The Effect of Milwaukee's Parental Choice Program on Student Achievement in Milwaukee Public Schools

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SCDP Comprehensive Longitudinal Evaluation
of the Milwaukee Parental Choice Program

Report #11

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SCHOOL CHOICE
DEMONSTRATION PROJECT

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Abstract

This paper examines evidence on the "systemic effects" of expanding school choice in Milwaukee, Wisconsin. Milwaukee is home to one of the nation's largest and longest-running school choice programs. If there are systemic effects from expanding school choice we should be able to see them in Milwaukee. This paper also introduces a novel method for analyzing systemic effects. Taking full advantage of student-level data, we develop a new measure of those effects based on the extent of voucher options that each student has each year. The idea behind this measure is that school systems face greater competitive pressure to serve students well when students have more options to leave. This type of measure might be useful for future analyses of systemic effects. Using this new approach, we find that students fare better academically when they have more options from Milwaukee's voucher program. The effects are modest in magnitude, but they are robust to multiple specifications of the model.

Introduction

When choice and competition in education are expanded by offering families vouchers, how is the achievement of students who remain in traditional public schools affected? This is really the central policy question surrounding school choice. If choice works as its promoters have suggested, then student achievement in traditional public schools should rise as those schools experience greater motivation to attract students and the revenue those students generate. But if choice works as its detractors suggest, student achievement in traditional public schools should decline as talent and resources are drained from those public schools, making it harder for them to teach effectively.

Of course, one could support school choice even if it produced no improvement in traditional public schools as a "lifeboat" for individual students faring poorly in their prior public schools. But given the limited number of students likely to participate in even the largest school choice programs, the biggest policy potential (or peril) for school choice is in its effects on the whole school system, not in its effects on participating students.

This paper examines evidence on the "systemic effects" of expanding school choice in Milwaukee, Wisconsin. Milwaukee is home to one of the nation's largest and longest-running school choice programs. If there are systemic effects from expanding school choice we should be able to see them in Milwaukee.

This paper also introduces a novel method for analyzing systemic effects. Taking full advantage of student level data, we develop a new measure of those effects based on the extent of voucher options that each student has each year. The idea behind this measure is that school systems face greater competitive pressure to serve students well when students have more options to leave. This type of measure might be useful for future analyses of systemic effects.

Using this new approach, we find that students fare better academically when they have more options from Milwaukee's voucher program. The effects are modest in magnitude, but they are robust to multiple specifications of the model.

This report and its companion reports are the second in a series of annual reports on the Milwaukee Parental Choice Program (MPCP) that will be conducted by the School Choice Demonstration Project (SCDP). Future reports on the systemic effects of the program will examine such topics as the supply-side response to school choice expansion and the effect of choice on integration by race and ethnicity in schools.

An initial draft of this report was greatly improved based on comments from the SCDP Research Advisory Board, particularly David Campbell of the University of Notre Dame and Tom Loveless of the Brookings Institution. This ongoing research project is being funded by a diverse set of philanthropies including the Annie E. Casey, Joyce, Kern Family, Lynde and Harry Bradley, Robertson, and Walton Family Foundations. We thank them for their generous support and acknowledge that the actual content of this report is solely the responsibility of the authors and does not necessarily reflect any official positions of the various funding organizations or the University of Arkansas. Finally, we are grateful to the Milwaukee Public Schools, the private schools in the MPCP, and the state Department of Public Instruction for the willing cooperation, advice, and assistance that has made this research possible.

Prior Research

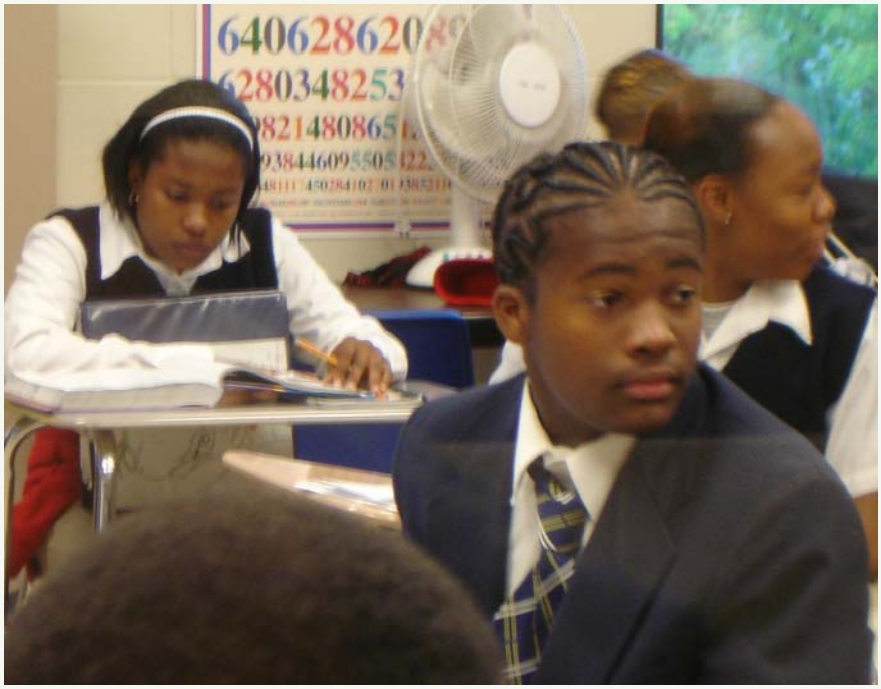
There have been a fairly large number of high quality studies on the effects of private school choice on the academic achievement of participating students. Of the ten studies with a random-assignment research design, all but one show significant positive effects for participating students for at least some sub-groups of students in some subjects. But, as we mentioned, the bigger policy question revolves around how expanding school choice with vouchers affects academic achievement for students who remain in traditional public schools.

On the question of systemic effects from expanding school choice with vouchers, rigorous evidence is less common than for participant effects. We have relatively few large and long-running programs to examine. And, more importantly, designing a rigorous study is complicated by the difficulty in identifying an appropriate counter-factual. That is, it is very hard to know how students would have fared in school systems had there not been an expansion of choice and competition. We can compare growth in student achievement in districts with greater choice and competition to achievement in districts with less choice and competition, but no two districts are identical. It is always hard to know whether greater achievement across districts is due to the difference in choice and competition or to some other, unobserved differences between those districts.

A fairly large literature exists examining the effects of choice and competition among school operators without the introduction of voucher programs by focusing on competition between school districts or between public and private schools. Clive Belfield and Henry Levin have reviewed that literature and conclude: “The sampling strategy identified more than 41 relevant empirical studies. A sizable majority report beneficial effects of competition, and many report statistically significant correlations. For each study, the effect size of an increase of competition by one standard deviation is reported. The positive gains from competition are modest in

scope with respect to realistic changes in levels of competition. The review also notes several methodological challenges and recommends caution in reasoning from point estimates to public policy."[1]

That final sentence is worthy of elaboration. Competition between school districts or between already existing public and non-subsidized private schools may be fundamentally different in its effects than competition produced by the introduction of a school choice program. While Belfield and Levin's review reminds us that competition in education exists even in the absence of school choice programs, and gives us some reason to expect that competition should be positively related to achievement, we cannot draw strong conclusions about the likely effects of voucher programs on public school student achievement from that literature.



But there are also a number of studies that have specifically examined the effect of expanded choice and competition from voucher programs. Programs in Florida and Milwaukee have been the subject of the most examination. In Florida there have been four studies conducted on the effects of the Opportunity Scholarship voucher program that was part of the state's A+ accountability system.[2] Under that program, schools were graded from A to F based on a number of student achievement indicators. Schools that received two failing grades in a four-year period had to offer vouchers to their students with which those students could leave for other public or private schools.

All four studies found that schools made exceptionally large improvements in student achievement when faced with the prospect of receiving a second failing grade and having to offer vouchers to their students. The studies

1 Clive R. Belfield and Henry M. Levin, "The Effects of Competition Between Schools on Educational Outcomes: A Review for the United States," *Review of Educational Research*, Vol. 72, No. 2, 279-341 (2002).

2 Rajashri Chakrabarti, "Vouchers, Public School Response and the Role of Incentives: Evidence from Florida," Federal Reserve Bank of New York Staff Report, Number 306, October 2007; Jay P. Greene and Marcus A. Winters, "Competition Passes the Test," *Education Next*, Summer 2004; Cecilia Elena Rouse, Jane Hannaway, Dan Goldhaber, and David Figlio, "Feeling the Heat: How Low Performing Schools Respond to Voucher and Accountability Pressure," CALDER Working Paper 13, Urban Institute, November 2007; Martin West and Paul Peterson, "The Efficacy of Choice Threats Within School Accountability Systems," Harvard PEPG Working Paper 05-01, March 23, 2005 (subsequently published in *The Economic Journal*, March, 2006).

differ in the extent to which they attribute these gains to the competitive effect of the vouchers or the stigma of receiving a failing grade. West and Peterson, as well as Rouse, et al., cannot rule out the stigma explanation.

But Chakrabarti as well as Greene and Winters empirically examine and fail to find a strong stigma effect. Chakrabarti does so by comparing the effects of schools receiving a failing grade in Florida before the voucher provision was introduced to the effects after the voucher component was added and finds a significantly larger improvement after vouchers were included. Greene and Winters explore the possible stigma effect by examining how failing schools fared once the four-year "window" for being eligible for vouchers had closed. They found that failing schools significantly slipped once the possibility of having vouchers had been removed by receiving three subsequent passing grades. Neither test for stigma is definitive, but the Florida evidence gives us some reason to believe that the threat of voucher competition spurs significant improvement in traditional public schools.

There is also another systemic effects study in Florida by Greene and Winters, but it examines the McKay Scholarship voucher program for disabled students rather than the Opportunity Scholarship.[3] The McKay program offers vouchers to all disabled students in Florida public schools with which they can attend other public or registered private schools. The question examined by Greene and Winters was whether disabled students remaining in Florida public schools performed better academically when their school faced greater competitive pressure from nearby private schools receiving McKay Scholarship students. The measure of competition their study employs is the number of private schools registered to participate in the McKay program within a five or ten mile radius of each public school. The study found that disabled students performed significantly better when their school experienced an increase in competitive pressure from the McKay program.

Three rigorous studies have also been conducted on the systemic effects of the voucher program in Milwaukee.[4] Both Hoxby and Chakrabarti find that schools exposed to greater voucher competition make greater academic improvement than schools in Milwaukee less exposed, and greater improvement than demographically similar schools outside of Milwaukee unexposed to competition from the voucher program. The difficulty

3 Jay P. Greene and Marcus A. Winters, "The Effect of Special Education Vouchers on Public School Achievement: Evidence From Florida's McKay Scholarship Program," Manhattan Institute, Civic Report Number 52, April 2008.

4 Martin Carnoy, et al. "Vouchers and Public School Performance," Economic Policy Institute, October 2007; Rajashri Chakrabarti, "Can Increasing Private School Participation and Monetary Loss in a Voucher Program Affect Public School Performance? Evidence from Milwaukee," Federal Reserve Bank of New York, 2007 (forthcoming in the *Journal of Public Economics;)* Caroline Minter Hoxby, "The Rising Tide," *Education Next*, Winter 2001.

is in measuring how exposed each school is to voucher competitive pressure. Hoxby and Chakrabarti use the percentage of students eligible for subsidized lunch and therefore meeting the income requirements for eligibility for the voucher program as a proxy for competitive pressure. Schools with more students eligible to leave with vouchers were classified as more exposed to voucher competition.

Carnoy, et al. successfully replicate these findings, but they conduct additional analyses with alternative measures of competition that fail to show positive results. In particular, they employ a measure similar to the one used by Greene and Winters in their evaluation of the McKay Scholarship program whereby the extent of competitive pressure is measured by the proximity to each public school of voucher-receiving private schools. Using that measure of competition Carnoy, et al. fail to find any competitive effect. Of course, it is also possible that proximity in Milwaukee is not a particularly good way to measure competitive pressure given the city's small size and accessible public transportation system, but the lack of robustness across different measures undermines confidence in positive results.

Carnoy, et al. also extend the analysis conducted by Hoxby and Chakrabarti to subsequent years and fail to find continued improvement in those later years. That is, using Hoxby and Chakrabarti's measure of competition Carnoy, et al. find that schools more exposed to competitive pressure improved after the program expanded in 1998 but those improvements did not grow larger in later years. Of course, it could be that the gains from competition had already occurred and did not expand without an additional significant expansion in the size of the program. But again, the lack of compounding gains undermines confidence in Hoxby and Chakrabarti's positive results.

This study builds upon the work by Hoxby, Chakrabarti, and Carnoy, et al. The present study differs in that it has individual student data while the previous studies relied upon aggregate school results. And because we have individual student data we are able to employ a novel measure that captures the extent of competition for each student. These new data and new approach may help resolve some of the issues raised in prior research in Milwaukee and Florida.

Data and Method

There were two sets of data used, voucher-using student data and public school student achievement data. The first dataset contained student-level data on students enrolled in the Milwaukee Parental Choice Project (MPCP) voucher program. These data included student addresses and the name of the voucher-accepting school that the student attended.

The MPCP dataset was used in the creation of the voucher-options variable – our novel measure of the options available to each student in each year. The student addresses were geocoded and compared to a geocoded set of the schools in the Milwaukee Public School district to determine the nearest public school to that student. This school was then paired with the actual voucher-accepting school attended by the student to determine the distance between the two schools. From this distance measure four values—the 25th percentile (.940 miles), the median (2.02 miles), the 75th percentile (3.68 miles) and the 90th percentile (5.56 miles)—were chosen to act as a radii for the voucher-options variable. We also use as a fifth "radius" the whole city of Milwaukee. This allows us to estimate our chosen model with varying radii as a robustness check.

To repeat, we cannot actually observe the distance between where MPS students live and voucher-accepting private schools because we do not have the addresses of MPS students. But we can measure the distance between each MPS student's school and voucher-accepting options. We understand that using the distance from the MPS school is an imperfect proxy for the distance from each student's home, but given the data limitations this is the best method for gauging the proximity of MPS students to their voucher options.

For an observation on a student in a given year, the voucher-options variables are interactions between a free-lunch status indicator variable and counts of private schools meeting the following requirements for that year: 1) are located closer to the MPS school than the radius of interest; 2) serve the grade in which the student is enrolled; and 3) accepted vouchers during the year observed. Free or reduced-price lunch status was used to proxy for voucher eligibility; because of the structure of the voucher program, we can be certain that students eligible for a free or reduced-price lunch are eligible for a voucher. That is, the number of voucher options available to each student is a function of their eligibility for the program (free lunch status) and the number of voucher-receiving private schools in given grade for a given year within a given distance. The number of options increases or decreases for each student if their eligibility for the program changes or if the number of private schools serving the next grade-level changes or if more private schools come on-line over time.

For an example of the voucher-options creation process, we can examine a hypothetical student and construct her voucher-options count. Consider a 3rd grader who was eligible for free or reduced-price lunch in the 1999-2000 school year. Her median-radius voucher-options value is a count of the number of voucher-accepting schools that were open for the 1999-2000 school year, that served the 3rd grade, and that were located closer to her attended MPS school than 2.01 miles. However, if the third grader was not eligible for free or reduced-price lunch, the voucher-options value for the student would be zero. Descriptive and summary information for the voucher-options variables can be seen in Table 1.

The second set of data contained public school student achievement information. The achievement data obtained were a panel of individual data of the universe of students from the Milwaukee Public School (MPS) system from 1999 through 2006.[5] The data included grade, year, school attended, testing information, free and reduced-price lunch status, and a unique identifier that allowed us to follow each student through time. Descriptive and summary information on these variables can be seen in Table 1.

Student achievement data in our panel comes from two tests, the Wisconsin Knowledge Concepts Examination (WKCE) and the Terra Nova Achievement Examination (Terra Nova). Both tests examine knowledge in language arts, mathematics, and reading, while the WKCE additionally examines social studies and science knowledge.

The testing policy regime for Milwaukee changed during the time period covered by the panel. From 1999 until 2006, students in grades 4, 8, and 10 were given all five components of the WKCE. Students in other grades varied from year to year on what test, if any, they received. The tests taken by each grade in each year can be seen in Table 2.

5 Years refer to the first year of an academic year; for example, 1999 refers to the 1999-2000 school year.

The test scores in the MPS student achievement dataset are measured in normal curve equivalent (NCE) units. NCEs place the student on a normal curve defined by a representative sample of students taking the test. NCEs are similar to percentile ranks in that they allow comparison of achievement across grade but they are favorable in that they are equal-interval scaled. The equal-interval scale means that the difference between two scores measures a gap of the same magnitude as that between two other scores with the same difference. For instance, the gap between scores of 45 and 50 is of the same magnitude as the gap between 50 and 55.

We run a student-level fixed-effects analysis comparing test scores to the voucher-options count and use the fixed effects parameters to control for unobserved, time-invariant characteristics of the students:

$$(1) \qquad Y_{it} = \beta_0 + \beta_1 \, Voucher\_Options_{it} + \Phi Z + \alpha_i + \varepsilon_{it}$$

where Z is a sometimes-included vector of controls for test, grade and/or year; α_i are the student fixed-effects parameters; and ε_{it}, the error term, is assumed to cluster around school grade level in order to account for the shared experience of students enrolled in a particular grade level in a particular school.

Some students took different tests (WKCE and Terra Nova) in different years. To account for the possibility that the tests might not be comparable even when using normal curve equivalents, we estimate the model over three different samples: the full sample, observations that come from the WKCE, and observations that come from the Terra Nova. When the model is run over the full sample, we include a control for the test that was taken.[6]

The number of voucher-accepting schools may not be the only achievement-affecting change between years and grades. To account for anything else that may have changed between years and grades and might have affected student outcomes, we run the model with 4 separate specifications. We run it with no controls, with controls for year, with controls for grade, and with controls for both year and grade.

Conceptually, our model captures whether student achievement is higher or lower when each student has more or fewer voucher options available to him or her. The student fixed effect should control for all time-invariant characteristics of each student. Essentially, we are comparing students against themselves. If Milwaukee Public Schools are competing effectively, they should serve students better as those students have more options available to them to leave the public system and student achievement should rise.

It may be difficult to visualize exactly how MPS more effectively serves students with more voucher options given the difficulty of school officials to make fine distinctions between what is provided to each student. But school officials do not have to make fine distinctions for them to be more attentive to students with more options. Students with more options tend to be clustered in particular grades, in particular schools, and in particular years. MPS simply has to react to the fact that the entry of a few voucher middle schools, for example, creates more pressure to serve students in middle school grades – especially in schools with higher concentrations of subsidized lunch students who are eligible for vouchers. MPS officials may be able to detect

6 We also ran analyses in which we converted both WKCE and Terra Nova scores to "z-scores" based on the within sample mean and standard deviation. Converting to z-scores produces similar results.

the schools, grades, and times when they face greater competitive challenges without being conscious of that competition or discussing it with others.

We also considered a model in which the dependent variable would be the gain in student achievement from the previous year's test result. A potential advantage of such a model is that it would capture any trend in a student's achievement. Model (1) above only compares student achievement in each year to the student's average achievement, as captured in the student fixed-effect. Unfortunately, the alternative model would discard roughly half of the available data because it would require that students have test results in the same subject in subsequent years. Given the irregular testing schedule (see Table 2) and "holes" in the MPS records, we would lose roughly half of our observations. And data would be excluded in a non-random way that might bias any findings. In addition, we believe that controlling for year effectively "de-trends" test results without a comparable loss in data.

Nevertheless, we performed analyses with the change in test score as the dependent variable. The results are generally similar to those of our preferred model with selected results presented below. Detailed results of this alternative model are available from the authors upon request.

Results

Results from the initial combined-sample estimations can be seen in Table [A]. The coefficients for the voucher-options variable are positive and highly significant across subjects and radii.

The reported coefficients measure the expected change in NCE score from the addition of one voucher option inside the specified radius from the school attended by an MPS student. For instance, Table [A] shows that the addition of one voucher-accepting school anywhere in Milwaukee will improve student achievement on the Language Arts portion of either the WKCE or the Terra Nova by .055 NCE points. The addition of a voucher-receiving private school would increase a student's standardized Math score by .047 NCE and Reading score by .058 NCE.

If we had instead reported the analyses using the gain in test score as the dependent variable, the impact of adding a voucher-accepting private school would have been a gain of .178 NCE in Language Arts, .107 NCE in Mathematics, and .148 in Reading. All three results are statistically significant at $p < .01$. But as stated above, we do not prefer this gain-score model because it discards a large number of observations in a non-random way that could distort results. The point is that this alternative specification produces results that are generally consistent with the main results we report.

Another way to measure the effect is to examine the effect size in terms of standard deviations. Using the coefficient for Language Arts, for example, a one standard deviation change in the number of voucher-accepting schools in Milwaukee (36.96 schools) would lead to a test score gain of 2.03 NCE points. NCE scales are set to

have a standard deviation of 21.06, so the one standard deviation change in voucher options equates to a change of .10 standard deviations in NCE score. Effect sizes for the models using a whole-city voucher-options count and no controls are shown in Table [F]

This method was used to calculate effect sizes for all of the regressions. Although the coefficients drop steadily as the radius is expanded, the effect sizes are roughly constant across choice of radius. The same competitive effects of the voucher program are being measured in each regression, but the effects are divided between fewer schools when the radius is small. This suggests that MPS schools feel competition from any voucher school opened in Milwaukee, not just the schools opened nearby.

The results for the separated sample regressions can be seen in Table [B]. While all coefficients were positive and significant, it is worth noting that the values on analyses of the WKCE are consistently greater than those on the Terra Nova. This may provide evidence that the WKCE is emphasized more than the Terra Nova in MPS schools, but also may be a result of the changes through time to the WKCE and the creation of its NCE values. That being said, however, the coefficients for the Terra Nova are positive and significant. The results on both sub-samples reinforce the combined sample result that MPS students are improving as the number of voucher-accepting school options for them increases.

Results for the separated sample regressions with various controls can be seen in Tables [C]-[E]. Though the values for smaller radii are inconsistent, the regressions using the whole city count are overwhelmingly positive and significant. Since Table [A] shows that the addition of a voucher-accepting school anywhere in Milwaukee has an effect on MPS schools, the whole-city count is preferred to the smaller radii counts. The whole city count models show that even after controlling for test taken, for year, and for grade, the number of voucher-accepting school options has a positive relationship with student achievement.

Discussion and Conclusion

Using an individual fixed-effects model with a novel measure of systemic effects, we find that students in Milwaukee fare better academically when they have more free private options through the voucher program. It appears that Milwaukee public schools are more attentive to the academic needs of students when those students have more opportunities to leave those schools. This finding is robust across several different specifications of the model.

This finding is also consistent with most prior studies of systemic effects from voucher programs in Milwaukee and Florida. In addition, this study may help explain the null results Carnoy, et al. produced using a proximity measure of competition in Milwaukee. We did not find a greater competitive response from public schools to private options located closer to them than to private options located elsewhere in the city. If that is correct, then proximity is not a useful way to capture variation in competitive pressure. So, our results are also consistent with Carnoy, et al.'s results.

While we find positive results from voucher competition in Milwaukee, it is also important to put in perspective the magnitude of the benefits. A one standard deviation increase in private options available to each student results in about one-tenth of a standard deviation increase in achievement. Results of that magnitude suggest that voucher competition has been a positive if not a transforming force in the Milwaukee public school system. If 37 additional private schools participate in the MPCP, we can expect that student achievement for students remaining in MPS will rise by about one-tenth of a standard deviation or 2 NCE points on standardized tests.

We come to this conclusion by observing the variation in voucher options available to students over the last few years. But if we can extrapolate our findings to the entire history of MPCP, then the effects of choice and competition on MPS students is less modest. Over the last two decades Milwaukee has gone from having no voucher-accepting schools to having 124 as of 2007-08. If each addition of 37 voucher schools increases MPS performance by 2 NCE, then the existence of MPCP over the last two decades has improved MPS student achievement by 6.7 NCE on standardized tests. Of course, we cannot generalize outside of the period we observed with confidence, but it helps consider the overall effect of having the voucher program and not just the effect of recent expansion.

The best way to increase confidence in these findings is to continue studying the effects of choice and competition in Milwaukee and elsewhere. No single study of a single program can be definitive, but this research contributes to the finding that expanded choice and competition improve the academic performance of students who remain in traditional public schools.

Table 1 : Descriptive statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
vou25	Number of voucher accepting schools within .94 miles of attended public school	370516	2.5804	2.1376	0	10
vou50	Number of voucher accepting schools within 2.02 miles of attended public school	370516	10.154	6.8782	0	31
vou75	Number of voucher accepting schools within 3.68 miles of attended public school	370516	25.526	15.113	0	62
vou90	Number of voucher accepting schools within 5.56 miles of attended public school	370516	42.552	21.442	0	84
WCMP	Number of voucher accepting schools within the city of Milwaukee	370516	65.928	27.024	9	98
freelunch	Indicator of eligibility for free or reduced-price lunch	370784	0.7485	0.4339	0	1
voucomp25	Free-lunch-weighted voucher options count within .94 miles of attended public school	370516	2.0767	2.2427	0	10
voucomp50	Free-lunch-weighted voucher options count within 2.02 miles of attended public school	370516	8.0873	7.6156	0	31
voucomp75	Free-lunch-weighted voucher options count within 3.68 miles of attended public school	370516	20.268	17.59	0	62
voucomp90	Free-lunch-weighted voucher options count within 5.56 miles of attended public school	370516	33.441	26.66	0	84
voucompWC	Free-lunch-weighted voucher options count in the city of Milwaukee	370516	50.931	36.965	0	98
TN	Indicator that test observation is from the Terra Nova	370782	0.4857	0.4998	0	1
nceLanguage Arts	NCE score on language arts examination	243660	45.029	19.102	1	99
nceMathematics	NCE score on mathematics examination	310876	40.363	19.321	1	99
nceReading	NCE score on reading examination	291492	42.548	19.482	1	99
nceScience	NCE score on WKCE science examination	84337	39.5	19.231	1	99
nceSocial Sciences	NCE score on WKCE social sciences examination	83920	41.803	19.291	1	99

Table 2 : Test observations in Milwaukee

Year / Grade	1999	2000	2001	2002	2003	2004	2005	2006
2	-	TN: all	-	-	-	-	-	-
3	-	TN: all	TN: m[1]	TN: m	TN: all	TN: all	TN: m, r[2]	TN: m, r
4	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all
5	-	TN: all	TN: all	TN: all	TN: all	TN: all	TN: m, r	TN: m, r
6	-	TN: all	TN: all	TN: all	TN: all	TN: all	TN: m, r	TN: m, r
7	-	TN: all	TN: all	TN: all	TN: all	TN: all	TN: m, r	TN: m, r
8	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all
9	-	TN: all	TN: all	TN: all	TN: all	TN: all	TN: all	-
10	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all	WKCE: all

1. Third graders in 2001 and 2002 received only the mathematics portions of the Terra Nova.

2. In 2005 and 2006, only the mathematics and reading portions of the Terra Nova were administered.

Table [A]: Combined sample regressions, voucher-options coefficients only

		25 (.94 m)	50 (2.02 m)	75 (3.68 m)	90 (5.56 m)	Whole City	*Observations (Groups)*
No Controls	Language Arts	0.513***	0.235***	0.105***	0.075***	0.055***	*243491*
		(0.090)	(0.031)	(0.013)	(0.008)	(0.006)	*(97598)*
	Mathematics	0.466***	0.190***	0.086***	0.062***	0.047***	*310608*
		(0.100)	(0.031)	(0.013)	(0.008)	(0.005)	*(112146)*
	Reading	0.567***	0.244***	0.110***	0.077***	0.058***	*291226*
		(0.092)	(0.031)	(0.013)	(0.008)	(0.006)	*(109637)*
	within-R^2	***0.07***	***0.07***	***0.07***	***0.07***	***0.07***	
	OLS R^2	***0.80***	***0.80***	***0.80***	***0.80***	***0.80***	
Year	Language Arts	0.160***	0.106***	0.041***	0.030***	0.028***	*243491*
		(0.059)	(0.021)	(0.008)	(0.005)	(0.003)	*(97598)*
	Mathematics	-0.096	-0.016	-0.016*	-0.009*	-0.004	*310608*
		(0.072)	(0.020)	(0.008)	(0.005)	(0.003)	*(112146)*
	Reading	0.110*	0.078***	0.029***	0.020***	0.020***	*291226*
		(0.060)	(0.021)	(0.008)	(0.005)	(0.004)	*(109637)*
	within-R^2	***0.16***	***0.16***	***0.16***	***0.16***	***0.16***	
	OLS R^2	***0.82***	***0.82***	***0.82***	***0.82***	***0.82***	
Grade	Language Arts	0.025	0.056**	0.016**	0.012***	0.003	*243491*
		(0.058)	(0.023)	(0.007)	(0.004)	(0.002)	*(97598)*
	Mathematics	-0.082	0.002	-0.003	0.001	0.003	*310608*
		(0.061)	(0.019)	(0.007)	(0.004)	(0.002)	*(112146)*
	Reading	-0.010	0.037**	0.008	0.005	0.000	*291226*
		(0.052)	(0.019)	(0.006)	(0.004)	(0.002)	*(109637)*
	within-R^2	***0.15***	***0.15***	***0.15***	***0.15***	***0.15***	
	OLS R^2	***0.81***	***0.81***	***0.81***	***0.81***	***0.81***	
Year and Grade	Language Arts	0.006	0.046**	0.009	0.008*	0.010***	*243491*
		(0.055)	(0.023)	(0.007)	(0.004)	(0.002)	*(97598)*
	Mathematics	-0.069	0.006	-0.003	0.002	0.009***	*310608*
		(0.060)	(0.018)	(0.007)	(0.004)	(0.002)	*(112146)*
	Reading	-0.022	0.028	0.003	0.002	0.005***	*291226*
		(0.050)	(0.019)	(0.006)	(0.004)	(0.002)	*(109637)*
	within-R^2	***0.18***	***0.18***	***0.18***	***0.18***	***0.18***	
	OLS R^2	***0.82***	***0.82***	***0.82***	***0.82***	***0.82***	

Robust standard errors in parentheses. Errors clustered around school grade level.

* Significant at 10% confidence level

** Significant at 5% confidence level

*** Significant at 1% confidence level

Table [B]: Separated samples, no controls, voucher-options coefficients only

		25 (.94 m)	50 (2.02 m)	75 (3.68 m)	90 (5.56 m)	Whole City	*Observations (Groups)*
WKCE	Language Arts	1.305***	0.566***	0.267***	0.185***	0.132***	*84070*
		(0.374)	(0.112)	(0.043)	(0.026)	(0.018)	*(68444)*
	Mathematics	1.065***	0.438***	0.214***	0.151***	0.108***	*132781*
		(0.261)	(0.081)	(0.034)	(0.022)	(0.015)	*(90961*
	Reading	0.894***	0.373***	0.181***	0.126***	0.089***	*131814*
		(0.212)	(0.069)	(0.028)	(0.019)	(0.012)	*(90155)*
	Social Studies	1.974***	0.838***	0.405***	0.284***	0.217***	*83750*
		(0.515)	(0.139)	(0.056)	(0.035)	(0.023)	*(68139)*
	Science	1.936***	0.797***	0.394***	0.279***	0.220***	*84169*
		(0.465)	(0.135)	(0.055)	(0.034)	(0.024)	*(68446)*
	within-R^2	***0.03***	***0.03***	***0.03***	***0.03***	***0.03***	
	OLS R^2	***0.91***	***0.91***	***0.91***	***0.91***	***0.91***	
Terra Nova	Language Arts	0.111*	0.090***	0.034***	0.024***	0.018***	*159491*
		(0.065)	(0.024)	(0.008)	(0.005)	(0.004)	*(75711)*
	Mathematics	0.147*	0.077***	0.027***	0.022***	0.017***	*177895*
		(0.085)	(0.025)	(0.010)	(0.006)	(0.004)	*(82767)*
	Reading	0.282***	0.145***	0.057***	0.039***	0.029***	*159490*
		(0.083)	(0.029)	(0.011)	(0.007)	(0.004)	(75710)
	within-R^2	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	
	OLS R^2	***0.84***	***0.84***	***0.84***	***0.84***	***0.84***	

Robust standard errors in parentheses. Errors clustered around school grade level.

* Significant at 10% confidence level

** Significant at 5% confidence level

*** Significant at 1% confidence level

Table [C]: Separated samples, year controls, voucher-options coefficients only

		25 (.94 m)	50 (2.02 m)	75 (3.68 m)	90 (5.56 m)	Whole City	*Observations (Groups)*
WKCE	Language Arts	0.173	0.154*	0.065**	0.050***	0.035***	*84070*
		(0.156)	(0.083)	(0.027)	(0.016)	(0.010)	*(68444)*
	Mathematics	0.104	0.076**	0.031**	0.025***	0.017***	*132781*
		(0.106)	(0.037)	(0.013)	(0.008)	(0.004)	*(90961*
	Reading	0.100	0.076**	0.031***	0.023***	0.015***	*131814*
		(0.076)	(0.033)	(0.011)	(0.007)	(0.004)	*(90155)*
	Social Studies	0.059	0.116	0.046	0.040**	0.036***	*83750*
		(0.162)	(0.083)	(0.029)	(0.019)	(0.012)	*(68139)*
	Science	0.024	0.071	0.033	0.033*	0.033***	*84169*
		(0.155)	(0.088)	(0.029)	(0.018)	(0.010)	*(68446)*
	within-R^2	***0.26***	***0.26***	***0.26***	***0.26***	***0.26***	
	OLS R^2	***0.93***	***0.93***	***0.93***	***0.93***	***0.93***	
Terra Nova	Language Arts	0.189***	0.122***	0.048***	0.035***	0.032***	*159491*
		(0.067)	(0.025)	(0.009)	(0.006)	(0.004)	*(75711)*
	Mathematics	0.047	0.036	0.006	0.008	0.009**	*177895*
		(0.092)	(0.027)	(0.011)	(0.007)	(0.004)	*(82767)*
	Reading	0.098	0.075***	0.022**	0.015**	0.017***	*159490*
		(0.077)	(0.029)	(0.011)	(0.006)	(0.004)	(75710)
	within-R^2	***0.03***	***0.03***	***0.03***	***0.03***	***0.03***	
	OLS R^2	***0.85***	***0.85***	***0.85***	***0.85***	***0.85***	

Robust standard errors in parentheses. Errors clustered around school grade level.

* Significant at 10% confidence level

** Significant at 5% confidence level

*** Significant at 1% confidence level

Table [D]: Separated samples, grade controls, voucher-options coefficients only

		25 (.94 m)	50 (2.02 m)	75 (3.68 m)	90 (5.56 m)	Whole City	*Observations (Groups)*
WKCE	Language Arts	0.142	0.143*	0.060**	0.047***	0.032***	*84070*
		(0.166)	(0.086)	(0.029)	(0.017)	(0.011)	*(68444)*
	Mathematics	0.076	0.076**	0.031**	0.026***	0.023***	*132781*
		(0.112)	(0.039)	(0.014)	(0.008)	(0.005)	*(90961*
	Reading	0.076	0.076**	0.031***	0.024***	0.020***	*131814*
		(0.085)	(0.035)	(0.012)	(0.007)	(0.004)	*(90155)*
	Social Studies	0.033	0.106	0.041	0.037*	0.037***	*83750*
		(0.171)	(0.086)	(0.031)	(0.020)	(0.013)	*(68139)*
	Science	-0.036	0.044	0.019	0.023	0.027**	*84169*
		(0.164)	(0.090)	(0.030)	(0.019)	(0.011)	*(68446)*
	within-R^2	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	
	OLS R^2	***0.93***	***0.93***	***0.93***	***0.93***	***0.93***	
Terra Nova	Language Arts	0.046	0.073***	0.022***	0.016***	0.009***	*159491*
		(0.065)	(0.024)	(0.008)	(0.004)	(0.003)	*(75711)*
	Mathematics	-0.003	0.035	0.009	0.010**	0.013***	*177895*
		(0.079)	(0.023)	(0.009)	(0.005)	(0.002)	*(82767)*
	Reading	0.040	0.058**	0.013*	0.008*	0.001	*159490*
		(0.069)	(0.024)	(0.008)	(0.004)	(0.002)	(75710)
	within-R^2	***0.03***	***0.03***	***0.03***	***0.03***	***0.03***	
	OLS R^2	***0.85***	***0.85***	***0.85***	***0.85***	***0.85***	

Robust standard errors in parentheses. Errors clustered around school grade level.

* Significant at 10% confidence level

** Significant at 5% confidence level

*** Significant at 1% confidence level

Table [E]: Separate samples, year and grade controls, voucher-options coefficients only

		25 (.94 m)	50 (2.02 m)	75 (3.68 m)	90 (5.56 m)	Whole City	*Observations (Groups)*
WKCE	Language Arts	0.143	0.143*	0.059**	0.046***	0.032***	*84070*
		(0.164)	(0.087)	(0.029)	(0.017)	(0.011)	*-68444*
	Mathematics	0.083	0.072*	0.029**	0.024***	0.016***	*132781*
		(0.106)	(0.038)	(0.014)	(0.008)	(0.005)	*(90961*
	Reading	0.074	0.068**	0.027**	0.021***	0.013***	*131814*
		(0.077)	(0.034)	(0.011)	(0.007)	(0.004)	*-90155*
	Social Studies	0.049	0.114	0.045	0.040**	0.037***	*83750*
		(0.170)	(0.087)	(0.031)	(0.020)	(0.013)	*-68139*
	Science	-0.015	0.055	0.024	0.027	0.028**	*84169*
		(0.161)	(0.091)	(0.031)	(0.019)	(0.011)	*-68446*
	within-R^2	***0.26***	***0.26***	***0.26***	***0.26***	***0.26***	
	OLS R^2	***0.93***	***0.93***	***0.93***	***0.93***	***0.93***	
Terra Nova	Language Arts	0.001	0.047*	0.009	0.007	0.006**	*159491*
		(0.066)	(0.024)	(0.008)	(0.005)	(0.003)	*-75711*
	Mathematics	-0.039	0.012	-0.003	0.002	0.009***	*177895*
		(0.079)	(0.024)	(0.009)	(0.005)	(0.002)	*-82767*
	Reading	-0.005	0.029	-0.000	-0.001	0.002	*159490*
		(0.069)	(0.024)	(0.008)	(0.005)	(0.002)	-75710
	within-R^2	***0.06***	***0.06***	***0.06***	***0.06***	***0.06***	
	OLS R^2	***0.85***	***0.85***	***0.85***	***0.85***	***0.85***	

Robust standard errors in parentheses. Errors clustered around school grade level.

* Significant at 10% confidence level

** Significant at 5% confidence level

*** Significant at 1% confidence level

Table [F]: Effect sizes, no controls, whole city

		Effect Size
Combined Sample	Language Arts	.10
	Mathematics	.08
	Reading	.10
WKCE	Language Arts	.24
	Mathematics	.20
	Reading	.16
	Social Studies	.40
	Science	.40
Terra Nova	Language Arts	.03
	Mathematics	.02
	Reading	.05

Effect sizes calculated using within-sample standard deviations on the voucher-options variable, which vary based on the test considered.

About the Authors

Jay P. Greene is endowed chair and head of the Department of Education Reform at the University of Arkansas. His research was cited four times in the Supreme Court's opinions in the landmark Zelman v. Simmons-Harris case on school vouchers. His articles have appeared in policy journals, such as The Public Interest, City Journal, and Education Next, in academic journals, such as Education Finance and Policy, Economics of Education Review, and the British Journal of Political Science, as well as in major newspapers, such as the Wall Street Journal and the Washington Post. Jay Greene is the author of Education Myths (Rowman & Littlefield, 2005). Greene has been a professor of government at the University of Texas at Austin and the University of Houston. He received his B.A. in history from Tufts University in 1988 and his Ph.D. from the Government Department at Harvard University in 1995.

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