ARE EDUCATIONAL VOUCHERS ONLY REDISTRIBUTIVE?*

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It is unclear if vouchers increase educational productivity or are purely redistributive, benefiting recipients by giving them access to more desirable peers at others' expense. To examine this, we study an educational voucher programme in Colombia which allocated vouchers by lottery. Among voucher applicants to vocational schools, lottery winners were less likely to attend academic secondary schools and thus had peers with less desirable observable characteristics. Despite this, lottery winners had better educational outcomes. In this population, vouchers improved educational outcomes through channels beyond redistribution of desirable peers. We discuss potential channels which may explain the observed effects.

Much of the debate regarding school vouchers revolves around its impact on voucher recipients (e.g. Rouse, 1998; Howell and Peterson, 2002; Krueger and Zhu, 2003). However, standard economic theory suggests a prima facie case that receiving a voucher makes one better off by expanding the opportunity set for school choice. However, it also suggests that the overall welfare impact of vouchers depends not simply on their impact on participants but also on their impact on non-participants. This impact depends in part on competitive effects on other schools but it also depends on whether vouchers improve educational productivity, for example, by allowing students to attend more effective schools or to attend schools better matched to their idiosyncratic needs, or whether they simply redistribute fixed educational inputs.

Vouchers could potentially create negative externalities if students are affected by peers and share common preferences over a fixed set of available peers. In this case, if vouchers help some students to obtain more desirable peers, others will have less desirable peers. In particular, the movement of voucher students from public schools to private schools could potentially reduce the average peer desirability both in private schools and for 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 (Hsieh and Urquiola, 2006; Epple and Romano, 1998).[1]

Testing whether vouchers work solely through peer effects or through some other mechanism is difficult empirically since lottery winners typically attend schools with more desirable peers. If voucher effects persisted in a context in which voucher recipients obtained less desirable peers, this would provide some evidence that, at least in that context, vouchers improve outcomes through channels other than peer effects. Finding such a perverse lottery is difficult. However, because of some peculiar features of Colombia's PACES voucher programme, we can identify a population in which those

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

who obtain vouchers do not join peers with superior observed characteristics and measure the effect of vouchers in this population. To do this, we use data from Colombia's PACES voucher programme, previously discussed in Angrist *et al.* (2002; 2006). In the Colombian voucher programme, students were required to apply and be accepted at a private school before they could apply for the voucher. The programme stipulated that students could apply to either academic or vocational private schools (*escuelas tecnicas*). After gaining acceptance to these schools, students then submitted applications to the voucher programme and a lottery was used to determine which students received the voucher. Because it was administratively difficult to retain the voucher if one switched schools, there was considerable stickiness in schools attended by voucher winners. Less than 20% 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 applicants who did not win a voucher were more likely to attend an academic school.

In general, academic schools are more prestigious than vocational schools in Colombia and their students are more likely to complete secondary school and obtain high examination scores. Therefore, among applicants to vocational schools, voucher winners did not attend schools with higher average scores or higher participation rates on Colombia's college entrance examination than their counterparts among voucher losers. In fact, point estimates suggest that among applicants to vocational schools, voucher winners attended schools where students were 25% less likely to attend college and about 33% more likely to drop out. We perform a number of comparisons across multiple measures of peer quality and we find that among applicants to vocational schools, voucher winners attended schools with peers with less desirable observable characteristics than voucher losers. Despite not having observably more desirable peers, among those who applied to vocational schools, voucher lottery winners have significantly better educational outcomes than losers, including a 25% increase in the likelihood of graduating from high school and a one-third of a standard deviation increase in college entrance examination scores. The results suggest the observed effects of vouchers, in this context, are not solely the result of interaction with better peers.

What then was the channel by which vouchers led to better outcomes in this population? One hypothesis is that the voucher created economic incentives for voucher recipients. Students' vouchers were renewed only if students successfully completed a grade. The incentive to pass a grade is similar to cash incentive programmes which reward students for schooling outcomes. Emerging evidence from these programmes shows that students' schooling outcomes improve as a result of such programmes (Kremer *et al.*, 2009; Bettinger, 2008; Barrera-Osorio *et al.*, 2008).

Another hypothesis is that private vocational schools may be teaching skills that students' value highly, relative to those available at the public vocational schools, and hence students may have more incentive to stay enrolled and to study. Experimental evidence from both the US and Colombia suggests that there are some people who express preferences for vocational education and receive substantial benefits as a result (Cullen *et al.*, 2005; Attanasio *et al.*, 2008).

The fact that voucher winners at vocational schools perform better than they would have done in the absence of the voucher may shed light on policies focused on

school-to-work transitions. Youth unemployment is one of the most pressing social and economic problems facing less developed countries (World Bank, 2007). Many countries, like Colombia, suffer from high youth unemployment and little is known about how best to smooth the school-to-work transition in less developed countries, or how to boost human capital for those not on the academic schooling track. Vocational education is one promising avenue for addressing the problem, in particular through the dynamic private vocational sector.

Our findings that vocational schools may improve students' long-run outcomes may suggest that private vocational schooling can help students transition from secondary school into advanced training and the labour force. In particular, whereas academic schools are likely to cover a common canonical curriculum whether public or private, in vocational education it is particularly important to adapt to the needs of the labour market. In Colombia, 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 have more flexibility than the public sector to eliminate or transform curricula that are no longer demanded by the general economy.

The remainder of this article is organised as follows: in Section 1, we present a brief model of educational attainment that allows for the possibility that vouchers could potentially both have a direct productive effect and allow recipients to obtain better peers, at the expense of others. This model is a simplified version of peer effects models previously used in the voucher literature (Hsieh and Urquiola 2006) and our goal in using this model is to show that vouchers have a productive effect above any peer effects generated by the change in peers. In Section 3, we address the data and empirical strategy. In Section 4, we show the relationship between winning the voucher and subsequent peer quality in the schools voucher winners attend. We compare a number of different measures of peers to demonstrate that among applicants to vocational schools, voucher winners had no better peers than voucher winners. In Section 5, we show that voucher winners, particularly those in vocational schools, had better educational outcomes than voucher losers. Section 6 discusses potential mechanisms by which the voucher affected students. Section 7 provides a brief conclusion. The voucher programme is discussed in Section 2.

1. Theoretical Framework

As noted above, there is a presumption that vouchers do benefit recipients, but a key question in assessing their desirability for society as a whole is whether vouchers are simply redistributive or whether they lead to productivity gains, because private schools are more efficient, because schools respond to competitive pressures, or because vouchers allow students to better match with the schools that meet their particular needs.

There are several possible channels through which vouchers could potentially have a negative impact on non-recipients but we focus on peer effects, since this is the most plausible channel through which vouchers could have a significant negative effect on non-participants not just during a transition period but in steady state. In the short run, before private school capacity can respond, school choice could hurt non-participants

by squeezing them out of a limited supply of private school places. Similarly, there may be short-run fixed costs in public schools so that transfers of students and budget to private schools could hurt some students at public schools. However, in the long run, if the cost of education is close to linear in the number of students and there is free entry into school provision, it is unlikely that there would be significant negative externalities through these channels, particularly as the value of the voucher was less than the cost of publicly provided education.[2,3]

It is worth noting that even if voucher programmes benefit participants only by allowing them to obtain peers they prefer, this need not harm others if students are heterogeneous and have different preferences about which peers they prefer. For example, if some students in an English speaking country want to go to a French-immersion school and others want to go to a Chinese-immersion school, a voucher programme that allowed each group to attend a school with peers with similar preferences might help both groups. But if students share the same preference-ordering over peers and schools are of fixed size then any gains in peer desirability for students who take advantage of school choice will be linked to losses for other students.

Welfare judgments about the overall desirability of vouchers will clearly depend on distributional preferences but it seems likely that a key question is whether any benefits of vouchers on participants are entirely due to zero-sum sorting or whether there is also a 'productive' impact of vouchers.

Because we are trying to test the hypothesis that there was no gain in average test scores for society as a whole, we focus on a simple linear-in-means model of peer effects where test score gains for participants are fully offset by losses for others and the somewhat more general class of models in which test scores are monotonic in a common index of peer quality so an improvement in peers for one individual necessarily implies a worsening of peers for another. Of course in other models in which different peers are beneficial for different individuals (Hoxby and Weingarth, 2006; Duflo *et al.*, 2008), changes in peers associated with school choice could improve test scores for each individual but, if this were the case, then the programme would automatically have raised average test scores.

We therefore consider a model which nests the hypotheses that vouchers help participants by allowing them to attend more productive schools and that they help participants only by allowing them access to more desirable peers at the expense of other students. In particular, we assume that all schools have the same number of students and that educational outcomes for person i are given by:

$$Y_i = \beta_o X_i + \beta_1 \bar{X}_s + \beta_2 P + \varepsilon_i \tag{1}$$

where X_i is student i's socioeconomic status or genetically determined ability, $\bar{X}_s$ is the average level of X_i in school s, and P indicates programme participation. In this linear framework β_1 is a purely redistributive effect and β_2 is the purely productive effect. We

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[2] A number of new schools are believed to have been created in response to Colombia's voucher programme.
[3] One other channel through which vouchers could potentially create negative externalities is if they lead to the creation of schools teaching ideologies that are inimical to other members of the population. We do not believe that this took place in this context and in any case this type of externality is not the focus of this article.

use the linear-in-means model throughout the article since we lack data on the distribution of students' peer characteristics but, as discussed below, many of our results would hold in a more general model in which educational outcomes were non-decreasing in peer characteristics. In such a model, re-sorting of peers could change average test scores but would hurt educational outcomes to some. (More generally, we could assume that $Y_i = \beta_0 X_i + \beta_1 f[X_i \ldots X_{i-1} X_{i+1}, X_N] + \beta_2 P + \varepsilon_i$, where N is the number of students per school and $f(.)$ is increasing in all its arguments.) Under the hypothesis that $\beta_2 > 0$ and $\beta_1 = 0$ vouchers work purely through a productive effect and the benefit to participants will be equal to the social benefit.

Consider the case where the voucher has no productive effect ($\beta_2 = 0$) but peer effects are positive ($\beta_1 > 0$) and peer effects are linear in means as in (1). In this case, the observed difference between voucher winners and losers in a lottery is just $\beta_1(\bar{X}_{winner} - \bar{X}_{loser})$ 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. 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.[4] Vouchers may have positive effects for participants, by helping them to move to schools where their peers have better X values. However, in this case the quality of peers may decline for students already in private schools as a result of the influx of less prepared voucher students. Moreover, if the voucher winners had high X values relative to the public schools they leave, the voucher programme may hurt those left behind in public school by lowering the average achievement level of students in that public school. This pure peer effects story is precisely the type of model used by previous researchers in studying the general equilibrium effects of vouchers (Hsieh and Urquiola, 2006; Epple and Romano, 1998).

More generally, under (1), estimating the differences in outcomes between lottery winners and losers, yields $\beta_1(\bar{X}_{winner} - \bar{X}_{loser}) + \beta_2$. This is the effect estimated by Angrist *et al.* (2002; 2006). This would be the observed effect of the voucher on participants. However, the social effect of the programme on average test scores would only be equal to β_2. β_1 and β_2 are not separately identified and hence one cannot conclude there is a productive effect of vouchers, rather than just a redistribution effect.

In this article, we argue that it is possible to test the hypothesis that $\beta_2 > 0$, by finding a population for whom winning the lottery does not lead to an improvement in peer quality. If $\bar{X}_{winner} = \bar{X}_{loser}$, then comparing test scores of winners and losers will yield an estimate of β_2, the productive effect. We identify two groups of voucher applicants. One set had applied to private academic schools prior to the voucher lottery. The other applied to private vocational schools prior to the lottery. 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 $\bar{X}_{winner} - \bar{X}_{loser}$ is generally positive or zero. In contrast, for those who applied to vocational schools, $\bar{X}_{winner} - \bar{X}_{loser}$ is likely to be negative. As we also show in the next Section, voucher winners who had applied to vocational schools obtained peers with lower academic achievement, lower college attendance rates and higher rates of dropout than their

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[4] In a more general model where peer effects are not linear-in-means, vouchers could either increase or decrease mean test scores. However, as long as the impact of peers' test scores on own test scores is monotonic, someone is made worse off by vouchers if there is no productive effect of vouchers.

fellow applicants who lost the lottery. Thus, if vouchers are purely redistributive, allowing recipients to obtain better peers but having no intrinsic productive effect, so $\beta_2 = 0$ and $\beta_1 > 0$, our simple model would imply that the difference between voucher winners and losers should be positive among students who had applied to academic schools and a negative among those who had applied to vocational schools. However, in our data we find positive effects in both cases. As we show later in the article, we find that voucher winners who applied to vocational schools and voucher winners who applied to non-vocational have better educational outcomes than their voucher lottery loser counterparts – higher tests scores after three years, a greater likelihood of taking the college entrance exam, higher scores on this examination and more years of schooling completed. Hence, we can reject the hypothesis that there is no productive effect of vouchers and that they work solely through positive peer effects.

2. Background on the PACES Voucher Programme

Private schools play a prominent role in education in Colombia as they do in many other developing countries. Nationwide, almost 1/3 of students attend private schools. In Bogotá, the percentage of students in private school is much higher and over 70% of the 1,300 secondary schools in Bogotá are private (King *et al.*, 1997). During the 1990s Colombia implemented a secondary school voucher programme that provided over 125,000 vouchers to people residing in poor neighbourhoods. The programme was initially launched in Colombia's major cities in an effort to increase secondary enrolment rates amongst the poorest families in Colombia. In 1998, the programme was phased out with the election of a new president.

Students could only apply for the voucher at the end of 5th grade, as students in Colombia were about to enter secondary school. Students receiving the voucher could attend any private school that accepted the voucher; however, many schools, particularly the elite private schools in Colombia, would not accept the voucher. Slightly less than half of private secondary schools participated in the voucher programme. While initially the voucher covered most tuition fees, the government did not increase the voucher to keep pace with inflation and by 1998 when we collected data, the voucher covered about 56% of tuition. Families had to pay any fees not covered by the voucher.

The private schools that took part in the programme served lower-income students and charged lower tuition fees than those private schools that chose not to participate. Non-participating private schools had significantly higher teacher–pupil ratios than participating schools. However, teacher–pupil ratios were comparable between public and participating private schools (King *et al.*, 1997).

Schools with a vocational curriculum were over-represented among participating schools. Data from the Instituto Colombiano para el Fomento de la Educación Superior (ICFES) show that only 16% of all high school graduates attended vocational schools. By contrast, 25% of voucher winners in our sample applied only to vocational schools and an additional 23% applied to schools with both vocational and academic tracts.[5]

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[5] We call schools with both vocational and academic tracts 'hybrid' schools throughout the article. About 23% 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.

In order to target the poorest families, eligibility was limited to families living in neighbourhoods classified as belonging to the two lowest (out of six possible) socio-economic strata. To enforce the eligibility rule, parents were required to present a utility bill with household stratification (Calderón, 1996). In addition, vouchers were only available to students attending public primary schools.[6]

At the start of the application process, students and their families began by filling out voucher forms printed in newspapers or available at local offices of the Institute for Educational Loans and Technical Studies Abroad (ICETEX), the national-level public institution that administered the programme. Students listed a particular school they wished to attend before receiving a voucher. In order to receive a voucher for that school, the student needed to have applied and been accepted by that school. Where necessary, ICETEX used a public raffle in cities to select the voucher recipients if the demand exceeded voucher supply. The voucher's value corresponded to the average tuition for a low-to-middle income level private school. Renewal of the voucher through the end of students' secondary schooling was contingent upon passing grades.

Because students applied to private schools prior to the lottery, we can separate lottery applicants by the characteristics of the schools they applied to. Technically, the lottery could be viewed as two separate lotteries – a lottery for students who had applied to vocational schools and a lottery for students who applied to other schools. Applicants to vocational schools tend to differ systematically from other applicants; they tend to come from families where the parents are less educated, they are also more likely to be living in the poorest of Colombian neighbourhoods, and they typically applied to schools whose students attained lower than average scores on college entrance examinations.

While the voucher rules suggested that voucher winners could transfer to schools other than the one they listed on their application, few actually did. The process of transferring the voucher was sufficiently complex that, according to the survey data in Angrist *et al.*, (2002), winners who transferred schools rarely retained their vouchers. The lack of portability in practice meant voucher winners who initially applied to vocational schools were much more likely to stay at the same school and hence the same type of school. Table 1 shows the enrolment patterns of voucher winners and losers who applied to the voucher programme. Of the students who applied to vocational schools, 60% of voucher winners were still in vocational schools three years after the voucher lottery. Only 43% of voucher lottery losers who had applied to vocational schools were still enrolled in vocational schools. As we demonstrate later in the article, the vocational schools had inferior characteristics along several dimensions (e.g. academic completion, college attendance, fees).

Angrist *et al.* (2002) provide support for the validity of the lottery's randomisation. Among all voucher applicants, there are no significant differences in age, gender, or the likelihood of having a phone by voucher win/loss status. Similarly, in the sample of students surveyed, there are no differences in pre-lottery characteristics across voucher

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[6] Students who applied for the voucher are likely better students or come from families with more interest in education than similar students who did not apply. The proportion of students who applied unsuccessfully for the voucher and attended private school is higher than the proportion of students attending private school in the poorest quintile of the population. Similarly, the proportion of students taking the college entrance examination among voucher lottery losers is higher ($\sim$21%) than it is among the poorest quintile of the population ($\sim$12%).

Table 1

Attendance Patterns of Lottery Applicants

| | School Applied To | | | |
| | Vocational | | Non-Vocational | |
School Attended Three Years after Voucher Lottery	Winner	Loser	Winner	Loser
Vocational	0.596	0.426	0.037	0.063
Non-Vocational	0.269	0.426	0.800	0.752
Dropout	0.135	0.147	0.159	0.179

Survey data are from Angrist *et al.* (2002). Sample includes 1,176 voucher applicants from Bogotá in 1995.

lottery winners and losers. This symmetry across winners and losers suggests the treatment and comparison are comparable and that the randomisation in the lottery was valid.

In prior research on the effects of Colombia's voucher programme, Angrist *et al.* (2002) find that after three years, lottery winners were 15 percentage points more likely to have attended private school, had completed 0.1 more years of schooling and were about 10 percentage points more likely to have finished 8th grade, primarily because they were less likely to repeat grades. While the programme did not significantly affect dropout rates, lottery winners scored 0.2 standard deviations (or about one grade level) higher on standardised tests. Angrist *et al.* (2006) show that the voucher also increased the likelihood of secondary school completion for participants by 15–20%. After correcting for the greater percentage of lottery winners taking college admissions tests, the programme increased test scores among participants by two-tenths of a standard deviation in the distribution of potential test scores. Thus, if the benefits to participants were not at the expense of negative externalities for non-participants, then the programme was very cost effective, given the low cost to the government and the benefits arising from the likely increase in winners' earnings due to greater educational attainment. Below, we present evidence casting doubt, at least in the Colombian context, on the hypothesis that the positive impact on beneficiaries was from peer effects of the type that would create negative externalities for non-participants.

3. Data and Empirical Strategy

The data used for this analysis are derived from three sources. First, we use data from a survey of voucher applicants carried out in Bogotá by Angrist *et al.* (2002). During 1998 and 1999, Angrist *et al.* (2002) interviewed 1,176 applicants from the 1995 cohort of applicants to the programme. Of those, 51% won a voucher to attend a private secondary school. Using the ICFES classification of academic and vocational schools we determined that roughly 25% of applicants applied to vocational schools and the remaining 75% to academic or hybrid schools. For 283 students in the survey sample, we also have standardised test scores for a test taken three years after the lottery.[7] In Table 2 we present some other descriptive statistics from the survey sample.

[7] Tests cover the mathematics, reading and writing sections of a standardised test entitled *La Prueba de Realización.* Of the 473 applicants invited, 283 attended.

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)	0.155 (0.154)	15.01 (1.361)	0.027 (0.092)	0.052 (0.092)
Male	0.497	−0.051 (0.060)	0.505	−0.012 (0.034)	0.008 (0.034)
Mother's Schooling	5.22 (2.58)	0.303 (0.322)	5.935 (2.882)	−0.048 (0.203)	0.713** (0.200)
Father's Schooling	4.75 (2.90)	−0.089 (0.394)	5.429 (3.202)	0.583** (0.243)	0.678** (0.242)
Living in Poorest Neighbourhood	0.197	−0.003 (0.048)	0.1295	−0.006 (0.023)	−0.068** (0.024)
Living in Next Poorest Neighbourhood	0.535	−0.050 (0.060)	0.5746	0.026 (0.034)	0.039 (0.034)
Mean ICFES at Schools Applied to	45.8 (2.5)	0.266 (0.301)	46.38 (3.162)	−0.375 (0.230)	0.610** (0.209)

Data are from the household surveys. Standard deviations are in parentheses in columns (1) and (3). Standard errors are in parentheses in the other columns reporting differences.

The second source of data relies on matching administrative records from the ICFES with data on their college entrance exams (Angrist *et al.*, 2006). Since 90% of Colombian students who finish secondary school take the ICFES exam (World Bank, 1993), this is likely to be a good proxy for high school graduation, while only about 75% of these students go on to post-secondary schooling (World Bank, 1993). Hence, we view participation in the ICFES examination as a proxy for high school graduation more than as an indicator of college attendance.

The final source of data comes from a survey we conducted of schools in our sample. In January 2006, attempts were made to contact a sample of 300 schools with a heavy concentration of voucher applicants. In choosing which schools to survey, we opted for schools which had the highest number of voucher applicants in attendance. While not random, the selection procedure accounted for almost 85% of the schools that voucher winners attended. In our school survey, we gathered extensive information about school and peer characteristics that we use to demonstrate the differences between the various schools students chose to attend.[8]

As discussed in detail in Angrist *et al.* (2006), winners and losers seem comparable on observable characteristics such as age, sex and telephone access; this is consistent with

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[8] Twenty-seven schools no longer existed and some schools refused to participate in the survey. Overall, we were able to match 61% of voucher winners and 59% of voucher losers. The difference is not significant. 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. Of the school characteristics we can track performance and participation in the college entrance examination before and after the lottery, we find that these characteristics are stable.

the hypothesis that the lottery was indeed random. Table 2 reproduces some of these results for the sample of students upon which we focus while disaggregating these comparisons across voucher status by the type of schools that students applied to. For example, among applicants to vocational schools, there were no statistically significant differences between voucher winners and losers in age, sex, parental schooling, neighbourhood wealth and quality of the schools that they applied to. Similarly, there are no significant differences between voucher winners and losers who had applied to non-vocational schools.

Table 2 also reports differences between individuals who applied to vocational and those who applied to non-vocational schools. While there is no significant observed difference in age or gender between applicants to the respective types of schools, there is a significant difference between parents' education levels and neighbourhood of residence. Among students who applied to vocational schools, their mothers and fathers had completed on average 5.2 and 4.8 years of schooling respectively. Among students applying to non-vocational schools, parents had completed 5.9 and 5.4 years of schooling. The differences are statistically significant. Additionally, students who applied to the vocational schools were about 50% more likely to be living in the poorest neighbourhoods in Bogotá. The average ICFES score was also much lower at vocational schools relative to non-vocational schools.

4. Effect of Vouchers on Peer Quality

To identify the effects of vouchers on peer quality, we rely on data from a survey of school administrators. When we compare specific individual school characteristics, we find little evidence that among voucher applicants who applied to vocational schools, voucher winners attended schools where their peers had more desirable observable characteristics compared to the schools that voucher lottery losers attended. In fact, almost all of the point estimates suggest that observable measures of peer quality are lower for voucher winners in the population of those who applied to vocational private schools. Due to the limited sample size the differences between many of the individual measures of peer quality between winners and losers are not statistically significant. However, an aggregate Average Effect Size measure, combining several individual indicators of peer quality is significantly lower for voucher winners. The finding that voucher winners have lower peer quality is not unique to Colombia. Hoxby (2003) makes a similar point in reviewing the literature on school choice and competition in the US. Participants in school choice programmes often have lower peer quality after exercising choice.[9]

4.1. *Schools of Attendance*

Among applicants to private vocational schools, lottery winners were much more likely to attend vocational school. To test whether the voucher winners were more likely than

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[9] The overall evidence on vouchers in the US is mixed (Barrow and Rouse, 2008) while it is generally more positive outside of the US (Zimmer and Bettinger, 2007). The relevant comparison for our article is that the voucher recipients often have peers with inferior characteristics and often have better educational outcomes.

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	0.426 (0.497)	0.171** (0.059)	0.176** (0.059)	0.0631 (0.243)	−0.025* (0.014)	−0.029* (0.015)
Attending Private School in 6th Grade	0.898 (0.303)	0.025 (0.034)	0.024 (0.034)	0.898 (0.304)	0.053** (0.018)	0.049** (0.018)
Attending Private School in 7th Grade	0.695 (0.462)	0.134** (0.051)	0.132** (0.052)	0.683 (0.466)	0.177** (0.028)	0.179** (0.028)
Attending Private School at the Time of the Survey	0.531 (0.501)	0.178** (0.058)	0.171** (0.059)	0.539 (0.499)	0.153** (0.033)	0.151** (0.032)
Attending Non-Vocational School	0.426 (0.497)	−0.156** (0.057)	−0.186** (0.057)	0.757 (0.430)	0.040 (0.028)	0.035 (0.027)

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' neighbourhood.

voucher losers to attend vocational schools, we estimate the following equation in Table 3

$$W_i = \alpha + \gamma V_i + \boldsymbol{\pi}\mathbf{Z}_i + u_i \qquad (2)$$

where W_i is an indicator for the type or school that student i attends three years after the voucher lottery, $\mathbf{Z}_i$ is a vector of controls (age, gender, access to phone, the time of the survey and the students' neighbourhood), and V_i is an indicator of 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 article correct for heteroscedasticity.

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% (0.17/0.43) 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.

The other panels of Table 3 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.

4.2. *Measures of Peer Quality*

To test whether the voucher winners had peers with different characteristics, we re-estimate (2) where W_i represents an indicator for peer quality at the school that student i attends three years after the voucher lottery, As before, $\mathbf{Z}_i$ is a vector of controls (age, gender, access to phone for interview, the time of the survey and the students' neighbourhood), and V_i is an indicator of whether the student won a voucher. The coefficient γ shows the effect of winning the voucher on the average quality of peers. We report these estimates in Table 4.

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

In order to increase our power, we can take advantage of the fact that we have multiple measures of school quality. One technique for doing this is to compute the Average Effect Sizes (AES) across a category of peer characteristics. AES is a technique used for estimating the effect of treatment on multiple dependent variables,[10] while allowing for correlation between these variables. To estimate the AES we first scale outcome variables in terms of standard deviation units, and so that positive numbers indicate more desirable peers. We jointly estimate the effects of the voucher on observable measures of peer quality and report these 'average effect sizes' for vocational schools in Column 4 of Table 4.

The first set of peer characteristics upon which we focus relate to the ICFES examination. The ICFES examination is the college entrance examination in Colombia and 90% of high school graduates take the examination although only about 75% of exam takers go on to college (World Bank, 1993). These graduating students are the peers and perhaps the role models of entering students at the high school. Throughout the 1990s, the median and standard deviations for schools were stable and the relative rankings of schools did not change. Since these test scores tend to be stable over time, they are likely to indicate the average 'type' of student attracted to the school.

The central ICFES measures we use are

- (*i*) the mean ICFES score for the school,
- (*ii*) the proportion of students who take the ICFES relative to 6th grade class (the first year of high school),[11] and
- (*iii*) the proportion of students who take the ICFES relative to the size of the senior class.

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[10] 'Average effect sizes' have long been used in medical research (O'Brien, 1984). Recent research by Kling *et al.* (2006) and Bloom *et al.* (2006) utilise this methodology as well.

[11] While we observe the number of students taking the ICFES examination from each school, we only observe the number of students in sixth grade for schools participating in the SABER, a national survey of a random sample of schools.

Table 4

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) Average Effect Size	(5) Losers' Mean	(6) Coefficient on Voucher Status Without Covariates	(7) Coefficient on Voucher Status With Covariates
(a) Academic Indicators of Peer Quality							
Student College Entrance & Graduation Behaviour (8 measures)							
Mean ICFES Score	46.50 (3.19) [94]	−0.152 (0.423) [220]	−0.186 (0.455) [215]		47.21 (3.47) [317]	0.005 (0.287) [645]	−0.117 (0.297) [632]
Proportion of Entering Class who later take the ICFES	0.759 (0.423) [50]	−0.043 (0.075) [126]	−0.070 (0.085) [125]		0.905 (0.879) [172]	0.130 (0.097) [353]	0.142 (0.102) [345]
Ratio of Students Taking the ICFES and the Size of Senior Class	1.060 (0.015) [88]	0.011 (0.020) [198]	0.023 (0.019) [194]	−0.167* (0.094)	1.05 (0.59) [247]	−0.034 (0.038) [493]	−0.040 (0.042) [482]
Proportion of Students Enrolling in College	0.314 (0.316) [85]	−0.074* (0.042) [189]	−0.090** (0.045) [185]		0.352 (0.312) [231]	0.046 (0.029) [457]	−0.028 (0.030) [488]
Student Dropout Behaviour (3 measures)							
Percentage of Students Who Dropped Out	0.034 (0.034) [89]	0.012* (0.006) [202]	0.008 (0.007) [198]	0.119 (0.227)	0.028 (0.034) [254]	−0.003 (0.003) [502]	−0.003 (0.003) [491]

Table 4

(*Continued*)

| | Vocational | | | | Non-Vocational | | |
	(1) Losers' Mean	(2) Coefficient on Voucher Status Without Covariates	(3) Coefficient on Voucher Status With Covariates	(4) Average Effect Size	(5) Losers' Mean	(6) Coefficient on Voucher Status Without Covariates	(7) Coefficient on Voucher Status With Covariates
(b) Other Indicators of Peer Quality							
Existence of Remedial or Vocational Programmes (6 measures)							
Has Job Training Programme	0.152 (0.360) [178]	0.089** (0.042) [402]	0.093** (0.045) [394]	0.267** (0.116)	0.216 (0.412) [504]	0.030 (0.030) [498]	0.032 (0.031) [974]
Has Tutoring for Disadvantaged Students	0.281 (0.045) [178]	0.072 (0.056) [402]	0.065 (0.057) [394]		0.349 (0.477) [504]	0.063* (0.037) [996]	0.074** (0.037) [974]
Fees (2 measures)							
Fees	40752.6 (47212.4) [174]	−8778.2 (5959.8) [243]	−9497.9 (6151.0) [241]	−0.387** (0.176)	63318.4 (62572.9) [482]	−2136.1 (4384.0) [774]	−5361.6 (4874.1) [752]

Standard deviations appear in columns (1) and (5). 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, the time of the survey and controls for the students' neighbourhood. Sample sizes are listed in square brackets and in the last four rows reflect multiple measures per student. Standard errors are clustered at the student level in these regressions. For the Average Effect Sizes, outcomes are standardised so that they are monotonic in school quality. Effect sizes are standardised within outcomes. Effects are measured in a model with covariates including age, gender, access to phone, the time of the survey and controls for the students' neighbourhood. Standard errors take into account correlation within measures.

A limitation of our strategy is that we only measure the characteristics of the schools after the voucher lottery. Ideally we would like to use pre-voucher ICFES scores so that we measure pre-determined characteristics of the school population and not the possible results of improvements in educational attainment due to the voucher programme. Our measure of mean test scores and our measure of the proportion of students taking the ICFES (relative to the 6th grade class) are taken from the 1998–9 school year. At that time, none of the applicants in the voucher sample had taken the ICFES examination. In 1998–9, students were typically in 7th or 8th grade and still had several years before they could take the ICFES examination. Our other ICFES examination statistics were measured in January 2006. As discussed above, schools' ICFES test scores are stable over time, so this may be an adequate proxy for ability. The PACES programme we examine was small relative to the relevant population. For example, in 1995, there were 2,378 voucher students out of the 567,000 students in Bogotá. Hence, any impact of the programme on school quality is likely to be small.

Among vocational school applicants, voucher lottery winners attend schools that score 0.15 to 0.18 points lower on the ICFES examination than voucher lottery losers. The point estimate is negative but the difference is not significant. Among non-vocational school applicants, the difference in the types of schools that voucher winners attend is similarly insignificant. In our other measures of students' ICFES-taking behaviour, we find that voucher winners at vocational schools attend schools where a lower proportion of students go on to take the college entrance exam, although these differences are not statistically significant. In Column (4) of Table 4, we pool these estimates across these ICFES characteristics and report the average effect size. Here we find significant estimates. Among students who initially applied to vocational schools, voucher winners attended schools where their peers were less likely to attend college.

In the other rows of Table 4, we show other measures of school quality, many of which are significant. For example, voucher winners at vocational schools attend schools where a smaller fraction of students enrol in college.[12] Voucher winners also appear to attend schools where a higher percentage of students drop out, although these correlations are at best marginally significant. When we look at the average effect size, students who won the voucher attended schools where their peers were more likely to drop out but the effect is not significant.

Table 4(b) presents other school characteristics that may serve as indicators of peer quality. Among applicants to vocational schools, voucher winners are more likely than voucher losers to attend schools with programmes focused on tutoring disadvantaged students and unsurprisingly with vocational programmes.[13] The existence of these programmes suggests that voucher winners' peers were preparing for vocational careers and/or their peers potentially had learning difficulties. Additionally, voucher winners also attended significantly less expensive schools. The fact that voucher winners

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[12] The effects on college attendance should not necessarily match with the ICFES taking results because only 75% 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).

[13] The sample sizes in Table 4(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. We estimate (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 and two measures of the availability of programmes for disadvantaged students.

attended less expensive schools even before considering the voucher subsidy may suggest that voucher winners' peers' parents were either poor or had less interest in their children's education. In Column (4), we estimate the average effect sizes for these other categories of peer quality. We find that voucher winners are more likely to attend schools with remedial or vocational programmes than voucher lottery losers. The schools that these voucher winners attend also tend to charge lower fees.[14] These differences are all statistically significant.

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

The key lesson that we draw from Table 4 is that voucher winners at vocational schools do not attend schools with peers of higher status across a variety of measures. Most of the time, the differences are insignificant; however, despite our small sample size, we frequently find that schools that voucher winners attended had students with less desirable observables than schools that voucher losers attended. When we look at average effect sizes, we also find that among students initially applying to vocational schools, voucher winners attend schools with lower peer quality than voucher losers.

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

5. Voucher Effects

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

In Table 5, we estimate the effects on both the likelihood that students take the college entrance examination and students' performance on that examination. These outcomes are available for a much larger sample because the data is taken from administrative sources rather than survey data. There are, however, several obstacles in matching the administrative data. The student records from PACES often included incorrect ID numbers. To improve the accuracy of matching, we used multiple matching strategies – matching by ID alone, matching by ID and city of residence, and matching by ID number and name.

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[14] Both public and private schools can charge fees. We focus on matriculation and monthly fees. The matriculation fees are much larger for voucher lottery losers than for winners while monthly fees are more comparable across the groups.

Table 5

Effects of Voucher on College Entrance Examination Outcomes

	Vocational		Non-vocational	
Dependent Variable	(1) Losers' Means	(2) Regression-Adjusted Voucher Diff	(3) Losers' Means	(4) Regression-Adjusted Voucher Diff
(*a*) Probability of Taking ICFES				
ID Match	0.255	0.061*	0.288	0.059**
	(0.436)	(0.030)	(0.453)	(0.018)
ID & City Match	0.252	0.049*	0.273	0.058**
	(0.435)	(0.030)	(0.445)	(0.017)
ID & Name Match	0.188	0.054*	0.212	0.034**
	(0.392)	(0.028)	(0.409)	(0.016)
N	361	810	1200	2612
(*b*) Performance Outcomes on the ICFES				
Maths Score cond'l on taking	41.46	0.766	42.39	0.309
	(4.87)	(0.637)	(4.762)	(0.356)
		[257]		[875]
Reading Score cond'l on taking	45.71	2.06**	47.19	0.343
	(5.95)	(0.780)	(5.450)	(0.396)
Maths Score (Upper Bound Estimate)	–	2.517**	–	1.527**
		(0.616)		(0.330)
Reading Score (Upper Bound Estimate)	–	4.364**	–	1.695**
		(0.738)		(0.3648)
N	87	256	319	874

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 *et al.* (2006).

Table 5 shows the proportion of voucher lottery losers who take the college entrance examination and the difference by voucher status for applicants to each type of school. The results suggest that students who applied to vocational schools and won vouchers were 5–6 percentage points more likely to take the ICFES examination than students who applied to vocational school and did not win the voucher. The voucher effect on the likelihood of taking the ICFES examination at non-vocational schools was between 3 and 6 percentage points. Given that more students from non-vocational schools took the ICFES examination, the relative effect on voucher students in vocational schools is much larger. In our most conservative matching strategy, the voucher led to about a 25% increase in the likelihood that a student at a vocational school took the ICFES examination while the voucher led to a 13% increase in the likelihood a voucher winning student from a non-vocational school took the ICFES examination. Given that the ICFES examination is a better indicator of high school completion than college entrance, the results suggest that voucher lottery winners were much more likely than voucher lottery losers to complete secondary school.

Moreover, as the second panel of Table 5 shows, voucher students who applied to vocational schools tend to have higher reading test scores than students who lost the voucher lottery. As discussed in Angrist *et al.* (2006), the unconditional comparisons are likely lower bounds on the true estimate since the average test scores for voucher

winners are likely lower because the voucher affected the probability of taking the examination (and the marginal students were likely of lower ability). Angrist *et al.* (2006) provide a discussion of how to estimate an upper bound for the true effect under the assumption that any voucher effect is monotonic. These estimates are reported in Table 5 and suggest significant positive effects of the voucher in both mathematics and reading among vocational students. The raw difference in test scores of voucher winners and losers at non-vocational schools is not significant but similar to the vocational schools, this difference is likely biased downward. The upper bounds suggest significant positive effects suggesting that at the end of high school, voucher lottery winners had higher academic achievement than voucher lottery losers.

In Table 6, we estimate the effects of the educational voucher on other outcomes. These other outcomes were measured using survey data three years after students applied for the voucher and three years before they took the ICFES examination. In terms of academic outcomes, the results are different in their significance between vocational and non-vocational schools. The signs of the coefficients suggest uniformly that voucher winners at both types of schools are more likely to complete more years of

Table 6

Voucher Effects by Type of School Applied To

| | Coefficient on Voucher Status | | | |
| | Vocational | | Non-vocational | |
Dependent Variable	(1) Losers' Means	(2) Basic Controls	(3) Losers' Means	(4) Basic Controls
Started 6th Grade in Private	0.898	0.024 (0.034)	0.898	0.049** (0.018)
Started 7th Grade in Private	0.695	0.132** (0.052)	0.683	0.179** (0.028)
Currently in Private	0.531	0.171** (0.059)	0.539	0.151** (0.032)
School Years Finished	7.51 (0.936)	0.139 (0.099)	7.53	0.092 (0.058)
Currently in School	0.853	−0.011 (0.041)	0.820	0.006 (0.023)
Finished 6th Grade	0.946	0.032 (0.023)	0.941	0.016 (0.013)
Finished 7th Grade	0.861	0.045 (0.039)	0.854	0.018 (0.022)
Finished 8th Grade	0.643	0.094* (0.056)	0.655	0.087** (0.031)
Ever Repeated a Grade	0.248	−0.063 (0.052)	0.207	−0.053** (0.026)
Number of Repetitions of 6th Grade	0.242	−0.063 (0.052)	0.171	−0.053** (0.026)
Applicant is Working	0.225	−0.047 (0.047)	0.176	−0.029 (0.024)
Total Hours Worked	6.65 (15.72)	−2.42 (1.65)	5.36 (14.46)	−0.856 (0.903)
N	129	283	444	858

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

schooling and less likely to repeat grades. In the non-vocational schools, the effects on school years finished, grade repetition and 8th grade completion are statistically significant. However, while the coefficients are of similar magnitude in the vocational schools, only the coefficient on 8th grade completion is statistically significant.

The key finding in Tables 5 and 6 is that voucher winners who applied to vocational schools had better outcomes than voucher losers who had also applied to vocational schools. While it is useful to note that voucher winners at non-vocational schools also had positive outcomes, the effect in vocational schools is of greater interest for the purpose of this article. This is because among applicants to vocational schools, voucher winners had peers with lower quality observable characteristics.

6. Other Voucher Mechanisms

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

If peer effects were not the channel through which vouchers worked, then what was? The data suggest a few hypotheses. First, winners had more incentive to devote effort to school. Voucher students lost the voucher if they failed to pass a grade. The presence of incentives in Colombia's voucher programme is one of its distinguishing features separating it from other publicly funded voucher programmes world-wide. In recent years, economists have found evidence that cash incentives or merit scholarships based on academic performance can lead to increased test scores; Kremer *et al.* (2009), Bettinger (2008), Angrist and Lavy (2009).[15] Voucher students lost the voucher if they failed to pass a grade. The presence of incentives in Colombia's voucher programme is one of its distinguishing features, separating it from other publicly funded voucher programmes world-wide.

Our findings are similar to those of a recent Colombian experiment focused on high school students provided subsidies for attendance. In Colombia a recent experiment focused on high school provided subsidies for attendance but the timing of the payments differed. Barrera-Osorio *et al.* (2008) finds that attendance increased by 2–4 percentage points. One of the treatments provided families with a lump-sum payment about the time that fees were due for the next school year and another provided a lump-sum payment at the start of tertiary schooling. These lump-sum payments increased college attendance by over 9 percentage points. While the results are not completely comparable due to the differences in time and in the underlying population, the magnitude of the results are similar to those estimated here. A second possibility is that voucher winners attended schools with greater school inputs; however, we find little evidence to support this. When we look at schools that

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[15] An alternative explanation is that schools had incentives to promote voucher students after each grade in order to keep voucher monies coming to the school. Angrist *et al.* (2002) reject this explanation given that test scores on an independent test were improving for voucher students relative to other students. Angrist *et al.* (2006) show long-term effects of the programme on a common examination.

voucher winners attended, we find that winners were more likely to attend schools with a greater proportion of teachers who only have secondary school training and a smaller proportion of teachers with advanced degrees. We find no differences in voucher status in what types of facilities were available at students' schools.

Another channel through which the greater demand-side choice offered by vouchers may have improved outcomes is by allowing students to choose the type of schooling they valued. Academic schools instruct students in the fields of science, humanities or the arts. Vocational schools prepare students primarily for participation in the labour market, either in the production sector or the service sector. They typically focus on commercial, industrial, agrarian or pedagogical skills and their curricula exhibit considerable heterogeneity.

The focus of public and private vocational schools is very different. Table 7 shows some basic characteristics of private and public vocational schools in Colombia. Of public schools, 25% have an industrial curriculum and 62% have a commercial one, whereas only 4% of private vocational schools have an industrial curriculum and 92% have a commercial focus (both differences are highly statistically significant).[16] Accordingly, vocational enrolment differs between public and private schools: in public vocational schools, 32% of students are enrolled in a school with an industrial focus and 48% in schools with a commercial focus. By contrast, only 9% of private vocational enrolment is in schools with an industrial focus and 85% is in schools with a commercial focus.

Table 7

Characteristics of Public and Private Vocational Schools

	Vocational Schools		
	Private	Public	Private-Public
Total Number of Schools	316	266	
Share Industrial	0.038	0.248	−0.210***
			(0.029)
Share Commercial	0.924	0.624	0.300***
			(0.033)
Total Enrolment	62,871	79,367	
Share of Enrolment in Industrial Schools	0.092	0.318	−0.226***
			(0.002)
Share of Enrolment in Commercial Schools	0.853	0.482	0.371***
			(0.002)
Probability School Has Specialised Industrial Teacher	0.038	0.365	−0.327***
			(0.063)
Probability School Has Specialised Commercial Teacher	0.794	0.683	0.111
			(0.069)
Dropout Rate – 10th Grade	0.030	0.072	−0.042***
			(0.011)
Dropout Rate – 11th Grade	0.022	0.092	−0.070
			(0.014)

Notes. Data based on C-600 1998 School Census. Shares do not add up to one because the other vocational categories (Agricultural, Pedagogic and Social Promotion) have been omitted. The coefficient in parentheses in the last column is the standard error of the difference between private and public. Standard errors appear in parentheses in the final column.

[16] 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 school teachers.

In schools with an industrial focus, emphasis and instruction are on activities such as welding, electrical works, carpentry and cabinetmaking, metallurgy, smelting, welding and metallic ornamentation. By contrast, in schools with a commercial curriculum, students spend a significant amount of time, both during school time and in apprenticeships outside school learning how to carry out basic accounting functions, how to setup and administer a small enterprise, communication skills, information technology, computer maintenance and software design; event logistics; and office clerical work. Similarly, the type of apprenticeships that students undertake differs depending on the vocational focus of the school. For example, data from the 2006 school survey suggests that students in industrial schools are more likely to participate in apprenticeships that take place with Servicio Nacional de Aprendizaje (SENA), Colombia's governmental job training agency, while students in schools with a commercial focus are more likely to undertake apprenticeships in the private sector, working in offices, small enterprises, universities and communications.

Students may value some types of vocational or academic education more than others. In the annual school census for Bogotá, we can identify the central emphasis of vocational schools that voucher winners and losers attend.[17] Among students not attending academic programmes, there is a clear preference for commercial education as opposed to an industrial, agricultural or pedagogical curriculum. Lottery winners who had initially applied to vocational schools were more likely to attend schools with job training or apprenticeship programmes (Table 4). Almost all of these apprenticeships took place in the service sector. Students' preferences for commercial schools may derive from the fact that students value a commercial education more than other types of vocational training. White collar jobs are more prestigious than blue collar jobs and the service sector has grown considerably while the share of jobs in factories has declined (Cárdenas and Bernal, 1999).

Students who lose the lottery are more likely to attend public schools and there are a limited number of commercial vocational schools in the public sector. If student demand for these schools is greater than the available spots, then students who want to attend vocational schools will be forced to attend industrial rather than commercial vocational schools or to attend academic schools. Students in the industrial school may be more likely to drop out because that training is less valuable to them than the commercial education would be. If the voucher increases the share of students who can attend a commercial school (because they switch to private commercial schools), then this effect may be driving the increase in retention/years of education attained. Whether voucher applicants attend academic schools or industrially oriented vocational public schools, the match between students and schools is likely to be worse than for voucher winners. This could explain why voucher winners in vocational schools are 25% more likely to graduate from high school (Table 5).[18]

Our results suggest that if policymakers offer disadvantaged youth the option of private vocational education, a significant number will choose it and academic outcomes for this group will be better than they would be in the absence of the option.

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[17] The annual school census is entitled the C-600. We can only match 1,856 students (of 4,044) to their school of application.

[18] 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, which prevents any conclusive statistical analysis.

These results are similar to other studies (Kemple and Snipes, 2000; Cullen *et al.*, 2005) which provide experimental evidence that students in vocational schools in the US have greater academic attainment than similar students enrolled in non-vocational schools.[19] Similarly, Attanasio *et al.* (2008) find that vocational training programmes in Colombia improve earnings for participants.

Why are public vocational schools less likely to supply the types of training in demand from the labour market and from students? The private market may be able to adapt more quickly than the government to changes in the economy and the demand for skills. For example, the Secretariat of Education in Bogotá determines the curriculum and curricular standards for all public schools (both vocational and academic), while private schools have complete autonomy to select their curricular focus. Additionally, in public schools, hiring and firing of teachers is strongly influenced by FECODE, the Colombian teachers union, whereas in private schools the school principal exercises such authority. The potential to adapt quickly to the needs of the labour market depends on a school's ability to change curriculum and, more importantly, select qualified teachers. Table 7 shows some evidence that private schools can change faculty more readily than public schools. In the school census, we find that the probability a public vocational school has a specialised teacher for industrial teaching is 37% – a number ten times larger than the probability a private vocational school has such a teacher (3.8%). By contrast, private vocational schools are 10 percentage points more likely than public vocational ones to have a specialised teacher for commercial teaching.[20] Given the bureaucratic and administrative hurdles for firing or substituting a teacher in the government sector, it is plausible that specialised curricular conversion will take much longer in public than in private schools.

Based on the 1998 school census for Bogotá, amongst schools with a vocational focus, dropout rates in grade 10 (when students fully engage in their vocational curricula) are more than twice as high in public than in private schools. The dropout rate for 10th graders in public vocational schools is 7.2%, while for private vocational schools is 3% (the difference is highly statistically significant – t-stat of 3.93). Similarly, the dropout rate in 11th grade in public vocational schools is 9% while in private vocational schools is 2.2% (the difference is highly statistically significant – t-stat of 4.91). Given that the likelihood of this population attending a post-secondary institution is very low, it is also likely that the practicality and expected return of what students learn in 10th and 11th grade greatly influences their decision to remain in school. For example, in the census data underlying Table 7, we find that dropout rates are twice as high in industrial than in commercial vocational schools. The dropout rate (combining 10th and 11th grades) in industrial schools is 7.9% whereas in commercial ones it is 4% (the difference is highly statistically significant – t-stat of 2.46). Even within private vocational schools, dropout rates are almost twice as high for industrial (4%) as for commercial schools (2.5%, the difference is not statistically significant at conventional levels).

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[19] Other studies on the efficacy of vocational education include Kemple (2004), Kemple and Rock (1996), Stern *et al.* (2000) and Maxwell and Rubin (2000).

[20] In the data underlying Table 7, we find that public vocational schools have, on average 1.1 more specialised industrial teachers than private vocational ones (the difference is highly statistically significant – t-stat of 3.59). Private vocational schools have, on average 1.2 more specialised commercial teachers than public vocational ones (the difference is highly statistically significant – t-stat of 3.22).

Finally, practical training in private vocational schools is much more attuned with the growing demands of the economy. According to data from Colombia's Central Bank, salaries in the commercial sector grew at least as much as salaries for industrial workers between 1999 and 2005.[21]

7. Conclusion

Previous work suggested that students who participated in voucher programmes had better academic outcomes than students who applied unsuccessfully for the voucher. The previous research, however, could not rule out the hypothesis that vouchers were purely redistributive and that while voucher participants benefited from more desirable peers, others had less desirable peers due to the general equilibrium effects of the programme, so there were no overall social educational gains from the programme (Hsieh and Urquiola, 2006; Epple and Romano, 1998).

In this article, we examine a subpopulation in which voucher winners do not join peers of higher observable quality. Among applicants to vocational schools, voucher lottery winners stayed in vocational schools, while voucher lottery losers were more likely to transfer into academic schools. Across a variety of measures, voucher winners who had applied to vocational schools prior to the lottery attended schools with no higher and indeed often with lower observable peer quality as compared to voucher losers. This is similar to other research on school choice programmes that shows that choice beneficiaries often have lower peer quality as a result of choice programmes (Hoxby, 2003). Despite having worse peers, voucher winners in this population had significantly better outcomes than voucher losers. They are more likely to stay in private school, more likely to finish eighth grade and less likely to repeat a grade. Furthermore, voucher winners are more likely to take the college entrance examination, and their test scores are between 1/3 and 2/3 of a standard deviation higher than losers. This suggests that, at least in this population, vouchers are not merely a zero-sum game in which benefits to voucher participants are offset by losses to non-participants. There are multiple channels that can explain the voucher effect. One important channel of impact in this population may be private schools' greater nimbleness in adapting to labour market needs. Vouchers may have improved the match between students and schools resulting in improved performance. The flexibility of vocational schools in implementing new curricula and in adjusting to shifting demands from the labour market may increase the overall efficacy of such schooling in improving students' outcomes. Additionally, unlike many other voucher programmes, Colombia's programme included incentives created by the programme's conditioning the renewal of the voucher on satisfactory academic performance. Another plausible explanation is that students responded to these incentives to stay in school.

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

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