Public-Private Partnerships in Schooling: Cross-Country Evidence on their Effectiveness in Providing Cognitive Skills

Ludger Wößmann
Ifo Institute for Economic Research
at the University of Munich

PEPG 05-09

Preliminary draft
Please do not cite without permission

Prepared for the conference:
"Mobilizing the Private Sector for Public Education"
Co-sponsored by the World Bank
Kennedy School of Government, Harvard University, October 5-6, 2005

Version: September 25, 2005

Ludger Wößmann

Ifo Institute for Economic Research
at the University of Munich and CESifo
Poschingerstr. 5
81679 Munich, Germany
Tel.: ++49-89/9224-1699
Fax: ++49-89/9224-2699
E-mail: woessmann@ifo.de
Internet: www.cesifo.de/link/woessmann_l.htm

Abstract

This paper provides a comparative analysis of the association between student achievement and public-private partnerships (PPPs) in education across different countries. It uses student-level data from the PISA international student achievement test that provides information on the public-private character of both operation and funding of each tested school. The cross-country "big picture" results suggest that public school operation is associated with lower student outcomes, but public school funding with better student outcomes. Thus, systems of PPPs that combine private operation with public funding do best among all possible operation-funding combinations, while systems of PPPs that combine public operation with private funding do worst. Within-country results suggest that the advantage of private operation is particularly strong in countries with large shares of public funding. The results favor educational PPPs of the form where the state does the funding and the private sector runs the schools.

Preliminary. Please do not quote without author's explicit permission. Comments welcome.

1. Introduction

The issue of public-private partnership (PPP) is a much-debated topic, and increasingly so in the education sector (for examples, cf. Human Development Network 2001; Peterson 2003). However, given that PPPs are mostly either project-based endeavors or systemic features of whole education systems, evidence usually comes only in the case-study form (cf., e.g., World Bank 2004, chapter 7; Patrinos 2000, 2002). This paper, by contrast, uses the opportunities of internationally comparable data to provide cross-country evidence on the association between student achievement and PPPs across different countries. The PISA international student achievement study tested students' basic skills in math, reading and science in an internationally comparable way. The PISA micro database is unique among recent international tests in containing information for each tested school both about whether it is publicly or privately operated and about which share of its funding comes from public and private sources. These data provide the opportunity of presenting "big picture" cross-country evidence on PPPs in schooling.

Such an international perspective carries two particular advantages relative to analyses within a country. First, comparisons across countries allow for the recognition of systemic effects, in that the existence of private schools may affect the behavior and performance of nearby public schools. If public schools behave differently because there are private schools nearby, then there may be effects of private involvement even though the performance between individual private and public schools may not differ. Cross-country evidence can detect such systemic effects where both private and public schools may perform at a higher level because of the existence of private competition. The second advantage of cross-country evidence is that it allows analyzing possible differences in the effects of PPPs when they exist in different situations.

In basically all countries, the ultimate responsibility and supervision of the school system remain with the state – whether the system makes use of PPPs or not. But beneath this state supervision, both the operation and the funding of schools may show differing shares of public vs. private involvement. If we think of school operation and school funding as the two broad tasks under consideration, and if we understand PPPs as any collaboration between public and private entities, then conceptually there are two specific ways in which PPPs can exist in the school system. In the first case, schools are operated (managed) by a public entity, but draw heavily on private funding – e.g., parents have to pay tuition fees. In the second

case, schools are operated by a private entity – be it a business, the church or else – but get most of their funding from a public entity – be it through base funding or vouchers.

As Figure 1 shows, both forms of PPPs exist in a system-wide manner.[1] In the first type of PPP, prevalent in the systems in the top left quadrant of Figure 1, the majority of schools are operated by private entities, but all schools receive the vast majority of their funding from public sources. This combination is given in the Netherlands, Belgium, Ireland and, to a lesser degree, in Denmark. The second type of system-wide PPP combines a high share of public operation with a relatively low share of public funding. This combination of private financing of publicly managed schools, depicted in the bottom right quadrant of Figure 1, exists particularly in Mexico, but to a lesser extent, it can also be observed in Italy, New Zealand, Brazil and Greece.

Figure 1 depicts two more groups of countries. The systems in the bottom left quadrant combine relatively low shares of public operation and public funding. This is true in Korea, where about half of both operation and funding is private, and to a lesser extent in Japan, France and Spain. Finally, in the systems in the top right quadrant, the vast majority of schools is both publicly operated and publicly funded. This is particularly true in Norway, Iceland, Finland, Sweden, Latvia and Germany. But actually, most countries have the vast majority of their schools both publicly operated and publicly funded. Both in terms of the share of publicly operated schools and in terms of the average share of public funding of schools, 20 out of 29 countries have more than 87% public involvement.

This paper will analyze the performance of students in systems characterized by the two forms of PPPs relative to the other two forms of school systems. While it will detect substantial performance differences between the different forms of systems, a quick glance at Figure 1 already reveals that a simple division between public operation and funding on the one side and private operation and funding on the other side does not seem to be fundamentally decisive for student performance. For example, two well-known top performers in PISA, Finland and Korea, characterize the opposite systems of sole public responsibility (100% public funding and 97% publicly operated schools in Finland) and large private involvement (51% private funding and 49% privately operated schools in Korea). But we will see that the more intricate combination of public and private involvement in the two forms of PPPs seems to have important consequences for students' educational performance.

[1] Details on the data underlying Figure 1 will be provided in Section 2.2 below.

While there are the discussed advantages of cross-country evidence, it also has shortcomings. Despite the extensive information on family and school background that allows accounting for other observable influence factors, thereby allowing comparing students who are equal in terms of other observable characteristics, the international student achievement test still provides observational data. In these data, private involvement is not randomly divided between a treatment group that has private involvement and a control group that does not have private involvement. Therefore, in contrast to randomized experimental evidence, the evidence presented in this paper has to be interpreted cautiously in terms of descriptive conditional correlations, which do not necessarily allow for causal inferences because they may also reflect effects of other, unobservable characteristics. Still, the multivariate analysis goes substantially beyond bivariate correlations in terms of detecting underlying relationships by disentangling these relationships from other observable influences at the student level. Furthermore, as will be discussed in Section 4.1, theory has some guidance as to which direction any remaining bias in the presented "higher-level descriptives" goes, and given the specific results that will be obtained, these considerations will be of considerable help in the interpretation of results.

While the paper goes into the question of effects of different forms of private involvement in quite some detail, it should also be clarified right from the start what the paper is *not* about. The topic of the paper is explicitly the *effectiveness* of PPPs in providing *cognitive* skills for students. Therefore, it does not deal with questions of efficiency (for which relative costs would have to be taken into account), nor with questions of equity of school systems with differing private involvement, nor with questions of the provision of non-cognitive skills. While it goes without saying that all these issues are of tremendous importance, they go beyond the scope of this paper.

2. Public and Private Involvement in Schooling around the World

Before we describe the models and econometric evidence, this section provides some background on the international data as well as some more thorough descriptive patterns of public and private involvement in schooling around the world.

2.1 The PISA Database

The database of the Programme for International Student Assessment (PISA) distinguishes itself from previous international tests by providing data both on whether individual schools

are publicly or privately operated and on which shares of schools' funding stems from public and private sources. PISA is an international student achievement test of representative random samples of 15-year-old students conducted in 2000 by the Organisation for Economic Co-Operation and Development (OECD). The study tested student performance in math, reading and science in 32 developed and emerging countries, 29 of which can be used in this paper.[2] The OECD ensured a consistent and coherent study design and as much comparability as possible among the participating countries.[3]

The PISA 2000 study had a special focus on the reading literacy of students, with a sample size of the database used in this paper of 130,242 students. The sample sizes in the other two subjects are 72,493 students in math and 72,388 students in science. In this paper, the main focus will be on reading performance – because of the larger sample size – and on math performance, which is generally viewed as being most readily comparable across countries. Also, math performance has often been found to be most strongly related to productivity (e.g., Bishop 1992). The specific student-level database used in this paper was constructed by Fuchs and Wößmann (2004), who provide more detailed information and notes on the specific database. They combine the test results with rich background information on students and schools from PISA background questionnaires answered by the specific students and heads of schools tested in PISA and with additional country-level data.[4]

As a general background on the data, Table 1 provides descriptive statistics for each country on the level and variation of test performance in the three subjects. The test results were scaled on a score with an OECD mean of 500 points and an OECD standard deviation of 100 points. In all data descriptions and analyses presented in this paper, only students in schools that had both data on private vs. public operation and on the share of private vs. public funding were included. The sample size stands at an average of 4,500 students in 168 schools per country.

---

[2] Among the PISA participants, Australia and Canada did not provide data on the public vs. private operation of schools. Liechtenstein was not included in the analysis because it features only 11 schools (with 314 students), 2 of which are private, and because it lacks several internationally comparable country-level data. Data for the Netherlands are provided, although there is a caveat in that the response rate in the Netherlands was relatively low.

[3] Adams and Wu (2002), OECD (2001) and the PISA webpage at www.pisa.oecd.org provide detailed information on the PISA study.

[4] Fuchs and Wößmann (2004) also provide imputed data for missing observations, which are used in this paper with the exception of the data on private vs. public operation and funding, for which only original data is used.

2.2 Differing Patterns of Public and Private Funding and Operation

In the PISA database, data on public vs. private operation of schools comes in the form of a dummy that classifies each school as either public or private. In the school background questionnaire, a public school was defined as "a school managed directly or indirectly by a public education authority, government agency, or governing board appointed by government or elected by public franchise." A private school, by contrast, was defined as "a school managed directly or indirectly by a non-government organization; e.g., a church, trade union, businesses, other private institutions."

Data on public vs. private funding of schools is recorded as the respective share of total funding coming from public and private sources. Heads of school were asked, "About what percentage of your total funding for a typical school year comes from the following sources?", where the answer categories were "Government (includes departments, local, regional, state and national)", "Student fees or school charges paid by parents", "Benefactors, donations, bequests, sponsorships, parent fund raising" and "Other". For the purposes of this paper, only the first category was classified as public funding, and the remaining sources as private funding.[5]

Descriptive statistics on the share of publicly operated schools and the average share of public funding in each country, already visualized in Figure 1, are provided in Table 2. On average across the 29 countries, 83% of schools are publicly operated, and the remaining 17% are managed by a private entity. But the share of publicly operated schools varies substantially across countries, with Belgium (25%) and the Netherlands (26%) at the bottom end and Russia (100%), Latvia (99%) and Iceland (99%) at the top end. The average share of public funding of schools across the countries is 87%, with Mexico (37%) and Korea (49%) at the lower end and Luxembourg, Sweden, Finland, Norway and Iceland all with a public share above 99%.

From the perspective of PPPs, it is particularly interesting to note that the shares of public involvement in operation and funding can differ substantially within a country (column (M) in Table 2). At the one extreme, the public share is substantially larger in funding than in operation in the Netherlands (difference of 69 percentage points), Belgium (63) and Ireland (52). At the other extreme, the public share can also be substantially larger in operation than in funding, as for example in Mexico (difference of 48 percentage points) and Italy (19).

---

[5] This paper does not make use of the sub-division of private sources between parental charges and other benefactors.

It is also revealing to look at the relative shares of public funding in publicly vs. privately operated schools in each country (columns (N) and (O) in Table 2). Thus, while in most countries publicly operated schools receive nearly all of their funding from public sources, 56% of the funding of publicly operated schools in Mexico stems from private sources, and 45% in Korea. On average across all countries, the share of public funding in publicly operated schools (at 91%) is 25 percentage points higher than in privately operated schools (at 66%). The share of public funding in privately operated schools differs particularly strongly across countries, with the privately operated schools tested in Brazil, Greece and Mexico receiving no funding at all from public sources (and those in the United Kingdom only 2%), while privately operated schools in the Netherlands, Finland, Luxembourg and Sweden receive more than 95% of their funding from public sources.

Even more striking is the difference in public funding that publicly and privately operated schools in a country receive (column (P) in Table 2). At the one extreme, the share of public funding in UK public schools is 96 percentage points higher than in UK private schools. This difference is also quite large in other countries, such as Greece (87 percentage points), Brazil (87), Poland (76), the United States (74) and Switzerland (73). At the other extreme, there is no difference at all in the share of public funding between publicly and privately operated schools in the Netherlands and Luxembourg, and the differences are also very small in Sweden (0.6 percentage points) and Finland (1.5).

3. Why Should the Public-Private Division Matter?

Do these cross-country differences in public vs. private involvement in the operation and funding of schools matter for student achievement? From a theoretical point of view, both positive and negative aspects of both operation and funding of schools by the state vs. the private sector have been advanced in the literature. The main case usually made in terms of the operation of schools is that private operation is more efficient than public operation because market forces create incentives for cost containment and performance-conducive qualitative innovation in private school management (e.g., Chubb and Moe 1990; Hanushek et al. 1994; Shleifer 1998; Bishop and Wößmann 2004). In accordance with this reasoning, empirical evidence tends to find that performance in privately managed schools is superior to performance in publicly managed schools.[6] Some of the empirical contributions also show

[6] Important contributions to the empirical literature include Howell et al. (2002), Hoxby (2003a, 2003b) and Neal (1997) for the United States, Bradley and Taylor (2002) and Levaĉić (2004) for England, Sandström

that the existence of private schools improves the performance of nearby public schools that face their competition, an issue that complicates the empirical identification of the effects of private school operation and that we will come back to below.

The case in favor of public provision of schools is less clear, if we separate it from the conceptually different case of public vs. private funding, in particular because the government could always write specific contracts with private providers to ensure that certain requirements are observed (cf. Shleifer 1998). However, one point in favor of public provision sometimes made is that only direct public provision of schooling could yield an inculcation of students with ideological and cultural goals and beliefs pursued by the government, a task that might not be easily contracted out to the private sector (e.g., Gradstein and Justman 2002; Pritchett 2003). Ideological inculcation may be an issue hard to pin down empirically, and it is certainly beyond the scope of a paper focusing on cognitive skills. But in a similar vein, direct public school operation might allow a closer monitoring of implemented curricula – although the incentives for monitoring may again be stronger in the private sector.

In terms of the relative merits of public and private funding (as opposed to operation) of schools, it is sometimes argued that private or parents-based funding can increase accountability and provide incentives for efficient behavior from the demand side (cf. Jimenez and Paqueo 1996; Chubb and Moe 1990). It is not obvious, though, to what extent this benefit of private involvement would go beyond the benefit of private provision and the choice that parents can make between different private providers, which would already induce performance-conducive incentives from the demand side.

This latter point can even be turned into the opposite case favoring public funding, if combined with the idea that some families may be too poor to choose privately operated schools if they have to be funded privately. As long as there are credit constraints that provide poor families from borrowing against possible future income gains of their children due to improved educational performance (cf. Loury 1981; Galor and Zeira 1993; Gradstein et al. 2004), poor families' choices of better schools that require higher private funding will be constrained. Public funding can relax the credit constraints, which can allow greater choice for all families and therefore increase schools' incentives to behave efficiently. The empirical evidence of positive performance effects of (mostly publicly provided) school vouchers to

---

and Bergström (2005) for Sweden, Angrist et al. (2002) for Colombia, Cox and Jimenez (1991) for Colombia and Tanzania, James et al. (1996) and Bedi and Garg (2000) for Indonesia and Mizala and Romaguera (2000), Mizala et al. (2002), Sapelli and Vial (2002), Vegas (2002) and Hsieh and Urquiola (2003) for Chile.

finance the attendance of privately operated schools (see references above) can be viewed as one aspect of this possible positive effect of public funding.[7]

Given the different theoretical arguments as summarized in Table 3, we might expect the public vs. private nature of the operation and funding of schools to have an impact on student achievement. The direction and size of this impact remains an empirical question, though.

4. The Empirical Models

This section describes the different specifications of the empirical model of the association between PPPs and student performance analyzed in this paper, and how they may or may not be affected by selection bias.

4.1 Observables, Unobservables and the Possibility of Selection Bias

Given the separate arguments for and against public involvement in the operation and funding of schools, our empirical models will allow for separate effects of operation and funding:

$$T_i = \alpha + \gamma_1 O_s + \gamma_2 F_s + \varepsilon_i \quad , \tag{1}$$

where T_i is the achievement test score of student i, O_s is a dummy showing whether the student's school s is publicly (as opposed to privately) operated, F_s is the share of the school's funding stemming from public (as opposed to private) sources and ε_i is an error term.

Now, assume that true achievement model can be represented by:

$$T_i = \alpha + \beta_1 O_s + \beta_2 F_s + B_i \beta_3 + U_i \beta_4 + \varepsilon_i \quad , \tag{2}$$

where B are additional background features that can be observed, like parent's level of education, and U are additional features affecting performance that remain unobserved, for example parents' valuation of their children's education.

What are the consequences of B und U for our estimates of the association between public involvement and student performance? Two observations can help us understand the specific nature of possible biases in our empirical models. First, given that we look at the effects of operation and funding separately, the arguments on credit constraints discussed in Section 3 above bear on the association between family background and funding, but not on the private

[7] A lot of the discussion of the relative merits of public vs. private involvement in schooling, in particular on the funding side, also surrounds equity rather than effectiveness outcomes (cf., e.g., Glomm and Ravikumar 1992; Epple and Romano 1998; Nechyba 2000; Ladd 2002). For reasons of scope, in this paper we do not deal with the issue that public funding might serve to redistribute income or to raise opportunities for specific disadvantaged sub-groups of the population, leaving this important issue for future research.

vs. public operation of schools. Second, families who can afford to send their children to schools that require large shares of private funding may tend to have other, often unobserved features conducive to the children's learning. For example, they may show a greater valuation of educational outcomes per se, or they may simply use their larger income also to buy private afternoon lessons for their children if they are underperforming in a given subject. Therefore, the selection bias would generally make privately funded schools look better than they really are. Thus, we would expect any bias to affect estimates of funding effects rather than operation effects, and we would expect the bias to point in the direction that publicly funded schools look worse than they are. In what follows, we depict these ideas more formally.

Consider first the observable background features *B*. Following the above-mentioned theories of credit constraints, it seems reasonable to assume that *B* will be positively related with the share of private funding in the school, i.e. negatively related with *F*. Therefore, there will be non-zero elements in the covariance matrix between the *B* features and *F*. But if $F'B \neq 0$, estimating the effect of *F* with equation (1) will yield an estimate γ_2 that is a biased estimate of the true effect β_2 of equation (2). Using the standard formula for omitted-variable bias (cf., e.g., Greene 2000, p. 334), the expected value of the estimate is:

$$E(\gamma_2) = \beta_2 + \left[(F_s F_s)^{-1} F_s' B_i \right] \beta_3 \quad . \tag{3}$$

However, given that we assume *B* to be observable, we can easily control for *B* in our regression:

$$T_i = \alpha + \varphi_1 O_s + \varphi_2 F_s + B_i \varphi_3 + \varepsilon_i \quad , \tag{4}$$

where φ_2 is no longer biased by the observables. This is the reason why we include extensive controls for background factors *B* in all our empirical specifications (see Section 4.3 for details of the *B* vector).

Now, consider the unobserved background features *U*. If the covariance matrix $F'U \neq 0$, estimating the funding effect by equation (4) yields the following biased estimate:

$$E(\varphi_2) = \beta_2 + \left[(F_s F_s)^{-1} F_s' U_i \right] \beta_4 \quad . \tag{5}$$

Assuming for the moment only one unobserved variable U_i, we can also write:

$$E(\varphi_2) = \beta_2 + \frac{\mathrm{cov}(F_s, U_i)}{\mathrm{var}(F_s)} \beta_4 \quad . \tag{6}$$

This derivation allows us to pin down the likely direction of the bias. The estimate φ_2 will be *lower* than the true effect β_2 of equation (2) if β_4 is positive and cov(F_s,U_i) is negative. And this is likely to be the case in our application. Let's say that U_i is (unmeasured) parents' valuation of education. Then β_4 is positive, i.e. parents' valuation of education has a positive impact on their children's educational performance. And cov(F_s,U_i) is negative, because parents' valuation of education is positively associated with their willingness (and probably ability) to provide private funding, i.e. negatively related to the share of public funding in their school. Therefore, the estimate φ_2 will be a lower bound for the true effect β_2. The larger the covariance between the unobserved features U and the share of private funding, and the larger the effect β_4 of the unobserved features on student performance, the larger will be the underestimation of the effect of public funding.

4.2 Alternative Empirical Specifications

Altogether, in this paper we will estimate six different versions of the basic empirical model (4). In the first specification, the variables on public vs. private involvement will be measured at the country level and entered in a cross-country regression performed at the student level:

$$T_i = \alpha + \beta_1 O_c + \beta_2 F_c + B_i \beta_3 + \nu_c + \eta_s + \varepsilon_i \quad , \tag{7}$$

where O_c and F_c are the share of publicly operated schools and the average share of public funding of schools in country c, respectively. Both student test scores T_i and background features B_i are measured at the student level (the school characteristics in B at the school level), so as to yield as clean a control for other influence factors as possible. Note that in the empirical application, the error term will have higher-level components at the school and country level, whose implementation will be discussed in Section 4.3 below.

The reason why we start with a cross-country specification with country-level public-private data is the possibility discussed in Section 3 above that the mere existence of private schools in a city may have systemic effects due to their effect on how the public schools in the city perform, because these public schools are now faced with competition from private schools. Thus, looking at the simple relative performance of privately and publicly operated schools may well fail to observe the effects of the existence of the privately operated school. By contrast, such systemic effects will be captured in the specification that measures private involvement at the level of the country. The specification shows whether countries with a larger sector of publicly operated schools and with a larger share of public funding fare

differently on average on the PISA test than countries with larger shares of private involvement.

A second advantage of the specification is that it evades the problem of selection bias just discussed. While it may be the case that students whose performance differs for other reasons may select into private schools in non-random ways, such selection effects will cancel out at the country level. Under the quite confident assumption that there is no school selection across country boarders of an order of magnitude that might affect the presented results, any non-random selection would occur within the observation level of the public-private measures in specification (7) and would therefore not affect the estimates of β_1 and β_2 in this specification.

The second specification simplifies the picture even further, by classifying the countries into the four quadrants of Figure 1 established by the shares of public operation and public funding. That is, public-private involvement will be measured just by attributing dummies to the countries whether they belong to the top left (*TL*), the bottom left (*BL*) or the bottom right (*BR*) quadrant of Figure 1, where the reference category is the top right quadrant:

$$T_i = \alpha + \beta_1 TL_c + \beta_2 BL_c + \beta_3 BR_c + B_i \beta_4 + \nu_c + \eta_s + \varepsilon_i \quad . \tag{8}$$

This quadrant-dummy specification has the same advantages as the specification with country-level public-private data, only that it provides the results in an even simpler (but also coarser) way: Does the performance of the countries in the four quadrants of Figure 1 differ systematically from each other?

The third specification adds an interaction term between public operation and public funding to specification (7):

$$T_i = \alpha + \beta_1 O_c + \beta_2 F_c + B_i \beta_3 + (O_c F_c)\beta_4 + \nu_c + \eta_s + \varepsilon_i \quad . \tag{9}$$

The coefficient on the interaction term ($O_c F_c$) depicts whether any effect of public funding F differs between countries with lower or higher shares of publicly operated schools.

The fourth specification makes use of the individual-level data of public-private involvement in schools. That is, both public operation O_s and public funding F_s are now measured at the level of each school s, still in a regression encompassing all countries:

$$T_i = \alpha + \beta_1 O_s + \beta_2 F_s + B_i \beta_3 + (O_s F_s)\beta_4 + \eta_s + \varepsilon_i \quad . \tag{10}$$

Note that O_s is now a dummy representing whether the student's school is publicly (as opposed to privately) operated, while F_s is the share of public funding of the school.

In this specification, the considerations on possible selection bias now come into play, which suggested that the estimate β_2 on the effect of public funding may be biased downwards, i.e. biased in favor of schools with larger shares of private funding. The specification can again be estimated with and without an interaction effect. In the specification using school-level data on public-private involvement, the coefficient on the interaction term depicts whether any association between student performance and public funding F differs between publicly and privately operated schools.

The fifth specification adds country fixed effects to specification (10):

$$T_i = \alpha_c + \beta_1 O_s + \beta_2 F_s + B_i \beta_3 + (O_s F_s)\beta_4 + \eta_s + \varepsilon_i \quad , \tag{11}$$

where α_c is a country-specific intercept implemented by adding a full set of controls for country dummies. By disregarding any variation that exists between countries, this specification in effect estimates the average effect of public operation and funding *within* the countries in the pooled dataset. That is, the specification shows whether on average, publicly operated and publicly funded schools in a country fare differently from privately operated and privately funded schools in the same country. The previous considerations suggest that the relative importance of selection bias may get ever more severe in this specification, because the selection-free variation that exists between countries is now no longer considered.

Finally, the sixth specification estimates the same specification separately within each country c:

$$\forall c: \quad T_i = \alpha + \beta_1 O_s + \beta_2 F_s + B_i \beta_3 + \eta_s + \varepsilon_i \quad if\ i \in c \quad . \tag{12}$$

By doing so, this specification can depict whether the within-country associations between public-private involvement and student performance are heterogeneous across the countries. The presented results on this specification will not consider an interaction term ($O_c F_c$), because initial experimentation showed that samples seem to get too small in most countries to properly identify the interaction effect within individual countries.

4.3 Specifics of the Microeconometric Model

As discussed above, the empirical specifications control for an unusually extensive set of background factors B. The control vector of background data encompasses 60 variables, including 8 variables on student characteristics, 28 variables on students' family background,

14 variables on resource inputs at home and at school and 10 variables on institutional features of the school system.[8]

It was also indicated before that the error term of the regression has a non-trivial structure because of the complex data structure produced by the PISA survey design and the multi-level nature of the explanatory variables. Given the possible dependence of students within the same school, the use of school-level variables and the fact that schools were the primary sampling unit (PSU) in PISA (cf. Adams and Wu 2002), the independence assumption usually made with respect to individual observations in standard econometric methods should be relaxed in favor of the assumption that only the variation between schools (PSUs) provides independent variation (cf. Moulton 1986). This is implemented by the clustering-robust linear regression (CRLR) method, which allows any given amount of correlation of the error terms within PSUs and requires only that observations be independent across PSUs (cf. White 1984; Deaton 1997). For variables measured at the country level, we even allow any given covariance of error terms at the country level.

PISA used a stratified sampling design within each country, producing varying sampling probabilities for different students. To obtain nationally representative estimates from the stratified survey data at the within-country level, we employ weighted least squares (WLS) estimation using sampling probabilities as weights. WLS estimation ensures that the proportional contribution to the parameter estimates of each stratum in the sample is the same as would have been obtained in a complete census enumeration (DuMouchel and Duncan 1983; Wooldridge 2001). Furthermore, at the between-country level, our weights give equal weight to each country.

[8] The 8 control variables on student characteristics are: student gender, student age and 6 dummies for grade level. The 28 control variables on family background are: 5 dummies for parental education, one dummy each on the migration status of father, mother and student, 3 dummies on family status, 3 dummies on parents' work status, 2 dummies on parental occupation, 6 dummies on the number of books at home, 5 dummies on the school's community location and the country's GDP per capita. The 14 control variables on resource inputs are: class size in the subject, educational expenditure per student in the country, 2 dummies on availability of instructional material, 3 dummies on teacher education, instruction time, 2 dummies on homework time in the subject, 2 dummies on parental support and 2 dummies on computer availability at home. The 10 control variables on institutions are: external exit exams, standardized tests and 8 dummies on school autonomy in determining course content, in choosing textbooks, in formulating the school budget, in deciding on budget allocations, in hiring teachers, in firing teachers, in establishing teachers' starting salaries and in establishing teachers' salary increases. See Fuchs and Wößmann (2004) for details.

5. Empirical Results on Public-Private Division and Student Achievement

This section presents the empirical results on the association between PPPs and student achievement. It shows how student performance is associated with public vs. private involvement in the operation and funding of schools both across and within countries.

5.1 Public vs. Private Funding and Operation Measured at the Country Level

The specifications (7) and (8) that use only the variation between countries and disregard variation within countries by aggregating the measures of public-private involvement at the country level have the advantages of capturing system-level effects and of evading within-country selection biases. Column (Q) in Table 4 presents the results of the quadrant-dummy specification (8) for math performance. This specification compares student performance in the four basic system types of Figure 1, with the type representing the largest number of countries, the top right quadrant of systems with large public shares in both operation and funding, serving as the reference category.

The results show that there are large and statistically significant systematic performance differences between systems that make strong use of PPPs and systems that do not. Systems with a relatively low share of public operation, but large share of public funding perform best. Their average performance is 37.9 PISA test-score points higher than the average performance of systems that are mainly publicly operated and funded. Given that the test scores are scaled to have an international standard deviation among the OECD countries of 100, the effect size can be interpreted as percentage points of an international standard deviation. That is, PPP systems that combine public funding with private operation perform more than one third of an international standard deviation better than pure public systems. To provide an alternative benchmark for the size of this performance difference, we can also compare it to the unconditional performance difference between 9th-grade and 10th-grade students (the two largest grades in PISA), which is 30.3 PISA test-score points in math.[9] That is, 15-year-old students in public-funding private-operation PPP systems on average perform more than the equivalent of a whole grade level better than same-aged students in mainly publicly funded and operated systems.

By contrast, students in systems that combine large shares of public operation with relatively low shares of public funding, i.e. the second type of PPP, perform 36.6 test-score

[9] The values in reading and science are 33.2 and 32.4, respectively.

points *worse* than students in purely public systems. Interestingly, there is no difference at all in the average performance of students in systems that combine large shares of private operation and funding and students in systems that combine large shares of public operation and funding.

Figure 2 depicts the result pattern graphically. It shows that the two forms of PPPs have diametrically opposite consequences relative to all-public or mainly-private systems. The performance difference between the two forms of PPPs adds up to 74.6 points. These results suggest that it makes a fundamental difference *how* the partnership between public and private in PPPs is conceived: Reserving funding for the public side but contracting the operation to the private sector brings huge gains in performance, but transferring funding to the private side and leaving the operation of schools in the public hand brings huge losses. The picture also suggests that there are no significant interactions between operation and funding at this level: Public operation has a negative effect, independent of the mode of funding, and public funding has a positive effect, independent of the mode of operation. Therefore, in a mainly privately operated and funded system, the two effects cancel out and average performance is similar to a mainly publicly operated and funded system.

The pattern of results is exactly the same in the other two subjects, reading and science, as the results reported in columns (Z) and (AE) in Table 5 show. The size of the performance differences in these two subjects is somewhat lower.

The very same pattern of negative effects of public operation and positive effects of public funding emerges in specification (7) with country-level data on public-private operation and funding. As the results reported in columns (T), (AA) and (AF) in Tables 4 and 5 reveal, the coefficient on public operation is statistically significantly positive in all three subjects, and the coefficient on public funding is negative in all three subjects and statistically significantly so in math and reading.[10]

5.2 Cross-Country Regressions with School-Level Public-Private Measures

Columns (X), (AC) and (AH) in Tables 4 and 5 report the results of specification (10) that uses individual-level data on public-private involvement, first without an interaction term.[11]

[10] The results on public operation are consistent with evidence from a previous international student achievement test, TIMSS, showing that student performance was superior in countries with a larger share of private enrollment and with a larger share of public funding going to privately operated schools (Wößmann 2001, 2003).

[11] This specification and the results are very similar to those reported in Fuchs and Wößmann (2004).

Note that the difference between this and the previous specifications is not in the level of estimation, because all specifications use student-level data on test scores and background features. The difference is in the level at which the measures of public vs. private operation and funding of schools are measured.

The qualitative results of the specification measuring public-private involvement at the school level are the same as those of the specification with country-level public-private measures in all three subjects: Public operation is negatively associated with student achievement and public funding is positively associated with student achievement. As argued in Section 4.1 above, selection bias is likely to bias the estimate on public funding in the specification with school-level public-private measures downwards. However, we still get a statistically significant positive estimate. Therefore, the effect of public funding on student achievement seems indeed to be positive, and likely to be even larger than the reported coefficient estimates of this specification suggest. This pattern is also consistent with the relative size of the coefficient estimate in the specifications with country-level and school-level public-private measures. The lower size in the specification with school-level public-private measures could be attributed to the selection bias, which is operative within countries but not across countries.

The coefficient estimate on public operation is also smaller in absolute terms in the specification with school-level public-private measures. As argued above, theories of credit constraints would not predict a bias of the coefficient on public vs. private operation. Note also that any selection bias would predict a difference in the coefficient estimates of the two specifications that would go the other way, pushing the coefficient in the specification with school-level public-private measures even more into the negative.

In sum, all specifications that use the cross-country variation, both using country-level and school-level measures of public-private involvement, yield the result that public operation has a negative and public funding a positive effect on student performance.

5.3 Interactions between Funding and Operation

To see whether the effect of public funding differs under public vs. private operation of schools, the next specification adds an interaction term between operation and funding to the model. Columns (U), (AB) and (AG) in Tables 4 and 5 report results of specification (9) that adds the interaction term to the country-level measure specification (7). As already apparent

in the quadrant-dummy specification depicted in Figure 2, there is no significant interaction effect in any of the subjects in this specification with country-level public-private data.

But the interaction results are different in specification (10) that estimates the interaction term on individual-level data on public-private involvement, reported in columns (Y), (AD) and (AI). In all three subjects, the interaction term is statistically significantly negative. This means that public operation has a slightly negative effect already in schools with low public funding, but this effects gets ever more negative with increasing public funding. This pattern is depicted graphically in panel (a) of Figure 3. The pattern might either be driven by increasing lack of accountability in schools that do not receive any private funding, or it may be driven by the selection bias of higher-performing students into schools with larger shares of private funding.

At the same time, the negative interaction term means that the positive effect of public funding is strongly concentrated in schools that are privately operated, while the effect of public funding reduces to about zero in publicly operated schools (cf. panel (b) of Figure 3). This pattern might suggest that it is particularly the role of public funding in allowing everyone – including low-income families – to opt for privately operated schools that drives the positive association between public funding and student performance. In this sense, public funding can enable more choice, in that families that would otherwise be credit constrained can choose privately operated schools if funding comes from public sources.

5.4 Regressions Using Only Variation within Each Country

Results of specification (11), which adds country fixed effects to the previous specification (10), are reported in the top panel of Table 6. An interaction term between public funding and operation was never statistically significant in the three subjects and was thus dropped from the specification. In this specification that disregards the between-country variation and exploits only the within-country variation, the coefficients on both public operation and public funding are negative, and the coefficient on public funding is the larger one in absolute terms. This might suggest that the association between public funding and student performance within countries is mostly driven by the selection bias of higher-performing children into schools with larger shares of private funding. However, this specification using the within-country variation in the pooled cross-country dataset also foreshadows systematic differences in the associations between countries.

This becomes apparent in the lower panels of Table 6, which report results of estimating the model separately for each country, as in specification (12). We restrict our attention to reading performance here because the reading samples are substantially larger than the samples in the other two subjects, which becomes particularly relevant when restricting the estimations to within each country. It should still be recognized that in some countries, cell sizes get worryingly small, as is evident from the small number of privately operated schools in some country samples, reported in column (I) in Table 1.

A broad systematic pattern emerges when we look at the countries separately by their affiliation to the four quadrants of Figure 1 again. Running the pooled within-country regressions separately for each quadrant (again including country fixed effects), it becomes apparent that the negative coefficient on public operation in the specification pooling all countries is mainly driven by the countries in the top left panel, while the negative coefficient on public funding is mainly driven by the countries in the bottom right panel. All other panel-wise coefficients are statistically insignificant.[12] Note that the lower performance of publicly operated schools in the top left quadrant is unlikely to be caused by credit-constraint-based selection patterns, as all schools in the systems of this quadrant – be they publicly or privately operated – receive the vast majority of their funding from public sources.

By contrast, the lower performance of schools with larger shares of public funding in the bottom right quadrant is quite likely to be driven by credit-constraint-based selection bias. Nearly all schools in the systems of this quadrant are publicly operated, but rich families, whose children may perform better for reasons other than the public-private division of school operation and funding, can provide additional private funding for their schools. Finally, note that in the top right quadrant, there is a statistically significant negative association of student achievement with public school operation and a statistically significant positive association with the share of public school funding in several countries, as is the pattern in the specifications using the cross-country variation.

Still, it should be borne in mind that the specifications using the variation within each country face the fundamental problem of selection bias. This might bias particularly the estimates on public funding in the negative direction.

[12] The positive coefficient on public operation in the bottom left quadrant is driven by the highly imprecise estimate in Japan.

6. Conclusion

This paper has presented cross-country evidence on the effectiveness of public-private partnerships (PPPs) in providing cognitive skills to students. The main result is that across countries, public operation of schools is negatively associated with student performance in math, reading and science, while public funding of schools is positively associated with student performance in the three subjects. This suggests that school systems based on PPPs in the sense that the state finances schools but contracts their operation out to the private sector are the most effective school systems. By contrast, school systems based on PPPs in the sense that they require a lot of private funding but keep the operation of schools in the public sector fare even worse than systems where operation and funding is either both public or both private. Thus, the results favor the particular form of educational PPPs where the state does the funding and the private sector runs the schools.

While this paper has looked at the relative effectiveness of PPPs in providing cognitive skills, aspects of efficiency, equity and non-cognitive skills have been left for future research. To look at the relative efficiency of PPPs, defined in terms of output per input, one would have to add a comparison of the costs at which PPPs operate relative to mere-public or mere-private schools. If the different systems show systematic differences in their spending levels, then effectiveness is only one side of efficiency. It would also be interesting to analyze whether the effect of PPPs differs for students from different parts in the performance distribution, i.e. whether the effects are heterogeneous between elite and disadvantaged students. Specifications that interact the public-private measures with family-background measures could also provide evidence on equity aspects of private involvement. It also remains an open issue whether and how PPPs affect the non-cognitive skills, behaviors and beliefs of students.

Another road for future research would be to look at the different channels through which the effects of PPPs may come about. For example, PPPs may differ from other schools in the education level of the teachers that they hire or in the autonomy that they are granted in different areas, and one may get glimpses of the importance of these different channels by comparing the presented results to regressions that do not control for these other aspects of educational production.

References

Adams, Ray, Margaret Wu, eds. (2002). *PISA 2000 Technical Report*. Paris: Organisation for Economic Co-operation and Development (OECD).

Angrist, Joshua, Eric Bettinger, Erik Bloom, Elizabeth King, Michael Kremer (2002). Vouchers for Private Schooling in Colombia: Evidence from a Randomized Natural Experiment. *American Economic Review* 92 (5): 1535-1558.

Bedi, Arjun S., Ashish Garg (2000). The Effectiveness of Private Versus Public Schools: The Case of Indonesia. *Journal of Development Economics* 61 (2): 463-494.

Bishop, John H. (1992). The Impact of Academic Competencies on Wages, Unemployment, and Job Performance. *Carnegie-Rochester Conference Series on Public Policy* 37: 127-194.

Bishop, John H., Ludger Wößmann (2004). Institutional Effects in a Simple Model of Educational Production. *Education Economics* 12 (1): 17-38.

Bradley, Steve, Jim Taylor (2002). The Effect of the Quasi-Market on the Efficiency-Equity Trade-off in the Secondary School Sector. *Bulletin of Economic Research* 54 (3): 295-314.

Chubb, John E., Terry M. Moe (1990). *Politics, Markets, and America's Schools*. Washington, D.C.: Brookings Institution Press.

Cox, Donald, Emmanuel Jimenez (1991). The Relative Effectiveness of Private and Public Schools. *Journal of Development Economics* 34 (1): 99-121.

Deaton, Angus (1997). *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. Baltimore: The Johns Hopkins University Press.

DuMouchel, William H., Greg J. Duncan (1983). Using Sample Survey Weights in Multiple Regression Analyses of Stratified Samples. *Journal of the American Statistical Association* 78 (383): 535-543.

Epple, Dennis, Richard E. Romano (1998). Competition Between Private and Public Schools, Vouchers, and Peer-Group Effects. *American Economic Review* 88 (1): 33-62.

Fuchs, Thomas, Ludger Wößmann (2004). What Accounts for International Differences in Student Performance? A Re-examination using PISA Data. CESifo Working Paper 1235. Munich: CESifo.

Galor, Oded, Joseph Zeira (1993). Income Distribution and Macroeconomics. *Review of Economic Studies* 60 (1): 35-52.

Glomm, Gerhard, B. Ravikumar (1992). Public versus Private Investment in Human Capital: Endogenous Growth and Income Inequality. *Journal of Political Economy* 100 (4): 818-834.

Gradstein, Mark, Moshe Justman (2002). Education, Social Cohesion, and Economic Growth. *American Economic Review* 92 (4): 1192-1204.

Gradstein, Mark, Moshe Justman, Volker Meier (2004). *The Political Economy of Education: Implications for Growth and Inequality*. Cambridge, MA: MIT Press.

Greene, William H. (2000). *Econometric Analysis*. Fourth edition. Upper Saddle River, NJ: Prentice Hall.

Hanushek, Eric A., with others (1994). *Making Schools Work: Improving Performance and Controlling Costs*. Washington, D.C.: Brookings Institution Press.

Howell, William G., Patrick J. Wolf, David E. Campbell, Paul E. Peterson (2002). School Vouchers and Academic Performance: Results from Three Randomized Field Trials. *Journal of Policy Analysis and Management* 21 (2): 191-217.

Hoxby, Caroline M., ed. (2003a). *The Economics of School Choice*. A National Bureau of Economic Research Conference Report. Chicago: University of Chicago Press.

Hoxby, Caroline M. (2003b). School Choice and School Competition: Evidence from the United States. *Swedish Economic Policy Review* 10 (3): 9-65.

Hsieh, Chang-Tai, Miguel Urquiola (2003). When Schools Compete, How Do They Compete? An Assessment of Chile's Nationwide School Voucher Program. NBER Working Paper 10008. Cambridge, MA: National Bureau of Economic Research.

Human Development Network (2001). *Handbook on Public Private Partnerships in Education*. Washington, D.C.: World Bank. (http://www.ifc.org/ifcext/edinvest.nsf/Content/PublicPrivatePartnerships)

James, Estelle, Elizabeth M. King, Ace Suryadi (1996). Finance, Management, and Costs of Public and Private Schools in Indonesia. *Economics of Education Review* 15 (4): 387-398.

Jimenez, Emmanuel, Vicente Paqueo (1996). Do Local Contributions Affect the Efficiency of Public Primary Schools? *Economics of Education Review* 15 (4): 377-386.

Ladd, Helen F. (2002). School Vouchers: A Critical View. *Journal of Economic Perspectives* 16 (4): 3-24.

Levaĉić, Rosalind (2004). Competition and the Performance of English Secondary Schools: Further Evidence. *Education Economics* 12 (2): 177-193.

Loury, Glenn C. (1981). Intergenerational Transfers and the Distribution of Earnings. *Econometrica* 49 (4): 843-867.

Mizala, Alejandra, Pilar Romaguera (2000). School Performance and Choice: The Chilean Experience. *Journal of Human Resources* 35 (2): 392-417.

Mizala, Alejandra, Pilar Romaguera, Darío Farren (2002). The Technical Efficiency of Schools in Chile. *Applied Economics* 34 (12): 1533-1552.

Moulton, Brent R. (1986). Random Group Effects and the Precision of Regression Estimates. *Journal of Econometrics* 32 (3): 385-397.

Neal, Derek (1997). The Effects of Catholic Secondary Schooling on Secondary Achievement. *Journal of Labor Economics* 15 (1): 98-123.

Nechyba, Thomas J. (2000). Mobility, Targeting, and Private-School Vouchers. *American Economic Review* 90 (1): 130-146.

Organisation for Economic Co-operation and Development (OECD) (2001). *Knowledge and Skills for Life: First Results from the OECD Programme for International Student Assessment (PISA) 2000*. Paris: OECD.

Patrinos, Harry A. (2000). Market Forces in Education. *European Journal of Education* 35 (1): 61-80.

Patrinos, Harry A. (2002). Private Education Provision and Public Finance: The Netherlands as a Possible Model. NCSPE Occasional Paper No. 59. New York, NY: National Center for the Study of Privatization in Education, Teachers College, Columbia University.

Peterson, Paul E., ed. (2003). *The Future of School Choice*. Stanford, CA: Hoover Institution Press.

Pritchett, Lant (2003). "When Will They Ever Learn"? Why *All* Governments Produce Schooling. Bread Working Paper 31. Cambridge, MA: Harvard University, Bureau of Research in Economic Analysis of Development.

Sandström, F. Mikael, Fredrik Bergström (2005). School Vouchers in Practice: Competition Will Not Hurt You. *Journal of Public Economics* 89 (2-3): 351-380.

Sapelli, Claudio, Bernardita Vial (2002). The Performance of Private and Public Schools in the Chilean Voucher System. *Cuadernos de Economía – Latin American Journal of Economics* 39 (118): 423-454.

Shleifer, Andrei (1998). State versus Private Ownership. *Journal of Economic Perspectives* 12 (4): 133-150.

Vegas, Emiliana (2002). School Choice, Student Performance, and Teacher and School Characteristics: The Chilean Case. World Bank Policy Research Working Paper 2833. Washington, D.C.: World Bank.

White, Halbert (1984). *Asymptotic Theory for Econometricians*. Orlando: Academic Press.

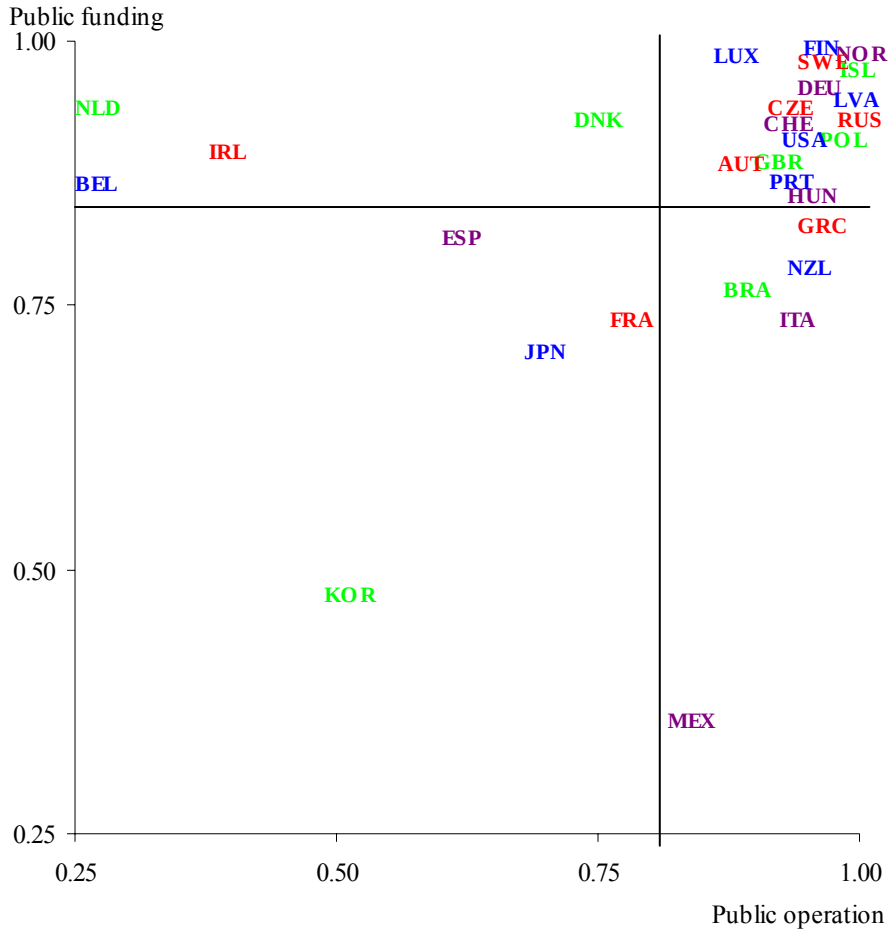
Wooldridge, Jeffrey M. (2001). Asymptotic Properties of Weighted *M*-Estimators for Standard Stratified Samples. *Econometric Theory* 17 (2): 451-470.

World Bank (2004). *World Development Report 2004: Making Services Work for Poor People*. Washington, D.C.: World Bank.

Wößmann, Ludger (2001). Why Students in Some Countries Do Better: International Evidence on the Importance of Education Policy. *Education Matters* 1 (2): 67-74.

Wößmann, Ludger (2003). Schooling Resources, Educational Institutions and Student Performance: the International Evidence. *Oxford Bulletin of Economics and Statistics* 65 (2): 117-170.

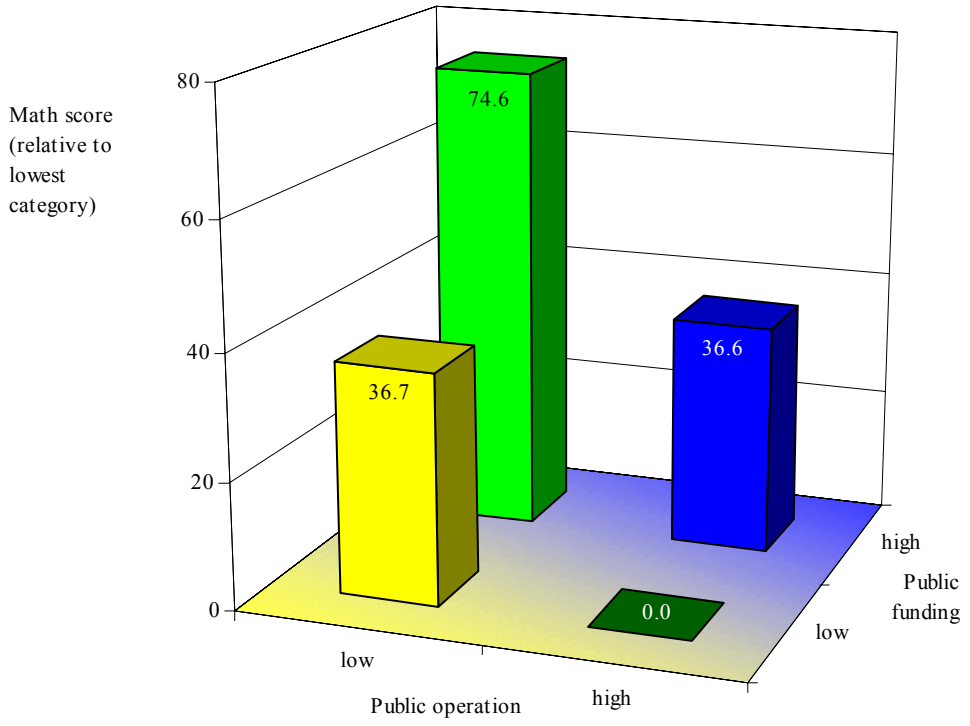
Figure 1: Public Funding and Public Operation of Schools



Notes: Average share of public funding and share of publicly operated schools in the country, respectively. – The acronyms stand for: AUT: Austria, BEL: Belgium, BRA: Brazil, CZE: Switzerland, CHE: Czech Republic, DEU: Germany, DEN: Denmark, ESP: Spain, FIN: Finland, FRA: France, GBR: United Kingdom, GRC: Greece, HUN: Hungary, IRL: Ireland, ICE: Iceland, ITA: Italy, JPN: Japan, KOR: Korea, LUX: Luxembourg, LVA: Latvia, MEX: Mexico, NLD: Netherlands, NOR: Norway, NZL: New Zealand, POL: Poland, PRT: Portugal, RUS: Russian Federation, SWE: Sweden, USA: United States.

Source: Own calculations based on PISA micro database.

Figure 2: Student Achievement in the Four Quadrants of Public-Private Involvement

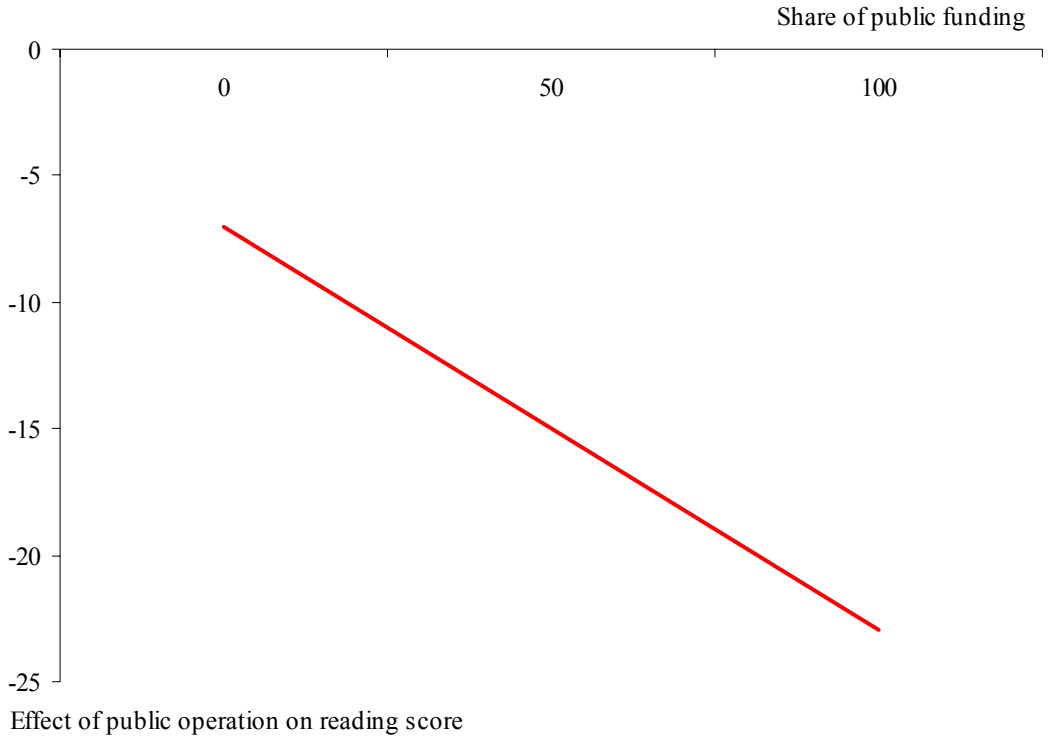


Notes: The distinction into countries with relatively low and relatively high shares of public operation and funding follows the quadrants in Figure 1.

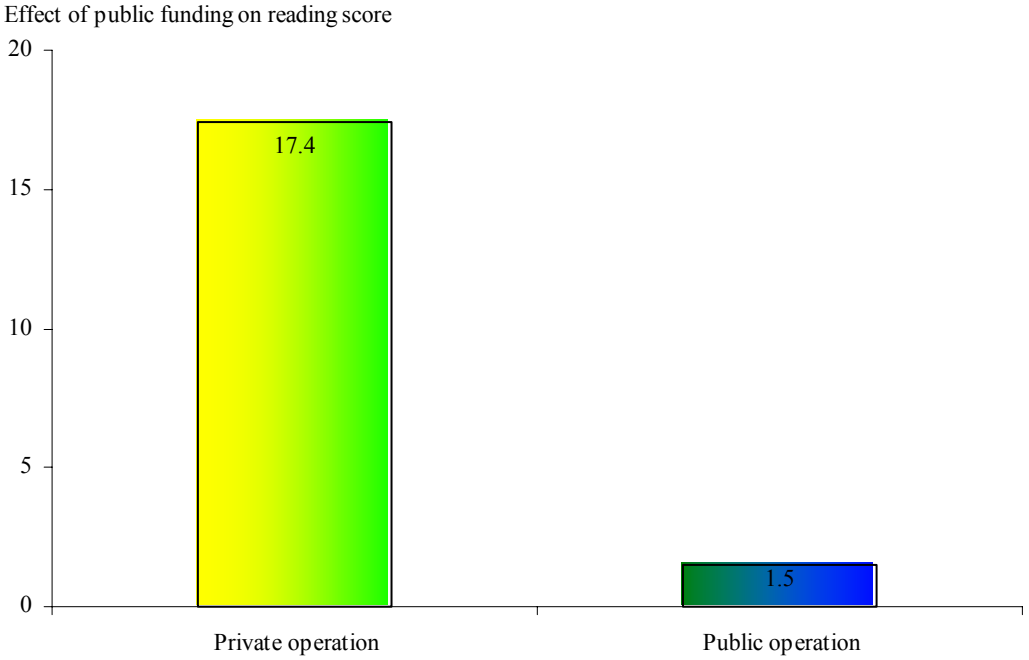
Source: Table 4, column (Q).

Figure 3: The Interaction of Public Operation and Public Funding

(a) Effect of public operation depending on type of funding



(b) Effect of public funding depending on type of operation



Source: Table 5, column (AD).

Table 1: Test Performance and Sample Size

	Math		Reading		Science		Sample size (students)	Sample size (schools)	Number of privately operated schools in sample	Missing in original sample[a]
	Score	SD	Score	SD	Score	SD				
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
AUT	515	92	507	93	519	91	4,501	203	20	5.1
BEL	520	106	507	107	496	111	6,345	203	149	4.9
BRA	334	97	396	86	375	90	3,956	256	27	19.1
CHE	529	100	494	102	496	100	5,830	269	26	4.4
CZE	498	96	492	96	511	94	5,343	228	23	0.4
DEU	490	103	484	111	487	102	4,442	192	8	12.4
DNK	514	87	497	98	481	103	4,009	208	51	5.3
ESP	476	91	493	85	491	95	5,818	174	65	6.4
FIN	536	80	546	89	538	86	4,864	155	6	0.0
FRA	517	89	505	92	500	102	4,080	153	36	12.7
GBR	529	92	523	100	532	98	8,676	337	16	7.1
GRC	447	108	474	97	461	97	4,305	144	5	7.9
HUN	488	98	480	94	496	103	4,766	183	8	2.5
IRL	503	84	527	94	513	92	3,793	137	83	1.6
ISL	514	85	507	92	496	88	3,236	125	2	4.0
ITA	457	90	487	91	478	98	4,704	161	9	5.6
JPN	557	87	522	86	550	90	5,217	134	39	0.7
KOR	547	84	525	70	552	81	4,676	137	64	6.1
LUX	446	93	441	100	443	96	3,251	22	3	7.9
LVA	463	103	458	102	460	98	3,038	123	1	22.0
MEX	387	83	422	86	422	77	3,894	156	26	15.3
NLD	556	89	530	91	527	96	2,246	89	66	10.3
NOR	499	92	505	104	500	96	3,972	165	3	4.2
NZL	537	99	529	108	528	101	3,456	144	7	5.8
POL	470	103	479	100	483	97	3,586	125	5	1.9
PRT	454	91	470	97	459	89	4,554	148	11	0.7
RUS	478	104	462	92	460	99	6,566	242	0	2.0
SWE	510	93	516	92	512	93	4,416	154	6	0.0
USA	493	98	504	105	499	101	2,947	116	6	23.4
Mean	492	94	492	95	492	95	130,487[b]	4,883[b]	771[b]	6.6

Notes: [a] Share of observations without information on public operation or funding (in percent). These observations are not counted in the columns on sample size. – [b] Sum. – See notes to Figure 1 for a list of country acronyms.

Source: Own calculations based on PISA micro database.

Table 2: International Differences in Public Funding and Public Operation of Schools

	Average share of public funding	Share of publicly operated schools	Difference	Average share of public funding in publicly operated schools	Average share of public funding in privately operated schools	Difference
	(K)	(L)	(M)	(N)	(O)	(P)
AUT	90.4	88.8	1.6	96.2	44.2	52.1
BEL	87.5	24.6	63.0	95.1	85.0	10.1
BRA	78.0	89.4	-11.4	87.3	0.0	87.2
CHE	93.8	93.5	0.3	98.5	25.5	73.0
CZE	94.9	93.9	1.0	96.2	74.5	21.7
DEU	97.3	95.9	1.4	98.2	77.1	21.1
DNK	94.3	75.5	18.8	99.9	76.9	23.0
ESP	82.9	61.9	20.9	95.3	62.8	32.5
FIN	99.8	97.2	2.6	99.9	98.3	1.5
FRA	75.5	77.8	-2.4	77.3	69.1	8.2
GBR	89.8	90.8	-1.0	98.7	2.2	96.4
GRC	83.7	95.8	-12.0	87.4	0.0	87.4
HUN	87.4	95.3	-7.8	87.9	78.3	9.5
IRL	91.1	39.5	51.6	98.0	86.6	11.4
ISL	99.4	99.2	0.2	99.9	40.4	59.5
ITA	75.2	94.2	-19.0	79.2	10.1	69.1
JPN	72.5	69.6	2.9	88.4	36.0	52.4
KOR	49.1	50.6	-1.5	54.9	43.3	11.6
LUX	100.0	87.9	12.1	100.0	100.0	0.0
LVA	95.6	99.2	-3.6	95.7	89.0	6.7
MEX	36.8	84.5	-47.6	43.6	0.0	43.6
NLD	94.7	26.0	68.7	94.7	94.7	0.0
NOR	99.5	98.5	1.0	99.8	82.3	17.5
NZL	80.2	95.1	-14.9	83.4	18.4	65.0
POL	92.2	97.1	-4.9	94.4	18.1	76.4
PRT	87.9	92.7	-4.8	88.5	80.1	8.4
RUS	93.5	100.0	-6.5	93.5	–	–
SWE	99.9	96.6	3.3	99.9	99.3	0.6
USA	91.6	94.6	-2.9	95.6	22.1	73.6
Mean	86.9	83.0	3.9	91.2	65.9	25.4

Notes: In percent. – See notes to Figure 1 for a list of country acronyms.

Source: Own calculations based on PISA micro database.

Table 3: Aspects of Public and Private Involvement in School Provision and Funding

	Positive aspects of involvement of:	
	Public sector	Private sector
Provision	Inculcation of beliefs and cultural values	Incentives for cost containment and qualitative innovation
Funding	Enabling choice for credit-constrained families	Increased accountability

Table 4: Public-Private Involvement and Math Performance across Countries

	Country-level public-private measures					School-level public-private measures			
	(Q)	(R)	(S)	(T)	(U)	(V)	(W)	(X)	(Y)
Top left quadrant	37.93***								
	(12.52)								
Bottom left quad.	0.02								
	(7.73)								
Bottom right quad.	-36.64***								
	(8.17)								
Public operation		-74.55***		-93.80***	-193.15**	-19.68***		-24.69***	-9.05
		(14.78)		*(13.81)*	*(94.26)*	*(2.40)*		*(2.69)*	*(5.98)*
Public funding			24.51	91.05***	3.73		1.64	18.56***	30.18***
			(26.69)	*(27.03)*	*(77.00)*		*(3.53)*	*(3.96)*	*(6.40)*
Interaction					113.45				-20.37***
					(109.86)				*(7.63)*
Observations	72,493	72,493	72,493	72,493	72,493	72,493	72,493	72,493	72,493
Strata						29	29	29	29
PSUs	29	29	29	29	29	4,870	4,870	4,870	4,870
R^2	0.314	0.309	0.293	0.315	0.316	0.297	0.293	0.298	0.298

Notes: Dependent variable: PISA international math test score. – Least-squares regressions weighted by students' sampling probabilities. – Regressions include 60 control variables for student, family and school characteristics. – Clustering-robust standard errors in parentheses. – Country-level public-private measures: countries as clusters (PSUs). – School-level public-private measures: schools as clusters (PSUs). – Quadrant dummies refer to country's position in Figure 1. – Interaction = interaction term between public operation and public funding.

Significance level (based on clustering-robust standard errors): *** 1 percent. – ** 5 percent. – * 10 percent.

Source: Own calculations based on PISA micro database.

Table 5: Public-Private Involvement and Reading and Science Performance across Countries

	Reading					Science				
	Country-level public-private measures			School-level public-private measures		Country-level public-private measures			School-level public-private measures	
	(Z)	(AA)	(AB)	(AC)	(AD)	(AE)	(AF)	(AG)	(AH)	(AI)
Top left quadrant	28.28**					17.00				
	(10.45)					*(12.45)*				
Bottom left quad.	-9.56					5.86				
	(6.39)					*(6.61)*				
Bottom right quad.	-13.06**					-18.36***				
	(5.76)					*(6.53)*				
Public operation		-56.95***	-35.15	-19.27***	-7.04		-55.61***	-183.89**	-17.94***	-6.31
		(10.71)	*(70.13)*	*(2.30)*	*(4.88)*		*(11.86)*	*(80.54)*	*(2.42)*	*(5.01)*
Public funding		59.06**	78.07	8.35**	17.42***		22.07	-90.88	0.79	9.39*
		(23.62)	*(59.05)*	*(3.29)*	*(5.37)*		*(20.49)*	*(66.11)*	*(3.36)*	*(5.24)*
Interaction			-24.80		-15.91**			146.01		-15.11**
			(84.64)		*(6.30)*			*(94.11)*		*(6.41)*
Observations	130,242	130,242	130,242	130,242	130,242	72,388	72,388	72,388	72,388	72,388
Strata				29	29				29	29
PSUs	29	29	29	4,882	4,882	29	29	29	4,870	4,870
R^2	0.310	0.311	0.311	0.306	0.306	0.254	0.256	0.257	0.252	0.252

Notes: Dependent variable: PISA international reading/science test score. – Least-squares regressions weighted by students' sampling probabilities. – Regressions include 60 control variables for student, family and school characteristics. – Clustering-robust standard errors in parentheses. – Country-level public-private measures: countries as clusters (PSUs). – School-level public-private measures: schools as clusters (PSUs). – Quadrant dummies refer to country's position in Figure 1. – Interaction = interaction term between public operation and public funding.

Significance level (based on clustering-robust standard errors): *** 1 percent. – ** 5 percent. – * 10 percent.

Source: Own calculations based on PISA micro database.

Table 6: Estimations within Countries

	Public operation		Public funding		Observations	PSUs	R^2
Pooled							
Math	-1.63	*(2.45)*	-10.63***	*(3.98)*	72,493	4,870	0.346
Science	-4.01*	*(2.32)*	-10.51***	*(3.51)*	72,388	4,870	0.281
Reading	-5.99***	*(2.14)*	-10.43***	*(3.52)*	130,242	4,882	0.341
Reading							
Top left	-13.66***	*(3.62)*	-12.40	*(11.02)*	16,388	637	0.348
BEL	-38.51***	*(7.07)*	-0.17	*(14.27)*	6,345	203	0.506
DNK	5.94	*(11.36)*	-44.56	*(42.58)*	4,006	208	0.238
IRL	-28.17***	*(6.18)*	-16.86	*(13.95)*	3,791	137	0.330
NLD	-9.91	*(6.81)*	-17.80	*(35.79)*	2,246	89	0.471
Bottom left	7.51**	*(3.40)*	-5.75	*(5.99)*	19,773	598	0.331
ESP	-13.05*	*(7.34)*	-11.58	*(9.52)*	5,805	174	0.383
FRA	6.99	*(4.75)*	-3.18	*(8.73)*	4,077	153	0.494
JPN	36.29*	*(21.56)*	-28.67	*(18.40)*	5,215	134	0.241
KOR	6.10	*(5.67)*	-12.04	*(11.57)*	4,676	137	0.261
Bottom right	-4.41	*(7.78)*	-13.88**	*(5.65)*	20,284	861	0.418
BRA	15.11	*(22.75)*	-20.29**	*(10.01)*	3,951	256	0.342
GRC	-23.64	*(17.23)*	2.86	*(16.66)*	4,301	144	0.364
ITA	26.79	*(19.39)*	-56.49***	*(21.08)*	4,704	161	0.356
MEX	-32.26***	*(11.01)*	-0.88	*(6.12)*	3,873	156	0.433
NZL	-20.21	*(14.80)*	-68.81***	*(19.70)*	3,455	144	0.294
Top right	-2.79	*(4.73)*	-11.12	*(8.24)*	74,022	2,795	0.319
AUT	14.60	*(12.70)*	-50.38***	*(17.32)*	4,501	203	0.400
CHE	-34.69*	*(19.14)*	69.35**	*(28.05)*	5,822	268	0.429
CZE	-9.14	*(12.19)*	59.03*	*(30.20)*	5,343	228	0.384
DEU	-25.25	*(20.40)*	6.03	*(54.93)*	4,430	192	0.486
FIN	-2.12	*(11.11)*	-238.14	*(254.08)*	4,863	155	0.221
GBR	-83.86***	*(26.85)*	-5.76	*(27.73)*	8,658	337	0.331
HUN	-3.99	*(12.55)*	28.81	*(24.81)*	4,761	183	0.425
ISL	-48.75***	*(17.90)*	32.96	*(24.56)*	3,229	125	0.175
LUX	21.89*	*(11.29)*	–		3,132	22	0.459
LVA	-40.72***	*(13.41)*	-20.17	*(44.35)*	3,037	123	0.315
NOR	-35.83	*(24.07)*	276.67**	*(115.33)*	3,967	165	0.182
POL	-23.41	*(52.29)*	-24.23	*(66.03)*	3,585	125	0.290
PRT	4.83	*(20.68)*	-3.01	*(10.43)*	4,549	148	0.527
RUS	–		-5.81	*(25.34)*	6,563	242	0.279
SWE	-10.32	*(7.85)*	275.32	*(403.53)*	4,415	154	0.209
USA	-47.06	*(15.07)*	11.81	*(19.04)*	2,942	116	0.355

Notes: Dependent variable: PISA international test score. – Least-squares regressions weighted by students' sampling probabilities. – Regressions include 60 control variables for student, family and school characteristics. – Clustering-robust standard errors in parentheses. – Schools as clusters (PSUs). – Regressions that pool countries control for country fixed effects. – The organization of countries follows the four quadrants of Figure 1. – See notes to Figure 1 for a list of country acronyms.

Significance level (based on clustering-robust standard errors): *** 1 percent. – ** 5 percent. – * 10 percent.

Source: Own calculations based on PISA micro database.