Does School Integration Generate Peer Effects? Evidence from Boston's Metco Program

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The Metropolitan Council for Educational Opportunity (Metco) is a desegregation program that sends students from Boston schools to more affluent suburbs. Metco increases the number of blacks and reduces test scores in receiving districts. School-level data for Massachusetts and micro data from a large district show no impact of Metco on the scores of white non-Metco students. But the micro estimates show some evidence of an effect on minority third graders, especially girls. Instrumental variables estimates for third graders are imprecise but generally in line with ordinary least squares estimates. Given the localized nature of these results, we conclude that peer effects from Metco are modest and short lived. (*JEL* I21, I28, J13, J18)

Few questions in American public life are as controversial as the social consequences of school integration. Policymakers and researchers have debated the impact both on the individual students who are bused to school for the purposes of racial balance and on residential patterns in school districts affected by busing. Even the proximate effects of desegregation efforts have not been clear cut. The Supreme Court's 1955 *Brown v. Board of Education II* decision declared that schools should be integrated "with all deliberate speed," but in many districts integration was slow and incomplete. Integration policies nevertheless appear to have been at least partly successful, in the sense that they increased the probability that white and black students study together (Finis Welch and Audrey Light, 1987; Christine Rossell and David Armor, 1996). Moreover, research by labor economists strongly suggests that the end of de jure segregation led to economic gains for blacks.[1]

Busing programs typically send black students to schools that were previously all white and vice versa, often in the face of resistance from local school boards and other elected officials. In an influential study, James S. Coleman (1975) argued that court-ordered busing accelerated the exodus from central cities ("white flight"), sparking a literature looking at the impact of desegregation efforts on racial mixing in schools. Few studies, however, have looked at the impact of desegregation on the primarily white students who remain in the schools to which black students are bused, i.e., on the students in schools where the fraction minority increased as a consequence of busing.[2] In this paper, we use the Metco desegregation

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[1] See, e.g., James P. Smith and Welch (1989) and David Card and Alan B. Krueger (1992).

[2] An exception is Jonathan Guryan (2001), who looks at the impact of court-ordered busing on white and black dropout rates. Charles Clotfelter (1999) is a recent study of white flight.

program to study the impact of busing on students in schools to which the Metco students were bused.

The Metco program, one of the largest and longest-running desegregation programs in the United States, is unusual in that it sends mostly black students *out* of the Boston district into schools in the surrounding, mostly white suburban districts. In contrast with court-ordered desegregation efforts, Metco is voluntary on the part of both the families of students being bused and the school districts receiving the bused students, and has not been associated with white flight. In 1970, four years before the 1974 federal court decision that imposed busing within the Boston district, 29 Metco-receiving districts enrolled almost 1,400 students. In the 2000–2001 school year, almost 3,200 Metco students attended school in 32 suburban districts. Most Metco-receiving districts were and have remained relatively affluent suburban communities with growing populations. In many of these districts, Metco students account for almost all black and Hispanic students. These factors suggest that Metco provides a useful laboratory for the study of the impact of desegregation on students in host districts.

Our study begins with a largely descriptive analysis of the impact of Metco students on schools across Massachusetts. Here we use aggregate school-level data from the newly instituted statewide Massachusetts Comprehensive Assessment System (MCAS) testing program. The aggregate analysis shows that Metco-receiving districts tend to be higher scoring, while Metco participation pulls down the overall average score in schools within districts. On the other hand, there is no effect of Metco participation on the scores of white students in receiving districts. This finding is consistent with the hypothesis that Metco participation has no negative externalities, since Metco students are all nonwhite, although Metco participation clearly does have composition effects.

We then turn to a more micro- and causally focused investigation of the effect of Metco on the Iowa Test of Basic Skills (ITBS) scores of elementary and middle-school students in the Brookline Public Schools, one of the largest Metco-receiving districts. The Brookline experience is of historical interest since the Metco program was initiated by a group of Brookline civil rights activists. Moreover, while Brookline has one of the best school systems in the state, it is the only large district with both substantial Metco participation and a significant number of black and Latino residents. This fact allows us to assess the impact of Metco on different racial groups.

In addition to providing an evaluation of the impact of Metco, the results presented here may shed light on more general questions regarding the school environment and peer effects. As noted above, Metco substantially increases the minority population in schools in the receiving districts. In addition, because Metco students have markedly lower average test scores than suburban students, the Metco program lowers average scores in receiving districts. The relatively low scores of Metco students, a fact noted by Metco critics, is politically significant in Massachusetts, where schools and districts are evaluated on the basis of average test scores. More important, the increased presence of lower-performing students in suburban districts may adversely affect students resident in the district if peer performance and/or racial composition matters for student learning, a possibility explored in a large empirical literature.[3]

Finally, evidence on the impact of Metco is also relevant for assessing possible consequences of school choice policies promoted by the 2001 No Child Left Behind (NCLB) Act. NCLB requires districts to allow students in schools judged to be "failing" the opportunity to change schools at public expense. Metco can be viewed as a pilot program in this mold since it is publicly funded and participants have generally opted out of low-achieving public schools. Policymakers and parents in the schools that accept these students may wonder what the consequences will be for high-achieving children when low achievers from poor areas choose to attend their schools.

Section I provides additional background on Metco and presents a brief analysis of school-level data from Metco-receiving and neighboring districts. The school-level analysis provides some evidence on the "big picture" but has a number of important limitations, such as confidentiality restrictions that preclude an analysis

[3] Recent examples include Michael A. Boozer et al. (1992), Caroline Hoxby (2000), Hanushek et al. (2002), and Steven G. Rivkin (2000). See Abigail Thernstrom and Stephan Thernstrom (2003) for a review.

of test scores for black students. We therefore turn in Section II to an analysis of micro data from Brookline, beginning with descriptive statistics characterizing Metco's impact on the school environment. Section III discusses OLS estimates of the effect of Metco on the test scores on non-Metco students. In Section IV, we report the results of an instrumental variables (IV) strategy for estimating the effect of Metco. Section V concludes with an assessment of the case for negative peer effects in the Metco program. Both the aggregate and Brookline micro data show no evidence of an impact of Metco on white students in receiving districts. On the other hand, there is some evidence of a negative effect on the scores of minority third grade girls in Brookline in some subjects. But the highly specific nature of this result suggests that negative peer effects, if any, are modest and short-lived.

I. The Metco Program

The birth of Metco was an important chapter in the battle over school desegregation in Boston.[4] In 1963 and 1964, Black parents boycotted Boston schools for failing to integrate, and in 1974 Boston school assignment was taken over by a federal district judge after a protracted legal struggle. Against this backdrop, the Brookline Civil Rights Committee approached the Brookline School Committee in 1964 to request that black students from Boston be enrolled in the Brookline Public Schools. By 1970, 29 suburban school districts had enrolled 1,361 Metco students. Four of these districts later abandoned Metco, but 7 districts joined the program. Metco-participating districts in the 2001–2002 school year, along with the number of Metco students and the proportion minority in each district, are indicated in Table 1. Most Metco districts are in the greater Boston area, but a few serve the Springfield school district in the center of the state. Five percent of the Boston district, or roughly 3,200 students, participate in Metco, and Metco students account for a substantial portion of the black and Hispanic students in receiving districts.

Boston parents who are interested in Metco place their child on a waiting list. Every year, Metco coordinators in suburban districts notify METCO, Inc., of the number of openings they have for the following year at each grade level. Applicants are selected from the waiting list on a first-come-first-served basis. Boston parents do not get to choose a suburban district, although they may refuse a placement. Placement typically becomes more difficult as grade advances. The state provides funding to districts that accept Metco students according to a formula determined by legislators and the Massachusetts Department of Education. Today, state Metco funding hovers around $2,800 per student, plus transportation costs, considerably below average per-student expenditure in the state and less than provided by a statewide school-choice program.

The Metco program remains controversial. There is a long waiting list, but some Boston educators worry that Metco pulls relatively motivated or high-achieving students out of the Boston Public Schools. Others believe Metco's focus on race is anachronistic (Larry Tye, 1995a). Metco also generates controversy in some receiving districts, despite generally strong political support in these communities. Critics argue that Metco is costly, pulls down average test scores (a factor of increasing importance since Massachusetts introduced mandatory statewide testing), and negatively influences local students. In 1990, for example, the Lincoln School Committee held a forum on Metco in response to concerns about costs, behavior problems, and the time spent by teachers with Metco children (Muriel Cohen, 1990). Lincoln's Metco participation continues to be high, at about 13 percent of enrollment (excluding schools at Hanscom Air Force Base), though down from a 20-percent target established in 1975. Recently, a new effort by a group of parents attempted to reduce further the Lincoln district's expenditure on Metco, but this appears to have generated little community support (Megan Tench, 2003). Also, in a decision that was later reversed, the Lynnfield School Committee voted to withdraw from Metco in the wake of concerns that "minority students are not being helped and are dragging down the rest of the school" (Doreen Iudica Vigue, 1999).

Despite strong public interest in Metco, there is little evidence regarding the effect of Metco participation on the students commuting daily

[4] This section draws on Ruth M. Batson and Robert C. Hayden (1987) and METCO, Inc. (1970).

TABLE 1—2002 DISTRICT CHARACTERISTICS

	Number enrolled		Percent enrolled				
District name	Total (1)	Metco (2)	White (3)	Asian (4)	Hispanic (5)	Black (6)	Metco (7)
A. Boston Area							
Lincoln	1,004	88	77.79	5.88	3.49	12.75	8.76
Weston	2,307	160	80.93	9.54	2.60	6.42	6.94
Lincoln-Sudbury	1,310	85	87.18	4.43	1.30	7.02	6.49
Concord	2,006	109	85.79	6.38	1.89	5.33	5.43
Lexington	6,010	289	77.57	15.19	1.70	5.39	4.81
Brookline	5,960	285	66.66	18.47	5.34	9.40	4.78
Wayland	2,926	127	85.58	7.96	2.32	4.10	4.34
Wellesley	3,883	146	87.48	6.00	2.24	4.04	3.76
Newton	11,313	419	81.13	10.60	2.78	5.38	3.70
Needham	4,498	149	89.17	4.96	2.05	3.80	3.31
Melrose	3,449	113	94.32	1.57	0.84	3.16	3.28
Cohasset	1,367	43	95.32	0.29	1.17	3.00	3.15
Bedford	2,186	61	84.49	7.69	2.61	4.57	2.79
Sherborn	458	11	94.10	3.06	0.44	1.97	2.40
Dover-Sherborn	959	21	94.68	2.61	1.25	1.46	2.19
Marblehead	2,853	61	94.15	1.23	0.95	3.68	2.14
Belmont	3,574	74	83.24	10.18	2.55	3.72	2.07
Sudbury	3,011	59	92.43	4.32	0.83	2.36	1.96
Scituate	3,005	58	95.81	0.27	0.70	3.19	1.93
Arlington	4,265	80	86.59	6.00	2.46	4.88	1.88
Foxborough	2,835	49	94.50	1.80	1.41	2.22	1.73
Sharon	3,512	60	88.24	5.84	1.22	4.67	1.71
Lynnfield	1,831	27	94.48	2.62	1.15	1.42	1.47
Westwood	2,599	35	94.00	3.23	1.04	1.46	1.35
Natick	4,398	58	90.70	4.09	1.93	3.05	1.32
Walpole	3,654	41	96.93	0.79	0.57	1.67	1.12
Hingham	3,411	37	95.46	2.08	1.03	1.35	1.08
Wakefield	3,434	35	96.21	1.40	1.08	1.28	1.02
Dover	602	6	91.86	5.15	1.33	1.16	1.00
Reading	4,285	40	94.68	3.13	0.75	1.31	0.93
Swampscott	2,368	21	95.78	1.18	1.10	1.77	0.89
Braintree	4,906	42	90.77	4.12	1.73	3.10	0.86
Framingham	8,391	17	70.04	5.34	17.29	7.07	0.20
B. Springfield Area							
East Longmeadow	2,624	49	95.39	0.99	0.95	2.55	1.87
Longmeadow	3,234	49	92.76	4.14	0.62	2.41	1.52
Southwick-Tolland	1,869	19	97.65	0.32	0.37	1.50	1.02
Hampden-Wilbraham	3,873	18	95.12	1.76	1.19	1.83	0.46

Notes: Enrollment statistics are from the Massachusetts Department of Education Web site. Metco statistics were provided by the Department of Education at our request. Lincoln statistics are for grades K–8 only and include schools at Hanscom Air Force Base.

from Boston. This largely reflects the difficulty of finding an appropriate comparison group for Metco students. Although Metco students are more likely to graduate from high school than are other Boston public school students, Metco students might well have had more favorable outcomes in any event.[5] On the other side of the

[5] Two largely descriptive studies of Metco are by Richard Boardman and Linda Brandt (1968) and Keith W. Clarke (1975), who interviewed Metco parents. Gary Orfield et al. (1997) also surveyed Metco parents. More recently, Susan E. Eaton (2001) discusses interviews with adults who participated in Metco. This research establishes that most Metco participants strongly believe they benefitted from the program. Armor (1972) compared Metco participants with a small number of nonparticipating siblings. Cary A. Elliott (1998) surveyed Metco graduates and a small comparison group, looking at the effect of Metco participation on high school graduation and college atten-

TABLE 2—CROSS-DISTRICT ESTIMATES FOR FOURTH-GRADE MCAS SCORES

		Districts inside Route 495			Metco-receiving districts		
			Estimates			Estimates	
Subject	Level	Means (1)	No DE (2)	DE (3)	Means (4)	No DE (5)	DE (6)
		Panel A. All students					
Math	Pass	87.1	109	−37.1	93.1	7.34	−34.3
		(11.8)	(24.5)	(29.5)	(5.85)	(16.1)	(19.2)
	Proficient	48.0	261	−90.7	61.2	42.2	−95.8
		(19.4)	(39.6)	(42.5)	(14.5)	(37.6)	(40.0)
English	Pass	93.9	58.1	−6.47	96.7	11.7	−5.75
		(7.25)	(15.7)	(20.7)	(4.14)	(11.3)	(14.2)
	Proficient	62.4	233	−37.2	74.5	28.6	−42.4
		(18.6)	(39.7)	(42.3)	(10.7)	(29.0)	(36.0)
N schools		451	451	451	141	141	141
		Panel B. White students					
Math	Pass	90.0	84.4	−5.10	94.6	16.6	−3.78
		(8.89)	(17.2)	(23.2)	(5.02)	(12.9)	(17.8)
	Proficient	51.1	257	−28.5	63.9	69.6	−35.0
		(18.2)	(36.3)	(41.6)	(14.0)	(35.8)	(41.5)
English	Pass	95.3	30.6	1.90	97.3	5.98	0.399
		(5.88)	(10.4)	(15.9)	(3.52)	(9.24)	(13.1)
	Proficient	65.8	217	19.2	77.0	63.4	12.1
		(17.0)	(33.4)	(40.3)	(10.5)	(27.6)	(36.4)
N schools		443	443	443	141	141	141
N districts		117	117	117	35	35	35

Notes: The table reports the coefficients on fraction Metco (0–1) in regression models for the outcomes indicated. The inside–Route 495 sample includes Metco and non-Metco districts inside or straddling Route 495. The Metco-receiving sample is limited to districts with Metco students, including those in the Springfield area. Models for the latter sample include a Springfield dummy. All models without district effects (denoted No DE) include a dummy for districts inside or straddling Route 128. All models include number tested and a dummy for school type (elementary only, elementary and middle, or middle school only). Both samples exclude schools in Boston and at Hanscom Air Force Base. Number of schools in columns (1) to (3) is the number tested in math.

Metco equation, there has been almost no research on the impact of Metco participation in receiving districts, other than policy reviews of the sort mentioned above.[6]

A. *School-Level Analysis*

To provide an initial look at the impact of Metco, we analyzed school-level average test scores in the population of Metco-receiving districts and those nearby. Table 2 reports the coefficient on fraction Metco from a regression of fourth-grade test scores from the 2002 MCAS exams on the fraction Metco in each school. MCAS scores are coded here as dummies for groups we label "passing" or "proficient."[7] We focus on fourth-grade scores

dance. These studies suffer from lack of a good control group and/or incomplete follow-up of applicants and controls. A small randomized study of the impact of a Hartford desegregation program is discussed in Robert L. Crain and Jack Strauss (1985). Elliot and Crain and Strauss found some benefits, while Armor did not.

[6] Sanjay Jaggia and David G. Tuerck (2001) estimate the relation between district-level MCAS scores and a range of variables, including fraction Metco in district. They find a positive association between fraction Metco and scores, but this seems likely to be due to the fact that Metco-receiving districts are among the best in the state.

[7] The passing group had scores above the level denoted warn/fail in MCAS score reports, i.e., "needs improvement or better." The proficient score group had scores in the proficient or advanced (highest) groups. The data appendix provides additional information on the MCAS data.

because this is the only grade in which the MCAS tests both mathematics and English. A study of fourth-grade scores is also more useful than scores from middle-school grades since there are many more elementary schools than middle schools in each district, facilitating an analysis conditional on district effects. Other regressors include a dummy for districts inside or straddling Route 128 (Boston's inner beltway), the number of students tested in the relevant subject, and a dummy for school type (elementary or middle).

In a sample of districts operating inside or straddling Interstate 495 (Boston's outer beltway), schools with Metco students have much higher scores than those without. This can be seen in column (2) of Table 2, which shows, for example, that a 10-percentage-point increase in fraction Metco is associated with a 26-point-increase in the fraction proficient in math (the mean is 48 percent). We limit the analysis to districts around and inside Route 495 because this highway approximates the boundaries of the Boston conurbation.

Schools with Metco students have higher test scores because Metco-receiving districts tend to be more affluent and have higher scores. This is apparent in the move from column (2) to column (3), which reports the results of including a full set of district effects in the regression. These within-district regressions show a consistently negative relation between the fraction Metco and scores, with significant effects on the probability of being proficient in math. This same pattern appears in columns (5) and (6), which report results with and without district effects in a sample of Metco-receiving districts only (including Springfield-area districts). Here, the positive association without district effects in weaker. Again, however, controlling for district effects, the relation between fraction Metco and average test scores is consistently negative and significantly different from zero for math proficiency.

For a first pass at the question of whether the negative correlation between fraction Metco and average test scores is primarily a composition effect (i.e., due to the presumably lower scores of Metco students relative to residents of receiving districts), panel (B) of Table 2 shows the results of a parallel analysis in a sample limited to white students. Since Metco students are all nonwhite or Hispanic, the results for whites are unaffected by the presence of Metco students. The estimates for white students from models without controls for district effects continue to show that students in Metco-receiving districts have higher scores. Importantly, however, there is no clear association between fraction Metco and the scores of whites.

The results in Table 2 are at best suggestive, if only because they are not very precise. Moreover, if districts assign Metco students to schools with higher scores, the results in panel (B) may be biased toward finding no effect on white students in receiving schools. Also, because there are so few black and Latino students in the receiving districts, confidentiality restrictions prevent us from analyzing nonwhites separately. In the next section we therefore turn to a detailed analysis of micro data from Brookline, one of the largest Metco-receiving districts, with a substantial resident minority population and one for which we can better address the concern that Metco assignment may be endogenous.

II. Descriptive Analysis of Micro Data

A. *Metco in Brookline*

Brookline has about 6,000 public school students attending eight neighborhood elementary schools with grades kindergarten through eight and a single high school. Brookline is affluent relative to Boston but more heterogeneous than most suburban districts. Roughly 10 percent of Brookline students are black (including Metco students), 17 percent are Asian, and 4 percent are Hispanic. Typically, 10 percent are designated limited-English-proficient (LEP) and 12 percent qualify for a free or reduced-price lunch. More than 30 percent come from homes in which English is not the first language. Yet Brookline students consistently do well on national and state tests and have low dropout rates and a high probability of college attendance.

Under its current Metco participation agreement, Brookline enrolls 300 Metco students each year, about 5 percent of total enrollment in the district. According to school administrators, Metco students are initially assigned to classes where class size is expected to be small. Once a Metco student is assigned to a particular Brookline school, transfer to a new school is unusual.

TABLE 3—BROOKLINE SUMMARY STATISTICS

		School characteristics		All students					Tested students			Metco tested students	
Grade	School year	Enrolled (1)	Class size (2)	Metco (3)	Percent Metco (4)	Percent ESL/TBE (5)	Percent sp. ed. (6)	Percent tested (7)	Percent Metco (8)	Percent black (9)	Percent sp. ed. (10)	Percent black (11)	Percent male (12)
3	1994[a]	498	20.8	16	3.21	9.24	—	88.2	3.64	9.79	14.1	81.3	25.0
	1995[a]	496	20.7	13	2.62	9.07	—	86.5	3.03	8.16	14.5	84.6	38.5
	1996	511	22.2	20	3.91	11.94	18.8	81.2	4.34	9.64	15.4	88.9	38.9
	1997	490	20.4	25	5.10	11.43	21.2	85.3	4.78	11.48	17.0	85.0	50.0
	1998	503	21.9	34	6.76	9.94	21.3	87.9	7.24	14.03	21.3	90.6	37.5
	1999	454	20.6	16	3.52	11.45	18.5	87.9	3.76	6.77	18.1	66.7	33.3
	2000	451	18.8	19	4.21	11.09	18.2	88.9	4.24	10.97	16.5	100.0	35.3
5	1994[a]	506	21.1	27	5.34	9.29	—	89.1	5.99	11.53	10.9	88.9	51.9
	1995[a]	467	20.3	27	5.78	9.42	—	79.0	7.32	11.38	15.5	85.2	40.7
	1996	483	20.1	24	4.97	6.63	19.1	88.0	4.94	12.00	14.1	85.7	33.3
	1997	501	22.8	18	3.59	6.39	19.8	91.4	3.06	7.64	16.6	85.7	35.7
	1998	487	21.2	27	5.54	6.57	21.8	90.3	6.14	12.27	19.3	85.2	40.7
	1999	493	20.5	25	5.07	7.91	20.1	89.2	5.45	10.45	18.0	83.3	50.0
	2000	470	20.4	34	7.23	7.87	20.4	90.9	7.49	13.35	20.1	87.5	31.3
7	1994[a]	417	21.9	25	6.00	6.95	—	89.4	6.70	13.14	13.4	88.0	52.0
	1995[a]	457	19.9	24	5.25	7.00	—	87.3	6.02	11.28	16.5	79.2	37.5
	1996	479	20.8	30	6.26	8.35	13.8	89.4	6.54	10.51	12.6	82.1	53.6
	1997	420	20.0	31	7.38	6.19	24.5	93.1	7.42	12.28	20.5	69.0	41.4
	1998	460	20.0	28	6.09	3.91	20.4	94.6	6.21	11.95	18.2	88.9	44.4
	1999	473	20.6	20	4.23	6.13	19.9	93.7	4.29	9.26	17.8	94.7	36.8
	2000	457	19.9	26	5.69	7.44	22.5	92.8	6.13	12.74	21.5	84.6	38.5

Notes: Columns (1) to (7) show statistics for the population enrolled. Column (6) shows the percentage of students designated as special education and column (7) shows the proportion tested. Special education data are missing for 1994 and 1995. Columns (8) to (10) show statistics for the population tested. Columns (11) and (12) show statistics for the population of Metco students tested.

[a] 1994 and 1995 tests were given in March. Tests were given in November in other years.

B. *Data and Descriptive Statistics*

Achievement is measured here using the ITBS for third, fifth, and seventh graders. The ITBS was administered in March 1995 and March 1996 and then in November of each academic year after that. Data are available for the 1994–2000 school years. In principle, all students except LEP or those with severe special needs are tested. Parents may request that their child not be tested, but such requests are rare. Our analysis uses test scores reported as the national percentile rank, which measures achievement relative to the score distribution in a 1992 reference population. For additional information, see the Data Appendix.

Table 3 presents descriptive information for the Brookline school system for the period for which we have ITBS scores. A typical grade has close to 500 students with an average class size of 20 to 21. Third- and fifth-grade classes are largely self-contained except for special classes (e.g., art and physical education), so the class sizes for these grades represent the typical number of students in the class for core subjects. For seventh-grade students, the reported number of classes is the number of "home rooms" and therefore a less accurate measure of class size for core subjects.

The proportion of students taking the ITBS ranges from a low of 79 percent among fifth graders in 1995 to a high of 95 percent among seventh graders in 1998. Special education and LEP students (in English as a second language [ESL] and transitional bilingual education [TBE] programs) account for most of those who do not take the test. In particular, special education students have an individualized education plan that may exempt them from taking standardized tests. The remainder of those not tested consist of students who were ill or whose parents requested that they not take the exam. Most of the variation in the proportion tested comes from efforts by school administrators to increase the participation of special education students and from fluctuation in the number of special education and LEP students. Variation in ESL/TBE participation across grades reflects the fact that most Brookline students spend only one or two years in ESL or TBE programs.

The percentage of students enrolled in special education programs averages somewhat below 20 percent.[8] There has been a steady increase, however, in the fraction of special education students tested. For example, in 1996, special education students accounted for 8 percentage points of the almost 19 percent of third graders not tested. By the 2000 school year, special education students accounted for only about 4.5 percentage points of the third graders not tested. Importantly, variation in the proportion tested does not appear to be related to the proportion Metco.

Table 3 shows an estimate of the proportion of all students in a school, grade, and year from Metco in column (4), as well as the proportion of tested students from Metco in column (8). Although Metco status is reasonably well measured from 1996 forward, both measures rely on incomplete information for the 1994 and 1995 school years, for which Metco status must be inferred from a variety of sources. The proportion Metco varies from a low of 2.6 percent in 1995 in third grade to a high of 7.4 percent in 1997 in seventh grade. Metco students generally represent a higher proportion of tested students than they do of all students because few Metco students are LEP or have severe special needs. Consistent with the historical emphasis on desegregation, Metco students are overwhelmingly black. Hispanic students constitute the second largest Metco ethnic group, followed by a small number of Asians. The Metco students in our sample are also more likely to be female than male.[9] A table in our working paper (Angrist and Lang, 2002) shows there is considerable variation in the proportion Metco both across schools and within schools over time.

Not surprisingly, given the relatively high average family income in Brookline and the reputation of the school system, Brookline students generally perform well on the ITBS. As shown in Table 4, the average core national percentile rank among non-Metco students is 72 for third and fifth graders and 76 for seventh graders. Test scores by subject are similarly high, although language scores tend to be slightly lower than the overall scores, possibly reflecting the high proportion of non-native English speakers. There is also a significant racial gap for Brookline residents, with the average score for blacks around the overall national median (fifty-first, fiftieth, and fifty-fifth percentiles in the three grades) and with whites around the top quartile (seventy-fourth, seventy-fifth, and eightieth percentiles in the three grades). The standard deviation of test scores ranges from 22 to 26 points, depending on grade and subject. The standard deviation of grade/school/year cell averages is naturally much smaller, in the 5-to-7 range.

Metco students have test scores significantly below those of Brookline residents.[10] The average core national percentile rank is about 22 points lower for Metco students, a gap almost as large as the standard deviation of test scores among Brookline students. On the other hand, black students in the Metco program have scores broadly similar to those of blacks from Brookline, while nonblack Metco students, who are mostly Hispanic and Asian, typically have scores between those of non-Metco Hispanics and Asians.[11]

Despite the gap in scores by Metco status, Table 4 suggests that Metco students benefit from time in the Metco program. In particular, Metco students generally show more improvement between third and seventh grades than do Brookline residents. It is possible that this reflects more favorable sample selection for older Metco students than for younger Metco students, but the simplest explanation is that the Brookline Metco program raises the achievement of participants.[12] Of course, the ideal evaluation strategy for assessing the value of Metco for participants would use comparisons with an otherwise similar group of non-Metco students

[8] This excludes children in out-of-district placements. Special education status is unavailable for the first two years in the sample but can be determined for students who remained in the school system after 1995.

[9] Anecdotal evidence suggests Metco girls stay in the program longer than boys (Tye, 1995b).

[10] Children of town employees may attend Brookline schools regardless of where they live, and there are a small number of (mostly foreign) students who pay tuition through a variety of programs. These groups are included in our sample of Brookline residents.

[11] Metco students have MCAS scores higher than the Boston average, but below the suburban average. See statistics posted at http://www.metcoinc.org/news.htm.

[12] The fact that scores increase from grade to grade suggests that a Brookline education also increases non-Metco student achievement more than most school systems.

TABLE 4—TEST SCORES BY RACE AND METCO STATUS

		Non-Metco					Metco		
Grade	Subject	All (1)	Black (2)	Hispanic (3)	Asian (4)	White (5)	All (6)	Black (7)	Non-black (8)
3	Core	71.6 (24.2) [6.8]	51.2 (27.6)	54.2 (27.6)	71.9 (22.8)	74.3 (22.7)	49.0 (25.5) [22.2]	47.2 (25.1)	60.1 (25.2)
	Reading	70.7 (24.7) [5.9]	51.7 (28.4)	54.9 (26.4)	63.7 (23.8)	74.8 (22.8)	47.9 (26.8) [21.4]	46.1 (26.8)	58.8 (24.8)
	Math	72.0 (24.7) [7.3]	50.8 (28.4)	54.9 (28.0)	76.4 (22.6)	74.0 (23.3)	47.9 (26.4) [22.9]	45.7 (26.3)	62.0 (23.4)
	Language	67.8 (25.7) [7.1]	49.9 (27.4)	52.9 (28.5)	71.6 (23.7)	69.5 (24.8)	52.9 (25.9) [21.2]	51.6 (25.6)	60.8 (27.2)
5	Core	72.3 (22.7) [5.1]	49.8 (25.7)	56.9 (26.3)	72.2 (21.8)	75.0 (20.9)	50.6 (22.1) [15.8]	48.0 (20.9)	67.3 (22.8)
	Reading	72.4 (22.7) [4.3]	52.2 (25.9)	57.9 (25.8)	65.2 (23.4)	76.3 (20.3)	52.5 (23.6) [16.9]	49.9 (22.8)	68.9 (21.9)
	Math	70.6 (23.2) [6.1]	47.8 (25.3)	57.2 (26.8)	76.0 (21.3)	72.3 (21.8)	46.7 (26.4) [18.3]	44.4 (22.3)	61.6 (24.3)
	Language	69.2 (24.4) [6.1]	49.2 (27.3)	54.8 (28.2)	70.1 (23.3)	71.5 (23.0)	52.9 (23.4) [16.6]	50.5 (22.4)	67.8 (24.4)
7	Core	76.4 (21.8) [4.7]	55.0 (24.4)	59.6 (27.9)	76.4 (19.8)	79.5 (19.8)	57.1 (20.7) [15.7]	55.1 (20.2)	66.5 (20.5)
	Reading	77.0 (22.6) [4.4]	57.4 (25.3)	63.8 (27.5)	70.7 (23.5)	80.8 (20.2)	57.5 (22.6) [15.9]	55.6 (22.5)	66.4 (21.2)
	Math	74.0 (23.4) [5.0]	51.4 (25.7)	55.4 (29.0)	78.7 (20.2)	76.4 (21.5)	55.9 (22.2) [17.1]	54.5 (22.0)	63.3 (20.2)
	Language	73.9 (22.4) [5.3]	55.0 (24.6)	59.0 (27.9)	75.0 (19.9)	76.5 (21.1)	57.1 (21.8) [17.5]	55.1 (21.3)	66.8 (20.9)

Notes: Columns (1) to (5) show statistics for the population of tested non-Metco students. Columns (6) to (8) show statistics for the population of tested Metco students. Reported test scores are means of the National Percentile Rank from the Iowa Test of Basic Skills administered from the 1994–1995 school year through the 2000–2001 school year. Standard deviations are reported in parentheses. Standard deviations for school/grade/year cell means appear in brackets.

from Boston, a project we hope to pursue in the future.

C. *Metco and the School Environment*

Differences in average achievement between Brookline residents and Metco students are large enough for the presence of Metco students to reduce average test scores in Brookline. This can be seen in the top panel of Table 5. Columns (1) to (4) of the table report unweighted estimates of the grouped equation

$$(1) \quad \bar{y}_{gjt} = \alpha_g + \beta_j + \gamma_t + \delta m_{gjt} + \lambda s_{gjt} + u_{gjt}$$

where $\bar{y}_{gjt}$ is the average score in the grade g/school j/year t cell, s_{gjt} is class size in the cell, including Metco, and m_{gjt} is fraction Metco (based on tested students) [where $g \times j \times t = 3 \times 8 \times 7 = 168$ cells]. Columns (5) to (8) report estimates treating individual students as the unit of observation and replacing $\bar{y}_{gjt}$ with $\bar{y}_{gjt(i)}$, the average score of students in the cell, excluding student i. These estimates capture the

TABLE 5—METCO EFFECTS ON THE SCORE DISTRIBUTION FOR ALL STUDENTS

	Grouped data				Micro data			
Subject	(1) Pooled	(2) 3rd	(3) 5th	(4) 7th	(5) Pooled	(6) 3rd	(7) 5th	(8) 7th
	Panel A. Dependent variable: mean test score							
	Cell means				Peer means			
Core	−22.1	−21.8	−28.0	−16.9	−23.9	−18.1	−30.3	−19.3
	(7.25)	(14.6)	(12.8)	(11.8)	(6.74)	(13.5)	(11.2)	(9.50)
Reading	−18.7	−22.7	−27.3	−14.0	−20.1	−18.7	−27.7	−16.1
	(6.65)	(14.0)	(12.8)	(10.2)	(6.08)	(12.0)	(10.9)	(8.37)
Math	−20.7	−19.8	−30.2	−14.3	−23.2	−14.6	−33.0	−17.0
	(8.43)	(16.5)	(17.2)	(13.5)	(7.83)	(14.9)	(14.4)	(10.5)
Language	−19.5	−22.0	−19.0	−14.2	−22.6	−24.1	−22.0	−17.6
	(7.81)	(15.1)	(13.3)	(11.6)	(7.32)	(14.3)	(11.7)	(9.65)
N	168	56	56	56	8,159	2,672	2,797	2,690
	Panel B. Dependent variable: second decile of test score							
	Cell quantiles				Quantile regression			
Core	−51.4	−61.7	−37.8	−48.6	−48.6	−56.7	−43.0	−51.9
	(14.4)	(31.8)	(23.3)	(23.1)	(15.5)	(38.0)	(31.2)	(28.1)
Reading	−45.2	−58.3	−41.3	−41.1	−43.3	−57.5	−45.8	−31.7
	(15.2)	(35.1)	(22.0)	(23.8)	(16.5)	(33.8)	(25.8)	(32.0)
Math	−37.6	−48.3	−31.4	−35.3	−44.4	−40.5	−40.0	−31.2
	(17.1)	(34.6)	(28.7)	(29.3)	(14.5)	(47.1)	(36.7)	(33.2)
Language	−35.7	−43.0	−1.79	−44.5	−40.3	−47.4	−23.0	−49.6
	(14.1)	(31.2)	(23.4)	(21.7)	(15.6)	(42.8)	(31.5)	(29.5)
N	168	56	56	56	8,629	2,798	2,966	2,865

Notes: The table reports the coefficient on fraction Metco estimated from the Riverside testing data using equation (1) in the text. Standard errors are reported in parentheses. Standard errors in columns (1) to (4) are robust. Standard errors in columns (5) to (8) of panel (A) are clustered by grade/school/school–year cell. Standard errors in columns (5) to (8) of panel (B) are boostrapped. In columns (1) to (4) of panel (A) the dependent variable is the mean test score for the grade/school/school year cell. In columns (5) to (8) of panel (A), the dependent variable is the peer mean score. The peer mean score is the grade/school/school year cell mean score omitting the student's own score from the mean. In columns (1) to (4) of panel (B) the dependent variable is the second decile of the test score. Columns (5) to (8) of panel (B) report microdata quantile regression estimates for the second decile of the test score. Covariates include class size and fixed effects for school and school year. Columns (1) and (5) include cohort and grade fixed effects. The *N* row displays the number of observations (or cells) in the regression. For columns (5) to (8), the *N* row displays the number of observations in the core test score regression.

effect of fraction Metco on non-Metco students' peer means, since Metco students are included in $\bar{y}_{gjt(i)}$ but excluded from the estimation sample. Except for the fact that the dependent variable is a peer mean and the equation includes individual-level controls, the resulting estimates are similar to estimation using cell means weighted by the number of non-Metco students in a cell.[13]

The results tell a similar story for both estimation strategies. As with the school-level data, the presence of Metco students has a marked negative effect on average performance. Increasing the number of Metco students by ten percentage points in Brookline (about two per class) lowers average scores by almost 2½ percentage points, or about 40 percent of the standard deviation of the group averages. Of course, this may be a pure composition effect arising from the large gap between the scores of Metco and non-Metco students, a point to which we return below.

Because Metco students' scores are concentrated in the lower tail of the Brookline residents' score distribution, increasing the fraction Metco shifts the overall score distribution most sharply in the lower tail. To illustrate this point, the bottom panel of Table 5 shows the effect of

[13] The standard errors in columns (5) to (8) are adjusted for cell-clustering. All models using data pooled across grades include a set of cohort effects (for 11 grade/year cohort groups). Models using microdata include dummies for sex and race.

fraction Metco on the 0.2 quantile (second decile) of the score distribution in each cell. The estimates in columns (1) to (4) were constructed by replacing the mean score with the 0.2 quantile score in equation (1), while columns (5) to (8) report quantile regression estimates using micro data. The estimates suggest that increasing the proportion Metco from 0 to 10 percent lowers the second decile of the core national percentile rank score distribution by 4 to 6 points.

The quantile results, like those for average scores, may simply reflect the fact that Metco students have lower scores than Brookline residents on the ITBS. But the magnitude of the effect on the lower tail is nevertheless of interest. First, previous research suggests a strong positive correlation between individual achievement and the achievement levels of peers in the classroom. While the proper interpretation of this correlation is disputed, it may indicate a peer effect.[14] The effect of fraction Metco on average scores is large enough that increases in fraction Metco may induce a negative peer effect that is sufficiently large to appear in our data. Second, increasing the number of students at the bottom of the achievement distribution may have an especially adverse impact on other students if, for example, classroom instruction is targeted at low-achievers or if low-achieving students are more likely to be disruptive or require more of the teacher's attention.

Another aspect of the relation between fraction Metco and the Brookline school environment, not described in Table 5, is the impact on racial composition. A number of authors have found a negative association between percent minority in schools or classes and academic performance, particularly for minority students. The mechanism behind this effect is unclear since percent minority is presumably a proxy for a variety of economic and social differences. In any case, increasing the fraction Metco sharply increases the proportion minority in Brookline schools; indeed, the "first-stage effect" of fraction Metco on percent minority is close to one. As with peer effects that operate through test scores, any effects of school racial composition may also be detected through an analysis of Metco.

III. Impact on Non-Metco Students

We estimated the effect of Metco students on the achievement of non-Metco students using two models similar to those used to construct the estimates in Table 5. The first is a regression of the average national percentile rank of non-Metco students on the fraction Metco in a grade, school, and year. The regression includes grade, school, and year main effects, as well as controls for class size:

$$(2)\qquad \bar{y}^{*}_{gjt} = \alpha_{0g} + \beta_{0j} + \gamma_{0t} + \delta_0 m_{gjt} + \lambda_0 s_{gjt} + \eta_{gjt}$$

where $\bar{y}^{*}_{gjt}$ is the average score in the cell, omitting Metco students. The model includes controls for cohort when grades are pooled, since some students are observed more than once. Equation (2) was estimated without weighting, since weighted estimation generates the same results as estimation using micro data if there are no student-level controls.

The second approach uses micro data and adds controls for student characteristics. The regression model in this case can be written

$$(3)\qquad y_{gjti} = \alpha_{0g} + \beta_{0j} + \gamma_{0t} + \delta_0 m_{gjt} + \lambda_0 s_{gjt} + \mathbf{X}_i'\mathbf{\Gamma}_0 + \varepsilon_{gjti}$$

where $\mathbf{X}_i$ is a vector of race, sex, special education, and TBE/ESL dummies and ε_{gjti} is an individual random error term. As in equation (2), the model includes cohort dummies when grades are pooled. Both equations (2) and (3) presume that Metco effects operate essentially as a contemporaneous "treatment effect." In practice, however, effects of exposure to Metco students may be cumulative. Since the fraction Metco in a cohort is fairly persistent over time, the pattern of effects across grades provides some evidence on this point and is discussed in the assessment of results.

The standard errors for the micro model were adjusted for clustering using the formula in Kung-yee Liang and Scott L. Zeger (1986), i.e., the procedure implemented by the *Stata* cluster

[14] For references to empirical studies and a recent theoretical model of peer interactions in education, see Edward P. Lazear (2001). For a skeptical look at peer effects, see William N. Evans et al. (1992).

TABLE 6—OLS RESULTS FOR NON-METCO STUDENTS

	Grouped data				Micro data			
Subject	Pooled (1)	3rd (2)	5th (3)	7th (4)	Pooled (5)	3rd (6)	5th (7)	7th (8)
Panel A. All non-Metco students								
Core	3.19	1.41	1.57	6.62	−5.18	−1.60	−6.50	−3.45
	(7.52)	(14.2)	(13.7)	(12.3)	(5.88)	(10.9)	(10.2)	(8.16)
Reading	5.30	−2.06	−1.14	10.2	−2.78	−3.93	−5.82	0.067
	(6.91)	(13.9)	(13.5)	(10.1)	(5.09)	(9.74)	(11.2)	(6.89)
Math	4.53	4.66	−0.322	8.34	−4.81	4.46	−11.8	−2.86
	(8.72)	(16.7)	(17.5)	(14.1)	(7.03)	(12.1)	(12.9)	(9.42)
Language	0.531	−4.63	4.91	5.42	−8.38	−11.5	−3.18	−4.96
	(8.11)	(14.1)	(13.9)	(12.3)	(6.57)	(11.6)	(10.2)	(8.11)
N	168	56	56	56	8,146	2,672	2,796	2,678
Panel B. Black non-Metco students								
Core	−78.1	−218	21.8	−68.0	−33.1	−170	26.9	−3.75
	(36.6)	(92.8)	(79.8)	(45.0)	(24.5)	(54.4)	(49.8)	(30.4)
Reading	−66.2	−288	14.9	−2.40	−29.7	−180	20.0	19.2
	(36.0)	(94.9)	(62.1)	(43.6)	(24.5)	(56.6)	(39.5)	(33.2)
Math	−50.0	−92.1	22.5	−61.2	−5.4	−31.1	32.7	2.62
	(37.0)	(81.0)	(81.6)	(51.9)	(28.3)	(66.1)	(55.6)	(36.5)
Language	−102	−237	0.529	−83.4	−47.3	−175	29.4	−12.4
	(41.0)	(65.7)	(88.9)	(52.5)	(25.0)	(52.9)	(57.8)	(32.0)
N	146	45	49	52	534	169	183	182

Notes: Columns (1) to (4) report OLS estimates of the coefficient on the fraction Metco variables in equation (2) using cell means. Columns (5) to (8) report student-level estimates from equation (3). The fraction Metco variable was constructed from the Riverside testing data. Robust standard errors are reported in parentheses in columns (1) to (4). Standard errors in columns (5) to (8) are clustered by grade/school/school–year. The dependent variable is the relevant test score. Covariates include class size and fixed effects for school and school year. Models for columns (5) to (8) also include race, gender, ESL/TBE, and special education indicator variables as covariates. Models for columns (1) and (5) contain grade and cohort fixed effects. The *N* row shows the number of observations in the core regression (or the number of cells).

command. In practice, the standard errors from this procedure may be misleading, especially when there are few clusters, and inference using grouped data has been shown to be more reliable (see, e.g., Ziding Feng et al., 2001; Stephen Donald and Kevin Lang, 2001). This leads us to report results using both cell means and individual data. Both the grouped and micro equations use the fraction Metco tested for m_{gjt} since this is more consistently measured and probably more accurate than the fraction Metco enrolled (though estimates using both measures are similar).

Pooled estimates of equation (2) generate small positive, but insignificant, effects of fraction Metco on average non-Metco scores in each subject. This can be seen in the first four columns of panel (A) in Table 6. The estimates using microdata, reported in columns (5) to (8), are negative but again small and insignificant, suggesting that the proportion Metco has no effect on non-Metco students. On the other hand, it should be noted that the standard errors for the microdata estimates in column (5) are such that the smallest negative effect that could be detected (i.e., the effect that would be significant at the 5-percent level in a one-tailed test) is about $5.9 \times 1.64 = -9.7$. Since the effect of fraction Metco tested on peer means is −24 (see column [5] in Table 5), the smallest detectable peer effect that operates solely through the test scores of all classmates is about 0.4. On the other hand, if the lower tail of the score distribution matters for achievement, then peer effects as small as 0.2 would be significant.

The results therefore reject effects in the upper range of those found in prior research on peer effects, but smaller effects cannot be ruled out. For example, using data from Texas schools, Hoxby (2000) reports estimates of the effect of the average peer score ranging from 0.1 to 0.55. Our estimates for Brookline rule out the high end of these effects but not the low end. It bears emphasizing, however, that earlier studies of peer effects report estimates that are not fully captured by differences in test scores. For example, Eric Hanushek et al. (2002), also using data from Texas schools, report large effects of racial composition that do not appear to be driven solely by the achievement differences of classmates.

Earlier analyses also suggest that peer effects may be especially important within racial groups. For example, black students may interact more with other blacks. Estimates for black residents of Brookline, reported in panel (B) of Table 6, show no significant Metco effects on fifth and seventh graders, but some of the estimates for third graders are negative and significant. The smaller estimates in column (6) are probably more reliable since these control for such individual student characteristics as sex, special education status, and ESL/TBE status. These estimates show significant negative effects in the third grade on all scores except math.[15] Adding a Metco student to a class (i.e., going from 0 to about 5 percent Metco) is estimated to reduce black test scores by 8 to 9 points, or 0.3 of the standard deviation of the score distribution for black third graders who live in Brookline.[16]

The effects on black students cannot be easily explained by a traditional peer effect that operates solely through test scores, since Table 5 suggests that increasing the fraction Metco by 5 percentage points reduces average test scores among peers by only about 1.25 points. Effects as large as those in panel (B) of Table 6 may therefore signal some sort of endogeneity problem or omitted variables bias. On the other hand, this result could be explained by a localized peer effect where additional Metco students displace relatively high-scoring and high-social-economic-status (SES) Brookline residents in a minority student's immediate peer group. Moreover, as noted above, peer effects need not operate solely through test scores. The fact that the negative effects appear for language and reading is consistent with Eaton's (2001) account of Metco, since some Metco students reported differences in speech patterns to be a major hurdle in adapting to the suburban environment.[17] But the fact that negative estimates are limited to the third-grade sample and absent for math scores also suggests these effects be spurious or at least may dissipate quickly.

As an initial check on the OLS estimates, we computed estimates controlling for individual student effects, exploiting the fact that about 40 percent of the sample is observed twice. These results, reported in detail in our working paper (Angrist and Lang, 2002), are generally in line with the OLS estimates in Table 6. Not surprisingly, however, the fixed effects estimates are not as precise as those in Table 6.

IV. Instrumental Variables Estimates

There are at least two reasons why the estimates in Section III could be biased by omitted variables. First, school officials may reduce class size when students are doing poorly or allow larger classes when students are doing well.[18] This notion is supported by the fact that non-Metco students in smaller classes have lower average scores than those in larger classes. Since Metco students are more likely to be assigned to smaller classes, this can generate spurious negative correlation between fraction Metco and non-Metco achievement. Although the estimates in Table 6 control for a linear term in class size, this may be inadequate and class size may not be measured accurately. A second source of bias, and one that works in the opposite direction, may arise from efforts to place Metco students where non-Metco students are doing relatively well, a source of bias that may

[15] Estimates for blacks and Hispanics together suggest the impact on minority students is driven primarily by effects on blacks.

[16] Because Metco status is less well-measured in the first two years, it's worth noting that the results for blacks and whites are similar when these two years are omitted. Although the same specification is used for all of the estimates in Table 6, the OLS results are similar when class size is omitted (though the IV results are not; see below).

[17] Similarly, Alison Bethel (1999) recounts the concerns of upper-middle-class black parents from Concord, an affluent Metco-receiving suburb of Boston. These parents worry about negative examples and a tendency of some of their children to affect "a certain street savvy style and language" when mixing with poorer blacks.

[18] For example, accelerated math classes at one school are offered with the stipulation (spelled out in a memo to parents) that these classes are larger than usual.

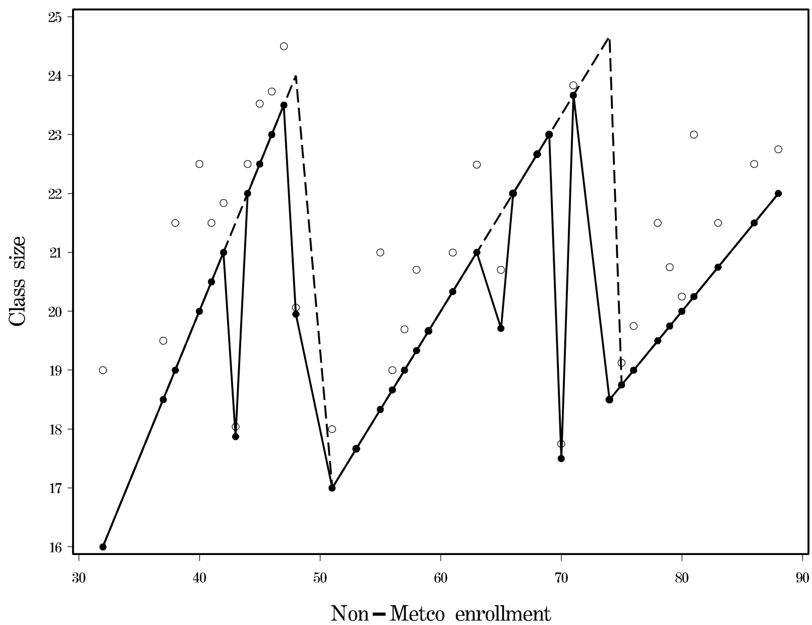

FIGURE 1. PREDICTED AND ACTUAL CLASS SIZE
(*Circles denote size with Metco students included; dots denote size without Metco. Data are for Brookline third graders.*)

also affect the within-district estimates in Section I. Our instrumental-variables strategy provides a check on both sorts of bias.

A. *Maimonides at 25*

The IV estimates exploit the fact that Metco students are assigned to Brookline schools partly on the basis of a space constraint. Class size in Brookline is capped at 25 by agreement with the teachers' union and, in practice, classes as large as 25 are rare. This motivates the following version of what Angrist and Victor Lavy (1999) termed Maimonides' rule, after the biblical scholar, who proposed a maximum class size of 40 in a Talmudic commentary. With a maximum size of 25, the rule is

$$r_{gjt} = e_{gjt}/(\text{int}(e_{gjt}/25) + 1) \tag{4}$$

where e_{gjt} is *non-Metco enrollment* and r_{gjt} is predicted class size. Figure 1 plots r_{gjt} against enrollment using a dashed line and actual class size against enrollment using connected dots for third graders. The figure shows that r_{gjt} captures the relation between third-grade enrollment and class size remarkably well.

Our discussions with school officials suggest that Metco students are typically assigned to schools in light of information about the enrollment anticipated for the coming year. When classes are expected to be small, the Boston Metco office is notified that space is available for Metco students. We model the Metco assignment process as allocating 1 Metco student per classroom if predicted enrollment is fewer than 23. We use predicted instead of actual class size to determine space availability since the latter may be endogenous and is unknown when Metco students are accepted. This reasoning leads to the following instrumental variable for the number of Metco students in a class:

$$z_{gjt} = \min[\max(23 - r_{gjt}, 0), 1]. \tag{5}$$

The first stage is plotted in Figure 2 for third graders, with enrollment again shown on the *X*-axis. Note that the instrument is similar to a simple indicator for $r_{gjt} < 23$, though differs in that z_{gjt} can take on fractional values. For example, for $e_{gjt} = 45$, we have $z_{gjt} = 0.5$.

Although much of the variation in the number of Metco students remains unexplained by

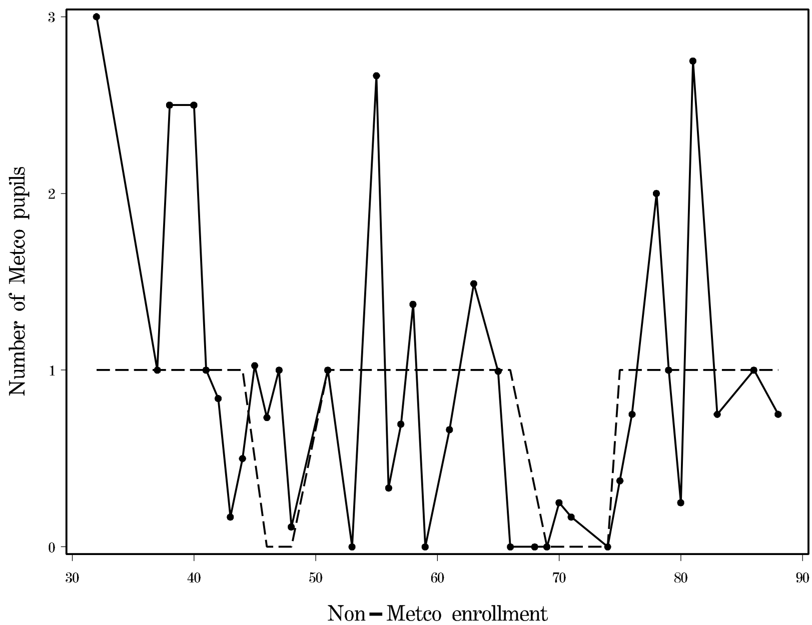

FIGURE 2. ACTUAL NUMBER OF METCO STUDENTS IN THIRD GRADE CLASSES AND THE NUMBER PREDICTED AS A FUNCTION OF THIRD-GRADE ENROLLMENT.

this model, z_{gjt} is clearly correlated with Metco placements in the third grade. The IV analysis that follows focuses on third graders since z_{gjt} is most highly correlated with the number of Metco students entering the school system. We also briefly discuss results for fifth graders using a modified version of the identification strategy where fifth graders are linked to their third-grade cohort size.

The second-stage equation for the IV estimates for third graders is

$$(6)\quad y_{jti} = \beta_{2j} + \gamma_{2t} + \delta_2 a_{jt} + \lambda_2 n_{jt} + \varphi_2 e_{jt} + \mathbf{X}_i'\mathbf{\Gamma}_2 + \xi_{jti}$$

where a_{jt} is the average number of Metco students per third-grade classroom in school j in year t, n_{jt} is the corresponding number of non-Metco students, and e_{jt} is the total grade enrollment. (Here we drop grade subscripts since the analysis uses data for third grade only.) Note that this model differs from that used to construct the OLS estimates. In particular, we replace m_{gjt}, the *fraction* Metco in a grade, with a_{jt}, the average *number* Metco in a third-grade class, while total class size, s_{gjt} is replaced with non-Metco class size, n_{jt}. Equation (6) is more attractive than equation (3) in this context because it allows us to experiment with alternative assumptions regarding non-Metco class size effects. It seems sensible to use equation (6) to explore specifications where a_{jt} is treated as endogenous while n_{jt} is not. In contrast, it is difficult to rationalize a model that treats the fraction Metco, m_{jt} $(=a_{jt}/s_{jt})$, as endogenous, while at the same time treating total class size, s_{jt} $(=a_{jt} + n_{jt})$, as exogenous.

In principal, two instruments, z_{jt} and r_{jt}, are available for the two potentially endogenous variables, a_{jt} and n_{jt}. In practice, however, both of these instruments are nonlinear functions of the same underlying grade-level enrollment variable, e_{jt}. Consequently, two-stage least squares (2SLS) estimates treating class size as endogenous are imprecise. We therefore begin by discussing models where only the number of Metco students per class is treated as endogenous, while imposing alternative assumptions regarding the impact of non-Metco class size. The first set of estimates is from models that include non-Metco class size as an exogenous covariate. The second set is based on a model that restricts class size effects to be

TABLE 7—OLS, FIRST-STAGE, AND REDUCED-FORM ESTIMATES FOR ALL NON-METCO THIRD GRADERS

	Dependent variable											
	Core			Reading			Math			Language		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A. OLS											
Number Metco in class	0.586	0.162	−0.145	0.369	0.081	−0.177	0.593	0.343	0.056	−0.018	−0.340	−0.609
	(0.601)	(0.626)	(0.713)	(0.502)	(0.520)	(0.601)	(0.657)	(0.653)	(0.731)	(0.647)	(0.666)	(0.726)
Number non-Metco enrolled	−0.033		−0.038	−0.0029		−0.0042	−0.047		−0.049	0.012		0.0089
	(0.076)		(0.077)	(0.060)		(0.061)	(0.084)		(0.084)	(0.080)		(0.081)
Number non-Metco in class	0.658		−0.530	0.584		−0.530	0.368		−0.530	0.656		−0.530
	(0.215)			(0.207)			(0.252)			(0.207)		
N		2,672			2,773			2,716			2,763	
	Panel B. First-stage—Dependent variable is number Metco in class											
Instrument	0.921	0.875	0.873									
	(0.185)	(0.163)	(0.170)									
Number non-Metco enrolled	0.0014		0.0016									
	(0.016)		(0.016)									
Number non-Metco in class	0.0205											
	(0.040)											
N		2,812										
	Panel C. Reduced form											
Instrument	−0.069	−1.50	−2.67	0.280	−1.10	−2.36	0.369	−0.513	−1.64	−0.429	−1.85	−3.13
	(1.39)	(1.33)	(1.60)	(1.01)	(1.02)	(1.32)	(1.63)	(1.41)	(1.63)	(1.53)	(1.49)	(1.75)
Number non-Metco enrolled	−0.029		−0.021	−0.0020		0.0087	−0.045		−0.037	0.015		0.025
	(0.078)		(0.073)	(0.062)		(0.058)	(0.086)		(0.082)	(0.080)		(0.076)
Number non-Metco in class	0.610		−0.530	0.586		−0.530	0.356		−0.530	0.620		−0.530
	(0.259)			(0.241)			(0.302)			(0.243)		
N		2,672			2,773			2,716			2,763	

Notes: Panel (A) reports OLS estimates of equation (6) in the text. Panel (B) shows the impact of predicted number Metco on actual number Metco. Panel (C) shows estimates of the effect of predicted Metco (the instrument) on test scores. Models include school–year and school fixed effects and race, sex, ESL/TBE, and special education dummies. Standard errors clustered by grade/school/school year cell are reported in parentheses. Models shown in columns (3), (6), (9), and (12) of panels (A) and (C) constrain the effect of the number of non-Metco in class to be −0.53, similar to the effect found in Angrist and Lavy (1999).

zero. Finally, we compute estimates assuming that λ_2 equals −0.53, a value derived from Angrist and Lavy (1999).

For purposes of comparison, the top panel of Table 7 reports OLS estimates of equation (6) for each score in the full sample of third graders. Similar to the regressions in Table 6 with fraction Metco as an explanatory variable, these estimates show no relation between the number of Metco students in a class and non-Metco students' test scores. The table also reports positive and significant coefficients on non-Metco class size when this variable is treated as an exogenous covariate. It seems unlikely that the positive class size coefficients have a causal interpretation. These coefficients most likely reflect a tendency in borderline cases to choose a smaller class size when the grade has a number of struggling students. The OLS estimates of the effect of the number Metco remain small and insignificant regardless of whether the model includes non-Metco class size and non-Metco enrollment variables as controls.

B. *First-Stage and Reduced-Form Effects*

The first stage equation for models where non-Metco class size is treated as exogenous is

$$(7)\quad a_{jt,i} = \beta_{1j} + \gamma_{1t} + \delta_1 z_{jt} + \lambda_1 n_{jt} + \varphi_1 e_j + \mathbf{X}_i'\mathbf{\Gamma}_1 + v_{jt,i}$$

where $a_{jt,i}$ is the average number of Metco students per class in school j at date t, and the i subscript indicates that the equation is estimated using micro data. The reduced-form effect of z_{jt} on third-grade test scores is

$$\pi = \delta_1 \delta_2$$

obtained by substituting equation (7) into equation (6). First-stage estimates for models where the effects of non-Metco class size are assumed to be 0 or −0.53 were calculated by setting $\lambda_1 = 0$ in this equation, so that the model is identified using z_{jt} as the sole instrument.

Panel (B) in Table 7 reports the first-stage estimates for the full sample, including students with missing scores. The estimates of δ_1, ranging from 0.87 to 0.92, are largely insensitive to assumptions regarding the impact of non-Metco class size. The first-stage coefficients are precisely estimated with t-statistics of over 5 for each model. Because the first-stage estimates are close to one, the reduced-form effect, π, is almost the same as the second-stage coefficient, δ_2. Second-stage estimates are therefore omitted.

The reduced form estimates are reported in the bottom panel of Table 7. Consistent with the OLS estimates reported in the top panel, estimates from models that treat non-Metco class size as exogenous show no relation between z_{jt} and test scores. The results become increasingly negative, however, as we move to models where the assumed class-size effect is zero, and finally to models where the class-size effect is set at -0.53. In the latter specification, the estimated effect of Metco students on their non-Metco peers is negative and at least marginally significant for the core national percentile rank score and for two of the three subject tests. For example, the estimate in column (3) suggests that the presence of a Metco student reduces average non-Metco scores by 2.7 points, with a clustered standard error of 1.6.

The strong positive OLS estimates of the effects of class sizes on achievement suggest an endogeneity problem with this variable. Discounting positive effects, however, it remains to choose between specifications where class-size effects are zero and specifications where class-size effects are substantially negative, as in Angrist and Lavy (1999). Because classes are much smaller and SES much higher in Brookline than in the Angrist/Lavy sample, zero may be a better estimate of the average causal effect in this context. In the next subsection, we discuss 2SLS estimates using multiple instruments in an attempt to estimate the effects of number Metco and non-Metco class size jointly.

C. *2SLS Estimates*

As noted above, the instrumental variable z_{jt} is approximately equal to an indicator for $r_{jt} < 23$. Since predicted class size ranges from 16 to 24.67 in the third-grade sample, it seems natural to look for increased statistical power by adding dummy instruments for values of r_{jt} other than 23. We therefore computed 2SLS estimates using an instrument set consisting of 6 indicator variables for high values of predicted class size:

$$(19 \leq r_{jt} < 20), (20 \leq r_{jt} < 21),$$

$$(21 \leq r_{jt} < 22), (22 \leq r_{jt} < 23),$$

$$(23 \leq r_{jt} < 24), \text{ and } (24 \leq r_{jt} < 25)$$

plus a linear term for r_{jt} itself. Both the number Metco, a_{jt}, and non-Metco class size, n_{jt}, were treated as endogenous when using multiple instruments.

The 2SLS estimates, reported in Table 8, show near-zero effects of class size on non-Metco achievement in Brookline. Not surprisingly, therefore, the expanded instrument set generates coefficient estimates for the effect of Metco that are not significantly different from zero in the full sample. For example, the estimated effect of Metco on core national percentile rank scores with or without class size controls is about -0.80, with a standard error of 1.35. The estimate in column (3), which reports the results of dropping enrollment controls from the model for national percentile rank scores, is -1.36 with a standard error of 1.1, comparable to the reduced-form estimate in column (2) of Table 7, and slightly more precise. Note, however, that the 2SLS estimates are only about half as precise as the corresponding OLS estimates for third graders in Table 6. (To make the comparison, divide the standard errors in Table 6 by 20.)

The 2SLS estimates for black students are reported in panel (B) of Table 8. These estimates are also broadly consistent with the OLS estimates reported in Table 6, suggesting Metco students have a negative impact on the reading and language scores of their third-grade black peers. Like the OLS estimates, the 2SLS estimates show no effect on math scores. The estimated effects of fraction Metco on reading scores without class-size controls are significantly different from zero, while other estimates are not as sharp. Some of the 2SLS estimates for blacks are also markedly larger than the corresponding OLS estimates, perhaps implausibly so. On the other hand, the 2SLS estimates with controls for class size and enrollment are rea-

TABLE 8—2SLS ESTIMATES FOR NON-METCO THIRD GRADERS WITH NUMBER METCO AND NUMBER NON-METCO ENDOGENOUS

	Dependent variable											
	Core			Reading			Math			Language		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A. All non-Metco students											
Number Metco in class	−0.771	−0.801	−1.36	−1.14	−1.12	−1.27	−0.889	−0.953	−0.950	−1.16	−1.11	−1.62
	(1.34)	(1.35)	(1.08)	(1.20)	(1.21)	(0.893)	(1.47)	(1.47)	(1.12)	(1.41)	(1.40)	(1.24)
Number non-Metco enrolled	0.270	0.270		0.074	0.077		0.0050	−0.0020		0.224	0.253	
	(0.469)	(0.474)		(0.425)	(0.430)		(0.554)	(0.560)		(0.425)	(0.424)	
Number non-Metco in class	−0.028			0.0052			−0.038			0.017		
	(0.076)			(0.059)			(0.084)			(0.078)		
First-stage F-stat[a]	9.79	9.58		8.14	8.10		9.89	9.72		8.24	8.13	
N		2,672			2,773			2,716			2,763	
	Panel B. Black non-Metco students											
Number Metco in class	−8.27	−10.5	−12.3	−11.1	−13.8	−16.1	2.72	−1.63	−0.612	−10.4	−14.1	−10.9
	(6.91)	(6.42)	(6.06)	(7.95)	(7.49)	(6.92)	(6.79)	(6.59)	(5.08)	(7.10)	(6.89)	(5.30)
Number non-Metco enrolled	0.947	0.759		1.31	1.01		−0.058	−0.387		−0.937	−1.29	
		(1.16)	(0.474)		(1.22)	(1.31)		(1.39)	(1.38)		(1.34)	(1.34)
Number non-Metco in class	−0.061			−0.0055			−0.247			−0.147		
	(0.284)			(0.333)			(0.263)			(0.333)		
First-stage F-stat[a]	2.28	2.59		2.22	2.78		2.48	2.65		2.59	3.05	
N		169			182			176			182	

Notes: The table reports 2SLS estimates of equation (6) in the text. Models include school–year and school fixed effects and sex, ESL/TBE, and special education dummies. Panel (A) includes race dummies. Standard errors clustered by school/school year cell are reported in parentheses. The sample is restricted to non-Metco third graders in panel (A). The sample is restricted to black non-Metco students in panel (B). The instrument set includes a linear term for predicted class size (pclass) and the following six indicator variables: $1(24 \le r_{jt} < 25)$, $1(23 \le r_{jt} < 24)$, $1(22 \le r_{jt} < 23)$, $1(21 \le r_{jt} < 22)$, $1(20 \le r_{jt} < 21)$, $1(19 \le r_{jt} < 20)$.

[a] *The first-stage* F-stat refers to the F-statistic on the vector of instruments in the first stage. The F-statistic uses standard errors clustered by school/year cell.

sonably close to the OLS estimates in Table 6 (compare $-170/20 = -8.5$ in column (6) of Table 6 with -8.3 in column (1) of Table 8). The estimated class size effects are not significantly different from zero for blacks.

As a final check on the results for third graders, we reestimated the OLS model separately for male and female black students. Just as the presence of Metco students seems more likely to affect minority residents of Brookline than whites, the fact that Metco students are disproportionately female suggests it is worth looking for differential effects by sex. We return to OLS for this analysis since the IV and OLS estimates are broadly consistent, while the OLS estimates are more precise. The additional OLS results, reported in Table 9, are from equations estimated separately for black boys and black girls, with the percentage of male and female students from Metco entered as separate regressors in each subsample. These results support the notion that within-gender effects are more important. Again, results for third graders are consistently negative. Moreover, these negative estimates are generally larger in magnitude within sex groups than across, and the only significant estimates in the tables are for the effect of percent female Metco on black girls in third grade.[19]

D. *IV Estimates for Fifth Graders*

The IV first stage exploited above does not work as well for fifth graders as for third graders, probably because the allocation of Metco students to schools is primarily determined at the time the students begin attending school in Brookline. Moreover, Metco students tend to enter in younger grades and then stay in the schools to which they were originally assigned. At the suggestion of a referee, we therefore tried a variant of the IV strategy for fifth graders using the predicted number of Metco students in a fifth-grade school and cohort, looking back to that cohort's enrollment in third grade.

For all fifth graders, this turns out to generate a first stage a bit weaker than that for third graders, but still significant. On the other hand, when looking back two years, we lose two years

[19] Because the separate samples of black girls and boys are small and robust standard errors are biased downward, the table shows unadjusted standard errors in parentheses as well as robust standard errors in brackets.

TABLE 9—OLS RESULTS FOR BLACK NON-METCO STUDENTS

	Male				Female			
Subject	Pooled (1)	3rd (2)	5th (3)	7th (4)	Pooled (5)	3rd (6)	5th (7)	7th (8)
	Panel A. Coefficient on fraction of male students from Metco							
Core	−27.1	−120	101	−83.6	18.9	38.6	55.1	−66.1
	(37.2)	(77.6)	(89.5)	(53.7)	(35.8)	(87.6)	(59.8)	(66.5)
	[40.7]	[64.7]	[80.2]	[35.9]	[28.2]	[69.0]	[40.0]	[51.5]
Reading	−15.7	−98.8	103	−48.7	9.40	18.3	39.2	−30.9
	(37.2)	(82.4)	(84.0)	(55.4)	(38.4)	(91.1)	(66.3)	(73.8)
	[37.2]	[62.9]	[72.6]	[37.3]	[31.2]	[76.9]	[48.8]	[51.8]
Math	−18.6	−45.2	88.9	−70.0	71.6	186	85.4	−77.9
	(39.1)	(81.5)	(87.2)	(59.1)	(38.0)	(88.2)	(60.5)	(74.9)
	[42.4]	[63.1]	[85.1]	[38.7]	[31.9]	[64.4]	[37.8]	[61.9]
Language	−41.3	−98.0	100	−102	−13.1	−6.18	27.3	−83.8
	(36.5)	(72.3)	(84.3)	(55.2)	(36.4)	(88.3)	(64.6)	(61.4)
	[37.8]	[68.6]	[79.2]	[39.1]	[30.0]	[74.5]	[42.8]	[49.8]
	Panel B. Coefficient on fraction of female students from Metco							
Core	2.28	9.26	−101	58.4	−59.8	−232	−70.8	48.0
	(39.6)	(97.4)	(109)	(54.5)	(36.1)	(84.4)	(71.0)	(50.5)
	[40.1]	[70.6]	[121]	[44.6]	[32.7]	[65.5]	[47.3]	[43.5]
Reading	2.54	−50.1	−125	50.8	−55.4	−208	−51.4	34.2
	(40.5)	(106)	(99.3)	(56.3)	(39.5)	(91.1)	(79.3)	(56.0)
	[39.2]	[84.3]	[116]	[43.1]	[30.9]	[70.3]	[57.6]	[33.9]
Math	23.1	162	−119	73.7	−93.3	−258	−108	13.0
	(41.4)	(95.9)	(105)	(59.1)	(38.8)	(87.4)	(72.3)	(56.9)
	[42.5]	[95.6]	[126]	[47.9]	[36.1]	[64.3]	[56.4]	[52.1]
Language	−1.95	51.3	−69.2	52.0	−17.3	−179	−32.5	88.1
	(39.2)	(86.9)	(107)	(56.1)	(37.0)	(87.1)	(76.6)	(46.5)
	[38.7]	[83.6]	[101]	[47.4]	[38.4]	[74.6]	[52.6]	[48.1]
N	276	81	93	102	258	88	90	80

Notes: The table reports student-level OLS estimates by sex. Columns (1) to (4) report estimates for male non-Metco black students. Columns (5) to (8) report estimates for female non-Metco black students. Panel (A) reports coefficients on the percentage of male students who are Metco. Panel (B) reports coefficients on the percentage of female students who are Metco. Standard errors are reported in parentheses. Standard errors clustered by grade/school/school–year cell are reported in brackets. Covariates include class size, fixed effects for school and school year and ESL/TBE, and special education indicator variables. Columns (1) and (5) contain grade and cohort fixed effects. The *N* row displays the number of observations included in the core test score regression.

of data. Probably for this reason, the first stage is no longer significant for blacks. The resulting IV estimates of the effect of Metco students on all fifth graders, not reported in detail to save space, are similar to the OLS estimates for fifth graders, again showing no significant effects of the fraction Metco on the scores of all students.

V. Summary and Conclusions

Although Metco students have markedly lower test scores than students in Brookline and most other host districts, we find little evidence of socially or statistically significant effects of Metco students on their non-Metco classmates. Our analysis of average MCAS scores from a cross-section of schools suggests that the negative association between fraction Metco and test scores within districts can be accounted for by composition effects. Similarly, both OLS and IV estimates using micro data from Brookline show no effect of Metco students in the full sample of non-Metco students. The OLS estimates are precise enough to rule out test-score-mediated peer effects at the high end of those reported in the literature, although smaller effects are possible. Moreover, in contrast with most of the findings in previous research on peer effects, our results also imply no adverse impact of increasing the fraction minority on most students.

Consistent with previous research, which shows racial composition effects to be strongest within racial groups, we do find some evidence for a negative impact of fraction Metco on the reading and language scores of black third graders. These results turn out to be driven by effects on girls, consistent with the fact that Metco students are more likely to be female. Perhaps Metco students displace relatively high-scoring local students among the peers of young black girls resident in the host district. But a number of factors lead us to conclude that any effects on minority students in the host district are modest and short-lived. First, many of these estimates are imprecise. Also, the finding seems highly localized, specific to a particular grade/sex combination. Finally, the pattern of effects by grade is noteworthy for the fact that exposure to Metco students has a large cumulative dimension. We might therefore expect treatment effects to grow as grade advances. Instead, the effects seem to fade.

Of course, Metco is only one program, and a fairly unique social experiment, and most of our evidence comes from a single district. At the same time, we believe that a careful analysis of Metco provides uniquely compelling evidence on the effects of integration and peer effects more generally. Most studies of peer effects and student mixing are confounded by omitted-variables bias and spurious effects that arise any time individual characteristics are regressed on group averages. Although not discussed in detail here, we note that individual student achievement is indeed highly correlated with school-by-grade averages in Brookline, with estimates not unlike similar correlations reported in many other studies. The evidence from Metco—an exogenous shock to peer composition of the sort that students are exposed to when integration policy shifts—casts doubt on the usual sort of evidence presented in support of peer effects.

Finally, our Metco results are of policy interest in light of the accountability provisions of the NCLB, which promote a Metco-like choice program with the potential to require out-of-district placements for students from schools judged to be underperforming. It seems likely that many of the students in these schools will be drawn from urban areas like Boston. The willingness of school districts to accept such out-of-district placements will undoubtedly depend in part on the perceived consequences for local students.

Data Appendix

1. Table 1. Enrollment and demographic data in Table 1 are from the Massachusetts Department of Education files available through their Web page (http://www.doe.mass.edu/infoservices/reports/enroll/ or from the authors). Metco counts by school for 2002 were provided by the DOE and aggregated to the district level. These were also used to construct the estimates in Table 2.
2. Table 2. MCAS Data for 2002 are from the Massachusetts Department of Education Web page, available at the time of this writing through http://www.doe.mass.edu/mcas/2002/results/data/ (see state results by race/ethnicity) or from the authors. The MCAS contains an English language arts component and mathematics component, as well as other subjects in some grades. The score is a scaled score, also reported by "proficiency level." Scores are reported by school, grade, and race.

At our request, the DOE provided a tabulation of the number of Metco students in each school and grade, as measured in October 2001 (for the 2002 school year) and October 2002 (for the 2003 school year). We matched this to the school-level data file on scores. MCAS scores are reported as scaled scores on a scale of 200–280 and then grouped into four categories: 218 or less is denoted warning/failing, 220–238 is denoted needs improvement, 240–258 is denoted proficient, and higher scores are considered advanced. Scaled scores are a piecewise linear function of raw scores, with a minimum below which all raw scores are scaled to be 200 and a ceiling above which everyone receives 280. For details, see http://www.doe.mass.edu/mcas/2003/news/02techrpt.pdf.

The 2002 score distributions for grade 4 are:

Subject	W/F	NI	P	A
ELA	8.9	36.6	46	7.6
Math	18.1	41.7	27.3	12.1

About 96 to 97 percent of enrolled students were tested in 2002, depending on subject and grade.

3. Brookline data (Tables 3–9). For the purposes of this analysis, ITBS scores from the test publisher were linked with administrative data on student characteristics from the school district. This was a fairly involved process unifying records across different formats and layouts. A detailed account is given in a document available from the authors. The linked file provides information such as sex, race, and whether the student was a Metco student. Also included was programmatic information such as whether students participated in an ESL/TBE program or a special education program, and school characteristics such as enrollment in the grade, number of classes in the grade, and Metco enrollment in the grade.

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