Should LMICs Build Preschools or Improve Primary Education? Experimental Evidence from Côte d'Ivoire

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Abstract

In Low- and Middle-Income Countries, there is a debate as to whether priority should be given to building preschools or improving the existing primary education system. To answer this question, we partnered with the Government of Côte d'Ivoire to implement a randomized controlled trial aiming to measure the relative impact of opening public preschools and of a multi-faceted intervention designed to improve the quality of primary school education. Both had positive effects on children' skills, but the preschools proved more cost-effective over the duration of the pilot. However, evidence suggests that this conclusion may not always hold, especially in the longer term. Finally, the two interventions appear to be substitutes, as their simultaneous implementation did not improve children's outcomes beyond what was achieved by each intervention when implemented separately.

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I. Introduction

A growing number of Low- and Middle-Income Countries (LMICs) are considering or have already launched large-scale preschool construction programs with the objectives of fostering child development and eventually improving the overall performance of their education systems.[1] For instance, in sub-Saharan Africa, Equatorial Guinea, Ghana, Mauritius, Angola, Cape Verde, the Seychelles, and South Africa have already achieved gross pre-primary enrollment rates above 80 percent (see *Appendix 1*), and countries such as Côte d'Ivoire, Liberia, Madagascar, and Senegal are currently undertaking large-scale preschool construction programs. This reflects the global consensus on the importance of preschool education illustrated by Sustainable Development Goal 4.2. ("all girls and boys have access to quality pre-primary education so that they are ready for primary education"), which is supported by a body of evidence from high-income countries.[2]

Unfortunately, evidence on the impact of state-run preschool programs in LMICs is limited and these countries' ability to implement large-scale programs of sufficient quality to promote child development remains to be established. Indeed, existing studies either focus on programs implemented by NGOs or private entities (Martinez et al., 2017; Dean and Jayachandran, 2020; Bassi et al., 2024), raising scalability concerns, or by governments, but in contexts where supply of preschool services is already substantial (Bouguen et al., 2018; Bjorvatn et al., 2022; Berkes et al., 2023), which raises external validity concerns (particularly with regard to the specificity of the children on whom the impact of preschool is estimated). In fact, the only evidence on the impact of a large-scale program implemented by a LMIC government suggests that human capital and financial constraints can prevent the implementation of large-scale public preschool programs of sufficient quality to foster child development (Carneiro et al., 2020). More generally, in a context where the quality of education is low, the question arises as to whether LMICs should prioritize building preschools or focus on improving primary education to enhance the overall performance of the education system.

[1] In LMICs, the number of children under five who are at risk of developmental delay is estimated at 250 million (Lu et al., 2016). These developmental delays have multiple causes, including an insufficient level of cognitive stimulation, dietary deficiencies, chronic infections, and so on.

[2] Evidence from high-income countries shows that investment in preschools, which cater for children aged 3-5, can be particularly effective (Duncan and Magnuson, 2013; Gray-Lobe et al., 2022), in particular through early learning activities (generally centered on the exploration of written and spoken language, creative and motor activities, etc.) and extended interaction between children. Preschools can also provide children with access to basic health care. Additionally, canteens, where they exist, allow children to have their basic nutritional needs met. More generally, a substantial body of evidence shows that investment in high-quality early childhood interventions can help tackle child development delays and the resulting cost to society (Heckman, 2006; Heckman, 2013; Duncan and Magnuson 2013; Duncan et al., 2023).

To answer these questions, we were able to leverage the implementation of a large-scale pilot project launched by the Ministry of Education (MoE) of Côte d'Ivoire in 2018, which aimed to improve the quality of learning in the first years of primary school. As part of this project, a group of primary schools was selected to receive an ambitious multi-faceted intervention targeting grades 1 to 3 (in theory, children aged six to eight), designed to concomitantly address the main challenges encountered by the primary education system (referred to as the "*primary school*" intervention hereafter). These challenges included the lack of a) adequate school infrastructure, b) financial resources, c) learning incentives, and d) pedagogical practices. In parallel, a group of localities was selected to receive a preschool offering a two-year course aimed at preparing children (aged four to five, in theory) for entry into primary school (referred to as the "*preschool*" intervention hereafter). The underlying idea behind this second intervention was to help children familiarize themselves with the language of instruction (French) before entering primary school. Both interventions were implemented by the MoE in six particularly disadvantaged regions located in the north of the country – in total, the preschool intervention was implemented in 357 localities and the primary school intervention in 378 schools.

In partnership with the MoE, we planned a 2x2 cross-cutting randomized controlled trial from the outset of the pilot project to measure and compare the causal impact of the interventions when implemented both separately and jointly. First, 136 localities were randomly selected among those eligible (which, in particular, were required to have a primary school). Second, these localities were randomly divided into four groups of equal size: 34 localities only received the *preschool* intervention; 34 only received the *primary school* intervention; 34 received both; and 34 received neither. Finally, in the summer of 2023, four years after the start of the interventions, we collected follow-up data on a representative subset of children aged 4 to 8. In particular, we collected data on the development level of children aged 4 to 5 (preschool-aged children) using the *International Development and Early Learning Assessment* (IDELA), and on the cognitive skills of children aged 6 to 8 (children of grade 1-3 age) using the *Early Grade Reading Assessment* (EGRA) and the *Early Grade Mathematics Assessment* (EGMA).

Our conclusions are manifold. First, the *preschool* intervention improved the development level of preschool-aged children (aged 4 to 5 at follow-up). Although only 35 percent of these children were enrolled in preschool at follow-up, the overall level of child development was nevertheless higher by 0.23 standard deviations in localities that received the preschool intervention, compared to children in control localities. These effects materialize for both cognitive and non-cognitive skills, as motor

ski/lls, emergent literacy and emergent mathematics were all significantly higher in localities that received the preschool intervention. Finally, our data suggests that these positive effects may persist into the early years of primary school, as children's literacy and math skills remained higher among 6–7-year-olds in the localities that received the preschool intervention. It is worth noting that, part of this effect may be driven by the fact that the intervention increased the share of children from this age group who were enrolled in primary school at follow-up (+10 percentage points).

Second, the *primary school* intervention improved the cognitive skills of children aged 6 to 8 at follow-up (children of grade-1-to-3 age). Although only 46 percent of children in this age group were enrolled in primary school at follow-up in the group of localities that received the primary school intervention, average competencies in literacy and mathematics had increased by 0.24 standard deviations in localities that received the primary school intervention compared to children in control localities. Incidentally, these effects seem to be mainly driven by the component aimed at improving teachers' pedagogical practices. Indeed, the timing of the effects of the primary school intervention during the first three years of the pilot project closely matches that of the implementation of the pedagogical component: simultaneous in all three grades from the first year of implementation in mathematics, and staggered over the first three years in literacy. The primary school intervention also appears to have increased the share of children aged 6 to 8 who were enrolled in primary school at follow-up by seven percentage points (p-value=0.137).

Third, over the course of the pilot, the preschool intervention proved more cost-effective than the primary school intervention. On the one hand, we find that both interventions had similar effects on the competencies of children aged 6 to 7 (who should have completed grade 1 and grade 2 respectively at the time of follow-up).[3] On the other hand, the cumulative cost of the primary school intervention over the five years of the pilot is higher than that of the preschool intervention. However, evidence suggests that the greater cost-effectiveness of the preschool intervention may not hold in the longer term and/or for less dispendious primary school interventions limited to components with a small cost-benefit ratio (*e.g.*, interventions designed to improve pedagogical practices). Indeed, the cost of the primary school intervention is actually lower than that of the preschool intervention if we exclude the component that provided school staff with incentives to encourage children's learning (which was discontinued after the first two years of the program due to its high cost and apparent lack of effect).

[3] We restrict ourselves to children in this age group because, as the interventions implemented as part of the pilot study only ran for four years, children aged 8 cannot be assumed to have benefited from the full two-year preschool intervention. For reasons of comparability, we therefore compare 6- and 7-year-old children in the group of localities that received the preschool intervention and in the group of localities that received the primary school intervention.

Moreover, the two types of intervention tend to differ intrinsically in the nature of their cost structures: while building preschool involves irreducible variable costs (related to the salaries of additional staff hired), interventions aimed at improving the quality of primary school education generally have more limited variable costs. This suggests that, unless the effects of the former increase over time relative to that of the latter, interventions aimed at improving the quality of primary school would tend to be more cost-effective in the long run.

Fourth, the preschool and primary school interventions evaluated as part of this project appear to be substitutes rather than complements, as we find that implementing both interventions concurrently did not increase the cognitive skills of children aged 6 to 7 beyond what each intervention achieved when implemented alone. We identify two concomitant substitution effects at work to explain this result. On the one hand, the interventions appear to be perceived as substitutes by households. This is evidenced by the drop in the share of children aged 4 to 7 who had ever attended preschool at follow-up, from 30 percent in localities that only received the preschool intervention to only 22 percent in localities that received both interventions (the two coefficients being statistically different at the 1 percent level). This reduction is particularly marked for lower-achieving girls (but not boys). On the other hand, the two interventions appear to be substitutes in the educational production function. While the development level of 4- to 5-year-old boys remains comparable in the two groups of localities that received the preschool intervention (despite the drop in preschool enrollment mentioned above), the addition of the primary school intervention does not further increase the cognitive skills of 6- to 7-year-old boys. Note that the latter substitution effect seems more important than the former in explaining the overall results.

Our study contributes to different strands in the literature. First, it adds to the literature on the impact of expanding access to preschool in LMICs (Martinez et al., 2017; Bouguen et al., 2018; Carneiro et al., 2020; Dean and Jayachandran, 2020; Bjorvatn et al., 2022; Berkes et al., 2023; Bassi et al., 2024). First of all, it is only the second randomized controlled trial to measure the impact of a large-scale government preschool program implemented in a context where the supply of preschool services is virtually non-existent, as is most often the case in Sub-Saharan Africa. Furthermore, it is the first to provide robust evidence that LMIC governments have the capacity to implement preschool education of sufficiently high quality to promote child development. Incidentally, our study is also the first to measure the quality of teaching practices using a standardized tool (Teach ECE) based on classroom observations. This data makes it possible to objectively measure the quality of pedagogical practices, provides a benchmark for this important mediating variable and allows the Ivorian government to

identify dimensions in which teacher training could be reinforced (*e.g.*, further fostering children's autonomy, perseverance and social and collaborative skills) to strengthen the beneficial effects of preschool for children. Finally, our results suggest that, as in high-income countries, the positive effects of preschool education may be lasting, as they are still present in children of early primary school age.

Our study also contributes to the literature on primary education, and on education in general. First, our results indicate that, in LMICs, substantial gains may be achieved by encouraging pedagogical practices that are more conducive to children's learning, notably by allowing more space for children's interaction, autonomy and manipulation (at both preschool and primary school level). These gains seem to be achievable at relatively low cost by modifying teacher training and encouraging in-service training. This provides further evidence of the effectiveness of this lever in improving children's learning, particularly at primary school level (see Kremer, Brannen, and Glennerster (2013), Akyeampong et al. (2020), and Evans and Mendez Acosta (2020) for reviews).

Second, we show that investments at different education levels can have very different cost structures and are not necessarily equally cost-effective. In particular, our study is a reminder that despite large positive effects, expanding access to preschool entails incurring relatively high variable costs. As a consequence, if policymakers' main objective is merely to improve children's academic performance, improving primary education may prove more cost-effective, especially in the long term. This does not mean that preschool construction programs should be abandoned. Indeed, the preschool intervention's cost-benefit ratio compares relatively well with traditional parent support programs designed to foster child development (see J-PAL (2020) for a literature review).

Finally, while previous data has shown that investments at the same education level can be complements (Mbiti et al., 2019), our results provide additional evidence that investments made at different levels of the education system can in fact be substitutes – see also Gunnsteinsson et al. (2022), Goff et al. (2023), and Adhvaryu et al. (2024). As mentioned above, we also highlight two mechanisms to explain this result: a) the two interventions appear to be substitutes in the educational production function; b) the two interventions are perceived as substitutable by parents. Taking into account the potential substitutability of investments made at different levels is important to stagger their implementation and/or introduce corrective measures that will help reap their full benefits and avoid widening gender inequalities, as girls are particularly affected by the second type of substitution effect.

The remainder of the article is organized as follows: in section II, we describe the context and intervention; in section III, we describe our research design; in section IV, we present our study results; in section V, we conclude.

II. Context and interventions

A. Context

Our study is set in Côte d'Ivoire, a lower-middle income country with a population of 20.3 million, 41 percent of whom are under the age of 15. In 2018, the per capita income was US$2,169,[4] with substantial differences across regions (INS, 2015). French is the only official language and, in a context of linguistic fragmentation (78 different indigenous languages are used in the country), is used as a *lingua franca* and the sole language of instruction in the education system.

Over the past decade, the formal education system, which begins with six years of primary school,[5] has experienced a rapid increase in enrollment rates as a result of proactive policies that gradually made schooling free and compulsory for all children aged six to 16. Between 2009 and 2018, the percentage of children of official primary school age actually enrolled in primary school rose from 56 to 90 percent (UNESCO, 2020).[6] Again, there are differences between regions, the northern part of the country recording significantly lower enrollment rates (MENETFP, 2018).[7]

With universal primary education in sight, attention is now turning to improving the performance of the education system and, in particular, the primary education system, which has revealed a number of weaknesses. First, primary school completion rates are relatively low, with the gross intake ratio in the last grade of primary school reaching only 70 percent in 2018 in Côte d'Ivoire – compared with an average of 87 percent in LMICs (UNESCO, 2022).[8] Second, learning outcomes are poor. At the end of primary school, 60 percent of Ivorian pupils have not achieved the minimum reading skills

[4] The data is in constant 2015 US dollars and comes from the World Bank: https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?locations=CI

[5] The six primary school grades are: CP1, CP2, CE1, CE2, CM1, and CM2. "CP" stands for "Cours Préparatoire," "CE" stands for "Cours Elémentaire," and "CM" stands for "Cours Moyen."

[6] The public sector accounts for 87 percent of total enrollment. As a consequence, primary education expenditures accounted for 47 percent of government expenditure on education in 2018 (UNESCO, 2020), according to the UNESCO: https://data.worldbank.org/indicator/SE.XPD.PRIM.ZS?locations=CI (last accessed in August 2022).

[7] For example, national education statistics on *gross* enrollment rates show that it is only 70 percent in the Bagoué region, 85 percent in the Béré region, 79 percent in the Bounkani region, 78 percent in the Folon region, and 69 percent in the Tchologo region. It should be noted that the Ministry's statistics are higher than those published by the UNESCO (which are not available at the regional level), and that they are therefore difficult to compare with the average figure given in the body of the text.

[8] The primary school completion rate in Côte d'Ivoire was more comparable to the rates of low-income countries, which averaged at 67 percent (UNESCO, 2018).

that would allow them to continue their education without difficulty, and 83 percent of them have not mastered the minimum math skills (PASEC, 2020). These figures are particularly low, as illustrated by the corresponding overall means for the 14 Sub-Saharan African countries surveyed, which are 52 and 62 percent respectively (see *Appendix A.2*).[9] Finally, gender disparities are persistent, as the primary education completion rate stood at 74 percent for boys in 2018, against 66 for girls (UNESCO, 2022).[10] Boys also tend to acquire better math skills than girls (PASEC, 2020).

Preschool provision is still underdeveloped and enrollment rates are low, as is still the case in most Sub-Saharan African countries (see *Appendix A.2*): in 2018, only nine percent of preschool-age children were enrolled in a preschool, with higher rates among better-off and urban households (MENETFP, 2018).[11] But, in 2016, the Ministry of Education made plans to substantially increase the number of public preschool units by 2025 to improve children's school readiness and the overall performance of the education system (MENETFP, 2017).

B. The interventions

In 2017, the Ministry of Education designed the "*Education Service Delivery Enhancement Project*" (ESDEP), a multi-faceted project designed to improve the performance of its education system by jointly tackling the most salient issues faced at the primary school level – most of which are widely shared among Sub-Saharan African countries (see Ménascé and Flore (2015), PASEC (2020), INS (2022)). In what follows, schools and localities that were offered an intervention as part of the ESDEP project are referred to as "ESDEP schools" and "ESDEP localities," respectively.

Specifically, the project aimed to improve children's learning outcomes in the first three years of primary school by:[12]

1. *Improving school infrastructure (component #1)*: A large share of schools lack adequate classrooms, toilets, access to water, etc. In 2018, nationwide, 26 percent of public primary schools lacked at least one classroom[13] (MENETFP, 2018) and close to half reported using

[9] The other countries are Benin, Burkina Faso, Burundi, Cameroon, Chad, The Republic of Congo, The Democratic Republic of Congo, Gabon, Guinea, Madagascar, Niger, Senegal, and Togo.
[10] Based on UNESCO data. For boys: https://data.worldbank.org/indicator/SE.PRM.CMPT.MA.ZS?locations=CI-XN. For girls: https://data.worldbank.org/indicator/SE.PRM.CMPT.FE.ZS?locations=CI-XN (last accessed in February 2023).
[11] In 2018, urban areas accounted for 50 percent of the population, but 63 percent of preschools and 77 percent of preschoolers. Urban population data: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=CI (last accessed in May 2024).
[12] In the Ivorian education system, these grades correspond to CP1 (grade 1), CP2 (grade 2), and CE1 (grade 3) respectively.
[13] Historically, primary schools in Côte d'Ivoire have consisted of two blocks of three classrooms. Many localities, sparsely populated at the time their school was built, only received one block at the time and have not since received the second one, even though their growing population would require it.

classrooms that were either in poor condition or built from temporary materials.[14] Moreover, only 46 percent of primary schools had sanitary facilities and only 40 percent had access to a water point (MENETFP, 2018).[15] To address this problem, ESDEP schools were given the opportunity to apply for funding to build infrastructure, including classrooms, toilets, and/or a water point.[16] Selected communities were closely involved in recruiting and supervising the construction company.

2. *Increasing schools' financial endowments (component #2)*: Schools rarely receive financial endowments from the government to buy teaching materials and mainly rely on community donations to do so.[17] As a result, they often lack the appropriate materials to facilitate learning. To address this problem, ESDEP schools received an *annual* grant averaging US$1,140 per school (the amount depending on the number of teaching groups).
3. *Providing school staff with incentives to support learning (component #3)*: Beyond their intrinsic motivation, school staff face limited incentives to promote children's learning. To address this issue, two measures were taken. First, ESDEP schools received a second annual grant averaging US$1,265 per school per year, the exact amount of which depended on their overall school performance, as measured by annual indicators for pupil learning, dropout rates, repetition rates, etc.[18,19] In particular, this entailed collecting annual information on children's competencies in literacy and mathematics from a representative sample of pupils in grades 1-3 (more information on this data is provided below). Second, these figures were shared with School Management Committees (SMC), together with national averages when available and an overall assessment of the school's situation ("very poor," "poor," "medium," "good," or "very good,"). To encourage community oversight of the schools, SMCs in turn shared these results with their community at the start of the school year in a ceremony organized specifically for that occasion.

[14] For instance, in study regions, 51 percent of primary schools use classrooms in poor conditions (25 percent) or built from temporary materials, generally straw huts or buildings consisting of a few rows of concrete blocks and a tin roof (30 percent), representing 30 percent of the total number of classrooms.
[15] For instance, in study regions, these figures are 49 percent and 24 percent, respectively.
[16] In this subsection, unreferenced statistics were calculated by the authors using administrative information collected annually by the Ministry of Education on all primary schools in the country. We used information collected during the 2017/2018 school year – *i.e.*, before randomization was carried out.
[17] Furthermore, in the regions covered by the pilot, only 16 percent of School Management Committees received a grant in the 2017/2018 school year, with a median amount of US$265.
[18] Specifically, the Ministry of Education collected information on improvements in pupil learning using standardized tests. To measure these improvements, data on test results were collected at the beginning of the first year of program implementation and at the end of each subsequent year.
[19] In order not to put large schools at a disadvantage, the amount of these endowments increased with the size of the school.

4. *Promoting better pedagogical practices (component #4)*: Teaching practices are considered to be outdated and could be significantly improved, in particular by allowing more room for pupils' interaction, participation, and practice. To address this issue, teachers were trained in new simple approaches to teaching literacy and mathematics. In literacy, they were requested to shift from a mixed method to a syllabic one,[20] to make pupils read along with their fingers, to correct pupils when they made an error, and to explain new words more frequently. In mathematics, teachers were encouraged to make children use manipulatives, draw schematic representations of problems, and justify their reasoning. To facilitate these pedagogical changes, schools and teachers received textbooks, exercise books, teaching guides, and lesson sheets. Inspectors and pedagogical advisors (operating within a designated school district) were also asked to visit grade-1-to-3 teachers regularly to ensure the smooth implementation of the intervention. School principals were given the same instruction.[21]
5. *Improving children's school readiness, in particular through better mastery of the language of instruction (component #5):* The use of French as the sole language of instruction exacerbates children's difficulties, especially in the early years of primary school, as it is rarely spoken by children in their homes. To address this problem, a subset of ESDEP localities was selected to receive a community preschool with the aim of fostering children's development and helping them acquire a greater command of French during the two years preceding their entry into primary school.[22] Developed in collaboration with the UNICEF, the curriculum is play-based and tailored to the needs of young children aged four to five. Classes are taught in French by an educator and an assistant recruited from the children's community and specifically trained for these positions.[23] Each facility has two classrooms and is equipped with child-friendly hand-washing stations and toilets, a playground, as well as school furniture and educational materials. Communities were closely involved in recruiting and supervising the construction company.

[20] The "syllabic method" is a synthetic method of teaching reading in which children begin by learning letters before gradually moving to syllables and then to words. This is contrasted with the "whole language approach," in which children are asked to learn to recognize words as a whole, without learning to recognize letters or syllables. The "mixed method" corresponds to a more or less extensive blend of the first two approaches (*e.g.*, using the syllabic method to decipher words that are pronounced normally and the whole language approach to identify words whose pronunciation does not match their spelling).
[21] Teacher training courses in literacy and mathematics teaching practices each lasted seven days. Teachers also benefited from an additional day of training per month.
[22] The use of French as the language of instruction is not yet seriously called into question by the Ministry of Education, in part because it is considered to serve the higher purpose of helping to strengthen the construction of a particularly linguistically fragmented nation.
[23] Initial training for educators lasted two months, and a refresher course was organized in Year 2. Assistants received only two weeks' training before taking up their position.

ESDEP schools also benefited from occasional deworming campaigns to combat pupil absenteeism, and from the distribution of school kits for girls in grades 1, 2 and 3 to encourage their enrollment in primary school.

In what follows, the "*primary school*" intervention encompasses components 1 to 4, while the "*preschool*" intervention corresponds to component 5. *Appendix A.3* provides additional information on components 1 and 5.

C. Pilot and timeline

Before considering scaling up the program, the Ministry of Education piloted the intervention in six northern regions combining the lowest primary school enrollment and educational achievement rates, and the highest levels of poverty (Bagoué, Béré, Bounkani, Kabadougou, Poro, and Tchologo). Together, these regions account for 12 percent of the country's population and 28 percent of its surface area.[24]

As displayed in *Figure 1,* the pilot project ran for five school years (one year of preparation and four years of implementation), from September 2018 to August 2023. In Year 0 of the project (the 2018/2019 school year), ESDEP schools were invited to apply for funding for the construction of primary school infrastructure (*e.g.*, classrooms, toilets, and/or a water point) in the fall, and approved projects were carried out in the spring. In preparation for the primary school intervention, the new textbooks, exercise books, teaching guides, and lesson plans were printed, and teachers in grades 1 to 3 of ESDEP schools received training on the new pedagogical approaches. In the subset of ESDEP localities selected to receive the preschool intervention, the infrastructure was built and the staff hired and trained.

From Year 1 (the 2019/2020 school year) to Year 4 (the 2022/2023 school year), both interventions were implemented. As far as the primary school intervention is concerned, it is worth noting that all but one of its components began simultaneously in Year 1. While the new pedagogical approach for mathematics was implemented in all three grades from Year 1, the new literacy teaching approach was only introduced gradually from Year 1 to Year 3, with grade 1 receiving it from Year 1, grade 2

[24] The poverty rate was 69 percent in the Bagoué region, 56 percent in the Béré region, 62 percent in the Bounkani region, 72 percent in the Kabadougou region, 54 percent in the Poro region and 66 percent in the Tchologo region. In comparison, the poverty rate in the country as a whole was 46 percent (Enquête sur le Niveau de Vie des Ménages, 2015).

from Year 2, and grade 3 from Year 3.[25] Moreover, the component aimed at providing incentives to school staff to support learning (ESDEP component #4) was discontinued from Year 3 due to its high cost.

At the end of Year 2, the first cohort of children that could have benefited from the full two-year preschool intervention became eligible to start primary school. By the end of Year 4, these children should have finished grade 2.

Over the course of the four-year pilot, a total of 378 schools received the primary school intervention, representing 28 percent of the primary schools located in the study regions, and 357 localities received a preschool, representing a 42 percent increase in the supply of preschool classes in the study regions.[26]

III. Research design

In collaboration with the MoE, we took advantage of the ESDEP pilot to design a randomized controlled trial allowing us to measure the causal impact of the preschool and primary school interventions when implemented separately and jointly.

The trial was planned from the very onset of the ESDEP pilot, ensuring that its overall implementation would not compromise the integrity of the research project.

A. Sampling

Localities

In August 2017, the six regions covered by the pilot project counted 1,313 localities with a primary school, spread across 68 school districts.

Among these 1,313 localities, we identified eligible ones, *i.e.* those which, in Year 0: 1) did not yet have a preschool; 2) only had one primary school; 3) had children enrolled in the first years of primary school – representing a subset of 861 eligible localities. The first restriction allows us to measure the impact of preschool in a context where access to preschool is virtually null, as is most often the case

[25] It should also be noted that, by design, schools only received the annual grant on the basis of their overall performance at the start of Year 2, based on data collected on learning performance indicators (pupil learning, dropout rates and repetition rates) at the end of Year 1.

[26] Specifically, 117 localities received a community-based preschool program similar to those studied in this article, and 240 received a pre-primary class (built from 2022).

in most areas of Sub-Saharan Africa. The second restriction aims to reduce the risk of non-compliance in the treatment group among children of primary-school age. The third restriction is designed to avoid unduly reducing statistical power. We then constituted a sample of 136 localities by randomly selecting two eligible localities from each of the 68 school districts. [27]

Note however that at the government's request, in the 56 school districts where its Social Safety Net Program[28] (SSNP) targeting the poorest households was implemented in Year 0, one locality was randomly selected among eligible localities receiving the SSNP and the second one among eligible localities not receiving the SSNP. In the 12 school districts in which the SSNP was not implemented, both localities were selected at random among eligible ones.

Children and households

At follow-up, we carried out a census of all households in each sampled locality to identify all children aged between four and eight (*i.e.*, children old enough to be enrolled either in a preschool or in grades 1 to 3). On the basis of these census lists, we randomly selected up to 15 children in each age group for study inclusion. This allows us to measure the impact of interventions on a representative sample of children in their target age group. In total, 8,397 children were sampled, representing 5,722 distinct households.

B. Design and research questions

Experimental design

The 136 sampled localities were randomly assigned to the four experimental groups in two consecutive draws.

First, 34 of the 68 school districts (accounting for 68 of the 136 localities) were randomly selected to receive the *primary school* intervention. The choice of randomization level stemmed from the central role that school inspectors and pedagogical advisors, appointed at the school district level, were to play in the primary school intervention (as detailed in *Section II.B*). The draw was stratified by region and by whether or not a locality's school district was covered by the SSNP. To avoid any

[27] The six regions in the study area actually comprised 69 school districts at the start of the project, but one of these districts had to be left out from the study because it only included one locality eligible for the program.
[28] The Social Safety Net Program is an intervention implemented in collaboration with the World Bank in which a quarterly allowance is paid to the poorest households.

contamination, the 310 elementary school that received the primary school intervention outside the experiment were selected from the 34 school districts selected to benefit from this intervention.

Second, 68 of the 136 localities were randomly selected to receive the *preschool* intervention. This second draw was stratified according to the results of the first draw, the region of the localities and whether or not their school district was covered by the SSNP.

These two draws split the sample into four groups of 34 localities: those only receiving the preschool intervention (the *PRE* group); those only receiving the primary school intervention (the *PRI* group); those receiving both (the *PRE+PRI* group); and those receiving neither (the *CON* group).

Figure 2 summarizes the design of the study and maps the different groups.

Research questions

We measure the impact of the preschool and primary school interventions on their targeted age group over different time horizons, when implemented separately or jointly. For each experimental group, *Appendix A.4* describes children's exposure to the different interventions according to their age.

First, our experiment allows us to measure the impact of the preschool intervention on child development (cognitive and non-cognitive skills). We measure its short-term impact by comparing children aged 4 to 5 at follow-up in the *PRE* group (*i.e.,* children who were old enough to have been enrolled in an ESDEP preschool in Year 4, during the school year that had just ended at follow-up) and in the *CON* group. Similarly, we measure its medium-term impact by comparing children aged 6 to 7 in the *PRE* group (*i.e.,* children who should have been enrolled in grades 1 or 2 in Year 4 and could have been enrolled in an ESDEP preschool for two years before then) and in the *CON* group. Assuming that preschools have a positive effect in the short term, this comparison enables us to find out whether these effects are lasting, or whether children who do not have access to a preschool catch up by the end of grade 2.

Second, we measure the impact of the primary school intervention on children's cognitive skills. We do so by comparing children aged 6 to 8 in the *PRI* group (*i.e.,* children who should have been enrolled in grade 1 to 3 in a primary school receiving the ESDEP in Year 4) and in the *CON* group.

Third, we compare the impact of the preschool intervention with that of the primary school intervention. We do so by comparing children aged 6 to 7 in the *PRE* group (*i.e.,* children who could

have been enrolled in an ESDEP preschool for two years in the past and who, in Year 4, should have been enrolled in grade 1 or 2 in a primary school *not* receiving the ESDEP) and in the *PRI* group (*i.e.*, children who did not have access to an ESDEP preschool and who, during the school year that had just ended at follow-up, should have been enrolled in grade 1 or 2 in an ESDEP primary school).

Finally, we assess the degree of complementarity or substitutability of the preschool and primary school interventions by comparing children aged 6 to 7 in the *PRE*, *PRI*, and *PRE+PRI* groups.

C. Data

Our main analysis uses data collected from selected children and households between June and August 2023, four years after the start of the interventions (Year 4).[29] These data are supplemented by various data sources, including administrative data, classroom observations, and survey data collected from primary school teachers and principals.

Primary outcomes

Our main outcome is children's development, understood as their cognitive and non-cognitive skills. For children aged 4 to 5 at follow-up, we measure cognitive and non-cognitive skills using the *International Development and Early Learning Assessment* (IDELA).[30] It is an oral test consisting of 22 activities in which children are asked, for example, to reproduce geometric shapes, identify the first sound of a word, perform simple mathematical operations or identify different feelings that a child of their age might experience. The tool measures children's overall development, as well as development in four sub-dimensions: 1) motor development, 2) language development and basic reading skills, 3) basic mathematical skills, and 4) social-emotional development.[31] The test was administered in the child's mother tongue by trained interviewers.

For children aged 6 to 8 at follow-up, we measure cognitive skills using the *Early Grade Reading Assessment* (EGRA) and the *Early Grade Mathematics Assessment* (EGMA).[32] EGRA and EGMA are two oral tests designed to assess, respectively, the basic literacy and mathematical skills of pupils

[29] Ideally, the follow-up survey should have been scheduled for the end of Year 5. Unfortunately, the contract between the government of Côte d'Ivoire and the World Bank that financed the ESDEP pilot made this impossible. The ESDEP pilot had to end on December 31, 2023.
[30] This tool was developed by the non-governmental organization *Save the Children* and, in accordance with the developers' guidelines, was adapted to the Ivorian context. It is suitable for measuring the level of development of children aged 3.5 to 6.5 and is commonly used in the early childhood development literature.
[31] The score for each of the four areas is calculated as an average of the child's performance in the associated activities. An unweighted average of the four areas is calculated to create a total score that reflects children's overall learning and development.
[32] Both tools were developed by USAID and, in accordance with the developers' guidelines, were adapted to the Ivorian context.

in early primary school. Both tests were administered in French (the language of instruction) by trained interviewers.

Appendix A.5 provides information on the various tasks involved in the three tests.

For each child, we also obtained enrollment data from their caregivers.

Control variables

Our set of control variables includes background information collected at follow-up on sampled children (age and gender), as well as on their main female and male caregivers (*e.g.*, age, marital status, relationship to the child, and mother tongue).

It also includes data from different administrative sources. First, we use *locality*-level data from the 2014 census (*i.e.*, number of inhabitants, gender ratio, and whether the locality is considered urban or rural) and from the MoE (variables indicating whether the locality had access to electricity and whether it was covered by the SSNP at the time of randomization). Second, we exploit *school*-level data gathered by the MoE during the 2017/2018 school year (that is, prior to randomization).[33] In particular, we use information on the total number of pupils, the gender ratio, the total number of classrooms, the condition of these classrooms (in good condition, in poor condition, or built with temporary materials), the number of teachers, the number of textbooks available for literacy and mathematics respectively, etc. We also use information on whether or not there is a functioning SMC and a "Club des Mères d'Elèves Filles," another type of school committee commonly found in Côte d'Ivoire which can be particularly involved in the running of schools. Finally, we use information on the distance between the school and the Inspectorate.

Other

Other data sources include classroom observation data collected by a survey firm in both preschools and primary schools. In preschools, we used the Teach ECE tool (World Bank, 2021) to assess the overall quality of pedagogical practices.[34] In primary schools, we designed simple observation tools to assess whether the simple teaching practices promoted as part of the primary school intervention were actually used by teachers in grades 1 to 3 to teach literacy and mathematics.

[33] This information is collected annually by the MoE (between December and February) for each primary school.
[34] This tool was designed by the World Bank to monitor and improve teaching quality, especially in LMICs.

We also use survey data collected by the same survey firm from primary school teachers, as well as monitoring data collected by the MoE as part of the pilot project. This includes information on preschool opening dates and data on the learning outcomes of random subsets of children enrolled in grades 1 to 3 at the end of Year 1 and Year 2, collected to determine the amount of the pupil-performance-based grant disbursed as part of the primary school intervention.[35] To measure pupil learning, the MoE used a slightly modified version of the EGRA-EGMA tests described above and in *Appendix A.5*.

D. Econometric specification

We measure the impact of the interventions on outcome y_i using an Intention-To-Treat (ITT) analysis. To do so, we estimate the following equation:

$$y_i = \beta_{PRE} T_i^{PRE} + \beta_{PRI} T_i^{PRI} + \beta_{PRE+PRI} T_i^{PRE+PRI} + \mu_i + X_i\gamma + \varepsilon_i \qquad \textbf{(Eq. 1)}$$

Where y_i is the outcome for child *i* measured at follow-up, T_i^{PRE} is a dummy variable equal to 1 if child *i*'s locality was selected to receive the preschool intervention only, T_i^{PRI} is a dummy variable equal to 1 if the locality of child *i* was selected to receive the primary school intervention only, and $T_i^{PRE+PRI}$ is a dummy variable equal to 1 if child *i*'s locality was selected to receive both interventions. Additionally, μ_i is a vector of strata fixed effects generated by interacting localities' region and their school district's SSNP status (Bruhn and McKenzie, 2009). X_i is a vector containing covariates selected using a double-lasso procedure to avoid any suspicion of p-hacking (Belloni et al., 2014). The full set of covariates included in the double-lasso procedure and the list of variables selected to produce the main results are reported in *Appendix A.6*.

In this equation, the parameters of interest are ITT estimates β_{PRE}, β_{PRI}, and $\beta_{PRE+PRI}$ which capture the impact of the preschool intervention, the primary school intervention, and the effect of concomitantly implementing both.

[35] We were able to convince the Ministry of Education to collect these test scores in the 34 control localities in addition to collecting them in the 68 localities receiving the primary school intervention. In each primary school, the EGRA-EGMA tests carried out by the Ministry of Education took place over two days. The first day was devoted to selecting 8 pupils per level among those present, who then took the EGRA test. On the second day, the same pupils took the EGMA test. It should be noted that these assessments were administered as part of surprise visits. The fact that the visits were unannounced limits the risk of bias that could arise from strategic behavior on the part of teachers or headteachers. In particular, it reduces the risk of the weakest pupils being asked to stay at home on the day of the tests, and of the assessments therefore being carried out on a selected group of high-performing pupils.

Unless specified otherwise, standard errors are clustered at the locality and household levels to account for possible correlation of outcome variables within localities and households.

E. Summary statistics and validity tests

Summary statistics

In *Table 1* (*column 1*), we provide descriptive information on the localities, schools, households, and children included in the study sample. Information on localities and schools comes either from the 2014 census or from MoE administrative data collected prior to randomization. Information on households and children were collected at follow-up.

First, the localities included in our sample are medium-sized rural villages with limited access to electricity. In 2014, their average number of inhabitants was just over 1,400 and, at the time of randomization, 97 percent of these localities were deemed rural and only 38 percent were connected to the grid.

Second, while the ideal primary school would include six classrooms in good condition (one per grade) and six teachers, sampled schools had an average of 5.5 pedagogical groups and 4.9 teachers. Moreover, 41 percent of primary schools lacked at least one classroom and, overall, 34 percent of classrooms were either in poor condition or built with temporary materials (16 and 18 percent, respectively). Additionally, 49 percent of primary schools did not have latrines, 84 percent did not have handwashing facilities, and 73 percent did not have a water point.

At follow-up, households included in our sample were mainly monogamous (78 percent). Of the children sampled, 44 percent were girls and 21 percent were aged 4, 20 percent were 5, 20 percent were 6, 20 percent were 7, and 19 percent were 8.

Balance checks

In *Table 1*, we test whether the average observable characteristics of localities, schools, households, and children are comparable in the four experimental groups. We present the coefficients obtained by successively regressing each of the characteristics presented in the left-hand column of the table on dummy variables indicative of children's, parents', households', schools' or localities' treatment status dummies (T_i^{PRE}, T_i^{PRI}, or $T_i^{PRE+PRI}$) and stratum fixed effects. We also test the equality of the estimated coefficients associated with the three treatment dummies. Differences between groups are rarely statistically significant, suggesting that the randomization procedure created comparable

groups: of the 150 tests performed, four are statistically significant at the 10 percent level, three at the 5 percent level, and zero at the 1 percent level.

IV. Results

A. Implementation of the interventions

We begin by examining how the preschool and primary school interventions were implemented.

Preschool intervention

Preschools were built in the first year of the project (Year 0) and scheduled to start welcoming children from the 2nd year (Year 1). As displayed in *Appendix A.7.A*, delays in preschool openings were minimal according to administrative data: 60 percent of the 68 preschools opened at the start of Year 1 (the 2019/2020 school year). This figure rose to 90 percent a month later, and approached 100 percent in subsequent months.[36]

Pedagogical practices observed in preschools were perfectible but relatively good. Teach ECE observation data collected in May 2020 from the 68 preschools shows that teaching practices obtained an overall average score of 3.1 out of 5 (*Appendix A.7.B*).[37] If practices are relatively good in some areas (*e.g.*, creating an atmosphere conducive to learning), others show considerable scope for improvement in others. In particular, we find that children's autonomy and social and collaborative skills could be further encouraged, notably by creating the necessary conditions for children to assume responsibilities within the classroom and to interact with each other more regularly.[38] It is worth noting that some of these dimensions seem to be easily perfectible with relatively light training. Observation data collected in May 2023 on a randomly selected subset of preschools (24 out of 68) reaches similar conclusions.

We find no differences in the way the preschool intervention was implemented in the *PRE* and *PRE+PRI* groups. In particular, Teach ECE observation data collected in May 2020 shows that

[36] Overall, administrative data on opening dates can be considered to be highly accurate. It should be noted that in the event of delays, the communities concerned were encouraged not to wait for construction work to be completed before starting the preschool intervention, and to make space available to accommodate the children with the aim of starting the intervention at the start of the 2019/2020 school year.

[37] Educators were observed in each class of each preschool. The distribution of scores is as follows: 2 percent of educators scored between 1 and 1.99, 37 percent between 2 and 2.99, 56 percent between 3 and 3.99 and 6 percent between 4 and 5.

[38] These observations are consistent with qualitative data and discussions with MoE representatives, suggesting that teaching tends to be highly teacher-centered, leaving little room for interaction and initiatives.

teaching practices received an overall average score of 3.2 in the *PRE* group and 3.1 in the *PRE+PRI* group.

Primary school intervention

Both survey data collected from primary school teachers and principals in May 2023 and monitoring data collected by the MoE on the implementation of the interventions suggest that all components of the primary school intervention were implemented as planned.

In all, 41 of the 68 schools selected to receive the primary school intervention received a grant to fund different types of infrastructure investment (*PRI*: 23; *PRE+PRI*: 18): 19 schools were able to finance the construction of a block of three classrooms (*PRI*: 8; *PRE+PRI*: 11), 28 schools the construction of a block of latrines (*PRI*: 14; *PRE+PRI*: 14),[39] ten schools the purchase of furniture (tables, desks, benches, armchairs, cupboards, etc.) (*PRI*: 8; *PRE+PRI*: 2), eight schools the construction of an office for the principal (*PRI*: 2; *PRE+PRI*: 6), and six schools the installation of a water point (*PRI*: 3; *PRE+PRI*: 3) (*component #1: improving school infrastructure*). Moreover, schools received a financial subsidy based on the number of teaching groups, averaging US$1,096 per year (*component #2: increasing schools' financial endowments*), as well as a second grant, disbursed in the third and fourth years of the program (Years 2 and 3), which was conditional on their overall performance and averaged US$715 per year.[40] Annual meetings were held in the localities to discuss their primary schools' performance (*component #3: providing school staff with incentives to support learning*).[41]

As shown in *Appendix A.8,* teachers' pedagogical practices also changed in the desired direction (*component #4: promoting better pedagogical practices*). Survey data collected from primary school teachers suggest that nearly all grade-1-to-3 teachers in schools selected to receive the primary school intervention were using the new pedagogical materials designed as part of the project to prepare their lessons – in both literacy and mathematics. Classroom observations also suggest that, four years after the start of the intervention, the key pedagogical principles put forward by the intervention were still used more frequently in *PRI* and *PRE+PRI* schools, especially in mathematics. It should be noted, however, that the intervention had no impact on the percentage of teachers who reported using a syllabic-like approach to teaching reading, which was already 85 percent in the control group. Finally, follow-up survey data indicate that the intervention also increased the share of teachers reporting that

[39] A latrine block contains 4 latrines: two for girls and two for boys.
[40] No misappropriation or misuse of any of the financial endowments was reported.
[41] On average, sampled schools selected to receive the primary school intervention received US$5,813 in total over the four-year period, US$5,787 for schools in the *PRI* group and US$5,860 for schools in the *PRE+PRI* group.

inspectors and pedagogical advisors had intervened in their class since the start of the school year (from 76 to 94 percent in the *PRI* group and to 91 percent in the *PRE+PRI* group), as well as the average number of such visits (from 1.7 initially to 4.0 in the *PRI* group and 4.5 in the *PRE+PRI* group). However, the impact of the intervention on the share of teachers reporting that their school principal had intervened in their class is more limited, with qualitative evidence suggesting that they may already be too busy to take on these additional tasks.

Again, we find no differences in the way the primary school intervention was implemented in the *PRI* and *PRE+PRI* groups. None of the coefficients presented in *Appendix A.8* are statistically different from one group to another.

B. Impact of the preschool intervention alone

To measure the impact of the preschool intervention, we compare children aged 4 to 5 at the time of the follow-up survey in the *PRE* and *CON* groups (*Table 2, column 3*).

First, building a preschool in a locality substantially increased the probability of a child of preschool age being enrolled in one at follow-up, although there is still considerable room for improvement (*Table 2, Panel A*). While only 3 percent of control children aged 4 to 5 were enrolled in a preschool during the school year that had just ended at the time of the follow-up survey, this share increased by 32 percentage points in the *PRE* group. Hence, the proportion of children not enrolled in preschool remained high, with 65 percent of *PRE* children aged 4 to 5 not enrolled in preschool at follow-up. In the *PRE* group, 53 percent of children considered that the child was too young, and 23 percent that they lacked the necessary funds.

Second, the quality of the intervention implemented by the MoE was sufficient to promote child development (*Table 2, Panel B*). Despite preschool enrollment being limited, the IDELA score capturing overall child development was 0.23 standard deviations higher in *PRE* group localities than in the control group. The effect is statistically significant on motor skills (p-value=0.054), emergent language and literacy (p-value=0.046), and emergent numeracy/mathematics (p-value=0.019), which increased from 0.21 to 0.28 standard deviations. The magnitude of the effects is substantial, with a simple back-of-the-envelope calculation suggesting that, in the subset of children who attended preschool as a result of the preschool intervention, child development improved by 0.72 standard deviations.

Third, in line with the literature, we find that children at the lower end of the child development distribution benefit most from the intervention (*Table 2*, *Panel C*). In the *PRE* group, the share of children whose level of development would have fallen in the first quartile of the child development distribution had they not received the preschool intervention (proxied by the distribution in the control group) is reduced by 10 percentage points (statistically significant at the 5 percent level). The intervention increased the percentage of children in the top quartile by 9 percentage points (statistically significant at the 10 percent level).

Fourth, the positive short-term effects of the preschool intervention seem to persist into the early years of primary school (*Table 3*, *column 3*). Focusing on children aged 6 to 7 at the time of the follow-up survey, we find that children's average competencies in literacy and mathematics were 0.23 standard deviations higher in *PRE* localities than in the control group. This effect is particularly significant on literacy skills (+0.28 standard deviations, p-value=0.006), suggesting that, as intended, preschool successfully helped children become more familiar with the language of instruction. The effect on mathematics skills is less obvious (+0.16 standard deviations, p-value=0.148).

Interestingly, this medium-term effect may be explained not only by the impact of the intervention on the development of enrolled children, but also by the increase in the share of children enrolled in primary school at follow-up that it generated. Indeed, the share of 6- and 7-year-olds enrolled in school rose from 35 percent in the control group to 45 percent in *PRE* localities. This suggests that preschools enabled some children who would not otherwise have attended primary school (or who would only have done so later on) to gain a foothold in the education system and start primary school at the recommended age.

C. Impact of the primary school intervention alone

To measure the impact of the primary school intervention, we compare children aged 6 to 8 at the time of the follow-up survey in the *PRI* and *CON* groups (*Table 4*, *column 4*).

First, the primary school intervention increased the share of 6- to 8-year-old children who were enrolled in a primary school at follow-up from 39 to 46 percent in the *PRI* group (p-value=0.133) (*Table 4*, *Panel A*). It also increased the share of 6- to 8-year-old children who had *ever* been enrolled in a primary school at follow-up from 40 to 47 percent. This suggests that improving learning conditions for children, including through actions that are visible to all (*e.g.*, construction of

classrooms and/or toilets, organization of public meetings), can contribute to reducing the share of out-of-school children.

Second, the primary school intervention increased children's cognitive skills. Despite enrollment being, once again, limited in primary school, the average competencies in literacy and mathematics of children aged 6 to 8 increased by 0.24 standard deviations in the *PRI* group (statistically significant at the 1 percent level). This time, effect sizes are very similar for literacy and mathematical skills (0.22 and 0.24 respectively). Again, a simple back-of-the-envelope calculation suggests that, in the subset of children who attended primary school, cognitive skills increased by 0.52 standard deviations. We also find that the primary school intervention helped decrease by 11 percentage points the share of children whose level of competencies would have fallen within the lower half of the cognitive skills distribution had they not received the primary school intervention (proxied by the distribution in the control group).

Third, a detailed analysis of administrative test score data, collected by the MoE on a random subset of pupils at the end of Year 1 and Year 2, suggests that it is the improvement in teachers' pedagogical practices that is driving these effects (additional information on collected data and sampling strategy can be found in *Appendix 9*).[42] While the pedagogical approaches were implemented simultaneously for all three levels from Year 1 in mathematics, their implementation was staggered from Year 1 to Year 3 in literacy. In Year 1, while first-graders benefited from all components of the primary school intervention, second- and third-graders benefited from all components but the one aimed at improving teaching practices in literacy. As displayed in *Table 5* (column 4), by the end of Year 1, pupils' average competencies had improved in all three grades in mathematics, but only in grade 1 in literacy. In Year 2, while first- and second-graders benefited from all components of the primary school intervention, third-graders benefited from all components but the one aimed at improving teaching practices in literacy. By the end of that school year, pupils' skills had increased in all three grades in mathematics, but only in the first and second grades in literacy.

Although we cannot assess what impact the component aimed at improving teachers' pedagogical practices would have had if it had been implemented alone, our results show that this component is the main driver for the primary school intervention's effects.

[42] Data were collected in 102 localities (out of the 136 sampled localities): the 68 localities selected to receive the primary school intervention and the 34 control localities.

D. Discussion on the cost-effectiveness of the preschool and primary school interventions

We begin by comparing the magnitude of the impact of the preschool intervention with that of the primary school intervention. To do so, we restrict our focus to children aged 6 to 7 at the time of follow-up[43] and find that the two interventions had similar effects on children's enrollment in primary school and average competencies in literacy and mathematics (*Table 3*). In the *PRE* group, four years after the children were offered to enroll in an ESDEP preschool, their average competencies were 0.23 standard deviations higher at follow-up than those of control group children (column 3). In the *PRI* group, two years after the children should have enrolled in grade 1 at an ESDEP primary school, their average competencies were 0.26 standard deviations higher than those of the control group (column 4). These two effects are not significantly different at the 10 percent threshold (p-value=0.813, see column 6).

With regard to intervention costs, the preschool intervention proved considerably less costly than the primary school intervention over the five years of the pilot project (*Table 6*). In total, we estimate that the preschool intervention cost close to US$52,858 per locality and the primary school intervention close to US$82,000 per primary school. On the costs of the *preschool* intervention, it should be noted that with an average of 26 children per class, the total cost of the intervention per child is only US$254 per year for the duration of the pilot project, and only US$155 per child per year if fixed costs are excluded to better assess the long-term financial cost to the MoE's budget. Regarding the costs of the *primary school* intervention, we observe marked differences across components. In particular, component 3, which aimed at providing school staff with incentives to support learning, accounts for 47 percent of the intervention's total cost. The expensiveness of this component is mainly due to the substantial cost of collecting data to monitor schools' annual performance. That is why this component was no longer implemented from Year 3 onwards.

As a consequence, the preschool intervention proved more cost-effective than the primary intervention *over the course of the pilot*, but evidence suggests that this conclusion may not hold in the longer term and/or for more targeted primary school interventions, limited to components with a small cost-benefit ratio (*e.g.*, interventions designed to improve pedagogical practices). The first reason is that designing more cost-effective primary school interventions seems within relative reach.

[43] As mentioned in *Section III.B*, in the *PRE* group, these children were old enough to have been enrolled in an ESDEP preschool for two years in the past and old enough to have been enrolled in grade 1 or 2 in a primary school *not* receiving the ESDEP during the school year that had just ended at follow-up. In the *PRI* group, these children did not have access to an ESDEP preschool and were old enough to have been enrolled in grade 1 or 2 in an ESDEP primary school during the school year that had just ended at follow-up.

In fact, the total cost of the primary school intervention given here represents more of an upper bound to the actual cost of the intervention whose effects we measure in *Table 3*. Indeed, our estimate includes the entire cost of component #3, which was discontinued as of Year 3, whereas the reported effects of the primary school intervention measure its impact on individuals who were expected to enter grade 1 as of Year 3, and therefore would not have been exposed to component #3.[44] One consequence is that, although we cannot infer from our experiment that a primary school intervention focused solely on improving pedagogical practices in grades 1-3 would have effects similar to those reported in Table 3, our results nevertheless suggest that interventions in primary schools could easily gain in cost-effectiveness by being more targeted to reduce costs.

The second reason is that it is potentially more difficult to increase the relative cost-effectiveness of the preschool intervention, especially over the longer term, because there are no clear sources of savings, and because the intervention includes a large proportion of variable costs. Indeed, opening new preschools inherently involves recruiting teachers and incurring relatively high variable costs. In this respect, it should be noted that the amount of these variable costs would have been considerably higher had preschool teachers been MoE teachers and not members of the recipient communities. In contrast, the primary school intervention relies on a preexisting body of teachers, its costs are mainly fixed (building infrastructure, developing new pedagogical tools, etc.). Therefore, in the long term, unless the effects of the preschool intervention increase relative to those of the primary school intervention, the latter may be more effective than the former.

Given the positive effects of the preschool intervention on child development, these results should not lead LMICs to abandon preschool construction programs. Indeed, their cost-effectiveness compares relatively well with traditional parent support programs designed to foster child development (see J-PAL (2020) for a literature review),[45] which tend to cost several hundred dollars per child.[46]

[44] Since some of these children entered primary school before the recommended age, the costs of component 3 cannot be deducted from the total cost of the intervention to account for the actual cost of the primary school intervention whose effect we are measuring on children aged 6 and 7 at follow-up.

[45] These parenting programs designed to foster early childhood stimulation have been shown to be particularly effective at improving child development. See for instance Baker-Henningham and López Bóo (2010), Gertler et al. (2014), Rao et al. (2014), Aboud and Yousafzai (2015), Britto et al. (2015), and Britto et al., (2017).

[46] For example, the program studied in Attanasio et al. (2014) costs about US$750 per child, the intervention discussed by Andrew et al. (2020) costs US$251, and the one studied in Attanasio et al. (2022) costs US$322.

E. Impact of combining the preschool intervention and the primary school intervention

We compare the effect of the preschool intervention, of the primary school intervention, and of implementing the two interventions concomitantly on children aged 6 to 7 in the *PRE*, *PRI*, and *PRE+PRI* groups (see *Table 3*, columns 5, 7, and 8).

The joint implementation of the preschool and primary school interventions fails to improve children's cognitive skills beyond what was achieved by each intervention when implemented alone, suggesting some degree of substitutability between the two interventions. While children's cognitive skills increased by 0.24 standard deviations in the *PRE+PRI* group compared to the control group (statistically significant at the 5 percent level), this effect is not statistically different from those observed in the *PRE* group (0.26 standard deviations) and *PRI* group (0.21 standard deviations) at the 10 percent threshold – p-values are 0.969 and 0.827 respectively.

Two distinct but potentially concomitant substitution effects may help explain why the combination of the two interventions does not result in a more substantial improvement of children's competencies than that achieved by the interventions taken separately. First, the two interventions may be actual substitutes in the educational production function. Second, the two interventions may be perceived as substitutable (whether or not they actually are) by parents faced with various constraints (financial, temporal, etc.). These parents may decide whether or not to enroll their children in preschool and/or primary school based on their expected returns and general preferences.

First, we find evidence of the second type of substitution effect, as evidenced by the preschool enrollment rates, with the share of children ever enrolled in a preschool at follow-up dropping from 33 percent in the *PRE* group to 23 percent in the *PRE+PRI* group. We interpret this effect as the result of households forgoing non-compulsory preschool education when a concomitant improvement in the primary education system occurs, presumably to reduce (direct and opportunity) costs. The consequence is that the effect of the preschool intervention on child development is significantly reduced in the *PRE+PRI* group, and is no longer statistically different from 0. The IDELA score measuring children's overall development increases by only 0.08 standard deviations in *PRE+PRI* group localities compared with control group localities (versus 0.23 standard deviations in the *PRE* group).

While the drop in preschool enrollment is comparable for boys and girls (*Table 7*), it affected two different subsets within these demographic groups. As displayed in *Figure 4*, although the distribution

of development levels for boys aged 4 to 5 who were *never* enrolled in preschool is similar in the *PRE* and *PRE+PRI* groups, it is not the case for girls. This implies that the characteristics of boys aged 4 to 5 *who did enroll* in preschool are comparable in the *PRE* and *PRE+PRI* groups, but not for girls. In the *PRE* group, girls with a lower level of development are under-represented among girls who *never* enrolled compared with girls in the *CON* group, suggesting that these girls are over-represented among those who enrolled in preschool. In the *PRE+PRI* group, it is girls with higher levels of development who are under-represented among girls who *never* enrolled, suggesting that these girls are over-represented among those who enrolled in preschool. Thus, the concomitant implementation of the two interventions seems to have decreased households' probability of sending their daughter to preschool if she had a low level of development (compared to what would have happened had the village only received the preschool intervention) – whereas this decision does not seem to be correlated with the level of development for boys.

Second, we also find evidence of the first type of substitution effect, and suspect that it may actually be the main driver of the disappointing cognitive ability results in the *PRE+PRI* group. While the level of development of 4- to 5-year-old boys remains comparable in the two groups of localities that received the preschool intervention (despite the drop in preschool enrollment mentioned above), the addition of the primary school intervention does not further increase the cognitive skills of 6- to 7-year-old boys. This suggests that the two interventions are substitutes in the educational production function. Indeed, evidence suggests that the pedagogical practices promoted by the primary school intervention are particularly well-suited to children at the bottom of the skills distribution (but less so for those higher up) and that, all things being equal, the preschool intervention reduces the share of children in that part of the distribution. Hence, it is possible that the preschool intervention reduces the effect of the primary school intervention by reducing the proportion of children in this category that benefit most from the new pedagogical practices.

V. Conclusions

The results of this study are promising for LMICs for a number of reasons. First, we show that it is possible for LMICs to implement a public preschool system promoting child development, with particularly pronounced effects for children at the bottom of the child development distribution. Effects also seem to persist into the early years of primary school, in particular by helping children gain a foothold in the education system and reducing the proportion of children who stay out of school.

Second, our results indicate that it is possible to improve the performance of an under-achieving primary school education system through interventions designed to improve learning conditions. We measure the effect of a multi-faceted intervention targeting grades 1 to 3 (in theory, children aged six to eight) designed to concomitantly address the main challenges faced by primary school education and find sizable effects on children's learning outcomes (in literacy and mathematics). Here again, the effects are particularly significant for children at the lower end of the cognitive skills distribution. It is also interesting to note that an analysis of the mechanisms at play suggests that enhancing teachers' pedagogical practices is a particularly promising lever to improve children's outcomes.

Third, while the preschool intervention proved more cost-effective than the primary school intervention over the course of the pilot, evidence suggests that more targeted primary school interventions are likely to be more cost-effective, especially in the long run. The reason lies in the important irreducible variable costs inherent to opening up new preschools (related to the salaries of additional staff hired). This does not mean that preschool programs should be abandoned, as their cost-effectiveness compares favorably with traditional child development interventions, but rather suggests that their motivation cannot lie solely in their medium-term effects on children's academic skills. Future studies will tell how both types of investment fare on children's learning outcomes in the long term, and whether the effect of preschool programs can also be felt in other important areas, promoting education, reducing crime, improving health, and raising earnings, as in high-income countries (Garces, Thomas and Curry, 2002; Deming, D., 2009; Heckman et al., 2010; Campbell et al. 2014; García et al., 2014; Rossin-Slater and Wüst, 2020; Gray-Lobe, Pathak, and Walters, 2023).

However, the study also highlights a number of reasons for caution. Most importantly, we find evidence of two types of substitution effects that may contribute to reducing the effectiveness of investments made at different levels of the education system. First, we find that such investments can be perceived as substitutable by households. In our study, we observe that the concomitant implementation of the preschool and primary school interventions led households to forgo preschool education. Worryingly, this substitution effect was particularly detrimental to girls with low levels of development. Second, we find evidence that educational investments made at different levels may be substitutes in terms of their impact on children's skills. Although this calls for future research, these results encourage the implementation of corrective measures to limit these unexpected undesirable effects, and suggest that investments at different levels of the education system should be made (and their effects tested) sequentially, starting with the lowest levels.

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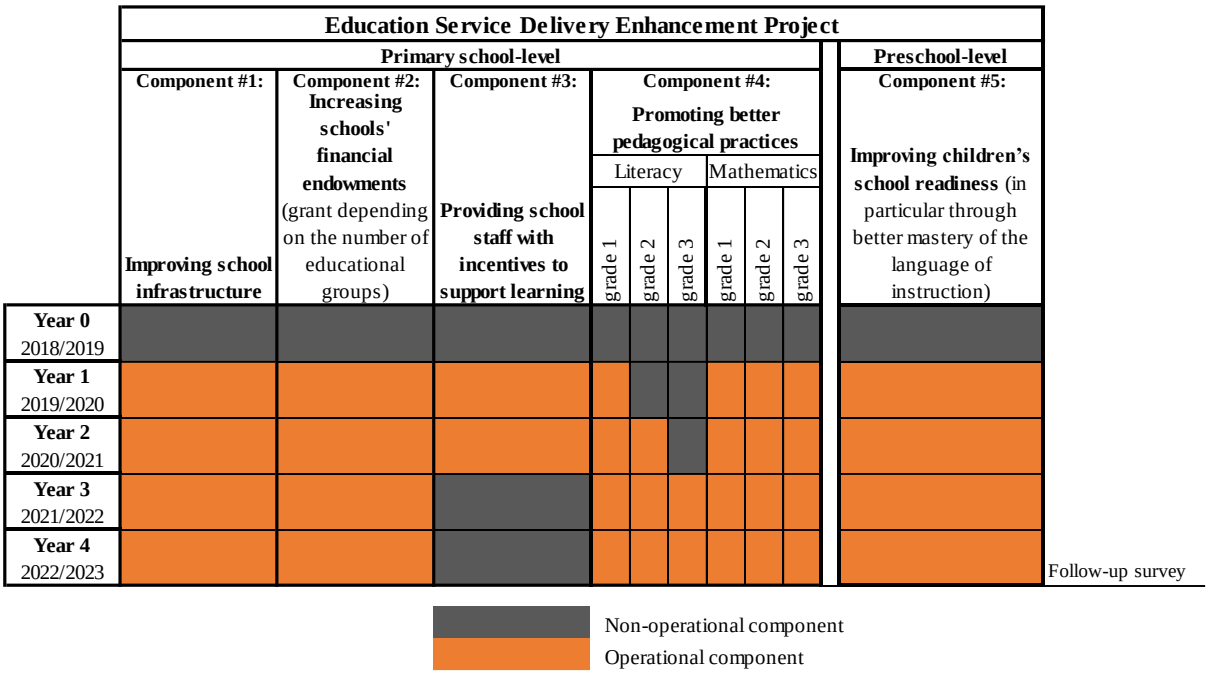
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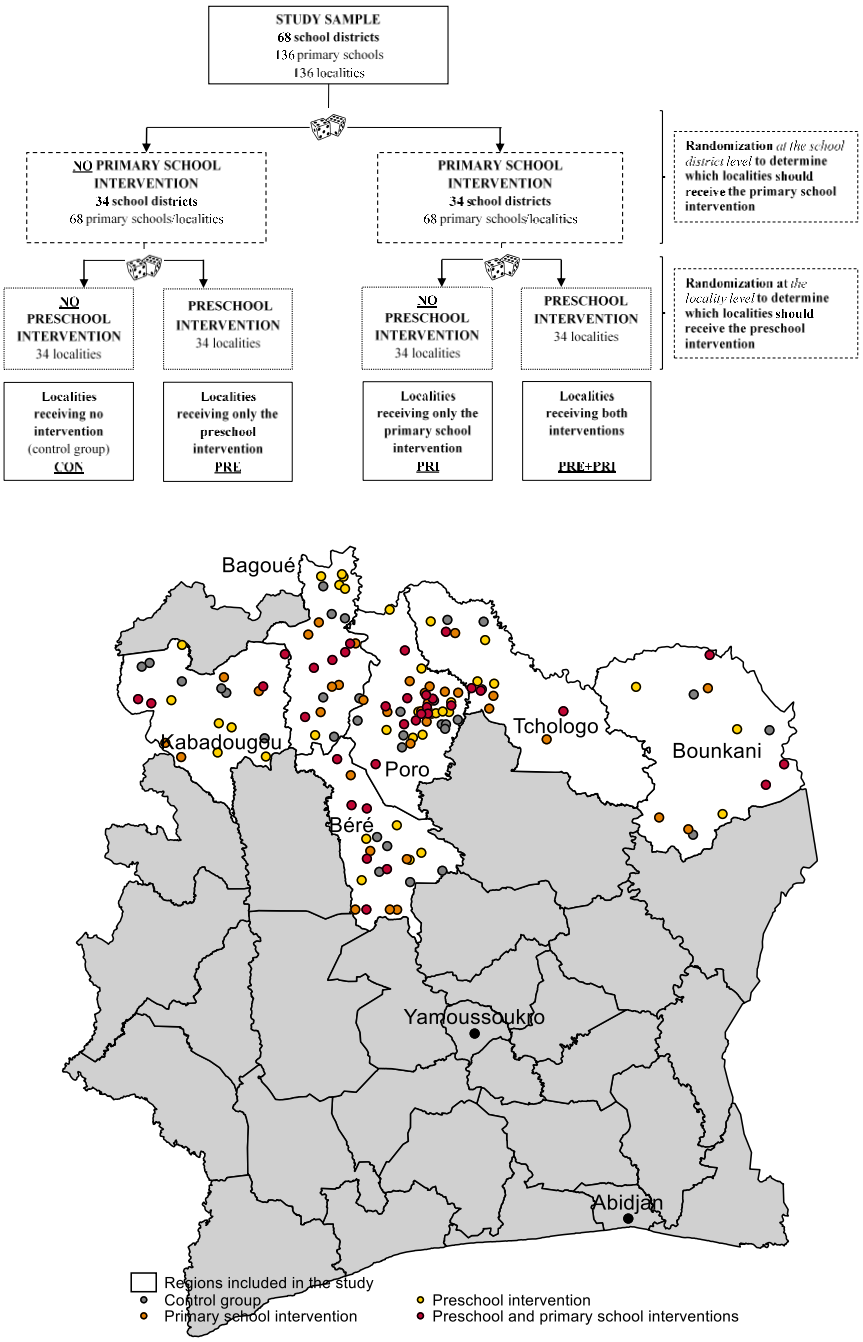
Figures

Figure 1: Project timeline



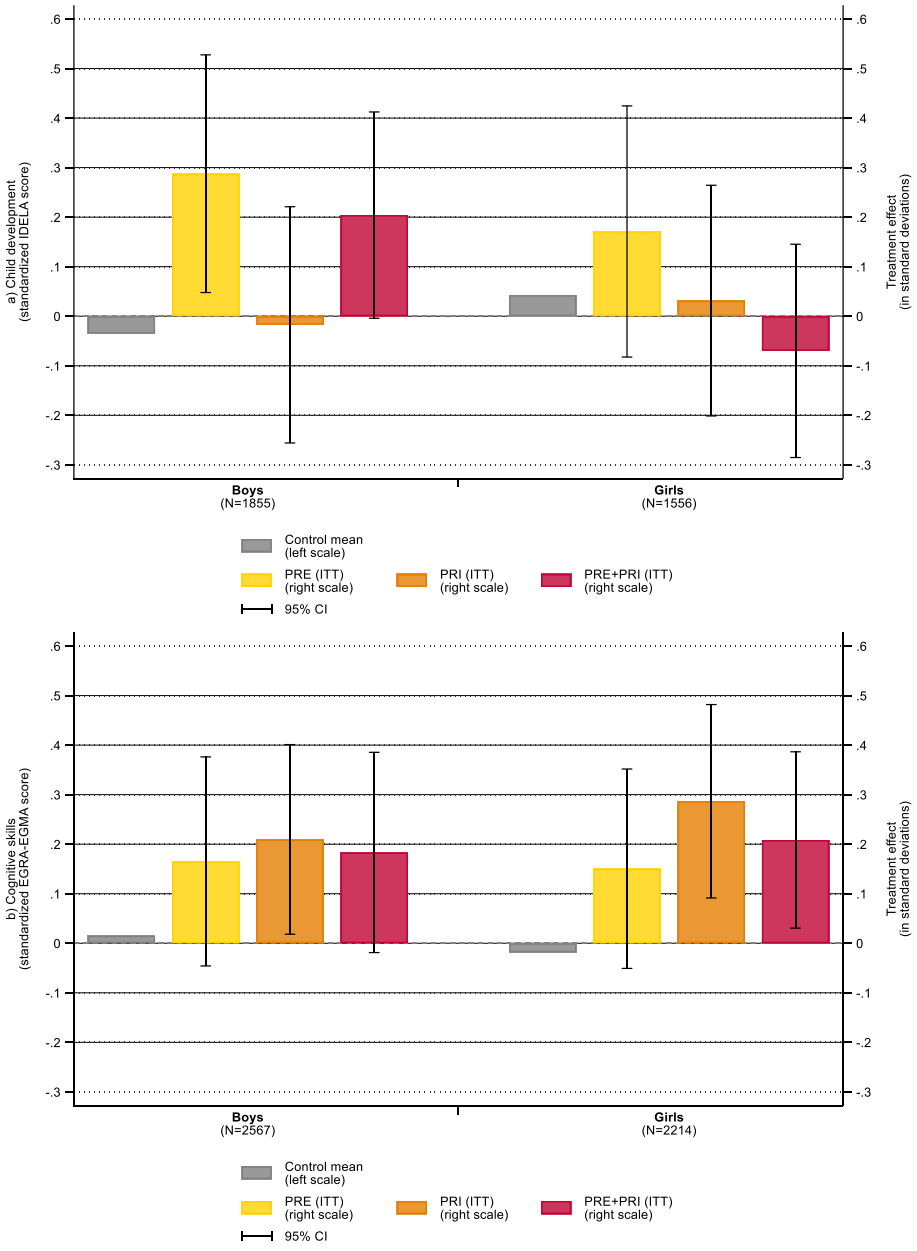
Notes: In this figure, we show when each component of the Education Service Delivery Enhancement Project (ESDEP) started. Year 0 was the preparation year (corresponding to the 2018/2019 school year). All but one of the ESDEP components began simultaneously at the start of Year 1. Indeed, while the new pedagogical approach for mathematics was implemented in all three classes from Year 1, the new approach for literacy was only introduced gradually over the first three years of the pilot, with grade 1 classes receiving it from Year 1, grade 2 classes from Year 2, and grade 3 classes from Year 3. Component #3 was discontinued from Year 3.

Figure 2: Experimental design and location of sampled localities



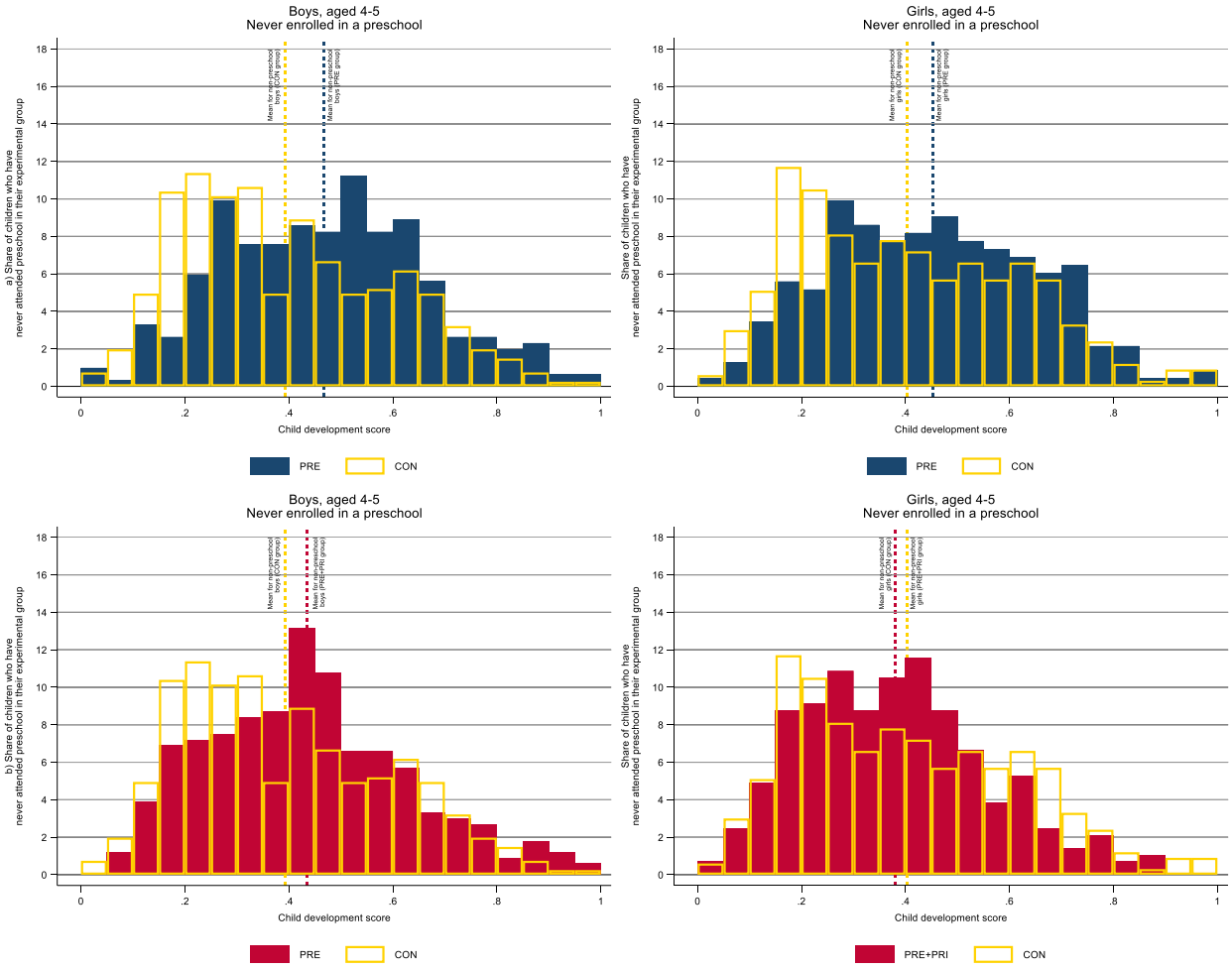
Notes: The study covers six of the country's regions: Bagoué, Béré, Bounkani, Kabadougou, Poro, and Tchologo. First, sampled localities were randomly selected from all eligible localities in these regions. In total, 136 localities were selected, spread across 68 school districts. Second, 34 of the 68 school districts were randomly selected to receive the primary school intervention. Third, 68 of the 136 localities were randomly selected to receive the preschool intervention. Of the 136 localities, 34 received both the primary school and preschool interventions, 34 received only the preschool intervention, 34 received only the primary school intervention, and 34 received nothing.

Figure 3: Heterogenous effects on child development (children aged 4-5) and cognitive skills (children aged 6-8) by gender



Notes: This figure depicts the impact of the interventions on the development level of boys and girls aged 4 to 5 (Panel a)) and on the cognitive skills of children aged 6 to 7 (Panel b)).

Figure 4: Level of development of children who had never been enrolled in a preschool at follow-up (*CON*, *PRE*, and *PRE+PRI*)



Notes: This figure shows the distribution of development level observed at follow-up for boys and girls who had never been enrolled in preschool in the *CON*, *PRE*, and *PRE+PRI* groups. Child development is measured using the non-standardized IDELA score, ranging from 0 to 1, with higher scores reflecting more advanced levels of development. Panel a) compares the distribution in control group localities (*CON*) and in the localities that only received the preschool intervention (*PRE*). Panel b) compares the distribution in control group localities (*CON*) and in the localities that received both the preschool and the primary school interventions (*PRE+PRI*). The mean of each distribution is represented by a vertical dotted line that follows the color code: yellow for the *CON* group, blue for the *PRE* group, and red for the *PRE+PRI* group. The average development level of non-preschool children in the *PRE* and *PRE+PRI* groups is almost always higher than the control group average, suggesting that children with low development levels are over-represented among those enrolled in preschool. The only exception is non-preschool girls in the *PRE+PRI* group, who have a lower average development level than the girls in the control group. This suggests that these girls are less likely to be enrolled in preschool when the two interventions are implemented concomitantly in a locality.

Tables

Table 1: Background characteristics at follow-up and balance checks

			Balance checks					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			β_{PRE}	β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRE} = \beta_{PRI}$	$\beta_{PRE} = \beta_{PRE+PRI}$	$\beta_{PRI} = \beta_{PRE+PRI}$
	Total #obs.	Sample mean (s.d.)	Diff. (s.e.)	Diff. (s.e.)	Diff. (s.e.)	P-value	P-value	P-value
Panel A: Locality-level characteristics (prior to randomization)								
Total number of inhabitants (2014 census)	128	1413.51	-30.58	217.88	45.36	0.792	0.876	0.870
		(1790.17)	(387.73)	(518.46)	(376.90)			
Rural locality	135	0.97	0.00	-0.00	-0.00	0.944	0.960	0.986
		(0.17)	(0.04)	(0.04)	(0.04)			
Electrified locality	135	0.38	0.00	-0.12	0.01	0.246	0.918	0.246
		(0.49)	(0.11)	(0.11)	(0.12)			
Panel B: School-level characteristics (prior to randomization)								
Total number of pupils	135	174.70	-13.26	4.78	13.72	0.258	0.086	0.538
		(89.46)	(21.66)	(22.74)	(22.72)			
Number of pedagogical groups	135	5.50	0.30	-0.01	0.11	0.292	0.510	0.732
		(1.11)	(0.26)	(0.31)	(0.26)			
Number of teachers	135	4.90	0.07	-0.01	0.13	0.936	0.666	0.616
		(1.52)	(0.43)	(0.41)	(0.37)			
Lacks at least one classroom	135	0.41	0.03	0.01	-0.11	0.814	0.204	0.404
		(0.49)	(0.12)	(0.13)	(0.11)			
Share of classrooms:								
in good condition	135	0.66	0.08	0.02	0.04	0.454	0.506	0.948
		(0.37)	(0.08)	(0.08)	(0.09)			
in poor condition	135	0.16	-0.07	-0.01	-0.07	0.426	0.766	0.468
		(0.27)	(0.07)	(0.06)	(0.06)			
in non-permanent materials	135	0.18	-0.01	-0.01	0.03	0.898	0.426	0.616
		(0.27)	(0.06)	(0.07)	(0.07)			
The school had:								
latrines	135	0.51	-0.17	-0.16	-0.08	0.964	0.466	0.550
		(0.50)	(0.11)	(0.12)	(0.12)			
a water point	135	0.27	0.18	0.03	0.15	0.158	0.798	0.350
		(0.44)	(0.11)	(0.10)	(0.11)			
a hand-washing basin	135	0.16	-0.06	-0.16 *	-0.18 **	0.198	0.104	0.630
		(0.36)	(0.10)	(0.09)	(0.09)			
a school management committee	135	0.78	0.11	-0.06	-0.06	0.020	0.046	0.954
		(0.42)	(0.06)	(0.09)	(0.09)			
Panel C: Household-level characteristics (at follow-up)								
Household status								
Monogamous	5722	0.78	-0.02	-0.00	0.01	0.607	0.270	0.574
		(0.41)	(0.03)	(0.03)	(0.03)			
Polygamous	5722	0.10	0.01	0.00	-0.00	0.648	0.459	0.819
		(0.30)	(0.02)	(0.02)	(0.02)			
Other	5722	0.06	-0.01	-0.01	-0.00	0.777	0.642	0.443
		(0.25)	(0.01)	(0.01)	(0.01)			
Missing	5722	0.05	0.02	0.02	-0.01	0.865	0.076	0.120
		(0.23)	(0.01)	(0.01)	(0.01)			
Panel D: Child-level characteristics (at follow-up)								
Age	8397	5.96	-0.05 **	0.01	-0.00	0.006	0.053	0.433
		(1.41)	(0.03)	(0.03)	(0.03)			
Girls	8325	0.46	0.01	0.02	0.01	0.344	0.990	0.368
		(0.50)	(0.02)	(0.02)	(0.02)			
Biological mother lives in household	8397	0.85	-0.00	0.00	0.00	0.879	0.853	0.975
		(0.36)	(0.02)	(0.02)	(0.02)			
Biological father lives in household	8397	0.80	-0.03	-0.03	0.01	0.982	0.206	0.271
		(0.40)	(0.03)	(0.03)	(0.03)			

Notes: In this table, we present the average characteristics of localities, schools, households, and children surveyed at follow-up. Then, we examine the degree of similarity of the experimental groups compared in this study: 1) T_{PRE} and C, 2) T_{PRI} and C, and 3) $T_{PRE+PRI}$ and C. To carry out these tests, we regressed each variable displayed in the left-hand column on a vector of dummy variables indicating observations' treatment status (T_{PRE}, T_{PRI}, and $T_{PRE+PRI}$, respectively), and strata fixed effects. We also test the equality of the coefficients associated with T_{PRE}, T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-values.
In Panels A and B, standard errors are boostraped (1,000 replications). In Panels C and D, standard errors are clustered at the village and household levels.
*, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Table 2: Impact on cognitive and non-cognitive skills of children aged 4 and 5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			β_{PRE}	β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRE}=\beta_{PRI}$	$\beta_{PRE}=\beta_{PRE+PRI}$	$\beta_{PRI}=\beta_{PRE+PRI}$
	Total #obs.	Control Mean (s.d.)	Diff. (s.e.)	Diff. (s.e.)	Diff. (s.e.)	P-value	P-value	P-value
Panel A: Enrollment								
Ever attended preschool	3335	0.05	0.33 ***	0.04 *	0.23 ***	0.000	0.021	0.000
		(0.21)	(0.03)	(0.02)	(0.03)			
Enrolled in a preschool at follow-up	3335	0.03	0.29 ***	0.04 *	0.22 ***	0.000	0.105	0.000
		(0.17)	(0.03)	(0.02)	(0.03)			
Panel B: Child development								
Child development (std)	3411	-0.00	0.23 **	0.01	0.08	0.062	0.153	0.494
		(1.00)	(0.12)	(0.11)	(0.10)			
Motor development (std)	3411	-0.00	0.21 *	0.04	0.12	0.108	0.352	0.422
		(1.00)	(0.11)	(0.10)	(0.10)			
Emergent language and literacy (std)	3411	-0.00	0.28 **	-0.07	0.02	0.014	0.058	0.438
		(1.00)	(0.14)	(0.11)	(0.11)			
Emergent numeracy/mathematics (std)	3411	-0.00	0.19 **	-0.02	0.07	0.035	0.118	0.358
		(1.00)	(0.08)	(0.10)	(0.08)			
Social-emotional development (std)	3411	-0.00	0.14	0.00	0.06	0.279	0.494	0.627
		(1.00)	(0.12)	(0.11)	(0.10)			
Panel C: Distributional effects								
Share of respondents in the following quartile(s) of the control group:								
In quartile 1	3411	0.25	-0.10 **	-0.05	-0.06	0.231	0.282	0.861
		(0.43)	(0.04)	(0.05)	(0.04)			
In quartiles 1 or 2	3411	0.50	-0.08	0.02	-0.00	0.109	0.156	0.653
		(0.50)	(0.06)	(0.06)	(0.05)			
In quartiles 1 to 3	3411	0.75	-0.09 *	-0.01	-0.01	0.129	0.086	0.956
		(0.43)	(0.05)	(0.04)	(0.04)			

Notes: In this table, we present the Intent-to-Treat effect of the intervention on our primary outcome (*e.g.*, child development) for children aged 4 and 5 (*i.e.*, children who were old enough to have been enrolled in a preschool built as part of this project during the school year that had just ended at follow-up). To do so, we estimate equation (1) for each outcome displayed in the left-hand column. Covariates were selected using a Double Lasso procedure. We report the coefficients and standard errors associated with the three dummy variables T_{PRE}, T_{PRI}, and $T_{PRE+PRI}$ indicative of children's treatment status. We also test the equality of the coefficients associated with T_{PRE}, T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-values.

Child development is measured using the *International Development and Early Learning Assessment* (IDELA) which measures children's overall development, as well as development in four sub-dimensions: motor development, language development and basic reading skills, basic mathematical skills, and social-emotional development. Variables reflecting child development were standardized by taking into account their age.

In panel C, we calculated the thresholds for dividing the control group into quartiles according to children's level of development. Our estimates show the effect of the interventions on the proportion of children in the different groups whose level of development corresponds to the 1st, 2nd, 3rd or 4th quartile of the control group.

Standard errors are clustered at the village and household levels. *, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Table 3: Impact on cognitive and non-cognitive skills of children aged 6 to 7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			β_{PRE}	β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRE} = \beta_{PRI}$	$\beta_{PRE} = \beta_{PRE+PRI}$	$\beta_{PRI} = \beta_{PRE+PRI}$
	Total #obs.	Control Mean (s.d.)	Diff. (s.e.)	Diff. (s.e.)	Diff. (s.e.)	P-value	P-value	P-value
Panel A: Enrollment								
Ever attended primary school	3264	0.35	0.12 ***	0.08 *	0.08 **	0.357	0.368	0.942
		(0.48)	(0.04)	(0.04)	(0.04)			
Enrolled in a primary school at follow-up	3264	0.35	0.10 **	0.08 *	0.07 *	0.601	0.533	0.947
		(0.48)	(0.04)	(0.04)	(0.04)			
Panel B: Child development								
Cognitive skills (std)	3236	0.00	0.23 **	0.26 ***	0.24 **	0.813	0.969	0.827
		(1.00)	(0.11)	(0.10)	(0.09)			
Literacy (std)	3236	-0.00	0.28 ***	0.25 **	0.18 **	0.746	0.323	0.523
		(1.00)	(0.10)	(0.10)	(0.09)			
Mathematics (std)	3236	-0.00	0.16	0.24 **	0.25 ***	0.506	0.422	0.887
		(1.00)	(0.11)	(0.10)	(0.10)			
Panel C: Distributional effects								
Share of respondents in the following quartile(s) of the control group:								
In quartile 1	3236	0.25	-0.08 ***	-0.04	-0.09 ***	0.161	0.780	0.070
		(0.43)	(0.03)	(0.03)	(0.03)			
In quartiles 1 or 2	3236	0.50	-0.11 **	-0.11 ***	-0.13 ***	0.967	0.607	0.497
		(0.50)	(0.05)	(0.04)	(0.04)			
In quartiles 1 to 3	3236	0.75	-0.10 **	-0.11 **	-0.08 **	0.936	0.696	0.621
		(0.43)	(0.05)	(0.04)	(0.04)			

Notes: In this table, we present the Intent-to-Treat effect of the intervention on our primary outcome (*e.g.*, children's cognitive skills) for children aged 6 and 7 (*i.e.*, children who were old enough to have been enrolled in a preschool for two years in the past and who, during the school year that had just ended at follow-up, were old enough to have been enrolled in grades 1 or 2 in a school not receiving the primary school intervention). To do so, we estimate equation (1) for each outcome displayed in the left-hand column. Covariates were selected using a Double Lasso procedure. We report the coefficients and standard errors associated with the three dummy variables T_{PRE}, T_{PRI}, and $T_{PRE+PRI}$ indicative of children's treatment status. We also test the equality of the coefficients associated with T_{PRE}, T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-values.

Children's cognitive skills are measured using the Early Grade Reading Assessment (EGRA) and the Early Grade Mathematics Assessment (EGMA) (both generating scores out of 100). The cognitive skills outcome is calculated as the simple average of the EGRA and EGMA overall scores.

In panel C, we calculated the thresholds for dividing the control group into quartiles according to children's cognitive skills. Our estimates show the effect of the interventions on the proportion of children in the different groups whose cognitive skills correspond to the 1st, 2nd, 3rd or 4th quartile of the control group.

Standard errors are clustered at the village and household levels. *, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Table 4: Impact on cognitive and non-cognitive skills of children aged 6 to 8

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			β_{PRE}	β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRE} = \beta_{PRI}$	$\beta_{PRE} = \beta_{PRE+PRI}$	$\beta_{PRI} = \beta_{PRE+PRI}$
	Total #obs.	Control Mean (s.d.)	Diff. (s.e.)	Diff. (s.e.)	Diff. (s.e.)	P-value	P-value	P-value
Panel A: Enrollment								
Ever attended primary school	4809	0.40	0.14 ***	0.07	0.07	0.108	0.054	0.955
		(0.49)	(0.04)	(0.05)	(0.04)			
Enrolled in a primary school at follow-up	4809	0.39	0.12 ***	0.07	0.06	0.224	0.097	0.827
		(0.49)	(0.04)	(0.04)	(0.04)			
Panel B: Child development								
Cognitive skills (std)	4781	-0.00	0.16	0.24 ***	0.19 **	0.382	0.712	0.576
		(1.00)	(0.10)	(0.09)	(0.09)			
Literacy (std)	4781	-0.00	0.19 **	0.22 **	0.14 *	0.765	0.621	0.389
		(1.00)	(0.09)	(0.09)	(0.08)			
Mathematics (std)	4781	0.00	0.11	0.24 ***	0.21 **	0.205	0.327	0.783
		(1.00)	(0.10)	(0.09)	(0.09)			
Panel C: Distributional effects								
Share of respondents in the following quartile(s) of the control group:								
In quartile 1	4781	0.25	-0.07 **	-0.06 *	-0.08 ***	0.631	0.672	0.360
		(0.43)	(0.03)	(0.03)	(0.03)			
In quartiles 1 or 2	4781	0.50	-0.06	-0.11 ***	-0.11 ***	0.203	0.209	0.990
		(0.50)	(0.04)	(0.04)	(0.04)			
In quartiles 1 to 3	4781	0.75	-0.07 *	-0.10 **	-0.06 *	0.633	0.697	0.308
		(0.43)	(0.04)	(0.04)	(0.03)			

Notes: In this table, we present the Intent-to-Treat effect of the intervention on our primary outcome (*e.g.*, children's cognitive skills) for children aged 6 to 8 (*i.e.*, children who were old enough to have been enrolled in grades 1 to 3 during the school year that had just ended at follow-up). To do so, we estimate equation (1) for each outcome displayed in the left-hand column. Covariates were selected using a Double Lasso procedure. We report the coefficients and standard errors associated with the three dummy variables T_{PRE}, T_{PRI}, and $T_{PRE+PRI}$ indicative of children's treatment status. We also test the equality of the coefficients associated with T_{PRE}, T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-values.
Children's cognitive skills are measured using the Early Grade Reading Assessment (EGRA) and the Early Grade Mathematics Assessment (EGMA) (both generating scores out of 100). The cognitive skills outcome is calculated as the simple average of the EGRA and EGMA overall scores.
In panel C, we calculated the thresholds for dividing the control group into quartiles according to children's cognitive skills. Our estimates show the effect of the interventions on the proportion of children in the different groups whose cognitive skills correspond to the 1st, 2nd, 3rd or 4th quartile of the control group.
Standard errors are clustered at the village and household levels. *, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Table 5: Impact on test scores of enrolled pupils at the end of Year 2 and Year 3

	(1)	(2)	(3)	(4)	(5)
			β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRI}=\beta_{PRE+PRI}$
	Total #obs.	Control Mean (s.d.)	Diff. (s.e.)	Diff. (s.e.)	P-value
Panel A: Enrolled children, at the end of Year 1					
EGRA					
Grade 1	741	-0.00	0.40 ***	0.58 ***	0.360
		(1.00)	(0.15)	(0.15)	
Grade 2	725	0.00	-0.02	0.10	0.478
		(1.00)	(0.14)	(0.18)	
Grade 3	750	-0.00	0.06	-0.11	0.262
		(1.00)	(0.17)	(0.16)	
EGMA					
Grade 1	741	-0.00	0.62 ***	0.73 ***	0.503
		(1.00)	(0.13)	(0.14)	
Grade 2	725	-0.00	0.41 ***	0.54 ***	0.332
		(1.00)	(0.14)	(0.14)	
Grade 3	750	-0.00	0.31 **	0.22	0.459
		(1.00)	(0.13)	(0.13)	
Panel B: Enrolled children, at the end of Year 2					
EGRA					
Grade 1	728	-0.00	0.49 ***	0.48 ***	0.943
		(1.00)	(0.15)	(0.13)	
Grade 2	746	-0.00	0.38 **	0.42 **	0.828
		(1.00)	(0.16)	(0.17)	
Grade 3	743	-0.00	0.08	0.20	0.392
		(1.00)	(0.15)	(0.15)	
EGMA					
Grade 1	728	0.00	0.73 ***	0.70 ***	0.875
		(1.00)	(0.13)	(0.17)	
Grade 2	746	0.00	0.48 ***	0.57 ***	0.487
		(1.00)	(0.15)	(0.15)	
Grade 3	743	-0.00	0.50 ***	0.67 ***	0.161
		(1.00)	(0.12)	(0.13)	

Notes: In this table, we present the Intent-to-Treat effect of the primary school intervention on pupils' cognitive skills. Data was collected at the end of Year 1 (2019/2020) and Year 2 (2020/2021) by the Ministry of Education from a representative subset of pupils enrolled in grades 1 to 3 in the CON, PRI, and PRE+PRI groups (see Appendix A.9 for information on the sampling strategy). To do so, we estimate equation (1) for each outcome displayed in the left-hand column (without covariates). We report the coefficients and standard errors associated with the two dummy variables T_{PRI} and $T_{PRE+PRI}$ indicative of children's treatment status. We also test the equality of the coefficients associated with T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-values.

Children's cognitive skills are measured using a modified version of the Early Grade Reading Assessment (EGRA) and the Early Grade Mathematics Assessment (EGMA).

Standard errors are clustered at the village and household levels. *, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Table 6: Cost of the interventions

Preschool intervention	Per school
1) Curriculum development (UNICEF)	384
2) Drawing up of construction specification document	126
3) Classroom construction (incl. supervision)	20 685
4) School equipment	2 697
5) Recruitment, training and supervision of preschool staff (pre-service and in-service)	592
6) Community teacher salary (incl. transfer fees)	21 672
7) Community outreach	3 512
Total preschool intervention	**52 858**

Primary school intervention	Per school
1) Improving school infrastructure (component #1)	13 788
2) Increasing school's financial endowments (component #2)	4 384
3) Providing school staff with incentives to support learning (component #3)	36 443
4) Promoting better pedagogical practices (component #4)	22 542
5) Community outreach	2 742
Total primary school intervention	**79 899**

Appendix

Appendix A.1: Trends in the gross pre-primary enrollment rate by region in the world and current pre-primary enrollment rate in Sub-Saharan African countries

Appendix A.2: Percentage of pupils ***not*** *meeting* minimum reading and mathematical skills requirements at the end of primary school in PASEC 2019 Sub-Saharan countries

Appendix A.3: Additional information on ESDEP components

Appendix A.4: Exposure to the interventions of children enrolled in the age-appropriate class by experimental group

Appendix A.5: Additional information on tests used to measure children's cognitive and non-cognitive skills

Appendix A.6: List of covariates included in the Double-Lasso procedure

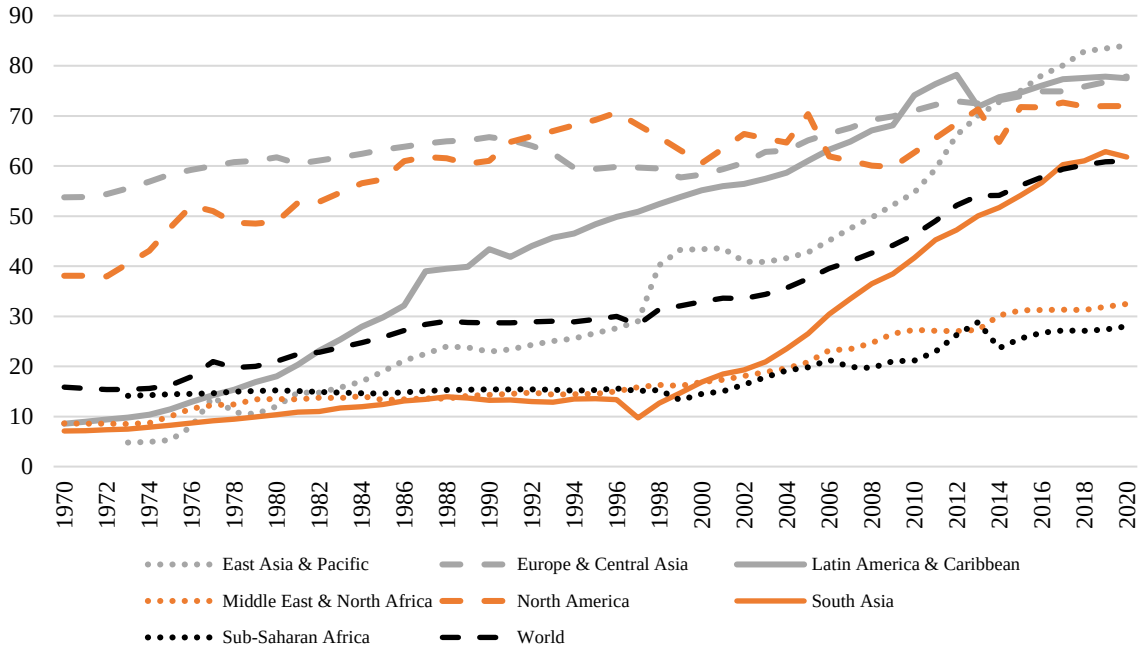
Appendix A.7: Details on the implementation of the *preschool* intervention

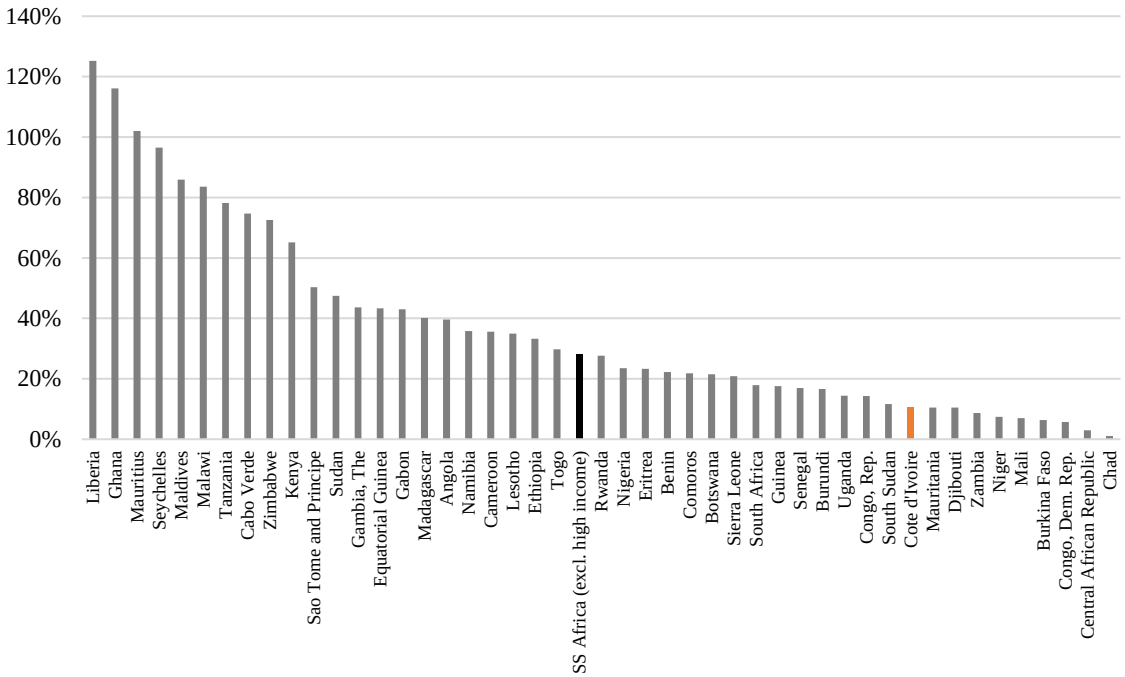
Appendix A.8: Details on the implementation of the *primary school* intervention

Appendix A.9: Impact on enrollment by age

Appendix A.10: Sampling strategy for test score data collected by the Ministry of Education as part of the implementation of the ESDEP

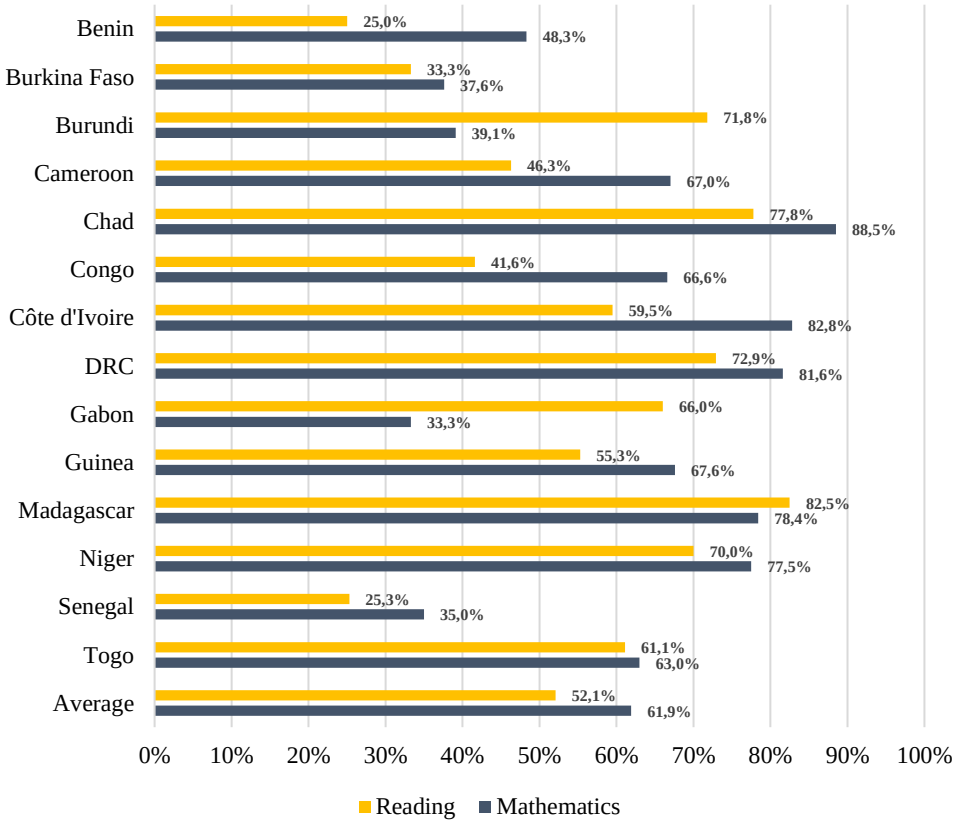
Appendix A.1: Trends in the gross pre-primary enrollment rate by region in the world and current pre-primary enrollment rate in Sub-Saharan African countries





Notes: The gross pre-primary enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the preschool level. For each country, current enrollment in pre-primary education is proxied by its most recent statistics available for the 2015-2020 period. Data is missing for Eswatini, Guinea-Bissau, Mozambique, and Somalia.
Data source: https://data.worldbank.org/indicator/SE.PRE.ENRR

Appendix A.2: Percentage of pupils ***not*** *meeting* minimum reading and mathematical skills requirements at the end of primary school in PASEC 2019 Sub-Saharan countries



Notes: Percentage of pupils *not* meeting minimum reading and mathematical skills requirements at the end of primary school. In the 14 countries that participated in the 2019 PASEC assessments, 52.1 percent of pupils did not meet minimum requirements in reading at the end of primary school, and 61.8 percent did not meet minimum requirements in mathematics. This puts Côte d'Ivoire below average for literacy, and well below average for mathematics.
Data source: PASEC (2020)

Appendix A.3: Additional information on ESDEP components

A. Improving school infrastructure at the primary school level (component #1)

The following pictures illustrate the type of infrastructure built as part of the primary school intervention.



Notes: Three-classroom unit built as part of the preschool intervention (in pink)



Notes: School furniture supplied with the building.

Classes are built in blocks of three, following the same model.

B. Improving children's primary school readiness by building preschools (component #5)

Preschools built as part of the ESDEP intervention aim to prepare children aged 4 to 5 for primary school. Developed by the Ministry of Education and the UNICEF, the curriculum is play-based and tailored to the needs of young children. Classes are taught in French by an educator and an assistant recruited from the children's community and specifically trained for these positions. Each facility has two classrooms and is equipped with child-friendly hand-washing stations and sanitary facilities, a playground, as well as furniture and educational materials.

The following pictures illustrate the type of infrastructure built as part of the preschool intervention.



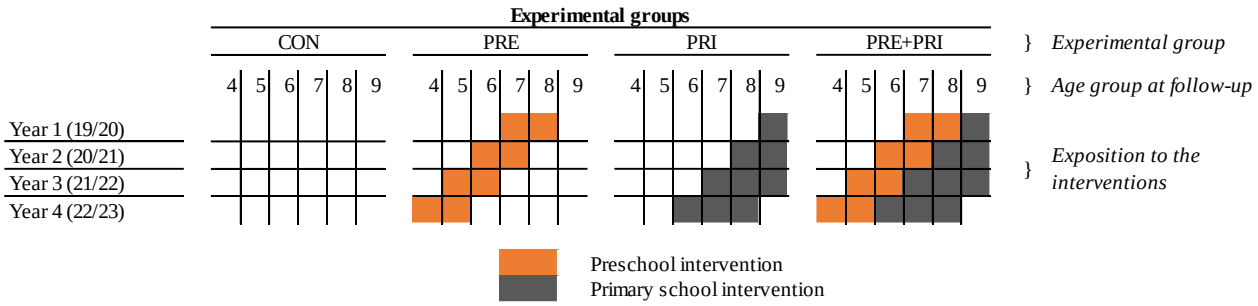
Notes: Community preschool, with both classrooms (back), the sanitary facilities and the handwashing station (right)



Notes: Community preschool, with both classrooms and part of the sandbox delimited by colourful tyres

Preschools were all built following the same model. However, communities were encouraged to finance the construction of a fence around the school, as well as doors to close off the classrooms.

Appendix A.4: Exposure to the interventions of children enrolled in the age-appropriate class by experimental group



Appendix A.5: Additional information on tests used to measure children's cognitive and non-cognitive skills

INTERNATIONAL DEVELOPMENT AND EARLY LEARNING ASSESSMENT (IDELA)

IDELA is a tool for measuring the development level of children aged between 3.5 and 6. It is an oral test administered by an interviewer during a one-to-one interview with the child. The test comprises 22 activities in which the child is asked, for example, to reproduce geometric shapes, identify the first sound of a word, perform simple mathematical operations or identify different feelings that a child of his or her age might experience.

IDELA measures children's level of development in four different areas: motor development, emergent language and literacy, emergent numeracy/mathematics, and social-emotional development. The score for each of the areas is calculated as an average of each subtask performance. An unweighted average of the four areas is calculated to create a total score that reflects children's overall learning and development.

The following table lists the activities associated with each of the dimensions studied.

Motor development	Emergent language and literacy	Emergent numeracy/mathematics	Social-emotional development
1. Copying a shape	1. Expressive vocabulary	1. Comparison by size and length	1. Self-awareness
2. Drawing a person	2. Print awareness	2. Sorting and classification	2. Naming friends
3. Folding paper	3. Letter identification	3. Shape identification	3. Emotional awareness/regulation
4. Hopping	4. First letter sounds	4. Number identification	4. Empathy/perspective taking
	5. Emergent writing	5. One-to-one correspondence	5. Solving conflict
	6. Oral comprehension	6. Addition and subtraction	
		7. Puzzle completion	

This tool was developed by the NGO Save the Children[48] and has been adapted to the Ivorian context. The test takes about 30 minutes per child. The interviewers who were in charge of collecting these data were previously trained in the use of the tool.

[48] For more information, see: https://idela-network.org/

EARLY GRADE READING ASSESSMENT (EGRA)

EGRA is a test designed to assess the basic literacy skills of children in early primary school. The main focus is on reading skills. It is an oral test usually administered by an interviewer in a one-to-one interview with a child. The test consists of the following eight tasks:

a) Letter name identification: The interviewer asks the child to name the letters he/she points to with his/her finger on a piece of paper. Both upper- and lower-case letters are used. The task is timed and the child must identify as many letters as possible in 60 seconds (the visual aid contains a set of 100 letters). The task stops early if the child's first 10 answers are wrong.

b) Identification of the initial sound of words: The interviewer asks the child to pronounce the first sound of 10 words that are read to them orally (*e.g.*, the word "soup" begins with the sound "sssssss"). The task is not timed. The task stops early if the child's first 5 answers are wrong.

c) Letter sound identification: The interviewer asks the child to identify the sound associated with a letter (*e.g.*, "S") or grapheme (*e.g.*, "pl," "erre") that they point to on a paper chart. The task is timed and the participant must identify a maximum number of letters and graphemes in 60 seconds (the visual aid contains a set of 100 letters and graphemes). The task stops early if the child's first 10 answers are wrong.

d) Familiar word reading: The interviewer asks the child to read familiar words (*e.g.*, "my," "key," "school") and points to them on a paper chart. The task is timed and the child must read as many familiar words as possible in 60 seconds (the visual aid contains a set of 50 familiar words). The task stops early if the child's first 5 answers are wrong.

e) Made-up reading: The interviewer points to made-up words on a paper chart and asks the child to read them (*e.g.*, "dozo," "rané," "rigla"). The task is timed and the child must read as many of the made-up words as possible in 60 seconds (the paper chart contains a set of 50 made-up words). The task stops early if the child's first 5 answers are wrong.

f) Reading a text: The interviewer asks the child to read a short text composed of simple words and printed on paper. The task is timed and the child must read as many words as possible from the story in 60 seconds (the story has a total of 60 words). The task stops early if the child cannot read any of the first 9 words of the text.

g) Reading comprehension: At the end of the previous task, the interviewer hides the sheet on which the text is written and asks the child questions about the section of text they have just read. The task is not timed.

h) Listening comprehension: The interviewer reads a short text to the child (twice) and asks a series of 5 questions. The task is not timed.

i) Dictation: The child must write a sentence read by the interviewer (twice). The task is not timed.

The EGRA score is calculated as the average percentage of correct answers (out of the total number of possible correct answers) given by the child on the different tasks.

EARLY GRADE MATHEMATICS ASSESSMENT (EGMA)

EGMA is a test designed to assess the basic mathematical skills of children in early primary school. It is an oral test usually administered by an interviewer in a one-to-one interview with the child. Children do not need to be able to read to take the EGMA test. The test consists of the following 6 tasks:

a) Oral counting fluency: The interviewer asks the child to count out loud as far as possible starting from 1. The task stops as soon as the child makes a mistake or after 60 seconds.

b) One-to-one correspondence: The interviewer asks the child to count 30 circles without making a mistake in 60 seconds. The task stops as soon as the child counts the same circle twice, counts a circle incorrectly, or after 60 seconds.

c) Number identification: The interviewer asks the child to identify numbers aloud on a piece of paper. The task is timed and as many numbers as possible must be identified in 60 seconds (the visual aid contains 20 numbers in all).

d) Quantity discrimination: The interviewer shows the child pairs of numbers on a piece of paper and asks the child to read aloud the two numbers that make up each pair and then to identify the larger of the two. The child must compare 10 pairs of numbers. The task is not timed and stops if the child makes 4 successive mistakes.

e) Missing number: The interviewer asks the child to find the missing number in a series of numbers presented on paper (*e.g.*, "41, 42, ..., 43," "105, 110, ..., 120"). The child is asked to work on 10 series of numbers. The task is not timed and stops if the child makes 4 successive mistakes.

f) Calculation exercise: The interviewer asks the child to add, subtract and multiply. The child is asked to perform 10 operations. The task is not timed.

g) Problem solving: The interviewer asks the child to solve a problem ("Yao has 14 oranges. His father gives him 25 more oranges. How many oranges does Yao have now?"). The child is asked to work on 6 problems. The task is not timed and stops if the child makes 4 successive mistakes.

The EGMA score is calculated as the average percentage of correct answers (out of the total number of possible correct answers) given by the child on the different tasks.

EGMA and EGRA were both developed by the United States Agency for International Development (USAID).

Appendix A.6: List of covariates included in the Double-Lasso procedure

The set of baseline covariates considered as part of this procedure includes the following variables:

Information on the children:

- Age of the child
- Dummy variables indicating the sex of the child (boy, girl, or missing)

Information on the adult caregiver interviewed at follow-up:

- Dummy variables indicating their mother tongue (Dioula, French, Lobi, Senoufo, Other)
- Dummy variables indicating their marital status (monogamous, polygamous, other, missing)

Information on the village:

- Number of men in 2014 (census data)
- Number of women in 2014 (census data)
- Number of inhabitants in 2014 (census data)
- Dummy variable indicating whether the village is rural
- Dummy variable indicating whether the village is electrified
- Distance to school inspectorate
- Distance to health center

Information on the school:

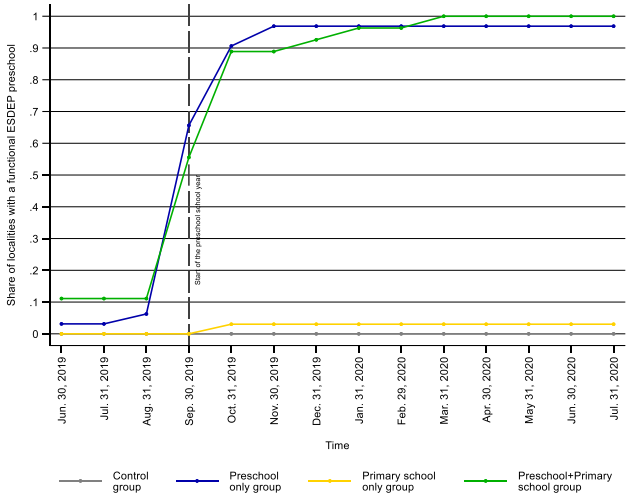
- Dummy variable indicating whether the school has a school management committee (COGES)
- Dummy variable indicating whether the school has a “Club des Mères d’Elèves Filles”
- Dummy variable indicating whether the school is electrified
- Total number of children enrolled
- Gender ratio in grades 1 to 6
- Total number of pedagogical groups
- Total number of classrooms in total
- Total number of classrooms in good condition
- Total number of classrooms in poor condition
- Total number of classrooms built with temporary materials

- Total number of teachers
- Dummy variable indicating whether the school has functional latrines
- Dummy variable indicating whether the school has a functional water point
- Dummy variable indicating whether the school has a functional hand-washing facility
- Dummy variable indicating whether the school has an operational canteen
- Dummy variable indicating whether the school has a library
- Dummy variable indicating whether the school benefited from deworming sessions during the 2017-2018 school year
- Dummy variable indicating whether the school benefited from vaccination sessions during the 2017-2018 school year
- Total number of literacy textbooks
- Total number of mathematics textbooks
- Number of years since the school opened
- School surface area
- Number of children refused admission to grade 1
- Number of children refused admission to CP1 due to insufficient capacity
- Number of children refused admission to CP1 because they were too young
- Number of children refused admission to CP1 because they were too old
- Number of children refused admission to CP1 because they could not provide a birth certificate

Note that when implementing the double-lasso procedure, we require that strata fixed effects (which, by definition, are orthogonal to T_i) be systematically included in the estimated equation.

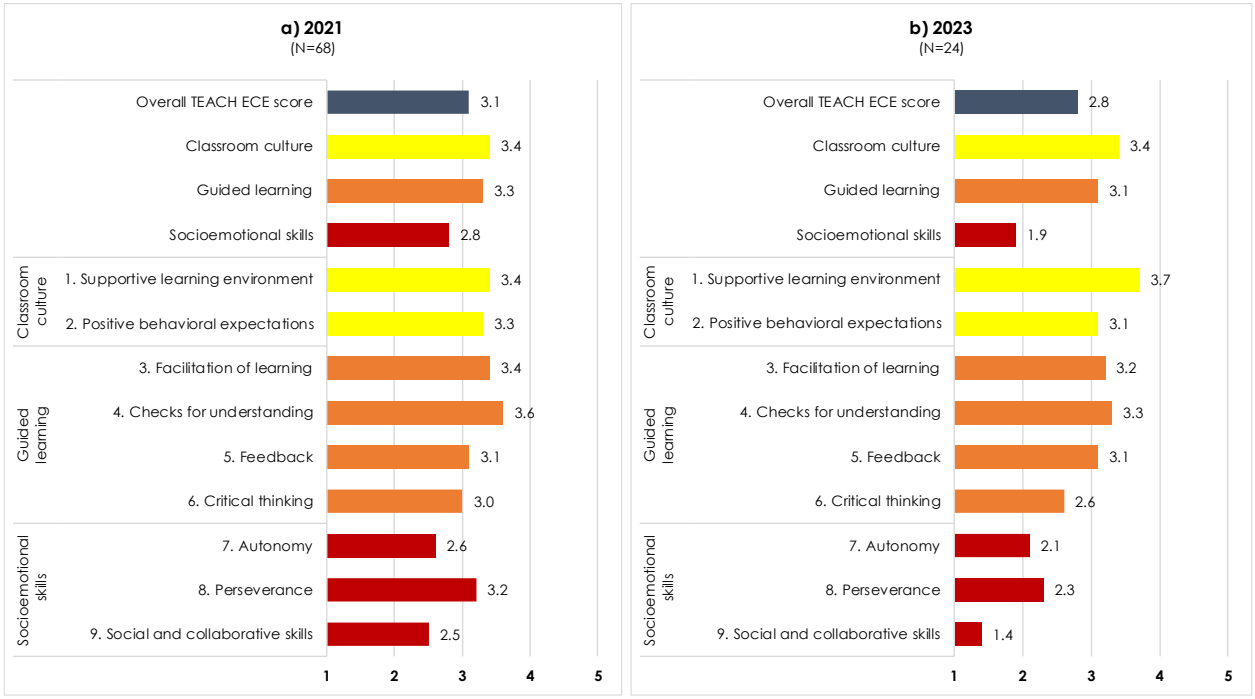
Appendix A.7: Implementation details for the *preschool* intervention

A. Percentage of preschools ready to welcome children by date



Notes: In this figure, we present the percentage of preschools that were ready to welcome children at different dates by treatment group. Overall, delays were limited and compliance is high. First, 60 percent of the 68 preschools opened under the ESDEP were able to welcome pupils at the start of the 2019/2020 school year. This figure rises to 90 percent one month later, and approaches 100 percent in subsequent months. Secondly, a preschool was opened in all localities selected to receive the preschool intervention (*PRE* and *PRE+PRI*), and none was opened in localities selected not to receive the intervention (with the exception of one school opened by mistake in the *PRI* group).

B. Quality of pedagogical practices in preschools



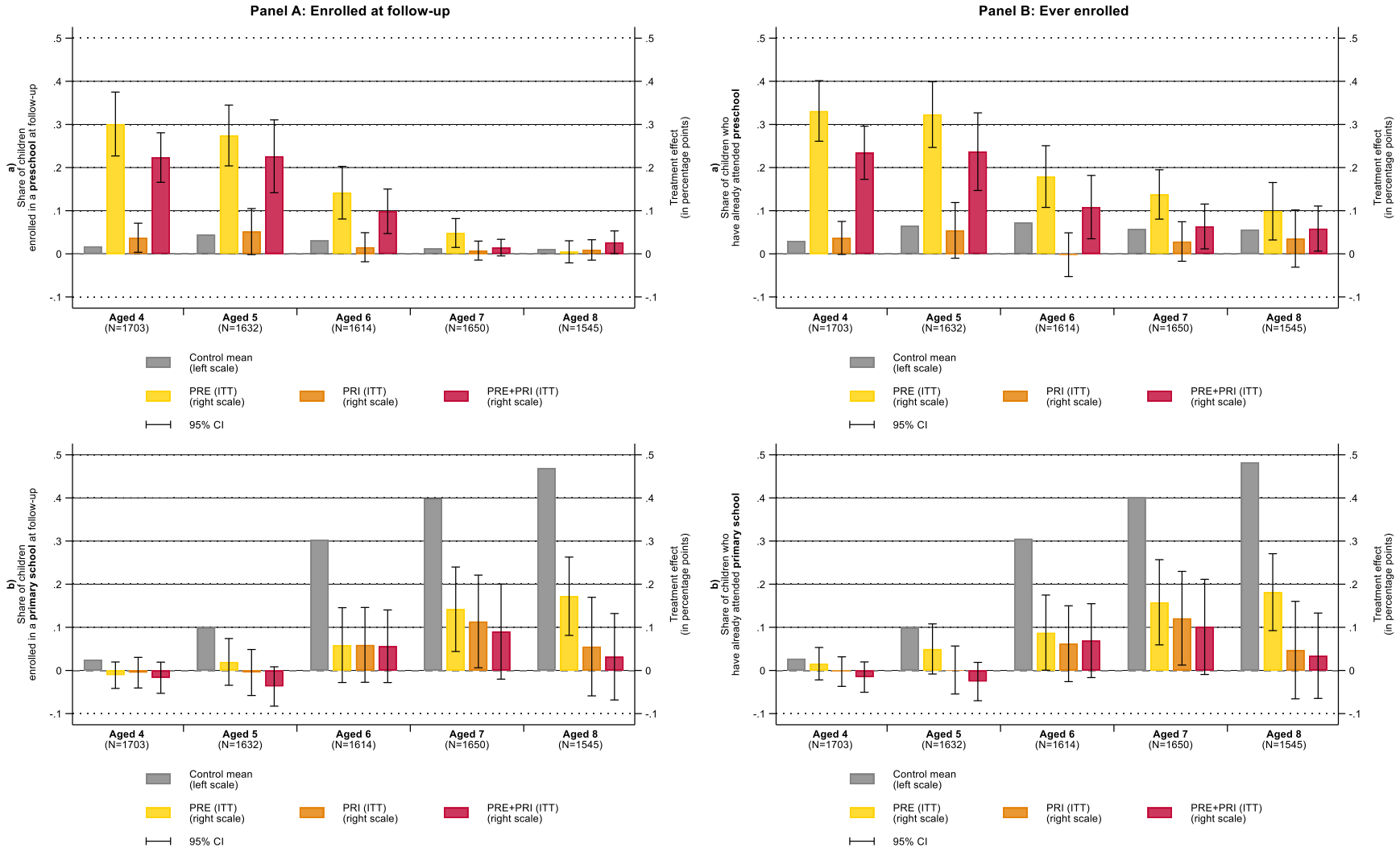
Notes: In this figure, we present the average quality of the pedagogical practices of preschool educators observed by interviewers in 2021 (panel A) and 2023 (panel B). The figure provides the "global Teach ECE" score, which provides a measure of educators' overall performance. We also show their performance in three sub-areas ("classroom culture", "guided learning," and "socio-emotional skills") and the nine related competencies. In 2021, observations were carried out in all 68 preschools. In 2023, observations were conducted in a subset of 24 randomly selected preschools. In 2021 and 2023, data was collected in every classroom of every preschool observed.

Appendix A.8: Implementation details for the primary school intervention

	(1)	(2)	(3)	(4)	(5)	(6)
			β_{PRE}	β_{PRI}	$\beta_{PRE+PRI}$	$\beta_{PRI} = \beta_{PRE+PRI}$
	Total #obs.	**Control Mean (s.d.)**	**Diff. (s.e.)**	**Diff. (s.e.)**	**Diff. (s.e.)**	**P-value**
Panel A: Teaching literacy						
a) Teacher survey data						
Number of lessons per week	313	20.58	-1.81	-2.58	-1.46	0.584
		(9.00)	(1.94)	(2.21)	(2.07)	
Mainly uses the ESDEP teaching guide and lesson sheets to prepare lessons	313	0.00	0.05 *	0.98 ***	1.00 ***	0.275
		(0.00)	(0.03)	(0.02)	(0.01)	
Teacher primarily uses syllabic approch	313	0.85	-0.07	0.04	0.01	0.650
		(0.36)	(0.05)	(0.05)	(0.06)	
b) Classroom observation data:						
Teacher makes pupils read aloud with their fingers	318	0.48	-0.00	0.48 ***	0.51 ***	0.497
		(0.50)	(0.10)	(0.08)	(0.08)	
Number of pupils doing so	318	12.42	1.82	20.52 ***	24.82 ***	0.318
		(18.99)	(4.69)	(4.11)	(4.40)	
Teacher explains the meaning of new words	318	0.70	-0.03	0.08	-0.03	0.163
		(0.46)	(0.09)	(0.08)	(0.08)	
Number of times teacher does so	318	3.39	0.30	1.27	0.60	0.351
		(4.60)	(0.86)	(0.78)	(0.75)	
Teacher corrects errors made by pupils	318	0.90	0.08	0.07	0.05	0.551
		(0.30)	(0.05)	(0.06)	(0.06)	
Number of times teacher does so	318	14.51	0.54	-3.51	-3.87	0.861
		(16.39)	(3.47)	(3.33)	(3.22)	
Panel B: Teaching mathematics						
a) Teacher survey data						
Number of lessons per week	313	9.35	-0.08	0.20	1.04	0.394
		(4.47)	(0.92)	(0.98)	(0.96)	
Mainly uses the ESDEP teaching guide and lesson sheets to prepare lessons	301	0.02	0.04	0.96 ***	0.98 ***	0.531
		(0.13)	(0.03)	(0.02)	(0.02)	
b) Classroom observation data:						
Teacher gets pupils to use manipulatives	318	0.83	-0.06	0.13 *	0.09	0.219
		(0.38)	(0.09)	(0.07)	(0.07)	
Number of pupils doing so	318	21.80	-2.83	6.47 *	11.14 ***	0.186
		(19.33)	(4.34)	(3.52)	(3.96)	
Teacher gets pupils to draw schematic representations of problems	318	0.71	0.03	0.26 ***	0.22 ***	0.413
		(0.46)	(0.10)	(0.08)	(0.08)	
Number of pupils doing so	318	24.28	-1.74	4.49	9.10 **	0.156
		(27.94)	(4.94)	(4.24)	(4.24)	
Teacher asks pupils to justify their reasoning	318	0.73	-0.14	0.26 ***	0.25 ***	0.814
		(0.45)	(0.10)	(0.07)	(0.07)	
Number of pupils doing so	318	3.69	0.90	1.79	2.61 **	0.467
		(4.53)	(1.31)	(1.22)	(1.08)	
Panel C: Supervision						
The school principal visited the classroom	313	0.66	-0.00	0.09	0.16 **	0.282
		(0.48)	(0.08)	(0.08)	(0.07)	
Number of visits	309	3.35	0.62	0.78	1.07	0.766
		(6.67)	(1.16)	(1.06)	(1.04)	
The school inspectors and pedagogical advisors visited the classroom	313	0.76	-0.04	0.18 ***	0.15 ***	0.592
		(0.43)	(0.07)	(0.06)	(0.05)	
Number of visits	313	1.71	-0.09	2.27 ***	2.82 ***	0.269
		(1.50)	(0.35)	(0.39)	(0.48)	

Notes: In this table, we present the Intent-to-Treat effect of the interventions on teachers' pedagogical practices in literacy and mathematics, as well as on their level of supervision by school principals, inspectors, and pedagogical advisors. To do so, we estimate equation (1) for each outcome displayed in the left-hand column (without adding any baseline covariates). We report the coefficients and standard errors associated with the three dummy variables T_{PRE}, T_{PRI}, and $T_{PRE+PRI}$ indicative of children's treatment status. We also test the equality of the coefficients associated with T_{PRI} and $T_{PRE+PRI}$ and report the corresponding p-value.
The sample includes all teachers in grades 1-3 of the 136 primary schools participating in the experiment. Survey and observation data were collected from teachers in grades 1-3. Observations were made during both literacy and math lessons. Data were collected in May 2023, four years after the start of the interventions.
Standard errors are clustered at the school level. *, **, *** denote significance at the 10, 5, and 1 percent levels respectively.

Appendix A.9: Impact on enrollment by age



Notes: This figure illustrates the impact of the interventions on the enrollment status of children of different ages.

Appendix A.10: Sampling strategy for test score data collected by the Ministry of Education as part of the implementation of the ESDEP

As part of the implementation of the ESDEP, the MoE collected information on the literacy and mathematics skills of children enrolled in grades 1 to 3 in the 68 localities selected to receive the primary school intervention at the end of Year 1 and Year 2. The data was used by the administration to measure pupils' progress and calculate the amount of the grant that was based on children's learning performance. To measure progress, the MoE used a modified version of the EGRA and EGMA tests. Note that while we managed to convince the MoE to collect the same data (following the same procedure) in the 34 localities of the control group, these data were not collected in the *PRE* group. In each of the 102 primary schools, a random subset of eight pupils per grade was selected among the children present.

The tests were carried out in May 2021 by the Ministry of Education. In total, data could be collected in 96 of the 102 target schools: a) 64 of the 68 localities selected to receive the primary school intervention were actually tested; b) 32 of the 34 localities in the control group were actually tested. The share of schools that could not be tested is therefore identical in both groups (6 percent). The average number of children actually tested is similar in control group localities and in the localities selected to receive the primary school intervention.

To limit the risk of sampling bias, these assessments were administered as part of surprise visits. The fact that the visits were unannounced limits the risk of bias that could arise from strategic behavior on the part of teachers or principals. In particular, it reduces the risk of weaker pupils being asked to stay home on the day of the tests, and of the assessments therefore focusing on a set of better performing pupils. This risk could otherwise be particularly high in schools receiving a transfer whose amount is conditional on children's performance. Moreover, data collectors administering the tests did not know the treatment status of the localities.