Education Economics
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713415403

A comparative look at private and public schools' class size determinants

Angela K. Dills [a]; Sean E. Mulholland [b]
[a] Department of Economics, Wellesley College, Wellesley, USA [b] Department of Economics, Stonehill College, Easton, USA

First published on: 22 February 2010

To cite this Article Dills, Angela K. and Mulholland, Sean E.(2010) 'A comparative look at private and public schools' class size determinants', Education Economics,, First published on: 22 February 2010 (iFirst)
To link to this Article: DOI: 10.1080/09645290903546397
URL: http://dx.doi.org/10.1080/09645290903546397

Education Economics
2010, 1–20, iFirst Article

Routledge
Taylor & Francis Group

A comparative look at private and public schools' class size determinants

Angela K. Dills[a]* and Sean E. Mulholland[b]

[a]*Department of Economics, Wellesley College, Wellesley, USA;* [b]*Department of Economics, Stonehill College, Easton, USA*

(*Received 29 September 2008; final version received 20 July 2009*)

This paper tests three theories of class size determination: that schools assign better-behaved students, higher quality teachers, or higher-achieving students into larger classes. Furthermore, we estimate how these methodologies differ between public and private schools. Using a nationally representative sample from the USA, we show that, within public schools, third-grade class size is correlated with first-grade ability and, to a lesser extent, first-grade behavior. Private schools, however, appear to assign teachers reporting greater control over school policy to larger classes and teachers with more experience to smaller classes. Class size determination is due to uniquely different processes within public and private schools.

Keywords: class size; private schools

JEL codes: L33; H40; I21

1. Introduction

Many economists, beginning with Adam Smith, suggest that subsidies given to public institutions alter their incentives, production processes, and output relative to private institutions (Smith 1776; West 1964; Alchian 1968; Friedman and Friedman 1979; Brown 2001). Differences in the production processes of public and private schools are of particular interest in the debate over whether, and how, private schools perform better than public schools. One vein of the education production function literature examines whether private schools produce greater academic and non-academic outcomes for students than public schools. However, a much smaller line of study drills down to determine *how* private and public schools may differ in their production processes.

We consider one particular aspect of the production process: whether public and private schools use similar methods when assigning students and teachers to classes of various sizes. A vast literature focuses on the role class size plays in increasing student achievement with some finding that class size and teacher quality matter while others do not (see Betts (1996) for a survey of some of this literature). One difficulty facing researchers is that students may not be randomly assigned to a class size. Furthermore, student and teacher assignments may differ for public and private schools.

*Corresponding author. Email: adills@wellesley.edu

ISSN 0964-5292 print/ISSN 1469-5782 online

DOI: 10.1080/09645290903546397
http://www.informaworld.com

Using a nationally representative sample of elementary school students in the USA, we test three theories of class size assignment. First, we test whether schools engage in compensatory education, assigning lower-achieving students to smaller classes. Second, we test Lazear's (2001) hypothesis that schools optimally place better-behaved students into larger classes. Third, we test whether schools sort teachers into differently sized classes based on their characteristics.

Private school administrators and teachers face different incentives than their public school counterparts, emphasizing different objectives under different constraints. We find that these different incentives result in distinctive public and private methods for assigning students and teachers to various class sizes. Public institutions appear to assign class size for third-grade students based on ability and, to a lesser extent, behavior. Private institutions appear to assign class size by teachers, with third-grade class size varying within school by the teachers' educational background, experience, and their self-reported control of school policy.

Our results highlight differences in public and private schools' production processes. In addition, the results suggest unique school quality endogeneity issues for private and public schools. The observed endogeneity of class size reduces the researchers' ability to find consistent effects of class size on student achievement in both private and public institutions; however, the bias may be generated by processes unique to private and public schools. Therefore, specific private and public methods may be required to address the endogeneity of students, teachers, and class size.

In the next section, we present three theories of class size assignment. In Section 3, we discuss institutional differences between public and private schools in the USA that may affect their use of class size assignment. Section 4 discusses the empirical strategy; Section 5 the data. We conclude with an extended discussion of the implications of our results for the public/private school debate as well as for the estimation of education production functions.

2. Class size determination: three hypotheses

We consider three possible ways that schools may sort their inputs: placing lower-ability students into smaller classes, placing more poorly behaved students into smaller classes, and placing teachers with certain characteristics into smaller classes. We describe the existing evidence for these mechanisms. Much of the literature on class size examines elementary schools; we, too, focus on elementary school students.[1]

2.1. Compensatory education

First, we follow the line of thought presented in Azerhielm (1995) and Boozer and Rouse (2001) where class size is compensatory. Assigning lower-achieving students to smaller classes helps equalize achievement across students. Both papers find strong evidence that public schools assign lower-achieving tenth graders to smaller classes.[2]

These papers focus on high schools, whereas we look at elementary education. We may expect greater compensatory sorting in elementary schools because elementary school administrators may have greater control over how to organize each class. In addition, most third graders in our sample, 82%, have one teacher for all of their core subjects. By high school, students select courses and administrators must first ensure

that students enroll in the course of their choice and then determine the optimal teacher, classmates, and class size. Course selection by students constrains administrators' ability to sort teachers and students as students' progress in their academic career.

2.2. *Lazear's theory of behavior*

Even if students are homogeneous in ability, they may not be homogeneous in their self-control. Lazear (2001), theorizes that class size is determined by the public good aspects of classroom education. One student may interrupt the education process by misbehaving or asking a question other students do not share. This forces the teacher to devote time addressing the lone interrupting student, diminishing his classmates' learning. The public good nature of classroom learning may lead schools to choose class size based on student behavior. Lazear's hypothesis suggests that schools place better-behaved students into larger classes.

Prior research provides some support for Lazear's hypothesis. As Lazear (2001) notes, schools place special education students in smaller classes. Emotionally disturbed students may be more disruptive through misbehavior; learning-disabled students may disrupt the class through asking less-shared questions. Hanushek and Rivkin (1997), document that about one-third of the decline in class size in the 1980s can be attributed to the increase in special education students and the smaller classes in which they enroll.

If girls are better-behaved than boys, Hoxby's (2000b) findings of gender peer effects also fit this theory. Lazear's expansive definition of disruption includes time lost when one student asks a question to which most or all students know the answer. In some sense, part of his definition includes ability differences; however, his theoretical advancement on the production of education rests in misbehavior of the non-academic type. Furthermore, ability and behavior are correlated.[3]

We are not aware of other research that explicitly tests Lazear's theory, although some recent papers discuss the effect that classmates' behavior may have on student achievement (Figlio 2007; Burke and Sass 2008). In addition, other research discusses how class size affects teaching methods and class time. For example, Betts and Shkolnik (1999) and Rice (1999) find that an individual public school teacher spends more time disciplining when teaching a larger class than when teaching a smaller one. Time addressing and correcting disruption is a function of how often one or more students disrupt the class, the number of students, and how adept the teacher is at rules creation and enforcement. Better-behaved students are less likely to disrupt the class, thus reducing the time spent in discipline, *ceteris paribus*. However, increasing the number of students, holding student conduct and rules enforcement constant, increases the probability that any one student is misbehaving, and thus increases the class time consumed addressing the disruption. Neither Betts and Shkolnik (1999) nor Rice (1999) specifically address how administrators allocate students, class size, and teachers within their school.

Many public schools do not randomly assign students to classes. Using six observable student characteristics, Clotfelter, Ladd, and Vigdor (2006) fail to reject the null hypothesis of random student assignment in almost half of the North Carolina public elementary schools they analyze. Just as students may be sorted into classes based on their characteristics, classes may vary by size based on teacher characteristics.

2.3. Teacher sorting

The teacher's ability to control the classroom atmosphere is a vital component of the educational process. Teachers who develop and enforce successful rules for behavior lower the probability of individual student disruption and can devote more time to instruction. An administrator can call on these creative teachers to instruct larger classes so that the total amount of time lost to disruption is the same across all class sizes. If classroom rules and enforcement methods are highly regulated and teachers are given little control over the discipline process, the benefits from assigning teachers to varying sized classes may result in little, if any, benefit. Sorting teachers and students by other means, such as behavior, may be the best alternative.

Teacher sorting complicates estimation of teacher quality effects. If teachers and students are non-randomly assigned to classes of differing sizes and types, researchers may be unable to precisely estimate the effect of teacher quality. If more productive teachers are placed into larger classes, the overall public good aspect of the classroom may diminish their effectiveness as an individual teacher. Teacher sorting may explain why it is often difficult to find measures of teacher quality without using repeated cross-sections of students in an individual teacher's classes (Rivkin, Hanushek, and Kain 2005).

Other research finds evidence of teacher sorting across classrooms. For example, Clotfelter, Ladd, and Vigdor (2005) show that novice teachers are more likely to be assigned to black students. Analyzing North Carolina public schools, Clotfelter, Ladd, and Vigdor (2006) find that teachers are variously sorted within schools. In some public schools, better teachers are matched with better students; in other public schools, better teachers are matched with lower quality students. Teachers may similarly be sorted into classes of varying sizes based on their characteristics.

3. Why might US public and private schools assign class size differently?

Private schools educate 12% of elementary and secondary students in the USA.[4] Forty-four percent of private school students attend Catholic schools, another 37% attend other religious schools, and the remaining attend non-sectarian schools (Broughman, Swaim, and Keaton 2008). Private schools rely on revenue from tuition, private donations, and, if applicable, support from their affiliate religious organization. Education in the USA is primarily a state matter: public schools are funded principally with state and local tax revenues.

Public and private school teachers and administrators face significant structural differences in their work environment. Many of these differences are due to unionization of public school teachers and state regulations of public schools.

Public school teachers are much more likely to be unionized than private school teachers.[5] Union-negotiated contracts limit public schools' flexibility in compensating teachers. Public school teacher pay is almost exclusively based on education and experience; in private schools, factors such as merit also influence teacher pay (Ballou and Podgursky 1998). Unionization affects internal decision-making as well as student outcomes. Hoxby (1996), demonstrates that teachers' unions reduce class size and increase spending while lowering student achievement.

State regulations of public schools constrain teachers and administrators in a variety of ways. All states require public school teachers to be certified for their subject and grade level; private school teachers are generally not subject to state licensure requirements.[6] Ballou and Podgursky (1998), find that teacher certification

requirements reduce principals' satisfaction ratings of their teachers, suggesting that the requirements influence hiring and promotion practices.

States or localities may require public teachers to use recommended teaching methods and allocate a given number of hours to each subject area thus limiting the instructor's freedom over classroom time management. State or local discipline guidelines also may constrain public school teachers (Public Agenda 2004). The teachers' lack of control over discipline requires other mechanisms to reduce the class time lost.

Many states regulate the maximum class size in public schools, especially for early elementary school (K-3) students (Mitchell and Mitchell 2000). Regulations capping class size restrict public schools' ability to assign, for example, teachers with excellent class-management skills to larger classes. Further, maximum class size regulations reduce the ability of the school to offset the higher salary of advanced degree teachers by increasing the number of students instructed by the more educated teacher. Interestingly, average class size is larger in public schools than in private schools.[7] So even if private schools were subjected to average class size restrictions, most would not be constrained by such regulation.

Private schools may face fewer obstacles when allowing class size to vary within schools. Private school administrators determine their own student–parent–teacher contracts. In addition, private schools may not have to follow many state or local regulations of classroom etiquette. These freedoms result in a greater portion of private school teachers reporting that they have control over disciplining students than public school teachers (NCES 1997). Private school teachers also perceive better student attitudes toward learning and more respect from their students (NCES 1997). Fewer discipline issues likely reduce the time lost due to disruption in the classroom.

In addition to their distinct constraints, differences between public and private schools may reflect distinct institutional objectives. This can take many forms. Public schools may minimize the variance in student understanding, while private schools may raise the average level of understanding. Private schools may focus on non-academic outcomes relative to their public school counterparts.

Little information exists as to what objective schools seek to maximize, and whether these objectives are a function of school characteristics. Survey evidence of elementary school principals suggests some differences in stated objectives between public and private schools. The nationally representative early childhood longitudinal survey (ECLS) covering eight- or nine-year-old third graders in the USA, asked principals how much they emphasize a variety of goals and objectives for their teachers. On several items, public and private schools place a similar emphasis: aligning curricula and instructional strategies with high standards, challenging high achievers, working well with other staff, and participating in professional development activities. Private school principals, however, emphasize assisting all children to achieve high standards and a quiet, orderly environment more than public school principals; public school principals emphasize communicating well with the parents and being open to new ideas and methods more than private school principals.

With different goals and constraints faced by private and public schools, students' academic outcomes are likely to be different. Private schools in the USA provide greater academic outcomes relative to public schools, at least for certain subgroups (Neal 1998). In Chile, non-religious private schools perform similarly to public schools, although Catholic private schools perform somewhat better (Carnoy and McEwan 2000). Italian public high schools are associated with better academic performance than private schools (Bertola, Checchi, and Oppedisano 2007). French

and Austrian private schools produce lower academic quality than public schools although Brazil's private schools outperform its public schools (Vandenberghe and Robin 2004).

The theoretical debate also suggests differences in the academic outcomes. Epple and Romano (1998) model the education market as a stratified hierarchy of school qualities, with private schools doing systematically better than public schools. Brunello and Rocco (2008), however, note that private schools may optimally choose a lower level of quality than public schools, providing an easy route to a degree.

Public and private schools differ in non-academic outcomes as well. Private schools in the USA are safer (NCES 1997). Private schools offer more discipline and security as well as more opportunities for extracurricular activities (Figlio and Stone 1999). This suggests that private schools may be satisfying different constituencies. Private schools may also improve non-academic outcomes such as reduced teen sexual activity and criminal behavior (Figlio and Ludwig 2000).

Gaining a greater understanding of these differences requires a deeper analysis of schools' production process. However, much of the literature does not look at students, teachers, administrators, and parents as economic agents seeking to maximize their own objectives (Betts 1997).[8] We focus on how the goals of these agents are reflected in class size variation within private and public schools.

4. Empirical strategy

We test all three hypotheses of within-school assignment of class size: compensatory education, Lazear's theory of behavior, and teacher sorting. In so doing, we also estimate the differences between public and private schools. Compensatory education states that higher-ability students are assigned to larger classes. Lazear's theory of behavior predicts that better-behaved students are assigned to larger classes. The third hypothesis states that teachers with certain characteristics or skills are assigned to larger classes. We estimate the following for student i, in school j, at time t using ordinary least squares:[9]

$$\begin{aligned}\text{class size}_{ijt} = {} & \beta_1 \text{exam}_{ijt-2} + \beta_2 \text{behave}_{ijt-2} + \beta_3 \text{control}_{ijt} + \beta_4 \text{exam}_{ijt-2} \cdot \text{private}_{ijt} \\ & + \beta_5 \text{behave}_{ijt-2} \cdot \text{private}_{ijt} + \beta_6 \text{control}_{ijt} \cdot \text{private}_{ijt} + \gamma X_{ijt} + \delta_j + \varepsilon_{ijt}\end{aligned}$$

Student ability, measured by first-grade standardized exam scores, and first-grade student behavior are both measured two years prior to the dependent variable of third-grade class size, thereby eliminating any endogeneity concern. Third-grade class size cannot directly affect first-grade test scores or first-grade behavior. Teacher control and a vector of teacher characteristics, X_{ijt}, including experience and degree held, are measured contemporaneously. Teachers with larger classes may believe they have less control over discipline policy; teacher control may be endogenous. This potential endogeneity, however, works against finding evidence to support the hypothesized assignment of teachers with more control into larger classes.

We allow the coefficients on the explanatory variables to differ for public and private schools by including interaction terms with a private school dummy. The coefficients on the un-interacted variables reflect the production process within public schools; the coefficients on the interacted variables reflect the difference between public and private schools production methods. If private schools use their resources differently than public schools, we expect these interaction terms to be significant.

School fixed effects, δ_j, control for any school-specific characteristics such as school size, school-wide discipline policy, principal effectiveness, and the like. For example, school size may affect the ability to sort teachers and students. Valued, informal information on individual student behavior may be easier to obtain in small schools and result in better student–teacher–class size matching. This may partially explain the negative correlation between school size and performance (Andrews, Duncombe, and Yinger 2002; Foreman-Peck and Foreman-Peck 2006; Kuziemko 2006). More students, however, provide greater opportunities to sort students into differently sized classes. The school fixed effects subsume state fixed effects, controlling for state-specific policies that may affect class size determination.

Class sizes certainly vary across schools. However, including school fixed effects allows us to concentrate on the within-school class size assignment: how teachers and students are assigned to a class once they have either enrolled or accepted a position at a particular school? The fixed effects estimation requires that any observed sorting occurs within school and that any explanation of private and public schools differences arises from within-school variation.[10]

Although we use student-level data, the class size variable only varies at the teacher level. For this reason, we cluster the standard errors by teacher to account for the fact that there is less variation in the class size and teacher variables than the individual-level data would suggest. These produce more conservative standard errors, making it more difficult to reject the null hypotheses that students are sorted randomly.

5. Data and summary statistics

Empirically examining these interrelationships requires data on four characteristics: class size, student behavior, student performance, and teacher characteristics. We use a large, nationally representative survey of the USA: the ECLS of first graders in the spring of 2000 and the third-grade follow-up in the spring of 2002. Forty percent of the third graders are eight-year old; 59% are nine-year old. The ECLS includes 15–20 students in each school, typically in two to three different teachers' classrooms. The teachers, principals, parents, and students are surveyed. We limit the sample to non-special education students as special education students are frequently required to be placed into smaller classes.

This survey provides two notable advantages over large-scale datasets covering an entire state, such as those in Florida, North Carolina, and Texas. First, the ECLS provides a nationally representative sample. Although this may mute our results because of policy differences across states and districts, it also presents an overview that is more generally applicable across the USA. More importantly, the ECLS provides data on private schools; private school data in this detail are rare. One relative disadvantage is that the large-scale datasets benefit from millions of observations. The ECLS, however, provides a sample sized in the thousands, more than sufficient for this empirical analysis.

Our identification relies on schools sampled with at least two different class sizes. About one-third of the sample, 30.7%, consists of students in schools with only one observed class size. Although included in the estimation, these observations do not identify the estimated coefficients of interest because there is no within-school variation in class size. The fixed effects capture the schools' class sizes exactly.

Most of our samples provide useful variation. We observe two different class sizes for 38% of the observations, three class sizes for 21% of the observations, and four or

more different class sizes for the remaining 10%. The larger enrollments of public schools lead to 77% of the public school observations having at least two different class sizes. This comprises 464 public schools and 1612 teachers. For private schools, 46% of the observations have at least two different class sizes. This encompasses 61 schools and 155 teachers. These sample sizes are sufficient to consistently estimate the coefficients of interest.

Table 1 presents panel-weighted means and standard deviations. As the fixed effects model relies on within-school variation, we also present the within-school standard deviations.

Public and private schools have similar class sizes in third grade – a few more than 21 students in a class. Public schools exhibit more within-school variation in class size.[11] The within-school standard deviation is around one student.

Private school students score higher on first-grade reading and math tests. Private schools are not more homogeneous in ability than public schools. There is a greater within-school variation in reading scores and slightly less within-school variation in math scores in private schools.[12]

The ECLS surveys first-grade teachers about the students' behavior in four categories: self-control, interpersonal skills, internalizing problem behaviors, and externalizing problem behaviors. In addition, parents are asked whether their child is better-behaved, as well-behaved, slightly less well-behaved, or much less well-behaved than other children their own age. We use principal components to construct a single factor that best captures the covariance in these five behavior measures. This factor allows us to use the information provided by all five of these measures while

Table 1. Summary statistics for ECLS.

	Public schools			Private schools		
	Mean	SD	Within SD	Mean	SD	Within SD
First grade						
Read test scores	70.374	18.827	15.027	77.324	19.613	15.595
Math test scores	56.718	14.800	11.738	61.618	14.394	11.634
Behavior measure	–0.042	1.034	0.828	0.017	0.924	0.695
Third grade						
Class size	21.190	3.546	1.322	21.588	5.468	1.001
Third-grade enrollment	85.953	42.571		36.797	23.186	
Teach policy	0.407	0.491	0.311	0.533	0.499	0.222
Years teaching	14.947	10.060	6.331	13.401	9.940	5.324
% with high school/associate/BA	0.246	0.431	0.268	0.472	0.499	0.244
% with one year beyond bachelor's	0.308	0.462	0.303	0.282	0.450	0.215
Master's degree	0.370	0.483	0.317	0.198	0.399	0.205
Ed specialist/ professional diploma/ doctorate	0.076	0.265	0.186	0.047	0.212	0.101
Child does not affect	0.679	0.467	0.300	0.815	0.389	0.142
Classes in classroom management	2.149	1.795	1.201	2.105	1.652	0.806

Note: Summary statistics weighted to reflect nationally representative samples. There are 5004 observations for public schools and 1706 observations for private schools.

avoiding the multicollinearity that would arise from including all five variables.[13] The behavior index is standardized to mean 0 and variance 1; better-behaved students score higher on this index.

Private school students are better-behaved than public school students. In addition, there is less within-school variation in student behavior in private schools. We observe almost as much within-school variation in first-grade behavior as overall variation.

Teachers' freedom and control of disciplining students can impact how students behave in class. Given the freedom to create and enforce his or her own rules, the teacher can fashion a technique to reduce misbehavior. The ECLS does not ask a specific question about teacher control over student discipline. Instead, we use teacher responses to the question 'At your school, how much influence do you think teachers have over school policy in areas such as determining discipline policy, deciding how some school funds will be spent, and assigning children to classes?' Teachers may respond: no influence, slight influence, some influence, moderate influence, or a great deal of influence. We code these answers into an indicator variable with the first three responses on the teacher's control of school policy coded as a 0 and the latter two as a 1.[14] About 53% of private school teachers feel they influence school policy at least moderately; 41% of public school teachers feel similarly. Ideally, we would measure the teachers' actual influence on school policy; the data limit us to measuring the teachers' perceived influence on school policy.

We control for other possible measures of teacher quality, including their education and years of teaching experience. Teachers self-report their years of experience teaching school as well as their highest degree obtained. Relative to their public school counterparts, private school teachers have taught for 1.5 fewer years. Private school teachers are less educated than their public school counterparts; there is also less within-school variation in teacher education.[15]

The ECLS also addresses how student misbehavior affects teachers. Teachers are asked whether they agree with the following statement: 'The level of child misbehavior (for example, noise, horseplay, or fighting in the halls or cafeteria) in this school interferes with my teaching.' They may strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree. We recode this question into an indicator variable equal to one if teachers strongly disagree or disagree with this statement. This variable equals zero if teachers respond with one of the latter three categories.[16] Responses may reflect teachers' ability to maintain good behavior or to disregard misbehavior. In private schools, 82% of teachers are unaffected by student misbehavior; in public schools, 68% are unaffected by misbehavior. Ideally, we would measure the actual effect of student misbehavior on the teacher. Unfortunately, as with the school policy variable, the ECLS only lists the teachers' reported distraction by student misbehavior.

We also include the number of classroom-management courses that a teacher took in college. On average, teachers take about two courses on classroom management.

6. Within private and public schools, what characteristics determine class size?

Regression results appear in Table 2. We report regressions using reading test scores and English class sizes. Results with math test scores and math class sizes are similar and reported in Appendix 1 (Table A1). Most students, about 93%, experience the same teacher and same class size for both math and reading.

Table 2. Third-grade class size regressions on teacher characteristics and first-grade test scores and student behavior.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Levels							
First-grade reading test score	0.086***		0.075**	0.075**	0.076**	0.075**	0.075**
	(2.64)		(2.43)	(2.43)	(2.46)	(2.46)	(2.45)
First-grade behavior measure		0.060*	0.045	0.045	0.045	0.046	0.046
		(1.83)	(1.42)	(1.43)	(1.44)	(1.46)	(1.46)
Teachers impact school policy				–0.026	–0.022	–0.023	–0.021
				(0.27)	(0.23)	(0.23)	(0.21)
Years taught					0.005	0.005	0.005
					(0.93)	(1.04)	(1.04)
One-year past bachelors					0.078	0.082	0.080
					(0.64)	(0.67)	(0.66)
Master's degree					0.042	0.049	0.048
					(0.32)	(0.37)	(0.37)
Ed specialist/doctorate/professional diploma					0.072	0.083	0.082
					(0.35)	(0.40)	(0.39)
Classes taken on classroom management						–0.016	–0.017
						(0.60)	(0.61)
Teacher undistracted by student behavior							–0.018
							(0.18)
Interactions with private school							
First-grade reading test score	–0.080		–0.059	–0.062	–0.044	–0.057	–0.058
	(1.52)		(1.12)	(1.17)	(0.83)	(1.12)	(1.14)
First-grade behavior measure		–0.127***	–0.115**	–0.104**	–0.111**	–0.111**	–0.113**
		(2.62)	(2.33)	(2.13)	(2.19)	(2.19)	(2.24)

Table 2. (*Continued*).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Teachers impact school policy				0.290	0.407	0.497*	0.480*
				(1.06)	(1.57)	(1.88)	(1.82)
Years taught					–0.044**	–0.041**	–0.043**
					(2.44)	(2.34)	(2.46)
One-year past bachelors					0.037	0.021	0.110
					(0.08)	(0.04)	(0.22)
Master's degree					0.403	0.390	0.468
					(0.80)	(0.77)	(0.89)
Ed specialist/doctorate/professional diploma					1.277**	1.361***	1.424***
					(2.52)	(2.69)	(2.75)
Classes taken on classroom management						–0.164*	–0.166*
						(1.90)	(1.93)
Teacher undistracted by student behavior							0.405
							(0.79)
F-test for private school terms	2.31	6.86	3.97	2.77	2.73	2.81	2.52
(*p*-value)	0.1284	0.0089	0.0191	0.0401	0.0081	0.0042	0.0070
R-squared	0.90983	0.90976	0.90992	0.90996	0.91066	0.91088	0.91091

*Significant at 10%; **significant at 5%; ***significant at 1%.
Note: School fixed effects included in all regressions but coefficients suppressed. Robust *t*-statistics in parentheses. Standard errors clustered by third-grade teacher. Omitted teacher education category is high school/associate's/bachelor. There are 5004 public school observations and 1706 private school observations for a total of 6710 observations.

The top panel of Table 2 presents the coefficients on the level terms; the bottom panel presents the coefficients for the terms interacted with a private school dummy variable. The columns, from left to right, examine the three hypotheses.

Column (1) examines the compensatory education hypothesis by itself. Public schools clearly sort by ability. Students that score one standard deviation higher on the reading test are, on average, in classes with 0.085 more students. This effect is modest, but statistically significant. Private school students are not sorted by ability. Although the difference is not statistically significant, the point estimate on the interaction term is a similar size to that on the un-interacted term. The sum of the two terms is small and statistically insignificant.

Column (2) tests Lazear's theory of sorting better-behaved students into larger classes. In a public school, a student behaving one standard deviation above the mean attends an English class with 0.06 more students than a student with average behavior. This effect is modest and significant at the 10% level. Private schools behave noticeably different. The interaction term of behavior with private school is significantly negative; the sum of the two is negative and significant at the 10% level. Private schools sort better-behaved students into smaller classes.

There is a strong correlation between ability and behavior. Including both in the regression, as in Column (3), reduces the statistical significance although the pattern of results is similar. Public schools sort by ability but not behavior; private schools do not sort by ability and sort by behavior in a manner inconsistent with Lazear. A private school student behaving one deviation above the mean is in a class with slightly fewer students.

Columns (4)–(7) gradually include teacher characteristics to determine whether teachers are sorted into differently sized classes. Although the teacher variables are measured contemporaneously with class size, many of these factors are exogenous such as experience and education. The variable that seems most likely to be endogenous is the teachers' perception of whether students' misbehavior is disruptive. *Ceteris paribus*, teachers instructing larger classes are more likely to be disrupted, biasing this coefficient downwards. We include the teachers' response to whether student behavior distracts them in the last column, as this variable is most likely to be endogenous.

Public school teachers do not appear to be sorted by their characteristics; all the point estimates are small and statistically insignificant. Private schools appear to sort teachers, however, into differently sized classes. In Columns (5)–(7), the private school teacher variables are jointly significant at the 5% level. Teachers that feel they affect school policy and teachers with an education specialist degree or doctorate are assigned to larger classes. In private schools, there is an effect of teacher experience on class size; teachers who have taught an additional year receive slightly smaller classes. Private school teachers with additional courses on classroom management teach smaller classes.

In results not presented here, we estimate the above regressions on samples stratified by urbanicity and by race. The pattern of results is similar for urban schools and for non-urban schools. The results are qualitatively similar for white students and for black students. Adding additional covariates, such as indicators for the students' race, to the full sample regressions also leads to qualitatively similar results.

The overall pattern of results suggests that public schools and private schools utilize their resources in distinct manners. This conclusion is supported by the *F*-tests for the joint significance of the private school terms. Public school students are sorted

by ability and possibly by behavior à la Lazear. Public school teachers are not placed into differently sized classes based on their characteristics.

7. Implications and conclusion

One oft-cited reason for why class size appears to have no effect on student outcomes is that students and teachers are not randomly assigned to class sizes. Many papers find little or no correlation between class size and labor market outcomes (Betts 1996) or class size and student performance (Hanushek 1986, 1989, 1997).[17] Studies from the early twentieth century (Loeb and Bound 1996) and natural experiments that randomly assign students into classes (Angrist and Lavy 1999; Krueger 1999) seem more likely to find significant effects of class size.[18]

This paper investigates how class size is determined and if the non-random allocation of students within schools differs for public and private schools. We explore three possible methods of class size determination: compensatory class size assignment, sorting by behavior à la Lazear, and teacher sorting.

This evidence suggests that class size is not randomly assigned; endogenous assignment reduces the ability of researchers to empirically find class size effects. Further, we find distinct differences in how public and private schools assign class sizes with public schools focusing on student characteristics and private schools on teacher characteristics.

As with previous research, we see evidence of compensatory education within public schools. However, we observe little sorting of students by ability within private schools. This difference occurs in spite of the fact that student ability is as variable within private schools as within public schools. We find some weak evidence of sorting students by behavior à la Lazear, in public elementary schools. If first graders are unlikely to seriously misbehave, as Figlio (2007) suggests, elementary school teachers may lose less instructional time developing and addressing the disruption. Elementary schools may gain little assigning class size based on behavior.

We find differences in how class sizes vary for public and private school teachers. Private school teachers who report greater control over school policy appear in larger classes while public school teachers do not. Private school teachers with more experience and more courses on classroom management are found in smaller classes. Private school teachers with doctorate degrees also find themselves in larger classes than their less-educated private school colleagues. However, public school teachers with doctorate degrees are in similarly sized classes as their public school colleagues.

These differences likely reflect the different constraints and objectives faced by public and private schools. Constrained by union contracts, public school principals may be unable to take into account teacher characteristics when assigning class size. However, because union contracts rarely account for student characteristics, public administrators can and do use student ability and behavior to determine class size.

Private school students are not, on average, sorted by ability, but are sorted perversely by behavior. This suggests that private schools may lower the student–teacher ratio of well-behaved students to enhance their academic success. Private schools further invest in a selected number of students by placing teachers with more experience in smaller classes. Rivkin, Hanushek, and Kain (2005) show that one characteristic of teachers that does affect student academic success is years of experience, especially the first year. By placing more experienced teachers in small classes of

well-behaved students, private schools invest more resources in developing a small number of high-quality students.

Focusing on well-behaved students may enhance the likelihood that these students will be admitted to prestigious secondary schools or colleges. Highly successful graduates serve as visible examples of a school adding high value to its students. Public schools are likely to emphasize basic skills for all students and not individual excellence because, *ceteris paribus*, public schools have less of a need to recruit students and greater incentives to ensure all students meet a minimum level of literacy. Private schools may invest more in a selected number of students relative to public schools as a marketing tool to attract students.

Evidence supporting this hypothesis comes from the Schools and Staffing Survey Questionnaire (NCES, 2000). During the 1999–2000 school year, a nationally representative sample of public and private schools principals across the USA were asked to rank their top three goals from a list of eight choices.[19] Public and private principals were similarly likely to list 'encouraging academic excellence' as one of their top three goals.[20] However, public school principals were much more likely to list 'building basic literacy skills (reading, math, writing, speaking)' in their top three goals: 80% of public school principals and 46% of private school principals listed 'building basic literacy skills' as one of their top three goals. These survey results are consistent with the ECLS responses presented earlier where private elementary school principals were more likely to emphasize assisting all children to achieve high standards than public school principals.

This emphasis on basic literacy by public school principals suggests that public schools focus more attention on helping all students obtain basic skills. In contrast, private school principals place a greater emphasis on academic excellence relative to basic skills. This is consistent with our results showing that public schools place poorer performing students in smaller classes while private schools do not. Furthermore, it also suggests why private school teachers with more experience are assigned to small classes with well-behaved students.

These results are particularly important given the larger discussion on the implementation of charter schools and vouchers. Many policymakers advocate that these programs require participating private schools to meet county or state regulations on class size, teacher pay, teacher experience, and the like. Our evidence on differing production processes suggests that the benefit from private schooling might be reduced if private schools are forced to behave more like public schools. How the school choice regulations are written and implemented will play an important role in to the degree to which students benefit from choosing a private school.

Differences in public and private schools are also important to the debate on the effectiveness of private schools. Chubb and Moe (1990), claim that privatization leads to effective organization of schools and hence increased student learning. The qualitative research in Benveniste, Carnoy, and Rothstein (2003) reveals little difference between public and private schools. Our estimates show that public and private schools assign the primary inputs into education production, teachers, and students, in different ways. Private schools are more likely to sort teachers; public schools provide more compensatory education to lower-ability students through smaller classes. Continued exploration of differences in how public and private schools operate is essential to a discussion of whether private schools provide a more effective education than public schools.

Acknowledgements

We thank seminar participants at the University of Georgia, University of South Florida, American Educational Finance Association, Southern Economic Association Meetings, and the Clemson University brown-bag lunch for comments on an earlier version of this paper. We also thank Jeff DeSimone, Jahn Hakes, Rey Hernández, Curtis Simon, John Warner, and Lei Zhang for helpful conversations. Errors or deficiencies that have survived this counsel are most assuredly ours alone.

Notes

1. Several of these, for example, focus on the Tennessee STAR experiment such as Krueger (1999).
2. In Texas, for example, class size is explicitly compensatory. Texas allows state funds to be used to reduce class size for compensatory education if school can show a certain percentage of students meet the state eligibility criteria for students at risk of dropping out of school. http://www.tea.state.tx.us/school.finance/audit/resguide12/comped/comped-09.html (accessed June 7, 2009).
3. In the elementary school data we use, the correlation for first-grade test scores and behavior is 0.2413. This is significant at the 1% level.
4. Authors' calculations from NCES (2007).
5. Authors' calculations from the Schools and Staffing Survey, 2003–2004 (NCES, 2004). About 78% of public school teachers are 'members of a teachers' union or an employee association similar to a union'; only 7% of private school teachers are.
6. The US Department of Education (2000) provides an overview of state regulations of teacher certification in private schools. Goldhaber and Brewer (2000) discuss state differences in teacher certification for public schools. For initial certification, most states require a public school teacher to pass a standardized test. Almost all prospective teachers pass these tests on the first try.
7. Authors' calculations using the ECLS.
8. For instance, parents may pressure schools to assign their child to particular classes or particular teachers may be more adept at receiving plum assignments (Sieber 1982; Oakes 1995). Although we cannot observe who influences the process, we test for non-random assignment of teachers and students and differential processes of non-random assignment within public and private schools.
9. Class sizes range from 10 to 35. Although the choice is discrete, the dependent variable takes on a large number of values. As such, limited depended variable estimation techniques are unwieldy.
10. We estimate similar regressions without fixed effects using a broad set of school-level controls. These estimates are qualitatively similar for both samples, although point estimates are frequently larger.
11. The reported differences in within-school standard deviations are all statistically significant at the 5% level.
12. The summary statistics report the raw exam scores; however, we standardize the exam scores in the regression analysis.
13. Parental measures of behavior may be more subjective than teachers.' As a robustness check, we construct the behavior index incorporating the teachers' responses to four behavior questions and omitting the parental response. The results are similar. We thank an anonymous referee for the suggestion.
14. In results not presented here, we recode the middle group of 'some influence' as a one so that these teachers are counted as having control over school policy. This change does not affect the public school results substantially. However, when coded this way, private school teachers with control over school policy appear in smaller, instead of larger classes as in Table 2. The smaller class size result is not statistically significant in the fuller specifications analogous to Columns (5) through (7) in Table 2.
15. Most elementary school teachers, both public and private, graduate from schools of education with a bachelor's degree in education. In our dataset, about 78% of public and private school third-grade teachers list their undergraduate major as elementary education.

16. Results are not sensitive to coding the middle group of 'neither agree nor disagree' as a 1 instead of a 0.
17. Hedges, Laine, and Greenwald (1994a and 1994b) criticize Hanushek's (1989) meta-analyses and review the same evidence to find that inputs do matter.
18. An exception to the natural experiments is Hoxby (2000a); using natural population variation she does not find significant evidence of class size effects.
19. Seven of the eight goals listed as options were the same for public and private principals. The eighth choice for private school principals was 'fostering religious or spiritual development.' The eighth choice for public school teachers was 'promoting multi-cultural awareness or understanding.'
20. This calculation is determined using sample weights.

References

Alchian, A. 1968. The economic cost and social impact of free tuition. *The New Individualist Review* 5, no. 1: 42–52.

Andrews, M., W. Duncombe, and J. Yinger. 2002. Revisiting economies of size in American education: Are we any closer to a consensus? *Economics of Education Review* 21: 245–62.

Angrist, J., and V. Lavy. 1999. Using Maimonides' rule to estimate the effect of class size on scholastic achievement. *Quarterly Journal of Economics* 114, no. 2: 533–75.

Azerhielm, K. 1995. Does class size matter? *Economics of Education Review* 14, no. 3: 229–41.

Ballou, D., and M. Podgursky. 1998. Teacher recruitment and retention in public and private schools. *Journal of Policy Analysis and Management* 17, no. 3: 393–417.

Benveniste, L., M. Carnoy, and R. Rothstein. 2003. *All else equal: Are public and private schools different?* New York: RoutledgeFalmer.

Bertola, G., D. Checchi, and V. Oppedisano. 2007. Private school quality in Italy. Working Paper no. 3222, Institute for the Study of Labor.

Betts, J.R. 1996. Is there a link between school inputs and earnings? A fresh scrutiny of an old literature. In *Does money matter? The link between schools, student achievement, and adult success*, ed. G. Burtless, 141–91. Washington, DC: Brookings Institution.

Betts, J.R. 1997. *Do grading standards affect the incentive to learn?* Mimeo, San Diego, CA: University of California.

Betts, J.R., and J.L. Shkolnik. 1999. The behavioral effects of variations in class size: The case of math teachers. *Educational Evaluation and Policy Analysis* 21, no. 2: 193–213.

Boozer, M., and C. Rouse. 2001. Intraschool variation in class size: Patterns and implications. *Journal of Urban Economics* 50: 163–89.

Broughman, S.P., N.L. Swaim, and P.W. Keaton. 2008. *Characteristics of private schools in the United States: Results from the 2005–2006 private school universe survey* (NCES 2008–315). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education.

Brown, W.O. 2001. Sources of funds and quality effects in higher education. *Economics of Education Review* 20, no. 3: 289–95.

Brunello G., and L. Rocco. 2008. Educational standards in private and public schools. *Economic Journal* 118, no. 533: 1866–87.

Burke, M., and T. Sass. 2008. Classroom peer effects. Working Paper no. 08–5, Federal Reserve Board of Boston.

Carnoy, M., and P.J. McEwan. 2000. The effectiveness and efficiency of private schools in chile's voucher system. *Educational Evaluation and Policy Analysis* 22, no. 3: 213–39.

Chubb, J.E., and T.M. Moe. 1990. *Politics, markets, and America's schools.* Washington, DC: Brookings Institution.

Clotfelter, C., H. Ladd, and J. Vigdor. 2005. Who teaches whom? Race and the distribution of novice teachers. *Economics of Education Review* 24, no. 4: 377–92.

Clotfelter, C., H. Ladd, and J. Vigdor. 2006. Teacher–student matching and the assessment of teacher affectiveness. *Journal of Human Resources* 41, no. 4: 778–820.

Epple, D., and R.E. Romano. 1998. Competition between private and public schools, vouchers, and peer-groug effects. *American Economic Review* 88 (March), no. 1: 33–62.

Figlio, D. 2007. Boys named sue: Disruptive children and their peers. *Education Finance and Policy* 2, no. 4: 376–94.
Figlio, D.N., and J. Ludwig. 2000. Sex, drugs, and Catholic schools: Private schooling and non-market adolescent behaviors. NBER WP #7990, National Bureau of Economics Research.
Figlio, D.N., and J.A. Stone. 1999. School choice and student performance: Are private schools really better? *Journal of Labor Research* 18: 115–40.
Foreman-Peck, J., and L. Foreman-Peck. 2006. Should schools be smaller? The size–performance relationship for Welsh schools. *Economics of Education Review* 25, no. 2: 157–71.
Friedman, M., and R. Friedman. 1979. *Free to choose.* New York: Avon Books.
Goldhaber, D., and D. Brewer. 2000. Does teacher certification matter? High school teacher certification status and student achievement. *Educational Evaluation and Policy Analysis* 22, no. 2: 129–45.
Hanushek, E.A. 1986. The economics of schooling: Production and efficiency in public schools. *Journal of Economic Literature* 24: 1141–77.
Hanushek, E.A. 1989. The impact of differential expenditures on school performance. *Educational Researcher* 18, no. 4: 45–65.
Hanushek, E.A. 1994. An exchange – Part II: Money might matter somewhere: A response to Hedges, Laine, and Greenwald. *Educational Researcher* 23, no. 4: 5–8.
Hanushek, E.A. 1997. Assessing the effects of school resources on student performance: An update. *Educational Evaluation and Policy Analysis* 19, no. 2: 141–64.
Hanushek, E.A., and S.G. Rivkin. 1997. Understanding the twentieth-century growth in US school spending. *Journal of Human Resources* 32, no. 1: 35–68.
Hedges, L.V., R.D. Laine, and R. Greenwald. 1994a. An exchange: Part I: Does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes. *Educational Researcher* 23, no. 3: 5–14.
Hedges, L.V., R.D. Laine, and R. Greenwald. 1994b. Money does matter somewhere: A reply to Hanushek. *Educational Researcher* 23, no. 4: 9–10.
Hoxby, C.M. 1996. The effect of teachers' unions on education production. *Quarterly Journal of Economics* 111, no. 3: 671–718.
Hoxby, C.M. 2000a. The effects of class size on student achievement: New evidence from population variation. *Quarterly Journal of Economics* 115: 1239–85.
Hoxby, C.M. 2000b. Peer effects in the classroom: Learning from gender and race variation. NBER Working Paper 7867, http://www.nber.org/papers/W7867
Krueger, A.B. 1999. Experimental estimates of education production functions. *Quarterly Journal of Economics* 114, no. 2: 497–532.
Kuziemko, I. 2006. Using shocks to school enrollment to estimate the effect of school size on student achievement. *Economics of Education Review* 25, no. 1: 63–75.
Lazear, E.P. 2001. Educational production. *Quarterly Journal of Economics* CXVI (August), no. 3: 777–803.
Loeb, S., and J. Bound. 1996. The effects of measured school inputs on academic achievement: Evidence from the 1920s, 1930s, and 1940s birth cohorts. *Review of Economics and Statistics* 78, no. 4: 653–64.
Mitchell, D.E., and R.E. Mitchell. 2000. *Class size: An amendment reflecting further research on state policies.* Riverside, CA: University of California, California Education Research Cooperative.
NCES (National Center for Education Statistics). 1997. *Findings from the condition of education 1997: Public and private schools: How do they differ?* (July, NCES #97–983). US Department of Education, Office of Educational Research and Improvement.
NCES (National Center for Education Statistics). 2000. *Schools and Staffing Survey, 1999–2000.* Washington, DC: National Center for Education Statistics.
NCES (National Center for Education Statistics). 2004. *Schools and Staffing Survey,* 2003–2004.
NCES (National Center for Education Statistics). 2007. *Digest of education statistics* (Table 2). http://nces.ed.gov/programs/digest/d07/ (accessed June 16, 2009).
Neal, D. 1998. What have we learned about the benefits of private schooling? *FRBNY Economic Policy Review* 4: 79–86.

Oakes, J. 1995. Ability grouping, tracking, and within-school segregation in New Castle County schools. Report to the US District Court for the District of Delaware in the Case of *Coalition to Save our Children v. State Board of Education, et al.*, December 9, 1994 (corrected January 1, 1995).

Public Agenda. 2004. Teaching interrupted: Do discipline policies in today's public schools foster the common good? New York: Public Agenda and Common Good. http://commongood.org/assets/attachments/22.pdf

Rice, J.K. 1999. The impact of class size on instructional strategies and the use of time in high school mathematics and science courses. Special issue: Class Size: Issues and New Findings. *Educational Evaluation and Policy Analysis* 21, no. 2: 215–29.

Rivkin, S.G., E.A. Hanushek, and J.F. Kain. 2005. Teachers, schools, and academic achievement. *Econometrica* 73, no. 2: 417–58.

Sieber, R.T. 1982. The politics of middle class success in an inner-city public school. *Boston University Journal of Education* 30, no. 1: 30–47.

Smith, A. 1776. *An inquiry into the nature and causes of the wealth of nations.* 1904 edition, ed. E. Cannan. London: Methuen.

US Department of Education. 2000. *State regulation of private schools.* Office of Non-public Education, June. http://www.ed.gov/pubs/RegPrivSchl/index.html (accessed June 16, 2009).

Vandenberghe, V., and S. Robin. 2004. Evaluating the effectiveness of private education across countries: A comparison of methods. *Labour Economics* 11: 487–506.

West, E.G. 1964. Private versus public education: A classical economic dispute. *Journal of Political Economy* 72: 465–75.

Appendix 1

Table A1. Third-grade class size regressions on teacher characteristics and first-grade math test scores and student behavior.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Levels							
First-grade math test score	0.091***		0.080***	0.080***	0.080**	0.079**	0.079**
	(2.75)		(2.59)	(2.58)	(2.58)	(2.57)	(2.58)
First-grade behavior measure		0.060*	0.045	0.045	0.045	0.046	0.046
		(1.66)	(1.28)	(1.28)	(1.30)	(1.32)	(1.32)
Teachers impact school policy				–0.028	–0.025	–0.025	–0.023
				(0.26)	(0.23)	(0.23)	(0.21)
Years taught					0.005	0.005	0.005
					(0.83)	(0.93)	(0.93)
One-year past bachelors					0.074	0.077	0.076
					(0.55)	(0.58)	(0.56)
Master's degree					0.035	0.042	0.042
					(0.24)	(0.29)	(0.29)
Ed specialist/doctorate/professional diploma					0.068	0.079	0.078
					(0.30)	(0.34)	(0.34)
Classes taken on classroom management						–0.016	–0.016
						(0.54)	(0.54)
Teacher undistracted by student behavior							–0.020
							(0.19)
Interactions with private school							
First-grade math test score	–0.090		–0.073	–0.074	–0.058	–0.069	–0.070
	(1.46)		(1.20)	(1.21)	(1.01)	(1.23)	(1.24)

Table A1. *(Continued).*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
First-grade behavior measure		–0.127**	–0.113**	–0.103**	–0.108**	–0.109**	–0.111**
		(2.37)	(2.14)	(1.96)	(2.02)	(2.02)	(2.07)
Teachers impact school policy				0.293	0.411	0.501*	0.484*
				(0.97)	(1.44)	(1.72)	(1.66)
Years taught					–0.043**	–0.040**	–0.043**
					(2.22)	(2.13)	(2.25)
One-year past bachelors					0.028	0.014	0.104
					(0.05)	(0.03)	(0.19)
Master's degree					0.397	0.387	0.465
					(0.72)	(0.70)	(0.80)
Ed specialist/doctorate/professional diploma					1.274**	1.360**	1.423**
					(2.28)	(2.43)	
						(2.49)	
Classes taken on classroom management						–0.165*	–0.167*
						(1.72)	(1.75)
Teacher undistracted by student behavior							0.410
							(0.73)
F-test for private school terms	0.144	0.0178	0.0502	0.0958	0.0459	0.0356	0.0515
(*p*-value)	2.136	5.624	2.995	2.118	2.048	2.069	1.873
R-squared	0.9099	0.9098	0.9100	0.9100	0.9107	0.9109	0.9109

*Significant at 10%; **significant at 5%; ***significant at 1%.

Note: School fixed effects included in all regressions but coefficients suppressed. Robust *t*-statistics in parentheses. Standard errors clustered by third-grade teacher. Omitted teacher education category is high school/associate's/bachelor. There are 5004 public school observations and 1706 private school observations for a total of 6710 observations.