The Effect of Charter Schools on District Costs and Efficiency: The Case of New York State

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Abstract

Charter schools can influence the costs of providing education by reducing economies of scale and influencing the share of high cost students the district serves. Charter schools might also increase district efficiency through competition. Utilizing data for New York State school districts from 1998/99 to 2013/14, we estimate difference-in-differences models to estimate the effect of charter schools on enrollment and the percentages of students in various need categories. Then, we estimate an expenditure function that controls for student test scores, costs factors, and other factors that might influence district efficiency to measure changes in district efficiency associated with charter school entry. We find that charter schools increase the cost of providing education in the short term and increase efficiency in the medium term. Estimated efficiency increases in the medium term are slightly larger than estimated cost increases.

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1. Introduction

Since the beginning of the charter school movement, concerns have been raised that charter schools would drain resources from traditional public schools and increase per pupil costs by attracting the least costly to educated students (Moodey's, 2013; Molnar, 1996; Arsen, Plank & Sykes, 1999). On the other hand, advocates have argued that competition created by charter schools can be "a tide that lifts all boats" by pushing public schools to increase efficiency (Hoxby, 2003). Given the financial constraints many school districts face after the "Great Recession" (Hull, 2010) and the growing number of charter schools, the question of how charter schools influence school district costs and efficiency is more salient than ever.

Despite the interest in these questions there is limited research on the topic. Arsen and Ni (2012) analyze the impact of charter school enrollments on school district budgets in Michigan, and find that higher levels of charter school enrollments are associated with declining fund balances and revenues declines that exceed expenditure declines. Bifulco and Reback (2014) evaluate the influence of charter schools on district revenues and expenditures in two districts in New York State, and find that charter schools had negative fiscal impacts. Also several studies have tried to estimate the effect of charter school on the performance of students who remain in traditional public schools (Booker, Gilpatric, Gronberg & Jansen, 2008; Bettinger, 2005; Imberman, 2011). But none of these studies directly address the effect of charter schools on costs and efficiency.

This study draws on the concepts from the literature on educational costs to estimate the effect that charter schools have on the amount of per pupil expenditures districts spend to achieve a given level of student outcomes. We posit that charter schools can affect the minimum costs required to achieve a given level of student outcomes by influencing the level of enrollment in the district and/or the proportion of students with relatively high needs. Competition from charter schools can also influence district efficiency, i.e. how much district expenditures exceed minimum costs given current technology.

Using data from New York, our empirical strategy begins by using a simple, difference-in-differences to estimate the effect of charter school entry on district enrollment and the percentages of students in various need categories. Next, using a district-level panel, we estimate an expenditure function that controls for service outcomes, district costs, and other factors that might influence district efficiency to measure changes in district efficiency associated with charter school entry. Finally, drawing on the same expenditure function, we use estimates of the effect of enrollment and student composition on district costs together with the estimates of the effects of charter school entry on those key costs factors to determine the effect of charter schools on the amount districts spend to achieve a given level of outcomes.

Our findings suggest that charter schools increase costs in school districts. While enrollment decreases as a result of charter school entry, the share of students with disabilities tends to increase. These findings are consistent with research showing that charter schools enroll lower shares of students with disabilities (Jabbar, 2016) and higher shares of high performing students from public schools (Welner, 2013; West, Ingram & Hint, 2006), and reduce the number of students in traditional public schools (Arsen & Ni, 2012; Bifulco & Reback, 2014). We estimate that the effects of charter schools on enrollment and student composition increase the minimum per pupil amount that a district of the typical size needs to spend to reach a given performance level by 2.1 percent, although we caution that this estimate has a large confidence interval around it.

Alternatively, there is some evidence that charter schools impact district efficiency. Our results suggest that charter schools increase efficiency five to eight years after charter school entry. The finding is consistent with literature showing that charter school entry leads to improved service provision in traditional schools (Booker et al., 2008). Our preferred point estimate indicates that 5 to 8 years after charter school entry the efficiency effect leads to a 2.5 percent decrease in per pupil operating expenditures used to obtain a given level of performance. Therefore, although charter schools' effects in the first years after entry are to increase district costs, in the medium term, district efficiency gains are sufficient to offset the cost increases.

These findings come with two caveats. First, education is characterized by the joint production of multiple outputs, and our estimates of the effect of charter schools on district efficiency only control for a limited set of those outcomes. Thus, the reduction of inefficiencies we estimate could reflect either the more efficient use of resources to educate students or reductions in spending for outcomes other than those for which we control. Second, even after controlling for the measures of student need that we include in our cost function, transfers to charter schools can leave district schools with students that have different underlying abilities to achieve educational objectives. We cannot determine whether the change in efficiency associated with charter school entry, as we measure it, is the result of improved district programming and operations, or changes in the underlying ability of its students.

The remainder of the article is organized as follows. Section 2 describes the charter school program in New York State. Section 3 lays out the key conceptual considerations that guide the interpretation of our analysis. Section 4 outlines our empirical strategy. Section 5 describes the sample and measures we use to implement our empirical strategy. Section 6 presents the results of our analysis, Section 7 presents key robustness tests, and Section 8 summarizes our conclusions.

2. New York State Charter School Program

In New York State, the first charter schools started operating in the fall of 1999. The law provides that charter school students can cross attendance and school district borders and are not restricted by any residency requirements. Charter schools select students by lottery if they are oversubscribed. In this lottery process, preference is given to students residing in the school district, where the charter school is located (NYS Charter School Law Subsection 2854 (2b)).

A charter school's primary source of funding in New York is per pupil payments from the districts in which their students reside. The amount a district pays per student is equal to the approved operating expenses per pupil in the district. Charter schools receive additional funding for students with disabilities. The additional weight students with disabilities receive in the funding formula varies between 1.65 for students with severe disabilities and 0.9 for students with less severe disabilities. Charter schools do not receive additional funding for students with limited English proficiency or living in poverty. Further, the districts provide textbooks, software, transportation, health and special education evaluation services to charter schools. (NYS Charter School Law Subsection 2853).

The charter application, approval, and evaluation process is closely regulated by the charter school law and overseen by the charter school authorizers. In a multistate comparison of charter school accountability laws and practices, the Center for Education Reform (CER) rated New York as a state that holds charter schools strictly accountable, pointing out that New York is one of the few states that have closed charter schools for performance reasons (CER, 2007). The National Alliance of Public Charter Schools identifies New York as being among the few states using performance-based charter contracts, comprehensive school monitoring, and systematic data collection processes (NAPCS, 2012).

For data availability reasons, we focus on charter schools outside NYC in this study. Table 1 shows the 20 districts outside NYC that have or have had charter schools since 1999/00. The first column shows the name of the school district followed by a column presenting the first year a charter school was opened in the district. The third column shows the total number of charter schools in the district for the year 2013/14 followed by a column showing the share of charter school enrollment during that year. The fifth column presents the share of charter schools students that reside outside the border of the district where the charter school is located. The sixth column shows the share of poor students in the district. The next column shows the share of students enrolled in a charter school for the adjacent district with the highest share of charter school enrollment. The last column presents the share of students receiving free lunch in these adjacent districts.

The first charter school was opened in Albany in the fall of 1999. The highest counts of charter schools are in Albany, Buffalo, and Rochester. Albany, Buffalo, and Lackawanna have the highest shares of charter school enrollments, each with more than 20 percent of public school students who reside in the district attending a charter school. All of the districts that have substantial charter school enrollments (more than 3 percent) also have high shares of low-income students (more than 39 percent free-lunch eligible). In contrast, even when charter schools locate in districts with low levels of poverty, only small numbers of students from these districts choose to attend charter schools. For a handful of charter schools, including those located in Greece, Ithaca, Kenmore-Tonawanda, and Roosevelt, the majority of their enrollments are drawn from outside the district where they are located. With the exception of Roosevelt, the districts where these charter schools are located have low levels of charter school enrollment themselves and low levels of poverty, while the adjacent districts that sends the majority of students to the charter school have high shares of charter school enrollment and high percentages of students receiving free lunch.

3. Conceptual Considerations

Analysis can focus on the impacts of charter schools on the public school system as a whole, including charter and traditional public schools, or on the traditional public schools themselves. Estimates of impacts on the entire system of public schools and thus, all public school students, would provide a more comprehensive picture. However, much of the discussion of charter schools has focused on the impacts on traditional public schools, including the questions of whether or not charter schools drain resources, cream-skim low cost students, or push traditional public schools to operate more efficiently. For this study, reliable fiscal data on charter schools is not available in a form that is comparable to that available for traditional public school districts, and so we focus on the effects of charter schools on traditional public schools.

We begin by assuming that per pupil expenditures in a district, *E*, are determined by the minimum costs of achieving the service outcomes chosen by the district given current technology, *C(S)*, and the efficiency with which the district operates, *e*.

$$E = \frac{C(S)}{e}$$

In this formulation, efficiency is scaled to have a maximum value of 1, so that in an optimally efficient district expenditures equal minimum costs, and in districts with less than perfect efficiency, expenditures exceed minimum costs.

Following the literature on educational costs (Downes & Pogue, 1994; Duncombe & Yinger 1998, 2005, 2008, 2011a, 2011b; Rechovsky & Imazeki, 2001, 2003), we assume that minimum costs depend on the level of service outcomes chosen, *S*; resource prices, *W*; student composition, *P*; and enrollment, *N*. Thus, we can write:

$$E = \frac{C(S;\ W, P, N)}{e}$$

Charter schools can influence a district's costs by influencing enrollment in the district. First, when charter schools enter a district we can expect some number of students to be drawn away from district schools into charters. If there are economies of scale in education, then sufficiently large reductions in enrollments in district schools will increase the amount of per pupil expenditure required to achieve a given level of service outcomes. Second, if students who are more costly to educate are more or less likely to transfer out of district schools into charters, then charter school entry will influence the composition of the students served by the district, and thus, the costs of achieving a given level of student outcomes. For instance, some studies have found the students from low-income families, with limited English proficiency (LEP), and/or disabilities are less likely to transfer to charter schools than other students (Jabbar, 2016; West, Ingram & Hint, 2006). If so, then charter school entry will increase the proportion of students in districts schools with high levels of educational need, and thus, will increase the costs of achieving a given level of student outcomes. These changes can be interpreted as movements along the minimum cost curve.

Charter schools may also influence the efficiency with which a school district operates. Advocates of expanding public school choice have argued that forcing public schools to compete for students will provide incentives for districts to improve services (Hoxby, 2000, Hoxby, 2003a,b). If districts respond to charter school competition by adopting new educational programs or by reallocating resources from less to more productive uses, this could increase district efficiency. There are also reasons to believe that charter school competition might reduce the efficiency with which districts operate. First, Rockoff (2010) and Duncombe and Yinger (2011a,b) argue that it takes time for districts to adjust to rapid, unforeseen changes in enrollment, and thus, in the short-run, charter schools might reduce district efficiency.[2] For instance, unforeseen reductions in enrollment might result in underutilization of administrators, facilities, or teachers in certain subjects (Bifulco & Reback, 2014). Second, the district might respond to the entry of charter schools by adopting new programming that requires additional expenditures. If these new programs fail to increase student outcomes, then the result will be decreased efficiency. Rather than moving districts to a different location on the cost curve, changes in efficiency influence how far from the minimum cost curve districts tend to operate.

4. Empirical Strategy

Our empirical strategy begins with defining the treatment and control group for the study. Table 1 shows that all districts with a high share of charter school enrollment are located in or adjacent to a district that has a charter school and also have a high share of students receiving free lunch. There are no districts with low-shares of free-lunch eligible students that ever during the time-period we observe reach significant levels of charter school enrollment, even when charter schools are located within the district borders or close-by. Because having charter schools locate nearby and having a high share of students in poverty are the primary predictors for charter school enrollment, we consider as treated all school districts that have charter schools or that are adjacent to a district with a charter school, and have a share of students receiving free lunch of at least 39 percent during the 1999/00 school year[3]. As a control group, we use all school districts with at least 39 percent share of students receiving free lunch in 1999/00 that neither have a charter within its border nor are adjacent to a district with charter school. Further, we limit the group of control

[2] Such an effect might, alternatively, be interpreted as increase the minimum costs of achieving a given level of student achievement.
[3] In two districts, Utica and Greece, charter schools open in 2013/14. Because we do not observe time periods after charter school opening, we consider these areas control districts.

districts to those that have an enrollment greater than 2,000 students because he treated districts are all at least that large.

In order to estimate the effect of charter schools on district costs, we first use this sample of treatment and control districts to estimate the effects of charter schools on enrollment and student composition. Specifically, we employ a standard difference-in-differences analyses:

$$Y_{dt} = \beta_0 + \beta_1 TREAT_{dt} + \delta_d + \theta T + \gamma_t + \varepsilon_{dt}$$

where Y_{dt} is either enrollment, percentage of free-lunch eligible, percentage of limited English proficient (LEP), or percentage of students with disabilities for district d in year t; $TREAT_{dt}$ is an indicator variable that takes the value of one in the treatment group districts in the years after a charter school was first established in the district or an adjacent district, and 0 otherwise; δ_d is a district specific fixed effect, θT is a time trend, and γ_t represents year fixed effects. Estimates of β_1 indicate how much more the variable of interest increased or decreased relative to pre-existing district-specific trends in the treatment districts during the years following the entry of charter schools than in the comparison districts during the same years. The equations are estimated using OLS with robust standards errors clustered by district.

To estimate the changes in efficiency associated with charter school entry, we draw on the cost-function literature and especially Eom, Duncombe, Nguyen, and Yinger (2014), who estimate a cost function for a similar time period to evaluate the effects of New York State's property tax relief for home owners on district spending. Particularly, we estimate the following expenditure equation:

$$\ln(E_{dt}) = \alpha_0 + \alpha_1 TREAT_{dt} + \alpha_2 \ln(S_{dt}) + \alpha_3 \ln(W_{dt}) + \alpha_4 \ln(P_{dt}) + \alpha_5 \ln(N_{dt}) + \ln(M_{dt})\phi_6 + \gamma_d + \eta_t + \upsilon_{dt}$$

Where all variables are defined as before, and M is a vector of variables that influence efficiency (discussed below). γ_d and η_t are district and year fixed effects, respectively, and υ_{dt} is an idiosyncratic error term. The coefficient on the treatment variable captures the shift in the amount of expenditures used to achieve a given level of service outcome. Since this model controls for other factors that influence district costs, we interpret this coefficient as the effects of charter schools on district efficiency.

The coefficients on the student composition variables, P, and enrollment, N, capture the effects of the proportion of students in different need categories (low-income, LEP, disabled) and enrollment on district costs. Together with our estimates of the effect of charter schools on these key cost factors, these coefficient estimates allow us to estimate the effect of charter schools on district costs, *C(S)*. The effect of charter schools on district efficiency combined with the effects on district costs tell us the net effect of charter schools on the amount of expenditures districts tend to use to achieve a given level of service outcomes.

These interpretations of the coefficient estimates in our expenditure equation depend on the assumption that we have controlled for all factors that influence district expenditures and that are correlated with the entry of charter schools. Two aspects of our analysis make this assumption plausible. First, the inclusion of district fixed effects controls for any unobserved factors that have constant effects on the costs or efficiency of a district overtime. Second, we include controls for a range of time varying variables that might influence district efficiency.

Two caveats on our analysis are worth noting. First, in the framework we are using, inefficiency arises when a district uses resources less effectively than current technology allows, or when it spends money on outcomes other than the ones measured and included in our estimation of the expenditure equation. Thus, if charter schools cause districts to spend money to achieve objectives other than the measures of student test scores that we include in our analysis, then that will be reflected as a decrease in efficiency in our analysis. Second, if charter schools attract relatively high (or low) achieving students away from district schools (controlling for free-lunch eligibility, LEP status, and disability), such that districts are able to achieve a given level of outcomes with lower (higher) per pupil expenditures, then that will be interpreted as an increase (or decrease) in district efficiency. In other words, we cannot determine whether the change in efficiency associated with charter school entry, as we measure it, is the result of improved district programming and operations, or changes in the underlying ability of its students.[4]

5. Data, Sample, and Measures

To estimate the effect of charter schools on school district expenditures, we utilize a data set including New York State school districts for the years 1998/99 to 2013/14 assembled from a variety of sources. New York City is excluded because we do not have data necessary to include it in estimates of the cost function. This section explains the variables used in the analysis in more detail. All variables are measured for traditional public schools in a school district. Table 2 provides the summary statistics for the baseline year 1998/99, the only year in the data set without charter schools for all treated districts. All variables are presented separately for treated and control districts. Differences in means are tested using a t-test.

Spending Measures

To measure spending, we used the school district operating expenditure measure from the Fiscal Profile Reporting System (FPRS) maintained by the New York State Education Department (NYSED). The expenditure measure includes instruction, support services such as transportation,

[4] It is worth noting that this limitation in interpretation would apply even if charter school entry were randomly assigned to districts.

and debt services (principal and interest). We excluded all tuition payments to charter schools from the measure.

Performance Measures

We use performance measures drawn from the New York State school district report cards. These measures are based on standardized tests examining student proficiency in mathematics and English. Starting in 1998-99, this system was used consistently until the 2009-10 school year when NYSED changed the cut scores for proficiency levels. We use a similar approach to Eom et al. (2014) to overcome this inconsistency. Specifically, we calculate adjusted proficiency rates based on cut scores before the change in proficiency levels assuming that the distribution of student test scores follows a normal distribution.[5]

We construct a performance index consisting of the equally weighted average percentage of students reaching proficiency levels in reading and mathematics exams in 4th and 8th grade. Further, we include the percentage of students receiving a Regents Diploma by passing at least five Regents exams and the percentage of students not dropping out of high school.

Cost-Related Measures

Researchers have long recognized that cost of education depends on many factors outside a school district's control. These factors include the wage environment, student enrollment, and concentration of disadvantaged students among the student population (see Duncombe and Yinger 2008 for an overview). To control for teacher salaries, we include the Comparable Wage Index (CWI) developed by Taylor and Fowler for the National Center for Education Statistics. The CWI

[5] Eom, et al. (2014) describe the approach in footnote 24 "To correct the proficiency rates for a change in the cut score, we assume the distribution of student scores in each district follows a normal distribution. We then approximate the cumulative standard normal with: $F\{Z\} = 1/[1 + \exp\{-1.702 Z\}]$, where $Z = (X - \mu)/\sigma$, X is the test score, and μ and σ are its mean and standard deviation, respectively. The proficiency rate at any given Z is $(1 - F\{Z\})$. Because our data set includes μ for each test in each district, we can use this equation to solve for σ using the observed new cut score, X_{NEW}, and the associated proficiency rate. With this estimate of σ we can then calculate $Z_{OLD} = (X_{OLD} - \mu)/\sigma$, where X_{OLD} is the old cut score. The proficiency rate at the old cut score is $(1 - F\{Z_{OLD}\})$".

is a measure of the systematic, regional variations in the salaries of college graduates who are not educators (Taylor & Fowler, 2006).[6] District enrollment counts are also drawn from NYSED Report Cards and represent official counts of students registered in the district as of October 1 of each school year. As in other work on cost functions, we use the log of student enrollment and the log of enrollment squared to allow for a nonlinear relationship between per pupil expenditures and enrollment (Duncombe & Yinger, 2008, 2011b). We also include the percent shares of students eligible for free or reduced price lunch, students with limited English proficiency, and students with disability, all of which are drawn from the NYSED school district report cards.

Efficiency-Related Measures

Costs are defined as the minimum spending required to provide students an opportunity to reach a given level of student performance. However, the dependent variable in the cost model is actual per pupil spending, and if a district operates inefficiently, actual per pupil spending will exceed the minimum required spending. While it is not possible to measure efficiency directly, it is possible to control for it indirectly and thereby to minimize the possibility of omitted variable bias.

We follow Duncombe and Yinger (2005, 2011a) and apply two techniques to control for efficiency. First, we run specifications including district fixed effects enabling us to control for all district characteristics including efficiency that do not vary over time. Second, we include variables in the cost function that have been linked to school district efficiency in previous research, but which are themselves unlikely to be influenced by charter school entry. These efficiency related variables include the income of residents in the district, sources of district revenue, tax price, and other factors affecting voter involvement in monitoring district officials.

[6] Comparable wage index values estimated by Lori Taylor using the methods developed for NCES for each district and each year in our sample are available at http://bush.tamu.edu/research/faculty/Taylor_CWI/.

Higher resident income and/or increased state aid to a school district may influence district efficiency by weakening voter's incentive to monitor school officials, and/or may encourage voters to push for a broader set of education objectives. A tax price decrease, similar to an increase in income, weakens voter's incentive to monitor school officials. Contrarily, an increase in tax prices is likely to boost voter's incentive to monitor school officials. Demographic factors such as the share of college educated parents and the share of children in the total population have been found to negatively influence school district efficiency. Thus, we include these demographic factors in the cost models as well.

The specific efficiency-related variables included in our analysis and the data sources used to construct those variables are detailed in Table 2. The School Tax Relief Program (STAR) in New York State provides state funded property tax relief for home owners in New York State. Eom et al. (2014) show that STAR increases school district inefficiency, and hence we include the star tax share. We construct this measurement using data from the NYSED Fiscal Profile Reporting System (FPRS) and the American Community Survey (ACS). To control for the amount of state aid a school district receives, we adjust state aid payments to the school district by district income, property value, and received STAR payments. Information on these variables comes from FPRS and ACS. In addition, we include a measure of the local tax share, calculated by dividing the market price of houses in a district by the property value per pupil; resident income per pupil; the percent share of college graduates residing in the district; and the percent share of 5 to 17 year olds in the school district. Information used to compute these variables are drawn from the FPRS and ACS.

Instruments

Similar to Eom et al. (2014), we treat the STAR tax share and the adjusted aid ratio as endogenous. STAR potentially induces changes in spending or performance and these changes may be capitalized into housing values. Therefore, we construct instruments substituting predicted housing prices and per pupil property values into the STAR tax share and adjusted aid ratio. The predications are based on 1999 housing values and inflated by the Case-Shiller home price indices for New York.[7] This instrument captures growth in market property value per pupil while removing the impact of STAR.

We also treat student performance as endogenous. Following Eom et al. (2014) again, we instrument for performance with exogenous traits of school districts in the rest of the district's county. A district's own choices are likely to be influenced by choices of nearby districts, and the choice of nearby districts are influenced by their exogenous traits. More specifically, we use average percentage of high cost students and LEP students in the rest of the county as instruments.

We examine the appropriateness of the instruments using overidentification and weak instrument tests. The results of these tests will be discussed in the next section. Further, we use Fuller's estimator (k=4), which according to Hahn, Hausman, and Kuersteiner (2004), proves to be less subject to potential bias from weak instruments than two-stage-least squares.

6. Results

Table 3 provides the results of our estimation of changes in cost-related factors associated with charter school entry. The table includes separate columns for each of the four dependent variables: share of the students in poverty, share of students with limited English proficiency, share of students with disabilities, and the log of student enrollment in the district. The first column for each of the four dependent variables uses a single post period, reaching over the entire time period

[7] The home price index is published by the Federal Reserve Bank of St. Louis.

after charter school entry, as the treatment variable. The second column splits the post period into three different periods. The sample includes 14 treated and 14 control districts.[8] All standard errors are clustered at the district level.

In the first model, we regress the share of students receiving free lunch on the treatment variable, fixed effects, and trends. The estimates for the first specification, using a single post period for the entire time after charter school opening, suggest that there is a positive and statistically significant relationship between charter entry and the share of students receiving free lunch. After charter school entry, a districts' share of students receiving free lunch increases by almost 3 percent. Breaking down the post period into three different time periods of equal length, we find positive coefficients on the treatment variables 1-4 years and 5-8 years after charter school entry. However, these coefficients are not statistically significant. The estimate for the last time period is negative and not statistically significant.

The next models use the share of LEP students as the dependent variable. The coefficient on the variable using a single post period is negative, close to zero, and not statistically significant. Breaking up the post period, the estimates for the first two time periods are negative, close to zero, and not statistically significant. The coefficient for the last post period is positive, greater compared to the other two estimates, but not statistically significant.

The results for regressing the share of students with disabilities on the treatment variable indicate increases in the share of students with disabilities (IEP) associated with charter school entry. The coefficients on the treatment variable is positive but not statistically significant for the specification using a single post period. Breaking down the post period into three time intervals of

[8] The treatment districts include all of the districts listed in Table 1 that have 39 percent or more students receiving free-lunch in 1999, plus Cohoes, Niagara Falls, and Rensselaer. As noted earlier, Utica and Greece are excluded from the treatment group and considered controls as we do not observe any post-period. Of 14 treatment group districts, 12 are observed for at least 9 post-treatment years and 13 are observed for at least 8 post-treatment years.

four years, we find a positive and statistically significant coefficient for the first time period. The opening of a charter school increased the number of students with disabilities by 1.3 percent in the district. The estimates for the following to time periods are also positive and similar in magnitude, but are not statistically significant.

The last two models use the log of school district enrollment as the dependent variable. The coefficient on the first treatment variable is negative and statistically significant. Charter school entry leads to a 5.1 percent decrease in school district enrollment. The estimate measuring the influence of charter schools for the first four years of charter school opening, is negative and statistically significant as well. Charter school entry is associated with a 3.7 percent decline in school district enrollment during the first four years after charter schools entry. The estimate for the following time period is virtually the same, but is not statistically significant. The estimate for the last time period is positive and not statistically significant.

Appendix Table A1 reports the first stage results obtained for the expenditure function using a single post period treatment variable and the instruments described in the previous section. We test for over identification restriction using the Hansen (1982) *J* test. The test statistic is far from rejection of its null (p value of 0.209), giving us confidence that our instrument set is appropriate. Moreover, our instruments are also strongly correlated with the endogenous variables, are statistically significant, and have the expected signs. Further, the F-statistic in the first stage regression of the IVs range between 85 and 394. These values are greater than the rule of thumb threshold of 10 suggested by Staiger and Stock (1977).

Table 4 shows the second stage results for our estimation of the expenditure function. The coefficient on the treatment variable using a single post period is negative and suggests a reduction of per pupil operating expenditures after charter school entry. However, the coefficient is not statistically significant. Splitting up the post period into three equal time periods of four years, we find a negative and statistically significant coefficient for five to eight years after charter school opening. The coefficient is greater in magnitude than the coefficient on the variable using a single time period. Charter school presence decreases per pupil operating expenditure by 2.5 percent five to eight years after the entry of charter schools. The coefficients on the time periods prior is smaller and not statistically significant. The coefficient on the time period after is of similar magnitude but not statistically significant.

Other coefficients show the expected signs and often statistical significance. The results are similar to Eom et al. (2014) despite differences in the sample. As expected, the Comparable Wage Index has a positive relationship with per pupil expenditures. The relationship between wages and expenditure is statistically significant in the first model. The enrollment coefficient on the log of enrollment is negative and the squared term is negative in Model 1 and positive in Model 2, although neither is statistically distinguishable from zero. The coefficient estimates indicate that for the averaged sized treatment district in our sample, 12,211 students, increasing enrollment by one percent leads to a 0.4 percent decrease in per pupil operating expenditures. As anticipated, the coefficients on the variables measuring shares of disadvantaged students are positive. Increasing the share of students with disabilities by one percentage point is associated with a 0.032 percent increase in per pupil expenditures in the district, a one percentage point increase in the share of LEP students leads to a 0.006 percent increase in per pupil expenditures, and a one percentage point increase in the share of free-lunch eligible students is associated with a 0.008 percent increase in per pupil expenditures. The estimated effects for the shares of students with disabilities is statistically distinguishable from zero, but the effect of the share of free-lunch eligible and LEP students is not. The estimated effects of these cost related variables are similar in the model that breaks the post-treatment variable into three. As expected increases in student performance are associated with increases in spending per pupil. The effect is statistically significant in the second model.

The efficiency measures show similar results compared to Eom et al. (2014) as well. Increases in the STAR or tax share lead to reductions in per pupil expenditures while increases in state aid and per pupil income are associated with increases in per pupil expenditures. The coefficients on the share of college graduates and youth suggest that increases in these share reduce the expenditures used to achieve student outcomes. Only the coefficient attached to college graduates is statistically significant.

7. Robustness Checks

Table 5 explores the robustness of the results to whether or not comparison districts are used in the estimation. When comparison districts are excluded from the estimation sample, effects are estimated solely off of differences in the timing of charter school entry among the treatment districts. Relying solely on treatment districts reduces the precision of treatment effect estimates, particularly for estimates of effects nine or more years after the entry of charter schools, which occurs during years when most of the treatment districts have already been exposed to charter schools for some amount of time. However, if there are any differences between the treatment and comparison group districts that influence deviations from district specific trends in a given year, then relying solely on treatment group districts may reduce bias in the estimated effects of charter school entry.

In this sample, when a single post-treatment period is used, the estimated relationship between charter school entry and the shares of free-lunch eligible, LEP, and disabled students are all positive, suggesting that the entry of charter schools is associated with an increase in the share of high cost students in the district. In the case of share of free-lunch eligible and share IEP, the estimate effects are similar in magnitude to those obtained when the comparison group is included, and the estimated effect on the percent LEP is much more positive. However, the effect estimates obtained using this sample are less precise than when the comparison group districts are included and are not statistically distinguishable from zero. The estimated effects on enrollment in this sample are similar to those for the main sample, indicating a substantial and statistically significant decrease in enrollment associated with charter school entry.

Table 6 re-estimates the expenditure function for the sample that only includes treated school districts. As in the sample the includes comparison districts, the coefficient attached to the treatment variable using a single time period is close to zero and statistically insignificant. Splitting up the post period, the effect of charter schools between five and eight years after entry remain negative, suggesting an increase in efficiency, but the coefficient is somewhat smaller and is not longer statistically significant. The estimated coefficients on some of the other variables, including enrollment have switch signs relative to the estimates using the sample that includes a comparison group and no longer have the expected signs.

In sum our robustness checks provide some support for the general conclusions that charter school entry increases the share of high-costs students that districts serve, and that charter school have, at most, small effects on efficiency that are limited to years 5 to 8 after the entry of charter schools. However, the estimated effects of charter schools on our main variables of interest are more precise when the sample that includes a comparison group is used, and other estimated coefficients in our expenditure function are more consistent with expectations when the sample that includes a group of comparison districts. Thus, in the following section we focus on the results from the sample that includes comparison districts.

8. Conclusion

Our findings suggest that charter schools influence school district costs beginning in the first four years of operation. All our models suggest that charter schools decrease the enrollment in traditional schools. The effect ranges between 5 and 6.7 percent depending on the sample used. In addition, our estimates indicate that the percent of low-income students increases by an average of between 3 and 3.6 percent, and the percent of disabled students increases by an average of between 1.8 and 2.5 percent in the years after charter schools enter. These findings are consistent with research showing that charter schools enroll lower shares of students with disabilities (Jabbar 2016), and higher shares of higher performing students from public schools (Welner 2013; West, Ingram, Hint 2006), and reduce the number of students in traditional schools (Arsen and Ni 2012; Bifulco and Reback 2014). Taken together, our results suggest costs increase for school districts after charter school entry.

Alternatively, there is some evidence that charter schools impact the efficiency of providing education. Our point estimates indicate that efficiency increases five to eight years after the entry of charter schools by 2.5 percentage points. The finding is consistent with literature showing that charter school entry leads to improved service provision in traditional schools (Booker et al. 2008).

To assess the magnitude of the estimated effects of charter school entry we focus on the estimates from the sample that includes comparison districts. We use the estimated average effect of charter school entry on each of the cost-related variables—percent free-lunch, percent LEP, and percent disabled, and enrollment—together with the estimated effects of these variables on costs from our expenditure function, to calculate the estimated effect of charter school entry on the minimum required cost of meeting a given level of student performance. Assuming charter schools are associated with a 5.1 percent decrease in district enrollments, a 3 percent increase in the percent free-lunch eligible, a 0.15 increase in the percent of students who are limited English proficient, and a 1.8 percent increase in the percent of students who have a disability (see columns 1,3, 5 and 7 of Table 3), and that these variables influence costs as estimated in the first column of Table 4, then charter schools are associated with a 2.1 percent increase in the expenditures required to achieve a given level of performance. It should be noted, however, that both the effects of charter school entry on the cost-related factors, as well as the effect of these factors on minimum costs are both estimated with considerable error, and so the estimated increase in costs has very wide confidence intervals.

In addition, some of the increase in costs of achieving minimum standards might be offset by increases in district efficiency associated with charter school costs. Our analysis suggests that impacts on efficiency are largest during the years 5 through 8 after the introduction of charter schools. The point estimates indicate that, holding enrollment and student composition constant, a charter school presence is associated with a 2.5 percent reduction in the expenditures used to achieve a given level of performance during this period. As an alternative to the exercise conducted in the previous paragraph, we can compute estimated impacts on expenditures due to cost increases and efficiency gains. To compute these alternative estimates of impacts on expenditures, we use the estimated changes in enrollment and shares of high need students during the period 5 to 8 years after charter school enrollments (see columns 2, 4, 6, and 8 are Table 3) together with the estimated effect of these factors on costs and of charter school impacts on efficiency 5 to 8 years after charter school entry (see column 2 of Table 4). These computations suggest that charter schools decrease the amount district spends per pupil to achieve a given level of student performance by 1.04 percent.

In sum our results suggest that charter schools effect the number and type of students who enroll in district school and thereby the costs district are required to incur to achieve desired levels of performance, and in the medium term, these cost increases are fully offset by efficiency increases. These conclusions come with several caveats. First, our estimates of the net effects of charter school on the amount districts spend to achieve performance levels have considerable confidence intervals around them. Second, the increases in efficiency associated with charter school entry could reflect either the more efficient use of resources to educate students or reductions in spending for outcomes other than those for which we control. Second, even after controlling for the measures of student need that we include in our cost function, transfers to charter schools can leave district schools with students that have different underlying abilities to achieve educational objectives. We cannot determine whether the change in efficiency associated with charter school entry, as we measure it, is the result of improved district programming and operations, or changes in the underlying ability of its students

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Table 1: Charter School Location in New York State Outside of New York City

District	First Charter Established	Number of Charter Schools in 2013/14	Percentage of Charter Enrollment in 2013/14	Percentage of Charter Students Outside District	Percentage of Student in District Receiving Free Lunch in 1999	Highest Percentage of Charter School Student in Adjacent District	Percentage of Students Receiving Free Lunch in Adjacent District
Albany	1999/00	11	21.71	22.15	51.48	5.41	42.67
Buffalo	2000/01	15	20.05	4.59	66.47	24.33	62.02
East Irondequoit[1]	2011/12	0	0.01	N/A	12.50	10.34	70.96
Greece	2013/14	1	0.01	97.29	11.95	10.34	70.96
Hempstead	2000/01	2	10.54	25.87	53.39	2.41	24.74
Ithaca	2009/10	1	1.17	59.33	19.09	1.61	19.88
Kenmore-Tonawanda	2001/02	1	2.53	88.72	14.89	20.05	66.47
Lackawanna	2001/02	1	24.3	42.24	62.02	20.05	66.47
Mohonasen[2]	2005/06	0	0	N/A	N/A	21.71	51.48
Mount Vernon	2011/12	1	3.1	1.25	42.45	2.03	62.12
Newburgh	2013/14	1	0.48	8.47	43.16	0.01	4.58
Niagara Wheatfield	2006/07	1	0.24	97.48	14.21	5.23	42.70
Riverhead	2000/01	1	2.6	53.2	25.81	0.7	0.00
Rochester	2001/02	9	10.34	3.49	70.96	0.45	3.04
Roosevelt	2000/01	1	8.82	55.43	53.06	2.44	24.74
Schenectady[3]	2000/01	0	1.7	N/A	49.27	0.01	7.98
Syracuse	2000/01	2	6.05	6.36	56.20	0.01	20.78
Troy	2001/02	2	18.68	12.91	39.39	5.4	12.45
Utica	2013/14	1	1.76	4.47	59.57	0.19	21.13
Yonkers	2005/06	1	2.03	3.72	62.12	3.1	42.45

Sources: Table based on information from the Basic Educational Data System (BEDS) and SUNY charter school institute.

1. Charter school closed in 2012/13

2. Charter school closed in 2008/09.

3. Charter school closed in 2004/05

Table 2: Summary Statistics for Treated and Control Districts

	Treated Districts		Control Districts		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean Difference
District Count	14		14		
Operating expenditures[1]	16,384	1,667	16,499	3,423	-114
Performance Index[1] (Mean of % proficient, % earning diploma, and % non-dropout)	46.02	6.51	49.52	9.12	-3.5
Cost Related Variables					
Comparable wage index[2]	1.02	0.12	1.00	0.13	0.02
Enrollment[1]	13,318	13,758	5,269	3,796	8,048*
Percent of students with disabilities[1]	14.37	5.12	13.75	2.78	0.62
Percent LEP students[1]	52.00	33.61	63.52	38.35	-11.52
Percent free lunch[1]	55.06	8.78	52.16	11.29	2.9
Efficiency Variables					
Local tax share[1,3,4]	0.54	0.22	0.50	0.19	0.04
State aid term[1,3,4]	0.05	0.03	0.05	0.05	0
Income per pupil[1]	100,197	26,151	97,647	31,937	2,549
Percent college graduates[3,4]	19.46	5.78	16.40	4.23	3.06
Percent youth (age 5 -17)[3,4]	28.22	2.19	29.08	3.85	-0.86
Instrumental Variables					
Average percent of high cost students in the county (excluding focal district)[1,5]	11.91	1.55	12.53	21.30	-0.62
Average percent of LEP students in the county (excluding focal district) [1,5]	22.74	24.34	21.30	20.85	1.44
Adjusted state aid ratio with 1999 property values[1,3,4,5]	0.05	0.03	0.05	0.05	0

Notes: Summary measurements are for the year 1998/99, the only year in the data set without charter schools for all treated districts. Variables including the STAR tax share are not available for 1998/99 as the program was implemented in 1999/00. All monetary values are adjusted for inflation and displayed in 2014 dollars. Differences in means are tested using a t-test: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Sources:

(1) From New York State Education Department.

(2) From National Center for Education Statistics.

(3) From American Community Survey

(4) From U.S. Census (the annual values for inter-census years between 1999 and 2009 were interpolated by using the linear growth rate between 1999 and 2009).

(5) From U.S. Census, Count Business Patterns

Table 3: Effects of Charter School Entry of Cost-Related Variables

	Share Free Lunch		**Share LEP**		**Share IEP**		**Log Enrollment**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Treatment								
Treatment X Post	2.956*		0.146		1.772		-0.0508*	
	(1.540)		(3.213)		(1.043)		(0.0279)	
Treatment X Years 1, 2, 3, and 4 Post		2.539		-0.599		1.340*		-0.0369**
		(2.566)		(1.857)		(0.774)		(0.0166)
Treatment X Years 5, 6, 7, and 8 Post		2.020		-0.146		1.100		-0.0305
		(1.620)		(1.842)		(1.145)		(0.0216)
Treatment X Years greater than 8		-0.310		2.021		0.384		0.0225
						(1.729)		
		(1.959)		(1.974)				(0.0316)
Other								
Trend	0.540***	0.772***	-3.048**	-3.604**	0.171*	0.122*	-0.000540	-0.00441*
	(0.179)	(0.133)	(0.405)	(0.454)	(0.0937)	(0.0714)	(0.00229)	(0.00237)
Constant	53.07***	52.84***	60.82***	61.37***	13.89***	13.94***	8.672***	8.676***
	(1.050)	(1.093)	(5.786)	(5.816)	(0.730)	(0.629)	(0.0177)	(0.0159)
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	448	448	448	448	448	448	448	448
Number of census	28	28	28	28	28	28	28	28
R-squared	0.363	0.256	0.710	0.716	0.158	0.131	0.196	0.254

Robust standard errors in parenthesis: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4: Estimates of Expenditure Functions

	Log of per pupil operating expenditure	
	(1)	(2)
Treatment X Post	-0.0179	
	(0.0140)	
Treatment X Years 1, 2, 3, and 4 Post		-0.006
		(0.0118)
Treatment X Years 5, 6, 7, and 8 Post		-0.0246*
		(0.0145)
Treatment X Years greater than 8		-0.0221
		(0.0206)
Performance Index	0.0383	0.304*
	(0.0467)	(0.170)
Comparable wage index	0.541***	0.253
	(0.148)	(0.198)
Enrollment[a]	-0.163	-0.463
	(0.342)	(0.446)
Enrollment squared[a]	-0.0128	0.000515
	(0.0190)	(0.0242)
Percent of students with disabilities[a]	0.032*	0.0280
	(0.01757)	(0.0205)
Percent LEP students[a]	0.00563	0.0125
	(0.00849)	(0.00856)
Percent free lunch[a]	0.00773	0.0116
	(0.0105)	(0.0135)
Local tax share[a]	-0.355***	-0.269***
	(0.0445)	(0.0683)
STAR tax share[a]	-0.389***	-0.323***
	(0.0972)	(0.110)
State aid term[a]	0.261***	0.238***
	(0.0372)	(0.0462)
Income per pupil[a]	0.265***	0.268***
	(0.0443)	(0.0563)
Percent college graduates	-0.133**	-0.213**
	(0.0678)	(0.105)
Percent youth (age 5 - 7)	-0.0748	0.307
	(0.220)	(0.319)
Observations	448	448
R-squared	0.903	0.892
Number of districts	28	28

Notes: All independent variables other than the treatment variables are entered in logs. Robust standard errors in parenthesis: *** p<0.01; ** p<0.05; * p<0.1. Regression is estimated with the Fuller (k=4) estimator and robust standard errors clustered at the district level.

[a] Variable is log transformed

Table 5: Estimate Effects of Charter School Entry on Cost-Related Variables, Using Sample of Treated Districts Only

	Share Free-Lunch	**Share LEP**	**Share IEP**	**Log Enrollment**
Treatment X Post	3.610	2.308	2.459	-0.0677**
	(2.898)	(1.747)	(2.083)	(0.0287)
Observations	256	256	256	256

Table 6: Estimates of Expenditure Functions Using Treated Districts Only

	Log of per pupil operating expenditure	
Treatment X Post	0.0176	
	(0.0191)	
Treatment X Years 1, 2, 3, and 4 Post		-0.0103
		(0.0131)
Treatment X Years 5, 6, 7, and 8 Post		-0.0248
		(0.153)
Treatment X Years 9, 10, 11, and 12 Post		0.0387
		(0.0247)
Performance Index	-0.439***	0.216*
	(0.153)	(0.120)
Comparable wage index	1.233***	0.978***
	(0.356)	(0.379)
Log of Enrollment	0.613	0.424
	(0.445)	(0.519)
Log of Enrollment Squared	-0.0459**	-0.0412
	(0.0234)	(0.0260)
Percent of students with disabilities	0.0269	0.0185
	(0.0254)	(0.0255)
Percent LEP students	0.0510**	0.0235
	(0.0202)	(0.0161)
Percent free lunch	0.00499	0.00228
	(0.00840)	(0.00884)
Local tax share	-0.473***	-0.364***
	(0.0804)	(0.0718)
STAR tax share	-0.512**	-0.320
	(0.209)	(0.197)
State aid term	0.377***	0.274***
	(0.0677)	(0.0654)
Income per pupil	0.372***	0.266***
	(0.0815)	(0.0855)
Percent college graduates	0.152	-0.0591
	(0.150)	(0.156)
Percent youth (age 5 - 7)	0.455	0.265
	(0.341)	(0.430)
Observations	256	256
R-squared	0.882	0.909
Number of districts	16	16

Notes: All independent variables other than the treatment variables are entered in logs. Robust standard errors in parenthesis: *** p<0.01; ** p<0.05; * p<0.1. Regression is estimated with the Fuller (k=4) estimator and robust standard errors clustered at the district level.

Table A1: Results First Stage Regression Used in Expenditure Function Estimation

	Dependent Variables		
	Performance Index	STAR Tax share	Adjusted aid ratio
Average percent of high cost students in the county (excluding focal district)	0.00292	-0.00859**	-0.00861**
	(0.00619)	(0.00384)	(0.00432)
Average percent of LEP students in the county (excluding focal district)	-0.00209**	0.000992*	0.00150***
	(0.000888)	(0.000521)	(0.000555)
STAR tax share with inflated 1999 property values	-0.355*	1.640***	0.640***
	(0.202)	(0.212)	(0.212)
Adjusted state aid ratio with 1999 property values	0.0742	0.0276	1.028***
	(0.0492)	(0.0287)	(0.0287)

Notes: Robust standard errors in parenthesis: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Other variables in the first stage results are not displayed.