Heterogeneous Competitive Effects of Charter Schools in Milwaukee*

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Abstract

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Proponents of charter schools claim that a highly competitive school choice environment will increase student performance. Results in the existing literature are mixed, without a clear pattern across states on the impact of charter schools on traditional public schools (TPS). However, all previous studies have ignored the heterogeneity in the types of charter schools that compete with TPS for students. Using longitudinal, student-level data from Milwaukee public schools (MPS), I estimate the competitive effects of charter schools sponsored by different authorizers on the outcomes of students attending TPS. Identification comes from the longitudinal variation in competition levels generated by the entry and exit of these different types of charter schools. I find that non-district sponsored charter schools have significant positive effect on students' math and reading achievement in neighboring public schools. However, only in math, this non-district sponsored charter school competitive effect is statistically different from the competitive effect of district sponsored charter schools. Secondly, this competitive effect varies across subgroups of students. Further, additional research is necessary to assess whether these findings can be attributed to competition from high quality charter schools or other possible consequences of higher autonomy from the school district. At least in Milwaukee, I can conclude that a competitive school market with non-district sponsored charter schools is beneficial to some subgroup of students without hurting other subgroups.

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1 Introduction

Market-oriented critics of public education system attribute under-performance of public schools as compared to private schools to the principal-agent problem as school principals are unable to control the activities of their boards members who might be influenced by other vested interests, such as teacher unions. Critics argue that this could be potentially one of the reasons why improving school inputs do not improve the quality of public school education (Clark, 2009). Among the proposed solutions are policies which give schools more autonomy and increase school choice that will exert competitive pressure on schools. Proponents of school choice claim that choice programs create competitive markets of school accountability, providing schools with incentives to improve their educational quality to attract students. By this logic, reforms that expand school choice, such as vouchers and charters, are potential policies to improve student achievement (Booker et al., 2008). Whether these kinds of market-based education reform will improve public school performance is an open question. Advocates claim that reforms that expand choice can increase outcomes for all students without increasing the allocation of resources for a subset of students (Friedman, 1962; Hoxby 2000).

A significant literature suggests that there is a lack of competition in the education market (Hoxby 2000, 2003b). Therefore, one argument is that there are potential gains to be made from exploiting the inefficiency in the public education market. Another argument is that there are gains from matching students to schools. For example, schools can target at-risk students or special education students. Research reports that both peer group achievement and racial composition can impact student achievement (Epple and Romano, 1998; Hanushek et al., 2003; Hoxby, 2001). Those opposed to school choice argue that such programs skim good students and drain resources away from public schools, and cause racial segregation (Bifulco and Bulkley, 2007). Regardless, since the early 1990s, school choice policy reforms have given some schools autonomy (charters) and introduced competitive effects through open enrolment and vouchers. As of 2010, vouchers still remain a contentious policy issue whereas charter schools enjoy broad political support.[1] President Obama, in his education reform, "Race to the Top," has put major emphasis on charter schools to improve student achievement.

Charter schools are public schools exempted from some state and local regulations. They do not teach religion or charge tuition, and they must comply with health and safety regulations. They operate under a limited-term charter (usually 3-5 years) that may be renewed, or revoked before the term ends by the authorizing entity. The number of charter schools has been growing rapidly since the first charter school law was passed in Minnesota in 1991. In 2009, they served more than 1.5 million students in 5,000 schools

[1] "Vouchers and the Provision of Public Services" by C. Eugene Steuerle, George Peterson, Robert D. Reischauer and Van Doorn Ooms, Brookings Institution Press 2000, 560pp.

(Center for Education Reform, 2009). The growth in charter school is in part motivated by the perception that charter school improves student academic outcomes. Advocates argue that charter schools not only improve academic performance of their students (direct effect), but also improve student outcomes at neighboring public schools through competitive pressures (indirect effect). However, critics of charter school claim that the positive effect of charter schools is due to high achieving student self selecting into charter schools.

However, the ambiguous effectiveness of charter schools (positive effect - Hoxby and Rockoff (2004), Angrist et al. (2011); negative effect - Sass (2006), Bifulco and Ladd (2006)) has contributed to a national debate not only over school choice but also over charter school policy. Policy makers are concerned about the effect of charter schools have had on the achievement of students attending charter schools as well as the educational outcomes of nearby public schools. To understand the indirect effect of a charter school, studies have borrowed from the industrial organization literature. However, instead of using a general equilibrium model of charter school entry, most studies have looked at partial equilibrium model of exogenous charter school entry. These studies have answered the question that given the entry decision of charter schools, what is the effect of the entry on the educational quality of nearby public schools?[2]

Similarly, this paper looks at the partial equilibrium model and estimates how charter schools improve student achievement at traditional public schools (TPS) through competitive pressure using longitudinal data from Milwaukee public school (MPS) district. However, this paper differs from previous studies as it specifically looks at the competitive effects of different types of charter schools. Recent direct charter school effects literature has focused on the heterogeneity of charter school effects. Nisar (2010) shows that while there is no significant impact of charter schools on student performance on average, there are important effects by charter type and student subgroups. For instance, charter schools with higher autonomy from the school district have a positive effect on their students' outcomes. Similarly, Gleason et al. (2010) find considerable heterogeneity in the effectiveness of charter schools on their own students.

Therefore, it is reasonable to expect that any competitive effects would depend on the type of the charter school and the students attending them. This paper estimates the effect that competition, measured by the presence and proximity of different authorizers of charter schools, has on the educational quality of TPS. This is one of the first studies using data from Milwaukee, which is not only an urban district with a highly competitive public school market but also one of the leading districts in school choice reform in US. As of the 2008-09 school year, 20% of public schools in MPS were charter schools, serving about 11% of public school students.[3] Per student basis of funding (100% of the amount

[2]See Mehta (2011) for an example of a general equilibrium model.

[3]Nationally, 2% of public schools were charters, serving around 4% of the population in 2008-09 (Institute

spent on a student in TPS[4]), non-district entities being allowed to sponsor charters, and no explicit caps on the number of charter schools, makes Milwaukee one of few school districts in the US that does not restrain competition.

The competitive effects of charter schools are hypothesized to come from the increased productivity at TPS. The mechanism through which this works depends on the perception and actions of TPS personnel and how parents choose schools. Theoretically, TPS do not want to lose students - a loss that also may mean a decrease in funding - to charter schools.[5] This should motivate the school personnel to actively respond to these losses of students by improving student outcomes (Hoxby, 2003). Few studies have examined how principals in TPS perceive and respond to competition, and have found mixed results (Betts, 2009; Cannata et al., 2011). However, no effects result in Cannata et al. (2011) may be because the closest charter school was, on average, more than 9 miles away, a distance that most parents might not be willing to travel for a charter school, thus reducing the principals incentive to respond. Alternatively, charter schools may have unintended negative effects on TPS if they draw away the most motivated families, and thus reduce the monitoring of these schools, allowing schools to reduce effort put into educating students (McMillan, 2004).

However, for my hypothesis of different competitive effects for different authorizer sponsored charter schools requires principals to respond differently and possibly more actively when non-district sponsored charter schools enter their education market. Students who attend these non-district sponsored charter schools do not belong to the district, which might prompt district personnel to put added pressure on principals who are losing students to react strongly when these non-district sponsored charter schools enter. In the above instances, when principals react strongly to the entry of charter schools, I mean that principals increase their effort to reduce the loss of students by increasing their productivity (educational quality) by either actively collaborating with teachers around instructional matters or increasing the community involvement, etc (Marks & Printy, 2003). Either way, the advent of charter schools appears to have led to significant competition among public schools for students in some districts, suggesting that the growth of charter schools may provide some insight into the effects of competition on student achievement.

Several issues arise during the estimation of competitive effects of charter schools on

of Education Sciences, US Department of Education, 2008).

[4]In many states, only part of the revenue follows students to charter schools. Charter schools across the United States are funded at 61% of their district TPS counterparts, averaging $6,585 per pupil compared to $10,771 per pupil at TPS (Center for Education Reform, 2008).

[5]An article in the Washington post "Future of D.C. Public Schools: Traditional or Charter Education?"asked, "Will traditional public schools improve with competition? Or will charters take over? ... With public confidence in DC schools at an all time low, more than 17,000 public school students - nearly one in four - have rejected the traditional system... That share is one of the largest in the nation and expected to rise when six more charter schools open their doors this fall" (dated 8/22/2006, page 1).

TPS. First, the location of charter schools is endogenous as charter schools locate in areas where students are not satisfied with their neighbourhood TPS quality or in areas with motivated parents. Next, students self select into charter schools. As a result, the entry of a charter school may change the composition of the student body at the neighborhood TPS. Using longitudinal, student-level data, I control for school fixed effects to address the potential bias caused by the endogeneity of charter school location, and student fixed effects to deal with potential self-selection bias. In addition, selection of a relevant measure of competition is difficult. I use several different definitions used in the literature, and look for robust results. Finally, controlling for other forms of competition such as vouchers and inter-district choice, that exists in the district/state requires in-depth knowledge of the public school market. Milwaukee has the longest running and the largest private school voucher program in the United States (Mader, 2008). I control for competitive effects faced by the TPS from other school choice programs, such as vouchers, which previous studies do not account for (vouchers (tax subsidies) in FL and San Antonio, TX). However, retrospectively, considering these other competitive effects does not significantly affect my result.

Summarizing, I estimate a value added gain model with student and school fixed effects using presence and number of charter schools sponsored by different authorizers and voucher schools within a certain distance from the neighboring TPS as measures of competition. Identification comes from the longitudinal variation in competition levels generated by the entry and exit of these different types of charter and voucher schools, while controlling for the quality of the TPS.

I find that overall charter schools have no competitive effect on student achievement in TPS. However, this result masks heterogeneity in the competitive effects of charter schools sponsored by different authorizers. I find that non-district sponsored charter schools have a positive and significant effect on students' math and reading achievement in neighboring public schools. This finding is consistent across both math and reading tests, and across alternative measures of charter school competition. However, only in math, this non-district sponsored charter school competition effect is statistically different from the district sponsored charter school competition effect. Secondly, this effect varies across subgroups of students. Further, I investigate the non-significant result for district sponsored charter schools. Newly opened district authorized charter schools have a significant and positive effect on reading achievement of students in nearby TPS. However this competitive effect is not statistically different from conversion district sponsored charter schools. This research contributes to the previous findings that expanded choice and competition improve the academic performance of students who remain in TPS, although in the case of Milwaukee it is for a particular subset of students without hurting the other subgroups.

The following section summarizes the previous literature on competitive effects of

charter schools. Section 2.3 details the charter schools in Milwaukee and the measures of competition used. Section 2.4 develops an empirical model of student achievement and discusses the estimation strategy. Section 2.5 presents the estimation results, and Section 2.6 concludes.

2 Literature review

School choice programs, such as charter schools, attempt to improve student achievement. A considerable number of studies have considered the direct effects of charter schools on the academic achievement of their students (Hoxby & Rockoff, 2005; Hoxby et al., 2009; Angrist et al., 2009; Gleason et al., 2010; Nisar, 2010). All studies with random assignment research design (lotteries) show significant positive effects for their students except for Gleason et al. (2010). However, another policy question revolves around how expanding school choice with charter schools affects academic achievement for students who remain in TPS (an indirect effect).

Research on the competitive effect of charter schools on the educational quality of TPS is less common. Due to the restrictive charter school policies in most states in terms of capacity and maximum number allowed, most studies have focused on states such as Florida, California, Arizona, Michigan, Texas and North Carolina, where charter school attendance is large, and have less anti-competitive charter policies. However, several studies use district level information, and therefore cannot control for student self-selection (Hoxby, 2003b; Bettinger, 2005; Ni, 2009). Similarly, these studies use the number of charter schools within 2.5 mile of TPS as a measure of competition, which might be problematic as parents would be less inclined to send their children to a far-away school. Most charter schools locate in urban cities (Cannata et al. 2011), however, most research is done at the state level. In contrast, I estimate effects in a large urban school district using longitudinal student level information, which helps to address self-selection bias.

Recent papers have explored the effect of charter school competition on TPS using student and school fixed effects to address student self-selection and endogeneity of charter school location problems. Bifulco and Ladd (2006) use state-wide data from North Carolina and found no significant competitive effects of charter schools. Sass (2006) finds modest improvement in math performance but not in reading performance of students in TPS in Florida from 1999-2003 due to competition from charter school entry. However, he does not account for the competitive effects of vouchers (Florida's Opportunity Scholarship Program), which started in 1999. Similarly, Booker et al. (2008) find a positive relationship between charter school penetration on TPS student outcomes in Texas, however, he too does not take into account the privately funded voucher program (Children's Educational Opportunity Foundation in San Antonio, TX) for a small subset of

his sample, which probably may not bias his results. In contrast, this study accounts for the presence of vouchers in Milwaukee that has the nation's longest-standing urban school voucher program. Bettinger (2005) and Ni (2009) find no effect of charter schools on test scores on neighboring public schools in Michigan. However, Hoxby (2003b) finds the opposite result, using a difference-in-difference approach to control for school productivity. She does not control for changes in student composition or school characteristics, which might lead to biased results. However, as stated before, these three studies (Hoxby, 2003; Bettinger, 2005; and Ni, 2009) were done at the district level, and cannot control for students' self-selection. Imberman (2011) addresses the endogenous location of charter schools using an instrumental variable that relies on local building supply, and finds negative effects of competition from charter school entry.

Even though, there is little research on the competitive effects of charter school on TPS. There is considerable research on the competitive effects of other school choice programs, such as vouchers. Vouchers are a contentious policy issue, and thus are implemented in only a few districts/states. Unlike charter schools, voucher schools are not part of the district, and some voucher schools can charge additional tuition than the subsidy received from the voucher. Gill & Booker (2007) summarize the results of the voucher studies conducted in Milwaukee, Cleveland, Florida and Washington, DC. Hoxby (2003a) finds large positive effects of vouchers in Milwaukee using a school level difference-in-difference strategy by using the large exogenous shift in 1998 in the participation of private schools in the program. Using a similar method, Chakrabarti (2008) finds comparable large competitive effects of vouchers in Milwaukee after the 1998 scaling up. Mader (2008) uses recent student level data to control for the incentives faced by public schools, and similarly finds large effects. As these three studies show that there is considerable competitive effect faced by TPS from vouchers in Milwaukee. If these voucher schools are located near charter schools, then not controlling for these schools might lead to biased estimates of the competitive effects of charter schools.

To summarize, four issues arise during the estimation of competitive effects of charter schools on TPS. First, the location of charter schools is endogenous as charter schools locate in areas where students are not satisfied with their neighbourhood TPS quality or in areas with motivated parents. Next, students self select into charter schools. As a result, the entry of a charter school may change the composition of the student body at the neighborhood TPS (Hoxby, 2003b; Bettinger, 2005; and Ni, 2009 cannot account for this). In addition, selection of a relevant measure of competition is difficult (Ni, 2008). Finally, controlling for other existing forms of competition that exists in the district/state requires in-depth knowledge of the public school market. I address all these issues in my estimation.

Results in the existing literature are mixed, without a clear pattern across states on the impact of charter schools on TPS. Gill & Booker (2007) state that further research needs to

investigate the cause of this inconsistent finding, and whether it varies depending on the design of the charter law. All previous studies have ignored heterogeneity in the types of charter schools. I hypothesize that the mixed findings reflect in part the heterogeneity in the charter school programs in different districts and states themselves. Preliminary observation shows that states that allow non-district entities to authorize charter schools have a positive effect of charter school entry on TPS (Hoxby, 2003b in Michigan and Arizona; Sass, 2006 in Florida). It is reasonable to expect that any competitive effects would depend on the design of the charter school program and the states and districts that they are implemented in. This paper explores that heterogeneity in the charter school programs, and aims to address some of the limitations of the past research. Specifically, I estimate how the competition from different authorizers of charter schools influence efficiency in TPS, measured in terms of improving student achievement.

3 Data

3.1 Charter Schools in Milwaukee

If the entry of charter schools in Milwaukee public school district is to provide a meaningful test of the school choice competition hypothesis, then the policies in Milwaukee must generate a viable, competitive charter sector that would elicit a response from TPS. As argued by Hoxby (2003) and Booker et al. (2008), features such as funding and entry rules will significantly impact the viability of the charter school sector. School finance varies across states creating different constraints for schools operating within a choice policy strategy. In many states, only part of the revenue follows students to charter schools. Charter schools across the United States are funded at 61% of their district TPS counterparts, averaging $6,585 per pupil compared to $10,771 per pupil at TPS (Center for Education Reform, 2008). In these states, when students switch to charter schools, TPS can actually benefit financially from losing students. As mentioned above, Milwaukee is one of the most supportive districts for school choice: funding in Milwaukee for charter schools is on a per student basis (100% of the money follows the student), and the Wisconsin charter school law is rated above national average (in terms of strong charter support) at the end of 2008-09 school year (Center for Education Reform, 2008). Wisconsin law makes chartering in Milwaukee more competitive by allowing non-district entities to sponsor charters. Therefore, everything else remaining constant (no increase in local taxes), the only way for TPS to receive more money is to compete for students. In this case, losing students to charter schools might reinforce a cycle of declining revenue, program cuts, and thus reduction in TPS' quality, and a further loss in enrolment in TPS facing charter competition.

Table 1 presents the growth of charter schools in MPS since the first charter school

was authorized in 1996. After a rapid growth of charter schools from 2000 to 2005, the net growth of charter schools has slowed. The expansion can be attributed to the supportive charter law environment since 2000. The recent slow growth may be due to a change in the guidelines in 2005 that made it harder to open a charter school. Further, the number of schools losing their charters has increased, as shown in Table 1. At the end of the 2008-09 school year, there were 42 schools in operation, with 14% of the total public school student population attending a charter school.[6] To put this in perspective, nationally, 2% of public schools were charters, serving around 4% of the population in 2008-09 (Institute of Education Sciences, US Department of Education, 2008). The total student enrolment in MPS has been decreasing in the past decade; therefore, with charter schools capturing a higher percentage of students, there is intense pressure on TPS to compete for these students or operate with lower funding.

Table 1: History of charters authorized by Milwaukee public school district

Year	Total # of char.	# of char. opened	# of char. closed	Change	% of schools as char.	% enroll in I	% enroll in NI
1996-1997	1	1	0	1	-	-	-
1997-1998	1	0	0	0	0.5%	-	-
1998-1999	1	0	0	0	0.5%	-	-
1999-2000	3	2	0	2	1.5%	-	-
2000-2001	6	3	0	3	2.9%	-	-
2001-2002	13	7	0	7	6.3%	-	-
2002-2003	17	4	0	4	7.8%	-	-
2003-2004	23	6	0	6	10.3%	5.2%	2.2%
2004-2005	36	13	0	13	15.7%	6.0%	3.0%
2005-2006	40	4	0	4	17.0%	6.8%	3.1%
2006-2007	42	4	2	2	18.8%	7.3%	2.9%
2007-2008	44	7	5	2	20.6%	10.8%	3.5%
2008-2009	42	3	5	-2	19.5%	10.6%	3.7%

Source: MPS district data.

Notes. I charter stands for MPS instrumentality charter schools. NI charter stands for MPS non-instrumentality charter schools (with more autonomy). Data before 2000 and total enrollment information broken down by school type for years 2000-2003 is not available to the author. However, information on those students who took the test from 2000-2003 is available.

There are three types of charter schools in Milwaukee: district sponsored "instrumentality" charter schools, district sponsored "non-instrumentality" and non-district sponsored charter schools.[7] Instrumentality charter schools are instruments of the district and enjoy some of the same independence of non-instrumentality charter schools, but operate as a part of the school district, face little risk of closure, and are covered by many of the same collective bargaining provisions as TPS. Instrumentality charter schools are unionized and must hire teachers from the union, but are not required to follow the collectively bargained seniority and tenure provisions that constrain decisions at TPS. Non-

[6] Enrolment data does not include voucher students.

[7] Instrumentality charters are similar to Boston's pilot school program, see Angrist et al., 2009.

instrumentality charter schools do not have to hire teachers from the union. Both types of charter schools have greater flexibility over their budgets, academic programs, and educational policies than traditional public schools, with non-instrumentality charter schools having greater autonomy than instrumentality charter schools. Table 1 provides further information on the extent of charter school penetration in MPS district. For each school year, the table provides the percentage of public schools which are MPS charters and the percentage of enrollment of public students in MPS charters and at non-instrumentality charters.

There are 40 charter schools sponsored by four entities in Milwaukee serving grades 3-8, with the majority coming from the district. While Milwaukee area technical college (MATC) has not yet exercised its chartering authority, the city of Milwaukee and University of Wisconsin-Milwaukee have chartered schools. I group the charter schools sponsored by these other entities into the non-district sponsored category. Table 2 shows the entry and exit of the different types of schools in Milwaukee. The entry and exit of these schools generates the variation in levels of competition faced by TPS, which I exploit in my estimation. As of the 2008-09 school year, there are 14 district sponsored instrumentality, 9 district sponsored non-instrumentality, and 17 non-district charter schools in Milwaukee.

Table 2: Entry and exit of charter and private (voucher) schools in Milwaukee serving grades 3-8

	Instrumentality			Non-Instrumentality			Private Schools			Non-MPS Charters		
Year	Total	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit
2000-01	3	1	0	3	2	0	100	13	6	2	1	0
2001-02	7	4	0	4	1	0	102	8	9	4	2	0
2002-03	9	2	0	5	1	0	102	9	1	7	3	0
2003-04	10	1	0	8	3	0	106	5	7	9	2	0
2004-05	12	2	0	10	2	0	117	18	10	11	2	0
2005-06	14	1	0	10	0	0	124	17	13	13	2	0
2006-07	15	1	0	10	0	1	120	9	11	14	1	0
2007-08	16	1	3	9	0	0	122	13	8	17	3	1
2008-09	14	1	N/A	9	0	N/A	127	13	N/A	17	1	N/A

Source: MPS district data.

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). Private Schools indicates those schools that participate in the voucher program. Non-MPS charters are charter schools sponsored by non-MPS entities in Milwaukee.

In addition to the information of the entry of charter schools, this paper also uses longitudinal data on student-level information of schools in grades 3-8 in Milwaukee public schools (MPS) from 2000-01 to 2008-09 to address student self-selection. MPS maintains data on all public school students, including enrolment and attendance information, student demographics, test scores, and residential addresses. MPS has administered standardized tests in consecutive years since 2000. Wisconsin Knowledge and

Concepts Examination (WKCE) was administered in grades 4, 8 and 10, and Terra Nova was administered in grades 3, 5, 6 and 7. Both the tests are supplied by the same test vendor (CTB/McGraw-Hill), and therefore, these test scores are measured on the same, vertically integrated scale. In the beginning of the 2005-06 school year, MPS changed their standardized test to meet the standards of the *No Child Left Behind Act*, which required states to test all students in reading and math in grades 3-8 and 10. The WKCE test now provides information for each student's achievement in math and reading for grades 3-8 and 10. However, due to changes in scale through time, all test scores are standardized using district mean by grade and school year to have zero mean and standard deviation of 1. I use gains in test scores as a measure of improvement in student achievement (a measure of productivity to correlate with competition effects literature).

3.2 Measure of competition

A central issue in estimating the impact of charter schools on TPS students is to select a relevant measure of competition. The measure of charter school competition varies across studies. There are at least three approaches in the literature to measuring the competitiveness of charters. From a policy perspective, the potential for charter school entry enabled by passing of a charter school law, and the school districts responding appropriately, could perhaps lead to the estimation of charter school competitive effect on TPS (Bettinger, 2005). However, to estimate the realized instead of potential entry effect, some studies measure competition using the spatially adjusted number of charter schools or presence of a competing charter school (Bettinger, 2005; Bifulco and Ladd, 2006; Sass, 2006). Another set of studies have used distance of a public school from a charter school to measure competition (Bifulco and Ladd, 2006).

Alternatively, the effect of charter school competition may depend on the realized loss of market share to charters, rather than merely the potential for such loss. Thus, some studies have used enrolment in a districts' charter schools as a threshold of competition (Booker et al., 2008; Hoxby, 2003). An advantage of this approach is that it counts not the number of charter schools, but instead the number of students that charter schools have successfully attracted away from TPS. However, if the TPS act in a different way when the charter school is present in its neighborhood, then this measures a lower value of competition, as more students would have switched if the school had not changed its behavior, thus leading to an upward-bias in the estimate. Additionally, I do not have the information of the number of students attending these non-district sponsored charter schools, so using enrolment share of different types of charter schools is not feasible for this study.[8]

[8]Table 24 in Appendix shows the results using total enrolment of charter school as a measure of competition. I use the capacity of district sponsored charter schools as the enrolment share is not available. The total enrolment for district sponsored charter school is available and used. The magnitude of the results are similar

A review of these studies indicates no clear relationship between the findings and measures of charter school competition, and there is no consensus about which measure is better than others. As I have student level information, I use measures of competition which are at student level and not at district level. For example, I cannot use the competitive measure which uses a dummy variable set to 1 if the enrolment in charter schools in that district is above 6% threshold of total enrolment (Hoxby 2003; Bettinger 2007; Ni 2008). As stated before, an important contribution is to explore heterogeneity in charter schools, which other studies have not considered. Therefore, I use several different measures of competition for the different types of charter schools in Milwaukee.

I measure competition as the presence and the number of charter schools within a certain radii of the TPS location. A geographic information systems (GIS) data-base was created covering all public schools in MPS. The enrolment information was used to group TPS into elementary and middle schools. Using the GIS and enrolment data, the presence and number of charter schools serving a grade within different radii of each TPS was determined. Similarly, using the address of private (voucher) schools, a similar competitive measure was calculated.

Table 3: Average number of different schools within 0.5 mile of a TPS (Grade 4)

	MPS charters	Instrumentality charters	Non-Instrumentality charters	Non-district charters
2000	0.08	0.03	0.05	0.02
2001	0.11	0.05	0.05	0.04
2002	0.13	0.05	0.08	0.08
2003	0.14	0.05	0.09	0.11
2004	0.19	0.08	0.11	0.12
2005	0.18	0.09	0.09	0.12
2006	0.18	0.09	0.09	0.12
2007	0.19	0.10	0.09	0.12
2008	0.21	0.10	0.11	0.12

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). MPS charters is a combination of these two sub-categories. Non-district charters are charter schools sponsored by non-MPS entities in Milwaukee.

to my findings but with larger standard errors.

Table 4: Average number of different types of schools within 0.5 mile of a TPS (Grade 7)

	MPS charters	Instrumentality charters	Non-Instrumentality charters	Non-district charters
2000	0.15	0.07	0.08	0.02
2001	0.19	0.09	0.10	0.04
2002	0.22	0.10	0.12	0.08
2003	0.23	0.10	0.13	0.11
2004	0.28	0.10	0.18	0.12
2005	0.23	0.10	0.14	0.12
2006	0.25	0.11	0.14	0.12
2007	0.20	0.07	0.14	0.12
2008	0.20	0.07	0.14	0.12

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). MPS charters is a combination of these two sub-categories. Non-district charters are charter schools sponsored by non-MPS entities in Milwaukee.

Tables 3 and 4 show the average number of different charters within a 0.5 mile radius of an elementary (grade 4) and middle (grade 7) TPS respectively. Over the years, as charter schools entered, the competition experienced by the TPS has increased. After the 2005-06 school year, there has been very little entry or exit in the Milwaukee charter school market, as shown in Table 2. As the identification comes from the longitudinal variation in the factors of competition (entry and exit of charter schools), most of the identification comes from the earlier years.

Table 5: Percent of TPS schools with different types of schools within 0.5 mile of a TPS (Grade 4)

	MPS charters	Instrumentality charters	Non-Instrumentality charters	Non-district charters
2000	8.3%	3.0%	5.3%	2.3%
2001	10.5%	5.3%	5.3%	3.8%
2002	12.8%	5.3%	7.5%	6.8%
2003	12.8%	5.3%	7.5%	9.0%
2004	14.3%	7.5%	7.5%	9.8%
2005	14.3%	9.0%	6.0%	9.8%
2006	14.3%	9.0%	6.0%	9.8%
2007	15.0%	9.8%	6.0%	9.8%
2008	15.0%	9.8%	7.5%	9.8%

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). MPS charters is a combination of these two sub-categories. Non-district charters are charter schools sponsored by non-MPS entities in Milwaukee.

Table 6: Percent of TPS schools with different types of schools within 0.5 mile of a TPS (Grade 7)

	MPS charters	Instrumentality charters	Non-Instrumentality charters	Non-district charters
2000	14.3%	6.8%	8.3%	2.3%
2001	18.0%	9.0%	9.8%	3.8%
2002	18.8%	9.8%	9.8%	6.8%
2003	18.8%	9.8%	9.8%	9.0%
2004	21.8%	9.8%	12.8%	9.8%
2005	19.5%	9.8%	10.5%	9.8%
2006	21.1%	11.3%	10.5%	9.8%
2007	17.3%	6.8%	10.5%	9.8%
2008	17.3%	6.8%	10.5%	9.8%

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). MPS charters is a combination of these two sub-categories. Non-district charters are charter schools sponsored by non-MPS entities in Milwaukee.

Tables 5 and 6 show the percentage of TPS with different types of charters within a 0.5 mile radius of elementary (grade 4) and middle (grade 7) traditional public school, respectively. As more charter schools have entered, the competition effect experienced by the TPS has increased. As of the 2008-09 school year, 7% of TPS faced competition from instrumentality charter schools, 11% from non-instrumentality charter schools, and 10% from non-district sponsored charter schools. These numbers increase to 27% of TPS faced competition from instrumentality charter schools, 20% from non-instrumentality charter schools, and 35% from non-MPS charter schools as the radius is increased to 1 mile. As shown in Table 1, TPS have been losing students to charter schools over the years. This should motivate school principals or administrators to respond actively to this threat of loss of funding by improving student outcomes, assuming the loss of students is due to low achievement at TPS.

Table 7 shows the percentage of TPS with the different types of schools within the specified radii for the 2008-09 school year. Most of the studies are done at the state level, and as stated before, there is no consensus on a good measure of competition. Therefore, I use Table 7 to find reasonable range for the radii to use for the measures of competition. At lower values of radii (0.25 and 0.3 miles), the percentage of TPS with charter presence is very low. Mid values of radii (0.4 to 0.6 miles) seems to be an appropriate measure of competition, as more than 75% of TPS have private (voucher) schools for higher radii. Sass (2006) states that competitive effects diminishes with the size of the radii as distant charter schools do not provide any competition, as expected. Therefore, I use the number of schools within 0.5 miles as a measure of competition, and then check the robustness of my results using 0.4 and 0.6 miles.

Table 8 shows summary statistics of student demographics for those attending TPS which face different levels of competition. TPS facing charter competition have substan-

Table 7: Percentage of TPS with different types of schools within the specified radii in year 2008-09

	MPS charters	Instrumentality charters	Non-Instrumentality charters	Non-district charters	Private (vouchers)
Within 0.25 m	5%	3%	2%	3%	28%
Within 0.3 m	6%	3%	3%	5%	40%
Within 0.4 m	11%	4%	7%	6%	55%
Within 0.5 m	16%	8%	8%	8%	67%
Within 0.6 m	20%	11%	12%	14%	74%
Within 0.75 m	25%	15%	14%	20%	83%
Within 1 m	36%	26%	19%	26%	92%
Within 1.25m	44%	37%	23%	34%	96%

Notes. Instrumentality stands for MPS instrumentality charter schools. Non-Instrumentality charter stands for MPS non-instrumentality charter schools (with more autonomy). Non-MPS are charter schools sponsored by non-MPS entities in Milwaukee. Private indicates those schools that participate in the voucher program.

Table 8: Summary statistics of student characteristics by charter competition

	All students	No MPS charter	> 1 MPS charter	No Instr charter	> 1 Instr charter	No NI charter	> 1 NI charter	No other charter	> 1 other charter
# of students	68,166	37,159	31,007	45,836	22,330	48,934	19,232	41,105	27,061
% Female	50%	50%	50%	50%	50%	49%	50%	49%	51%
% F/RL status	81%	78%	84%	79%	84%	78%	88%	79%	84%
% ELL status	8%	4%	13%	6%	12%	4%	18%	11%	3%
% Sp. Ed	19%	19%	20%	19%	20%	19%	20%	19%	20%
% Af. Am	62%	70%	53%	66%	54%	68%	49%	50%	80%
% Asian	4%	5%	4%	5%	3%	5%	3%	4%	4%
% Hispanic	17%	9%	28%	14%	24%	10%	36%	26%	4%
% White	13%	13%	13%	12%	15%	15%	9%	16%	8%
% Mobility	56%	53%	61%	54%	62%	55%	61%	50%	65%
Pre-Math	-0.01	0.00	-0.02	-0.01	-0.01	0.02	-0.07	0.03	-0.07
Pre-Read	0.00	0.01	-0.03	0.00	-0.01	0.02	-0.08	0.01	-0.03

Notes. Instr stands for MPS instrumentality charter schools. NI charter stands for MPS non-instrumentality charter schools. Other charters are charter schools sponsored by non-MPS entities in Milwaukee. F/RL is a dummy which takes a value of 1 if the student receives free or reduced lunch and 0 otherwise. ELL status is a dummy which takes a value of 1 if the student is an English language learner and 0 otherwise. Sp. Ed. status is a dummy which takes a value of 1 if the student is in special education and 0 otherwise. African Am., Asian, Hispanic and White are dummies for race. Mobility is a dummy variable which takes a value of 1 if the student changes school from the previous year.

tially more low-income and English language learners. Similarly, they have a higher percentage of Hispanic students. Charter schools may be targeting neighbourhoods with more heterogeneity in terms of race by offering bilingual classes. TPS facing charter competition have consistently lower scores than the schools facing no substantial charter competition. This is consistent with the fact that charter schools in Milwaukee are more likely to be located near low quality TPS.

4 Empirical Model

As discussed above, identifying competitive effects of charter schools on students' outcomes in TPS, while addressing potential self-selection bias and endogenous charter school location is challenging. I use a value added measure of student performance, which is measured as an increase in test scores. A value-added gain specification helps address a number of potential problems associated with omitted or mis-measured inputs, especially missing school and parent characteristics.[9]

The base model is of the following form:[10]

$$Y_{igt} - Y_{i(g-1)(t-1)} = \beta' X_{igt} + \delta C_{igt} + \gamma_i + \phi_s + \eta_{gt} + \epsilon_{igt}, \quad (1)$$

where Y_{igt} is the test score for individual i in grade g in year t, X_{igt} is the observable individual student characteristics in grade g in year t, C_{igt} is the competitive measure of charter schools for student i in grade g in year t, γ_i is a student fixed effect, ϕ_s is a school fixed effect, η_{gt} is grade-year level fixed effects, and ϵ_{igt} is a random error term.[11] The variable of interest is δ, the coefficient on C_{igt}. I measure the competitive effect, C_{igt}, using the presence and number of charter schools within 0.5 miles of a TPS.

Adding a school fixed effect controls for unmeasured time-invariant TPS quality. For example, if charter schools tend to locate where TPS are under-performing, as shown in Table 8, then competitive measures of the number of charter schools would reflect not only their competitive effect but also the unmeasured TPS quality. This would tend to bias downwards the estimated effects of charter schools on student achievement in TPS. The inclusion of school fixed effects controls for time invariant school characteristics. The inclusion of student fixed effects effectively controls for student ability and other time-invariant student characteristics.[12]

Identification of competitive effects comes from students who attend schools located

[9] Refer to Todd & Wolpin (2003) for a discussion of the restrictions on the education production technology implied by the different specifications.

[10] This formulation has some restrictions. First, the past experience of students does not deteriorate over time. I estimate equation with pre-test on the left hand side, and find estimate for λ of 0.95 for math and 0.99 for reading. I cannot reject the hypothesis that $\lambda = 1$.

[11] For a more general model of educational production function refer to Hanushek (1979).

[12] However, most literature find that including these student and school fixed effects makes it computationally intractable due to the large data sizes, and instead combine each unique campus student combination into a single spell that is estimated as a fixed effect (Bifulco & Ladd, 2006; Sass, 2006; Booker et al., 2008). This yields the following equation:

$$Y_{igt} - Y_{i(g-1)(t-1)} = \beta' X_{igt} + \delta C_{igt} + \theta_{si} + \eta_{gt} + \epsilon_{igt} \quad (2)$$

where $\theta_{si} = \gamma_i + \phi_s$ is the school-student spell effect for school 's' and student 'i'. Although individual and school effects are not separately identified, both individual and school heterogeneity can be eliminated by differencing the data with respect to spell means. Since in my case, it is not computationally intractable, I use the spell effect method for robustness check and find that I get similar results but with larger standard errors causing some of my estimates to be insignificant. The results are presented in Appendix A.

within the specified distance of a charter school and whose test score gains are observed in that school both before and after the nearby charter school opens. Students who move from TPS not located near a charter school to a school that is located near a charter school (and vice versa) contribute to the identification of school effects. In MPS, 56% of students switch schools. Thus, the competitive effect and school effect can be separately identified. Appendix B provides a simple explanation of the identification of this model.

5 Results

5.1 Overall competitive effects

Earlier results in Milwaukee suggest that district sponsored high autonomous charter schools have higher student achievement performance than district sponsored low autonomous charter schools (Nisar, 2010).[13] This could possibly suggest that these high autonomous charter schools might generate more competitive pressure on nearby TPS than low autonomous charter schools when they locate in their neighborhood as parents are more likely to switch out of a low quality school into high quality school (Hanushek et al., 2005). Similarly, students attending non-district sponsored charter schools are not considered part of the district, and hence district personnels would put added pressure on the principals of nearby TPS to improve their outcomes. This could possibly imply a higher competitive effect when a non-district sponsored charter school enters the education market of a TPS as compared to a district sponsored charter school. Therefore, I estimate the competitive effects of different authorizers of charter school on the education quality of nearby TPS, which is measured as an increase in the student achievement in math and reading test scores. After controlling for school and student heterogeneity, the results show strong evidence that the entry of non-district sponsored charter schools has a positive effect on student achievement in TPS. The above result is robust across various measures of competition for TPS, and different definitions of geographic market.

Tables 9 and 10 present the results of equation (1) using two alternative measures of charter school competition. The first panel reports the estimates when school competition is measured by the presence of different types of schools within a 0.5 mile radius (geographic market definition). The second panel reports the estimates when the competition is measured by the number of schools within a 0.5 mile radius. Irrespective of the measure used, non-district sponsored charter schools have a significant and positive effect on the education quality of nearby TPS.[14] The entry of a non-MPS authorized charter

[13] Angrist et al. (2009) find similar result in Boston.

[14] Since the students who attend these non-MPS sponsored charter schools do not have to take the standardized tests, the quality of these charter schools has not been measured. However, Nisar (2010) shows that higher autonomy charter schools are effective. One of the MPS administrator believes that these non-MPS charter schools are of higher quality than the charter schools hired by MPS. This is reasonable as these non-

Table 9: Competitive Effects of having different types of schools within 0.5 mile of a TPS (Math Achievement)

Competitive measure: Presence of the School				
	(1)	(2)	(3)	(4)
All Charters	0.026	0.027		
	(0.036)	(0.036)		
District Charters			0.005	
			(0.042)	
Instrumentality				0.022
				(0.046)
Non-Instrumentality				0.001
				(0.078)
Non-District Charters			0.094*♯	0.094*♯
			(0.049)	(0.049)
Private (vouchers)		-0.027	-0.026	-0.027
		(0.033)	(0.033)	(0.034)
Competitive measure: Number of Schools				
	(5)	(6)	(7)	(8)
All Charters	0.027	0.027		
	(0.026)	(0.027)		
District Charters			0.004	
			(0.027)	
Instrumentality				0.020
				(0.042)
Non-Instrumentality				-0.007
				(0.044)
Non-District Charters			0.119**†	0.119**‡
			(0.048)	(0.048)
Private (vouchers)		-0.009	-0.009	-0.009
		(0.016)	(0.016)	(0.016)
# of Obs	182,566			
# of Schools	131			
Adjusted R^2	0.268			

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.† - difference in competitive effects for different types of charter schools is statically significant at 5% significance level. ‡ - difference in competitive effects for different types charter schools is statistically significant at 10% significance level. ♯ - difference in competitive effects for different types of charter schools is statistically insignificant.*

schools is associated with a 0.12 standard deviation increase in math test scores and 0.08 standard deviation increase in reading scores. However, only the competitive effect on the math achievement for students in nearby TPS, when a non-district sponsored charter school enters, is statistically different from the two district sponsored charter school at 10% significance level as seen in column (8) of Table 9.

Nisar (2010) also shows that non-instrumentality charter schools are of higher quality in terms of improving the educational outcomes of their students. According to

district authorizers put a higher level of accountability on charter schools than the district on the schools they sponsor.

Table 10: Competitive Effects of having different types of schools within 0.5 mile of a TPS (Reading Achievement)

Competitive measure: Presence of the School				
	(1)	(2)	(3)	(4)
All Charters	0.033	0.033		
	(0.026)	(0.026)		
District Charters			0.014	
			(0.025)	
Instrumentality				0.018
				(0.044)
Non-Instrumentality				0.042*
				(0.023)
Non-District Charters			0.093* ♯	0.093* ♯
			(0.056)	(0.056)
Private (vouchers)		0.011	0.013	0.013
		(0.027)	(0.027)	(0.027)
Competitive measure: Number of Schools				
	(5)	(6)	(7)	(8)
All Charters	0.030	0.030		
	(0.020)	(0.020)		
District Charters			0.018	
			(0.021)	
Instrumentality				0.007
				(0.043)
Non-Instrumentality				0.027
				(0.019)
Non-District Charters			0.079** ♯	0.079** ♯
			(0.048)	(0.048)
Private (vouchers)		-0.006	-0.006	-0.006
		(0.016)	(0.016)	(0.016)
# of Obs	166,157			
# of Schools	131			
Adjusted R^2	0.291			

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. ♯ - Difference in effects for different types of charter schools is statistically insignificant.*

Hanushek et al. (2005), students are more likely to switch from a low performing school to a high performing school so the competitive effects of these high autonomous, high quality school should be higher than low quality charter schools nearby. These high autonomous district charter schools have a positive effect on the outcomes of TPS students in reading. However, it is not statistically different from low autonomous district sponsored charter schools as seen in column (4) and (8) of Table 10.

The competitive effect estimates of non-district sponsored charter schools are similar to the estimates (0.07-0.08) obtained by Hoxby (2003b), but on the higher end of the estimates (0.04) obtained by Booker et al. (2008) and Sass (2006). Table 19 and 20 in Appendix A show the results from the spell fixed effects strategy as explained in footnote 12 (used

by Sass, 2006; Bifulco & Ladd, 2006; and Booker et al., 2008). Results show that the effect sizes have comparable magnitude but larger standard errors, leading to insignificant results in the case of reading achievement. Further, the statistical difference between district and non-district sponsored charter school is not significant (due to larger standard errors). The results in Table 21 in Appendix C show that addressing student self-selection is important otherwise the results are biased downward (Hoxby, 2003b; Bettinger, 2005; Ni, 2009) as seen in columns (3) and (6). Finally, I should note that at least in the case of Milwaukee, controlling for other forms of competition has no effect on the competition effect of charter schools as seen in columns (2) and (6) of the main tables.

5.2 Robustness and interpretation of the overall effects

Tables 11 and 12 show the results using the number of charter schools as the competitive measure for different definitions of geographic market. The result for non-district sponsored charter schools holds for the medium range of radii. However, the result for the district sponsored non-instrumentality charter schools in reading only holds for the low or medium range of radii.[15] The above result shows that principals or district officials react stronger when losing students to non-district authorized charter schools than when losing students to district sponsored charter schools. This makes sense, especially from the districts perspective, as students in district sponsored charter schools are still considered part of the district. Secondly, as noted before, the low accountability of district authorized charter schools might also lead these charter schools to not compete as strongly for students as non-district sponsored charter schools. Table 24 in Appendix D shows the results using enrolment of charter schools within the geographic definition as the competitive measure. The magnitude of competitive effect for non-district sponsored charter school is the same but the standard errors are larger. As a result, the competitive effect is not statistically significant.

Unlike other states, a large number of charter schools in Milwaukee are converted either from TPS or private schools, in contrast to being newly established. Nine out of 15 district sponsored instrumentality charter schools are converted from TPS, while 4 out of 10 district sponsored non-instrumentality charter schools are converted from private schools. Unfortunately, due to the low number of private conversion charter schools, I cannot identify the competitive effects separately. Therefore, I regroup the district charter schools as those that were converted and those that were newly opened. Nisar (2010) finds that charter schools that are converted from TPS are less effective. This suggests that these charter schools should generate less competitive pressure on TPS due to being less effective, and already existing before they were converted. Table 13 shows the result of the competitive effects of conversion and non-conversion charter

[15]Tables 22 and 23 in Appendix D show the results using the presence of charter schools as the competitive measure.

Table 11: Robustness check of competitive effects of having different types of schools (Math Achievement)

	Competitive Measure: Number within the specified radii							
	0.25	**0.3**	**0.4**	**0.5**	**0.6**	**0.75**	**1**	**1.25**
Instrumentality	0.022	0.023	0.025	0.020	0.028	0.036	0.003	0.024
	(0.076)	(0.076)	(0.076)	(0.042)	(0.032)	(0.040)	(0.031)	(0.028)
Non-Instrumentality	-0.159	-0.029	-0.000	-0.007	-0.026	-0.028	-0.015	-0.025
	(0.180)	(0.078)	(0.061)	(0.044)	(0.036)	(0.033)	(0.025)	(0.024)
Non-District Charters	0.016	0.086	0.105	0.119**	0.123**	0.104**	0.039	0.018
	(0.065)	(0.074)	(0.066)	(0.048)	(0.058)	(0.045)	(0.038)	(0.032)
Private (vouchers)	0.016	0.011	-0.004	-0.009	-0.018	-0.025*	-0.020*	-0.020**
	(0.029)	(0.026)	(0.021)	(0.016)	(0.017)	(0.013)	(0.011)	(0.008)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Table 12: Robustness check of competitive effects of having different types of schools (Reading Achievement)

	Competitive Measure: Number within the specified radii							
	0.25	**0.3**	**0.4**	**0.5**	**0.6**	**0.75**	**1**	**1.25**
Instrumentality	-0.036	-0.036	-0.035	0.007	0.019	-0.010	-0.020	-0.011
	(0.048)	(0.048)	(0.049)	(0.043)	(0.032)	(0.030)	(0.020)	(0.018)
Non-Instrumentality	0.026	0.038*	0.037**	0.027	0.008	0.010	0.011	0.022
	(0.048)	(0.020)	(0.016)	(0.019)	(0.023)	(0.026)	(0.022)	(0.020)
Non-District Charters	0.100	0.065	0.074	0.079*	0.065	0.027	0.027	0.026
	(0.096)	(0.071)	(0.063)	(0.048)	(0.043)	(0.030)	(0.025)	(0.024)
Private (vouchers)	0.006	0.005	-0.009	-0.006	-0.013	-0.015	-0.011	-0.010*
	(0.028)	(0.023)	(0.021)	(0.016)	(0.012)	(0.011)	(0.008)	(0.006)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

schools. The newly opened charter schools have a positive effect on the outcomes of TPS students in math as well as reading. However, the coefficient in math is not robust across different definitions of geographic market. Irrespective, the competitive effect of non-conversion charter schools is higher than the effect of conversion charter schools for the different measures of competition and geographic market definition. Concentrating on the results where the geographic market definition is 0.5 mile, the difference between all 3 coefficient is only statistically significant in math as before. However, the difference between non-conversion district sponsored charter schools and non-district sponsored charter schools is not statistically significant (p=0.13).

Table 25 in Appendix E shows the long term effect of the entry of a charter on the educational quality of a nearby TPS. The instantaneous positive effect from the entry of a charter school obtained in Tables 9 and 10 seems to disappear the next year. Ni (2009) finds a similar result in Michigan. In Michigan, the effect is small or negligible in

Table 13: Competitive effects of conversion and non-conversion charter schools

	Competitive Measure: Presence of Charter School					
	Math			Reading		
	0.4	0.5	0.6	0.4	0.5	0.6
Conversion Charters	-0.114***	-0.038	-0.043	-0.082	-0.011	0.006
	(0.039)	(0.045)	(0.041)	(0.061)	(0.032)	(0.037)
Non-Conversion Charters	0.105***	0.066	0.074	0.068**	0.044	0.047
	(0.038)	(0.050)	(0.046)	(0.032)	(0.031)	(0.031)
Non-District Charters	0.106†§	0.096*‡§	0.116*‡§	0.065‡§	0.094*‡§	0.066♯§
	(0.069)	(0.050)	(0.067)	(0.064)	(0.056)	(0.045)
Private (vouchers)	-0.024	-0.025	-0.012	-0.017	0.014	0.020
	(0.031)	(0.033)	(0.033)	(0.029)	(0.028)	(0.027)
	Competitive Measure: Number of Charter School					
	Math			Reading		
	0.4	0.5	0.6	0.4	0.5	0.6
Conversion Charters	-0.169***	-0.021	-0.021	-0.135***	-0.009	0.003
	(0.055)	(0.047)	(0.050)	(0.045)	(0.032)	(0.031)
Non-Conversion Charters	0.103***	0.041	0.032	0.077**	0.041**	0.026
	(0.035)	(0.033)	(0.031)	(0.031)	(0.020)	(0.021)
Non-District Charters	0.108†§	0.121**‡§	0.127**♯§	0.076†§	0.081*♯§	0.065♯§
	(0.067)	(0.048)	(0.060)	(0.063)	(0.048)	(0.042)
Private (vouchers)	-0.007	-0.009	-0.017	-0.011	-0.006	-0.013
	(0.022)	(0.016)	(0.016)	(0.021)	(0.016)	(0.012)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies and grade-by-year fixed effects. †- difference in the competitive effects of all 3 charter schools is statistically significant at 1% significant level. ‡- difference in the competitive effects of all 3 charter schools is statistically significant at 10% significant level. ♯ - difference in the competitive effects of all 3 charter schools is statistically insignificant. § - difference in the competitive effect of non-district sponsored charter schools and district sponsored non-conversion charter schools is statistically insignificant.*

the short-run, but becomes substantially negative in the medium- and long-run. These results should caution the readers on the competitive effects of charter schools, especially if one expects TPS to react slowly to the entry of a charter school.[16]

If the charter schools attract previously low-achieving students from TPS, then the overall results obtained in the above section indicating the positive competitive effects need to be interpreted with caution even though student fixed effects are included. Therefore, I estimate the effect of an entry of a charter school on the composition of the students who remain at TPS using the following equation,

$$Composition_{igt} = \delta C_{igt} + \phi_s + \eta_{gt} + \epsilon_{igt}. \tag{4}$$

[16]Imberman (2011) suggests checking for evidence of trending prior to charter school entry, a way to check for endogenous entry of charter schools. This can be tested by using the following model as Imberman suggests

$$Y_{igt} - Y_{i(g-1)(t-1)} = \alpha + \delta_1 C_{igt} + \delta_2 C_{ig(t-1)} + \gamma_i + \phi_s + \eta_{gt} + \epsilon_{igt}, \tag{3}$$

in which lagged competitive charter effects δ_2 is not statistically significant. I find that they are statistically insignificant, and therefore there is no need to include them in the model.

The results, presented in Table 14, show that the entry and exit of district sponsored charter schools and voucher schools do not affect the composition of the TPS. However, the entry of non-district sponsored charter schools does change the composition of students at a TPS. It causes the Hispanic population to decrease by 4% and the African American population to increase by 3%. Similarly, it reduces the low income and ELL population by 2% and 4%, respectively. However, results from column (6) and (7) indicate that there is no change in the previous math and reading test scores of students who remain at TPS. This result further increases my confidence in the findings obtained in the previous section.[17]

Table 14: Competitive effects of charter schools on the composition of TPS

	Competitive Measure: Presence of Charter School within 0.5 m						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Hisp.	Af. Am.	F/RL	ELL	Sp. Ed.	Pre-Math	Pre-Read
Instrumentality	-0.003	0.002	-0.003	0.047*	0.001	-0.030	-0.002
	(0.009)	(0.010)	(0.006)	(0.026)	(0.007)	(0.039)	(0.029)
Non-Instrumentality	0.012	0.017	0.013	0.000	0.002	0.048	-0.036
	(0.023)	(0.039)	(0.030)	(0.026)	(0.005)	(0.075)	(0.049)
Non-District Charters	-0.044***	0.028*	-0.016	-0.037*	0.009	-0.016	-0.083
	(0.009)	(0.015)	(0.012)	(0.019)	(0.015)	(0.071)	(0.080)
Private (vouchers)	-0.004	0.011	0.003	0.002	0.007	-0.032	-0.040
	(0.008)	(0.010)	(0.009)	(0.008)	(0.007)	(0.032)	(0.027)
	Competitive Measure: Number of Charter School within 0.5 m						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Hisp.	Af. Am.	F/RL	ELL	Sp. Ed.	Pre-Math	Pre-Read
Instrumentality	-0.004	-0.000	-0.005	0.047*	-0.000	-0.025	0.011
	(0.008)	(0.010)	(0.006)	(0.025)	(0.007)	(0.040)	(0.035)
Non-Instrumentality	0.034	0.000	0.005	0.052	-0.007	0.061	-0.020
	(0.023)	(0.022)	(0.016)	(0.033)	(0.007)	(0.058)	(0.040)
Non-District Charters	-0.037***	0.027**	-0.016*	-0.036**	0.012	-0.029	-0.044
	(0.008)	(0.013)	(0.009)	(0.014)	(0.011)	(0.058)	(0.068)
Private (vouchers)	-0.003	0.002	0.000	-0.000	0.001	-0.030	-0.018
	(0.004)	(0.005)	(0.003)	(0.004)	(0.003)	(0.018)	(0.016)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include school dummies, and grade-by-year fixed effects and is weighted by the number of students in that grade and year. F/RL is a dummy which takes a value of 1 if the student receives free or reduced lunch and 0 otherwise. ELL status is a dummy which takes a value of 1 if the student is an English language learner and 0 otherwise. Sp. Ed. status is a dummy which takes a value of 1 if the student is in special education and 0 otherwise. Af. Am., and Hispanic are dummies for race (African American and Hispanic). Pre-Math test and Pre-Read test are previous test scores in math and reading, respectively.*

[17] Another test is to check whether pre-existing observable characteristics of students and schools are correlated with charter entry conditional on school and student fixed effect. A model suggested by Imberman was to test if δ is significant.

$$C_{igt} = \alpha + \delta X_{ig(t-1)} + \phi_s + \eta_{gt} + \epsilon_{igt}. \quad (5)$$

I find that for all the competitive measures for the different types of charter schools (using number of charter schools), there is no indication for observables varying with charter school entry in a time varying way that it would suggest that the unobserved time-variant effects are correlated with the error term.

5.3 Subgroup effects

Charter schools may target and help different types of students. Earlier results in Milwaukee suggest that district sponsored high autonomous charter schools have higher impact on African American and previously low-achieving students than district sponsored low autonomous charter schools (Nisar, 2010). This might suggest that these high quality and high autonomous charter schools might generate more competitive pressure on TPS in terms of achievement than low quality charter schools for these subgroups. Similarly, non-district sponsored charter schools could potentially target different types of students. Therefore, I examine the potential differential impact of charter competition on the education quality of different ethnicity and prior achievement of students in TPS. After controlling for school and student heterogeneity, the results show strong evidence that the entry of non-district charter schools has a significant and positive effect on African-American and previously low-achieving students in TPS. The above results are robust across these various measures of competition for TPS, and different definitions of geographic market. This effect is also statistically different than the competitive effect of both the district sponsored charter schools.

Table 15: Competitive effects of charter schools on African American students in TPS using number of charter schools as the competitive measure

	Math			Reading		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.018	-0.020	-0.012	0.079	0.047	0.067
	(0.094)	(0.059)	(0.044)	(0.146)	(0.045)	(0.042)
Non-Instrumentality	-0.060	-0.043	-0.050	0.014	0.021	0.002
	(0.071)	(0.049)	(0.037)	(0.023)	(0.020)	(0.031)
Non-District Charters	0.142*‡	0.149***†	0.158**†	0.096‡	0.100**‡	0.092**‡
	(0.072)	(0.051)	(0.061)	(0.066)	(0.049)	(0.045)
Private (vouchers)	-0.009	-0.011	-0.022	-0.001	-0.004	-0.023
	(0.025)	(0.018)	(0.018)	(0.024)	(0.018)	(0.014)
# of Obs		115,576			105,600	
# of Schools		131			131	

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. † - difference in competitive effects for non-district and district sponsored charter schools is statically significant at 5% significance level. ‡ - difference in competitive effects for all 3 competitive effects of charter schools is not statistically significant.*

Table 15 and 16 report separate estimates of the impact of charter school entry for African American and Hispanic students at nearby TPS, respectively. Each table reports coefficients for charter school competition measured, using the number of different types of charter schools within a 0.4-0.6 miles of the location of TPS. For African Americans, the estimates of non-district authorized charter school penetration are 0.10 in reading and 0.15 in math. However, only the competitive effect in math is statistically different than

Table 16: Competitive effects of charter schools on Hispanic students in TPS using number of charter schools as the competitive measure

	Math			Reading		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.048	0.027	0.042	-0.020	0.007	0.005
	(0.038)	(0.065)	(0.076)	(0.061)	(0.056)	(0.046)
Non-Instrumentality	-0.004	-0.039	-0.053	0.034	-0.009	-0.012
	(0.047)	(0.042)	(0.048)	(0.031)	(0.031)	(0.034)
Non-District Charters	0.072‡	0.057‡	0.024‡	0.351‡	0.364‡	-0.020‡
	(0.130)	(0.128)	(0.139)	(0.302)	(0.305)	(0.180)
Private (vouchers)	-0.036	-0.044	-0.006	-0.002	0.016	0.008
	(0.031)	(0.033)	(0.035)	(0.049)	(0.035)	(0.024)
# of Obs		30,118			27,123	
# of Schools		125			126	

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. ‡ - difference in competitive effects for all 3 competitive effects of charter schools is not statistically significant.*

the district sponsored charter school competitive effects. Table 26 in Appendix F shows that this coefficient is also statistically significant when using charter school presence as a measure of competition. Similarly, Table 28 in Appendix F shows that this coefficient is statistically different than competitive effect from an entry of a non-conversion district sponsored charter schools at 10% significance level. In fact, this estimate of 0.15 standard deviation indicates that African Americans attending a TPS with a non-district sponsored charter school within its neighborhood would perform math at a grade level higher in three years as compared to African Americans attending a TPS without a nearby non-district sponsored charter school. However, there is no significant effect for Hispanics, even though they have a higher coefficient in reading. The exact source of this difference for African Americans is open for interpretation. A higher percentage of Hispanic students attend non-district charter schools suggesting that TPS may compete more for them than African-Americans. Table 14 in the previous sub-section shows that after the entry of a non-MPS charter school reduces the Hispanic population at the TPS by 4%, and increases the African-American student population by 3%.

Finally, I examine the potential differential impact of charter competition by prior student achievement. Nisar (2010) shows that district sponsored charter schools have a positive impact on previously low-achieving students. Table 17 and 18 report separate estimates of the impact of charter school entry differentiated by students' previous test score levels as compared to the district mean test score level. The tables report coefficients for charter school competition measured using number of schools within 0.4-0.6 miles of the TPS.[18] However, the results show that district sponsored charter schools have no

[18]Tables 29 and 30 in Appendix G present the analysis using presence of a charter school as the competition measure.

Table 17: Competitive effects of charter schools on previously low achieving students in TPS using number of charter schools as the competitive measure

	Math			Reading		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	-0.009	0.003	0.055	0.060	0.064	0.092
	(0.088)	(0.044)	(0.047)	(0.142)	(0.081)	(0.065)
Non-Instrumentality	-0.001	0.055	-0.004	0.009	0.021	-0.003
	(0.055)	(0.042)	(0.041)	(0.033)	(0.030)	(0.028)
Non-District Charters	0.116**†	0.121***†	0.147***‡	0.081‡	0.093‡	0.067‡
	(0.058)	(0.049)	(0.046)	(0.086)	(0.064)	(0.058)
Private (vouchers)	-0.049	-0.036	-0.038	-0.024	-0.022	-0.028*
	(0.043)	(0.042)	(0.050)	(0.029)	(0.021)	(0.017)
# of Obs		87,291			76,632	
# of Schools		131			131	

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. † - difference in competitive effects for all 3 competitive effects of charter schools is statistically significant at 5% significance level. ‡ - difference in competitive effects for all 3 competitive effects of charter schools is not statistically significant.*

Table 18: Competitive effects of charter schools on previously high achieving students in TPS using number of charter schools as the competitive measure

	Math			Reading		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.108	0.063	0.038	-0.033	-0.024	-0.022
	(0.074)	(0.048)	(0.038)	(0.041)	(0.035)	(0.028)
Non-Instrumentality	0.090	0.077	0.045	0.063**	0.057**	0.039
	(0.102)	(0.092)	(0.064)	(0.026)	(0.022)	(0.027)
Non-District Charters	0.061‡	0.110‡	0.079‡	-0.004‡	0.019‡	0.008‡
	(0.081)	(0.089)	(0.075)	(0.069)	(0.054)	(0.045)
Private (vouchers)	-0.033	-0.015	-0.017	-0.005	-0.002	-0.004
	(0.020)	(0.015)	(0.012)	(0.036)	(0.036)	(0.037)
# of Obs		95,275			89,525	
# of Schools		129			128	

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.‡ - difference in competitive effects for all 3 competitive effects of charter schools is not statistically significant.*

effect on previously low achieving students, but the estimate on non-district sponsored charter school penetration is positive and statistically significant in math. This estimate is also robust across different geographic market definition and the difference between the three competitive estimates is statistically significant.

For previously high achieving students, there is no effect of non-district sponsored charter schools. However, there is a significant effect for these students for district sponsored non-instrumentality charter schools. Again, the exact source of difference is open for interpretation, but the fact that these non-instrumentality charter schools have a large

positive effect on previously high-achieving students (Nisar, 2010) suggests that TPS may compete more for these students. Another possibility is that after the entry of these MPS non-instrumentality charter schools might lead to a more homogeneous student composition at TPS. Sorting may explain our results, to the extent that these charter schools may help remove students with behavioral or unmotivated students from the TPS classrooms which might lead the teachers at TPS to teach to the previously high-achieving students. However, the difference between the three estimates is not statistically significant.[19]

Thus, I find robust evidence of a positive effect of non-district sponsored charter school penetration on student performance at nearby TPS, although it is hard to identify the specific mechanisms which are driving this observed relationship.

6 Conclusion

I find that the emergence of charter schools in Milwaukee has had some impact on student test scores for those students who stay back at TPS. A key insight is that the estimated competitive effect depends on the type of charter schools that enter the market. Overall, charter school entry has had no competitive effect on student achievement of nearby TPS in Milwaukee. However, this result masks heterogeneity in the type of charter schools that enter. I find that non-district sponsored charter schools have a positive and significant effect on students' outcomes in neighboring public schools. This indirect effect is statistically different than the effect of an entry of a district sponsored charter school. The positive competitive effect of non-district authorized charter schools vary across subgroups of students. They have a positive and significant effect on previously low-achieving students and African Americans at TPS, which is statistically different from the competitive effect due to the district sponsored charter schools.

The literature on charter schools' competitive effects show mixed results. I argue that this may stem from the types of charter schools environments across states. First, a district or state that allows a non-district authority to charter schools might lead to more competition especially if the non-district sponsored charter schools are funded at the same level of TPS and the students are not considered as a part of the district. Secondly, the quality of charter schools differs across states, leading to different levels of competition. For example, Bifulco & Ladd (2006) find no effect of attending charter schools in North Carolina, and therefore, find no competitive effect. This study successfully investigates and finds that the first hypothesis is true that the competitive effect depends on the authorizing types of charter schools in the district/state. As a caution I should specify that, in Milwaukee, the total public student population has been declining for the past decade; therefore, any increase in charter school enrolment would translate to

[19]Table 31 in Appendix H shows the results for students broken down by achievement quartiles. The above results still hold.

a corresponding reduction in TPS enrolment and funding. However, districts or states with increasing enrolment might be less likely to feel competitive pressure from charter school entry. Further studies should investigate if the increase in the flow of funding to charter schools (being funded at the same level as TPS) would cause a competitive effect on TPS.

However, these estimated competitive effects are substantial when compared to other school choice programs, such as charter schools and vouchers, and represent about one-third the annual gains made by the students in these schools.[20] I find effects sizes which are of similar or slightly larger magnitudes than found in other competitive effect studies. Hoxby (2003b) finds the largest effect sizes among the charter school competition studies of 0.06-0.08 standard deviations. However, these effect sizes are modest as compared to other interventions such as reducing class size, but I would argue that charter school intervention may be less expensive for the district on a per student basis as compared to these other interventions. The evidence in this paper supports claims that expanding school choice may generate gains as long as the expansion of choice is to these non-district sponsored charter schools. These gains are also realized under broader choice provisions, such as vouchers operating in the same district.

Additionally, further research is needed to examine how TPS change their resource allocation or how school personnel change their behavior in response to an entry of a nearby charter school, and how these adjustments relate to TPS ability to stabilize enrolment. Finally, research is needed to better understand the competitive effects in different settings, such as districts with increasing enrolment or states with cap on the number of charters. This would help policy makers design and implement policies that would preserve the benefits of school choice, and at the same time improve the outcomes for those students who choose to remain in TPS. At least in the case of Milwaukee school district, I can conclude that the benefits of school choice have improved the outcomes for some subgroup of students who choose to remain at TPS without hurting the remaining subgroups.

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Appendix A

Table 19: Competitive effects of having different types of schools using spell fixed effects (Math Achievement)

Math				
Competitive measure: Presence of the School within 0.5m				
	(1)	(2)	(3)	(4)
All Charters	0.029	0.031		
	(0.056)	(0.057)		
District Charters			0.009	
			(0.066)	
District Instrumentality				0.045
				(0.064)
District Non-Instrumentality				-0.010
				(0.138)
Non-District Charters			0.108	0.108‡
			(0.079)	(0.078)
Private (vouchers)		-0.047	-0.046	-0.048
		(0.044)	(0.044)	(0.044)
Competitive measure: Number of Schools within 0.5m				
	(5)	(6)	(7)	(8)
All Charters	0.036	0.037		
	(0.040)	(0.040)		
District Charters			0.017	
			(0.042)	
District Instrumentality				0.044
				(0.060)
District Non-Instrumentality				-0.004
				(0.072)
Non-District Charters			0.135*	0.134*‡
			(0.081)	(0.081)
Private (vouchers)		-0.014	-0.013	-0.013
		(0.025)	(0.025)	(0.025)
# of Obs	182,566			
# of Schools	131			
Adjusted R^2	0.441			

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. ‡ - difference in competitive effects for all 3 competitive effects of charter schools is statistically insignificant.*

Table 20: Competitive effects of having different types of schools using spell fixed effects (Reading Achievement)

Read				
Competitive measure: Presence of the School within 0.5m				
	(1)	(2)	(3)	(4)
All Charters	0.036	0.035		
	(0.038)	(0.039)		
District Charters			0.016	
			(0.036)	
District Instrumentality				0.033
				(0.065)
District Non-Instrumentality				0.045
				(0.044)
Non-District Charters			0.107	0.107‡
			(0.100)	(0.101)
Private (vouchers)		0.019	0.021	0.020
		(0.042)	(0.043)	(0.043)
Competitive measure: Number of Schools within 0.5m				
	(5)	(6)	(7)	(8)
All Charters	0.045	0.045		
	(0.032)	(0.032)		
District Charters			0.033	
			(0.032)	
District Instrumentality				0.023
				(0.061)
District Non-Instrumentality				0.042
				(0.034)
Non-District Charters			0.109	0.109‡
			(0.092)	(0.091)
Private (vouchers)		-0.006	-0.006	-0.006
		(0.026)	(0.026)	(0.026)
# of Obs	166,157			
# of Schools	131			
Adjusted R^2	0.471			

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. ‡ - difference in competitive effects for all 3 competitive effects of charter schools is statistically insignificant.*

Appendix B

Consider a simple two period model with two TPS in both periods and entry of a charter school in the second period. Let ΔY_{it} be the outcome under consideration. C_{st} is the measure of competition and α is the required competitive effect. γ_i and ϕ_s is the student and school fixed effect respectively. Assume there is no uncertainty then the outcome equation is given as follows:

$$\Delta Y_{it} = \alpha C_{st} + \gamma_i + \phi_s$$

The following four cases show how α, ϕ_{s1} and ϕ_{s2} are identified.

- Case 1 : Student does not change schools and no entry of charter school near school 1 in period 2
  - Time period 1: $\Delta Y_{i1} = \gamma_i + \phi_{s1}$
  - Time period 2: $\Delta Y_{i2} = \gamma_i + \phi_{s1}$
  - Does not help in identification
- Case 2 : Student does not change schools and entry of charter school near school 1 in period 2
  - Time period 1: $\Delta Y_{i1} = \gamma_i + \phi_{s1}$
  - Time period 2: $\Delta Y_{i2} = \alpha + \gamma_i + \phi_{s1}$
  - Helps to identifying competitive effect
- Case 3 : Student changes schools and no entry of charter school in period 2
  - Time period 1: $\Delta Y_{i1} = \gamma_i + \phi_{s1}$
  - Time period 2: $\Delta Y_{i2} = \gamma_i + \phi_{s2}$
  - Helps in identifying school effect
- Case 4 : Student changes schools and entry of charter school near school 2 in period 2
  - Time period 1: $\Delta Y_{i1} = \gamma_i + \phi_{s1}$
  - Time period 2: $\Delta Y_{i2} = \alpha + \gamma_i + \phi_{s2}$
  - Helps in identifying school effect and competitive effect

Appendix C

Table 21: Robustness check of the model: Competitive effects of charter schools (0.5 mile)

Competitive Measure: Presence of Charter School						
	Math			Reading		
	(1)	(2)	(3)	(4)	(5)	(6)
Instrumentality	0.022	0.002	0.007	0.018	0.022	0.020
	(0.046)	(0.038)	(0.023)	(0.044)	(0.031)	(0.013)
Non-Instrumentality	0.001	0.039	0.020	0.042*	0.040**	0.028
	(0.078)	(0.041)	(0.036)	(0.023)	(0.017)	(0.018)
Non-MPS Charters	0.094*	0.116***	0.037	0.093*	0.097***	0.050
	(0.049)	(0.031)	(0.036)	(0.056)	(0.023)	(0.048)
Private (vouchers)	-0.027	-0.010	-0.007	0.013	0.011	0.020
	(0.034)	(0.020)	(0.020)	(0.027)	(0.018)	(0.016)
Competitive Measure: Number of Charter School						
	Math			Reading		
	(1)	(2)	(3)	(4)	(5)	(6)
Instrumentality	0.020	-0.006	0.007	0.007	0.008	0.013
	(0.042)	(0.038)	(0.020)	(0.043)	(0.030)	(0.014)
Non-Instrumentality	-0.007	0.021	-0.002	0.027	0.034**	0.018
	(0.044)	(0.025)	(0.025)	(0.019)	(0.014)	(0.016)
Non-MPS Charters	0.119**	0.100***	0.053*	0.079*	0.080***	0.035
	(0.048)	(0.027)	(0.029)	(0.048)	(0.020)	(0.035)
Private (vouchers)	-0.009	-0.006	0.006	-0.006	-0.001	0.009
	(0.016)	(0.010)	(0.011)	(0.016)	(0.010)	(0.010)
Student FE	Yes	Yes	No	Yes	Yes	No
School FE	Yes	No	Yes	Yes	No	Yes

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, and grade-by-year fixed effects.*

Appendix D

Table 22: Robustness check: Competitive effects of having different types of schools (Math Achievement)

	Math							
	Competitive Measure: Presence within the specified radii							
	0.25	**0.3**	**0.4**	**0.5**	**0.6**	**0.75**	**1**	**1.25**
Instrumentality	0.022	0.024	0.025	0.022	0.022	0.015	-0.012	-0.005
	(0.076)	(0.076)	(0.076)	(0.046)	(0.034)	(0.035)	(0.038)	(0.035)
Non-Instrumentality	-0.157	-0.042	0.000	0.001	-0.011	-0.032	-0.022	-0.016
	(0.180)	(0.133)	(0.089)	(0.078)	(0.047)	(0.046)	(0.032)	(0.029)
Non-MPS Charters	0.015	0.081	0.104	0.094*	0.107	0.148***	0.073	0.014
	(0.066)	(0.078)	(0.068)	(0.049)	(0.066)	(0.054)	(0.052)	(0.059)
Private (vouchers)	0.005	-0.001	-0.026	-0.027	-0.014	0.006	-0.023	-0.045
	(0.035)	(0.032)	(0.031)	(0.034)	(0.034)	(0.033)	(0.052)	(0.063)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Table 23: Robustness check: Competitive effects of having different types of schools (Reading Achievement)

	Reading							
	Competitive Measure: Presence within the specified radii							
	0.25	**0.3**	**0.4**	**0.5**	**0.6**	**0.75**	**1**	**1.25**
Instrumentality	-0.036	-0.036	-0.036	0.018	0.026	-0.012	-0.012	0.004
	(0.048)	(0.048)	(0.048)	(0.044)	(0.031)	(0.032)	(0.028)	(0.026)
Non-Instrumentality	0.025	0.054	0.045*	0.042*	0.010	0.008	0.009	0.030
	(0.048)	(0.041)	(0.026)	(0.023)	(0.035)	(0.044)	(0.034)	(0.029)
Non- MPS Charters	0.099	0.051	0.064	0.093*	0.066	0.048	0.036	-0.005
	(0.096)	(0.073)	(0.064)	(0.056)	(0.047)	(0.041)	(0.033)	(0.040)
Private (vouchers)	-0.003	-0.004	-0.017	0.013	0.020	0.032	0.015	0.007
	(0.030)	(0.028)	(0.029)	(0.027)	(0.026)	(0.035)	(0.055)	(0.082)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Table 24: Robustness check: Competitive effects of having different types of schools using Enrollment of charter schools as a competitive measure

Competitive Measure: Enrollment within the specified radii						
	Reading			Math		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.065	0.062	0.053	0.229	0.039	0.071
	(0.076)	(0.055)	(0.048)	(0.206)	(0.171)	(0.114)
Non - Instrumentality	-0.120	-0.071	-0.063	-0.260	-0.072	-0.104
	(0.077)	(0.052)	(0.044)	(0.196)	(0.175)	(0.115)
Non MPS Charters	0.058	0.064	0.072	0.039	0.123	0.028
	(0.076)	(0.050)	(0.075)	(0.133)	(0.087)	(0.084)
Private	0.070	0.080	0.109	-0.024	-0.021	0.066
	(0.110)	(0.092)	(0.091)	(0.173)	(0.121)	(0.100)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Appendix E

Table 25: Competitive effects of charter schools on TPS after two years

Competitive measure: Number of charter schools						
	Math			**Reading**		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.056	-0.006	-0.010	-0.048	-0.046	-0.026
	(0.060)	(0.035)	(0.030)	(0.058)	(0.029)	(0.025)
Non-Instrumentality	0.016	0.010	0.015	-0.029	-0.031	-0.041*
	(0.038)	(0.029)	(0.026)	(0.030)	(0.029)	(0.022)
Non-MPS Charters	-0.027	0.003	0.006	0.010	-0.015	0.000
	(0.031)	(0.028)	(0.026)	(0.030)	(0.027)	(0.029)
Private (vouchers)	0.019	0.011	0.010	-0.012	-0.010	-0.009
	(0.018)	(0.009)	(0.009)	(0.014)	(0.011)	(0.010)
# of Obs	96,182	96,182	96,182	110,225	110,225	110,225
# of Schools	130	130	130	130	130	130

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Appendix F

Table 26: Competitive effects of charter schools on African American students in TPS using presence of charter schools as the competitive measure

	Reading			Math		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.076	0.052	0.067*	0.017	-0.019	-0.015
	(0.144)	(0.045)	(0.040)	(0.093)	(0.061)	(0.046)
Non-Instrumentality	0.008	0.022	-0.008	-0.063	-0.049	-0.038
	(0.022)	(0.021)	(0.040)	(0.078)	(0.072)	(0.040)
Non-District Charters	0.086‡	0.110*‡	0.091*‡	0.144*‡	0.124**†	0.138*†
	(0.067)	(0.061)	(0.052)	(0.075)	(0.052)	(0.070)
Private (vouchers)	-0.026	0.001	0.012	-0.027	-0.018	0.015
	(0.035)	(0.037)	(0.029)	(0.033)	(0.044)	(0.041)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. † - difference in competitive effects for different types of charter schools is statically significant at 10% significance level. ‡ - difference in competitive effects for different types charter schools is statistically insignificant.*

Table 27: Competitive effects of charter schools on Hispanic students in TPS using presence of charter schools as the competitive measure

	Reading			Math		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	-0.019	0.028	0.018	0.051	0.036	0.035
	(0.037)	(0.057)	(0.040)	(0.065)	(0.081)	(0.063)
Non-Instrumentality	0.109	-0.026	-0.015	0.032	-0.044	-0.028
	(0.087)	(0.121)	(0.091)	(0.166)	(0.115)	(0.085)
Non-MPS Charters	0.360‡	0.356‡	-0.020‡	0.087‡	0.085‡	0.028‡
	(0.300)	(0.302)	(0.179)	(0.129)	(0.129)	(0.137)
Private (vouchers)	0.055	0.028	-0.004	-0.034	-0.049*	-0.067**
	(0.062)	(0.043)	(0.034)	(0.046)	(0.025)	(0.028)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. ‡ - difference in competitive effects for different types charter schools is statistically insignificant.*

Table 28: Competitive effects of charter schools on African American and Hispanic students in TPS using number of charter schools within 0.5 mile radius as the competitive measure

Competitive Measure: Number of Charter School				
	African American		Hispanic	
	Math	Reading	Math	Reading
Conversion	-0.042	0.03	0.014	0.029
	(0.060)	(0.036)	(0.066)	(0.045)
Non-conversion	0.043	0.056	-0.012	0.004
	(0.045)	(0.036)	(0.053	(0.0029)
Non-MPS Charters	0.150**†	0.102*‡	0.055 ‡	0.365‡
	(0.051)	(0.049)	(0.127)	(0.305)
Private (vouchers)	-0.004	-0.011	-0.047	0.014
	(0.018)	(0.018)	(0.033)	(0.035)
# of Obs	115,576	105,600	30,118	27,123
# of Schools	131	131	126	125

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects. † - Difference in effects for all 3 types of charter schools is statistically significant at 5% (Diff between non-MPS and conversion or non-conversion charter schools is statistically significant at 1% and 10% respectively). ‡ - Difference in effects for all 3 types of charter schools is not statistically significant*

Appendix G

Table 29: Competitive effects of charter schools on previously low achieving students in TPS using presence of charter schools as the competitive measure

	Reading			Math		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	0.056	0.081	0.102	-0.009	-0.007	0.051
	(0.139)	(0.079)	(0.062)	(0.088)	(0.040)	(0.044)
Non-Instrumentality	0.009	0.007	-0.016	0.043	0.032	-0.007
	(0.046)	(0.043)	(0.046)	(0.067)	(0.047)	(0.036)
Non-MPS Charters	0.072	0.115	0.072	0.116**	0.121**	0.147***
	(0.089)	(0.084)	(0.069)	(0.058)	(0.049)	(0.046)
Private (vouchers)	-0.052	-0.041	-0.047	-0.009	-0.005	-0.017
	(0.036)	(0.029)	(0.035)	(0.026)	(0.016)	(0.017)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Table 30: Competitive effects of charter schools on previously high achieving students in TPS using presence of charter schools as the competitive measure

	Reading			Math		
	0.4	**0.5**	**0.6**	**0.4**	**0.5**	**0.6**
Instrumentality	-0.033	-0.022	-0.017	0.109	0.058	0.037
	(0.042)	(0.038)	(0.031)	(0.074)	(0.043)	(0.038)
Non-Instrumentality	0.060*	0.061**	0.026	0.068	0.055	0.017
	(0.035)	(0.029)	(0.036)	(0.073)	(0.050)	(0.052)
Non-MPS Charters	-0.014	0.015	0.004	0.061	0.108	0.084
	(0.071)	(0.059)	(0.048)	(0.079)	(0.075)	(0.069)
Private (vouchers)	-0.017	0.008	0.020	-0.008	-0.010	-0.020
	(0.025)	(0.026)	(0.032)	(0.026)	(0.021)	(0.020)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*

Appendix H

Table 31: Competitive effects of charter schools broken down by previous achievement quartiles

	Reading				Math			
	Competitive effect: Presence of schools				Competitive effect: Presence of schools			
	4th	3rd	2nd	1st	4th	3rd	2nd	1st
Instrumentality	0.152	0.054*	0.001	-0.021	-0.021	-0.012	0.077	0.014
	(0.126)	(0.032)	(0.064)	(0.069)	(0.086)	(0.061)	(0.061)	(0.044)
Non-Instrumentality	0.032	0.003	0.015	0.095	0.012	0.095	0.134*	0.132
	(0.071)	(0.071)	(0.046)	(0.059)	(0.063)	(0.102)	(0.081)	(0.089)
Non-MPS charters	0.144	0.091	0.104	0.071	0.192***	-0.063	0.123	0.170
	(0.112)	(0.101)	(0.101)	(0.106)	(0.069)	(0.113)	(0.108)	(0.153)
Private (vouchers)	-0.023	0.021	-0.046*	0.026	-0.042	0.014	-0.024	-0.042
	(0.040)	(0.032)	(0.027)	(0.043)	(0.069)	(0.047)	(0.043)	(0.054)
	Competitive effect: Number of schools				Competitive effect: Number of schools			
	4th	3rd	2nd	1st	4th	3rd	2nd	1st
Instrumentality	0.121	0.065**	-0.001	-0.020	-0.031	-0.012	0.068	0.002
	(0.134)	(0.033)	(0.064)	(0.064)	(0.075)	(0.058)	(0.056)	(0.039)
Non-Instrumentality	0.012	0.041	0.037	0.092*	0.011	0.078	0.111**	0.096*
	(0.041)	(0.044)	(0.030)	(0.048)	(0.052)	(0.102)	(0.052)	(0.056)
Non-MPS charters	0.125	0.055	0.087	0.079	0.207***	-0.047	0.087	0.153
	(0.085)	(0.084)	(0.083)	(0.094)	(0.064)	(0.086)	(0.094)	(0.138)
Private (vouchers)	-0.024	-0.003	-0.013	0.005	-0.011	0.009	-0.023	-0.018
	(0.032)	(0.019)	(0.019)	(0.026)	(0.027)	(0.017)	(0.022)	(0.029)

*Notes. *-significant at 10% **-significant at 5% ***- significant at 1%. Top quartile is 1st quartile. Bottom quartile is 4th quartile. Robust standard errors, adjusted for within-school clustering in parenthesis. The regressions include mobility per grade dummy, school dummies, and grade-by-year fixed effects.*