00987)	(0.00786)	(0.00763)	(0.00554)
Mean of outcome	0.252	0.290	0.176	0.218	0.366	0.227
Observations	22,608	22,608	22,608	34,611	34,611	34,611
R-squared	0.708	0.566	0.589	0.749	0.655	0.602
Number of schools	969	969	969	1,266	1,266	1,266

Notes: Robust standard errors clustered by school in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Observations at school-grade-year level. Categories for performance are mutually exclusive and the fraction across the four performance categories sums to one—results for "Percent Proficient" are excluded from the table. There are a total of 5,906 school-year observations in math and 7,689 in English. Each specification includes school, year, and grade-year fixed effects. The row labelled Mean of outcome' reports the mean of the dependent variable for all school-grade-year observations.

Table 6: Impact of Unionization on Achievement by Grade Level

	Math		English		
	elementary	middle	elementary	middle	high
Unionized	0.187*	0.157	0.0618	0.0464	0.0319
	(0.105)	(0.101)	(0.0819)	(0.0673)	(0.0387)
Percent tested	-0.00272	0.00537***	-0.00695***	-0.00415***	0.000283
	(0.00178)	(0.00156)	(0.00155)	(0.00144)	(0.00128)
Total students	1.28e-05	-1.46e-05	-2.01e-05	3.31e-05	6.22e-05
	(6.81e-05)	(5.56e-05)	(6.69e-05)	(4.85e-05)	(4.31e-05)
Years charter open	0.0234***	-0.0298	0.0140*	-0.0184	0.00368
	(0.00904)	(0.0182)	(0.00804)	(0.0118)	(0.0127)
AI-NA	-0.912	-1.833	-0.945	-1.315	-1.070***
	(0.831)	(1.455)	(0.720)	(0.860)	(0.288)
Asian	0.102	1.592**	0.404	1.051***	0.214
	(0.376)	(0.635)	(0.483)	(0.383)	(0.332)
Hispanic	-0.456***	-0.784***	-0.631***	-0.770***	-0.763***
	(0.160)	(0.201)	(0.149)	(0.166)	(0.162)
Black	-1.345***	-1.129***	-1.054***	-0.598**	-0.946***
	(0.347)	(0.323)	(0.346)	(0.262)	(0.253)
Free-reduced lunch	0.111	0.199***	0.0198	0.0190	0.0667*
	(0.0700)	(0.0722)	(0.0595)	(0.0542)	(0.0362)
Parents - HS Dropout	-21.56*	5.189	-16.38*	-4.088	-5.680
	(12.62)	(12.50)	(9.446)	(9.036)	(6.344)
Parents - Some college	-0.0705	0.0896	-0.0228	0.00872	0.180*
	(0.126)	(0.135)	(0.100)	(0.0959)	(0.105)
Parents - Bachelors +	-0.0710	0.123	0.0293	0.0257	0.171*
	(0.0839)	(0.106)	(0.0663)	(0.0679)	(0.0890)
Observations	16,010	7,288	16,015	10,759	8,912
R-squared	0.703	0.735	0.728	0.804	0.860
Number of schools	739	775	740	785	587

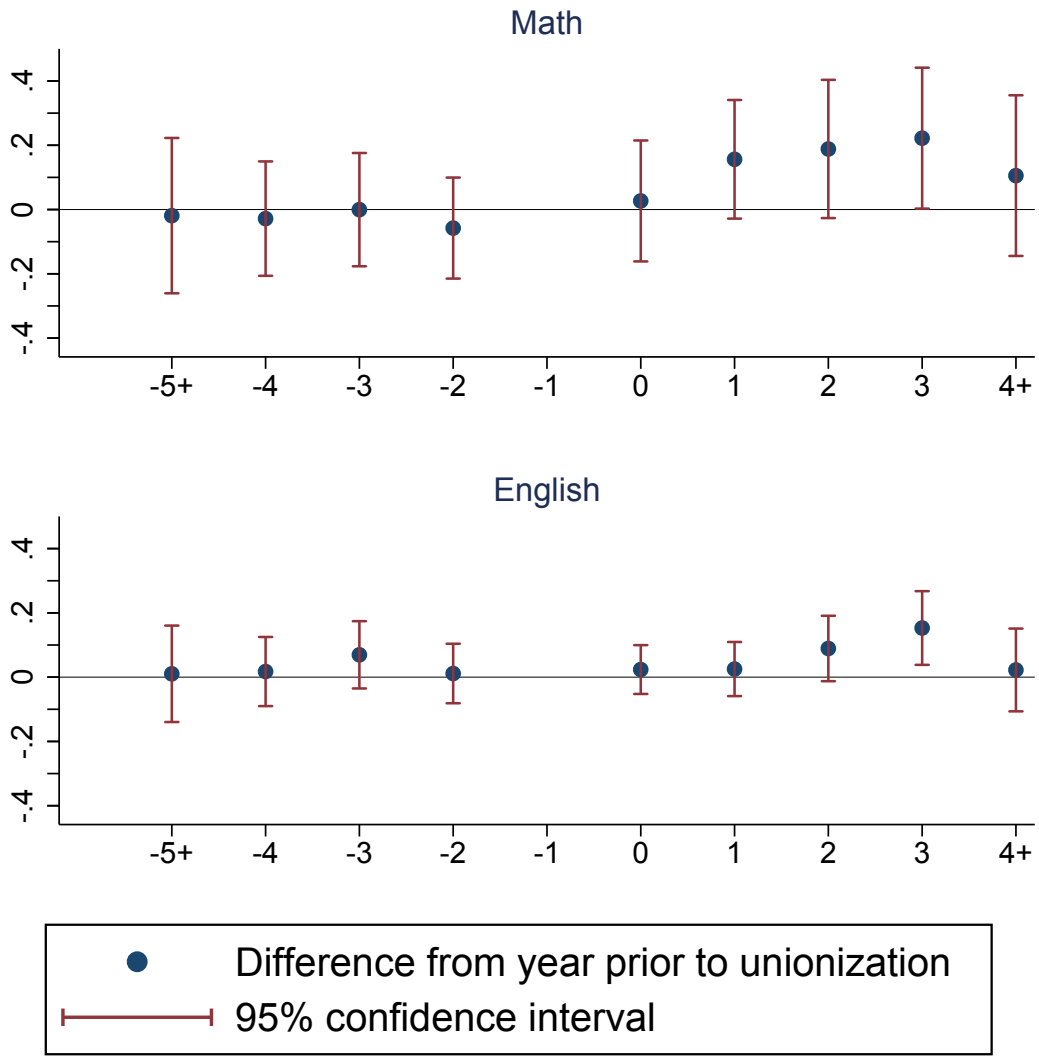
Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventionallevels as follows: *** p<0.01, ** p<0.05, * p<0.1. Observations are at the school-grade-year level, with 4566 school-year observations for elementary math and English, 4365 for middle school math, 4524 for middle school english, and 3325 for high school English. All specifications include school and year fixed effects.

Table 7: The Impact of Unionization on School Inputs Associated with Quality

	(1) Teacher Experience	(2) Teacher Masters+	(3) Non-Tenure Track	(4) Class Size
Unionized	-0.841***	0.0153	-0.0645	-0.653
	(0.279)	(0.0206)	(0.0518)	(0.564)
# Students	-0.000258	1.42e-05	5.38e-05	0.00280***
	(0.000296)	(1.30e-05)	(3.91e-05)	(0.000877)
Years charter open	0.0387	0.00125	0.0881***	-0.365***
	(0.0531)	(0.00223)	(0.00822)	(0.0568)
AI - NA	0.499	-0.126	-0.540*	5.508
	(2.842)	(0.117)	(0.325)	(5.531)
Asian	0.270	-0.0887	0.0281	-4.813**
	(1.598)	(0.0706)	(0.159)	(2.310)
Hispanic	-1.079*	-0.0156	0.192***	-1.846
	(0.622)	(0.0328)	(0.0702)	(1.497)
Black	-0.432	-0.0704	0.0323	-5.159**
	(0.745)	(0.0555)	(0.102)	(2.120)
Parents-HS dropout	-0.0400	-0.0234	-0.118**	-0.791
	(0.343)	(0.0227)	(0.0564)	(0.818)
Parents-Some college	-0.513	0.0138	-0.0168	0.884
	(0.434)	(0.0260)	(0.0605)	(0.985)
Parents-Bachelors +	0.725**	-0.0198	-0.0971**	-0.685
	(0.298)	(0.0193)	(0.0487)	(0.682)
Observations	6,628	6,630	6,193	6,743
R-squared	0.818	0.672	0.732	0.573
Number of schools	1,188	1,188	1,160	1,260

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1. Data were only available through the 2012 test year, so data is from 2003-2012. All specifications include year and school fixed effects.

Figure 1. Event Study Estimates of the Impact of Unionization on Student Achievement



Notes: This figure represents event study evidence of the impact of unionization on Math and English achievement scores. The underlying coefficient and standard error estimates and robustness analyses are shown in Appendix Table A3.

Appendix A. Appendix: Differences with Hart and Sojourner (2015)

Our main results suggest that unions raise student math achievement but have smaller and not statistically significant effects on English achievement. This differs from the conclusions of Hart and Sojourner (2015) (hereafter HS) who use similar data from California charter schools but conclude that unions do not have statistically significant effects on student achievement. The differences between our findings appear to be primarily driven by two differences in our methodology: 1) we estimate separate effects on achievement for math and English rather than pooling subjects, and 2) we do not use weights in our regression analyses, whereas HS weight their average test score observations by the number of students tested in each school-grade-subject-year cell. Other differences, for example in the unionization event dates, sample restrictions on which test-year observations are used, and slight differences in the specification of control variables all appear to have little to no qualitative impact on the estimated effects.

Appendix Table 4 presents our attempt to reconcile our results with those in HS. The first column of the Table shows our attempt to emulate the preferred specification of HS who find an effect of unionization of .017 (.037) (Table 3, column 5), but using our data on unionization dates and a slightly different composite measure of student achievement.[27] As shown in the second column of the Table, our estimate of the effect of unionization on achievement measured using the composite achievement measure and weighting observations by the number of test-takers is .022 (.024)—very

[27]As explained in the text, we identify 46 switchers, whereas HS identify 42, 32 of which match our data. Otherwise the data on school characteristics and student achievement are likely to be identical as we rely on common sources from California's Department of Education. Our composite measure of achievement differs in that we use just math and English test scores whereas HS also use Science and History scores. We ignore these since they are given in only a handful of grades and thus not defined for schools with no students in the relevant grade.

close to the estimate in HS. The next two columns show subject-specific estimates using sample weights, and show estimated effects of unionization on math and English achievement of .179 (.065) and -.016 (.023), respectively. HS also show estimates on math and English separately in Table 6 of their paper, and find estimated effects of .108 (.088) for math and .007 (.030) for English. The English results are broadly similar to our estimates, but HS's estimate for math is substantially smaller in magnitude than ours.

There are a variety of differences between our approach and HS's methodology that could potentially explain the differences in results. As a first pass, we reestimated the models just presented with HS's unionization data (which they graciously shared), and tried to match HS's sample by dropping grade 7 math scores and all 2013 data. Doing so led to estimates on composite, math, and English achievement of .059 (.022), .193 (.069), and .023 (.021)—little changed from Appendix Table 4's results except that the point estimate on English achievement is slightly higher (and so the estimated effect on composite achievement is slightly higher and statistically significant).

The last three columns of Appendix Table 4 show results from estimating the same regression models without weights. The estimated effects—especially for English achievement—change substantially when the model is estimated without weights. The impact of unionization on overall achievement increases to .103 (.027) and is strongly significant, driven by an increase in the estimated impact on English to .052 (.028), which becomes significant at the .1 level. The estimated impact on math achievement is similar to the weighted result, and very close in magnitude to estimates based on our specification in Table 3 (and slightly more precise).[28]

The substantial difference in results across weighted and unweighted models prompts

[28]Estimating the same model without sample weights but using HS's unionization dates and sample restrictions yields nearly identical results.

the question: which model's results should be viewed as more credible? While HS do not explicitly motivate their choice to use weights, a common motivation when using aggregate data like the average test scores used here is to address heteroscedasticity and improve efficiency under a model of constant treatment effects. If the error term in the individual level analog for the model of achievement scores in (1) were independent across observations, then weighting the regression using average test scores by the number of test takers would be efficient. As Dickens (1990) shows, however, in the presence of group-level error components weighting can exacerbate (or introduce) heteroscedasticity, leading to larger standard errors. While the standard errors for the results on overall achievement and English are slightly smaller using weights, for math the standard errors are larger with weights. Thus the efficiency case for weighting seems relatively unimportant in HS's results, and unfounded for the math results.

A second rationale for weighting that might be invoked is to attempt to estimate the average treatment effect of unionization at the student level in the presence of heterogeneous treatment effects that might differ with school size. As Solon et al. (2015) note, however, weighted least squares will only be consistent for this average student level effect under very restrictive conditions. More generally, while the difference between the weighted and unweighted results suggest heterogeneous treatment effects correlated with cohort size (i.e., the number of students in each school-grade), neither our unweighted specifications or HS's weighted specifications will in general consistently identify the student-level average treatment effect. In Appendix Table 5 we attempt to explicitly model heterogeneous unionization effects by adding interaction terms with cohort size to our basic specifications. Here the "students-tested" variable is normalized to zero at the mean number of students so the interpretation of the coefficient on "unionized" is the effect of unionization on student achievement

at the mean number of students in a school-grade. The coefficient estimates are imprecise, but a couple of observations seem relevant. First, the math results are very robust with nearly identical estimates of the unionization effect to those presented in Table 3, lending support to the conclusion that unions appear to increase student performance in math. For English, there appears to a negative interaction with the union variable and cohort size. This helps explain why the weighted results are more negative than the unweighted results in Table A4, and in Table A5 the estimated effects of unions on English achievement estimated at the mean are more similar across the models that do and do not use weights. In each case they are positive, yet small in magnitude.

Why might unionization effects be smaller or even negative for schools with larger cohorts? The background section in the paper notes several studies that have suggested unions might be more able to advocate for teacher interests over student interests in larger districts where parents may struggle to solve coordination problems to influence resource allocation. Another speculation is that unions might have more positive impacts in smaller schools with less professionalized human resource practices teams by facilitating communication between teachers and management, and perhaps improving morale and/or reducing teacher turnover. But importantly, the results show only that heterogeneity in union effects is correlated with size, but that does not mean size is the most conceptually important dimension across which the effects of unions differ. To wit, the pattern of results in Table 6 suggests that unionization effects appear smaller for students in higher grade levels. Since high school classes are larger than elementary or middle school classes, these grades get more weight and this heterogeneity might also explain the discrepancy between weighted and unweighted results. The fact that our math results are not sensitive to the inclusion of results might be driven by the fact that test scores are not available for

high-school math, but are for high-school English, where cohort sizes are larger.

We also do not have a definitive answer as to why unions might affect math performance more than English performance. Nonetheless it is commonplace in the economics of education literature to assess the impact of interventions separately on math and English achievement, and similarly common for interventions' estimated effects to differ across subjects. Understanding the sources of these differences in union effects on math versus English will require further study.

Table A1: The Impact of Unions on Math Achievement- Scale Scores

	(1)	(2)	(3)	(4)	(5)	(6)
Unionized	24.66***	17.28***	6.459*	6.263*	6.373*	6.214*
	(2.833)	(2.248)	(3.505)	(3.573)	(3.514)	(3.513)
Percent tested		0.796***		0.168***	0.169***	0.164***
		(0.0818)		(0.0623)	(0.0623)	(0.0624)
Total students		-0.00766***		-0.00190	-0.00117	-0.00107
		(0.00144)		(0.00235)	(0.00223)	(0.00218)
Years charter open		0.209		0.400	0.362	0.228
		(0.212)		(0.345)	(0.334)	(0.321)
AI - NA		-134.4***			-44.21	-48.72
		(45.66)			(34.44)	(33.34)
Asian		126.3***			17.36	22.96
		(16.76)			(14.98)	(14.65)
Hispanic		0.501			-21.47***	-20.88***
		(5.087)			(5.355)	(5.211)
Black		-16.43***			-49.62***	-45.70***
		(5.420)			(11.21)	(10.60)
Free-reduced Lunch		1.618				4.442**
		(4.506)				(2.256)
Parents-HS dropout		-18.86***				-6.249
		(6.252)				(4.058)
Parents-Some college		-26.71***				-0.337
		(7.756)				(4.166)
Parents-Bachelors +		35.98***				-0.760
		(5.684)				(2.855)
Observations	22,608	22,608	22,608	22,608	22,608	22,608
R-squared	0.249	0.409	0.738	0.739	0.741	0.743
School FE	no	no	yes	yes	yes	yes
School time tend	no	no	no	no	no	yes
School-grade weights	no	no	no	no	no	no
Number of schools	969	969	969	969	969	969

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1 Observations are at school-grade-year level, with a total of 5,906 school-year observations. All specifications include year and grade-by-year fixed effects.

Table A2: The Impact of Unions on English Achievement-Scale Score

	(1)	(2)	(3)	(4)	(5)	(6)
Unionized	9.026***	5.020***	1.573	1.583	1.793	1.795
	(2.000)	(1.293)	(1.304)	(1.300)	(1.273)	(1.268)
Percent tested		0.597***		-0.0358	-0.0359	-0.0396
		(0.0722)		(0.0331)	(0.0325)	(0.0325)
Total students		-0.00105		0.000341	0.00100	0.00105
		(0.000742)		(0.00141)	(0.00137)	(0.00135)
Years charter open		0.0812		0.0121	0.0426	0.0125
		(0.129)		(0.212)	(0.199)	(0.196)
AI - NA		-94.71***			-35.99***	-36.38***
		(20.60)			(11.06)	(11.13)
Asian		69.49***			13.31	14.52*
		(10.39)			(8.204)	(8.197)
Hispanic		-24.57***			-22.78***	-22.08***
		(3.160)			(3.319)	(3.269)
Black		-30.00***			-26.23***	-25.38***
		(3.545)			(6.164)	(6.097)
Free-reduced Lunch		1.308				1.550
		(2.664)				(1.011)
Parents-HS dropout		-11.29***				-3.708**
		(3.686)				(1.854)
Parents-Some college		-6.688				1.341
		(4.204)				(2.094)
Parents-Bachelors +		36.56***				1.914
		(3.512)				(1.370)
Observations	34,611	34,611	34,611	34,611	34,611	34,611
R-squared	0.220	0.531	0.806	0.806	0.808	0.809
School FE	no	no	yes	yes	yes	yes
School time trend	no	no	no	no	no	no
Student weights	no	no	no	no	no	no
Number of schools	1,266	1,266	1,266	1,266	1,266	1,266

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1 Observations are at school-grade-year level, with a total of 7,689 school-year observations. All specifications include year and grade-by-year fixed effects.

Table A3: The Impact of Unionization on Performance Event Study

	Math			English		
	(1)	(2)	(3)	(4)	(5)	(6)
5 years prior to unionization	-0.0717	-0.0458	-0.0206	-0.0133	0.00373	0.00983
	(0.131)	(0.135)	(0.123)	(0.0800)	(0.0807)	(0.0766)
4 years prior to unionization	-0.0464	-0.0387	-0.0299	0.0126	0.0176	0.0168
	(0.0907)	(0.0925)	(0.0905)	(0.0585)	(0.0550)	(0.0547)
3 years prior to unionization	0.00160	0.00367	-0.00175	0.0658	0.0668	0.0689
	(0.0904)	(0.0880)	(0.0894)	(0.0551)	(0.0524)	(0.0533)
2 years prior to unionization	-0.0686	-0.0544	-0.0593	0.00565	0.0135	0.0107
	(0.0798)	(0.0794)	(0.0800)	(0.0479)	(0.0471)	(0.0471)
0 years post unionization	0.0129	0.0366	0.0264	0.00667	0.0224	0.0236
	(0.0955)	(0.0969)	(0.0961)	(0.0388)	(0.0386)	(0.0388)
1 years post unionization	0.154	0.157*	0.156*	0.0216	0.0235	0.0252
	(0.0959)	(0.0952)	(0.0942)	(0.0427)	(0.0433)	(0.0429)
2 years post unionization	0.175	0.197*	0.189*	0.0707	0.0910*	0.0894*
	(0.113)	(0.113)	(0.110)	(0.0564)	(0.0533)	(0.0518)
3 years post unionization	0.199*	0.223**	0.223**	0.129**	0.152***	0.153***
	(0.109)	(0.107)	(0.112)	(0.0613)	(0.0585)	(0.0585)
4 years post unionization	0.132	0.158	0.147	0.0227	0.0437	0.0387
	(0.139)	(0.140)	(0.132)	(0.0727)	(0.0722)	(0.0689)
School-grade-year observations	22,204	22,204	22,204	33,958	33,958	33,958
Number of schools	952	952	952	1,243	1,243	1,243
Student demographics	no	yes	yes	no	yes	yes
Parent demographics	no	no	yes	no	no	yes

Notes: Sample includes all charter schools 2003-2013. Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1. All specifications include school, year, and grade-by-year fixed effects.

Table A4: Unionization Effect on Average Achievement, Hart and Sojourner Replication

	With Sample Weights			No Sample Weights		
	All	Math	English	All	Math	English
Postunionization	0.0217	0.179***	-0.0161	0.103***	0.199***	0.0521*
	(0.0241)	(0.0650)	(0.0233)	(0.0271)	(0.0553)	(0.0280)
Charter age						
Year 6-10	0.0332***	0.0298	0.0329**	0.0238**	0.0378*	0.0154
	(0.0116)	(0.0216)	(0.0132)	(0.0103)	(0.0194)	(0.0115)
Year 11+	0.0135	-0.0127	0.0231	-0.0225	-0.0342	-0.0150
	(0.0181)	(0.0341)	(0.0199)	(0.0173)	(0.0317)	(0.0194)
Demographics						
English Learners	-0.252***	-0.286***	-0.266***	-0.0768*	-0.0790	-0.100**
	(0.0538)	(0.101)	(0.0593)	(0.0459)	(0.0849)	(0.0510)
African American	-1.036***	-1.375***	-0.812***	-1.061***	-1.320***	-0.883***
	(0.104)	(0.193)	(0.119)	(0.0989)	(0.171)	(0.117)
Asian	0.512***	0.324	0.639***	0.503***	0.470	0.522***
	(0.162)	(0.320)	(0.164)	(0.159)	(0.304)	(0.172)
American Indian	-1.627***	-2.303**	-1.426***	-1.375***	-1.737**	-1.207***
	(0.324)	(0.992)	(0.254)	(0.290)	(0.761)	(0.263)
Filipino	-0.165	-0.180	-0.184	0.120	-8.99e-05	0.193
	(0.232)	(0.417)	(0.264)	(0.324)	(0.594)	(0.356)
Hispanic/Latino	-0.687***	-0.569***	-0.743***	-0.648***	-0.541***	-0.710***
	(0.0544)	(0.0978)	(0.0640)	(0.0536)	(0.0949)	(0.0632)
Eligible for subsidized lunch	0.0276	0.0928*	0.00480	0.0769***	0.150***	0.0376
	(0.0237)	(0.0529)	(0.0250)	(0.0226)	(0.0445)	(0.0247)
Parent education						
Not High School Graduate	-15.00***	-18.08**	-9.309*	-13.77***	-14.86**	-11.56***
	(4.223)	(7.911)	(4.858)	(3.742)	(7.344)	(3.954)
Some College	3.027	-8.039	8.744	0.340	-3.639	2.199
	(4.873)	(8.767)	(5.530)	(4.285)	(7.733)	(4.853)
College Graduate	-10.05	-1,588**	885.7**	40.54	-529.8	376.4
	(374.7)	(678.2)	(420.9)	(312.3)	(561.3)	(357.1)
School-grade-subjects	9,987	3,894	6,093	9,987	3,894	6,093
School-grade-subject-years	57,219	22,608	34,611	57,219	22,608	34,611

Notes: Sample includes all charter schools 2003-2013. Schools switching unionization status taken from both PRR and PERB. This table replicates column 5 from table 3 in Hart & Sojourner, 2015. Estimates in columns 1-3 are weighted by the total number of students tested in each school-grade-subject cell. *** p<0.01, ** p<0.05, * p<0.1 All specifications include year and grade-by-year fixed effects.

Table A5: The Impact of Unions on Achievement, With # of Students Interactions

	(1)	(2)	(3)	(4)	(5)	(6)
Math-Unweighted						
Unionized	0.639***	0.452***	0.200**	0.193**	0.196**	0.191**
	(0.0776)	(0.0621)	(0.0952)	(0.0967)	(0.0949)	(0.0951)
Students tested*unionized	0.00125**	0.000756**	0.000202	0.000105	0.000132	8.53e-05
	(0.000534)	(0.000370)	(0.00166)	(0.00175)	(0.00163)	(0.00154)
Math-Weighted						
Unionized	0.676***	0.414***	0.226**	0.216*	0.198*	0.191*
	(0.104)	(0.0701)	(0.109)	(0.111)	(0.111)	(0.109)
Students tested*unionized	0.000343	0.000269	-0.000894	-0.00123	-0.000779	-0.000449
	(0.000250)	(0.00179)	(0.00179)	(0.00197)	(0.00175)	(0.00150)
Observations	22,608	22,608	22,608	22,608	22,608	22,608
Number of schools	969	969	969	969	969	969
English-Unweighted						
Unionized	0.310***	0.190***	0.0621	0.0600	0.0675	0.0663
	(0.0708)	(0.0446)	(0.0484)	(0.0487)	(0.0478)	(0.0478)
Students tested*unionized	0.000547**	0.000201	-0.000158	-0.000155	-0.000185	-0.000175
	(0.000254)	(0.000171)	(0.000135)	(0.000136)	(0.000130)	(0.000132)
English-Weighted						
Unionized	0.285***	0.206***	0.0421	0.0205	0.0297	0.0397
	(0.0884)	(0.0492)	(0.0615)	(0.0677)	(0.0634)	(0.0600)
Students tested*unionized	0.000245	3.88e-05	-0.000143	-0.000123	-0.000145	-0.000138
	(0.000193)	(0.000143)	(0.000107)	(0.000112)	(0.000110)	(0.000109)
Observations	34,611	34,611	34,611	34,611	34,611	34,611
Number of schools	1,266	1,266	1,266	1,266	1,266	1,266
School characteristics	no	yes	no	yes	yes	yes
Student controls	no	yes	no	no	yes	yes
Parent controls	no	yes	no	no	no	yes
Year FE	yes	yes	yes	yes	yes	yes
School FE	no	no	yes	yes	yes	yes
School time trend	no	no	no	no	no	yes
Grade-Year FE	yes	yes	yes	yes	yes	yes

Notes: Robust standard errors clustered by school are in parentheses. Stars indicate whether coefficients are statistically significantly different from zero at conventional levels as follows: *** p<0.01, ** p<0.05, * p<0.1 Observations are at school-grade-year level, with a total of 5,906 school-year observations in math and 7,689 school-year observations in English.