



# Class-size reduction policies and the quality of entering teachers<sup>☆</sup>



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## HIGHLIGHTS

- Prior studies find little evidence of achievement gains from class-size policies.
- We study whether a fall in new teacher quality can explain these results.
- Using pre- and post-policy data, we find a general decline in cohort value-added.
- The quality drop was short lived due to attrition by the lowest performers.
- All schools saw a drop, so it cannot explain prior treatment-control policy effects.

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## ABSTRACT

Class-size reduction (CSR) policies have typically failed to produce large achievement gains. One common explanation is that CSR forces schools to hire low-quality teachers. Prior studies of this hypothesis have been hindered by poor data. Using different data, we find that hiring quality did fall with state-wide CSR. However, this drop was temporary due to attrition by the lowest performers. Furthermore, the drop was similar for schools classified as treated and control for prior evaluations of CSR. Therefore, differences in the quality of incoming teachers cannot explain the estimated performance of CSR. This is consistent with hiring spillovers in connected markets.

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## 1. Introduction

The potential for student achievement gains from smaller classes has been well documented in experimental and quasi-experimental research (Krueger, 1999; Krueger and Whitmore, 2001; Angrist and Lavy, 1999). For instance, analysis of the Tennessee STAR class-size experiment has found that being randomly assigned to a small (13–17 students) class as opposed to a larger class (22–25 students) in early elementary school has both short and long run effects on students. In particular, students in smaller classes had test scores roughly one-fifth of a standard deviation better on average (Krueger, 1999), better long

run educational attainment (Krueger and Whitmore, 2001), and better labor market outcomes (Chetty et al., 2011). As of 2005, this potential led to the adoption of class-size reduction (CSR) measures in thirty-two states (Council for Education Policy, Research and Improvement (CEPRI) 2005).

To date, studies of CSR policies find only mixed evidence of achievement effects, with estimates consistently falling short of what might be expected from the experimental research (Bohrnstedt and Stecher, 2002; Chingos, 2012).<sup>1</sup> Due to the high costs of implementation, \$21 billion over nine years in Florida (Florida Department of Education, n.d.) and \$1.5 billion a year in California (Bohrnstedt and Stecher, 1999), the efficacy of CSR policies has been called into question. One common

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<sup>1</sup> Note that not all experimental and quasi-experimental studies find significant class-size effects (Hoxby, 2000). A recent paper by Rockoff (2009) discusses the results of several class-size experiments from the beginning of the twentieth century and concludes that the balance of these early class-size experiments suggest that there was little achievement benefit to attending smaller classes. This conclusion comes with several caveats. Most importantly, it seems plausible that changes in the educational environment since the early twentieth century may have changed the role of class size in affecting achievement.

explanation for the under performance of CSR is that it forces schools to hire and retain teachers of lower quality in order to meet the class-size requirements (Stecher and Bohrnstedt, 2000; Imazeki, n. d.; Buckingham, 2003; CEPRI, 2005; Chingos, 2012). The gains from having smaller classes are thought to be offset by having teachers of lower quality in the classroom.

Previous studies of this hypothesis have focused on evidence from California's CSR program (Kane and Staiger, 2005; Jepsen and Rivkin, 2009). However, studies of California CSR are limited by the available data. Chief among these limitations is a lack of linked student–teacher test score data until several years after CSR's introduction (Kane and Staiger, 2005). Due to differential teacher attrition and human capital accumulation, this leaves the short-run implications of CSR induced hiring unanswered. Furthermore, the linked data that are available covers only a single district, prohibiting an analysis of heterogeneity across districts or the potential for across-district hiring spillovers. While school aggregated data is available for the period around the introduction of CSR, these data still do not include any pre-policy test measures. Identification using the school average data also relies on observed teacher characteristics in order to estimate changes in teacher quality as the data do not identify new teachers or link students to specific teachers (Jepsen and Rivkin, 2009). However, much of the education production function literature finds that these characteristics play only a small role in explaining the variation in student achievement (Goldhaber, 2008).

Using administrative data on individual students and teachers in grades four through six from an anonymous state (subsequently referred to as State X)<sup>2</sup> before and after the introduction of a state-wide CSR program, this paper explores the teacher quality hypothesis in detail, while overcoming the limitations of the prior work. As a starting point, we consider whether there is any evidence that a CSR-induced decline in teacher quality can explain the lack of an *estimated* effect from prior quasi-experimental evaluations of CSR performance.

We find little evidence to support the idea that the small CSR effects estimated using treatment-control comparisons are due to the quality of incoming teachers. Comparing schools categorized as treated (those for which CSR was binding) and control in prior quasi-experimental studies of CSR before and after the introduction of the policy, we find only a very small difference ( $\approx 0.15\%$  of a test score standard deviation) in average student performance attributable to the quality of hired teachers. In fact, schools classified as treated experience a slightly smaller drop in achievement attributable to newly hired teachers than those in the control group. This difference is of the opposite sign needed to support the teacher quality hypothesis. The estimates account for both the underlying quality of hiring cohorts and the potential short-run effect of hiring more teachers with less experience. It is important to note that these results are quite robust to several estimation approaches that account for many possible confounding influences including state-wide policy changes or general state-wide trends in the quality of hired teachers.

Interestingly, the small difference between treated and control groups masks a flat profile in cohort value-added before CSR followed by a sudden decline in the quality of teacher hiring cohorts in *both* treatment and control schools with the introduction of CSR. While the quality of cohorts may not explain the small treatment effect estimates of CSR, due to the strong possibility of treatment spillovers in this setting it may still be the case that teacher quality and student performance did suffer from CSR, a possibility missed by any treatment-control evaluation of CSR. Namely, with treatment and control schools operating in the same labor markets, the increase in teacher demand from the introduction of CSR may have reduced the quality of new hires even in the control schools. That is, schools not directly affected by CSR may have nevertheless hired lower quality teachers due to CSR as potential candidates were hired by schools forced to reduce class size.

While the general equilibrium nature of these potential hiring spillovers makes it difficult to completely rule out other possible explanations for the sudden decline in value-added associated with the CSR induced hiring increase, it is a potentially important effect of CSR that would go unnoticed in treatment-control comparisons. Further, we do provide some suggestive evidence that the drop in quality with increased hiring was not likely driven by changes in certification policies or in the financial attractiveness of teaching in State X that could possibly alter the selection into teaching over this time period.

To examine and quantify the possible state-wide CSR hiring effects, we trace the evolution of cohort mathematics value-added over time for three pre- and five post-policy hiring cohorts.<sup>3</sup> The estimates of cohort performance indicate a modest reduction in the average quality of both newly hired teachers and teachers who are retained after their first year. In terms of student achievement, the estimated conditional mean performance of the larger (up to 62% larger) post-CSR hiring cohorts ranges from 0.33% to 2.55% test score standard deviations lower than the smaller pre-CSR cohorts in each cohort's first year. This difference is equivalent to 10–15% of the standard deviation in teacher quality found in our sample.

Furthermore, the impact on individual students assigned to the marginal teachers may be quite large. Back of the envelope calculations based on individual teacher value-added suggest that more students, roughly 7% of all students assigned to a new cohort teacher, were assigned a teacher in the lowest quintile of the value-added distribution during CSR compared to before CSR. Given the large differences in mean value-added by quintile of between 25% and 73% of a test score standard deviation, this represents a potentially large effect for this subset of affected students.

However, the differences in cohort performance only persist partially over time as the composition of each cohort changes, with the differences in pre- and post-CSR second year cohort effects ranging from 1.09% to 1.98% standard deviations. However, there is evidence that further attrition leads to negligible differences among the remaining teachers after three to four years, implying a very small long-run CSR hiring effect on achievement. Importantly, the short-run CSR hiring effects identified here were missed completely by prior studies.

The results are informative beyond providing a better understanding of CSR programs. The results help fill a gap in the prior literature on the quality elasticity of teacher supply. Namely, the intervention studied here provides a rare opportunity to observe a substantial increase in the number of teachers hired for the same schools in a short time period. This sort of variation is preferred to relying on cross-sectional or longer run differences in teacher hiring to identify this elasticity. An understanding of the nature of the underlying teacher labor supply is useful for predicting the impact of any intervention that results in a sudden change in teacher demand. For instance, short-run increases in teacher demand associated with retirement buyout plans or changes in curriculum are often met with concerns over the quality of the new teachers hired (Center for Local State and Urban Policy, 2010). Additionally, recent papers have simulated the achievement effects of value-added based retention policies, the results of which depend critically on the assumptions regarding the quality elasticity of teacher supply (Goldhaber and Theobald, 2011; Boyd et al., 2011). The results found here are informative in predicting the fall in quality associated with such policies.

The paper proceeds as follows: Section 2 discusses the data used; Section 3 discusses the institutional details of the policy and concurrent Teacher Labor Market conditions; Section 4 gives the empirical strategy used and provides the baseline results and sensitivity checks; Section 5 presents further analysis assessing the implications of the baseline estimates for CSR policy performance, tracing out the long run hiring effects, and characterizing the magnitude of the effects for students; finally, Section 6 concludes.

<sup>2</sup> The State X Department of Education has requested the state be kept anonymous for all publications and presentations as a condition of data access and use.

<sup>3</sup> Similar results obtained using reading test scores are presented in an appendix. The decision to focus on mathematics scores only was made for the sake of brevity.

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