The Distributional Impacts of Large School Size on Learning Outcomes in Senegal

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Abstract

We investigate the causal effect of school size on learning outcomes by adopting methodologies of quasi-experimentations. Such a study is important in a context of massive increases in school enrolment and school systems' limited seat capacities, especially in Senegal. To achieve this goal, we assume selection on observables and provide estimates of not only mean effects, but also quantile treatment effects. The motivation for looking at quantile treatment effects is that the conditional expectation function of learning outcomes may not be informative enough, which would cause us to underestimate the overall effect of school size. The results point to no effect at all for second graders, whereas positive effects for a very small fraction of top performing fourth graders are noted. For this same grade, low-achievers are harmed by large school size. We show that the optimal school size lies between 470 and 500 students.

Keywords: school size; learning outcomes; impact evaluation; quantile treatment effects.

1. Introduction

The literature is inconclusive as to whether small or larger schools are preferable for educational systems. Recent research (e.g. Kuziemko (2006), Schwartz et al. (2011)) empirically argues the advantages of small schools, but proponents of school consolidation (Conant (1959a), Callahan (1962)) build on the concept of economies-of-scale to justify why a larger school is better. Other empirical studies (e.g. Wyse et al., 2008) simply do not find an effect of school size on learning outcomes. Yet, most of the research on school size has been undertaken in developed countries, which deal with different challenges than those faced in low-income countries. This renders the results from existing studies on school size not necessarily generalizable to growing economies. In these latter countries, an initiative (Education for All-Fast Track Initiative, EFA-FTI henceforth) has been launched to boost school enrolment. The number of children enrolled in schools in African EFA-FTI countries went up 50 percent between 2002 and 2008. In non-FTI countries, the increase was 27 percent (EFA-FTI (2010)). However, mechanisms to address the increased enrolment have not necessarily been rightly set up. Overall, teacher numbers have grown slightly less rapidly than enrolments; pupil-teacher ratios, particularly at pre-primary and primary school levels, remain high in many parts of the world, especially in Africa (Education International (2008)).

Senegal made progress expanding access to education over the last decade. The number of primary schools has increased by 57.8 percent between 2002 and 2011, in part to meet the EFA objectives. However, it has been shown that quality has deteriorated (DeStefano et al. (2009)) as enrolment increased. A further case is provided by national assessments conducted by the Program for the Analysis of Education Systems of CONFEMEN[1] (2006), which show that scores in mathematics and French have not improved from 1996 to 2006 for either second or fifth graders. Not only has quality failed to improve as enrolment has increased, but the Senegalese government's primary response to the rising demand for education has simply been the provision of additional physical facilities. Thus, a question of interest is whether policy makers should construct more schools and keep them small or instead allow schools to have an increased number of students, while also dealing with the pedagogical

[1] CONFEMEN stands for Conférence des Ministres de l'Education des Etats et Gouvernements membres de la Francophonie.

issues related to both cases. Should policy makers care only about mean effects, or should they also care about especially high- and low-performing students when designing school size policies? This paper provides a tentative answer to the question by looking at the impact of school size on the distribution of educational outcomes.

2. School size in the learning process

The theory of change relating school size to learning achievement was developed in industrialized countries but also applies, to a certain extent, to growing economies. This theory has been supplemented by empirical findings and follows two contradictory directions.

The first strand of theoreticians and researchers support the consolidation of schools. Among them, Conant (1959a) was a pioneer in discussing the positive role of large schools, emphasizing the decreased average costs per student and the diversity of classes that a large school can offer. Callahan (1962) associated large school size with a greater opportunity to specialize, while Smith and DeYoung (1988) explained that students at a small school may all be of the same demographic background. This in turn reduces the opportunity to learn from a diverse population as small schools attenders are less likely to find a group of peers from which they can comfortably acquire knowledge. This theory has been supported by empirical arguments from Bradley and Taylor (1998), who find a positive effect of enrolment on exam scores, and Barnett et al. (2002), who find that large schools are more cost-effective.

Conversely, the proponents of smaller schools argue that they operate more like a community than a company. Students attending such schools are individuals and not just numbers; their academic and personal requirements are met, unlike at large educational entities where discipline problems escalate and where the odds of a student feeling isolated are much higher. Strang (1987) raised the issue of possible alienating effects due to large school size and stressed that the alleged specialization of teachers in larger schools mentioned by Conant (1959a) and Callahan (1962) comes at the cost of a student having many teachers and finally none of them really knowing him/her. Newman (1992) points out that large schools contribute to a lack of intellectual engagement among students. Although one of the goals in increasing school size is to offer better programs, the social needs of students may be ignored, as also stated in Maxner (2005). Walberg and Walberg (1994), who are similarly proponents of small schools, underline the reinforced link between learners and community in smaller schools, a fact that they consider to be one of the advantages of such schools. From the perspective of this strand of researchers, when a school becomes larger, the overall educational process is jeopardized as bureaucracy increases. As a result of this, suppleness decreases, time spent on administrative tasks increases and students learn less because teachers teach less.

3. Data and Methodology

We make use of two rounds of data collected in grades 2 and 4 in Senegal in November 2009, June 2010 and June 2011 which includes information on the head teacher, the school and school environment, the teacher and class, the household, a pupil survey, and students' test results. The tests involved oral and written French and (written) mathematics. Oral tests included topics such as reading, word recognition, non-word recognition, number of sounds and letter recognition). Our data include 41 covariates (pre-treatment variables) and four outcomes: written French and math, an oral test and an index derived by principal component analysis on the measured outcomes. This latter outcome effectively filters measurement error and is expected to reflect school size effects with greater power than the individual level tests.

School size is a continuous and endogenous variable. Estimating its causal impact requires either a valid instrument or the implementation of a dose-response model (as proposed by Hirano and Imbens (2004)) under the assumption of selection on observables. Yet, we are not in possession of a valid instrument, and the implementation of the dose-response approach was not successful to achieve the required covariates balance that allows the drawing of a causal inference. We thus propose an

alternative strategy that dichotomizes school size but also mimics the continuous case by moving up the cut-off point. In practice, we move the cut-off point, by increments of one, starting at 240 and ending at 550 (median of school size is 358 students). Because of jumps in the school size variable, 128 cut-offs point are used in grade 2 and 133 at grade 4.

To start with, we compute doubly robust estimates of average treatment effects (ATE) and average treatment effects on the treated (ATET). The strategy implemented is suggested in Robins and Rotnitzky (1995). These estimations are a basis against which the results from the quantile treatment effects (QTE) can be compared.

To estimate the quantile treatment effects, we proceed, as suggested in Firpo (2007), in two steps. First, the propensity score is predicted via a standard probit model. Second, we assume $Q^q(Y_{ist}^k \mid T) = \alpha^q + \Delta^q T_{is}$ and solve the following optimization problem:

$$(\hat{\alpha}, \hat{\Delta}) = \arg\min_{\alpha,\Delta} \sum_i \omega_{i,j} * \rho_q(Y_{ist}^k - \alpha^q - \Delta^q T_{is})$$

Y_{ist}^k is the score in test *k* for student *i* in school *j*, and T_{is} is the dichotomous treatment indicator for student *i* in school *j*. $\omega_{i,j}$ is the weight of student i in treatment group j, $\rho(.)$ is a loss function. The weights scheme depends on whether we are estimating the QTE or the QTET. (See Firpo (2007) for details.) In practice, we estimate a quantity in between QTE and QTET. This is given by the following model:

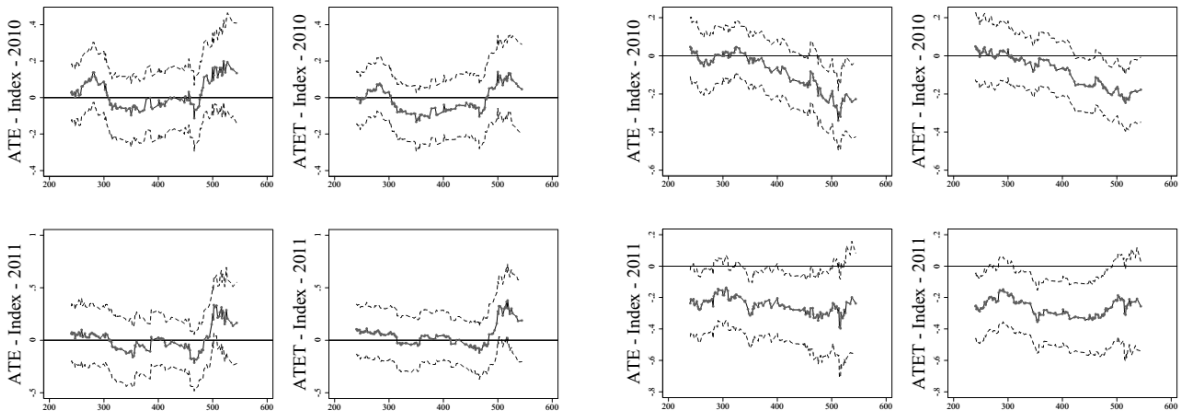
$$Y_{ist}^k = \alpha^q + \Delta^q T_{is} + X_{is}\xi^q + \upsilon_i^q$$

The attention we pay to the estimation of quantile treatment effects stems from their fundamental property of portraying the heterogeneous impact of large school size on any point of the distributions of learning outcomes. This is critically important since, if the mean curve is not informative enough, we may end up understating the overall effects of large school size on learning outcomes.

4. Results and discussions

We start by presenting mean treatment effects on the index score. This consists of implementing a doubly robust strategy to estimate ATE and ATET, with a threshold moving from 240 to 550 students.

Figure 1: Sensitivity of the Estimates to the Selection of the Cut-off Point, ATE and ATET within Confidence Interval, Grade 2 (left) and Grade 4 (right), Index of Measured Cognitive Outcomes



A visual analysis of figure 1 suggests no impact of large school size on the index for second graders when the cut-off point varies. None of the parameters of interest are statistically significant at grade 2 for other outcomes. At grade 4, the estimated effects (ATE and

ATET) are significant within a certain range whose bounds determine an interval outside which any effect of any kind is not observable. This range is estimated at 470-500 students and can be viewed as an optimal school size.

We also look at the effects of school size on the entire distribution of test scores at both grades by estimating effects at quantiles of one from one through 99. Since 99 quantiles are analyzed on eight outcomes (French, mathematics, oral and index scores at the follow-ups surveys of 2010 and 2011) and we consider 128 distinct values of the cut-off point at grade 2 and 133 at grade 4, we check the significance and direction of the 101,376 estimates at grade 2 and 105,336 at grade 4, which represent a total of 206,712.

The outputs are omitted due to space constraints, but we discuss the results for a particular cut-off point (440 students) suggested by a cluster analysis. The quantile effects are significant only in a very few cases at grade 2, suggesting the absence of an effect of large school size on the distribution of learning outcomes. At grade 4, the harmful effects are more present in the longer-term, which suggests the idea that length of exposure to school size matters. The adverse effects appear at almost every point of the distribution of students' achievements and are massive.

When all cut-offs are analyzed, we note once more the paucity of significant effects at grade 2 as 94 percent of the estimates are not statistically significant, 48 percent being related to the short run.[2] Only 2.6 percent of the estimates are positive, and these are mostly for high-achievers; just 0.1 percent of the estimates relate to low-achievers. Finally, 3.4 percent of the estimates are negative, these adverse effects invariably being detected for low- or high-achieving students and equally distributed between 2010 and 2011. At grade 4, 80 percent of the estimates are not significant, 44 percent being related to the short run (12 months). While only 2.6 percent are positive (2.4 percent for high-achievers), 17.4 percent are negative (12 percent for high-achievers and 5.4 percent for low-achievers). Amongst these harmful effects, 75 percent are detected in the longer-term (18 months).

We emphasize here that the proportion of negative effects exceeds that of positive effects, especially at the fourth grade level where it is almost seven times larger. Furthermore, if school size has any positive effect, the positive effects occur in a tiny proportion and mostly relate to top performers, who are, by far, less of a policy concern than weak students. From this analysis, quantile effects exist (especially at grade 4), and the picture depicted here mimics very well what we saw so far in the case of the cut-off point of 440 students: the importance of length to exposure and the quasi inexistence of effects at grade 2.

Ornstein (1990) stresses that family is the first educational body and the main source of students' development in the early years of schooling. Because young learners, especially those in grade 4, are making the transition from their habitual settings to school in this part of life, a small environment is preferable for their intellectual fulfillment to the seclusion that is associated with large schools.

The results of this research are very much consistent with the most recent conclusions on the topic, providing an extension of initial findings to a less developed area. Indeed, Egalite and Kisida (2013) show for primary and secondary schools and Kuziemko (2006) demonstrates for primary schools that school size has an adverse effect on students' outcomes. The effects identified are, however, smaller, probably because more endowments (e.g. more materials, better trained teachers, etc.) are likely to lessen the undesirable effects of school size. Conceptually, small schools are in a better position to offer adequate responses to students' individual needs, as has already been outlined in previous research (Strang, 1987; Maxner, 2005). It is also conceivable that in reasonably-sized schools, where teacher-pupil ratios and attention per pupil are expected to be higher, disruption is less likely to occur. Such conditions seem indispensable for a learning entity to be effectively run and adequately managed. The data show that a higher proportion of principals in large schools consider keeping order to be one of the objectives of the learning community. More specifically, the proportion of school principals that establish discipline as a priority is 11 percentage points lower in the group of small

[2] These percentages do not represent sample fractions. They represent sample fractions only if large school size affects all outcomes in the same manner, irrespective of the cut-off selected.

schools. This difference is statistically significant at the level of 1%. Thus, disruption appears to be one of the multiple ways in which school size can hurt learning. Among other objectives that are statistically more present in the management of small schools are the mastery of the core topics (French and mathematics) and the progression of students through the primary cycle.

The results quantile regressions show that the selection of the cut-off point that defines small and large schools does matter and may be part of the reason why the broader literature is inconclusive as to the existence and direction of the effects of large school size. Lee and Loeb (2000) define small schools as those with less than 400 students and large schools as those with more than 750 students. According to Conant (1959b, 1967), a large school has a total school population of about 400 students. In the study by Barker and Gump (1964), school size went up to 2,287 students. Lee and Smith (1997) suggest an ideal small high school with about 600-900 students.

5. Conclusions

The functioning of primary schools is at the heart of numerous debates on how to improve learning outcomes. These debates are of substantive importance for developing countries that have strongly struggled to expand access to education, in the sense that elementary education is the foundation for subsequent progress in life. Building on the statement of selection on observable characteristics, we provide evidence of the long-term and detrimental effects of large school size, especially at the higher grades of elementary school. Results from the quantiles models lend some confirmatory evidence of the long-term and adverse effects of school size on learning outcomes. Our findings agree with Egalite and Kisida (2013) and Kuziemko (2006). Importantly, knowledge on the role of school size in the educational process is extended to a developing economy. Furthermore, it should be emphasized that the magnitude of the effects is greater in the context of Senegal than those previously examined in the existing literature.

The conclusions of this research support the idea that a school consolidation policy will not necessarily be effective, even if it reduces the operating unit cost and may have other advantages. Harris (2006/2007) argues that the reduction in costs afforded by school consolidation can translate into diminishing returns to scale when the undesirable effects experienced in large schools (less cohesion and the possible need for a more formal bureaucratic structure, which may be costly and inefficient) are larger than those that create increasing returns to scale. Anyhow, attentive management of school dimensions is required to promote students' learning outcomes. Our research suggest that school consolidation is affordable up to a certain limit, which our analysis robustly places at 500 students with the lower bound being 470 students given the overall pattern of this analysis.

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