The Impact of Charter Schools on the Efficiency of Traditional Public Schools: Evidence from Michigan[1]

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Abstract

This paper tests the hypothesis that competition from charter schools improves the efficiency of traditional public schools. The analysis utilizes a statewide school-level longitudinal dataset of Michigan schools from 1994 to 2004. Fixed effect methods and two alternative estimations are employed. The results from three alternative estimation strategies consistently show that charter competition has a negative impact on student achievement and school efficiency in Michigan's traditional public schools. The effect is small or negligible in the short run, but becomes more substantial in the long run, which are consistent with the conception of choice triggering a downward spiral in the most heavily impacted public schools.

Keywords: *charter schools, competitive effect, school effectiveness, longitudinal analysis*

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Introduction

One of the central issues in the charter school debate revolves around whether the competition induced by charter schools improves school efficiency. Recent research in this regard has focused on whether charter schools are more efficient than traditional public schools (TPS). However, the more important issue that remains unresolved is whether charter competition improves the efficiency of TPSs and thereby benefits the vast majority of students in the public school system.

In microeconomic theory, school efficiency is related to the production process of schools, which transform "inputs" into "outputs." Inputs include students and teachers with certain characteristics as well as financial and material supports. Outputs refer to student outcomes such as achievement and graduation rates after a certain period of education. The production process within a school can be understood as the instruction, curricula, school organization, and governance that make it possible for students to acquire knowledge. School efficiency, often referred to productivity, is the extent to which educational inputs produce desired student outcomes. Increased efficiency means achieving better student outcomes with the same level of inputs, or the same student outcomes with fewer inputs.

School choice advocates argue that introducing school choice will result in TPSs working more efficiently. According to this argument, in the traditional system TPSs have little incentive to improve the quality of education they provide their students or to increase the efficiency of their use of resources. TPSs both operate in a relatively monopolistic market and are overburdened by a form of democratic control that leaves them vulnerable to the demands and goals of multiple interest groups (Chubb & Moe, 1990). By this view, the introduction of school choice frees the schools from the constraints of both bureaucracy and monopoly, and creates a market incentive mechanism that motivates TPSs to become more efficient.

Moreover, economists anticipate that the positive long-run effects on resource allocation, school quality, and even the existence of schools would be more substantial than the short-run effects (Hoxby, 2003a). In the short-run, an administrator who wants to raise school productivity has only certain options such as inducing the staff to work harder, getting rid of unproductive staff and programs, and allocating resources away from non-achievement oriented activities. However, in the long run, some general equilibrium mechanisms are available to an administrator. For instance, administrators can improve teacher quality through professional development, or propose high salaries in order to attract high quality teachers, and thus draw people into teaching who would otherwise pursue other careers (Hoxby, 2003a).

Other scholars, however, argue that TPSs will not necessarily be more efficient when they face competition from school choice. First, highly motivated students might be more active in choosing to attend choice schools; less motivated students would then be clustered in increasingly disadvantaged TPSs. These schools in turn would have difficulty responding to the competitive challenge because of negative peer effects over which school administrators have limited control. Second, losing students to choice schools will ordinarily decrease TPSs' educational revenue. Expenditure, however, cannot be so readily decreased. Losing students to competitors creates fiscal constrains for TPSs, which makes it harder for them to continue providing the same quality programs, let alone improving educational services. Since revenues decline faster than costs in TPSs that lose students, TPSs may be compelled to cut programs, which could spur the loss of further students and resources, and trigger a downward spiral (Arsen, Plank, & Sykes, 1999; Fiske & Ladd, 2000).

With the growth of school choice policies, the resolution of these contrasting viewpoints is clearly significant, since – for the foreseeable future – the majority of students will still remain in the TPS system. Although there are many forms of school choice policies, including vouchers, inter-district choices, and magnet schools, the impact of charter school policies on TPSs are especially important because charter schools have expanded very rapidly in the US over the past decade. They are also identified as a policy option for turning around failing schools under the No Child Left Behind Act (NCLB). However, the existing literature fails to provide consistent evidence on charter school effects on TPS efficiency. Researchers face two big empirical challenges in establishing the causal relationship between charter school competition and student outcomes: charter schools are not randomly located and students systemically sort themselves between charter schools and TPSs, often in unobserved ways that affect school effectiveness.

Using 11 years of school-level longitudinal data in Michigan, this paper tests the hypothesis that competition from charter schools improves the efficiency of TPSs. The analysis is based on fixed effect methods that implicitly control for unobservable time invariant school characteristics, and explicitly control for changing student composition and other factors induced by charter school policy. Two alternative estimations are also used for robustness checks. The analysis also separates the competition effect of charter schools from that of Michigan's inter-district school choice policy. My results show no positive competitive effect on student achievement in TPSs. Indeed, in areas with high charter school density I find a significant negative impact on the performance of traditional public schools. The findings cast doubt regarding the predicted positive competitive effect of school choice and reinforce the longstanding concern that school choice can lead, instead, to a downward spiral among schools in heavily impacted areas, especially schools that enroll high percentages of historically underserved students.

Literature Review

There is a substantial body of research on the impact of competition on educational outcomes. In most of this research, however, the competition analyzed is generated by private schools or neighboring public schools. In their comprehensive review of cross-sectional research in the U.S., Belfield and Levin (2002) concluded from more than 41 studies that competition has modest positive effects on student achievement.

Fewer studies specifically examine the competitive effects of school choice policies and charter schools in particular. Most studies have focused on whether charter schools are more or less efficient than TPSs (e.g., Bifulco & Ladd, 2004; Eberts & Hollenbeck, 2001; Hanushek, Kain, & Rivkin, 2002; Solmon, Paark, & Garcia, 2001). There has been relatively little research on the impact of charter school competition on the efficiency of TPSs. So far, studies of this issue have focused on states such as Florida, California, Arizona, Michigan, Texas, and North Carolina, where charter school laws have been in place long enough and charter school enrollments are sufficient to generate significant competitive pressure on TPSs. Among these studies, the results are mixed, with some studies finding positive competitive effects, and others finding no or negative competitive effects.

In order to establish the causal relationship between charter competition and school efficiency, a number of methodological challenges must be addressed. First, the location of charter schools is not randomly determined. It is reasonable to expect charter schools to locate in areas where students are not satisfied with the educational services they receive in TPSs, or in communities where parents tend to be more motivated and better informed. These characteristics of schools or communities are usually unobserved and will cause estimation bias if not controlled. Second, the student self-selection problem might confound estimation of the competitive effect on TPS efficiency. Students who move to charter schools probably differ systematically from the students who do not exercise their option to do so. They might differ in past performance and family background, which are observable, as well as in motivation and innate ability, which are unobservable. Charter schools might change the student composition of TPSs from which they draw their students. Consequently, changes in the composition of student in TPSs facing competition could be different from that of TPSs facing no competition. Past research has shown the salience of race, socioeconomic status, and student performance in student mobility patterns under Michigan's choice policies. The re-sorting does influence the composition of students in TPSs, with disadvantaged students increasingly concentrated in schools in central cities (Arsen et al., 1999; Ni, 2007). If peer effects matter, these schools in turn would have difficulty responding to the competitive challenge because of the changing student composition over which they have no control.

Several strategies have emerged in the empirical literature to address these problems. To solve the problem of the endogeneity of charter location, researchers usually rely on estimation strategies such as fixed-effects transformations to eliminate the unobserved heterogeneity. Alternatively, researchers could rely on instrumental variables (IV) estimators to obtain consistent estimation. Appropriate IVs should be correlated with where charter schools choose to locate, but not related to neighboring TPS outcomes. Empirically, however, IVs of this kind are hard to find in the charter school research. To correct for the student self-selection problem, scholars usually include lagged dependent variables to control for students' past performance, incorporate schools' student composition as additional explanatory variables, or control for unobserved student heterogeneity when longitudinal student-level data are available.

Using these research techniques, charter schools have been found to have modest positive impact on TPS student test scores in Texas and Florida, (Booker, Gilpatric, Gronberg et al., 2005a; Sass, 2006). By contrast, a study in California found that charter competition, measured in a variety of ways, failed to improve the performance of TPSs (Buddin & Zimmer, 2005). In North Carolina, Holmes et al. (2003) reported that TPSs facing competition gained approximately about one quarter of the average yearly growth. In another North Carolina study, however, Bifulco and Ladd (2004) found that competition of charter schools had no substantial impacts on TPS effectiveness. The authors attributed the different results between the two studies to the fact that Holmes and his colleagues did not use a student-level panel to account fully for potential differences between students in schools located near charter schools and those in schools located elsewhere.

North Carolina is not the only state where contradictory results about the impact of charter school competition on TPS effectiveness have emerged. Studies based on Michigan have also reported opposing conclusions. Bettinger (2005) estimated the short-run competitive effect of the first charter schools that opened in 1996, shortly after Michigan's charter school program had been introduced. Bettinger employed a difference-in-difference strategy and introduced an IV to correct the bias caused by the endogeneity of charter location. The study showed that charter schools had little or no effect on test scores in neighboring public schools. In contrast, a study by Hoxby (2003b) reached different conclusions. Applying a detrended difference-in-difference strategy to control for each school's initial productivity and trend, Hoxby found that TPSs in Michigan raised their productivity and achievement in response to charter school competition.

So far, past research has produced mixed results about the influence of choice competition on TPS effectiveness, even when it is based on charter schools in the same states. Aside from the different data and methods used, there are several other potential reasons for the inconsistent results. First, the measure of competition from charter schools varies in different studies. Some researchers use the number of charter schools within a given radius of public schools to measure the intensity of competition (Bettinger, 2005; Bifulco et al., 2004; Sass, 2006). Some use the distance of a public school from a charter school to measure competition (Bifulco et al., 2004; Holmes et al., 2003). Others measure competition by the percentage of students who have exited to charter schools, or identify a certain percent of a school district's enrollment in charter schools as the threshold of competition (Booker, Zimmer, & Buddin, 2005b; Hoxby, 2003b). For checks of robustness, some researchers evaluate several different measures of the degree of competition (Bifulco et al., 2004; Sass, 2006). There is no consensus about which measure is better than the others.

A related issue is that the unit of analysis varies across studies. Since the research question focuses on the organizational efficiency of schools, it is reasonable to take schools rather than individual students as the unit of analysis. Although students can decide how much time and energy to devote to studying, they have no discretion in allocating educational resources and have no responsibility to care about the performance of their peers. Instead, schools or school districts are the decision-making organizations that allocate resources to different programs and to different groups of students so as to collectively respond to charter competition. Nevertheless, researchers increasingly use students as the unit of analysis when student-level data are available. This is also desirable because students who choose to attend charter school might differ systematically from students remaining in TPSs in unobserved ways. Controlling for student fixed effects can reduce some sources of heterogeneity bias.

Third, studies have been conducted in different stages of state charter school development. For example, when Bettinger (2005) studied Michigan's charter schools in 1999, only a small number of charter schools were opened and had been in operation for less than three years. This is almost certainly too short for the long-run competitive effects of charter schools to unfold.

School Choice Context in Michigan

In 1993, Michigan became the eighth state to adopt a charter school law. A charter school, officially designated a public school academy (PSA) in Michigan, is a state-supported public school that operates independently under a charter granted by an authorizing body. In Michigan, PSAs can be chartered by local school districts, intermediate school districts, the state board of education or the governing boards of public community colleges, or universities. Charter schools have no geographic boundaries as do TPSs. Students are free to choose to go to any charter school in the state, on a space available basis. PSAs can serve any grades but most charter schools in Michigan serve students only in the K-8 range.

Originally, no limit was imposed on the number of charters that could be issued by any of the authorizing boards. However, in 1996, following a proliferation of charters issued by the board of Central Michigan University, the legislature imposed a cap on the total number of schools that may be chartered by the Michigan's 15 public universities. This cap of 150 schools has limited new school development since 2000. However, there is no cap on the number of schools chartered by other organizations. Thus, charter schools in Michigan have developed steadily during the past decade. With the first charter schools opened in Detroit in 1994, Michigan had 226 charter schools by 2005. The majority of Michigan charter schools now contract for services with private, for-profit Educational Management Organizations (EMO). About 92,000 students (or five percent of the state's public school population) enrolled in charter schools in 2005. So far, Michigan's charter enrollment is the third largest in the nation after California and Florida.[2]

It should be noted that the state's school finance system, commonly designated Proposal A, greatly facilitated the charter school program's development. Approved in 1994, Proposal A shifted the responsibility for funding school current operations from local districts to the state. Besides state and federal categorical aid, school districts have received almost all their operational revenues from the state in the form of a per-pupil

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[2] Source: http://www.publiccharters.org/section/states/mi

foundation grant, which was approximately $6875 in 2006.[3] That money goes directly to the school district that the students attend. Local voters could no longer increase taxes to support school operations. Charter schools receive a per-pupil allowance equal to the foundation allowance of the district in which the school is located[4]. Thus, the amount of operating revenue that districts and charter schools receive depends almost exclusively on the number of students they enroll. Essentially the only way schools can increase their revenue is to attract more students. As in other states, Michigan's charter schools must compete with TPSs for students and resources in order to survive and expand. Unlike other states, however, TPSs in Michigan lose the full per-pupil operational funding for a student who transfers out, and they lack authority to raise revenue locally to compensate for the lost funding. In this sense, the school finance system in Michigan is uniquely favorable to school choice policies, and creates the ideal competitive market for schooling. Undoubtedly, Michigan is an especially important case for studying the effects of charter schools on traditional public schools.

In addition to the charter school program, in 1996, the Michigan Legislature created an inter-district choice program (commonly designated "Schools of Choice") that allows students to choose public schools located outside their home districts. School districts can determine whether or not to accept nonresident students. However, they cannot prohibit students who live within their boundaries from attending public schools in another district that admit them. Up to 2004, about half of Michigan's 555 local districts enrolled

[3] A small set of hold-harmless districts, whose foundation in year 1994-95 exceeded $6,500, are eligible to levy additional local property taxes up to a cap to sustain funding above the state basic foundation allowance.

[4] However, there is a cap on the PSA foundation allowance, which limits their revenue below that of TPSs in the highest revenue school districts (Addonizio, Mills, & Kearney, 2000). In addition, charter schools receive federal and state categorical funding on the same basis as school districts.

nonresident students under the inter-district choice program. About 80,000 students enrolled in schools of choice through the state's inter-district choice policy. The charter school and inter-district choice programs are designed so differently that they are likely to have different impact on TPSs. In order to separate the competitive effect of charter schools from that of inter-district choice, this paper in contrast to previous studies of school choice in Michigan includes the measures of the intensity of inter-district choice as control variables.

Research Questions

This paper aims to address some of the limitations of past research and establish the causal relationship between charter competition and TPS efficiency. Specifically, I ask two questions: (1) how has competition from charter schools influenced efficiency in TPSs? and (2) does the competition generate different impacts on TPS efficiency in the short-run and the long-run?

Like Hoxby (2003b) and Betinger (2005), my analysis focuses on Michigan's charter school program. However, my research differs from these studies in several respects. First, the availability of more recent data allows me to evaluate both the short-run and long-run effects of the charter school policy. Second, more detailed school-level data enable me to capture other systematic changes induced by charter schools, including changes in student demographics, school expenditure, and class size. Third, my models explicitly control for the competition from Michigan's other choice program—inter-district choice—which might confound the effect of charter competition if not controlled. Fourth, I measure charter competition confronted by each district as the percentage of resident students who have transferred to charter schools, instead of charter school enrollment as a percentage of the total enrollment in charter host district. I will later elaborate on why the difference between these two measures is important.

Data and Methodology

Data Sources

This analysis utilizes a statewide school-level panel dataset of Michigan schools from 1994 to 2004. The data were assembled from three main sources: the Michigan Department of Education (MDE), the State of Michigan's Center for Educational Performance and Information (CEPI), and Common Core Data (CCD) from the National Center of Educational Statistics (NCES). The merged dataset includes information by schools for school choice enrollment, student demographics, school finance, and other school level factors over the 11 years.

Data on student achievement—the scale scores and percent of students attaining satisfactory performance levels on the Michigan Educational Assessment Program (MEAP) tests—come from the MDE's Office of School Assessment and Accountability (OSAA). These include reading and math scores in the 4th and 7th grades.[5] Since not all Michigan students were tested annually in the same subjects during the years included in this study, student-level longitudinal achievement data are not available. However, as noted, from a policy perspective, it is probably more relevant to see how schools as organizations respond to charter competition.

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[5] The 7th grade math was no longer tested after 2000.

Measure of Competition

Competition from charter schools is measured through two dimensions: the magnitude and the duration of the competition. The indicator of the magnitude of charter competition improves upon the one introduced by Hoxby (2003b), who defined whether or not a district faces strong charter school competition based on whether the charter school enrollment reach 6 percent of the total enrollment of the district. Her measure is based on the assumption that students always attend charter schools located in the district in which they reside. This assumption does not hold, however, in Michigan's case. More than one-third of Michigan's charter schools draw the majority of their students from districts other than the district in which the charter school is located. In other words, many students attend charter schools that are located outside the district where they live. Accordingly, I define charter competition as the percentage of students who live in a district who have transferred to charter schools. To construct the measure, I first identify the primary sending district for each charter school, i.e., the district in which the majority of students in each charter school lived. Then for each district, I calculate the total enrollment of all charter schools that primarily draw students from the district and divide it by the total enrollment of the district.[6] [7]

The degree of competition can be measured as either a continuous or dummy variable. Hoxby (2003b) and Bettinger (2005) used a dummy variable which takes the value of 1 if

[6] Although this measure is not the exact percentage of students that each district loses to charter schools, it is undoubtedly a more accurate measure than the charter enrollment as a percentage of the total enrollment of the host district.

[7] I also constructed the same measure of charter school competition as Hoxby used in her study. The two measures are highly correlated. The estimation based on this alternative measure of competition generated similar results but in a smaller magnitude. A possible reason for this is that the alternative measure underestimates charter competition in some districts and overestimates it in other districts. For example, many charter schools draw students from central cities, even though they are located in surrounding suburban districts. As a result, the estimation of the alternative measure is biased toward 0.

the percentage of charter enrollment reaches 6 percent, and 0 otherwise. As Hoxby (2003b) argued, the impact of competition should not be linear, but negligible at first and then becoming more observable when the share of charter enrollment reaches a certain point or threshold. I follow their method in my analysis. I have also tried to define the dummy variable using other cut points such as 3%, 5% and 10%, similar results emerged. Bettinger (2005) made the same observation in his study. In addition, I have checked for the consistency of the results with the continuous variable reflecting the exact percentage of students transferring to charter schools, and found the effects are less dramatic than using the dummy variables, but similar otherwise.

To capture the second dimension of charter competition, its duration, I created three dummy variables that distinguish the effect of charter competition in the short-run, medium-run, and long-run. For instance, if a district lost more than 6 percent of its students to charter schools for less than 4 years, I identify the charter competition as short-run. Likewise, the loss of more than 6 percent of students for 4 to 6 years is defined as the medium-run competition, and greater than 6 years as the long-run competition.

Finally, a vector of dummy variables measuring both the magnitude and the duration of charter competition is obtained by interacting the dummy variable reflecting whether more than 6 percent of students transfer to charter schools with the three duration dummy variables. The competition measure is a district-level measure since school-level charter enrollment data are not available. On the other hand, the loss of students to charter schools influences district revenues directly, and they must in turn decide how to adjust their resource allocation among individual schools. In this sense, school districts instead of schools should be the primary organization that responds to the competitive pressure introduced by charter schools.

Estimation Strategies

In order to estimate the competitive effect of charter schools on TPSs, I rely on an education production function approach, where student achievement is defined as a function of charter competition and other school-level controls. Several approaches are involved in estimating the charter competitive effect. First, I utilize pooled OLS to check how charter competition is related to student achievement. Then I employ fixed-effects (FE) estimators to establish the causal relationship between charter competition and student achievement. FE estimator overcomes the non-randomness of charter school location by implicitly controlling for the unobservable time invariant school characteristics that influence its likelihood of facing charter competition. It also addresses the student self-selection problem by explicitly controlling for changing student composition and other factors induced by charter schools. Finally, I include several other estimations to address the potential bias caused by endogeneity of charter competition.

In general, the education production function can be expressed as

$$Y_{it} = \boldsymbol{CS}_{it}\,\mathbf{B_1} + \boldsymbol{SCH}_{it}\mathbf{B_2} + \boldsymbol{IC}_{it}\,\mathbf{B_3} + I_t\,\delta + V_{it} \qquad (1)$$

where Y_{it} is the average student achievement of school *i* in year *t*, specifically in this study, the percentage of students passing the MEAP test at a satisfactory level. The satisfactory rate measures the school effectiveness when other educational inputs are *not* controlled. After controlling inputs such as expenditure and student demographics, the satisfactory rate measures school efficiency or productivity which reflects achievement per dollar spent. Scale scores were initially used but replaced by satisfactory rates mainly for two reasons. First, it is difficult to interpret the results because the score itself is not meaningful, and the cut score varies for each year. In addition, the reading scale scores before 2003 are not comparable to the reading scores after 2003, due to changes in the content and standards since that year.

The variables of interest in this analysis are included in $\boldsymbol{CS}_{it}$, a vector of dummy variables that reflects both the magnitude and the duration of charter competition of school *i* at time *t*. It should be noted that although the unit of analysis is the school, the competition measure, $\boldsymbol{CS}_{it}$, is a district-level measure. $\boldsymbol{SCH}_{it}$ is a vector of characteristics of school *i* at time *t*, including the percentage of students eligible for the free/reduced price lunch (FRL) program, percentage of students who are minority, pupil-teacher ratio, per-pupil operational expenditure in logarithmical form to impose a diminishing effect of spending on performance, and instruction expenditure as a percentage of total operational expenditure. $\boldsymbol{IC}_{it}$ indicates the competition that districts face through inter-district choice, the other statewide choice program in Michigan. Inter-district choice allows students to transfer between school districts. Therefore, while some districts gain students through the choice program, other districts lose students. $\boldsymbol{IC}_{it}$ is a vector of two dummy variables reflecting whether districts gained or lost students. The first dummy variable measures whether a district gained students, which takes value of 1 if the percentage of students gained by a district exceeds 6 and 0 otherwise. The second dummy variable measures the loss and takes value of 1 if the percentage of students lost by a district exceeds 6 and 0 otherwise.[8] A set of year dummies, I_t, is also included to capture any systematic influence

[8] The advantage of using two dummy variables instead of one categorical variable is that they allow for nonlinear relationship between inter-district choice competition and student outcomes.

not accounted for by the observable inputs that vary over time but are common to all schools. V_{it} is the unobserved error.

I start to estimate Equation (1) with OLS by pooling data across schools and over the years. However, in order to produce a consistent estimator of the competitive effect, pooled OLS assumes all school-level variables not controlled in the model are uncorrelated with charter competition, which is unlikely to be true in this analysis, because the location of charter schools might be influenced by unobserved features of TPSs.

To address the limitation of the pooled OLS in estimating Equation (1), I decompose the error term V_{it} in Equation (1) into a school fixed effect and an idiosyncratic error that changes over time (Wooldridge, 2000). The same set of school factors is included to capture the possible change of school factors including student mobility. The equation becomes:

$$Y_{it} = \boldsymbol{CS}_{it}\,\mathbf{B_1} + \boldsymbol{SCH}_{it}\mathbf{B_2} + \boldsymbol{IC}_{it}\,\mathbf{B_3} + I_t\,\delta + \theta_i + u_{it} \qquad (2)$$

where θ_i is an unobserved school fixed effect or heterogeneity that picks up all the unobserved characteristics of a school that are stable over time, including historical reasons that influence charter location. u_{it} is the idiosyncratic error term that changes across time for each school.

One way to estimate model (2) is through FE transformation with standard errors robust both to serial correlation and heteroskedasticity. It can readily eliminate the unobserved school heterogeneity (θ_i) that affects student achievement, and allows for arbitrary correlation between θ_i and $\boldsymbol{CS}_{it}$, which means that the location of charter schools is allowed to be related to historical differences among schools. Consistency of the FE estimator requires that charter competition is strictly exogenous after accounting for the school heterogeneity (which means, charter competition, $\boldsymbol{CS_{it}}$, must be uncorrelated with the idiosyncratic errors, u_{ir}, in all time periods r). But if future movements in charter competition depend on current unexplained changes in test performance, the strict exogeneity is violated and the FE estimator is biased. For example, suppose student achievement in a TPS changes because charter schools draw some TPS students who are systematically different in unobserved ways from the students remaining in the TPS. If the TPS draws more or less charter competition in the following years because of its changed student composition and achievement, the FE estimator is not accurate anymore. It is usually hard to tell which way the bias will go. The literature suggests that students with lower performance tend to choose to go to charter schools (Booker et al., 2005b; Ni, 2007). If these students happen to have lower academic abilities, the FE estimator will be biased upward because the average ability of students remaining in TPSs is higher than before. On the other hand, although students who actively switch schools have lower performance than the students who stay, they might be as a group more motivated and their parents might care more about their education. This suggests the opposite direction of bias.

If the strict exogeneity assumption fails, the bias of the FE estimator is of order 1/T and the magnitude of bias is c/T. This means that even though we do not know the value of c, the magnitude of the bias of the FE estimator decreases substantially for large T, which is 11 in this study. For robustness checks on the consistency of the FE estimator, I also estimate Equation (2) through a first-differenced (FD) estimator, where I first difference the equation across years to remove θ_i and estimate it by pooled OLS with robust standard errors. If the strict exogeneity assumption fails, the magnitude of the bias of the FD estimator is c, and it remains essentially the same as the length of time, T, grows. Although when the strict exogeneity assumption fails both the FE and FD estimates are biased, it is very useful to compare the two to gain a sense of whether the estimates are biased, and the direction and magnitude of any bias.

In the FE and FD estimations, the unobserved effect is defined to have the same partial effect on performance rates in all the time periods. This assumption might be too strong for this study, because 11 years is a relatively long time. A random trend model allows us to control for an additional source of heterogeneity. In addition to the level effect, θ_i, the random trend model allows each school to have its own time trend, g_{it} (Wooldridge, 2002), which can be written as:

$$Y_{it} = \boldsymbol{CS}_{it}\,\mathbf{B_1} + \boldsymbol{SCH}_{it}\mathbf{B_2} + \boldsymbol{IC}_{it}\,\mathbf{B_3} + I_t\,\delta + \theta_i + g_{it} + u_{it} \qquad (3)$$

In model (3), charter competition is not just a function of schools' initial historical factors, but also a function of how quickly a district is responding to the charter competition. For instance, if a TPS quickly responds to charter competition and improves its student achievement by innovations in instruction or governance, the random trend model allows the time trend of this school to be different from TPSs having no or little response when facing charter competition. There are many ways to estimate the random trend model. In this paper, I estimate it by first differencing the equation to eliminate θ_i and then applying the FE transformation to the first differenced equation, which eliminates the school-specific trend, g_{it}. In addition to estimating model (2) through both

FE and FD methods, and estimating the random trend model (3) though FE and FD strategies, I have also tried other robustness checks, which I will elaborate later.

Findings

Descriptive Statistics

Table 1 provides information on charter competition in Michigan from 1994 to 2004. The percentage of charter school enrollment statewide increased almost every year. In 2004, it reached 4.2 percent of all public school students. Although the first charter schools in Michigan were founded in 1994, no TPS experienced strong charter competition before 1996. By 2004, about 382, or 14.2% of all TPSs in Michigan have experienced long-run charter competition and an additional 7.9% have experienced only short- or medium-run charter competition. Table 2 further shows that most of TPSs facing strong charter competition are located in urban school districts. In 2004, about 79% of all TPSs in central cities experienced significant charter competition, and the majority of these schools had faced the long-run charter competition for more than 6 years.

[Table 1 about here]

[Table 2 about here]

Table 3 presents MEAP satisfactory rates for both math and reading in 4^{th} and 7^{th} grades. Throughout the 11 years, TPSs facing significant charter competition had consistently lower satisfactory scores than the schools facing no substantial charter competition, with only a few exceptions in the earlier years. The statewide mean satisfactory rates increased every year before 1998 and then varied across the subsequent years. This indicates that there are systematic fluctuations in the MEAP tests among years, which could be attributable to changes in cut scores, test difficulty, and new curricular requirements. Although this analysis compares schools facing charter competition with those facing no competition in the same year—and thereby the change of cut scores and difficulty levels of the tests across years should not influence the analysis results—it is important to include year dummies in the analysis in order to control for the statewide changes in the tests or ratings.

[Table 3 about here]

Table 4 displays the descriptive information of the variables used in the models, along with their means and standard deviations. As with the measures of charter competition, inter-district choice is a district-level measure. On average, about 3.5 percent of schools gained more than 6 percent of students through inter-district choice, and 2.7 percent of schools lost more than 6 percent of students. The means are calculated across all years, and the gain or loss of students were much bigger in recent years. As a matter of fact, in 2004, about 8.5 percent of schools were in districts that lost more than 6 percent of their students, and 10 percent of schools are in districts that gained more than 6 percent of their students through inter-district choice. On average, schools spend about 63% of their educational expenditure on the instruction. The standard deviation is fairly small, only about 4 percent, indicating there is not much variation in this variable among schools and over the years. Statewide, students who are eligible for the FRL program accounts for 32% of all students across years. This number increased every year. In 2004, about 40% of students statewide were eligible for FRL. Black students comprise the largest minority group in Michigan public schools. Hispanic and Asian students combined account only for about 6 percent of all students. Statewide, the percentages of minority students increased 6 percentage points between 1994 and 2004. The pupil-teacher ratio is about 19.1:1 on average, which has decreased slightly over the years.

[Table 4 about here]

Pooled OLS

First, I pool the data across years and estimate the satisfactory rates as a function of charter competition and other controls by OLS. A set of year dummies are added to allow for secular changes in student performance over time. Table 5 reports the results for both math and reading in 4th and 7th grades. For each subject and grade, the first column shows results with no other control variables, while the following column shows the results of the model including the full set of control variables. Heteroskedasticity-robust standard errors are reported in parentheses.

Looking at the pooled OLS results with no controls, it is clear that there is a strong negative association between charter competition and satisfactory rates for both subjects in both grades. For example, the results in column (1) show that, once a school faces strong charter competition, its satisfactory rate for 4th grade math decreases about 15.7 percentage points, or 0.8 standard deviations, in the short-run.[9] If the strong charter competition persists, the satisfactory rate drops further to 20.5 percentage points lower than schools facing no substantial charter competition. The negative association between charter competition and student achievement becomes much smaller in magnitude when the full set of control variables is included. For instance, column (2) shows that math satisfactory rate for 4th grade only decreases 4.31 percentage points under charter

[9] The standard deviation of 4th math satisfactory rates is 20.52.

competition in the short-run, after controlling for school characteristics such as student composition, expenditure, and pupil-teacher ratio. This is consistent with the fact that charter schools tend to locate near the schools with characteristics associated with low student performance. Once student demographic and financial variables are controlled, the effect of the charter school competition becomes much smaller. The subsequent columns show similar patterns for 4th grade reading, and 7th grade math and reading.

[Table 5 about here]

The gain and loss of students through inter-district choice both seem to have negative impacts on student achievement in the pooled OLS estimations. However, the magnitudes are much smaller than the impact of charter competition and some coefficients are insignificant. Educational expenditure is positively associated with student achievement across different specifications. Results in column (1) show that a 10% increase in operational expenditure per pupil increases the satisfactory rate by 1.9 percentage points. The estimated effects of other control variables are also consistent with expectations: if a school spends a larger share of its current operating expenditure on instruction, the satisfactory rate increases. High concentrations of low-income, Black, and Hispanic students are associated with lower satisfactory rates. However, high percentages of Asian students are associated with higher satisfactory rates in each subject in both grades. District size does not seem to be related to satisfactory rates.

Taking the results at face value, the estimates suggest that charter schools have a negative competitive effect on student achievement. It also implies negative competitive effect on school efficiency, since spending and other inputs are controlled in the models. However, although pooled OLS estimation explicitly controls several school factors, it cannot remove the unobserved school effects. If the unobserved school effects are correlated with the degree of charter competition, the pooled OLS estimates would be biased. To address this possibility, next I employ FE and other methods to remove the unobserved school heterogeneity in order to obtain consistent estimations of the competitive effect of charter schools.

Fixed Effect Estimations and Potential Sources of Bias

Table 6 shows the results of the impact of charter competition on the 4^{th} grade math satisfactory rate by FE estimations, followed by FD and random trend model estimations. Column (1) of Table 6 contains the FE estimates. The effect of charter competition in both the short- and medium-run is small and insignificant. However, the effect of long-run charter competition is negative and significant: a school facing strong charter competition for more than 6 years is estimated to decrease its 4^{th} grade math satisfactory rate by about 4.24 percentage points, or about .25 standard deviations. The fully robust t-statistic that allows for serial correlation and heteroskedasticity is quite large (t = 3.97).

The gain of students through inter-district choice does not seem to have an effect on the satisfactory rate. The loss of students to other school districts, however, has a positive impact on student achievement, as opposed to the competitive effect of the loss of students to charter schools. This is somewhat surprising, but can be explained by the different designs of the two choice policies. Michigan’s charter school program generates sharp and intense competition between charter schools and TPSs because charter schools have no pre-existing claims on students or resources. In order to survive and expand, charter schools have to compete aggressively with TPSs for students. By contrast, inter-district choice is more disciplined and controlled than charter school program. Most inter-district choice happens within intermediate school districts (ISDs) and contiguous ISDs, often coordinated to varying degrees by the ISD superintendents. In many cases, districts have agreements that constrain enrollment transfers, which induces more cooperation and even collusion among districts within a local ecology (Arsen et al., 2002).

Once the school fixed effects and aggregate time effects are controlled, other variables become much less significant than in the pooled OLS estimation. This is not surprising as student composition and expenditure vary much less within schools over time than across schools. Schools with high percentages of Black students show lower levels of satisfactory rates than schools with lower percentages of Black students. The coefficient on expenditure remains positive, indicating higher level of spending leads to higher student achievement.

[Table 6 about here]

FE estimators might account for most of the endogeneity of charter competition. However, how schools respond to charter competition in the past might influence the magnitude of charter competition in the future. If this is the case, the strict exogeneity assumptions will be violated, and the general FE estimator will be biased. As mentioned earlier, FD estimators are employed in order to check whether the FE estimate is biased and in which direction. The results are presented in column (2) of Table 6. The sample size is smaller for the FD estimator because one year of data is lost with the first differencing of the data. The estimated charter competition remains insignificant in the short- and medium-run. The long-run charter competition is negative and significant, indicating persistent charter competition decreases satisfactory rates by 3.65 percentage points. By comparison to the FE estimate, the FD estimate of charter competition is 0.6

percentage points bigger (4.24-3.65). This might indicate that there is small heterogeneity bias toward zero in the FE estimator, but the magnitude is not substantial.

A random trend model is also estimated to allow each school to have its own time trend. Column (3) in Table 6 presents the results. Again, the sample size is smaller than the FE estimation because by first differencing, one year of data is eliminated. Long-run charter competition decreases the 4^{th} grade math satisfactory rate by 4.73 percentage points, which is quite consistent with the FE and FD estimators. This further indicates that there is no evidence that undermines the strict exogeneity assumption of charter competition after controlling for school heterogeneity.

In addition to the heterogeneity bias, the second source of potential bias arises if charter competition is contemporaneously correlated with unobserved time-varying, idiosyncratic variables that affect student achievement. For example, parental motivation or other factors that might be correlated with charter competition are still in the time-varying error term, which could cause charter competition to be endogenous. In this study, this is less a concern because I am able to control for other school variables such as student composition, expenditure, and class size. By explicitly controlling for these variables, there should be much less variation left over in the time-varying error term. Further, the consistent estimates by the three different estimations—FE, FD, and the random trend model estimations—suggest that, after controlling for unobserved school heterogeneity and other variables, the problem associated with what is remaining in the idiosyncratic error is negligible.

Moreover, there is an empirical consideration to rely on conventional estimates, especially when the results are consistent using different approaches. If charter competition is still considered to be endogenous after netting out school fixed effects and controlling for other variables, the IV estimation would be ideal in obtaining consistent estimates. Such IVs should be related to charter competition, but have no impact on student achievement. However, truly external IVs are very hard to find in the charter school research. And using weak IVs that are not strictly exogenously tends to inflate the bias. More often than not, slight correlation between the IVs and the variables that they are instrumented for could cause larger bias than estimators using no IVs (Wooldridge, 2002).[10] From a policy perspective, we need to be cautious about the potential inflation of bias and put more weight on the conventional methods such as FE or FD estimations.

Table 7 through Table 9 show estimates of how charter competition influences the satisfactory rates for the 7th grade math, 4th grade reading, and 7th grade reading, respectively. These tables are organized in a similar fashion to Table 6. According to Table 7, charter competition seems to have no substantial effects on 7th grade math satisfactory rate in TPSs. One main reason is that as mentioned earlier, 7th math was no longer tested after 2000. This further supports the conclusion that the competitive effect of charter schools is negligible in the short-run, but becomes more visible in the long run.

[Table 7 about here]

Column (1) of Table 8 contains the FE estimates of 4th grade reading. It shows that the estimated charter competition has a small negative impact on reading in the short-run. Once facing the charter competition, the satisfactory rate of 4th grade reading decreases about 2.90 percentage points. The magnitude of the impact becomes larger in the

[10] I tried to estimate the impact of charter competition using lagged charter competition by two or three time periods as IVs. The methods produced very large point estimates. Since the IVs are not strictly exogenous, it is very likely that the endogeneity of IVs have translated into large biases.

medium-run. And in the long run, charter competition decreases the satisfactory rate by 10.08 percentage points, or 0.5 standard deviations.[11] Similar to the 4th grade math models, other variables such as expenditure and percentage of Asian students significantly influence the satisfactory rate in the FE estimation, but the effects disappear in the estimations of FD and random trend models presented in column (2) and (3) respectively. The positive effect of the loss of students through inter-district choice on 4th grade satisfactory rates fails to hold in the FD and random trend model estimations. However, the gain of students presents positive impact on student achievement in TPSs in the random trend model estimation. Again, the magnitude is much smaller than the negative impact of charter schools. Instructional expenditure as a percentage of total operational expenditure continues to show a positive influence on reading. In the FE estimation, a one percentage point increase in the instructional expenditure share results in a .24 percentage points increase in the 4th grade reading satisfactory rate. It is surprising to get consistent results, because there is not much variation in the share of expenditures devoted to instruction across schools and over the years. A possible explanation is that schools that had extra resources might have devoted them mostly on reading programs, which boosted reading achievement.

[Table 8 about here]

The results in Table 9 also show a large negative effect of charter competition on 7th grade reading achievement. In the results of FE estimates presented in column (1), charter competition shows a small negative effect on satisfactory rates in TPSs in the short-run. This adverse effect continues to grow in the medium-run, and in the long-run charter competition is estimated to decrease the satisfactory rate by 11.27 percentage points.

[11] The standard deviation of 4th reading satisfactory rates is 20.94.

Although the FE estimate shows a negative influence of charter competition on student achievement in the short- and medium-run, it disappears in the FD estimator and random trend model estimation in columns (2) and (3). However, although the magnitude varies across different estimates, the long-run negative effect of charter competition persists throughout all the estimations. The charter competition is estimated to cause more than a 0.5 standard deviation drop in the reading satisfactory rate.[12]

[Table 9 about here]

Discussion

My analysis reveals the important finding that charter school competition has had a negative impact on student achievement in Michigan's traditional public schools. The effect is small or negligible in the short-run, but becomes more substantial in the long run. The negative effect of charter competition is consistent for both math and reading tests in both 4^{th} and 7^{th} grades and robust across a range of econometric models and estimations. In the long run, for schools in districts where charter schools have drawn away a significant share of students, the estimated charter competition decreases their satisfactory rates by 0.2 standard deviations in math and 0.5 standard deviations in reading.

Compared to the significant negative effects of charter competition, the gain or loss of students through inter-district choice shows either no or small positive effects on student achievement. However, the positive effect seems to be limited to 4^{th} grade student reading and math, and not robust through the models. One possible explanation for the different impacts of the two choice programs is that in Michigan, inter-district choice is

[12] The standard deviation of 7^{th} reading satisfactory rates is 18.31.

more disciplined and controlled, often coordinated by district superintendents at the ISD level. These kinds of cooperative or controlled competition appear less likely to generate negative impacts on student achievement than charter competition.

The evidence in this paper does not support the positive competitive effect typically predicted by microeconomic theory, which presumes that charter schools spur competition among regular public schools and force them to improve their efficiency. It is also contradictory to the claim that charter competition benefits traditional public schools more substantially in the long run. Instead, my results are more consistent with the conception of choice triggering a downward spiral in the most heavily impacted schools. Charter school policy in Michigan has not generated a “rising tide” that lifts all boats. Rather, it produces gains and losses from the reallocation of students and resources.

In Michigan, about half of the charter schools are located in Detroit and other central cities, attracting students from these areas and their surrounding low-income suburbs. Many traditional public schools in urban districts have experienced great charter competition and faced acute financial pressure due to the loss of students to charter schools. For example, about 30,000 students who live in Detroit attended charter schools in 2004. Together with 5,000 students attending suburban schools through inter-district choice, Detroit Public Schools has lost about one fifth of its students or an annual loss of about $260 million educational revenue through both choice programs. Other central cities in Michgina, such as Lansing, Flint, Pontiac, and Benton Harbor have experienced similar losses. By contrast, the vast majority schools in rural and suburban areas are facing little competition from charter schools. In other words, the analysis in this paper largely reflects an urban phenomenon in Michigan. Charter competition reinforces the vicious cycle of enrollment loss, revenue decline, program cuts, lower educational quality, and further enrollment loss in these districts (Arsen et al., 1999).

My findings are consistent with Bettinger's finding (2005) that through 1999, charter schools had either no effect or a very small negative effect on the test scores of students in the TPSs. His Michigan data pertained to a period in which only the short-run effect of charter competition could be captured. However, my results contradict Hoxby's findings (2003b) of significant positive effects of charter competition on student achievement in TPSs. This is somewhat puzzling given that we both used school level Michigan's data and that I used a modified measure of charter competition based on her study. One possible reason for the divergence is that I could obtain more recent data and estimate the long-run competitive effect of charter schools. In addition, I have more detailed data on schools, so that in addition to the charter competition, my models can account for the changes of school characteristics across years, such as student composition, expenditure, and the participation in the inter-district choice program. Students systematically sort themselves between TPSs and charter schools (Ni, 2007), so the composition of students and other school-level factors are different between TPSs that face charter competition and those that do not. The estimation of the causal effect will be biased if these changes are not accounted for.

Furthermore, based on the data and charter competition measure I use in this paper, I generated a list of districts that faced charter competition that is somewhat different from the list in Hoxby's article.[13] In particular, some large central cities with more than 6 percent of charter school enrollment in 2000, such as Flint, Pontiac, Saginaw, and Benton Harbor, are not in her list. Since my analysis shows that charter competition is more

[13] See Hoxby (2003b) for the list of districts (Table 8.10, on p326).

likely to occur in central cities and triggers a downward spiral in the TPSs in these areas, leaving out the heavily impacted central districts in Hoxby's analysis might have diminished the negative competitive results.

It is worthwhile to note that this study finds significant negative competitive effects in Michigan, while some studies have found charter schools in other states to have no substantial effect (such as North Carolina, California) or slight positive effects (such as Florida and Texas) on student achievement in TPSs. At this stage, it is still too early to draw any conclusions without further research. However, several important features of charter school policies and school financial systems in different states might help to explain the different results. First, charter schools might operate differently in settings with overall growing or declining enrollment. For example, in states with growing enrollment, TPSs may be overcrowded. Charter schools could serve as a "release valve" for these schools, which may shift school enrollments closer to their optimal scale. In this environment, TPSs are less likely to feel much competitive pressure created through charter schools. By contrast, in states such as Michigan where the student population, in urban districts in particular, has been declining steadily for decades, charter school policies introduce a zero-sum game between charter schools and TPSs. Any increase in charter school enrollment translates into a corresponding reduction in enrollment in TPSs. Charter school policies in this setting create a very competitive schooling market. Second, school finance systems vary across states creating different incentives and constraints for schools operating within a choice policy regime. In some states, only part of the revenue follows students to charter schools when they leave their resident TPSs. In Michigan, however, students take the full amount of school funding with them to charter schools, and local districts have no ability to increase local revenues to maintain their school operations. Moreover, the foundation allowance for K-12 education remained at nearly the same nominal level over the past five years. The only way to obtain more educational revenue is to compete aggressively for more students. In such an environment, it is not surprising that charter schools have a more dramatic and negative effect.

Limitation of This Study

This paper addresses several limitations of earlier work and provides stronger evidence regarding the issues that are of intense interest in the school choice policy debate. I used detailed school-level data for many years, which allowed me to control for observable school characteristics and unobserved school heterogeneity, as well as address the endogeneity of charter competition through several econometric approaches. Still, there were some limitations with respect to the analysis and data that may affect the accuracy of the results. First, my measure of charter competition is not perfectly precise because there is no way to identify primary sending districts of charter schools before 2002 since student-level data were unavailable then. So, I have to rely on the information in 2003, assuming that each charter school had the same primary sending district since its establishment.[14]

In addition, although schools rather than individual students are the logical unit of analysis because schools as organizations respond strategically to the pressure from charter competition instead of students, student level data are ideal in order to fully

[14] For instance, if a charter school drew the majority of its students from one school district in year 2003, I assume it had always drawn the majority of its students from the same district since its establishment. Although I have found it is fairly consistent for 2003 and 2004, there is no way to test this for previous years.

account for the student self-selection problem. As mentioned earlier, students choosing to go to charter schools may be systematically different from otherwise similar students remaining in TPSs in unobserved ways. Although student composition in schools partially reflects the students' motivation and ability, directly control for student heterogeneity across years in econometric models will help to improve the analysis. Since 2003, each student in Michigan has been tested statewide annually in multiple subjects. In combination with Michigan's new Single Record Student Data (SRSD) which is updated three times a year, it will be possible in the future to get longitudinal student level data in the future to estimate the competitive effect of charter schools.

Implications for Future Research

The large scale panel quantitative data allow me to examine the competitive effect of charter schools, but not to identify the sources of the decrease in school efficiency due to charter competition. There are some possible explanations that emerged in the literature. First, charter schools tend to attract low-cost students, including elementary students and student without special needs. Since charter schools receive the same per-pupil allowance as TPS students, after charter schools draw away low-cost students, the concentration of high-cost students in the TPSs increase. As the level of charter competition increases, so does the average cost of educating the remaining students in TPSs (Arsen et al., 1999). Second, higher levels of student and possibly teacher turnover induced by charter schools, often during the school year, may creates a turbulent learning environment for students remaining in these schools.

Excessive turnover can hinder attempts to nurture a shared school culture, sense of community, and trust among members of the school community, which is important to improve children’s academic achievement (Bryk & Schneider, 2002). Constant loss of students to charter schools induces school closures in the long run. The relocation of students and teachers may be even more destructive to daily instruction practice and the development of trust. Other potential reasons for the negative competitive effects might relate to the design of charter school policies and the local contexts of implementations. Further research is needed to determine what accounts for the negative effects, and how state policymakers can help the heavily impacted schools to recover from the competition and improve their performance, since the evidence in this paper suggests that this is a problem that cannot be left to market forces alone.

Table 1 TPSs Facing Strong Charter Competition, by Year and Duration

Year	% of state enrollment in charter schools	Number of schools experiencing strong charter competition			Total
		short-run	medium-run	long-run	
1994	0.02	0	0	0	2,497
1995	0.03	0	0	0	2,502
1996	0.33	12	0	0	2,497
1997	0.86	87	0	0	2,499
1998	1.39	164	10	0	2,505
1999	2.19	116	356	0	2,508
2000	3.09	155	416	0	2,507
2001	3.77	76	391	8	1,844
2002	3.92	92	179	304	2,552
2003	3.67	93	144	358	2,712
2004	4.24	118	95	382	2,685

Table 2 TPSs Facing Strong Charter Competition in 2004, by Community Type

Community type	Number of schools experiencing charter competition			Universe of schools	% of schools experiencing strong competition
	short-run	medium-run	long-run		
Urban	70	62	337	595	78.8
Suburban	39	19	28	1364	6.3
Rural	9	14	17	726	5.5

Table 3 Summary Statistics of Satisfactory Rates, by Year, Charter Competition, and Subjects

	Math			Reading		
	No charter competition	Strong charter competition	Difference	No charter competition	Strong charter competition	Difference
			4th Grade			
1994	48.5	--	--	43.0	--	--
1995	61.2	--	--	42.9	--	--
1996	63.1	62.1	1.0	49.7	51.7	-2.0
1997	60.9	51.2	9.7	49.0	38.2	10.8
1998	75.1	62.6	12.5	59.1	45.7	13.4
1999	75.2	61.5	13.7	62.5	48.6	13.9
2000	79.9	64.7	15.2	61.7	49.6	12.2
2001	78.1	60.0	18.1	66.0	48.5	17.4
2002	70.3	49.4	20.8	63.1	39.2	23.9
2003	70.5	49.4	21.0	80.0	60.3	19.7
2004	77.7	59.4	18.4	83.9	68.7	15.2
			7th Grade			
1994	40.9	--	--	38.5	--	--
1995	48.3	--	--	34.8	--	--
1996	54.1	63.0	-8.8	41.6	52.6	-11.0
1997	50.9	45.3	5.6	39.3	33.4	5.9
1998	61.2	51.3	10.0	47.9	42.2	5.7
1999	65.8	47.6	18.2	54.7	41.5	13.2
2000	66.8	44.3	22.6	50.1	37.2	12.9
2001	--	--	--	60.5	40.4	20.1
2002	--	--	--	55.3	31.7	23.6
2003	--	--	--	65.6	39.8	25.9
2004	--	--	--	64.1	46.0	18.1

Note: 7th graders were no longer tested in math since 2001.

Table 4 Description of Explanatory Variables

Variable	Description	# of Obs	Mean	Std. Dev.	Min	Max
Inter-district choice						
Gain	Dummy variable (1—gained at least 6% students; 0—otherwise)	27308	0.035	0.184	0	1
Loss	Dummy variable (1—lost at least 6% students; 0—otherwise)	27308	0.027	0.161	0	1
Log (per-pupil exp)	Per-pupil expenditure in logarithm form	28184	8.90	0.17	8.22	10.88
Instr/exp (%)	% of instruction in total expenditure	28184	0.63	0.04	0.36	0.92
Log(enroll)	Log of district enrollment	26911	6.05	0.65	0.69	11.93
% FRL	% of students eligible for free lunch	26926	0.32	0.26	0	1
% Black	% of black students	27031	0.17	0.31	0	1
% Asian	% of Asian students	27031	0.02	0.03	0	0.85
% Hispanic	% of Hispanic students	27031	0.03	0.07	0	0.90
P/T Ratio	Pupil-teacher ratio	26669	19.10	3.67	0.1	49.1

Table 5 Pooled OLS Results: the Impact of Charter Competition on School Efficiency

	4th grade Math		7th grade Math		4th grade Reading		7th grade Reading	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Charter competition								
Short-run	-15.67**	-4.31**	-15.14**	-5.85**	-15.13**	-5.83**	-15.83**	-6.22**
	(1.101)	(0.922)	(2.778)	(1.783)	(1.052)	(0.858)	(2.294)	(1.443)
Medium-run	-16.59**	-0.07	-21.14**	2.29	-15.03**	-1.79*	-17.17**	-2.76*
	(0.943)	(0.782)	(2.342)	(1.911)	(0.891)	(0.724)	(1.506)	(1.151)
Long-run	-20.53**	-1.98			-20.79**	-5.95**	-22.55**	-6.98**
	(1.124)	(1.046)	--		(0.969)	(0.966)	(1.760)	(1.695)
Inter-district choice								
Gain		-1.99*		-6.77*		-1.60*		-1.48
		(0.802)		(2.755)		(0.737)		(1.173)
Loss		-0.54		-3.08		1.07		-3.09*
		(1.178)		(4.143)		(0.986)		(1.502)
Log(per-pupil exp)		18.81**		21.06**		20.17**		22.26**
		(1.622)		(3.221)		(1.573)		(2.655)
Instr/exp (%)		0.48**		0.46**		0.54**		0.51**
		(0.057)		(0.104)		(0.054)		(0.082)
Log(enroll)		-0.93		1.62		-0.51		2.49**
		(0.626)		(1.003)		(0.586)		(0.759)
% FRL		-0.29**		-0.22**		-0.30**		-0.22**
		(0.014)		(0.029)		(0.013)		(0.023)
% Black		-0.12**		-0.26**		-0.07**		-0.15**
		(0.014)		(0.027)		(0.013)		(0.021)
% Asian		0.37**		1.11**		0.32**		0.71**
		(0.057)		(0.191)		(0.056)		(0.140)
% Hispanic		-0.22**		-0.43**		-0.20**		-0.21**
		(0.036)		(0.072)		(0.031)		(0.047)
P/T Ratio		0.15*		0.29		0.16**		0.12
		(0.063)		(0.154)		(0.059)		(0.101)
Obs.	20191	19399	5192	4921	20173	19386	7559	6978
R^2	0.23	0.45	0.18	0.49	0.36	0.53	0.30	0.51

Note: The heteroskedasticity-robust standard errors are included in the parentheses. * significant at 5%; ** significant at 1%. Year dummies are included but the results are not reported.

Table 6 Fixed Effects, First Differencing, and Random Trend Estimations: Satisfactory Rate on the 4th grade Math Test

	(1) Fixed Effects (FE)	(2) First Differencing (FD)	(3) Random Trend Model (FD+FE)
Inter-district choice			
Charter competition			
Short-run	0.48	-0.98	-1.20
	(0.807)	(1.109)	(1.136)
Medium-run	-0.94	-0.93	-1.29
	(0.799)	(1.255)	(1.378)
Long-run	-4.24**	-3.65*	-4.73*
	(1.084)	(1.755)	(2.080)
Inter-district choice			
Gain	-0.51	1.17	2.40*
	(0.751)	(0.761)	(1.186)
Loss	3.24**	-0.13	-0.64
	(1.211)	(1.775)	(1.891)
Log(per-pupil exp)	17.26**	3.18	1.73
	(2.415)	(4.251)	(4.350)
Instr/exp (%)	0.08	0.17	0.16
	(0.055)	(0.085)	(0.089)
Log(enroll)	-0.14	-0.63	0.22
	(0.992)	(1.390)	(1.741)
% FRL	-0.03	0.02	0.02
	(0.020)	(0.026)	(0.028)
% Black	-0.23**	-0.21*	-0.26*
	(0.054)	(0.092)	(0.114)
% Asian	-0.06	-0.06	-0.02
	(0.062)	(0.124)	(0.137)
% Hispanic	-0.20**	-0.13	-0.27
	(0.072)	(0.119)	(0.128)*
P/T Ratio	-0.08	-0.04	-0.05
	(0.050)	(0.072)	(0.075)
Obs.	193999	16482	16482
R^2	0.33	0.10	0.10

The *R*-squareds are net of school fixed effects.
The robust standard errors are included in the parentheses, specifying standard errors that are robust to both heteroskedasticity and serial correlation.
See Table 5 for other notes.

Table 7 Fixed Effects, First Differencing, and Random Trend Estimations: Satisfactory Rate on the 7th Grade Math Test

	(1) Fixed Effects (FE)	(2) First Differencing (FD)	(3) Random Trend Model (FD+FE)
Charter competition			
Short-run	-2.28	-3.84	-5.78*
	(1.336)	(2.322)	(2.820)
Medium-run	-2.10	-0.18	-3.46
	(1.766)	(3.111)	(3.924)
Long-run	--	--	--
Inter-district choice			
Gain	-0.54	-1.79	-1.29
	(1.893)	(1.784)	(2.859)
Loss	-1.53	4.12	1.47
	(2.579)	(4.892)	(5.687)
Log(per-pupil exp)	7.42	-6.20	-6.52
	(3.971)	(8.053)	(10.233)
Instr/exp (%)	0.00	0.14	0.13
	(0.097)	(0.180)	(0.216)
Log(enroll)	-0.29	-4.14	-3.28
	(1.708)	(3.883)	(4.571)
% FRL	0.05	0.04	-0.01
	(0.033)	(0.049)	(0.062)
% Black	-0.06	-0.05	0.30
	(0.181)	(0.329)	(0.356)
% Asian	-0.80*	-1.15	-1.03
	(0.402)	(0.615)	(0.699)
% Hispanic	-0.18	-0.42	-0.32
	(0.145)	(0.254)	(0.316)
P/T Ratio	-0.20	0.06	0.07
	(0.133)	(0.153)	(0.178)
Obs.	4921	2523	2523
R^2	0.40	0.15	0.16

See Table 6 for notes.

Table 8 Fixed Effects, First Differencing, and Random Trend Estimations: Satisfactory Rate on the 4th Grade Reading Test

	(1) Fixed Effects (FE)	(2) First Differencing (FD)	(3) Random Trend Model (FD+FE)
Charter competition			
Short-run	-2.90**	-1.84	-2.08
	(0.728)	(1.110)	(1.137)
Medium-run	-4.75**	-3.17*	-3.73**
	(0.748)	(1.235)	(1.343)
Long-run	-10.08**	-10.22**	-11.88**
	(1.040)	(1.692)	(1.999)
Inter-district choice			
Gain	-0.76	1.04	2.98*
	(0.748)	(0.749)	(1.190)
Loss	4.61**	1.57	0.77
	(0.985)	(1.645)	(1.783)
Log (per-pupil exp)	17.57**	6.79	5.39
	(2.209)	(4.268)	(4.558)
Instr/exp (%)	0.24**	0.29**	0.30**
	(0.054)	(0.086)	(0.089)
Log(enroll)	-0.80	-0.43	0.81
	(0.937)	(1.425)	(1.707)
% FRL	0.002	0.02	0.02
	(0.017)	(0.025)	(0.027)
% Black	-0.09	-0.14	-0.24*
	(0.060)	(0.081)	(0.100)
% Asian	-0.20**	-0.02	0.03
	(0.073)	(0.130)	(0.143)
% Hispanic	-0.16	-0.17	-0.29*
	(0.083)	(0.111)	(0.120)
P/T Ratio	0.04	-0.02	-0.04
	(0.050)	(0.066)	(0.069)
Obs.	19386	16461	16461
R^2	0.51	0.24	0.24

See Table 6 for notes.

Table 9 Fixed Effects, First Differencing, and Random Trend Estimations: Satisfactory Rate on the 7th Grade Reading Test

	(1) Fixed Effects (FE)	(2) First Differencing (FD)	(3) Random Trend Model (FD+FE)
Charter competition			
Short-run	-3.04*	-1.66	-2.64
	(1.179)	(1.625)	(1.724)
Medium-run	-5.84**	1.39	-1.14
	(1.078)	(1.992)	(2.387)
Long-run	-11.27**	-9.31**	-16.55**
	(1.685)	(2.925)	(3.757)
Inter-district choice			
Gain	0.18	-1.98	-2.99
	(0.807)	(1.178)	(1.783)
Loss	-0.48	0.37	0.41
	(1.341)	(2.595)	(3.081)
Log(per-pupil exp)	12.70**	-0.66	-2.96
	(2.919)	(5.979)	(6.765)
Instr/exp (%)	0.39**	0.24	0.17
	(0.072)	(0.125)	(0.136)
Log(enroll)	-0.37	-1.10	-1.45
	(1.073)	(2.129)	(2.111)
% FRL	0.03	0.01	0.004
	(0.019)	(0.035)	(0.038)
% Black	-0.27**	0.27	0.22
	(0.100)	(0.176)	(0.212)
% Asian	-0.29*	0.11	0.06
	(0.125)	(0.258)	(0.282)
% Hispanic	-0.11	-0.01	-0.05
	(0.130)	(0.205)	(0.221)
P/T Ratio	-0.19**	-0.10	-0.11
	(0.060)	(0.101)	(0.109)
Obs.	6978	4874	4874
R^2	0.48	0.25	0.26

See Table 6 for notes.

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