Abstract Title Page

Title: Competitive Effects of Means-tested School Vouchers

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Background/context: School choice options—including both voucher and neo-voucher options like tuition tax credit funded scholarship programs—have become increasingly prevalent in recent years (Howell, Peterson, Wolf and Campbell, 2006). One popular argument for school choice policies, drawing from economic theory, is that public schools will improve the education they offer when faced with competition for students. Because state funds are tied to student enrollment, losing students to private schools constitutes a financial loss to public schools. If schools face the threat of losing students--and the state funds attached to those students--to private schools, they should be incentivized to cultivate customer (i.e., parental) satisfaction by operating more efficiently and improving on the outcomes valued by students and parents (Friedman, 1962). Alternatively, vouchers may have unintended negative effects on public schools if they draw away the most involved families from public schools and the monitoring of those schools diminishes, allowing schools to reduce effort put into educating students (McMillan, 2004).

However, it is generally difficult to gauge the competitive effects of private schools on public school performance because private school supply and public school performance affect each other dynamically. While private school supply may affect the performance of public schools, public school performance may also affect private school supply if poor public school performance increases the demand for private school education, encouraging the establishment of new private schools. Several factors may drive demand, including the cost of tuition, the ease of access to private school options (having schools nearby should lower transportation costs associated with private school attendance), and the variety of types of schools available (a wide range of religious denominations as well as secular options should increase the odds that families can find schools that suit their particular tastes). The interaction of these factors may be especially important.

Purpose / objective / research question / focus of study: This paper tests this economic theory by examining the effect of competitive threats from private schools on the standardized test performance of children attending public schools. Specifically, we examine whether students in schools that face greater threat of losing students to private schools due to the introduction of a tuition tax credit scholarships improve their test scores more than do students in schools that face less pronounced threats. This work should yield insight into whether voucher policies are an effective way to stimulate improvement in public schools.

We also tested whether the effects of competition were differentially effective for students who were themselves eligible for the program, or for students who attended schools with large proportions of their student body eligible for the program. We posited that schools might be more motivated to attend to students who they were at risk of losing through the program, producing stronger effects for eligible students. Likewise, we hypothesized that schools would be more likely to improve instruction generally if they had larger proportions of students eligible for the program, spurring improvements for students in those schools regardless of students' own eligibility. These analyses should tell us for which types of students and in which contexts school choice programs are most effective.

Setting: The study draws on data from Florida public school students from the 1999-2000 school year through the 2006-2007 school year. The data includes the full population of students who took the state standardized tests during that time period.

Population / Participants / Subjects: Our sample draws from the data of all Florida public school students who were in tested grades (grade 3 and higher) from the 1999-2000 school year through the 2006-2007 school year. 1999 is the first year following the introduction of Florida's school accountability program. Restricting our data to the post-accountability years allows us to avoid any contaminating effects from the introduction of the accountability program in the period prior to the introduction of the scholarship program that we study.

The full dataset includes 9,765,799 student-year observations, observed over the 1999-2000 to 2006-2007 school years, for a total of 2,787,158 students. Table 1 gives descriptive statistics for the sample.

Intervention / Program / Practice: We examine the effects of private school competition on public schools in light of Florida's Corporate Tax Credit (CTC) Scholarship program. This program, signed into law in 2001 and open to students in the 2002-2003 school year, provides corporations with tax credits for donations that they make to CTC organizations. These organizations, in turn, provide scholarships to students who qualify for free or reduced price lunch (i.e., whose family incomes are at or below 185% of the federal poverty line) and who either attended a Florida public school for the full school year before program entry, or who are entering kindergarten or first grade.

New participants were eligible for scholarships of up to $3,500 in the first year of the program; this limit rose to $3750 by 2006-2007, the last year included in this study. Funds can be used for tuition or school-related expenses like transportation. Students continuing in the program are subject to slightly less stringent income requirements, and are eligible for slightly larger scholarships.

Research Design: We use the introduction of Florida's CTC scholarship program as a source of exogenous variation that increased the potential demand for non-public school options after 2001, when the policy was announced, by lowering the effective cost of tuition for eligible students. We use a quasi-experimental fixed effects design, examining whether test scores improved more in the wake of the new policy for students attending public schools with more (or more varied) nearby private options that suddenly became more affordable for low-income students, than did scores for students attending schools with fewer (or less varied) potential competitors. We rule out several threats to internal validity, such as the possibility that students in schools facing greater competitive threats were improving more prior to the introduction of the CTC program, and test several specifications of our models beyond those detailed here.

Data Collection and Analysis: Our analysis draws on several sources of data from Florida. School data was drawn from the Florida Department of Education (DOE). The Florida DOE publishes public and private school addresses, including latitude and longitude measures for the public schools. The FDOE also publishes details on public schools such as the grades that they receive from the DOE, the grade ranges that they serve, and the percent of their students that are

subsidized lunch eligible. The address information was geocoded using ARCGis software to generate the competition measures detailed below. Test scores and demographic characteristics for all students in Florida public schools are provided through the Florida Department of Education Data Warehouse. We also have information on the schools that students attended during the year so we can match student data to data on the competitive threats faced by their schools.

Data were then analyzed using fixed effects regression models in Stata to isolate the effect of competitive pressures from private schools on public school performance. Our basic model is:

$$(1)\ Y_{ist} = \alpha_s + \beta C_s * P_t + \gamma \vec{X}_{it} + \varphi Y_{is,t-1} + \lambda M_{ist} + \mu S_{st} + \eta \vec{G}_{st} + \delta \vec{T} + \varepsilon$$

where Y_{ist} represents the math (or reading) score for student i in school s in year t; α_s represents a fixed effect for school s; C_s represents the measures of the competitive pressure faced by school s; S_{st} is a vector of school characteristics; P_t is an indicator for whether year t is post-policy implementation; $\vec{X}_{it}$ is a vector of student characteristics, including sex, race, English language learner status, and eligibility for free or reduced price lunch, for student i in year t; $Y_{is,t-1}$ is the lagged version of the test variable; M_{ist} indicates that a student lacked a test for the prior year; S_s represents school characteristics for school s in year t; G is a series of dummies indicating the student's grade; T is a series of year dummies; and ε represents an error term. The coefficient on the competition measures interacted with the post-policy indicator, β, is our parameter of interest.

We additionally tested the interaction of the competition measures with variables that might affect how strongly students or schools respond to the policy. Specifically, we included interactions of the Herfindahl index with students' own eligibility for the program (i.e., with an indicator for whether a student was eligible for free or reduced price lunch) and with the percent of the student body that was eligible for the program in the school that each student attended. We report robust standard errors, clustered at the school level, in our regression results.

We use four primary measures to estimate the competitive pressure that public schools face from private competitors. Our first measure is the distance between the physical addresses of each public school and the nearest private school that serves any of the grades taught in that public school. We call this the "distance" measure of competition.

Second, we consider the *number* of private schools within a 5 mile radius of the public school ("local private competitors"). We call this the "density" measure of competition. The distance and density measures gauge whether easier access to a private school of any type increased the competitive pressure on public schools when the new policy lowered the effective price of private school for eligible students.

Third, we consider the number of *types* of private schools concentrated within a 5 mile radius. A type is defined by religious affiliation; we identify 10 types of private schools,

including non-religious; non-denominational or multidenominational; Catholic; Protestant; Evangelical; Baptist; Islamic, Jewish; Christian general (no specific denominational information); and other. A type is considered to be represented if at least one school of that type is located within a five mile radius. We call this the "diversity" measure of competition.

In the final specification of the model, we use the counts of different types of schools within a five mile radius to generate a modified Herfindahl index score for each school. The Herfindahl index is a measure of market concentration given by the sum of the squares of the market shares held by each competitor. In our measure, a "competitor" is defined as a religious (or secular) type *r*, and the share is given by $\frac{Count_r}{\sum_R Count_r}$. Higher values of the Herfindahl index indicate a greater concentration of the share of private schools in the hands of one particular denomination or type of school; a Herfindahl index of 1 indicates a monopoly on the private school market by one denomination, while scores closer to 0 represent markets that are well-served by a variety of denominations. Because we include an "Any Threat" variable in the Herfindahl index analyses that functionally serves as a missing variable dummy (details below), we set the Herfindahl index to 0 for schools with no competitors within a five mile radius (and therefore with undefined Herfindahl index scores). These last two measures capture the variety of options available to students; public schools in areas with a greater variety of options should feel more competitive pressure in the wake of the policy change.

One additional competition measure is used primarily as a control in the density, diversity, and Herfindahl index models (i.e., those competition measures derived from the count of schools within a 5 mile radius). To determine whether any effects we see from these measures are due to the existence of *any* competition versus the *degree* of competition, we also included a dummy term indicating whether schools had at least one local private competitor (the "Any Threat" variable).

Test scores are drawn from the Florida Comprehensive Achievement Test. For the regression analyses, we use development scale scores, which enable us to track children's growth from grade to grade. Summary statistics are reported using the scale scores, which standardize performance across grades.

Findings / Results: Table 1 gives basic summary statistics for students in our study. Time-invariant characteristics (e.g., race and sex) were run with students as the unit of observation (n ranged from 2,787,156 to 2,787,156); time-variant characteristics (e.g., test scores, lunch status, and distance between public school attended and nearest grade-relevant private school threat) were run with student-years as the unit of observation (n ranged from 9,090,500 to 9,767,275).

Table 2 present the initial results of the regression analyses. All four measures of competition that we used—presented in columns 1-4, respectively—indicate that students who attend public schools that face greater competition from private schools improved their test scores significantly more in both math (Panel A) and reading (Panel B) following the introduction of the scholarship program than did students in schools facing less competitive pressure.

Greater access to private schools combined with the lower effective cost of tuition predicted significant improvements in test scores. After the policy was announced in 2001, each additional mile of distance between a student's public school and the nearest private school reduced the student's expected test score improvement by 1.98 (2.85) developmental scale points on the FCAT math (reading) test (Column 1, Panels A and B). Moreover, each additional private school within a five mile radius increased math (reading) scores by 2.48 (3.03) points after the policy announcement (Column 2, Panels A and B).

Greater variety of types of private schools also increased the competitive pressure on public schools in the wake of the policy announcement. The diversity measure specification (Column 3) indicates that the representation of an additional type of school was associated with significant increases in scores post-policy (b=9.41 for math, b=11.33 for reading). Finally, students whose private school options were less concentrated in the hands of one type of denomination, (i.e., those with lower Herfindahl index scores) saw significantly greater test score improvements in both math (b = -55.92) and reading (b = -66.78) post-policy than did students served by a less varied set of private schools.

We also tested how two eligibility variables—students' own eligibility for the program and the concentration of eligible students in the schools that students attended—moderated the effects of competition on students' performance. The positive influence of school competition was more marked for students whose family income rendered them eligible for the program (Table 3, Columns 1 and 3). There was no significant interaction between concentration of eligible students in a student's school and the competitive pressures faced by that school for either math or reading test scores (Table 3, Columns 2 and 4).

Conclusions: This work has important implications for education policy. Our results suggest that policies that introduce competition to public schools spur improvements in public school students' test scores. This work therefore helps inform a major policy debate regarding whether harnessing market forces is an effective way to help not only the students who enter the private education market, but also the students who remain behind in the public sector.

Moreover, this effect is stronger for students who are themselves eligible for the program. Under Florida's program, vouchers were offered to students from low-income families; the efficacy of the policy for these students suggests that means-tested voucher and scholarship programs may be an effective way of improving educational outcomes for such students. Since improving scores for low-income students is traditionally a major challenge in education policy, these results are especially encouraging. Our findings are consistent with the hypothesis that schools may be focusing more on educating eligible students in order to retain them in response to the competitive threat from private schools; however, future work should examine pathways further.

Appendix A. References

Friedman, M. (1962). Chapter 6. The role of government in education. In *Capitalism and Freedom* (pp. 85-98). Chicago: The University of Chicago Press.

Howell, W. G., Peterson, P. E., Wolf, P.J., & Campbell, D.E. (2006). *The education gap: Vouchers and urban schools*. Washington, D.C.: Brookings Institution Press.

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Appendix B. Tables and Figures

Table 1: Descriptive statistics

	Mean	Standard deviation
Test performance		
State scale math score	315.65	53.98
State scale reading score	307.17	55.21
Competition measures		
Miles to nearest private school competitor	2.13	3.28
Number of local private schools	12.44	11.57
Number of denominational types represented in 5 mile radius	4.56	2.58
Herfindahl index	.36	.25
Specific denominational measures		
Number of local Baptist schools	1.52	1.58
Number of local Catholic schools	1.93	2.56
Number of local "Christian" (general) schools	1.03	1.33
Number of local Evangelical schools	1.02	1.45
Number of local Protestant schools	1.07	1.48
Number of local Islamic schools	.10	.35
Number of local Jewish schools	.40	1.19
Number of local schools of other denominations	.07	.27
Number of local non-denominational schools	1.63	1.74
Number of local non-religious schools	3.66	4.16
Demographic measures		
Black	.22	
Hispanic	.23	
Asian	.02	
White	.50	
Other race	.03	
Male	.48	
English language learner	.18	
Free lunch eligible	.36	
Reduced lunch eligible	.10	
Observations	9,767,275	

Notes: Data from the Florida Education Data Warehouse, the Florida Department of Education's Florida School Indicators Reports, and the Florida Department of Education. Herfindahl index means include only children in schools for which at least one local competitor existed (92.4% of the sample); the Herfindahl index is undefined if there are no local competitors.

Table 2: Fixed effects regression results: test scores regressed on measures of competition*post-policy indicator

Panel A: Math

VARIABLES	(1) Distance	(2) Density	(3) Diversity	(4) Herfindahl
Distance*Post-policy	-1.98***			
	(0.29)			
Density*Post-policy		2.48***		
		(0.10)		
Diversity*Post-policy			9.41***	
			(0.47)	
Herfindahl*Post-policy				-55.92***
				(3.86)
Any threat*Post-policy		-22.68***	-35.47***	31.27***
		(3.64)	(4.06)	(3.74)
Constant	718.83***	708.69***	713.36***	716.93***
	(3.83)	(3.79)	(3.82)	(3.83)
Controls	X	X	X	X
Observations	9493701	9493701	9493935	9493935
R-squared	0.65	0.65	0.65	0.65

Panel B: Reading

VARIABLES	(1) Distance	(2) Density	(3) Diversity	(4) Herfindahl
Distance*Post-policy	-2.84***			
	(0.46)			
Density*Post-policy		3.03***		
		(0.10)		
Diversity*Post-policy			11.33***	
			(0.50)	
Herfindahl*Post-policy				-66.78***
				(4.15)
Any threat*Post-policy		-19.57***	-34.32***	45.83***
		(3.95)	(4.40)	(4.10)
Constant	667.37***	658.15***	662.14***	665.50***
	(4.42)	(4.35)	(4.39)	(4.42)
Controls	X	X	X	X
Observations	9,518,655	9,518,655	9,518,884	9,518,884
R-squared	0.55	0.56	0.56	0.55

Cluster robust standard errors in parentheses. Standard errors are clustered at the school level.
Controls included sex, race dummies, subsidized lunch eligibility dummies, English language learner dummies, prior year test scores, grade dummies, year dummies, percent of student body eligible for free or reduced price lunch and the prior-year FDOE grade. School fixed effects are also included.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 3: Interaction of diversity competition measure with own eligibility status and school percent eligible

	Math		Reading	
	(1)	(2)	(3)	(4)
	Own	School percent	Own	School percent
VARIABLES	eligibility	eligible	eligibility	eligible
Herfindahl*Post-policy	-40.39***	-34.84***	-45.29***	-36.15***
	(3.59)	(4.33)	(4.05)	(5.65)
Herfindahl*Post-policy*Eligibility term	-12.04**	.16	-16.88***	.02
	(4.44)	(.12)	(4.80)	(.13)
Herfindahl*Eligibility term	16.09***	.02	12.48**	-.07
	(4.02)	(.16)	(4.37)	(.19)
Post*Eligbility term	61.32***	1.64***	81.36***	1.84***
	(3.16)	(.08)	(3.67)	(.09)
Any threat*Post-policy	25.16***	31.16***	36.91***	41.70***
	(3.56)	(4.18)	(4.02)	(5.25)
Any threat*Post-policy*Eligibility term	8.60*	-.02	12.93**	.07
	(3.84)	(.09)	(4.37)	(.10)
Any threat*Eligibility term	-13.11***	-.31*	-12.15**	-.24
	(3.45)	(.12)	(3.97)	(.15)
Constant	728.23***	725.15***	684.10***	685.81***
	(3.66)	(3.59)	(4.20)	4.07
Observations	9,493,935	9,493,935	9,518,884	9,518,884
R-squared	.65	.65	.56	.56

Cluster robust standard errors in parentheses. Standard errors are clustered at the school level. Controls included sex, race dummies, subsidized lunch eligibility dummies, English language learner dummies, prior year test scores, grade dummies, year dummies, percent of student body eligible for free or reduced price lunch and the prior-year FDOE grade. School fixed effects are also included.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10