

How do Vouchers Work?

Evidence from Colombia

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Abstract

Some voucher skeptics argue that even if school vouchers benefit recipients, they do so by improving their peer groups at the expense of others', and if so, there may be no net benefit to society as a whole. A necessary condition for this argument is that voucher recipients have more desirable peers than they otherwise would have. We take advantage of an educational voucher program in Colombia, for which spots were allocated by lottery, to identify a set of applicants for whom winning the voucher did not lead to attending schools with peers with superior observable characteristics. In particular, we focus on those who applied to vocational private schools. In this population, lottery losers rather than winners were more likely to attend academic secondary schools. Despite this, we find that even in this population, lottery winners had better educational outcomes, including higher graduation rates and reading test scores. This casts doubt on the argument that voucher effects operate entirely through improving the set of peers available to recipients. One hypothesis is that private vocational schools are much better than public ones at adjusting to the demands of the labor market. Consistent with this hypothesis, private vocational schools are overwhelming concentrated in teaching skills preparing students for Colombia's rapidly growing service sector whereas public vocational schools are much more likely to teach industrial curricula which prepare students for more traditional blue-collar positions.

The effect of educational vouchers on participating students has attracted keen attention from both researchers and policymakers. In developing countries, public schools are particularly weak, so one might expect a particularly strong impact of voucher programs. Angrist, Bettinger, Bloom, King, Kremer (2002) and Angrist, Bettinger, and Kremer (2006) find positive effects found that Colombia's PACES voucher program had strong positive effects on voucher recipients' academic achievement. However, the welfare impact of vouchers depends not simply on their impact on participants, but also on their impact on others. This depends on the channel through which voucher programs work. If the Colombia program worked by allowing students to attend better functioning schools, then it would likely generate no significant externalities on non- participants and since it improved participants' outcomes, the overall welfare benefits would be fairly clear cut. On the other hand, if vouchers helped participants by getting them access to better peers at the expense of non-participants, the program, may not have been desirable for society as a whole.

In particular, vouchers may have helped voucher recipients only by allowing them to move to schools with better peers. However, movements of voucher students from traditional public schools to private schools may have a negative impact on their new peers and perhaps on those left behind in public school. In the simplest linear-in-mean model of peer effects, re-sorting does not affect average scores in the population. (See Hsieh and Urquiola 2003, Epple and Romano 1998).

One way to disentangle hypotheses regarding the importance of peer effects in how vouchers work would be to identify a population for which those who obtain vouchers do not obtain peers with superior observed characteristics and measure the effect of vouchers in this group. More generally, to the extent that winning vouchers creates different peer effects in different populations, one can use this to shed light on the importance of peer effects in accounting for the impact of vouchers. In the Colombian voucher program, students had to apply and be accepted at a private school before they could apply for the voucher. Students could apply to either academic or vocational private schools (escuelas tecnicas). Once students applied, a

lottery was used to determine which students received the voucher. There was considerable stickiness in schools attended by voucher winners, because it was administratively difficult to retain the voucher if one switched schools. Less than 20 percent of students that transferred after the first year of the voucher were able to retain their voucher. Thus, among applicants who applied to vocational private schools, we find that voucher lottery winners were more likely to stay in vocational schools whereas unsuccessful applicants were more likely to change to an academic school.

In general, academic schools are more prestigious than vocational schools in Colombia and have students who are more likely to complete secondary school and obtain high exam scores. Thus, among applicants to vocational schools, voucher winners did not attend schools with higher average scores or higher participation rates on Colombia's college entrance exam. In fact, voucher winners in this group attended schools with higher drop-out rates, less qualified teachers, and lower fees. Despite this, among those who applied to vocational schools, voucher lottery winners have significantly better educational outcomes than losers. The results suggest the observed effects of vouchers are not solely the result of interaction with better peers, casting doubt, at least in the Colombian context, on stories in which benefits to participants are offset by negative externalities on non-participants.

What was the channel by which vouchers led to better outcomes in this population? One hypothesis is that private vocational schools may be providing considerably better services to students, relative to those available at the public vocational schools, and hence students may have more incentive to stay enrolled and to study. Whereas academic schools are likely to cover quite similar curricula whether public or private, for vocational education it is particularly important to adapt to the needs of the labor market. Public vocational schools have a much higher proportion of offerings in industrial vocational training, such as metal working, carpentry, or electrical working, whereas private schools are much more likely to offer vocational training in service industries, like business, secretarial work, communication, and computers. The private sector may

71 have more flexibility than the private sector in shutting down or transforming schools teaching subjects that
72 are no longer in strong demand in the general economy.

73 The remainder of this paper is organized as follows. In section 2 we present background information
74 about the PACES program. In section 3, we address the data and empirical strategy. In section 4, we
75 present a brief model of educational attainment that allows for the possibility that vouchers to work either
76 by allowing participants to attend more productive schools or by helping them obtain better peers, at the
77 expense of others. We develop a way to test this model to identify whether peer effects are the primary
78 mechanism for any observed voucher effect. In Section 5, we show that voucher winners, particularly those
79 in vocational schools, had better educational outcomes than voucher losers. In section 6, we examine
80 alternative explanations of this voucher effect. Section 7 concludes.

81

82 **2. Background**

83 Private schools have always held a prominent role in education in Colombia. Nationwide, almost
84 1/3 of students attend private schools. In Bogotá, the percentage of students in private school is much
85 higher, and over 70 percent of the 1,300 secondary schools in Bogotá are private (King et. al. 1997). During
86 the 1990's, Colombia implemented a secondary school voucher program that provided over 125,000
87 vouchers to people residing in poor neighborhoods. The program was initially launched in Colombia's
88 major cities as an effort to increase secondary enrollment rates amongst the poorest families in Colombia.
89 Students receiving the voucher could attend any private school that accepted the voucher; however, many
90 schools, particularly the elite private schools in Colombia, would not accept the voucher. Slightly less than
91 half of private secondary schools participated in the voucher program.

92 The private schools that took part in the program served lower-income students and charged lower
93 tuition fees than those private schools that chose not to participate. Non-participating private schools had

94 significantly higher teacher-pupil ratios than participating schools. However, teacher-pupil ratios were
95 comparable between public and participating private schools (King et al 1997).

96 Schools with a vocational curriculum were over-represented among participating schools. Data from
97 the Instituto Colombiano para el Fomento de la Educación Superior (ICFES) show that only about 16
98 percent of all high school graduates attended vocational schools. By contrast, 25 percent of voucher
99 winners in our sample applied to purely vocational schools and an additional 23 percent applied to schools
100 with both vocational and academic tracts.¹

101 In order to target the poorest families, eligibility was determined by whether a family's neighborhood
102 was classified as belonging to the two lowest (out of six possible) socio-economic strata. To enforce the
103 eligibility rule, parents were supposed to present a utility bill with household stratification (Calderón, 1996).
104 In addition, vouchers were only available to students attending public primary schools.

105 The application process began with interested students and their families filling out voucher forms
106 printed in newspapers or available at local offices of the Institute for Educational Loans and Technical
107 Studies Abroad (ICETEX), a national-level public institution which administered the program. Students
108 listed a particular school they wished to attend (and which had accepted them on their application) before
109 receiving a voucher. In any given city ICETEX used a public raffle to select the final beneficiaries if the
110 demand exceeded voucher supply. The voucher's value corresponded to the average tuition for a low-to-
111 middle income level private school. Students could renew the vouchers through completion of the secondary
112 school as long as they did not fail grades.

113 Because students' applications were for specific schools, we can separate lottery applicants by
114 characteristics of the schools they applied to. The lottery could be viewed as two separate lotteries – a
115 lottery for students who had applied to vocational schools and a lottery for students who applied to other

¹ We call schools with both vocational and academic tracts "hybrid" schools throughout the paper. About 23 percent of the students in our data attended such schools. We classify these schools as academic although our results are similar if we classify them as vocational schools or exclude them instead.

116 schools. Applicants to vocational schools tend to differ systematically from other applicants. They tend to
117 come from families where the parents are less educated. They are also more likely to be living in the
118 poorest of Colombian neighborhoods, and they typically applied to schools with lower scores on college
119 entrance exams.

120 While the voucher rules suggested that voucher winners could transfer to schools other than the one
121 they listed on their application, few actually did. The process of transferring the voucher was such that,
122 according to the survey data in Angrist, et. al (2002), winners who transferred schools rarely retained their
123 vouchers. The lack of portability in practice meant voucher winners who initially applied to vocational
124 schools were much more likely to stay at the same school and hence the same type of school. Table 1 shows
125 the enrollment patterns of voucher winners and losers who had applied to the voucher program. Of the
126 students who had applied to vocational schools, 60 percent of voucher winners were still in vocational
127 schools three years after the voucher lottery. Only 42 percent of voucher lottery losers who had applied to
128 vocational schools were still enrolled in vocational schools. As we demonstrate later in the paper, the
129 vocational schools had inferior characteristics along several dimensions (e.g. academic completion, peer
130 discipline, fees).

131 Angrist et al (2002) provides some evidence on the validity of the randomization. Among all
132 voucher applicants, there are no significant differences in age, gender, and the likelihood of having a phone
133 by voucher win/loss status. Similarly in the sample of students surveyed, there are no differences in pre-
134 lottery characteristics across voucher lottery winners and losers. The symmetry across winners and losers
135 suggests they are comparable and that the randomization in the lottery was valid.

136 In prior research on the effects of Colombia's voucher program, Angrist et al (2002) finds that after
137 three years lottery winners were 15 percentage points more likely to have attended private school, had
138 completed 0.1 more years of schooling, and were about 10 percentage points more likely to have finished

139 8th grade, primarily because they were less likely to repeat grades. While the program did not significantly
140 affect dropout rates, lottery winners scored 0.2 standard deviations (or about one grade level) higher on
141 standardized tests. Angrist et al (2006) shows that the voucher also increased secondary school completion
142 for participants by 15-20 percent. After correcting for the greater percentage of lottery winners taking
143 college admissions tests, the program increased test scores among participants by two-tenths of a standard
144 deviation in the distribution of potential test scores. Thus, if the benefits to participants were not at the
145 expense of negative externalities for non-participants, then the program was very cost effective given the
146 low cost to the government and the benefits arising from the increase in winners' earnings due to greater
147 educational attainment. Below, we present evidence casting doubt, at least in the Colombian context, on the
148 hypothesis that the positive impact in beneficiaries was from peer effects of the type that would create
149 negative externalities for non-participants.

150

151 **3. Data and Empirical Strategy**

152 The data we use for the present analysis come from three sources. First, we use data from a survey
153 of voucher applicants carried out in Bogotá by Angrist et. al. (2002). During 1998 and 1999, Angrist et. al
154 (2002) interviewed 1,176 applicants from the 1995 cohort of applicants to the program. Of those, 51 percent
155 won a voucher to attend a private secondary school. Using the ICFES classification of academic and
156 vocational schools we determined that roughly 25 percent of applicants applied to vocational schools and
157 the remaining 75 percent to academic or hybrid schools. For 283 students in the survey sample, we also
158 have standardized test scores for a test taken three years after the lottery.² In Table 2 we present some other
159 descriptive statistics from the survey sample.

² Tests cover the math, reading, and writing sections of a standardized test entitled *La Prueba de Realización*. Of the 473 applicants invited, 283 attended.

160 The second source of data relies on matching administrative records from the ICFES with data on
161 their college entrance exams. (See Angrist et al., 2006.) Since 90 percent of Colombian students take the
162 ICFES exam (World Bank 1993), this is likely a good proxy for high school graduation.

163 The final source of data comes from a survey we conducted of schools in our sample. In January
164 2006, attempts were made to contact a sample of 300 schools with a heavy concentration of voucher
165 applicants. The sampling procedure while not random accounted for the schools almost 85 percent of
166 students had attended. In our school survey, we gathered extensive information about school and peer
167 characteristics that we use to demonstrate the differences between schools students attended.³

168 As discussed in detail in Angrist, Bettinger, and Kremer (2006), winners and losers seem
169 comparable on observable characteristics such as age, sex and telephone access, consistent with the
170 hypothesis that the lottery was indeed random. Table 2 reproduces some of these results for the sample of
171 students upon which we focus while disaggregating these comparisons across voucher status by the type of
172 schools that students applied to. For example, among applicants to vocational schools, voucher winners and
173 losers did not have statistically significant differences in terms of age, sex, their parents' schooling, their
174 neighborhood's wealth, and the average quality of the schools that they applied to. Similarly voucher
175 winners at non-vocational schools show no significant differences across voucher status.

176 Table 2 also reports differences between individuals who applied to vocational and non-vocational
177 schools. While there is no significant observed difference in age or gender between applicants to the
178 respective schools, there is a significant difference between parents' education levels and neighborhood of
179 residence. Among students who applied to vocational schools, their mothers and fathers had completed on
180 average 5.2 and 4.8 years of schooling respectively. Among students applying to non-vocational schools,

³ Twenty-seven schools not longer existed, and some schools refused to participate in the survey. There was no significant relationship between voucher status and the likelihood that we were able to contact the student's school of attendance. In surveying the schools in 2006, we are inherently assuming that since the voucher lottery, the characteristics of schools have not changed in a way which is different across voucher status of students.

181 their parents had completed 5.9 and 5.4 years of schooling. The differences are statistically significant.
 182 Additionally, students who applied to the vocational schools were about 50 percent more likely to be living
 183 in the poorest neighborhoods in Bogotá. The average ICFES score was also much lower at vocational
 184 schools relative to non-vocational schools.

185

186 **4. Theoretical Framework**

187 If voucher programs benefit recipients simply by moving them to schools with higher quality peers,
 188 they may not increase average educational achievement in society. We consider a model which nests the
 189 hypotheses that vouchers help participants by allowing them to attend more productive schools with the
 190 hypothesis that they help participants only by allowing them access to more desirable peers at the expense
 191 of other students. In particular, we assume that educational outcomes for person i are given by:

$$192 \quad (1) \quad Y_i = \beta_0 X_i + \beta_1 \overline{X_s} + \beta_2 P + \varepsilon_i$$

193 where X_i is student i 's socioeconomic status or genetically determined ability, $\overline{X_s}$ is the average level of X_i
 194 in school s , and P indicates program participation.⁴ [More generally, we could assume all schools have N
 195 students and that $Y_i = \beta_0 X_i + \beta_1 f[X_i \dots X_{i-1} \ X_{i+1}, X_N] + \beta_2 P + \varepsilon_i$, where $f(\cdot)$ is increasing in all its
 196 arguments.] Under the hypothesis that $\beta_2 > 0$ and $\beta_1 = 0$ vouchers work purely through a productive effect
 197 and the benefit to participants will be equal to the social benefit. Under the assumption that $\beta_2 = 0$ and β_1
 198 > 0 vouchers will not increase average test scores in society but will increase participants' test scores if they
 199 allow participants to obtain better peers. In the case of the linear increases peer effect specification of
 200 equation one, will be exactly offset by declines in test scores of non-participants, but more generally gains
 201 and losses need not exactly offset.

In this framework, estimating the differences in outcomes between participants and non-participants, yields $\beta_1(\bar{X}_{voucher} - \bar{X}_{non-voucher}) + \beta_2$. This is the effect estimated by Angrist et al. (2002, 2006). This would be the observed effect of the voucher on participants. However, if we aggregated across all individuals, the social benefit of the program would only be equal to β_2 . The difference between the private and the social benefits is therefore given by $\beta_1(\bar{X}_{voucher} - \bar{X}_{non-voucher})$.

Consider the case where the voucher has no direct effect ($\beta_2 = 0$) but peer effects are positive ($\beta_1 > 0$). In this case, the observed effect of the voucher is just $\beta_1(\bar{X}_{voucher} - \bar{X}_{non-voucher})$ which is positive so long as the average peer quality of private school students is greater than the average peer quality of public school students. Hence, an individual may benefit from attending a school with higher average test scores. However, vouchers will not raise average achievement in society as a whole, since $\bar{Y} = \beta_0\bar{X} + \beta_1\bar{X}$, where \bar{Y} and \bar{X} denote average levels for the entire society. Vouchers have positive effects for participants. It helps them to move to schools where their peers have better X values. However, the quality of peers may decline for students already in private schools. Moreover, if the voucher winners had high X values relative to the public schools they leave, the voucher program may hurt those left behind in public school. This pure peer effects story is precisely the type of model used by some voucher skeptics (e.g. Hsieh and Urquiola 2003, Epple and Romano 1998).

In this paper, we estimate that quantity by contrasting two very different sets of voucher applicants, those who applied to private academic schools and those who applied to private vocational schools. Because application took place prior to the voucher assignment, we can treat these two groups separately. As we show in the next section, among those who applied to academic schools $\bar{X}_{voucher} - \bar{X}_{non-voucher}$ is generally positive or zero. In contrast, for those who applied to vocational schools, $\bar{X}_{voucher} - \bar{X}_{non-voucher}$

is likely negative. As we show in the next section, voucher winners who had applied to vocational schools had peers with lower academic achievement, lower college attendance rates, and higher rates of dropout. Thus, in the pure peer effects story in which $\beta_2 = 0$ and $\beta_1 > 0$, our simple model would imply that the difference between voucher winners and losers should suggest a positive impact among students who had applied to academic schools and a negative impact among students who had applied to vocational schools. However, in our data we find positive effects in both cases. As we show later in the paper, we find that voucher winners who had applied to vocational schools and voucher winners who had applied to non-vocational have higher educational achievement than their voucher lottery loser counterparts including higher tests scores, increased likelihood of taking the college entrance exam, increased scores on the college entrance exam, and more years completed of schooling.

It is worth noting that we cannot argue that there are no peer effects from this evidence: we can simply reject the hypothesis that the positive impact of the program is entirely due to peer effects.

5. Effect of Vouchers on Peer Quality

Multiple measures of school quality suggest that voucher winners attended schools with peers with more desirable observable characteristics

Schools of Attendance

Among applicants to private vocational schools, winning the lottery had a large impact on the chance of attending a vocational school.

To test whether the voucher winners were more likely than voucher losers to attend vocational schools, we estimate the following equation in Table 3

$$(2) \quad W_i = \alpha + \gamma V_i + \pi Z_i + u_i$$

where W_i is the an indicator for the type or school that student i attends three years after the voucher lottery, Z_i is a vector of controls (age, gender, access to phone for interview, the time of the survey, and the students'

neighborhood), and V_i is an indicator for whether the student won a voucher. The coefficient γ shows the effect of winning the voucher on the type of school attended. The standard errors reported throughout the paper correct for heteroskedasticity.

Among applicants to vocational schools, voucher winners stayed in vocational schools while many voucher losers transferred to non-vocational schools. Among students who originally applied to vocational schools, voucher winners were 40 percent (.17/.42) more likely to be attending vocational schools three years later. The effect of the voucher on the type of school attended is much larger for vocational school applicants than it is for non-vocational school applicants. Among applicants to non-vocational schools, both voucher winners and losers stayed in non-vocational schools.

In the other panels of Table 3, we show that there are also significant effects on private school attendance for both vocational and non-vocational schools. Voucher winners at vocational schools are about 17 percentage points more likely to attend private school after three years than voucher lottery losers, and there is a 15 percentage point difference in private school attendance rates for voucher winners and losers at the non-vocational schools. For vocational schools, the difference is not significant until the second year after the lottery while the difference at non-vocational schools is already significant in the first year of the voucher.

262

263 *Measures of Peer Quality*

The first set of measures upon which we focus relate to the ICFES exam. The ICFES exam is the college entrance exam in Colombia and 90 percent of high school graduates take the exam although only about 75 percent of exam takers go on to college (World Bank 1993). These graduating students are the

267 peers and perhaps the role models of entering students at the high school. These test scores tend to be stable
268 over time and indicate the average "type" of student attracted to the school.⁵

269 The central ICFES measures we use are the mean ICFES score for the school, the proportion of
270 students who take the ICFES relative to 6th grade class (the first year of high school),⁶ and the proportion of
271 students who take the ICFES relative to the size of the senior class. A limitation of our strategy is that we
272 only measure the characteristics of the schools after the voucher lottery. Ideally we would like to use pre-
273 voucher ICFES scores so that we measure the quality of the school and not a result of improvements in
274 educational attainment due to voucher effects. Our measure of mean test scores and our measure of the
275 proportion of students taking the ICFES (relative to the 6th grade class) are from the 1998-99 school year.
276 At this time, none of the applicants in the voucher sample had taken the ICFES exam. In 1998-99, students
277 were typically in 7th or 8th grade and still had multiple years before they could take the ICFES exam. Our
278 other ICFES exam measures are measured in January 2006. If characteristics of schools are stable over
279 time, then this may be an adequate proxy for ability. There may, however, have been an effect of the
280 voucher on school quality. Previous results on the voucher program (Angrist et al 2002, Angrist, Bettinger,
281 Kremer 2006) show that the voucher improved educational outcomes as late as seven years after the voucher
282 lottery. These improved educational outcomes could have positively affected schools that voucher winners
283 attended by both improving the quality of peers and by providing additional resources (or at least a steady
284 stream of voucher revenue) to the school.⁷ In comparing the characteristics of schools that voucher lottery
285 winners and losers attended, any voucher related improvement in school quality will serve to bias our

⁵ Using school level data from the ICFES, we find that overall distribution of test scores and school's relative ordering is stable over time.

⁶ While we observe the number of students taking the ICFES exam from each school, we only observe the number of students in sixth grade for schools participating in the SABER, is a national survey of a random sample of schools.

⁷ An alternative story is that the voucher generated more competition and the non-voucher schools improved. However, the voucher program that we analyze is small relative to the relevant student population suggesting that there were likely few competitive effects (see Angrist, Bettinger, and Kremer 2006). Additionally, by 1998, the PACES voucher program was discontinued, and the purchasing power of the vouchers had already declined substantially making it less likely that the voucher was still affecting schools.

286 comparisons upward. In other words, if vouchers improved school quality, then measuring school
287 characteristics in 2006 will overstate the quality of schools that voucher winners attended relative to the
288 voucher losers.

289 In Table 4a, we estimate regressions similar to equation (2). When we look at vocational school
290 applicants, voucher lottery winners attend schools that score .15 to .18 points lower on the ICFES exam than
291 voucher lottery losers. The point estimate is negative but the difference is not significant. Among non-
292 vocational school applicants, the difference in the types of schools that voucher winners attend is similarly
293 insignificant. In our other measures of students' ICFES taking behavior, we find that voucher winners at
294 vocational schools attend schools where a lower proportion of students go on to take the college entrance
295 exam although these differences are not significant. In the other rows of Table 4, we show other measures
296 of school quality. Many of the characteristics are significant. For example, voucher winners attend schools
297 where a smaller fraction of students enroll in college.⁸ Voucher winners also appear to attend schools where
298 a higher percentage of students drop out, although these correlations are at best marginally significant.

299 Panel B of Table 4a presents other indicators of peer or school quality. Among applicants to
300 vocational schools, voucher winners are also more likely to attend schools with vocational training
301 programs and with programs focused on tutoring disadvantaged students.⁹ The existence of these programs
302 suggests that voucher winners' peers were preparing for vocational careers and/or their peers potentially had
303 learning difficulties. Additionally, voucher students also attended significantly less expensive schools. The
304 fact that voucher winners attended less expensive schools even before considering the voucher subsidy may

⁸ The effects on college attendance should not necessarily match with the ICFES taking results because only 75 percent of ICFES test takers go on to attend college (World Bank 1993) and our data for each of these outcomes come from separate sources (ICFES administrative records and headmaster self-reports).

⁹ The sample sizes in Table B for the final five measures often reflect multiple measures per student. For example, in the job training measure, we combine two measures – one about job training and the other about sponsored apprenticeships. Econometrically, we estimate Equation 2 by stacking these measures, including a dummy variable to control for the different measures, and clustering our standard errors at the individual level. We have two measures of fees, two measures of the availability of programs for disadvantaged students, 12 measures of what facility improvements are available (e.g. science labs, computers), and 8 measures of disciplinary problems (e.g. physical fights among students, verbal or physical abuse of teachers). Details on the survey are available in the data appendix.

305 suggest that voucher winners' peers' parents were either poor or had less interest in their children's
306 education.

307 [In terms of school quality measures, Table 4a shows that voucher winners who had applied to
308 vocational schools prior to the lottery are more likely to attend schools with a greater proportion of teachers
309 who only have secondary school training and a smaller proportion of teachers with advanced degrees. We
310 find no differences in voucher status in what types of facilities were available at students' schools and in
311 whether there were disciplinary issues at students' schools.]

312 Table 4a also reports differences in school characteristics for students who did not apply to
313 vocational schools prior to the voucher lottery. In this group, the results are mixed. At times the
314 coefficients suggest that voucher winners attend schools with lower academic quality than the schools
315 attended by voucher losers, and in some cases, the point estimate suggest the reverse. Across all of these
316 measures, however, we fail to find any significant differences between voucher winners and losers.

317 One limitation of Table 4a is the low sample size. We only have data for a sample of schools.
318 When we examine the effects of the voucher on the quality of students' schools of attendance among
319 students who initially applied to vocational schools, we generally find point estimates that suggest that
320 voucher winners attended lower quality schools than voucher winners; however, the standard errors are
321 large in part because of our low sample size.

322 While we report 12 different t-statistics in Table 4a, our survey data collected 72 measures of school
323 quality. Our low sample size throughout the paper impedes us from finding many significant effects in any
324 given measure. There are a couple of alternative techniques that may help us take advantage of the multiple
325 measures of school quality.

326 One approach is to examine the pattern of t-statistics on the voucher difference among all 72
327 measures. If there is truly no difference between the schools that vocational voucher lottery winners and

328 vocational voucher lottery losers attended, then the pattern of t-statistics on the voucher differences should
329 appear similar to a standard normal distribution.¹⁰ In the case of non-vocational schools, this is exactly what
330 we find. Figure 1A shows the distribution of these t-statistics compared to a standard normal distribution.
331 The t-statistic distribution is very similar to the standard normal distribution, and Shapiro-Wilk tests for
332 normality cannot reject that the resulting distribution is indeed distributed normally (P-value=0.97).
333 Kolmogorov-Smirnov tests also fail to reject normality (P-value=0.47). In the non-vocational schools, the
334 evidence seems to suggest that voucher winners attended similar schools to voucher losers – a conclusion
335 reached by King, Rawlings, Gutierrez, Pardo, and Torres (1997).

336 By contrast, we find that the pattern of t-statistics for voucher differences between vocational school
337 applicants to be quite different. In Figure 1B, we show the distribution of t-statistics compared to a normal
338 distribution. In this case the distribution appears skewed downward. Voucher comparisons suggest that
339 voucher winners are systematically attending lower quality schools. Shapiro-Wilk tests for normality
340 marginally reject that the distribution of t-statistics is normally distributed (P-value=0.07). Kolmogorov-
341 Smirnov tests marginally reject normality as well (P-value=0.07).

342 A second approach to examining the multiple measures of school quality would is to compute
343 "average effect sizes" within categories of school characteristics. "Average effect sizes" is a technique for
344 combining treatment effects within categories.¹¹ Kolmogorov-Smirnov tests assume independence among
345 the various dependent variables. By contrast, average effect sizes allow for correlation between the various
346 dependent variables. Given that our "dependent variables" in Table 4a are school characteristics, they are
347 likely correlated. To estimate the "average effect sizes," we first alter our measures of school characteristics

¹⁰ A similar methodology is used in McCrary and Royer (2003). All of our t-statistics are configured so that a negative outcome (e.g. worse peers) implies a negative t-statistic.

¹¹ "Average effect sizes" have long been used in medical research (e.g. O'Brien 1984). Recent research by Kling, Katz, and Leibman, (2006) and Bloom, Bhushan, Clingingsmith, Hong, King, Kremer, Loevinsohn, and Schwartz (2006) utilize this methodology as well.

348 by altering them so that they are monotonic and then normalizing them so that the measures are comparable.
349 We jointly estimate the effects of the voucher on school quality and then take the average of the estimated
350 treatment effects.

351 In Table 4b, we report these estimates for several categories of school characteristics. The first
352 category is teacher characteristics. We have six measures of teacher characteristics. When we combine
353 these, we find that voucher winners who initially applied to vocational schools attended schools where
354 teacher characteristics are much lower quality. When we compare students' college entrance behavior and
355 student dropout rates, the signs of the effects suggest that voucher winners attend lower quality schools.
356 The estimate is marginally significant for graduation and college entrance but not significant in the case of
357 dropout behavior.

358 In looking at other features of the schools, we also find that voucher winners are more likely to
359 attend schools with remedial or vocational programs than voucher lottery losers. The schools that these
360 voucher winners attend also have lower fees but more amenities around the school facilities. These
361 differences are all statistically significant.

362 The key lesson that we draw from Tables 4a and 4b and Figures 1A and 1B is that voucher winners
363 at vocational schools do not attend schools with peers of higher status or higher quality schools across a
364 variety of measures. Most of the time, the differences are insignificant; however, despite our small sample
365 size, we frequently find that schools that voucher winners had less desirable peers than schools that voucher
366 losers attended. When we look at the distribution of t-statistics implied by the voucher differences among
367 vocational school applicants, we see that systematically voucher winners attend lower quality schools, and
368 the resulting distribution of t-statistics is different from the distribution of t-statistics that we would expect if
369 the differences in school quality were not systematic. Using other methods of combining the estimated

370 differences, we also find that among students initially applying to vocational schools, voucher winners
371 attend schools with lower quality than voucher losers.

372 While we fail to find that voucher winners' had peers with better observable outcomes, we can't rule
373 out the possibility that there could be selection on unobserved peer quality. However, it seems unlikely that
374 selection on unobservables would go in the opposite direction (i.e. student with better educational outcomes
375 would have poor unobserved characteristics), and even more unlikely that it would go strongly enough in
376 that direction to outweigh the differences on observables.

377

378 **6. Voucher Effects**

379 Thus far, we have presented some evidence that among students who applied for vocational schools
380 prior to the voucher lottery, voucher winners attended schools with inferior peers and school quality
381 measures when compared to voucher lottery losers. In this section, we demonstrate that even among this
382 population in which winning a voucher led to less desirable peers, winning a voucher led to improved
383 educational outcomes.

384 In Table 5, we estimate the effects on both the likelihood that students take the college entrance
385 exam and students' performance on the exam. These outcomes are available for a much larger sample since
386 the data are based on administrative sources rather than survey data. In matching the administrative records,
387 there are a number of obstacles. The student records from PACES often included incorrect ID numbers. To
388 improve the accuracy of matching, we used multiple matching strategies – matching by ID alone, matching
389 by ID and city of residence, and matching by ID number and name. Table 5 shows these mean passing rates
390 for voucher lottery losers and the difference by voucher status for each type of school.

391 The results suggest that students who applied for vocational schools and won a voucher were 5-6
392 percentage points more likely to take the ICFES exam. The voucher effect at non-vocational schools was

393 between 3 to 6 percentage points. Given that more students from non-vocational schools took the ICFES
394 exam, the relative effect on voucher students in vocational schools is much larger. In our most conservative
395 matching strategy, the voucher led to about a 25 percent increase in the likelihood that a student at a
396 vocational school took the ICFES exam while the voucher led to a 13 percent increase in the likelihood a
397 student from a non-vocational school took the ICFES exam. Moreover, as the second panel of Table 5
398 shows, voucher students who applied to vocational schools have higher reading test scores than students
399 who lost voucher lottery. As discussed in Angrist, Bettinger, and Kremer (2006), the unconditional
400 comparisons are likely lower bounds on the true estimate since the average test scores for voucher winners
401 are likely lower because the voucher affected the probability of taking the exam (and the marginal students
402 were likely of lower ability). Angrist, Bettinger, and Kremer (2006) provide a discussion of how to estimate
403 an upper bound for the true effect under the assumption that any voucher effect is monotonic. These
404 estimates are reported in Table 5 and suggest significant positive effects of the voucher in both math and
405 reading among vocational students. The raw difference in test scores of voucher winners and losers at non-
406 vocational schools is not significant, but similar to the vocational schools, this difference is likely biased
407 downward. The upper bounds suggest significant positive effects.

408 In Table 6, we estimate the effects of the educational voucher on other outcomes. These other
409 outcomes were measured using survey data and were measured three years after students applied for the
410 voucher and three years before students took the ICFES exam. In terms of academic outcomes, the results
411 are different in their significance between vocational and non-vocational schools. The signs of the
412 coefficients suggest uniformly that voucher winners at both types of schools are more likely to complete
413 more years of schooling and less likely to repeat grades. In the non-vocational schools, the effects on school
414 years finished, grade repetition, and finishing 8th grade are statistically significant. However, while the

415 coefficients are of similar magnitude in the vocational schools, only the coefficient on finishing 8th grade is
416 statistically significant.

417 The key finding in Tables 5 and 6 is that voucher winners who applied to vocational schools had
418 better outcomes than voucher losers who had also applied to vocational schools. While it is useful to note
419 that voucher winners at non-vocational schools also had positive outcomes, for the purpose of this paper the
420 effect in vocational schools is of more interest. This is because, among applicants to vocational schools,
421 voucher winners had peers with worse observable characteristics and attended schools with lower overall
422 quality.

423

424 *Other Voucher Mechanisms*

425 Based on these results above, there is no evidence that voucher effects worked solely through
426 observable differences in peers. Winners did not attend schools with peers with higher test scores. The
427 results above are inconsistent with the hypothesis that voucher winners raised scores for participants by
428 helping them obtain peers with better observable characteristics. Nonetheless, voucher winners in vocational
429 schools experienced better outcomes than losers.

430 If peer effects were not the channel through which vouchers worked, what was? The data suggest
431 two hypotheses. First, winners had more incentive to devote effort to school. Voucher students lost the
432 voucher if they failed to pass a grade. While this difference in incentives did not lead to a difference in
433 labor market participation among students who applied to academic schools, it led to significant differences
434 in hours worked and labor market participation among applicants to vocational programs.

435 Another channel through which the greater demand-side choice offered by vouchers may have
436 improved outcomes is by allowing students to choose the type of schooling they valued. [Academic schools
437 instruct students in the fields of science, humanities or the arts. Vocational schools prepare students

438 primarily for participation in the labor market, either in the production sector or the service sector. They
439 typically focus on commercial, industrial, agrarian or pedagogical skills, and their curricula exhibit
440 considerable heterogeneity.]

441 According to the Colombian school census of 1998, amongst Bogotá public schools, 38% offer a
442 vocational curriculum while only 24% of private schools have a vocational track, and the difference is
443 highly statistically significant (t-stat of 6.5). However, the vocational focus of public and private schools is
444 very different. Of public schools, 25% have an industrial curriculum, and 64% have a commercial one,
445 whereas only 4% of private vocational schools have an industrial curriculum and 92% have a commercial
446 focus (both differences are highly statistically significant).¹² Accordingly, vocational enrollment differs
447 between public and private schools: in public vocational schools, 30% of students are enrolled in a school
448 with an industrial focus and 45% in schools with a commercial focus. By contrast, only 8% of private
449 vocational enrollment is in schools with an industrial focus and 78% is in schools with a commercial focus.

450 In schools with an industrial focus, emphasis and instruction are on activities such as welding,
451 electrical works, carpentry and cabinetmaking, metallurgy, smelting, welding and metallic ornamentation.
452 By contrast, in schools with a commercial curriculum, students spend a significant amount of time, both
453 during school time and in apprenticeships outside school, learning skills such as accounting, how to legally
454 register, setup and administer a small enterprise, communication, information technology, computer
455 maintenance and software design, event logistics, and office clerical work. Similarly, the type of
456 apprenticeships that students undertake differs depending on the vocational focus of the school. For
457 example, data from the 2006 school survey suggests that students in industrial schools are more likely to
458 participate in apprenticeships that take place with *Servicio Nacional de Aprendizaje* (SENA), Colombia's
459 governmental job training agency, while students in schools with a commercial focus are more likely to

¹² These are not the only tracks but they represent 85% of the supply of vocational curricula. The others are social work (9%) and pedagogic (3%), which basically trains students to become schoolteachers.

460 undertake apprenticeships in the private sector, working in offices, small enterprises, universities, libraries
461 and radio stations.

462 Students may value some types of vocational or academic education more than others. In the
463 annual school census for Bogotá, we can identify the central emphasis of vocational schools that voucher
464 winners and losers attend.¹³ Among students not attending academic programs, there is a clear preference
465 for commercial education as opposed to an industrial, agricultural, or pedagogical curriculum. Lottery
466 winners who had initially applied to vocational schools were more likely to attend schools with job training
467 or apprenticeship programs (Table 4). Almost all of these apprenticeships took place in the service sector.
468 Students' preferences for commercial schools may be because students value a commercial education more
469 than other types of vocational training. White collar jobs are more prestigious than blue collar jobs, and the
470 service sector has grown considerably while the share of jobs in factories has declined (Cárdenas and Bernal
471 1999).

472 Students who lose the lottery are more likely to attend public schools, and there are only a few
473 commercial vocational schools in the public sector. If student demand for these schools is greater than the
474 available spots, then students who want to attend vocational schools will have to attend industrial rather than
475 commercial vocational schools. Students in the industrial school may be more likely to drop out because
476 that training is less valuable to them than the commercial education would be. If the voucher increases the
477 share of students who can attend a commercial school (because they switch to private commercial schools),
478 then this effect may be driving the increase in retention/years of education attained. This story would also
479 explain why a stronger effect exists for applicants to vocational schools, since vocational schools exhibit
480 more heterogeneity in their curricula than academic schools.¹⁴

¹³ The annual school census is entitled the C-600. We can only match 1856 students (of 4044) to their school of application.

¹⁴ We would have liked to investigate this hypothesis in our data, but unfortunately, the sample of commercial and industrial schools is small in our data preventing any conclusive statistical analysis.

481 The private market may be able to adapt more quickly than the government to changes in the
482 economy and the demand for skills. First, in Bogotá, the Secretariat of Education determines the curriculum
483 and curricular standards for all public schools (both vocational and academic), while, private schools have
484 complete autonomy to select their curricular focus. Second, in public schools, the authority to hire and fire
485 teachers is strongly influenced by FECODE, the Colombian teachers union, whereas in private schools the
486 school principal exercises such authority. The possibility of adapting fast to the needs of the outside labor
487 market depends on the possibility of changing curriculum and, more importantly, selecting qualified
488 teachers. In the school census, we find that the probability a public vocational school has a specialized
489 teacher for industrial teaching is 37%, ten times larger than the probability a private vocational school has
490 such teacher (3.8%). In fact, public vocational schools have, on average 1.1 more specialized industrial
491 teachers than private vocational ones (the difference is highly statistically significant – t-stat of 3.59). By
492 contrast, private vocational schools are 10 percentage points more likely than public vocational ones to have
493 a specialized teacher for commercial teaching. Private vocational schools have, on average 1.2 more
494 specialized commercial teachers than public vocational ones (the difference is highly statistically significant
495 – t-stat of 3.22). Given the bureaucratic and administrative hurdles for firing or substituting a teacher in the
496 government sector, it is plausible that specialized curricular conversion will take much longer in public than
497 in private schools.

498 Based on the 1998 school census for Bogotá, amongst schools with a vocational focus, dropout rates
499 in grade 10, when students fully engage in their vocational curriculum, are more than twice as high in public
500 than in private schools. The dropout rate for 10th graders in public vocational schools is 7.2%, while for
501 private vocational schools is 3% (the difference is highly statistically significant – t-stat of 3.93). Similarly,
502 the dropout rate in 11th grade in public vocational schools is 9% while in private vocational schools is 2.2%
503 (the difference is highly statistically significant – t-stat of 4.91). Given that, as argued earlier, for this

504 population the likelihood of attending a post-secondary institution is very low, it is plausible that the
505 practicality and expected return of what students learn in 10th and 11th grade greatly influences their decision
506 to remain in school. For instance, among vocational schools, we find that dropout rates are twice as high in
507 industrial than in commercial schools. The dropout rate (combining 10th and 11th grades) in industrial
508 schools is 7.9% whereas in commercial ones it is 4% (the difference is highly statistically significant – t-stat
509 of 2.46). Even within private vocational schools, dropout rates are almost twice as high for industrial (4%)
510 as for commercial schools (2.5%, the difference is not statistically significant at conventional levels).

511 Finally, practical training in private vocational schools is much more attuned with the growing
512 demands of the economy. According to data from Colombia's Central Bank, salaries in the commercial
513 sector grew at least as much as salaries for industrial workers between 1999 and 2005.¹⁵

514

515 **7. Conclusion**

516 Previous work suggested that students who participated in Colombia's voucher program had better
517 academic outcomes, but could only do a little bit now to narrow down the mechanism. To the extent that
518 students in voucher schools had better peers, there could be no overall educational gain from the program
519 even if participants perform better. (e.g. Hsieh and Urquiola 2003. Epple and Romano 1998).¹⁶ To the extent
520 this is the case, voucher winners may perform better than losers, but there may be no aggregate benefit to
521 society of voucher programs.

522 However, in this paper, we examine a subpopulation in which voucher winners have no better peers
523 along observable dimensions. In particular, among applicants to vocational schools, voucher winners stayed
524 in vocational schools, while voucher losers were more likely to transfer into academic schools. In a variety
525 of measures, voucher winners who had applied to vocational schools prior to the lottery attended schools

¹⁵ http://www.banrep.gov.co/estad/dsbb/srea_011.xls, cited May 29, 2006

¹⁶ Gallego (2006) suggests that vouchers in Chile may have increased student test scores in both voucher and public schools.

526 with lower observable peer quality as compared to voucher losers. Thus among students who applied for
527 vocational schools *before* the voucher lottery, voucher winners if anything had worse peers, yet they had
528 significantly better outcomes than losers. Voucher winners are more likely to stay in private school, more
529 likely to finish eighth grade, and less likely to repeat a grade. Furthermore, voucher winners are more likely
530 to take the college entrance exam, and, given that they take the exam, more likely to pass it. This suggests
531 that vouchers have at least some productivity effect and are not a zero-sum game in which benefits to
532 voucher participants are offset by losses to non-participants.

533

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626 **Table 1. Attendance Patterns of Lottery Applicants**

	School Applied To			
	Vocational		Non-Vocational	
	Winner	Loser	Winner	Loser
School Attended Three Years after Voucher Lottery				
Vocational	.5962	.4264	.0369	.0626
Non-Vocational	.2692	.4264	.7995	.7517
Dropout	.1346	.1473	.1590	.1790

641 Survey data are from Angrist et al. (2002). Sample includes 1176 voucher applicants from Bogotá in 1995.

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Table 2. Summary Statistics by Type of School Applied to

	Vocational School Applicants		Non-Vocational School Applicants		(5) Difference Between Vocational and Non-Vocational Schools
	(1) Mean	(2) Difference by Voucher Status	(3) Mean	(4) Difference by Voucher Status	
Age	14.96 (1.299)	.1551 (.1542)	15.01 (1.361)	.0268 (.0917)	.0521 (.0916)
Gender	.4965	-.0510 (.0600)	.5047	-.0118 (.0343)	.0082 (.0343)
Mother's Schooling	5.221 (2.583)	.3029 (.3216)	5.935 (2.882)	-.0482 (.2027)	.7132** (.1999)
Father's Schooling	4.751 (2.899)	-.0893 (.3939)	5.429 (3.202)	.5827** (.2433)	.6776** (.2421)
Living in Poorest Neighborhood	.1972	-.0034 (.0476)	.1295	-.0055 (.0229)	-.0677** (.0241)
Living in Next Poorest Neighborhood	.5352	-.0499 (.0596)	.5746	.0261 (.0336)	.0394 (.0339)
Mean ICFES at Schools Applied to	45.77 (2.538)	.2664 (.3013)	46.38 (3.162)	-.3745 (.2298)	.6097** (.2085)

Data are from the household surveys. Standard deviations are in parentheses in columns one and three. Standard errors are in parentheses in the other columns reporting differences.

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Table 3. Effect of Voucher on Likelihood of Remaining in the Same Type of Schooling

	Coefficient on Voucher Status					
	Applicants to Vocational School			Applicants to Non-Vocational School		
	Loser's Mean	Without Covariates	With Covariates	Loser's Mean	Without Covariates	With Covariates
Attending Vocational School	.4264 (.4965)	0.171** (0.0591)	0.1755** (0.0585)	.0631 (.2434)	-0.0252* (0.0149)	-0.0294* (0.0158)
Attending Private School in 6th Grade	.8984 (.3033)	0.0254 (0.0344)	0.0242 (0.034)	.8975 (.3037)	0.0529** (0.0182)	0.0491** (0.0184)
Attending Private School in 7th Grade	.6953 (.4621)	0.134** (0.0511)	0.1316** (0.0522)	.6834 (.4657)	0.1773** (0.0283)	0.1793** (0.0283)
Attending Private School at the Time of the Survey	.5313 (.501)	0.1777** (0.0576)	0.1709** (0.0592)	.5386 (.4991)	0.1526** (0.0328)	0.1511** (0.0317)
Staying in the Same Type of School	.4264 (.4965)	0.171** (0.0591)	0.1755** (0.0585)	.7568 (.4295)	0.04 (0.028)	0.0351 (0.0269)

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Robust standard errors are in parentheses. Covariates include age, gender, access to phone for interview, the time of the survey, and controls for the students' neighborhood.

Table 4a. Characteristics of School of Attendance and Voucher Status

	Vocational			Non-Vocational		
	(1) Losers' Mean	(2) Coefficient on Voucher Status Without Covariates	(3) Coefficient on Voucher Status With Covariates	(4) Losers' Mean	(5) Coefficient on Voucher Status Without Covariates	(6) Coefficient on Voucher Status With Covariates
A. Academic Indicators of Peer Quality						
Mean ICFES Score	46.50 (3.188) [94]	-.1518 (.4234) [220]	-.1863 (.4552) [215]	47.21 (3.473) [317]	.0050 (.2871) [645]	-.1165 (.2971) [632]
Proportion of Entering Class who later take the ICFES	.7591 (.4225) [50]	-.0429 (.0749) [126]	-.0699 (.0852) [125]	.9048 (.8793) [172]	.1297 (.0974) [353]	.1417 (.1020) [345]
Number of Students Taking the ICFES Relative to Size of Senior Class	1.0596 (.0147) [88]	.0109 (.0199) [198]	.0228 (.0189) [194]	1.0528 (.5931) [247]	-.0338 (.0379) [493]	-.0395 (.0423) [482]
Proportion of Students Enrolling in College	.3141 (.3158) [85]	-.0736* (.0421) [189]	-.0897** (.0448) [185]	.3523 (.3122) [231]	.0460 (.0291) [457]	-.0280 (.0298) [488]
Percentage of Students Who Dropped Out	.0339 (.0339) [89]	.0118* (.0063) [202]	.0080 (.0065) [198]	.0284 (.0337) [254]	-.0027 (.0029) [502]	-.0026 (.0031) [491]
B. Other Indicators of Peer and School Quality						
Proportion of Teachers with Only Secondary Schooling	.0031 (.0005) [85]	.0028** (.0009) [194]	.0028** (.0008) [190]	.0066 (.0165) [238]	.0004 (.0013) [481]	-.0010 (.0013) [470]
Proportion of Teachers with Master's Degree	.02683 (.0283) [85]	-.0057 (.0039) [194]	-.0036 (.0041) [190]	.0206 (.0257) [234]	-.0049** (.0022) [466]	-.0054** (.0023) [456]
Has Job Training Program	.1517 (.3597) [178]	.0894** (.042) [402]	.0931** (.0448) [394]	.2163 (.4121) [504]	.0302 (.0302) [498]	.0323 (.0308) [974]
Has Tutoring for Disadvantaged Students	.2809 (.0451) [178]	.0718 (.0557) [402]	.0648 (.0569) [394]	.3492 (.4772) [504]	.0634* (.0366) [996]	.0743** (.0367) [974]
Fees	40752.6 (47212.4) [174]	-8778.2 (5959.8) [243]	-9497.9 (6151.0) [241]	63318.4 (62572.9) [482]	-2136.1 (4384.0) [774]	-5361.6 (4874.1) [752]
Specialized Facilities Available	.9367 (.3101) [979]	-.0034 (.0157) [2219]	-.0015 (.0167) [2175]	.9354 (.2866) [2769]	.0106 (.0084) [5472]	.0141 (.0087) [5351]
Student Disciplinary Problems	.0435 (.2042) [712]	-.0269 (.0169) [1616]	-.0292 (.0188) [1584]	.0433 (.2036) [2008]	-.0107 (.0117) [3968]	-.0084 (.0126) [3880]

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Standard deviations appear in columns 1 and 4. Robust standard errors appear in the other columns. The number of observations is in brackets. The first two outcomes are from administrative records from ICFES and SABER. The other outcomes are from a survey conducted in January 2006 of schools in our sample. Covariates are from survey data from Angrist et al (2002) and include age, gender, access to phone for interview, the time of the survey, and controls for the students' neighborhood. Sample size in the last four rows reflects multiple measures per student. Standard errors are clustered at the student level in these regressions.

658 Table 4b. Average Effect Sizes of School Characteristics Among Vocational Schools

Category of School Characteristics	Difference by Voucher Status (std. dev units)	Standard Error	Number of Measures
Teacher Characteristics	-.4260	.1315	6
Student College Entrance & Graduation Behavior	-.1671	.0942	8
Student Dropout Behavior	.1188	.2272	3
Existence of Remedial or Vocational Programs	.2672	.1160	6
Total Fees Across All Categories	-.3870	.1757	2
School Appearance	-.1589	.1329	4
School Facilities	.1330	.0552	22

659 All outcomes are from a survey conducted in January 2006 of schools in our sample. Within each category, outcomes are standardized
660 so that they are monotonic in school quality. Effect sizes are standardized within outcomes. Effects are measured in a model with
661 covariates including age, gender, access to phone for interview, the time of the survey, and controls for the students' neighborhood.
662 Standard errors take into account correlation within measures.
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Table 5. Effects of Voucher on College Entrance Exam Outcomes

Dependent Variable	Vocational		Non-vocational	
	(1) Losers' Means	(2) Regression-Adjusted Voucher Diff	(3) Losers' Means	(4) Regression-Adjusted Voucher Diff
A. Probability of Taking ICFES				
ID Match	.2548 (.4364)	.0607* (.0300)	.2875 (.4528)	.0586** (.0175)
ID & City Match	.2520 (.4348)	.0494* (.0299)	.2725 (.4454)	.0577** (.0174)
ID & Name Match	.1884 (.3915)	.0536* (.0281)	.2117 (.4087)	.0336** (.0164)
N	361	810	1200	2612
B. Performance Outcomes on the ICFES				
Math Score cond'l on taking	41.46 (4.865)	.7661 (.6370) [257]	42.39 (4.762)	.3094 (.3559) [875]
Reading Score cond'l on taking	45.71 (5.951)	2.060** (.7804)	47.19 (5.450)	.3427 (.3962)
Math Score (Upper Bound Estimate)	--	2.507** (.6156)	--	1.5270** (.3302)
Reading Score (Upper Bound Estimate)	--	4.364** (.7376)	--	1.6949** (.3648)
N	87	256	319	874

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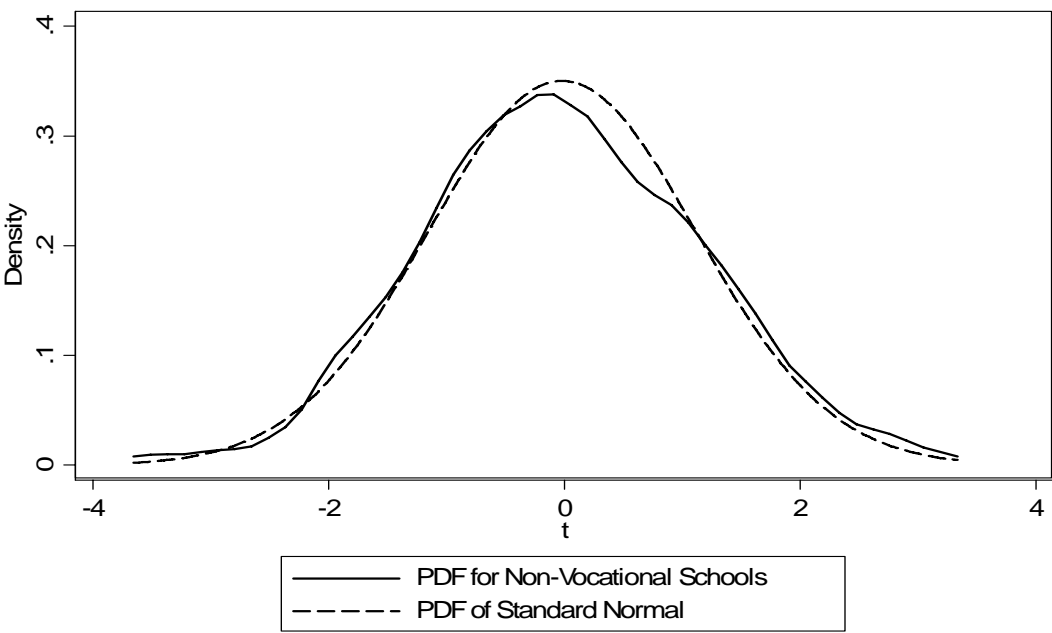
Robust standard errors appear in parentheses in columns 2 and 4. Standard deviations appear in columns 1 and 3. In the regression results reported in columns 2 and 4, we include covariates for age, gender, and access to phone. Upper bounds are computed using method described in Angrist, Bettinger, and Kremer (2006).

670 **Table 6. Voucher Effects by Type of School Applied to**

Dependent Variable	Coefficient on Voucher Status			
	Vocational		Non-vocational	
	(1) Losers' Means	(2) Basic Controls	(3) Losers' Means	(4) Basic Controls
Started 6 th Grade in Private	.8984	.0242 (.0340)	.8975	.0491** (.0184)
Started 7 th Grade in Private	.6953	.1316** (.0522)	.6834	.1793** (.0283)
Currently in Private	.5313	.1709** (.0592)	.5386	.1511** (.0317)
School Years Finished	7.512 (.9364)	.1391 (.0993)	7.534	.0915 (.0582)
Currently in School	.8527	-.0110 (.0414)	.8198	.0056 (.0233)
Finished 6 th Grade	.9457	.0315 (.0226)	.9414	.0156 (.0131)
Finished 7 th Grade	.8605	.0445 (.0390)	.8536	.0180 (.0217)
Finished 8 th Grade	.6434	.0937* (.0563)	.6554	.0872** (.0305)
Ever Repeated a Grade	.2481	-.0632 (.0515)	.2072	-.0527** (.0261)
Number of Repetitions of 6 th Grade	.2422	-.0632 (.0515)	.1708	-.0527** (.0261)
Applicant is Working	.2248	-.0469 (.0474)	.1757	-.0285 (.0243)
Total Hours Worked	6.6535 (15.7195)	-2.4168 (1.6489)	5.3573 (14.4642)	-.8555 (.9033)
N	129	283	444	858

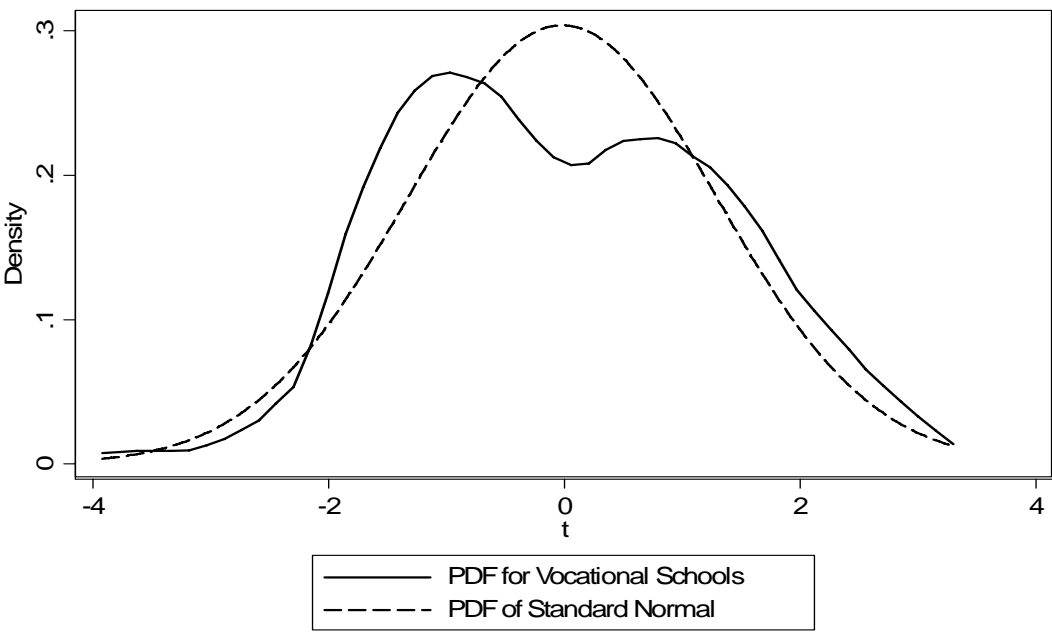
671 Standard errors appear in parentheses in columns 2 and 4. Standard deviations appear in the other columns.

672 Figure 1A. Empirical Distribution of T-statistics Underlying Table 4 for Non-Vocational Schools



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674 Figure 1B. Empirical Distribution of T-statistics Underlying Table 4 for Vocational Schools



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