Public gains, private strains:
Public investment and private schooling in Peru

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Abstract

Between 2007-2016, Peru experienced an increase in public educational investment, a substantial improvement in public sector learning outcomes, and an erosion in the private sector learning premium. We use longitudinal, geo-coded register data of primary schools in urban areas to study how the improvement in public schooling affected private schools. With a difference in differences (DiD) framework, we demonstrate that the increase in public school quality reduced enrolment and test scores in private schools, primarily in areas with lower education levels. Similarly, using a staggered DiD, we find that new public school openings, reduced enrolment in nearby private schools.

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1 Introduction

The delivery of private education has expanded significantly in low and middle-income countries over the past decades, especially in urban areas. The quality of private schools is often highly variable, ranging from smaller, lower quality, low fee schools to larger, high fee, elite schools (see e.g UNESCO, 2021, for developments). For some, a private school is an automatic choice, regardless of public school quality, while others have resorted to a private school due to an underperforming or neglected public sector. Several countries, both developed and developing, have introduced voucher type systems, where the government funds enrolment in private schools; a trend that can contribute to a further expansion of the private sector (see e.g. Epple et al, 2017 for a review). Private school expansion increases choice and can, at best, put pressure on public schools to improve. However, it can also increase inequality in educational provision, and its expansion becomes particularly concerning when many private schools underperform public sector schools.

There is a sizeable literature analyzing the competitive impact of private sector expansion on the public sector (see e.g. Urquiola, 2016 for a review). In contrast there are only a limited number of studies on the impact of public sector expansion or investment on the private sector. We contribute to the latter by focusing on Peru between 2007-2016, a period that saw a significant increase in the public sector education budget, and a substantial improvement in public sector learning outcomes. Like many other developing and emerging economies, Peru has seen a proliferation of private schooling over the past few decades, with highly variable quality. More specifically, we analyze whether the improvement in public sector quality changed the relative attractiveness of the private sector, with implications for enrolment and test scores.

For our analysis, we rely on a geo-coded, longitudinal administrative data set of primary schools in urban areas, and annual test scores for second grade pupils in these schools. The data show that funding, resourcing and results for public schools improved rapidly over 2011-16, and towards the end, public sector test results exceeded those of most private schools. The increase in public sector learning outcomes was not accompanied by a similar increase in private sector learning, implying a significant erosion of the private sector learning premium.

Our hypothesis is that as public school quality improved, parents who were on the margins of choosing between private and public schools, would increasingly choose a public one. To the extent that there is capacity, this should manifest itself as a fall in private school enrolment, in particular for the academically weaker schools. We are primarily interested in the impact of a quality change in the public sector on the private sector, but also conduct an analysis on quantity change, by studying how the opening of a public school in the immediate vicinity affects private schools. With our evaluation, we aim to provide an answer to the broader question of whether it is possible to reverse the pull of the private sector by investing in the public sector.

The limited number of related previous studies focus on either the impact of public school quantity or quality expansion on private schools. Regarding quantity, Chakrabarti and Roy (2016) examine whether the expansion of charter schools in Michigan, US, affected private school enrolment, and find no effect. Dinerstein et al. (2023) study a sizeable expansion of public schools in the Dominican Republic, and find large effects on the private sector; private schools were more likely to close, reduce prices, and improve quality in response to the public sector expansion.

Regarding the quality of public sector schooling, Dinerstein and Smith (2021) study the response of the private sector on a school funding reform in New York City that aimed to improve the quality of public schooling. Their research shows that the private sector adjusts to public school improvement; a significant boost in local public school funding led to a reduction in private sector supply within 1 mile of these public schools. Estevan's (2015) results for Brazil echo these findings; a public sector funding reform reduced private school enrolment in grade 1, but less so at higher grades, as there is a cost to switching schools. Using a randomized controlled trial, Andrabi et al (2024) study the equilibrium learning effects of a public school grants program in Pakistani villages. The program not only improved learning in the public sector, but also had a positive, competitive impact on private sector test scores, with a larger impact on those schools that faced a competitive threat.

In terms of modelling the effects of the public sector quality improvement on private schools, we rely on a difference in differences framework. We treat the drive to improve the public sector as an 'event' which is timed to begin from 2011, when the education budget started to expand significantly. Our control schools are private schools that are shielded from public

sector competition; more specifically those with no public sector competitors within a 1 km radius. It is worth noting here that the choice of primary school is likely to be very local; our data suggest that in urban areas there is an abundance of schools within a small radius. We study the effects of the public sector quality improvement on private primary school enrolment and test scores of second grade pupils in urban areas.

The results indicate that the improvement in public school quality had a negative impact on private sector enrolment, an average decrease of 10 percent three years after the funding increases accelerated, and a 17 percent fall after six years. The effect is concentrated on areas with lower parental schooling, suggesting that families with weaker socioeconomic status acted on the improvement of public schools. On learning, the results suggest that the increased competitive pressure from the public sector also led to weaker test performance for private school pupils. This data set does not allow us to determine precisely whether this is explained by pupil selection or changes within schools. However, additional analysis with a separate panel data set suggests that pupil selection is unlikely to explain the reduction of academic results in private schools.

While in urban areas investment focused more on quality rather than an increase in the physical number of schools, as an additional analysis, we also study the impact at the extensive margin. In this case, we compare enrolment and learning in a set of private schools before and after the opening of a new public school, depending on how close they were to the new public school. We estimate a staggered difference in differences model for school openings that take place throughout the period studied, relying on the estimator by Callaway and Sant'Anna (2021). We find that private schools which were within 1 km of the new school opening, lost pupils compared to the control group: private schools which were within a 1-2 km of the new school.

We also found substantial heterogeneity in this effect. The negative impact on private school enrolment was larger in the latter part of the period, when public schools were performing better, and the negative effects were concentrated in areas of lower socio-economic status, and to private schools which were academically weaker.

To end with, we conduct a simple exercise to compare public educational expenditure against the cost of privately producing second grade test scores, which are similar to the public school average. This indicates that by the end of the period studied, public schooling was transformed

into a more cost-effective provider of education, and was likely to provide better value for money than private schooling. This suggests that a potential voucher scheme, which has been under discussion in Peru (see Alonso-Pastor and Osain, 2023), may not be preferable to current public sector provision. Overall, our results show that significant investment in the public sector has the potential to crowd out private schools and rapidly improve educational attainment. Whether the public sector improvements in Peru were sustainable in the long run would require future work, which is complicated by the COVID-19 pandemic from 2020 onwards, which led to school closures.

The paper is structured as follows. Section 2 describes private schooling in Peru and background to the educational investments and reforms. Section 3 describes the data and illustrates a number of stylized facts. Section 4 presents the difference in differences analysis on the effects of public sector quality improvement on the private sector. Section 5 in turn reports the results on the opening of new public schools. Section 6 provides a cost effectiveness analysis and Section 7 concludes.

2 Background on Private Schools and Educational Reforms in Peru

The share of children attending a private primary school in Peru has risen over the past decades and over the period studied was around 40 percent in urban Peru. This trend is similar to Latin America more generally (see Elecqua et al., 2018). This is partly because public education systems were seen as failing, often due to weak academic results, teacher strikes and high costs for the taxpayer (Balarin, 2015, Cuenca, 2016). The private sector has been largely unregulated and very heterogeneous in terms of fees and quality of instruction. While vouchers or public subsidies for private schools have been a feature in some Latin American countries, this is not the case for Peru. Whereas there is a small chain of catholic private schools which is publicly subsidized (Fe y Alegría), these schools comprise no more than two percent of pupils. However, there has been a debate on the introduction of public-private partnerships in the form of 'school vouchers', which would allow parents to purchase private schooling (see e.g. Alonso-Pastor and Osain, 2023 for a review).

As recognized by Elecqua et al (2018), among others, the lack of state capacity has been one of the key drivers of private sector growth in Latin America. This relates to both the quantity

and quality of educational provision. In growing urban areas, lack of school places or longer distances create demand for private education. Similarly, as consumers' earnings grow, their demand for the quality of education increases, often precisely in urban areas. Both of these factors lead to the growth of private schooling, particularly in capital cities and other urban conglomerates.

The public education budget started to grow significantly more rapidly from 2011 onwards and expanded by 75 percent between 2011-2016 in nominal terms (Figure 1). The regional budget accounts for the largest share of the total education budget. Out of the 25 regions in Peru ('Departamentos'), 24 fund their basic education via the regional budget. The exception is the capital region of Lima, which funds its basic education via the national budget. The national budget is also more important for higher levels of education, such as universities.

The key reforms of the 2011-16 government are documented for instance by Saavedra and Gutierrez (2020), who divide the improvements into the following categories: 1) upgrades to infrastructure, 2) teacher-related reforms, 3) curricular and pedagogical reforms, 4) management of school systems. A broader context on the political economy of Peruvian educational reforms is provided by Balarin (2021). For practical purposes, we examine the package of public investment as an 'event' beginning from 2011, which also coincides with a new government.

Many of the actual reforms were not implemented before the middle of the 2010s, so their impacts might not be fully visible during the period that we study. The funding increases preceded several formal reforms, and the programs that were more focused on the school infrastructure are likely to be more relevant for the period analyzed. The 'Program of Maintenance of Educational Infrastructure' has since 2012 directed financing for schools for basic repairs and maintenance of school infrastructure. A national program to close the infrastructure gaps, the 'National Educational Infrastructure Program' (PRONIED) also started in 2014[1].

[1] Key legal changes in teacher-related reforms are the 2007 *Ley de Carrera Publica Magisterial* and especially the 2012 law *Ley de Reforma Magisterial*, which opened the possibility to change how teachers are hired and promoted, based on performance evaluations. The first teacher promotion contests took place from 2014. Individual schools were also rewarded for good performance, based on the *Bono Escuela* program from 2014-15.

3 Data and descriptive analysis

3.1 Data

Our school level data come from the Censo Escolar, which is an annual school census containing details on school infrastructure, location, teachers, and pupils, among other things. It covers all primary schools in Peru, both public and private.[2] We link these data to cross-sectional pupil level test score data from the Evaluación Censal de Estudiantes. This includes nationally comparable, annual test score data for second grade pupils in Reading and Mathematics. The second grade test score data are available continuously for 2007-2016, which explains the remit of our core analysis. We have chosen to focus on primary schooling, as the second grade is the only level for which there is a continuous series for a longer time period, covering a period pre and post the expansion in investment in public schooling. After 2016, the focus shifted on collecting test scores at higher grades. Neither of the above data contain sufficient information on household or parental characteristics, over the time period studied.

For a subset of pupils, a longitudinal dataset that tracks pupils and their test scores in grades 2 and 8, is available for several cohorts between 2009-19. This can also be matched to the school census for the same time period. We do not use this in the main analysis, but in Appendix B,

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A non-trivial salary bonus was given to principals and teachers of schools that performed in the top 1/3 of comparable schools in the region, based on a performance formula that accounted for learning outcomes, enrolment and retention. Bono Escuela has been evaluated by Leon (2016), who concludes that the program had positive effects on test scores in mathematics, and that it improved the attendance of teachers and school directors. In 2014, another intervention, the *Acompanamiento Pedagogico Multigrado* involved visits providing teachers feedback and continuous coaching on pedagogical practices in single-teacher and multigrade primary schools - typically small schools in remote areas. Majerowicz and Montero (2022) evaluate a 2016 randomised reassignment of the program and find that the teachers trained by this program improved their pupils' test scores by over 0.2 standard deviations. In terms of school management, the role of school principals was strengthened from 2015 onwards, when about 1/3 of existing principal positions were assigned on a meritocratic basis. Principals were also given more autonomy, for example with regards to minor maintenance purchases. Further to this, from 2015 data collection from schools and use of data was improved under a tool, *Semaforo Escuela*, which recorded information on school functioning and attendance based on school visits and teacher interviews.

[2] The sampling excludes schools with fewer than 5 pupils.

report on the effect on learning from moving from a private primary school to a public secondary school and vice versa.

To obtain data on key population and household characteristics at a more aggregate level, we have relied on the Encuesta Nacional de Hogares (ENAHO) for years 2005-2019. This is representative at the regional (Departamento) level. We also use Census sweeps (2007 and 2017) to compute some statistics of interest. For public finance regarding education, we use the Portal de transparencia del Ministerio de Economía y Finanzas (MEF).

The data pose a limitation to studying school exit, or closure as an outcome variable at a fine geographic level, given that the geolocation of schools is available only from 2016 onwards. We rely on the geographic location to establish the presence and extent of public sector competition for private schools, and thus our analysis can only include schools that existed in 2016. Appendix A provides an analysis on the determinants of exit rates of schools generally prior to 2016, to assess the potential bias in the sample used for our analysis.

One further limitation concerns data on private school fees, which are not readily available for the period we study. We use the data for fees in 2020 to generate a few descriptive statistics.[3] These relate to private schools in our sample that were operational in 2020. There is a strong correlation between learning levels in our data and the prices in 2020.

3.2 General descriptives

We begin the description of Peruvian primary education with a simple set of graphs (Figure 2). The left-hand figure shows total primary enrolment in urban districts of Peru for both the public and private sector. We use 'urban districts', which we have defined as those 255 districts that were at least 80 percent urban in the 2007 census. The figure shows that even though popularity of private schooling has kept marching upwards, that of the public sector schooling has experienced a turnaround. The right-hand side of Figure 2 shows that the share of pupils attending private schools starts to decline from 2014 onwards. These developments highlight a

[3] Source, Identicole website: https://identicole.minedu.gob.pe

sudden change in the appeal of the public school system, which is in contrast with what is happening in the rest of Latin America (Elecqua et al, 2018).

The next figure (Figure 3) documents how the learning premium associated with the private sector has been eroding over the period of 2007-2016. Reading scores in the public sector catch up nearly completely with private sector outcomes by 2016, whereas the public sector exceeded the private sector in Mathematics performance already by 2014.

In Figure 4, the development in private sector combined Mathematics and Reading scores are decomposed into four price quartiles for private schools, together with the same learning scores in the public sector. The figure illustrates that test scores in public schools surpass those in all the 3 lower quartiles by 2014 and almost reach the level of the top quartile of private schools by 2016.

Figure 5 plots the key school inputs by sector: the pupil-teacher ratio (PTR), basic infrastructure resources and the number of computers per pupil. PTRs in the public sector have been improving but have remained much higher (at about 22 pupils per teacher) than in the private sector, where the same figure hovers around 15. 'Basic resources' refers to an index consisting of five items, for which we were able to obtain a consistent series of data for the period studied: water, sewage, electricity, toilet and internet. Each school is rated between 0-5, and the values averaged over the urban districts by year, weighted by pupil numbers. Here too, the public sector has been catching up with the private sector, and there has been rapid improvement in infrastructure over time, as well as in the number of computers per pupil, partly explained by the increased emphasis on infrastructure investments.

Overall, the above descriptive evidence suggests that by 2014 the majority of the private schools are underperforming the public ones. We should emphasize that these figures do not control for pupil selection. However, private school pupils typically have parents with more resources than average, suggesting that if we'd be able to control for parental socioeconomic status, the relative performance of private schools would appear even worse.

The erosion of the private school learning premium should improve parental perception of public sector schools, if they are informed. Earlier research shows that there are various motives for choosing private schools, and they are not necessarily related to learning. For

example, Balarin (2015) suggests that in the Peruvian context an important factor for many parents in urban areas is the proximity of small local private schools compared to public schools, which are on average larger, and further away from each other.

4 Public school quality and private school enrolment

This Section focuses on the estimation and results on the impact of the improvement in public school on private school enrolment and test scores.

4.1 Conceptual framework

Our hypothesis is that as public school quality improves, parents who are on the margin of choosing between private and public schools, will increasingly choose a public one. This should manifest itself as a loss of pupils for private schools, particularly among the private schools that hold no local market power, or in other words, are competing for the same 'customers' as the public sector.

For a simplified model of school competition, suppose that parents choose schools based on the perceived school quality (ϕ), and the costs (C) associated with sending children to the school. Quality is based on perceptions, as comparative school test results are generally not published in mainstream media. However, one can assume that the increasing budget resources shape perceptions, as does word of mouth, possibly with a lag. The costs may differ depending on whether the school is public or private, with tuition being the main component of the cost. If parents compare their most preferred public and private schools, they face a binary choice of the form

$$(1) \quad max\{School^{priv}, School^{pub}\} = \max\{f(\phi^{priv}, C^{priv}), f(\phi^{pub}, C^{pub})\}$$

In this formulation, $\frac{\partial f(\phi,C)}{\partial \phi} > 0$ and $\frac{\partial f(\phi,c)}{\partial C} < 0$ and parents choose private over public whenever $f(\phi^{priv}, C^{priv}) > f(\phi^{pub}, C^{pub})$. Let's assume that the utility function is linear in quality and cost, and costs consist of tuition fees (π) and the distance to the school (d), both of which have been shown to be key factors for parents of primary school pupils in urban Peru

(Balarin, 2015)[4]. Equation (2) provides a straightforward framework for assessing the effects of an improvement in public school quality.

$$(2)\ \left(\phi^{priv} - \phi^{pub}\right) > \left[\left(d^{priv} - d^{pub}\right) + \pi\right].$$

For a parent to choose a private school, its quality premium has to exceed the costs due to tuition and excess distance (admitting that private school can be closer than public one). Improvements in public school quality would make marginal parents more likely to choose public schooling. Similarly, establishing new public schools would reduce d^{pub} for local parents, leading to shrinking of the private schools, if the quality of the public school is sufficiently high.

While we abstract from the more detailed aspects of competition, it is necessary to point out that when facing new competitive pressure, private schools may react by raising quality or reducing the price. However, their ability to do so would depend on their existing cost structure and profit margins. Given the large numbers of private schools in Peruvian urban areas, there is good reason to believe these markets to be quite competitive and local. For the average urban private primary school in Peru in 2011, there were 19.6 other private and 6.8 public schools within a 1km radius (Figure 6). Figures 7a and 7b illustrate how densely public and private schools are located on a map for areas in and around Lima.

4.2 Econometric model

Our hypothesis is that the improvement in public school quality, as manifested by the general improvement of test scores after 2011, increases competitive pressure on private schools. To test this, we rely on a difference in differences framework similar to Dinerstein and Smith (2021), that uses the post-2011 period, characterized by an increase in public sector funding and the consequent improvement in public test scores as an event. The control group consists of those private schools that are most unlikely to be affected by the improvement in public sector learning. We leverage the geographic location of each school to determine a control

[4] Balarin (2015) writes: "In most cases, the study found that the reasons for choosing a private school had to do with the closeness of the school to the home, which makes schooling more compatible with the families' (especially the mothers') other domestic responsibilities […] in precarious urban contexts that are perceived by their dwellers as being very high risk".

group of private schools. Our sample is confined to schools in "urban" districts. These are the 255 Peruvian districts, which were at least 80 percent urban in the 2007 Census. This allows us to focus on the most urban areas in Peru, while keeping the geographic domain of the analysis fixed.

With the full set of urban private schools, we estimate the following equation

$$(3)\quad \text{Ln}(\text{Enrolment}_i) = \beta_1 \text{Post}_t \times \text{Treat}_i + \lambda_i + \theta_t + \varepsilon_{it}$$

The dependent variable is the log of private school (*i*) enrolment. The model includes school fixed effects and year dummies. 'Treat' is defined as 1 if the private school has public sector competitor(s) within a 1km radius, and zero, if it doesn't. The control group thus has no immediate local public sector equivalent. The Post_t dummy refers to the years after 2011. We provide results for robustness checks where the radius is 0.5 and 1.5km instead of 1km, and a placebo check using pre-treatment periods only.

The local 1-km radii of schools are highly overlapping, and this spatial correlation would lead to incorrect standard errors. This is addressed using an arbitrary correlation regression by Colella et al (2023), which adjusts the standard errors based on correlation of residuals within 1-km distance of the schools.

In addition to models with enrolment as the dependent variable, we also estimate school level models where the dependent variable corresponds to the average second grade test scores for private schools. Private schools may respond to the increased competitive pressure from the public sector by increasing their quality. On the other hand, if increasing competition from the public sector reduces demand for private schools, shrinking profit margins may lead private schools to cut costs at the expense of quality. It is also possible that the selection of pupils into private school changes, as the quality of the nearby public schools evolves. We cannot fully disentangle this selection effect from a true change in quality, as the data do not allow us to track individual pupils continuously over time. However, with a subset of the data that tracks pupils in two years, we are able to provide some general descriptive analysis about students moving between private and public schools.

The summary statistics for the control and treatment groups are shown in Table 1. The two key differences between the groups are that the control group schools tend to be on average slightly larger and more expensive, based on their prices in 2020. While we don't have a time series of private school prices, we control for school fixed effects, which essentially controls for the fixed status of the school in the 'hierarchy' of private schools.

4.3 Results

The main results are shown in Table 2. There are two columns, one for the main specification (1) and another where instead of the post-2011 dummy variable, separate interaction terms with treatment are estimated for each year, keeping 2011 as the base year. The results in the first column suggest that private school enrolment declined by approximately 8 percent in the treated schools as opposed to the control schools in the post-2011 period, although this is significant only at the 10 percent level. The results in the second column indicate that the decline became statistically significant from 2015 onwards, reaching 10 percent four years after 2011, and 16.8 percent another three years later. It is logical that the impact on private schools is not immediate as one can expect there to be a lag between budget increases, improvements of facilities and academic results, and ultimately the perceptions of parents which drive the market reaction.

In Figure 8, the estimated coefficients in column (2) of Table 2 are plotted against time, separately for the treatment and control groups. It can be seen from the figure that the enrolment trends are not different prior to 2011, providing reasonable support for the parallel trends assumption underlying the difference in differences estimation. The divergence in enrolment begins from 2011 onwards and turns statistically significant around 2014-15.

Table 3 shows the results for models where the dependent variable corresponds to average second-grade combined Reading and Mathematics test scores for private schools. The results imply that pupils in the treated private school sample, with a nearby public sector school, had 0.11 standard deviations lower test scores. Increasing competition, if anything, appears to lead to worse test results in private schools. In principle, the negative result could arise from academically strong pupils switching to the public sector while school quality remains constant.

While this cannot be measured directly, it appears not to be supported by a subset of the data which tracks pupils over time.

For a subset of pupils, a longitudinal dataset that tracks pupils and their test scores in grades 2 and 8, is available for several cohorts between 2009-19. In this panel data set, socioeconomic status is available for the pupils when they are in grade 8 of secondary school, but not in primary schools. These data suggest that the average normalized socioeconomic index of private school primary pupils is 0.85 standard deviations above the mean, while on average, those who switch from private to public schools are about 0.5 standard deviations above the mean. Similar patterns apply to learning outcomes. This suggests that a loss of pupils from the private sector would lead to improved average socioeconomic status and learning outcomes in the private sector, which would not explain the negative effects in Table 3. This leaves a possibility that private school results decline due to a reduction in quality, possibly as a result of cost cutting.

In Appendix B, we also provide a short analysis of the effect of moving from a private primary school to a public secondary school and vice versa. The results indicate that those who switch from a private primary school to a public secondary school gain more in terms of learning than those who don't move. On the other hand, those who move from a public primary school to a private secondary school gain less than those who don't move between sectors.

4.4 Robustness and heterogeneity

While Figure 8 provides a visual description of the timing of the main effects, we also carry out alternative estimations to assess robustness. In Table 4, we restrict the sample to years 2007-2011, which we deem to precede the rapid improvement of public schools. We then define a 'placebo' treatment to include alternatively years 2009-2011 (model [1]), or years 2010-11 (model [2]). These estimations do not lead to statistically significant enrolment effects for private schools.

In Table 5, we provide alternative definitions for how the exposure to public sector competition is defined. In the main specification we assume that private schools which have no public competitors within 1km, are 'not treated'. We alter this distance to 0.5km and 1.5km. The key

idea is that there must be a natural distance in high-density areas after which schools compete significantly less with each other. Earlier work confirms that proximity of schools is very important for safety-conscious parents (Balarin 2015). On the other hand, since there are lots of primary schools, both public and private, it is fairly difficult to find private schools with a long distance to any public schools, leading to a selected sample. In Table 5, using 0.5 km instead of 1 km yields somewhat smaller coefficients, which however are strongly significant at the 1 percent level. Moving to 1.5 km also yields negative coefficients with a similar magnitude, but they are no longer statistically significant. One reason for this could be that only 0.75 percent of private schools are this distant from public schools, leading to a very selected treatment sample and weaker statistical power.

In Table 6, we estimate the main treatment effects for sub-samples that may contain more families on the margins of deciding between public and private schools. We divide the sample by the average district level of education for adults (proxying for socioeconomic status), and secondly, by school-specific test scores of private schools in 2011, and replicate the main estimation in Table 2 for these two sample splits. We expect that areas of lower socio-economic status are more elastic in their choice, and we expect that private schools that have weaker results would be under more pressure as the public sector improves. The results suggest that the first relationship holds quite clearly in columns 1 and 2 of Table 6: the reduction in demand is focused on private schools in areas with lower adult education levels. However, the evidence for differential effects according to private school quality is less clear. In columns 3 and 4, we observe that while the estimate for the treatment effect for the lower half is slightly larger relative to the high performing group of private schools, the effect is statistically significant only for the latter group.

In Table 7, we divide the sample into Lima, and other urban areas. This is to reflect the fact that labor markets, levels of wealth and development differ substantially between Lima and the rest of the country. Public schools in Lima are also funded from the central government budget instead of the regional budgets. The results show that the estimated effects are larger in urban areas outside Lima, but the estimates in this split are unprecise leading to non-significant effects for both groups.

5 Evidence from public school openings

An alternative way to examine the effect of public schools on the private sector is to focus on the effects of public school openings. Using the precise locations of new schools, we can assess how the nearby private schools are affected. This does not address public sector quality improvement directly and is more of a quantity effect (extensive margin), but if there was a general improvement in public sector learning since 2011, this should also be reflected in the quality of the new schools.

An immediate concern with this exercise is that the locations where new public schools are built are of course not exogenous. We address this by selecting the treatment and control groups within the vicinity of the new public school. Namely, we consider private schools within 1km to be 'treated' and those within 1-2kms as the 'control' schools. The treatment and control schools are thus practically in the same local area.

Over 2008-2019, we observe 1801 new public primary school openings. However, most of these take place in rural areas, or other areas where no private schools are present. In fact, only 186 of these openings have private schools nearby. Furthermore, for the sake of tractability, we trim our sample of affected private schools to ones that experience only one new public school opening in their vicinity (and not more than one). We end up with a sample of 129 public school openings, with 1204 private schools within a 2-km radius of one of these openings. Of these, 393 are within a 1 km radius and counted as 'treated'. The rest, 811 are the ones within 1-2kms, and are used as the control group (see Table 8).

To estimate the effect of public school openings on local private schools, a traditional two-way fixed effects estimation (TWFE) would follow for example the following form

$$(4)\quad \text{Ln}(\text{Enrolment}_{it}) = \beta_1 \text{Post}_{it} \times \text{Opening}_{it} + \lambda_i + \theta_t + \varepsilon_{it}$$

Here, the dependent variable is the log of private school enrolment (or an alternative outcome), which is explained by a dummy 'Opening_{it}', which indicates that a school was opened in the vicinity of the private school. The "Post" dummy variable indicates the years (for each private school separately) after the new public school appeared, so as to estimate the average yearly

effect on the dependent variable. The equation controls for private school fixed effects (λ_i) and year dummies (θ_t).

As pointed out by recent advances in econometrics, the specification (4) would produce unreliable estimates in the presence of heterogeneous treatment effects across time (for surveys, see de Chaisemartin and D'Haultfouille, 2023 or Roth et al, 2023). Given the rapid improvement of public schooling over the examined period, it seems highly probable that parameter β_1 in (4) would be different for earlier and later school openings, leading the TWFE to be a misguided choice for identification. We will therefore base our identification on the staggered difference-in-differences estimator (DiD) by Callaway and Sant'Anna (2021).

The results for the TWFE and staggered DiD models for private school enrolment are shown in Panel A of Table 9. The first column presents the results for the full sample, and the second and third for openings between 2008-2012, and openings from 2013 onwards respectively. Firstly, the differences between methods are clear. The staggered DiD produces results that are consistent with the facts established in the previous sections; the opening of new public schools had a larger negative impact on private school enrollment, as public schools improved over time. The TWFE estimates are substantially different, with even a different sign, which is possible and expected under considerable heterogeneity of treatment effects (Roth et al, 2023).

We find that in the early part of the sample, public school openings had a negative, but insignificant effect of four percent on private enrolment in the schools within a 1km radius. However, for openings since 2013, the effect is estimated to be a ten percent reduction, which is significant at the 1 percent level. The dynamic effects by year are plotted in Figure 9, which show that for openings prior to 2013, there is a dip in private enrolment immediately, but it does not quite reach statistical significance. For openings after 2013, the negative effects reach statistical significance 3 and 4 years after the opening of the school, and appear to grow over time, along with the standard error.

Panel B of Table 9 shows the results DiD estimates, when the outcomes of interest are the mean test scores of second graders in private schools. We find no evidence that the results would have changed due to the opening of new public schools, neither for the full sample or the subsamples.

As in Section 4.2, it is expected that parents who are closer to the margin of choosing between the public and the private sector, will be more sensitive to the appearance of new nearby public schools. In Table 10, the sample has firstly been divided into districts with lower and higher levels of education (defined as having more or less than median years of education for adults in 2007) and secondly, to private schools above and below the local median level of learning (as defined by the sum of Reading and Mathematics scores in the year before the public school is opened in the local area 2km within the new public school). In short, we would expect the response to school openings to be larger in districts with lower levels of education (due to lower socioeconomic status), and larger in private schools that are of worse quality.

The results in Tables 10 confirm these hypotheses. In districts with a lower level of adult schooling, the opening of public schools within a 1km radius leads to a 9 percent reduction in enrolment, which is statistically significant, whereas there is a smaller and statistically insignificant effect in areas with higher levels of education. For schools with lower than median results, we find a significant reduction of 11 percent in enrolment, whereas for schools with better scores, the effect is smaller and statistically insignificant. Both split samples were estimated with all school openings in the data to maintain sufficiently large samples. However, these average treatment effects may hide heterogeneity over time, as was seen in Table 9.

Overall, evidence from Sections 4 and 5 together suggests that both the quality and quantity of public schooling have a localized impact on private schools. The rapid improvement of quality since 2011, led to lower private school enrolment, unless they were shielded from competition by distance. The results appear to be driven especially by areas with a lower than average level of adult education. With this analysis, there was no evidence that private schools with poorer test scores would have been more hurt by public sector improvement. This is consistent with a possibility that parents may not be able to directly compare the quality of schools in their neighborhoods. This may be due to the fact that there generally are no ‘league tables’ or common public sources for the test results of primary schools. This ought not to be a foregone conclusion since in the analysis of public school openings, we do find that academically weaker private schools lose more pupils. Still, the small number of such openings implies that the nationwide impact on private sector would be very small. Further, the quality and perceptions of quality of newly opened schools can differ from those for average public schools.

6 Relative cost of public sector education

One way to gauge the cost-effectiveness of public education spending would be to compare the cost of educating a child in a private school versus a public school, *for a similar quality of the education.* Over the time period studied, Peru did not test primary school pupils in a way that would allow for value added of primary schooling to be estimated. However, grade 2 learning outcomes between private and public schools can be compared. This comparison is complicated by the fact that private sector pupils come from families with more resources. Further, to compare private and public costs of education, we have to include both urban and rural areas of the country since our budget data is at the level of regions, and we cannot separate expenditure in urban and rural areas.

Figure 10 shows the magnitude of the improvement in average public sector test scores, in comparison with the test score distribution for private schools in 2016 for Peru as a whole, including rural districts. Between 2011 and 2016, the public sector combined Reading and Mathematics scores increased from 971 to 1116, just about surpassing the modal private sector school scores in 2016.

To compare public and private schools with a similar performance in 2016, we are interested in answering the question "How expensive would a private school need to be to achieve the same results as the public sector average?". In Figure 11, we plot private sector school fees (in 2020) and test results in 2016 on a scatterplot. The smoothed dashed line in the figure shows the local average score for each price level.

Private schools that charge fees of 140-240 soles per month produce on average the same results as the average public school. Assuming that the government could consistently and at scale 'purchase' schooling at the midpoint of this range (190 Soles) from the private sector**,** we can compute the private sector cost of producing the current average public outcomes. In 2016, there were about 2.56 million primary public pupils in Peru. Funding private education for all of these pupils annually at the price of 190 Soles per month, would cost 190*12*2.56 million = 5837 million Soles (US $1540 million).

On the other hand, the total public sector education budget in 2016 for primary schooling was roughly 5960 million Soles.[5] Thus, based on this very simple calculation, the private sector would produce the education at about the same cost as the public sector for the same quality. However, taking some important facts into consideration suggests that this conclusion may be premature.

The calculation is based on a number of simplifications. Firstly, since students in private sector schools come from wealthier backgrounds, it is quite possible that we underestimate the cost-effectiveness of the public sector as parental investments can feed into private sector results. Secondly, both public school results and the cost of private schooling differ dramatically by area. If the country is divided into three parts: Lima, urban districts outside Lima, and rural districts outside Lima, the monthly private school fees required to reach the local public sector mean performance in these areas would be 940 Soles, 300 Soles and 90 Soles, respectively. Applying these prices to public pupil populations in the respective regions, educating all existing public sector pupils privately would raise the cost to about 10.000 million Soles, nearly doubling the cost of private provision compared to the simplified estimate above. [6]

The numbers from this exercise should be taken only as rough approximations, but they nevertheless point to the cautious conclusion that the public sector is relatively cost-effective in comparison to the private, especially once the high costs of good private schools in Lima and other urban centers are taken into consideration. Furthermore, these results echo those of Rentería (2023), who found that rapid expansion of private schooling in Peru since 1996 has not led to improved skills or labor market outcomes.

[5] From detailed 2016 budget items we added together 'Education primaria', 'Education basica especial' and ''Education basica alternativa'. Figures for Lima are from 'Gobierno national' and for the rest of the country from 'Gobiernos regionales', given that education for Lima is funded from the national budget, but for other regions, funding comes largely from the regional budget (Source: https://www.datosabiertos.gob.pe/dataset/ejecuci%C3%B3n-prepuestal-consulta-amigable-ministerio-de-econom%C3%ADa-y-finanzas-mef).

[6] In 2016 there were 0.49 million public primary pupils in Lima, 0.86 million in urban districts outside Lima, and 1.34 million in rural districts outside Lima. The average public sector combined test scores were 1206 for Lima, 1176 for urban districts and 1089 for rural districts. The required total cost would be (0.49*940+0.86*300+1.34*90)*12 = 10070 million Soles per year.

7 Conclusions

Over the 2010s, Peru's education budget increased significantly and a number of educational reforms were implemented. This led to a substantial improvement in the quality of public primary education, as measured by both test scores and observable school infrastructure.

In urban areas, which are already largely built-up, this period was characterized by an increase in the quality or average test scores of public schools as opposed to a large increase in the number of public schools. This provides an interesting setting to examine the effects of public sector improvement on the division of the primary education market between the public and private sectors. Due to a liberal regulatory environment, private schooling had, prior to these reforms, grown in size and increased its market share in urban Peru.

Firstly, we document how over a relatively short window of about 4-5 years, beginning from about 2011, the private sector learning premium in urban primary schools at grade 2 largely vanished. By 2016, only the most expensive private primary schools could match the learning outcomes of public schools.

Leveraging geocoded school data, we create a control group of private schools, which due to their location, faced substantially less competition from the improving public sector. In a difference in differences framework, we estimate that the increased competitive pressure from the public sector led to a 10 percent fall in private school enrolment after four years, and a 17 percent fall after seven years. Further estimates show that this effect was nearly completely driven by census districts which had lower parental educational levels. This suggests that parents with less resources were more sensitive to price in their choice of school and helped to reverse the trend of private sector growth in urban Peru.

We find no evidence that private schools would have improved their quality as a response to improving public schools. On the contrary, our findings indicate that average learning outcomes declined in affected private schools. However, these data do not allow us to isolate whether this is due to pupil selection as a result of public sector reforms. A separate panel data analysis suggests that pupils who move from a private primary school to a public secondary school have on average somewhat lower socioeconomic status and test performance than the

private school average, implying that a selection effect might not be driving our results on learning in private schools.

In the second analysis, we examine the impact of the opening of new public schools on nearby private schools using a staggered difference-in-difference specification. While this analysis mainly concerns the supply effect of public schooling, rather than a quality effect, we also know that as the public sector quality was improving over time, there may be significant heterogeneity in the effect of public school openings on private schools over time. We consider private schools which are closer than 1km to opening schools to be 'treated', while those within 1-2kms are 'control' schools, using staggered DiD by Callaway and Sant'Anna (2021). The results indicate that private schools lost on average 10 percent of pupils to newly opened public schools after 2013, but before that, the effect was not significant. Further, we find evidence that the negative impacts on private schools were concentrated on areas with lower levels of education, and on private schools that were academically weaker.

Overall, the results show that a comprehensive educational reform and increase in funding has the potential to rapidly improve educational attainment in the public sector and crowd out private schools. Globally, such reversals have been unusual, as low-fee private schooling has been gaining market share.

We conduct a simple value for money calculation for the public sector education in Peru, which suggests that in the post 2011 period, the improved learning outcomes were produced at a cost that is favorable compared to what the private sector could have achieved. Public policy can accommodate and encourage the private sector, for example by using subsidies or vouchers, or by regulating the private sector, for example by increasing accountability and comparability or by harmonizing entry procedures. The calculations suggest that a voucher scheme, which relies on private provision would be relatively expensive, if it aimed to produce the same quality as the public sector. The sustainability of the quality and cost of public sector provision, however, evolves over time, and has recently been shaken by the COVID-19 pandemic.

Private education has been expanding rapidly in many emerging economies as parents have discovered that public sector education is not meeting their needs. The Peruvian case in the 2010s provides an example of public investment that was able to reverse this trend. Further

research on similar experiences around the world is required to aid policymakers design balanced and cost-effective educational policies.

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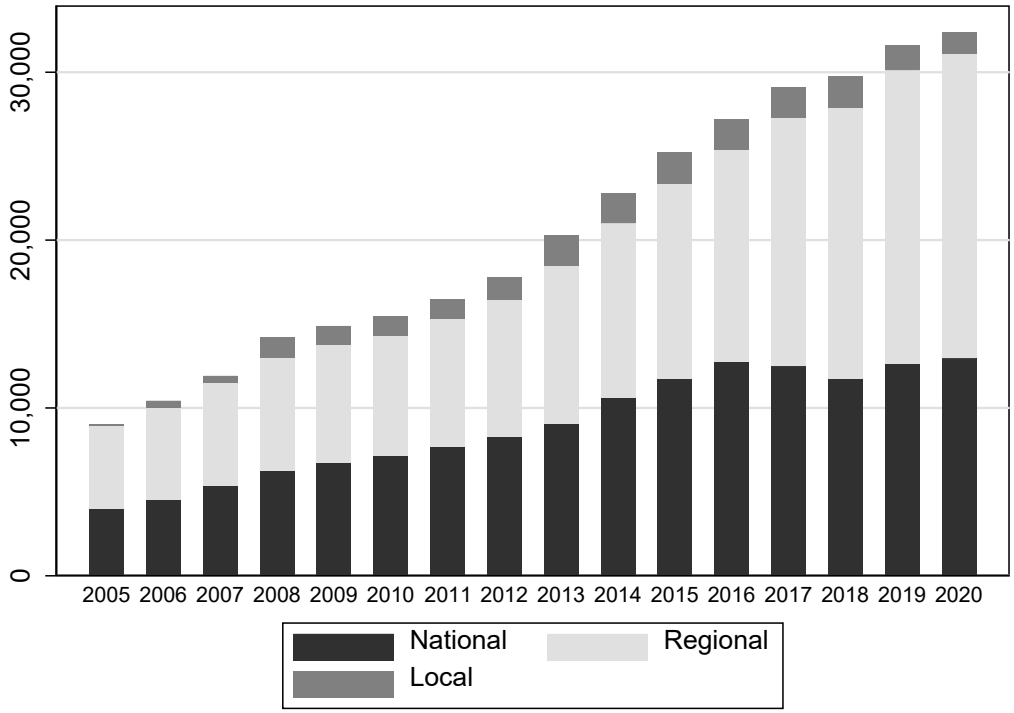
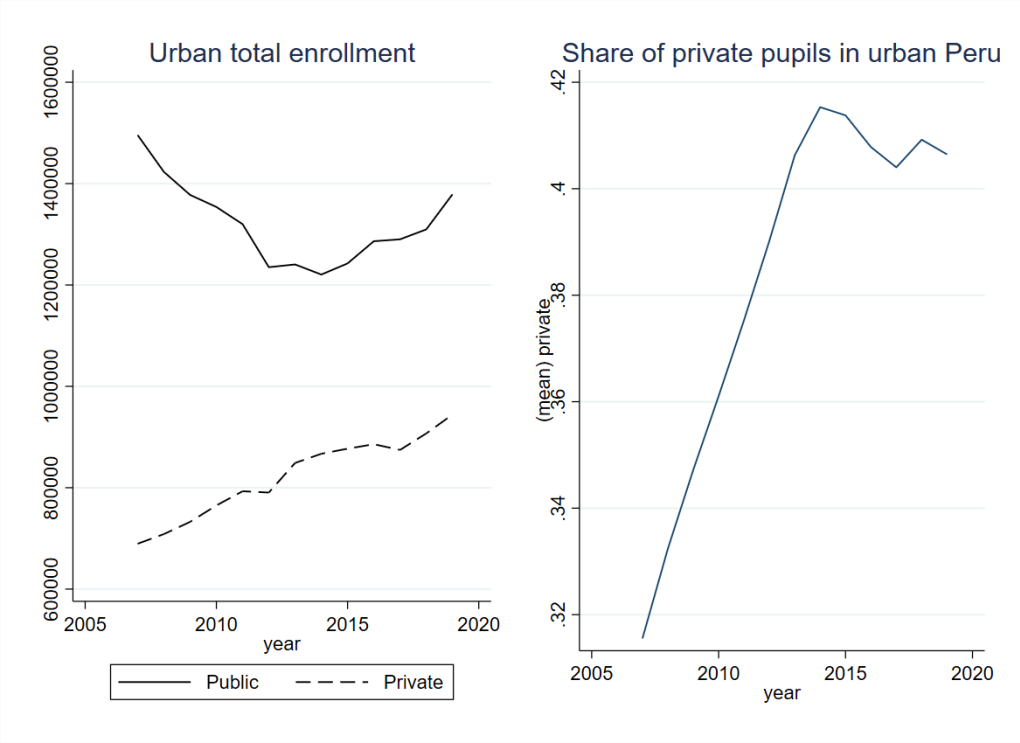
Figure 1 Total budget allocated to education in 2005-2020, millions of Soles



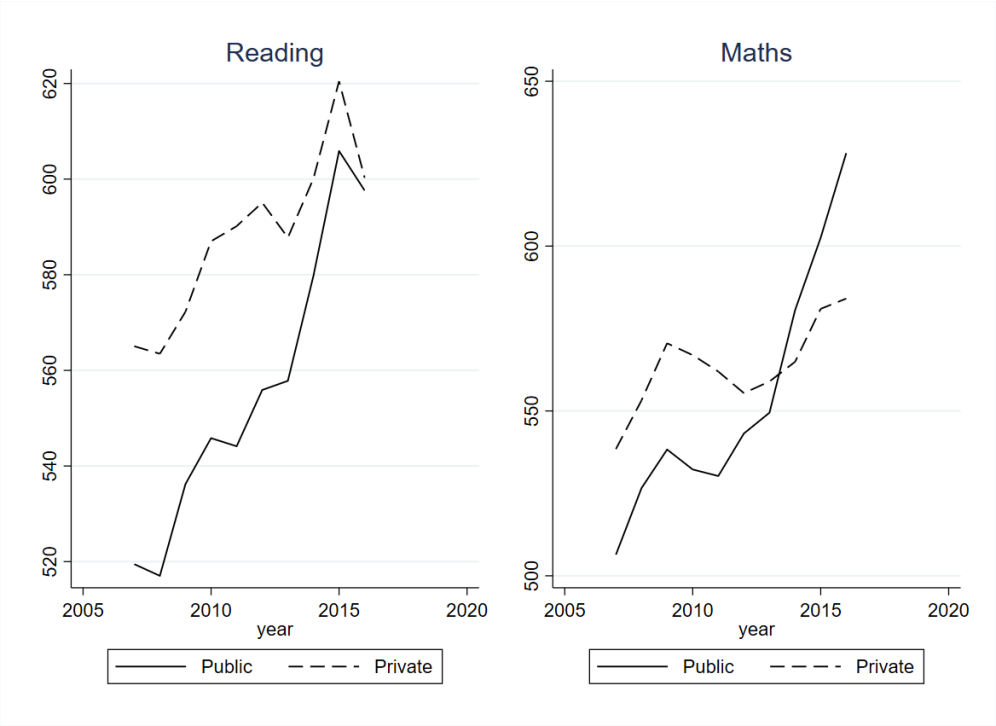
Source: Authors' calculations based on data from the Portal de Transparencia del Ministerio de Economía y Finanzas (Ministry of Economy and Finance).

Figure 2 Trends in private and public primary schooling in urban Peru



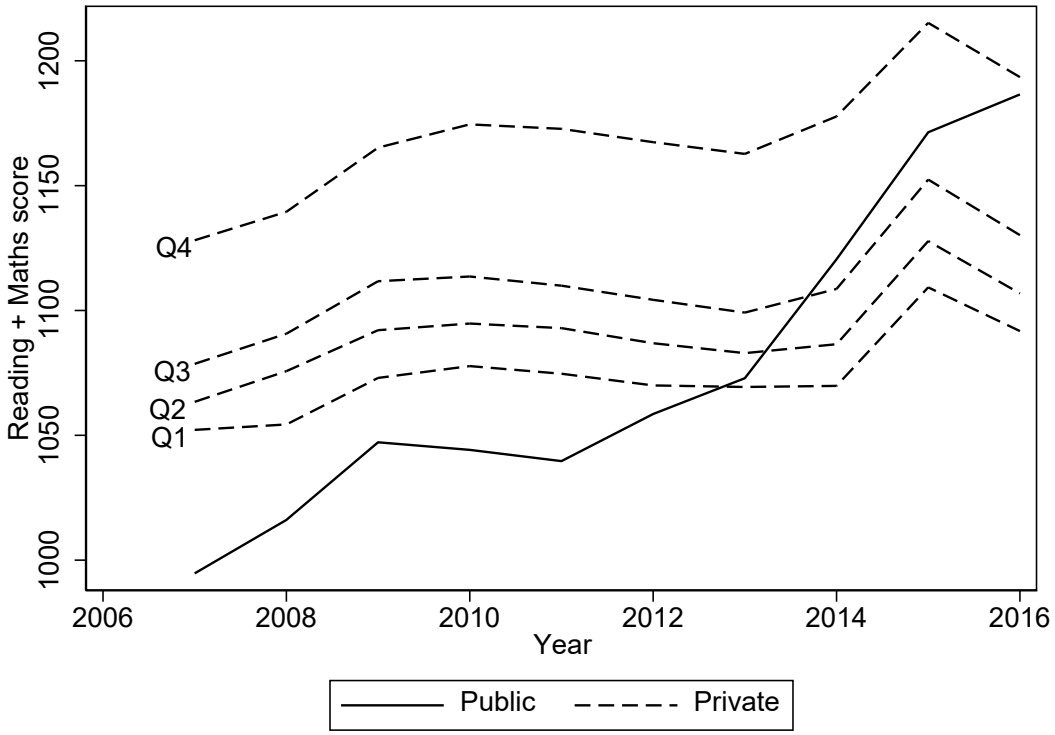
Notes: The sample, 'urban Peru', is defined as 261 districts, which in the census of 2006, had urbanisation rate of at least 80 percent.

Figure 3 Grade 2 test scores in private and public schools in urban Peru



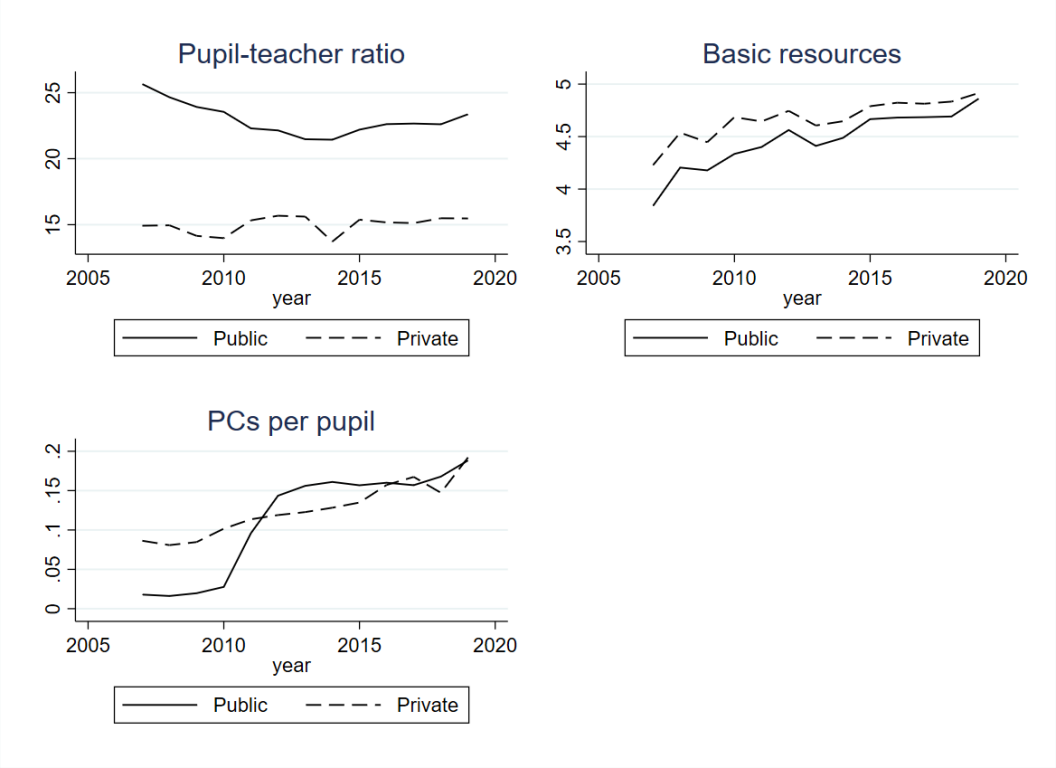
Notes: Sample – districts that were at least 80 percent urban in 2007.

Figure 4 Grade 2 test scores by quantiles of private school fees, compared to public sector schools (urban districts)



Notes: Price quartiles are Q1: 1-140 Soles, Q2: 141-180 Soles, Q3: 181-260 Soles, Q4: Over 260 Soles, no price. Prices are from 2020, and thus indicative. They are not available for the period studied (Identicole website: https://identicole.minedu.gob.pe/).

Figure 5 Developments in basic school resources in public and private sector (urban districts)



Basic resources refers to an index of five items: water, sewage, electricity, toilet and internet. Each school is rated between 0-5, and the values averaged across districts by year, weighted by pupil numbers.

Figure 6 Number of competitor schools within 1km of urban private schools, 2011.

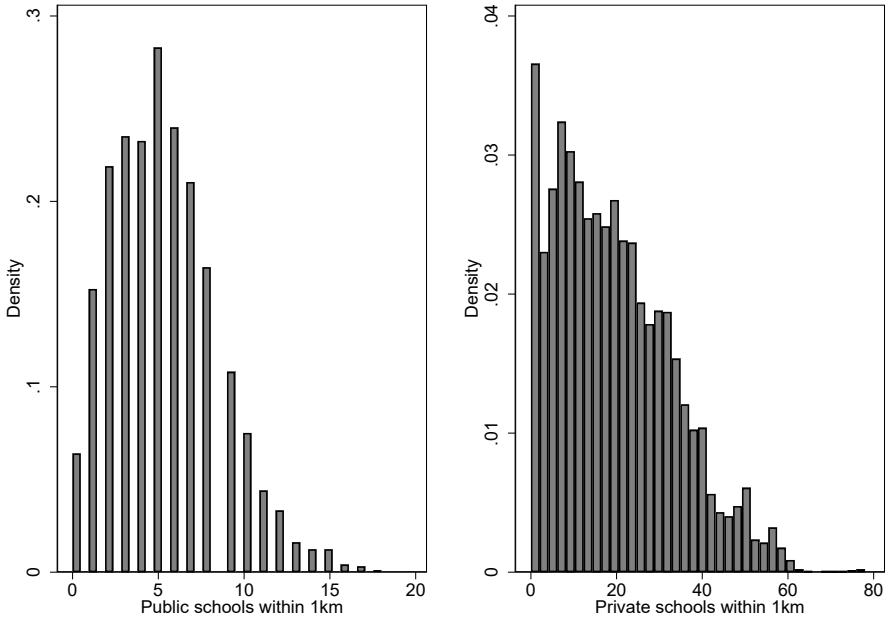


Figure 7a Density of private and public schools in and around Lima

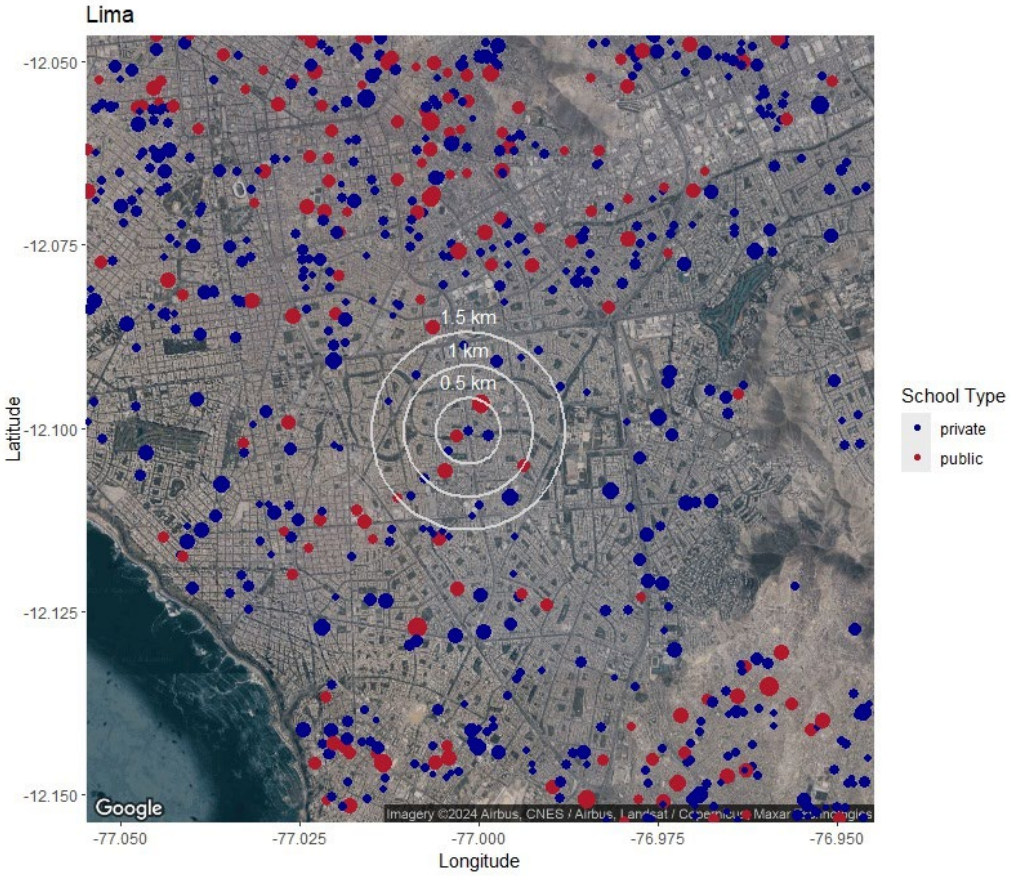


Figure 7b Density of private and public schools in and around Lima

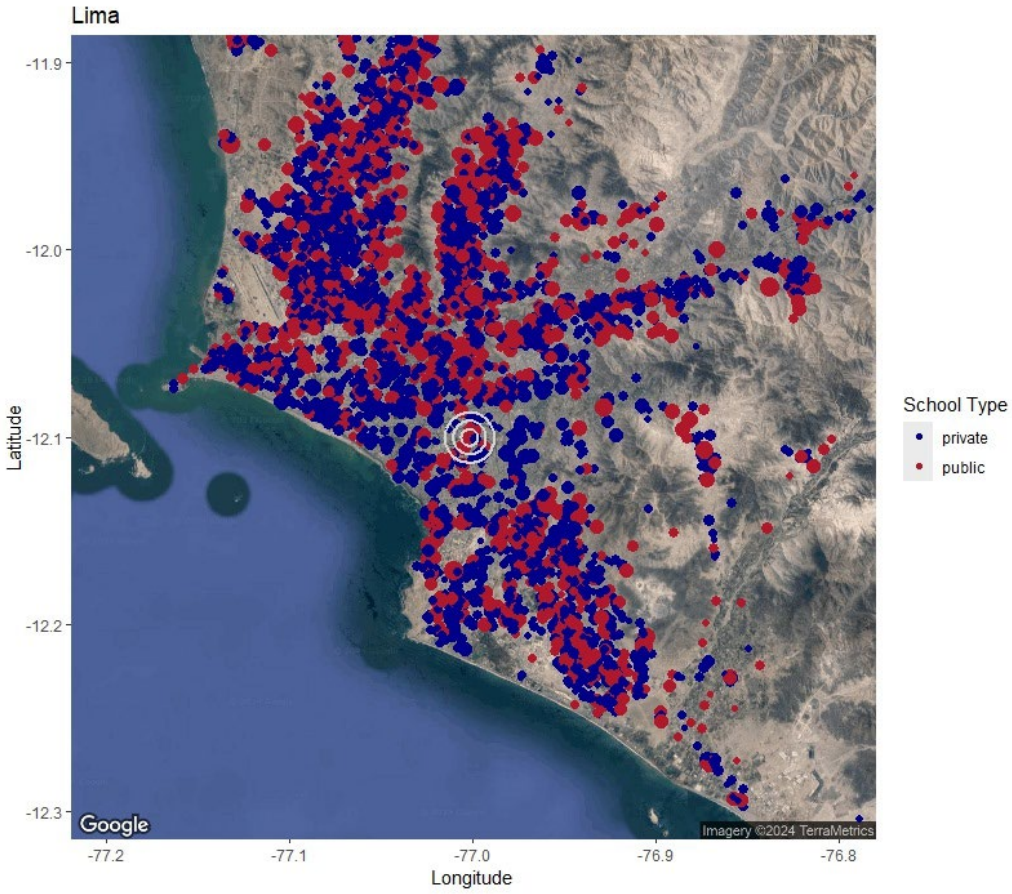
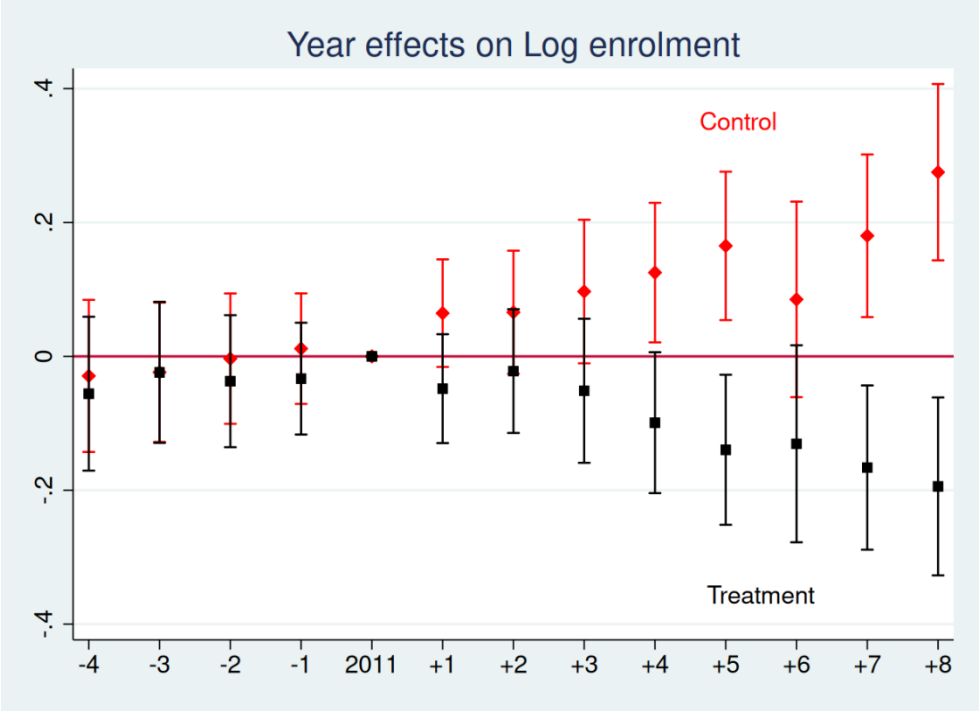
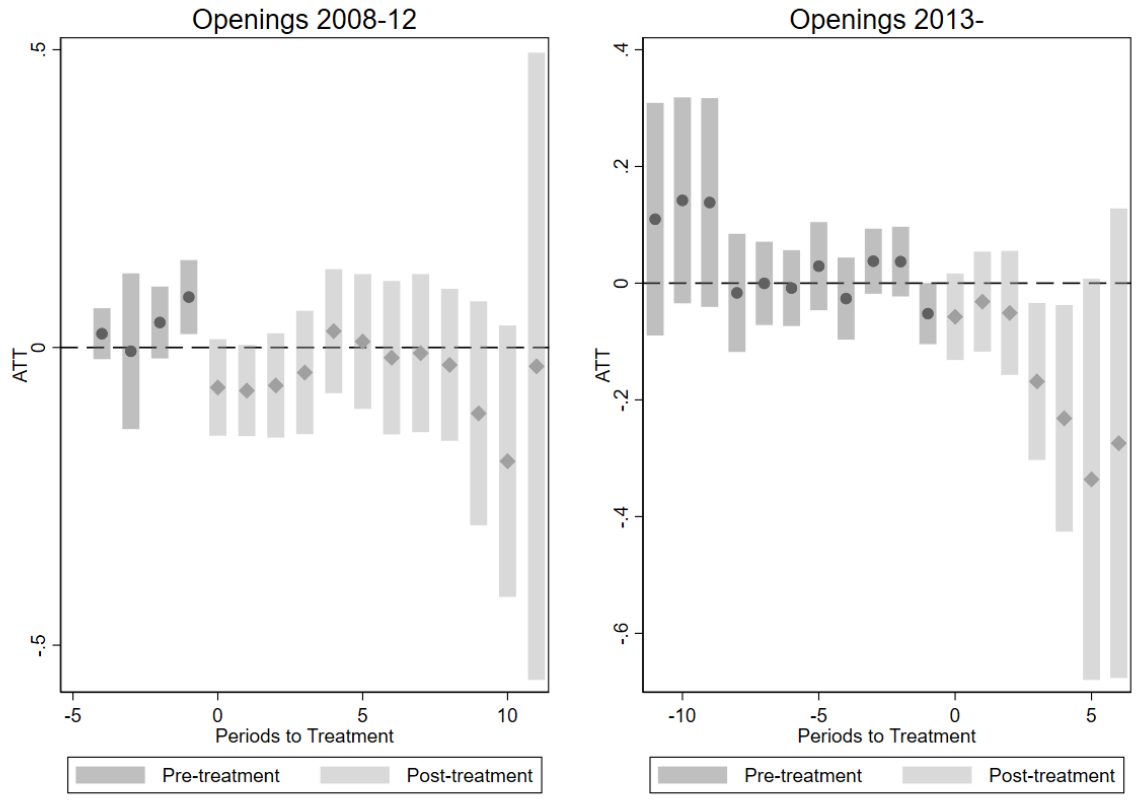


Figure 8 Annual enrolment effects in treatment and control groups, compared to 2011.



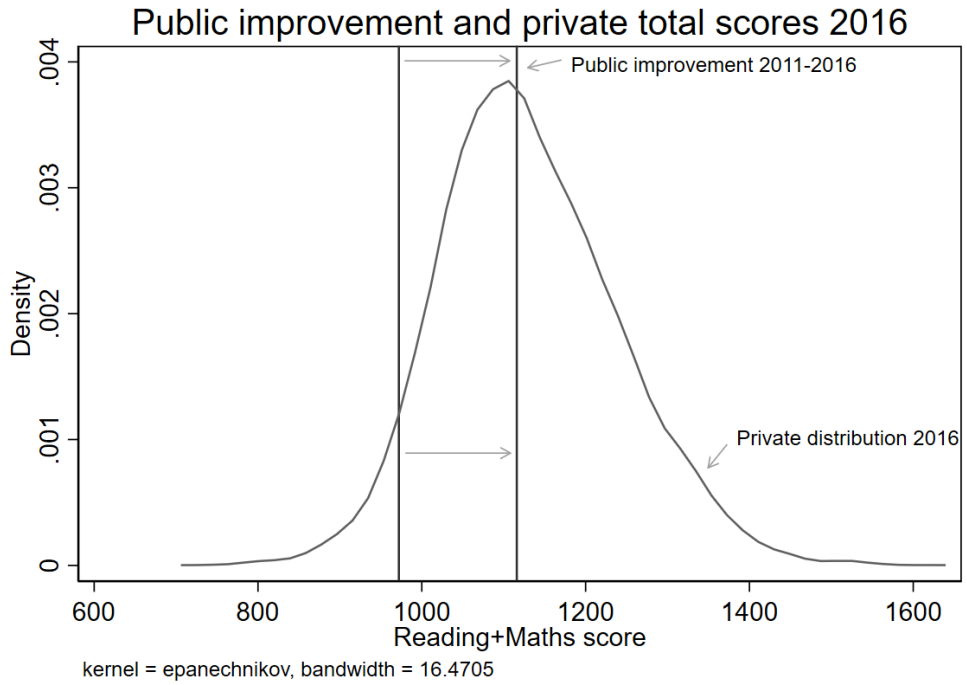
Notes: The coefficients and standard errors represent the estimates from Table 2, column 2.

Figure 9 Estimated dynamic impact of public school opening on private school enrolment within 1km of the opening.



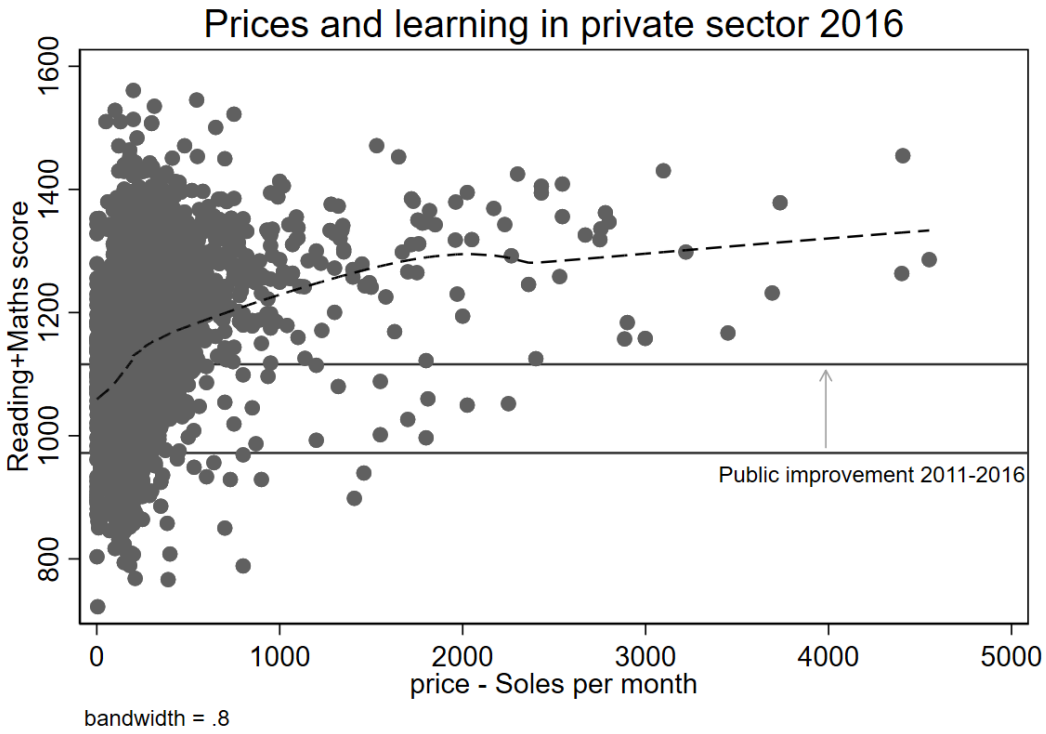
Notes: Estimates based on DiD event estimates using *csdid* package in STATA. The average post-treatment effects are reported in the lower panel of Table 9.

Figure 10 Score distribution of private schools in 2016 (Reading + Maths) , and average public sector improvement from 2011 to 2016.



Notes: Data includes both urban and rural districts.

Figure 11 Prices and learning in private sector schools in 2016.



Notes: Based on private schools in all of Peru in 2016. Dashed line is a smoothed local average of combined test score, based on the STATA command 'lowess'.

Table 1 Summary statistics for treatment and control groups

	Control (n = 2508)				Treatment (n = 87946)			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
School data								
Year	2013.7	3.7	2007	2019	2013.4	3.7	2007	2019
Enrollment	143.9	157.0	1	952	115.0	133.5	1	1597
Urban school	0.93	0.26	0	1	0.99	0.11	0	1
Maths+Reading score	1155	120	775	1487	1113	101	405	1674
Monthly price (2020)	610	1380	1	16000	234	290	1	12010
Pupil-teacher ratio	14.5	20.5	0.3	858	13.8	10.9	0.2	712
Census district data								
Urbanization rate	0.98	0.04	0.80	1	0.99	0.03	0.75	1
Population	179233	153166	3877	995150	264494	237867	1252	995150
% Native speaker	0.08	0.09	0.00	0.63	0.08	0.09	0.00	0.78
% Recent movers	0.19	0.07	0.05	0.41	0.15	0.05	0.02	0.41
Avg. years of schooling	9.70	1.54	5.64	13.22	9.41	1.12	4.62	13.28

Notes: Census district data is from years 2007 and 2017, and the figures in the table are a weighted average of census years. The control group consists of private schools with no public sector competitor(s) within a 1km radius.

Table 2 Difference in difference estimates

	[1] Ln (Enrollment)		[2] Ln (Enrollment)	
	Coef.	T-stat.	Coef.	T-stat.
Post × Treat	-0.081+	[-1.932]		
Year 2007	-0.084**	[-8.622]	-0.028	[-0.474]
Year 2008	-0.047**	[-5.757]	-0.017	[-0.321]
Year 2009	-0.040**	[-5.269]	-0.004	[-0.080]
Year 2010	-0.021**	[-3.272]	0.013	[0.305]
Year 2012	0.096*	[2.340]	0.066	[1.590]
Year 2013	0.123**	[2.973]	0.069	[1.463]
Year 2014	0.125**	[3.009]	0.108*	[1.974]
Year 2015	0.107*	[2.572]	0.133*	[2.537]
Year 2016	0.108**	[2.582]	0.164**	[2.887]
Year 2017	0.036	[0.870]	0.09	[1.202]
Year 2018	0.097*	[2.293]	0.182**	[2.899]
Year 2019	0.165**	[3.889]	0.276**	[4.070]
Year 2007 × Treat			-0.057	[-0.971]
Year 2008 × Treat			-0.031	[-0.574]
Year 2009 × Treat			-0.036	[-0.717]
Year 2010 × Treat			-0.035	[-0.807]
Year 2012 × Treat			-0.05	[-1.184]
Year 2013 × Treat			-0.025	[-0.536]
Year 2014 × Treat			-0.063	[-1.143]
Year 2015 × Treat			-0.107*	[-2.025]
Year 2016 × Treat			-0.138*	[-2.411]
Year 2017 × Treat			-0.136+	[-1.794]
Year 2018 × Treat			-0.168**	[-2.651]
Year 2019 × Treat			-0.195**	[-2.853]
Observations	90,454		90,454	
R-squared	0.827		0.828	

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects.

Table 3 Effect of public competition on test scores in private schools

	Learning (z)	
	Coef.	T-stat.
Post × Treat	-0.115**	[-3.521]
Year 2007	-0.227**	[-23.128]
Year 2008	-0.168**	[-19.331]
Year 2009	-0.024**	[-2.682]
Year 2010	0.015+	[1.894]
Year 2012	0.082*	[2.548]
Year 2013	0.072*	[2.260]
Year 2014	0.124**	[3.808]
Year 2015	0.393**	[11.906]
Year 2016	0.263**	[8.036]
Observations	54,926	
R-squared	0.5959	

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Learning outcomes are available for years 2007-2016 only and represent combined Mathematics and Reading scores.

Table 4 Robustness to alternative timing of the treatment

Pre-treatment placebos (Sample 2007-2011)				
		Coef. [T-stat]	Obs	R-Squared
[1]	Post 2008 × Treat	-0.021	30,728	0.907
		[-0.634]		
[2]	Post 2009 × Treat	-0.023	30,728	0.907
		[-0.622]		

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects.

Table 5 Robustness to altering the definition of treated

		Coef. [T-stat]	Obs	R-Squared	Share treated
[1]	Post 2011 × Treat (0.5km)	-0.064**	90,454	0.828	0.8119
		[-3.411]			
[2]	Post 2011 × Treat (1.0km)	-0.081+	90,454	0.827	0.9726
		[-1.932]			
[3]	Post 2011 × Treat (1.5km)	-0.067	90,454	0.827	0.9925
		[-1.095]			

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects.

Table 6 Treatment effects for sub-samples by local level of education and public school quality

Dependent: ln(Enrollment)	[1]	[2]	[3]	[4]
	Local edu level		Priv school results	
	Lower 50%	Top 50%	Lower 50%	Top 50%
Post × Treat	-0.152**	0.019	-0.118	-0.103**
	[-2.640]	[0.350]	[-1.147]	[-2.642]
Observations	46,204	44,250	34,192	34,965
R-squared	0.814	0.843	0.749	0.868

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Local level of education is by district using census 2007, with the median cutoff as 9.01 years of education. Private school results use a cutoff of 1109.2 for combined reading + maths test score in 2011.

Table 7 Treatment effects for Lima and other urban areas

Dependent: ln(Enrollment)	[1]	[2]
	Lima	Other urban
Post × Treat	-0.058	-0.115
	[-1.494]	[-1.325]
Observations	52,552	38,032
R-squared	0.835	0.817

Notes: '**': p < .01, '*': p < .05, '+': p< .1. T-statistics in brackets. Standard errors are corrected for spatial clustering within 1km radius using *acreg* in STATA. All models include school fixed effects and year effects. Lima is defined as departments of Lima and Callao.

Table 8 Number of public school openings and private schools in their vicinity.

Number of observations	
Relevant public school openings (2008-2019)	129
Private schools within 1 km (Treatment)	393
Private schools within 1-2km (Control)	811
Total private schools (Treatment + Control):	1204
Total observations over 2007-2019:	13374

Table 9 Effect of public school openings on private schools

Panel A: Ln Enrolment	All openings	Openings 2008-12	Openings 2013-
TWFE			
Within 1km	0.0048	-0.0264	0.0593+
	[0.2398]	[-0.9746]	[1.9283]
Observations	13374	6631	6743
DiD (Callaway & Sant'Anna 2021)			
Within 1km	-0.0599+	-0.0407	-0.0985**
	[-1.9071]	[-0.9130]	[-2.2104]
Observations	13269	6565	6684
Panel B: Combined score (z)			
DiD (Callaway & Sant'Anna 2021)			
Within 1km	-0.0375	-0.002	0.097
	[-0.6079]	[-0.0274]	[1.0450]
Observations	7935	4171	3694

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. T-statistics in parenthesis. All models control for school and year fixed effects. DiD implemented with *csdid* package in STATA, reporting the ATT. Sample for test scores is lower due to test scores not being available for 2017-19.

Table 10 Effect of public school openings on private schools enrollment by district level of education and by relative local private school test score

Ln Enrolment	**Local level of education**	
DiD (Callaway & Sant'Anna 2021)	Lower	Higher
Within 1km	-0.0927**	-0.0260
	[-2.0823]	[-0.5791]
Observations	7050	5794
	Private school test score	
	Lower	Higher
Within 1km	-0.1120**	-0.0454
	[-2.2135]	[-1.1913]
Observations	4183	4899

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. T-statistics in parenthesis. All models control for school and year fixed effects. DiD implemented with *csdid* package in STATA, reporting the ATT. 'Lower/Higher education' refers to districts with mean years of adult education below/above 8.96 years in 2007 Census. 'Lower/Higher test score' refers to private school having lower/higher test score compared to local median of private schools scores within 2km of the opening public schools in the year before the school opens. Sample for test scores is lower due to test scores not being available for 2017-19.

APPENDIX A: Selection of schools due to availability of geolocation

Data on the location of schools in the form of coordinates is available from 2016 onwards. In our econometric analysis, we are limited to a sample of schools, for which these location data are available prior to 2016. In other words, we are constrained to using schools which still existed in 2016. Schools which closed over 2007-2015 are thus dropped from the sample.

Over 2007-2015, a total of 1111 private schools closed. This represents an average annual exit rate of slightly under 0.6 percent. In the table below, the likelihood of exit is regressed on key school characteristics, year effects, and region effects, using a linear probability model.

Table A1 The likelihood that a private school closes, 2007-2015

	P(School closes)	
	Coef	T-statistic
Enrollment	-0.000015**	[-4.737207]
Urban school	0.001657	[0.723519]
Reading score	-0.000003	[-0.192363]
Mathematics score	-0.000016	[-1.507880]
Electricity	-0.008261**	[-2.758229]
Water	0.001867	[0.757746]
Sewage	0.001145	[0.459929]
Toilet	-0.004377*	[-2.389747]
Internet	-0.002348**	[-2.586214]
Year 2008	0.001201	[0.810083]
Year 2009	-0.001094	[-0.716714]
Year 2010	-0.005168	[-1.033520]
Year 2011	-0.001106	[-0.225484]
Year 2012	-0.001426	[-0.290029]
Year 2013	-0.000914	[-0.621998]
Year 2014	-0.001085	[-0.734587]
Year 2015	0.000047	[0.030922]
Constant	0.027165**	[5.133118]
Department FE	Yes	P(F-test): 0.026
Observations	36,374	
R-squared	0.003802	

Notes: (+): $p < .1$, (*): $p < .05$, (**): $p < .01$. The mean of the dependent variable in the sample is .0059383.

It is noteworthy that the year effects, especially post-2011, are predicting exit. This alleviates a worry that closure of private schools due to the reform prior to the introduction of geolocation data would have biased the main sample.

APPENDIX B: Value added learning for movers between public and private schools

The Department of Education in Peru has linked a subset of pupils' scores so that these pupils are observed twice, in grades 2 and 8, and for four cohorts.[7] The panel covers pupils who were in the second grade of primary school in 2009, 2010, 2012 and 2013, and consequently in the eight grade in 2015, 2016, 2018 and 2019.

The panel data allow us to study the value-added in learning between grades 2 and 8 for the tracked pupils, and therefore whether pupils who moved from a private to a public school improved their learning more than those who moved from a public to a private one.

The estimated model takes the following form

$$(1) \qquad \Delta Score_i = \alpha + \beta D_{i,public} + \beta D_{i,private} + \gamma_d + \delta_c + \varepsilon_i$$

The dependent variable is the change in the learning outcome scores between the primary and secondary schools. We explain the value added with district of origin fixed effects (d), cohort effects (c), and dummy variables for whether the pupil swapped to a public school $D_{i,public}$ from a private and vice versa $D_{i,private}$. The comparison group consists of pupils who don't move. The results shown in Table A1 indicate that those who switch from a private primary school to a public secondary school gain more in terms of learning than those who don't move.

[7] While the 8-graders are a full sample of the respective cohorts, only about 70-80 percent of the pupils can, depending on cohort, be matched to their primary school information. As such, the sample is slightly tilted towards urban areas.

Table A1 Learning for public-private school switchers

Sample:	[1]		[2]	
Urban pupils only	Reading VA		Maths VA	
	Coef.	S.E.	Coef.	S.E.
Switches to public sector	12.579**	[0.228]	29.673**	[0.309]
Switches to private sector	-10.122**	[0.276]	-18.273**	[0.374]
Cohort 2	-10.108**	[0.196]	13.639**	[0.265]
Cohort 3	-15.235**	[0.191]	17.100**	[0.259]
Cohort 4	-20.972**	[0.192]	19.772**	[0.259]
Constant	29.257**	[0.148]	7.126**	[0.200]
District Fixed Effects	Yes		Yes	
Observations	1,035,685		1,035,202	
R-squared	0.044		0.054	

Notes: Sample contains four cohorts of pupils observed in grade 2 in primary school and grade 8 in secondary school. 6.0 percent move from public to private sector between primary and secondary schools, 9.4 percent move from private to public sector. The dependent variable is the test score in grade 8 minus test score in grade 2.