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Paul Brabet

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THÈSE DE DOCTORAT
DE L'UNIVERSITÉ PSL

Préparée à l'Université Paris-Dauphine

Primary Education Quality in Sub-Saharan Africa

THREE ESSAYS ON IMPROVING STUDENT ACHIEVEMENT

Soutenue par

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Primary Education Quality in Sub-Saharan Africa

THREE ESSAYS ON IMPROVING STUDENT ACHIEVEMENT

Paul Brabet

Under the supervision of Élise Huillery

À mes proches

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Résumé

Depuis plusieurs décennies, la scolarisation à l'école primaire a beaucoup augmenté en Afrique subsaharienne. Néanmoins, une grande partie des élèves ne maîtrisent pas les savoirs fondamentaux (lire, écrire, compter) à la fin du cycle primaire. Pour améliorer l'apprentissage des élèves, de nombreuses études se sont concentrées sur la qualité des enseignants ou encore la gouvernance de l'école. L'objectif de cette thèse est de faire avancer la compréhension de la qualité de l'éducation et des résultats scolaires à travers trois études distinctes. La première porte sur le rôle des directeurs d'école et leur implication dans la gestion de l'école. Les résultats montrent que l'implication des directeurs d'école n'a pas d'impact sur les résultats scolaires des élèves, et que d'autres caractéristiques, telles que le leadership, pourraient jouer un rôle plus important. Le second chapitre se penche sur les réformes d'approche par compétences qui ont modifié la pédagogie des enseignants dans de nombreux pays d'Afrique francophone. Cette étude montre que l'approche par compétences a un impact positif sur les résultats en français des élèves. Enfin, la dernière étude analyse la relation entre le type de contrat des enseignants et les résultats scolaires. Il apparaît que les enseignants contractuels sont aussi productifs que les enseignants titulaires, et que le type de contrat de l'enseignant n'affecte pas significativement les résultats scolaires des élèves.

Mots clés : Qualité de l'éducation primaire, Résultats des élèves, Afrique subsaharienne, Gestion de l'école, Pédagogie des enseignants, Contrat des enseignants

Abstract

Over the past decades, primary school enrollment has significantly increased in Sub-Saharan Africa. Nevertheless, a large proportion of students do not master basic skills (reading, writing, arithmetic) by the end of the primary cycle. To improve student learning, numerous studies have focused on teacher quality or school governance. The objective of this thesis is to advance the understanding of education quality and student achievement through three distinct studies. The first focuses on the role of school principals and their involvement in school management. The results show that the involvement of school principals has no impact on student achievement, and that other characteristics, such as leadership, might play a more important role. The second chapter examines the competency-based reforms that have changed teaching practices in many Francophone African countries. This study shows that the competency-based approach has a positive impact on students' language test scores. Finally, the last study analyzes the relationship between teacher contract types and student outcomes. The results suggest that contract teachers are as effective as tenured teachers, and that the type of teacher contract may not significantly impact student outcomes.

Keywords : Primary education quality, Student achievement, Sub-Saharan Africa, School management, Teaching practices, Teacher contract

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General Introduction

The importance of education as a driver of individual well-being and economic growth is well-established in economic literature. At the individual level, the acquisition of human capital can enhance earnings, as the pioneered work of Mincer (1970) demonstrates, but it also develops individuals with cognitive skills and fosters social and emotional competencies. These individual benefits serve as a foundation for economic growth, as a skilled workforce increases overall productivity. Nations with high levels of educational attainment tend to experience long-term economic growth, greater political stability, and lower poverty rates. Investing in human capital is therefore critical for developing countries.

1 Education in Africa: from enrolment to learning

Recognizing the critical role that education plays in economic development, global efforts have increasingly focused on expanding educational access in regions where enrollment rates have historically lagged. Over the past few decades, sub-Saharan Africa has experienced substantial progress in broadening primary education. During the 1990s and early 2000s, enrolment rates rose significantly, and especially in primary school. Sub-Saharan Africa shifted from 72% of primary gross enrolment rates in 1990 to approximately 97% in 2010, while Europe and US had already rates above 100% in 1990¹. This rapid increase was partly driven by global initiatives like the Millennium Development Goals (MDGs), whose 2nd objective was to provide universal primary education by 2015. The World Bank and other international organizations played a critical role in encouraging investment in educational infrastructure, teacher recruitment, and policy reforms to make schooling accessible to all. Policymakers in developing countries have consequently increased their funding in education to benefit from improved education from their popula-

¹UNESCO Institute for Statistics

tion. From 1980 to 2010, real government expenditures on education doubled in sub-Saharan Africa P. W. Glewwe, Hanushek, et al. (2011). These efforts have resulted in millions more children attending school, significantly increasing the quantity of education provided.

The development of international standard tests to measure the cognitive skills and abilities of students made possible comparability between countries, such as PISA², SACQMEC³, or TIMS⁴, and show that pupils in Africa underperform compared to those in developed countries. Hanushek and Woessmann (2011) demonstrate that OECD countries are well ahead of developing regions in terms of basic knowledge, and several reports suggest that many students in sub-Saharan Africa are unable to read or perform basic arithmetic even after several years of schooling, meaning that these years of education did not translate into effective knowledge. The low quality of education in developing countries has been described by UNESCO (2013) as the *Global Learning Crisis*. As a result, the 4th Sustainable Development Goals (SDGs) advocate access to quality education for all, and more precisely, “ensure inclusive and equitable quality education and promote lifelong learning opportunities”.

This learning deficit has far-reaching implications. At the micro level, a student is much less likely to remain in school if attending a low-quality school rather than a high-quality school (Hanushek, Lavy, et al., 2008). In addition, Hanushek and Woessmann (2008) show that cognitive skills have a powerful effect on individual earnings and on economic growth. Low primary school quality hence limits the ability of young people to contribute meaningfully to economic development. Therefore, enhancing education quality remains a critical challenge in ensuring that this education translates into knowledge accumulation.

2 How to increase learning?

While making students stay at school and avoid dropping out to increase years of schooling remain critical challenges, most attention has been paid to increasing school quality in order to enhance basic knowledge acquisition. The situation in sub-Saharan Africa contrasts sharply with that in developed countries. In developed nations, educational systems typically benefit from better-trained teachers, more robust curricula, smaller class sizes, and greater availability of teaching materials

²Programme for International Student Assessment

³The Southern and Eastern Africa Consortium for Monitoring Educational Quality

⁴Trends in International Mathematics and Science Study

and resources. There is also a stronger emphasis on early childhood education, which has been shown to lay a critical foundation for future learning. In contrast, schools in many parts of Africa struggle with overcrowded classrooms, inadequate facilities, and a shortage of trained teachers. Moreover, socio-economic factors, such as poverty and limited access to early childhood education, exacerbate the challenges, resulting in uneven educational experiences for students across the region.

Numerous public policies as well as targeted interventions have tried to enhance student learning and to understand the determinants of the education production function (Hanushek, 1979), which models student learning as a function of several inputs such as student and family background characteristics, school resources, or teacher quality. The first strand of policies implemented pertained to material input, considering the scarcity of resources in developing countries. Concretely, these policies were characterized by more teachers to reduce the pupil-teacher ratio or more material resources such as handbooks or basic furniture (P. Glewwe, Hanushek, et al., 2011). However, the expensive “standard” school inputs are often not very effective at improving student outcomes (P. Glewwe and Muralidharan, 2016), and several studies demonstrate that more inputs are more effective when combined with another intervention that pertains to the management of the input concerned (Duflo, Dupas, et al., 2015; Piper, Zuilkowski, et al., 2018).

A strong focus has also been made on the role of teachers. The importance of teachers in the learning process has been widely demonstrated. Many studies showed that teacher quality has a consequent impact on student achievement in developed countries (Hanushek and Rivkin, 2006; Chetty, Friedman, et al., 2014) as well as in developing ones (De Talance, 2017). However, teachers in Africa are described as low-qualified, with high absenteeism, and often do not master the subjects they teach (Bold, Filmer, et al., 2017). As a result, several interventions try to give incentives to teacher to raise their effort with mitigated results. For instance, P. Glewwe, Ilias, et al. (2010) show that rewarding teachers for student performance is effective only if these rewards are based on test scores rather than graduation rates, as teachers increase their effort to raise short-run test scores by conducting more preparation sessions but do not attend the class more nor change their pedagogical methods. Muralidharan and Sundararaman (2011) show that providing a bonus to teachers based on test scores of their pupils increases student outcomes compared to teachers for whom bonus has been conditional to the average test scores of the school. Finally, Ganimian and Murnane (2016) argue that well-designed incentives increase teacher effort and student achievement from very low levels, but low-skilled teachers need specific guidance to reach minimally acceptable levels of instruction.

Another major emphasis has been placed on school governance and, precisely, on the decentralization of decision-making and school autonomy through school-based management. School-based management is characterized by a transfer of responsibility and decision-making of school operations into a combination of principals, teachers, parents, and other school community members by involving them in the school committee. Duflo, Dupas, et al. (2015) find that consequently of locally hiring contract teachers has a strong effect on student achievement. On the other side, Blimpo, Evans, et al. (2011) found that training of the school committee has no impact on learning outcomes except in schools where school committee members were educated. In this direction, the effectiveness of involving the community in the school committee may depend on local capacity. Beasley and Huillery (2017) find that giving a grant to the school committee increased parents' responsibility and participation but does not improve quality as teacher absenteeism increased and no impact on learning outcomes were found after the intervention.

Overall, all these interventions present divergent results, and there is no consensus about the most effective intervention to increase student learning. Evans and Popova (2016) show that reviews that examined interventions to increase student learning (McEwan, 2015; Ganimian and Murnane, 2016) draw drastically different conclusions. However, they argue that across reviews, the three different types of intervention that are effective with some consistency are pedagogical interventions that tailor teaching to student skills, repeated teacher training interventions, often combined with another pedagogical intervention, and improving accountability through contracts or performance incentives, which works at least in certain contexts.

3 Objective of the thesis

This thesis aims to explore three determinants of the quality of primary education and student achievement in francophone sub-Saharan Africa. Precisely, the three treatments for which I try to assess the effect on student outcomes are school principal involvement, the use of student-centred teaching practices known as *Approche par Compétences* (but referred to as competency-based approach in this thesis), and teacher contract type.

Methodology

One of the key issues in empirically studying education in Africa remains in the availability and quality of data. Nowadays, the vast majority of studies investigating determinants of student learning in Africa proceed to Randomized-Controlled-Trials (RCT) in order to determine a causal relationship between the interventions tested and the benefit for student achievement. Randomization, even though considered the gold standard, remains extremely costly. The alternative option, which is less robust statistically but also much more affordable, is to focus on quasi-experimental methods using existing microdata. Using PASEC data, this thesis adopts a treatment evaluation framework as methodology, using matching strategies to estimate, as far as possible, the causal impact between the treatment variable and student outcomes. The global aim of the three studies is to match on a large amount of inputs of the educational production function, such as student background, teacher characteristics, and school environment, as well as variables explaining treatment assignment.

Data

In this thesis, I use data from the *Programme d'Analyse des Systèmes Educatifs de la CONFEMEN* (PASEC). To ensure national representativeness, PASEC proceeds to a random draw to select schools within two stratification levels which are administrative boundaries (which change according to the wave) and, for some given countries, school status (private and public school). The PASEC 2000 diagnostic evaluation is designed to assess pupils in grades 2 and 5 at the beginning and end of the year in both mathematics and language, designed to allow comparability between countries. The mathematics test includes items that assess students' knowledge of number properties and their ability to perform simple calculations such as addition and subtraction, as well as knowledge of decimals and basic geometry concepts. The language test includes items that assess pupils' reading comprehension, orthography, vocabulary and syntax. The PASEC 2014 survey assesses grades 2 and 6 students at the end of the year in both mathematics and language, and the tests include items very similar to those in PASEC 2000. For both waves, there are three additional surveys for pupils, teachers, and school principals. The pupil survey provides detailed information on his background, such as his parents' education and facilities at home. The teacher survey offers rich information on its attributes, as well as classroom characteristics such as the number of pupils in the class or teaching material.

Eventually, the principal survey gives information about principal characteristics, school management, and school equipment and infrastructures.

Chapter 1: Does School Principals Involvement in School Management Affect Student Outcomes?

As interventions aiming to change school management in Africa present mixed results, the mere role of school principals needs to be investigated as it could be a determinant in enhancing students learning. To assess the impact of headmasters on learning outcomes, I construct an involvement score for principals that relies on four dimensions of school management: meetings with teachers, meetings with students' parents, interventions in the classroom to support teachers and management of absent teachers.

Preliminary findings suggest that more involved principals seem to be paid and that they are more likely to have received training in management but are less likely to teach than less involved ones. Moreover, I find that higher involvement is associated with students belonging to wealthier and more educated households, indicating that there is a sorting of students and principals. Eventually, principals with higher involvement are also linked to less absent teachers.

Considering the endogeneity of involvement, I conduct a nearest neighbour matching to estimate the impact of the involvement score on learning outcomes. Results do not suggest any significant relationship between school head's involvement and learning outcomes. This result has several policy implications in terms of training and selection of school principals. Considering that principals could have a substantial effect on learning outcomes and that descriptive studies depict them as lacking leadership abilities, changing appointment criteria and giving better training could be a key to enhance learning achievement.

Chapter 2: Assessing Competency-Based Approach Reforms in French-Speaking Sub-Saharan Africa

In the late 1990s, a large number of French-speaking African countries have undertaken Competency-Based Approach reforms following recommendations to improve basic knowledge acquisition, which remains particularly low on the international scale. The aim of the pedagogy was to make pupils play an active role in the learning process. The role of teachers had to evolve toward a mediator and support

student activity instead of simply giving a lecture class.

Public organizations have promoted this pedagogy as a key solution to enhance primary student learning, investing substantial financial resources in curriculum changes and teacher training. However, the implementation of CBA has been found controversial by some authors, arguing that African educational systems face challenges such as poorly trained teachers, high pupil-teacher ratio, and scarce material resources which makes it difficult to effectively change the pedagogy of teachers. Despite this ongoing debate, the impact of CBA on student learning has never been quantitatively assessed, leaving questions about its effectiveness in improving student knowledge unanswered.

Comparing teachers who were trained to CBA and use it and those who do not use it, I find that they teach students who have higher levels of abilities at the beginning of the year and who are wealthier on average. In addition, teachers who use CBA are younger, less experienced, slightly more trained, and better equipped with teaching material compared to teachers who do not use the pedagogy.

Conducting a double selection LASSO and a Kernel matching strategy with two metrics for students' similarity (Mahalanobis distance and propensity score), I find that the pedagogy is highly effective in improving student outcomes in language and mathematics. Finally, CBA appears to exacerbate within-classroom inequalities along with improving student outcomes, leaving aside low-achieving students and benefiting more to high-achieving ones. This result is contradictory to one of the key features of the pedagogy, which aims to help low-achieving students.

Chapter 3: Exploring the Effect of Contract Type on Teacher Productivity and Student Performance

Since the 1990s, the increased proportion enrolled in primary school caused overcrowding in many schools and a sharp rise in the number of pupils per teacher across the various education levels. The resulting deterioration in the quality of public education and its declining capacity to absorb the increasing numbers of primary students resulted in an overhaul of teacher hiring practices. Governments shifted away from hiring relatively expensive civil servant teachers toward hiring contract teachers instead, resulting in the hiring of huge numbers of contract teachers around the world.

Contract teachers differ fundamentally from regular teachers in that their job stability is not guaranteed. In fact, contract teachers can be dismissed by their

employer, which is either the local school committee, the parent-teacher association, or the Ministry of Education. Besides job instability, contract teachers may also differ from regular teachers in the qualification requirements to enter the job and the remuneration profile.

We find that contract teachers differ from regular teachers in that they are younger and less experienced, and teach more often in the public sector and in rural areas. Although their level of education and training is rather similar to regular teachers, contract teachers are paid much less in all countries. They do not seem to invest consistently more or less effort than regular teachers: based on self-report absenteeism, use of manuals and curriculum completion, contract teachers tend to exhibit more effort some countries but less effort in others. Contract teachers also teach socially and economically more disadvantaged students than regular teachers in all countries. Finally, conducting a Kernel matching and a nearest neighbor one, we show that students of contract teachers perform rather similarly to students of regular teachers. The policy implication is that giving teacher contract more or less job security may not be a crucial component of education systems.

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Chapter 1

Does School Principals Involvement in
School Management Affect Student
Outcomes?

Introduction

As highlighted in the general introduction, the low quality of primary education in sub-Saharan Africa has prompted many public policies that attempted to improve student learning by increasing resources considering the African context. Concretely, early policies were characterized by more teachers to reduce the pupil-teacher ratio or more material resources such as handbooks or basic furniture (Glewwe, Hanushek, et al., 2011). Nevertheless, the increase in material input approach showed its limits to enhance student achievement. As a matter of fact, there is growing evidence that more resources are not enough to make schools more efficient, and several studies demonstrate that more inputs are more effective when combined with another intervention that pertains to the management of the input concerned, whether it teacher or textbook (Duflo, Dupas, et al., 2015; Piper, Zuilkowski, et al., 2018).

In this context, school-based management was largely implemented in the last decade to enhance the management of resources and thus improve student achievement. Precisely, school-based management is characterized by a transfer of responsibility and decision-making of school operations into a combination of principals, teachers, parents, and other school community members by involving them in the school committee¹. According to the literature, school-based management interventions lead to diverse results. Duflo, Dupas, et al. (2015) find that consequently of hiring contract teachers, absenteeism of civil-servant teachers increases less, and the percentage of teachers hired that are relatives is lower when training to empower parents in the school committee is implemented. Lassibille (2016) found that the impact of specific actions designed to streamline and tighten the work processes of public primary school principals succeeded in modifying school principals' behaviour toward better management. On the other side, M. P. Blimpo, Evans, et al. (2011) found that training of the school committee has no impact on learning outcomes except in schools where school committee members were educated. In this direction, the effectiveness of involving the community in the school committee may depend on local capacity. Beasley and Huillery (2017) find that giving a grant to the school committee increased parents' responsibility and participation but does not improve quality as teacher absenteeism increased and no impact on learning outcomes were found after the intervention. Eventually, numerous studies focusing on the management of school resources attempted to enhance students' learning but with mitigated results.

¹See Patrinos and Fasih, 2009 for a typology of school-based management.

In developing countries, quantitative analysis of school management focuses on the effect of targeted interventions on changing the way the schools are managed, but the direct impact of school principals and their management on learning outcomes remains unclear. The mere role of headmasters needs to be investigated as it is the school's central component of management, and they could be a cornerstone to improve student learning through their leadership and their involvement. The positive effect of leadership has been widely demonstrated in the economic literature, and the same applies to the education sector. Lavy and Boiko (2019) demonstrates that the quality of CEOs of education in Israel have a significant and positive impact on student outcomes. Banerjee, Banerji, et al. (2017) also highlight the capacity of academic leaders to implement, monitor and support a pedagogical reform in India. More specifically, four studies in the US and Canada identify a positive and consequent effect of school principals through a principal fixed effect using their exogenous turnover within the school over time (Branch, Hanushek, et al., 2012; Coelli and Green, 2012; Dhuey and Smith, 2014; Dhuey and Smith, 2018).

Nevertheless, descriptive studies depicting the role of school principals in African countries demonstrate that the issues they face differ substantially from those experienced by their counterparts in developed countries. African school principals have to deal with limited budgets, shortage of school equipment and learning materials as well as low-skilled teachers (Oplatka, 2004; Bush and Oduro, 2006; Bush and Glover, 2016). Moreover, they are not described as leaders and involved in pedagogical activities as they are in developed countries due to a lack of training and low level of appointment. The effect of leaders and headmasters in developed countries and the particular context in Africa leads to the following research question: what is the impact of primary school principals' involvement in school management on learning outcomes in sub-Saharan Africa?

First, I provide a descriptive analysis of principals' involvement in school management and the relationship with observable characteristics. Second, I investigate the potential endogeneity of involvement to teachers and students. Third, I assess the impact of principal involvement on learning outcomes. I develop an involvement score for principals that relies on four dimensions of school management: meetings with teachers, meetings with students' parents, interventions in classroom to support teachers and management of absent teachers. I use a nearest neighbour matching to estimate the impact of the involvement score on learning outcomes and consider the endogeneity of the score. I divide the sample of students into two groups according to the median of the involvement score in the country to match two headmasters with considerable differences in their involvement. Second, I select matching vari-

ables taking students' and teachers' characteristics that significantly explain test scores variations in language or mathematics or treatment assignment. I find the nearest neighbour of each student among the other group based on the minimum distance in matching variables. The matching strategy leads to several strata, each one containing all treated that have the same nearest control, the nearest control, and all control students that are strictly identical to the nearest control. Once each student has found his match, I estimate the impact of the involvement score on language and mathematics test scores using OLS and a strata fixed to exploit the within-strata variation in principal involvement, adding characteristics of school principals as control variables.

Results suggest no strong relationship between principals' standard observable characteristics and their involvement in school management. More involved principals seem to be more paid but, with low significance, are more likely to have received training in management but less likely to teach. Moreover, I find that higher involvement is associated with students with wealthier and more educated households, indicating that there is a sorting of students and principals. Principals with higher involvement are also linked to less absenteeism among teachers. Finally, matching estimates do not suggest any significant relationship between the school head's involvement and learning outcomes. As I found no significant impact of principals' involvement on learning outcomes, this has several policy implications in terms of training and appointment of school principals. Considering that principals could have a substantial effect on learning outcomes and that descriptive studies depict them as lacking leadership abilities, changing selection criteria and giving better training could be a leverage in enhancing learning achievement.

This paper contributes to three different types of literature due to its wide coverage. First, it adds to the quantitative literature on the impact of school principals. To the author's knowledge, only four studies have investigated the direct impact of principals on learning outcomes, and all of them have found a positive and significant effect. Nevertheless, these studies rely on data from Canada and USA, where school principals receive high-quality training (Clark, Martorell, et al., 2009). To my knowledge, this is the first article that assesses the direct impact of school principals on student outcomes in Africa and, more broadly, in developing countries. Second, this paper enriches the education quality literature in Africa. School management has been at the center of many interventions that attempted to improve students' learning and present mitigated conclusions. Findings suggest that the management of the schools by principals is currently inefficient; interventions that could increase school principals' involvement in school management are therefore meaningless at

this time. Third, this paper contributes to the global literature on leadership. Studies have demonstrated the importance of leaders in firms (Bertrand and Schoar, 2003), development (Jones and Olken, 2005) and in the education sector (Lavy and Boiko, 2019). Results go against the benefits of leaders as I find that school principals have a null output since their productivity, measured by the involvement score, does not lead to any gain in students' learning. This raises concerns about what characteristics make a leader have a positive output.

The remainder of the paper is as follows. Section 1 summarizes the literature review concerning the relationship between principals' characteristics and learning outcomes, as well as the role of headmasters in Africa and their particular features. In Section 2, I present the PASEC 2014 database and descriptive statistics about the sample. Section 3 details the construction of the involvement score and investigates the characteristics of headmasters that are associated with it. Section 4 explains the empirical strategy to estimate the impact of principals' involvement on learning outcomes. Section 5 discusses the results, and Section 6 presents a brief analysis of community involvement before the conclusion.

1 Literature Review

The literature on school principals differs a lot according to countries and educational systems. Quantitative studies examining the impact of headmasters have been made in a handful of countries, and solely developed ones. For developing countries, few studies analyze quantitatively school principals, and existing studies focus mostly on English-speaking and East African countries. In the following section, I describe the literature on school principals related to student achievement before depicting school principals in African countries.

1.1 School principals and learning outcomes

The importance of leaders has been widely demonstrated in the economic literature, and the education sector represents a growing concern in studying the effect of leadership. First of all, Lavy and Boiko (2019) find that CEOs of education—Also called Superintendent in the US or Director of Education in Canada., have a positive impact on learning outcomes in Israel in reducing principal turnover that leads to better teacher retention and good school climate. Banerjee, Banerji, et al. (2017) highlights the importance of academic leaders in succeeding at implement-

ing and scaling up educational reform in India. Regarding school principals, the relationship between their characteristics and learning outcomes is a nascent but growing literature, and their contribution to student achievement is even more recent. Nevertheless, much is left to know about the importance of school principals and especially the pathways through which they can improve student learning. The first strand of the literature that pertains to the link between school principals and learning outcomes is observable characteristics of headmasters. Lavy (2008) shows that raising school principal wages leads to substantial effect on student outcomes in Israel. Clark, Martorell, et al. (2009) find no correlation between the education of principals in New York City primary schools and student achievement, whereas Ballou and Podgursky (1995) and Eberts and Stone (1988) find that more educated principals are associated with lower school performance, suggesting that more educated principals are assigned to low-quality schools. Clark, Martorell, et al. (2009) and Eberts and Stone (1988) find a positive correlation between teaching experience and school performance, whereas Brewer (1993) find no correlation. Eventually, Clark, Martorell, et al. (2009) find that experience as a principal or as a teacher has a significant effect.

To the author's knowledge, four studies investigate the direct impact of school principals on students' outcomes estimating a principal fixed effect with a school fixed effect to isolate the effect of the principal from the one of school, and identify the effect of individual principals through turnover within schools over time². Coelli and Green (2012) identify the effect of individual principals on graduation rates and English exam scores using an administrative data set of grade 12 students in British Columbia high schools in Canada. First, they estimate the variance of the individual quality of principals on student outcomes using a semi-parametric technique³. Second, they estimate a dynamic model that allows for a potentially cumulative effect of school principals on school over time, because it may take several years for a principal to have a measurable influence on student outcomes. They find that there is a considerable heterogeneity in principal quality, and that most effective principals improve graduation rates and more importantly English exam if they had enough time to make their mark and have their full effect. They find that a principal moving up one standard deviation in the principal quality distribution will increase graduation rates and English exam scores by approximately 2.5% points.

Branch, Hanushek, et al. (2012) use a semi-parametric approach (as Bertrand

²Studies based on principal fixed effects focus on Canada or USA where principal rotation occurs frequently.

³They assume that the effect is time-invariant such as Hanushek, Kain, et al. (2005) with teacher effects.

and Schoar (2003)) to estimate the variance in principal quality based on contributions to student achievement (value-added model) in maths and reading for grades 3 to 8 in Texas schools. They find a significant variation in principal quality, a principal in the top 16 percent of the quality distribution (i.e., one standard deviation above average) will lead annually to student gains that are 0.05SD or higher than average for all students in the school. In addition, the variance of quality increases in high-poverty schools, suggesting that principal skill is more important in low-achieving schools and a larger variation in the skills of principals in those schools.

Dhuey and Smith (2014) measure the effect of individual principals on gains in reading and maths achievement using a value-added framework⁴ for students in grades 4 to 7 in British Columbia in Canada. In addition, they estimate the effect of experience as a principal within a school (tenure) and overall experience as a principal (experience) on student achievement. They find that moving one standard deviation up the distribution of principal quality improves math scores by 0.408 standard deviations and reading scores by 0.289 standard deviations. They emphasize that the extent of principal experience and length of tenure in a school have no significant impact on student performance. Dhuey and Smith (2018), as in their previous study, use a value-added framework to estimate the effect of principals on gains in primary test scores in North Carolina for students in grades 3 to 8. They find that principals have a large effect on maths and reading test scores, value-added having a standard deviation across principals of approximately 0.17 in math and 0.12 in reading. They also emphasize that brand-new principals with no prior experience decrease the share of students who attend school daily and the share of teachers with more than 11 years of experience. They show that new principals increase teacher turnover and the share of teachers with 0 to 3 years of experience.

Finally, more recent studies try to assess the impact of school principals in developing countries through targeted intervention on leadership abilities. M. P. Blimpo, M. Blimpo, et al. (2015) study the impact of management manual distribution to principals, teachers, and pupils' parents along with training in Gambia, but find no effect on student outcomes. Asim, Gera, et al. (2024) conduct an RCT in Malawi that aims to strengthen leadership skills for the headmaster. Precisely, they implement classroom training that focuses on skills such as making more efficient

³Unlike Coelli and Green (2012), they focus on principals with three years tenure or less to control for variation in quality that pertain to differences in length of tenure.

⁴While their empirical strategy is similar to Branch et al. (2012), one fundamental difference is that they estimate pure principal effects, rather than principal by school effects. This is an important distinction as principal-by-school effects do not allow researchers to separate the independent influences of principal and schools.

use of resources available at the school, motivating and incentivizing teachers to improve performance, and curating inclusive school cultures which meet the needs of all students, including overage students, students with special needs, low-performing students, and girls. They found that the exposure to intervention significantly increased test scores in mathematics by 0.1SD and reduced repetition in lower grades.

1.2 School principals in Africa

While the effect of leadership and principalship on student achievement constitutes a growing literature in economics, studies that focus on developing countries and especially Africa are relatively scarce⁵. In fact, the lack of available and good-quality data makes it difficult to assess the direct effect of school principals on student outcomes and even to produce reliable descriptive statistics to analyze principals' characteristics and how they behave. The African context for school principals is very different from the one of developed countries, and existing studies demonstrate that problems faced by headmasters substantially differ from those experienced by their counterparts in developed countries⁶.

Bush and Glover (2016) show that in West African countries, clear selection criteria are rarely available, leaving open the prospect of personal factors and affiliations being more important than leadership capability when such appointments are made. Kitavi and Van Der Westhuizen (1997) emphasize that in Kenya principals are appointed on the basis of successful record as teachers most of the time, without any formal leadership training. Oplatka (2004) adds that in Nigeria and Botswana, teaching experience or a good teaching record is not even a prerequisite for appointment since connections may be the major determinant in recruitment. He adds that in many African countries, principalship is conceived as a public position rather than a means to increase student learning. Chapman and Burchfield (1994) argue that being a principal in Botswana is seen as an attractive career path due to its external rewards. In addition, African school heads have to deal with limited budgets, shortage of school equipment and learning materials as well as low-skilled teachers. However, the scarcity of resources is not associated with specific training to enable headmasters to prepare themselves for their leadership responsibilities. This is the case for South and East African countries as well as West African countries (Bush and Glover, 2016). Hence, headmasters are almost essentially focused on

⁵Even in educational science, the literature relative to principalship in Africa and especially West African countries is narrow (Hallinger, 2018.)

⁶Harber and Dadey (1993) and Chapman and Burchfield (1994) highlight the gap between the theory of school management and how schools were managed on everyday life in African countries.

management and maintenance tasks such as maintaining discipline, managing material resources, and budget allocation, and clearly neglect the leadership component of their role (Oplatka, 2004; Bush and Oduro, 2006; Bush and Glover, 2016). More than being oriented toward a managerial leadership style, Oplatka (2004) described principals in Africa as working with limited autonomy, autocratic leadership style, and low level of change initiation. They are required to obey their superiors unquestioningly and are expected to adopt an autocratic attitude in their relations with teachers. Moreover, they are likely to refrain from involving teachers and parents in decision-making and from delegation of responsibilities. As descriptive studies demonstrate it, headmasters in Africa behave in a very different way from those of developed countries, though few data are available.

2 Data and Sample

2.1 PASEC 2014 Data

Table 3.1 provides information of PASEC 2014 data. The database includes ten sub-Saharan French-speaking countries: Benin, Burkina Faso, Burundi, Cameroon, Chad, Congo, Côte d'Ivoire, Niger, Senegal, and Togo, and encompasses more than 1800 schools distributed among the 10 countries with almost 40,000 pupils. PASEC follows a standardized sampling procedure for each country and selects schools randomly at the regional level ensuring regional representativeness⁷. In each region, PASEC samples schools to assess grade 6 pupils and half of these schools are also chosen to be surveyed for grade 2. In each selected school, one 6th grade class is randomly selected, and one 2nd grade class is also selected if the school is chosen to be assessed for 2nd grade. Finally, twenty students are randomly drawn to take the test in the 6th grade class, and ten students for the 2nd grade class. PASEC data includes language and mathematics test scores for students assessed at the end of the year, along with various surveys that provide rich information on pupils' household characteristics, teachers and classroom equipment, and principals and school characteristics.

⁷The sampling procedure of PASEC data is described in Appendix 1.A.1

2.2 Sample for analysis

The final sample is detailed in Table 3.1. I removed from the analysis all private schools and private headmasters⁸, which amounts to drop a substantial number of schools, especially in Cameroon, Chad, and Congo. Consequently, all teachers from the private sector are withdrawn as well⁹. The two main outcomes of the analysis are test scores at the end of the year in language and mathematics. Consequently, observations for which there was no information on test scores for both mathematics and language were removed. I also excluded students for which there is missing information on characteristics for variables in Table 1.5, for whom the teacher has missing information for variables in Table 1.6, and for whom the principal has missing information for variables in Table 1.4. This procedure leads to drop a consequent number of observations but ensures a stable sample throughout the analysis. The final sample encompasses 19,155 students distributed in 1,123 schools (and as many headmasters) with 1,543 teachers¹⁰. As tests are different for Cameroon due to the English-speaking region of the country, and that grade 2 and grade 6 students do not take the same test and have different numbers of items that are summed, test scores are standardized within countries and within grades based on the control group (defined in the following section) of the final sample.

2.3 Principal characteristics

Tables 1.2 and 1.3 detail the characteristics of headmasters and their involvement in school management in the sample used for analysis. One could observe that there are only 20% on female principals in the final sample. The large majority of principals have a permanent contract, with only 12% of short-term contract headmasters¹¹. In terms of education, 64% of principals have not reached tertiary education, and only 3.8% have a degree equivalent to *Bac+3* (three academic years) or more. Moreover, approximately 57% received a pedagogical training of one year or less, with 8% that did not been trained at all. Interestingly, about two-thirds of headmasters are currently teaching, and all have at least one year of teaching experience. In addition, the average number of years of teaching experience (10 years) surpasses the average number of years of experience as a school principal (8 years).

⁸I explain the reason behind in the empirical strategy section.

⁹Some public schools may contain teachers hired by the private sector.

¹⁰Considering the sampling procedure, one teacher is present for schools that have been only selected for 6th grade and two teachers for schools that were selected for both 6th grade and 2nd grade.

¹¹Hired by the government or the local community as I only kept public schools.

This teaching involvement could theoretically stem from their previous role as teachers or result from the need to replace absent teachers, which is a common occurrence. As many appear to have transitioned from teaching roles to their current positions as headmasters or are still teaching, the pedagogical training reported by headmasters could be principal training as well as teacher training. Consequently, they may not have received formal academic training in school management, prompting the need for additional professional development, which explains the high number of principals who received additional training in school management (45%).

All teachers of the sample declare that their headmaster operates in classroom for pedagogy, and more than two-thirds declare that the principal supports them for administrative tasks as well as for discipline. Concerning the management of absent teachers, half of school principals manage to replace a teacher with a replacement teacher or by replacing him himself, and even if the teacher is absent for more than a week. Eventually, almost 80% of principals declare that they manage to organize a meeting with all teachers in the school at least once a month, and more than 55% declare meeting teachers for pedagogical questions more than once every two weeks, and 35% for administrative issues.

3 School Principals Involvement Score

To assess the effect of headmasters on students' outcomes, I construct an involvement score for school principals. The quality of a school principal can be characterized by his diploma, his training, his experience, or other observable characteristics, but depends on several other features such as his motivation, his management skills, his willingness to make students reach educational goals or his leadership abilities. I gather answers to the PASEC 2014 survey to construct a normalized z-score, which summarizes information on principals' involvement, and I investigate which observable characteristics of headmasters are associated with it before detailing the possible mechanisms through which involvement can raise learning achievement.

3.1 Involvement Score Construction

The involvement score encompasses four features of school management: meetings with teachers, management of absent teachers, interventions in classroom to support teachers, and meetings with students' parents. All the variables included in the score are detailed in Table 1.3. The variables are self-declared by the head-

master except for questions about the involvement in the classroom (answered by teachers), therefore the involvement might be slightly overestimated. The score is human resources oriented as it does not include management material resources as I do not have information on how the school budget is allocated and who provides and manages school equipment. I constructed the score using the summary index method from Kling, Liebman, et al., 2007: I normalize each variable of the score, and I compute the average of normalized variables:

$$PIS_s = \frac{1}{n} \sum_{k=1}^n \frac{X_{k,s} - \bar{X}_k}{\sigma_{X_k}} \quad (1.1)$$

Where PIS_s is the involvement score for the principal in the school s , $X_{k,s}$ is the value for an involvement variable k for the principal in the school s , \bar{X}_k is the mean of the variable X_k and σ_{X_k} is the standard deviation of the variable X_k . The normalization ensures that all variables have the same weight in the score, given that their modalities are very different. Hence, the meetings with teachers feature is more prevalent (three variables), meetings with parents and management of absent teachers are less important (two variables each) and the direct involvement in classroom has the lowest weight (one variable).

3.2 Involvement Score and Principals' Characteristics

In this section, I investigate the relationship between involvement in school management and headmasters' characteristics to identify which attributes are associated with higher involvement. First, I construct three dummy variables based on involvement distribution: the first one equals 0 for principals whose involvement is below the median in their country and 1 above, the second one equals 0 for principals who belong in the first tercile of involvement in their country and 1 in the third tercile, and a third one equals 0 for principal who belongs in the first quartile in their country of involvement and 1 for the fourth quartile. These different variables enable to determine how characteristics are associated with different levels of involvement. I estimate the following model using an OLS on three different groups of principal involvement:

$$X_s = \alpha + \beta Involved_s + \varepsilon_s \quad (1.2)$$

Where X_s is a characteristic of the principal in the school s , $Involved_s$ is a dummy that equals 1 if the principal in the s has an involvement score above the

median and 0 otherwise, and ε_s is the robust error term.

Table 1.4 presents the results. First, there are significantly fewer women involved in school management when comparing the first and fourth quartiles of involvement (-0.06), but not comparing both sides of the median or terciles. Regarding training, the further one moves towards the extremities of involvement, the smaller the difference between the control and treated groups, with decreasing significance (due to the loss of statistical power), and the same applies to the number of years of experience as a headmaster. Moreover, headmasters' salary seems to be higher for more involved headmasters ($+100,000$ to $+115,000$ FCFA), but with low significance, associated with marginally higher experience with low significance as well. The two main results that arise from these estimates concern the training in management and teaching. The fourth quartile of involvement contains significantly more headmasters ($+0.09$ at the 5% level) that received training in school management than the first quartile. Furthermore, regardless of the group comparison, there are consistently fewer principals who teach among the more involved groups compared to the less involved ones (-0.09 to -0.11). Since the involvement score includes variables that are time-consuming for headmasters, it is logical that those who teach spend less time on other activities, such as attending meetings or supporting teachers in their classrooms. Overall, school principal involvement does not seem to be strongly related to its observable characteristics.

3.3 Theory of change

Considering variables included in the score, principal involvement in school management may impact learning outcomes through several mechanisms. First, school principals operating more in classrooms could enhance lesson quality by supporting teachers with pedagogical issues (checking pupils' notebooks or assisting them for lessons) and reduce student absenteeism by helping teachers with administrative tasks or discipline (checking register for absenteeism and addressing disciplinary matters). Second, the involvement index could influence student achievement through improvements in teacher quality. Increased meetings between headmasters and teachers may lead to reduced teacher absenteeism and greater effort, resulting in more instructional time for students. Third, better replacement of teachers may lead to more instructional time if students would go home otherwise and might influence student learning through better lessons throughout the way the absent teacher is replaced. It is likely that when pupils are distributed in other classrooms or when another person (who is not a teacher) replaces the absent teacher, learning

conditions are worse than when an official replacement teacher or the headmaster himself substitutes the absent teacher. Eventually, more meetings with students' parents, particularly those of low-achieving students, can provide a clearer understanding of students' challenges, allowing teachers to better match lesson content to pupils' needs. Overall, a higher involvement from principals could have an indirect impact on student achievement by enhancing teacher quality through the compensation of deficient teachers and their support while also having a direct impact through classroom interventions and the replacement of absent teachers.

4 Empirical Strategy

4.1 Endogeneity of school principals involvement

Assessing the impact of principals' involvement on learning outcomes requires investigation concerning a potential sorting of students, teachers and headmasters. First, since teachers and headmasters are assigned to public schools by the government, better headmasters cannot selectively choose better teachers for their schools. Therefore, I exclude from the dataset all headmasters and teachers hired by the private sector, as well as all private schools where teacher and headmaster assignments were not carried out by the government, as previously said. Nonetheless, more attractive regions and schools face higher demand and, consequently, higher competition in hiring. As a result, these regions or schools may attract better headmasters, teachers, and students. Conversely, less attractive schools may end up with less efficient headmasters, teachers, and students. Furthermore, headmasters' involvement may also be endogenous due to teachers' performance. If teachers are inefficient, headmasters may need to compensate by increasing their involvement. For instance, principals could operate more in classrooms to support teachers or replace them more frequently in response to higher teacher absenteeism. Alternatively, if teachers are highly efficient, headmasters might have less incentive to be actively involved. The same logic applies to student achievement. With more low-achieving students, meetings with parents could occur more frequently, increasing the involvement index.

To test whether the principal involvement score is endogenous or not, I proceed to a comparison of student and teacher characteristics based on groups of involvement previously defined. I estimate the relation between headmaster involvement and student characteristics using OLS regression:

$$X_{i,s,g} = \alpha + \beta \text{Involved}_s + \delta_g + \varepsilon_{i,s,g} \quad (1.3)$$

Where $X_{i,s,g}$ is a given characteristic of pupil i in the s in the grade g , Involved_s is the treatment variable that equals 1 if the principal in the s of the student i has an involvement score above the median in its country and 0 otherwise, δ_g is a grade fixed effect that equals one if the student is in grade 2 and 0 if he is in grade 6, and $\varepsilon_{i,s,g}$ is the robust error term clustered at the school level. For teacher characteristics:

$$X_{j,s,g} = \alpha + \beta \text{Involved}_s + \delta_g + \varepsilon_{j,s,g} \quad (1.4)$$

Where $X_{j,s,g}$ is a given characteristic of teacher j in the s in the grade g , and $\varepsilon_{j,s,g}$ is the robust error term clustered at the school level.

β is the coefficient of interest. A positive coefficient for students' household education would suggest that more involved principals are in the same schools as children belonging to more educated households, indicating a sorting of headmasters, teachers, and students. A negative coefficient could suggest that headmasters are more involved to compensate for the failure of teachers or students or that they are less involved because teachers and students perform well, once again demonstrating that principals' involvement is endogenous, or, in other words, that they are not distributed randomly across the territory within countries.

Table 1.5 summarizes the findings for student characteristics. Coefficients associated to being in a higher group of involvement are positive (+0.05 to +0.07) and highly significant (though the significance decreases due to fewer observations) for whether the student speaks French at home, whether there are books at home, and for the wealth index. Surprisingly, I do not observe significant differences for having done preschool, having ever repeated, and ability to read of parents, generally associated with the previous significant variables. Overall, results suggest that principals' involvement is strongly endogenous, with more involved headmasters being in the same schools as wealthier and better-educated households.

Table 1.6 presents results for teacher characteristics. There are only two variables that significantly differ between groups of involvement. First, the sex of the teacher, with more female teachers (+0.04) in schools where the headmaster's involvement is above the median of involvement in its country. The coefficient is not significant for other groups of involvement. All other standard characteristics of teachers, such as age, contract type, education, experience, training, and salary, are

insignificant and have coefficients of low magnitude. Nevertheless, the number of days for which the teacher has been absent the month before the survey is negative (-0.027 to -0.036) and strongly significant. This finding suggests that involved headmasters are positively associated with teacher effort. One of the reason behind might be that more involved principals are those who monitor and control absenteeism more closely. However, higher involvement is not associated with fewer hours of lessons per week declared by the teacher.

4.2 Identification Strategy

To address the issue of endogeneity of involvement, I conduct a nearest neighbours matching. The matching procedure aims to pair students whose principals have a difference in involvement score by minimizing the differences between variables which their test score variations (matching variables). The global hypothesis behind this procedure is that conditionally on matching variables, the difference in test scores within each pair is the result of principals' difference in involvement. In other words, conditionally on observables, the assignment of an involved principal to students is random.

To define the treatment variable, I separate the sample in two subsamples according to whether the headmaster has an involvement score below or above the median in his country¹². Students whose principal has an involvement score above the median of their country are considered as part of the treated group (with index a) and those whose principal has an involvement score below the median are considered as part of the control group (with index b)¹³. In each country, I regress test scores in language and mathematics and the treatment variable on students' and teachers' characteristics¹⁴. I select all significant variables at a 10% level as matching variables, whether it is significant for language, mathematics or the treatment variable as advocated by Stuart (2010). Actually, I do not have enough significant variables to produce a robust matching using a 5% level threshold. On the opposite side, taking all students' and teachers' characteristics as matching variables leads to pair observations with substantial differences in characteristics even if the global distance is low. This results in 7 to 11 matching variables depending on countries.

¹²It is not possible to define the treatment with terciles or quartiles since there is not enough observation to conduct a matching

¹³The involvement score distribution differs substantially among countries and proceeding to a matching according to the median of involvement of the whole sample results in a systematic pairing of headmasters between different countries.

¹⁴Except for the days absent last month and the hours of lesson per week for teachers, and I add the location of the school.

For each student a in the treated group and each student b in the control group, I compute the total distance $D_{a,b}$ for the n matching variables selected¹⁵:

$$D_{a,b} = \frac{1}{n} \sum_{k=1}^n |x_{k,a} - x_{k,b}| \quad (1.5)$$

Where $D_{a,b}$ is the mean of all distances in matching variables for a given treated observation a and a given control observation b , $x_{k,a}$ is the value of the matching variable k for the observation a and $x_{k,b}$ is the value of matching variable k for the observation b . I match each treated observation a with its nearest control observation b taking the minimum distance $D_{a,b}$ among all possible control observation b . A single treated student could have several identical nearest controls, and a single control could be the nearest neighbor of several treated students. Hence, I create a stratum of nearest neighbors: all strictly identical controls (i.e. who have exactly the same values for matching variables) and all treated for whom these controls are nearest neighbors are gathered in a stratum. It should be noted that treated observations can be matched with a single control observation without having the same minimum distance $D_{a,b}$ to it, and that the matching is a draw without replacement as one observation can only be part of one stratum even if it is paired with several others. Moreover, treated students could have different headmasters within the stratum as well as control students, leading to different involvement scores. Proceeding this way, I prevent from not pairing an observation with its nearest neighbor because this latter has already been paired. As there is always a trade-off between the number of observations and within-stratum similarity, I decided to remove all the treated observations for which the minimum distance was higher than 0.1 to ensure that treated and nearest controls were similar enough in matching characteristics. Consequently, all the students that are matched in a stratum are almost identical in variables explaining test scores variation and treatment assignment. This strategy allows to use a strata fixed-effect in estimates and exploits the within-stratum variation in involvement between treated and control students. According to our main assumption, the difference in test scores among treated and control students within a stratum is due to the difference in principals' involvement.

To investigate the impact of principals' involvement on test scores, I proceed to three different regressions: test scores on involvement score only, test scores on principals' characteristics only, and test scores on involvement score and principals' characteristics.

¹⁵All the matching variables are standardized within countries to have the same weight in the total distance.

$$TS_{i,s,j} = \alpha + \beta Involved_s + \gamma X_s + \delta_j + \varepsilon_{i,s,j} \quad (1.6)$$

Where $TS_{i,s,j}$ is the test score of the observation i in the school s in the stratum j , $Involved_s$ is the treatment variable that equals 1 if the principal in the s of the student i has an involvement score above the median in its country and 0 otherwise, X_s are characteristics for the principal in the school s , δ_j is the strata fixed effect which is a dummy variable that equals 1 if the observation i is in the stratum j , and $\varepsilon_{i,s,j}$ is the robust error term clustered at the school level.

5 Results

5.1 Matching procedure and final sample

Table 1.A.1 summarizes matching variables selected for each country ¹⁶. The sex of the student, whether he has ever repeated a class or not and whether he speaks French at home have been selected for almost every country (at least 9 out of 10). Strikingly, the ability to read of the mother, the father, and the brother of students do not explain test scores variation as well as treatment assignment in many countries. The same applies to teacher characteristics. Apart from the sex of the teacher (selected in 8 countries), other teacher variables are not frequently selected.

The matching procedure led to a sample of 11,004 students distributed among 926 public schools as observations with a minimum distance larger than 0.1 were withdrawn, and since Cameroon and Congo were removed from the analysis due to large differences in characteristics and a low number of observations. The control group is composed of 5,810 students and the treatment group of 5,194 students, and there is a total of 3,079 stratum. Table 1.7 presents differences of all student and teacher characteristics within stratum. Overall, there are only 2 significantly different characteristics for Benin (although school location has a coefficient of 0.01), 1 for Burkina Faso, 2 for Burundi, 2 for Chad, 3 for Côte d'Ivoire, 1 for Niger, and none for Senegal and Togo. Student characteristics are well balanced in the remaining countries, even if treated pupils in Côte d'Ivoire are significantly older and more of them have a father who can read. The global picture for teachers is almost the same. Teachers associated to the treated group seem to be slightly less

¹⁶Tables of regressions of test scores and of the treatment variable on student and teacher characteristics are available upon request

trained and educated on average but with low and insignificant differences except for Côte d'Ivoire and Niger. In general, student and teacher characteristics are well balanced in the final sample, with only 11 significant differences out of 180 variables (without Cameroon and Congo).

5.2 Estimates for principal involvement

Table 1.8 presents the results of OLS estimates using the strata fixed effect. First, It can be noticed that the R^2 of each regression is 0.47, which is relatively high ¹⁷. The two estimates of test scores on the sole treatment variable with strata fixed effect show an insignificant effect of involvement on test scores, and more strikingly a negative coefficient. This suggests that the matching strategy may not have correctly addressed the endogeneity of the involvement score, the negative coefficient might reflect that headmasters have to compensate for students' or teachers' performance. For instance, headmasters might meet students' parents more frequently if students underperform. Another explanation for the negative coefficient could be poor quality involvement. Headmasters that operate in classroom could disturb teacher lessons, and meetings with teachers could be useless, time-consuming, and at the cost of better-prepared lessons. Principals who replace absent teachers themselves could also be less motivated to teach and have to because they could not find any substitute teacher, and this latter explanation questions the construction of the involvement score. The regression of test scores on principals' characteristics alone with the strata fixed effect shows that headmaster attributes do not seem to strongly affect student outcomes except for the contract term (+0.021SD) in language. Surprisingly, having received training in management is negatively associated with test scores in language (−0.07SD), and being a female headmaster seems to be positively correlated to mathematics outcomes (+0.10SD). Finally, the magnitude and the standard errors of coefficients resulting from estimates of test scores on the treatment variable and principal characteristics with the strata fixed effect are almost identical when estimated separately, except for whether the headmaster teaches (−0.07SD). This is consistent with results concerning the correlation between the involvement score and principals' characteristics presented previously.

As matching is performed on teacher characteristics, one cannot say that the lower absenteeism observed for students of the treatment group does not translate into meaningful learning since teacher absenteeism could be correlated with observ-

¹⁷In other words, the strata fixed effect explains approximately 47% of test score variation between students of the two groups within strata considering the insignificant coefficients.

able characteristics, which are balanced within strata. However, this result would be consistent with the fact that less absenteeism is due to increased control by the principal but does not yield to effort for teachers. The fact that lower absenteeism is not associated with a higher number of hours of lessons per week goes in the same direction. Finally, I investigate the effect of involvement controlling for teacher absenteeism. Findings do not show any difference in the impact of principal involvement after controlling for teacher absenteeism, but a significant though low negative impact (-0.01 to $-0.02SD$) of this latter variable on test scores. This finding shows that there is still enough variation in teacher absenteeism after controlling for teacher characteristics within the stratum and that this lower absenteeism effectively results in higher achievement. Further research is needed to investigate this result.

Finally, one could wonder if the low magnitude of the involved coefficient could stem from insufficient variation in the involvement score between treated and control pupils within stratum. Table 1.A.2 shows that the average difference in involvement score within stratum is 0.48, significant at the 1% level. Given that the principal involvement score is constructed as a z-score, this variation should be enough to capture the effect of involvement in school management.

6 Estimates with community involvement

School principal involvement could be closely related to local community involvement. In fact, community involvement could act as a substitute for principal involvement, compensating for headmasters who are low-involved. Table 1.10 presents variables for local community involvement. For all variables, more than half of the schools received help for the issue in question. For teacher pedagogical training and the payment of teachers' salaries, almost all principals receive help from the community, and all the schools in the sample receive help from the community for the coverage of exam fees. I construct a community involvement score with all variables in Table 1.10 the same method as for the principal involvement score, and create a dummy variable based on the median within country of community involvement. I estimate the following model with an OLS using the strata fixed effect and interacting both involvement scores:

$$\begin{aligned}
TS_{i,s,j} = & \alpha + \beta \text{PrincipalInvolved}_s + \phi \text{CommunityInvolved}_s \\
& + \theta \text{PrincipalInvolved}_s * \text{CommunityInvolved}_s + \gamma X_s + \delta_j + \varepsilon_{i,s,j}
\end{aligned} \tag{1.7}$$

Where *PrincipalInvolved_s* is the treatment variable that equals 1 if the principal in the school *s* of the student *i* has an involvement score above the median in its country and 0 otherwise and *CommunityInvolved_s* is a dummy variable that equals 1 if the local community of the school *s* of the student *i* has an involvement score above the median in its country and 0 otherwise.

Table 1.11 presents the results. Results do not show any relationship between principal involvement and community involvement. More surprisingly, community involvement is negatively associated with student mathematics outcomes (-0.08 to -0.09SD , significant at the 10% level). This result could stem from the endogeneity of the community involvement score, and that community might help more schools where students underperform. Further research is needed to investigate this result.

7 Conclusion

The positive impact of leaders has been widely demonstrated in the economic literature, and there are large evidence that the same applies to school principals in developed countries. As interventions aiming to change school management in Africa present mixed results, the mere role of school principals needs to be investigated as it could be a determinant factor in enhancing students learning. To assess the impact of headmasters on learning outcomes, I construct an involvement score for principals that relies on four dimensions of school management: meetings with teachers, meetings with students' parents, interventions in the classroom to support teachers and management of absent teachers.

More involved principals seem to be paid more but with low significance. They are more likely to have received training in management but are less likely to teach than those in the opposite treatment arm. However, the weakness of the coefficients does not suggest any strong relationship between involvement and standard observable characteristics of school principals. Moreover, I find that higher involvement is associated with students with wealthier and more educated households, indicating that there is a sorting of students and principals. Principals with higher involvement are also linked to less absenteeism among teachers.

Considering the endogeneity of involvement, I conduct a nearest neighbour matching to estimate the impact of the involvement score on learning outcomes. First, I divide the sample of students into two groups according to the median of the involvement score in the country to match two headmasters with considerable differences in their involvement. I select as matching variables student and teacher characteristics that significantly explain test scores variations in language or in mathematics, or treatment assignment. I find the nearest neighbour of each student among the other group based on the minimum distance in matching variables and gather in a stratum all treated that have the same nearest control, the nearest control, and all control students that are strictly identical to the nearest control. I assess the impact of the involvement score on language and mathematics test scores using an OLS estimate with a strata fixed to exploit the within-stratum variation in principal involvement, adding characteristics of school principals as control variables. Results do not suggest any significant relationship between school head's involvement and learning outcomes.

This result has several policy implications in terms of training and selection of school principals. Considering that principals could have a substantial effect on learning outcomes and that descriptive studies depict them as lacking leadership abilities, changing appointment criteria and giving better training could be a key to enhance learning achievement.

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Tables

Table 1.1: PASEC 2014 data and final sample

Data	Benin	Burkina Faso	Burundi	Cameroon	Chad	Congo	Côte d'Ivoire	Niger	Senegal	Togo	All
Raw data											
Total schools	166	191	180	271	165	167	174	180	163	190	1,847
Missing	38	44	34	128	87	97	44	18	46	57	596
	(23%)	(23%)	(19%)	(47%)	(53%)	(58%)	(25%)	(10%)	(28%)	(30%)	(32%)
Total teachers	245	282	270	400	245	254	257	262	243	284	2,742
Missing	64	44	33	289	58	113	51	21	34	65	772
	(26%)	(16%)	(12%)	(72%)	(24%)	(45%)	(20%)	(8%)	(14%)	(23%)	(28%)
Total pupils	3,765	4,385	4,316	4,888	3,297	3,544	3,812	4,009	3,712	4,167	39,895
Missing	748	541	211	1,425	1,166	1,216	526	1,067	921	559	8,380
	(20%)	(12%)	(5%)	(29%)	(35%)	(34%)	(14%)	(27%)	(25%)	(13%)	(21%)
Final sample											
Total schools	124	134	137	73	67	60	124	157	114	133	1,123
Total teachers	158	200	205	81	92	84	170	209	161	183	1,543
Total pupils	2,118	2,855	2,825	687	890	754	2,271	2,497	1,909	2,349	19,155

Note: The number reported for *Missing* are private schools or principals with missing information characteristics for the first row, teachers with missing information for characteristics for the second row, and students for which test scores are characteristics are missing.

Table 1.2: Principals' characteristics

Variables	Category	Obs	Freq		
Sex	Male	899	80.0%		
	Female	224	20.0%		
Status	Permanent	991	88.2%		
	Contract	132	11.8%		
Highest Class	Terminale or less	728	64.6%		
	Bac+1	225	20.0%		
	Bac+2	131	11.7%		
	Bac+3	22	2.0%		
	Bac+4 or more	20	1.8%		
Pedagogical training	No training	92	8.2%		
	6 months or less	178	15.9%		
	1 academic year	371	33.0%		
	2 academic years	339	30.2%		
	3 academic years or more	143	12.7%		
Additional training in school management	No	621	55.3%		
	Yes	502	44.7%		
Currently teaching	No	363	32.3%		
	Yes	760	67.7%		
	Mean	Median	SD	Min	Max
Age	43.8	43	8.2	20	63
Experience	8.3	7.0	6.4	1	35
Teaching	10.0	9.0	7.0	1	34

Table 1.3: Principals' involvement characteristics

Involvement variables	Category	Obs	Freq	
Support teacher (teacher survey)				
Operate in classroom for pedagogy	No	0	0.0%	
	Yes	1,123	100.0%	
	Missing	0	0.0%	
Operate in classroom for administration	No	141	12.5%	
	Yes	758	67.5%	
	Missing	0	20.0%	
Operate in classroom for discipline	No	241	21.5%	
	Yes	811	72.2%	
	Missing	71	6.3%	
Replacement of absent teachers (principal survey)				
Replace an absent teacher	No	79	7.0%	
	Other class/Another person	460	41.0%	
	Replacement teacher/Himself	569	50.7%	
	Missing	15	1.3%	
Call a replacement teacher when a teacher is absent for more than a week	No	259	23.1%	
	Sometimes/Other class/Another person	288	25.6%	
	Always/Himself	558	49.7%	
	Missing	18	1.6%	
Meetings with students parents (principal survey)				
Meet low-achieving students' parents	No	80	7.1%	
	Yes	1,043	92.9%	
	Missing	0	0.0%	
Annual number of meetings with parents	Mean	Median	Min	Max
	3.2	3	0	18

Table 1.3 continued from previous page

Involvement variables	Category	Obs	Freq
Meetings with teachers (principal survey)			
Frequency of meetings with all teachers	Never	5	0.4%
	Once a year	3	0.3%
	Once a quarter	237	21.1%
	Once a month	584	52.0%
	Once every 15 days	198	17.6%
	Once a week	95	8.5%
	Missing	1	0.1%
Frequency of meetings on pedagogical issues	Never	37	3.3%
	< 2 times per month	468	41.7%
	2-3 times per month	504	44.9%
	4 times a month or more	110	9.8%
	Missing	4	0.3%
Frequency of meetings on administrative issues	Never	88	7.8%
	< 2 times per month	641	57.1%
	2-3 times per month	330	29.4 %
	4 times a month or more	62	5.5%
	Missing	2	0.2%

Table 1.4: Difference in principal characteristics according to PIS groups

Principal characteristics		PIS groups		
		50-50	T3-T1	Q4-Q1
Female	Mean C	0.21	0.22	0.23
	T-C	-0.02	-0.03	-0.06*
	SE	(0.02)	(0.03)	(0.03)
Age	Mean C	43.73	43.61	43.64
	T-C	0.19	0.07	-0.32
	SE	(0.49)	(0.61)	(0.71)
Years of education	Mean C	11.81	11.78	11.71
	T-C	-0.10	0.02	0.09
	SE	(0.11)	(0.13)	(0.15)
Practical training (months)	Mean C	16.78	16.77	16.36
	T-C	0.79	1.15	1.39
	SE	(0.69)	(0.85)	(0.99)
Pedagogical training (months)	Mean C	3.37	3.44	3.34
	T-C	0.42**	0.34	0.26
	SE	(0.20)	(0.24)	(0.26)
Training management	Mean C	0.43	0.42	0.40
	T-C	0.03	0.06	0.09**
	SE	(0.03)	(0.04)	(0.04)
Contract	Mean C	0.13	0.14	0.13
	T-C	-0.02	-0.02	-0.02
	SE	(0.02)	(0.02)	(0.03)
Years of experience	Mean C	8.00	7.85	7.94
	T-C	0.68*	0.67	0.38
	SE	(0.39)	(0.48)	(0.55)
Currently teaching	Mean C	0.72	0.74	0.73
	T-C	-0.09***	-0.11***	-0.09**
	SE	(0.03)	(0.03)	(0.04)
Years of teaching	Mean C	10.04	9.95	9.83
	T-C	0.01	0.05	0.03
	SE	(0.42)	(0.53)	(0.60)
Monthly salary	Mean C	1879.14	1869.44	1870.99
	T-C	104.08*	115.51*	100.46
	SE	(56.52)	(68.92)	(79.21)
Observations		1123	750	567

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Grade 4 fixed-effect and constant terms are removed for readability.

Table 1.5: Difference in student characteristics according to PIS groups

Student characteristics		PIS groups		
		50-50	T3-T1	Q4-Q1
Female	Mean C	0.47	0.47	0.47
	T-C	0.01	0.02	0.02
	SE	(0.01)	(0.01)	(0.01)
Age	Mean C	12.08	12.06	12.03
	T-C	-0.05	-0.03	-0.08
	SE	(0.06)	(0.07)	(0.08)
Preschool	Mean C	0.19	0.19	0.19
	T-C	0.01	0.02	0.03
	SE	(0.01)	(0.02)	(0.02)
Have ever repeated	Mean C	0.53	0.52	0.51
	T-C	-0.01	-0.01	-0.01
	SE	(0.01)	(0.02)	(0.02)
Speaks French at home	Mean C	0.67	0.66	0.67
	T-C	0.05***	0.07***	0.06**
	SE	(0.02)	(0.02)	(0.02)
Father reads	Mean C	0.59	0.60	0.60
	T-C	0.01	-0.00	-0.01
	SE	(0.01)	(0.02)	(0.02)
Mother reads	Mean C	0.36	0.36	0.36
	T-C	0.02	0.03	0.02
	SE	(0.02)	(0.02)	(0.02)
Brother reads	Mean C	0.83	0.83	0.83
	T-C	0.01	0.01	0.00
	SE	(0.01)	(0.01)	(0.01)
Books at home	Mean C	0.44	0.45	0.46
	T-C	0.06***	0.05**	0.05*
	SE	(0.02)	(0.02)	(0.03)
Wealth index	Mean C	-0.19	-0.19	-0.17
	T-C	0.06*	0.08**	0.04
	SE	(0.03)	(0.04)	(0.05)
Grade FE		Yes	Yes	Yes
Observations		19155	12649	9579

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Grade fixed-effect and constant terms are removed for readability.

Table 1.6: Difference in teacher characteristics according to PIS groups

Teacher characteristics		PIS groups		
		50-50	T3-T1	Q4-Q1
Female	Mean C	0.27	0.28	0.28
	T-C	0.04*	0.03	0.03
	SE	(0.02)	(0.03)	(0.03)
Age	Mean C	37.21	37.51	37.34
	T-C	0.35	-0.30	-0.20
	SE	(0.43)	(0.53)	(0.61)
Contract teacher	Mean C	0.43	0.44	0.44
	T-C	-0.04	-0.05	-0.02
	SE	(0.03)	(0.03)	(0.04)
Years of education	Mean C	11.81	11.70	11.74
	T-C	-0.05	0.11	0.08
	SE	(0.10)	(0.12)	(0.13)
Years of experience	Mean C	10.69	10.91	10.80
	T-C	0.55	0.15	0.23
	SE	(0.42)	(0.52)	(0.60)
Pedagogical training (months)	Mean C	15.61	14.95	14.72
	T-C	0.35	1.18	1.27
	SE	(0.63)	(0.74)	(0.87)
Practical training (months)	Mean C	3.57	3.54	3.61
	T-C	-0.10	-0.05	-0.29
	SE	(0.19)	(0.22)	(0.26)
Monthly salary (in k FCFA)	Mean C	137.51	139.26	136.59
	T-C	-2.77	-3.75	-2.15
	SE	(5.56)	(6.84)	(7.75)
Days absent last month	Mean C	1.69	1.67	1.69
	T-C	-0.36***	-0.27*	-0.34*
	SE	(0.13)	(0.15)	(0.18)
Hours of lesson per week	Mean C	29.51	29.62	29.69
	T-C	0.23	0.49	0.36
	SE	(0.38)	(0.47)	(0.54)
Grade FE		Yes	Yes	Yes
Observations		1522	1018	778

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Grade fixed-effect and constant terms are removed for readability.

Table 1.7: Within-stratum differences for student and teacher characteristics

Variables	Benin	Burkina Faso	Burundi	Cameroon	Chad	Congo	Côte d'Ivoire	Niger	Senegal	Togo
Student characteristics										
Female	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.25 (0.25)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Age	-0.01 (0.01)	-0.01 (0.03)	0.00 (0.01)	0.08 (0.23)	0.02 (0.09)	-0.08** (0.04)	0.15*** (0.06)	-0.01 (0.05)	0.04 (0.05)	-0.01 (0.05)
Preschool	-0.10 (0.09)	-0.07 (0.08)	-0.07 (0.08)	0.00 (0.00)	-0.01 (0.12)	0.37 (0.41)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.08)
Have ever repeated	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Speaks French at home	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.16 (0.43)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.01 (0.01)	0.00 (0.00)
Father reads	-0.04 (0.08)	-0.08 (0.06)	0.00 (0.05)	-0.23 (0.23)	-0.07 (0.10)	0.00 (0.00)	0.14* (0.08)	0.00 (0.00)	-0.01 (0.09)	0.00 (0.00)
Mother reads	-0.04 (0.08)	0.00 (0.00)	0.03 (0.05)	0.00 (0.00)	0.07 (0.11)	0.00 (0.00)	0.13 (0.09)	0.00 (0.00)	-0.05 (0.08)	0.00 (0.00)
Brother reads	-0.03 (0.07)	0.00 (0.00)	0.01 (0.07)	0.00 (0.18)	-0.01 (0.13)	0.08 (0.39)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Books at home	0.00 (0.00)	0.00 (0.00)	0.07 (0.09)	0.00 (0.00)	0.08 (0.14)	0.62** (0.26)	0.14 (0.11)	0.00 (0.00)	0.01 (0.01)	0.00 (0.00)
Wealth index	0.00 (0.02)	-0.02 (0.06)	-0.04 (0.06)	0.07 (0.08)	0.01 (0.01)	0.57** (0.27)	-0.01 (0.01)	0.02 (0.01)	0.03 (0.03)	0.08 (0.08)

Table 1.7 continued from previous page

Variables	Benin	Burkina Faso	Burundi	Cameroon	Chad	Congo	Côte d'Ivoire	Niger	Senegal	Togo
Teacher characteristics										
Female	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.23 (0.21)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Age	-0.06 (0.15)	0.02 (0.05)	0.03* (0.02)	-0.12 (0.11)	0.11 (0.21)	-0.13** (0.06)	-0.06 (0.05)	-0.12 (0.13)	0.15 (0.13)	0.11 (0.14)
Contract teacher	0.07 (0.16)	-0.11 (0.17)	0.12 (0.09)	0.41 (0.34)	-0.31 (0.20)	0.00 (0.00)	0.12 (0.12)	0.01 (0.14)	0.00 (0.00)	0.04 (0.15)
Years of education	0.00 (0.16)	-0.16 (0.16)	-0.15 (0.15)	-0.19* (0.11)	0.38** (0.19)	-0.12 (0.10)	0.03 (0.03)	0.05 (0.14)	0.03 (0.06)	-0.04 (0.03)
Years of experience	-0.13 (0.14)	-0.02 (0.09)	-0.04* (0.02)	0.00 (0.07)	0.20 (0.23)	-0.20* (0.12)	0.09 (0.11)	-0.15 (0.13)	0.08 (0.06)	0.09 (0.14)
Pedagogical training (months)	0.01 (0.02)	0.02 (0.02)	0.03 (0.13)	0.00 (0.00)	-0.13 (0.20)	0.00 (0.00)	-0.37** (0.16)	-0.25** (0.12)	-0.16 (0.07)	0.24 (0.12)
Practical training (months)	-0.13 (0.12)	-0.01 (0.06)	-0.22 (0.13)	0.09 (0.10)	0.00 (0.02)	0.06 (0.84)	-0.32 (0.17)	-0.17 (0.11)	-0.07 (0.07)	0.32 (0.17)
Monthly salary (in k FCFA)	-0.37** (0.16)	0.00 (0.02)	-0.09 (0.14)	0.02 (0.18)	0.39* (0.23)	0.21 (0.17)	-0.03 (0.14)	-0.17 (0.14)	0.08 (0.05)	0.05 (0.14)
School location	0.01* (0.01)	-0.07** (0.03)	0.00 (0.00)	0.00 (0.00)	0.11 (0.18)	0.78 (0.64)	0.00 (0.02)	-0.01 (0.01)	-0.19 (0.20)	0.01 (0.01)
Student is in Grade 2	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Observations	1074	1744	2015	152	759	168	1196	1584	757	1875

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Strata fixed effect and constant terms are removed for readability.

Table 1.8: OLS estimates for Principal Involvement with strata fixed effect

Variables	Language test scores			Mathematics test scores		
	(1)	(2)	(3)	(1)	(2)	(3)
Involved	-0.03 (0.03)		-0.04 (0.03)	-0.01 (0.03)		-0.01 (0.03)
Female		-0.02 (0.06)	-0.02 (0.06)		0.10* (0.06)	0.10* (0.06)
Age		0.00 (0.01)	0.00 (0.01)		0.00 (0.01)	0.00 (0.01)
Years of education		0.00 (0.01)	0.00 (0.01)		0.01 (0.01)	0.01 (0.01)
Practical training (months)		0.01** (0.00)	0.01** (0.00)		0.00 (0.00)	0.00 (0.00)
Pedagogical training (months)		-0.01 (0.01)	-0.01 (0.01)		0.00 (0.01)	0.00 (0.01)
Training management		-0.07* (0.04)	-0.07* (0.04)		-0.04 (0.04)	-0.04 (0.04)
Contract		0.21** (0.09)	0.21** (0.09)		0.13 (0.08)	0.13 (0.08)
Years of experience		-0.01 (0.01)	-0.01 (0.01)		0.00 (0.01)	0.00 (0.01)
Currently teaching		-0.07 (0.04)	-0.08* (0.04)		0.02 (0.05)	0.02 (0.05)
Years of teaching		0.00 (0.01)	0.00 (0.01)		0.01** (0.00)	0.01** (0.00)
Monthly salary		0.00 (0.00)	0.00 (0.00)		0.00 (0.00)	0.00 (0.00)
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.47	0.47	0.47	0.47	0.47	0.47
Obs	11004	11004	11004	11004	11004	11004

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 1.9: OLS estimates for Principal Involvement with teacher effort and strata fixed effect

Variables	Language test scores			Mathematics test scores		
	(1)	(2)	(3)	(1)	(2)	(3)
Involved	-0.02 (0.03)		-0.03 (0.03)	-0.02 (0.03)		-0.02 (0.03)
Female		-0.01 (0.06)	-0.01 (0.06)		0.08* (0.05)	0.08* (0.05)
Age		0.00 (0.01)	0.00 (0.01)		0.00 (0.00)	0.00 (0.00)
Years of education		0.00 (0.01)	0.00 (0.01)		0.01 (0.01)	0.01 (0.01)
Practical training (months)		0.00 (0.00)	0.00 (0.00)		0.00 (0.00)	0.00 (0.00)
Pedagogical training (months)		0.00 (0.01)	0.00 (0.01)		0.00 (0.01)	0.00 (0.01)
Training management		-0.06* (0.03)	-0.06* (0.03)		-0.03 (0.03)	-0.03 (0.03)
Contract		0.19** (0.08)	0.19** (0.08)		0.10 (0.07)	0.10 (0.07)
Years of experience		-0.01 (0.01)	-0.01 (0.01)		0.00 (0.00)	0.00 (0.00)
Currently teaching		-0.06 (0.04)	-0.07* (0.04)		0.02 (0.04)	0.02 (0.04)
Years of teaching		0.00 (0.00)	0.00 (0.00)		0.01* (0.00)	0.01* (0.00)
Monthly salary		0.00 (0.00)	0.00 (0.00)		0.00 (0.00)	0.00 (0.00)
Days absent last month	-0.02*** (0.00)	-0.01** (0.01)	-0.02** (0.01)	-0.01** (0.00)	-0.01* (0.01)	-0.01* (0.01)
Hours of lesson per week	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.58	0.58	0.58	0.61	0.61	0.61
Obs	10870	10870	10870	10870	10870	10870

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 1.10: Community involvement variable

Involvement variables	Yes	No	Missing
The principal receives financial aid from the local community	802	303	18
The principal receives support from the local community for:			
the construction, rehabilitation, or maintenance of infrastructures	587	519	17
the arrangement, maintenance, or repair of equipment and furniture	733	372	18
the provision of textbooks	964	144	15
the provision of school supplies	895	212	16
managing the school canteen or meal supply	954	153	16
the teachers' pedagogical training	1,018	89	16
organizing extracurricular activities	1,027	78	18
the coverage of exam fees	1,106	0	17
the payment of teachers' salaries	1,037	65	21
the management of volunteer teaching staff	878	227	18
helping low-achieving students	990	108	25

Table 1.11: OLS estimates for Principal Involvement with and Community Involvement and strata fixed effect

Variables	Language test scores			Mathematics test scores		
	(1)	(2)	(3)	(1)	(2)	(3)
Principal involved	-0.04 (0.03)		-0.05 (0.04)	-0.01 (0.03)		-0.02 (0.04)
Community involved		-0.02 (0.04)	-0.03 (0.06)		-0.08* (0.04)	-0.09* (0.06)
Principal involved x Community involved			0.04 (0.07)			0.03 (0.07)
Principal controls	Yes	Yes	Yes	Yes	Yes	Yes
Strata FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.47	0.47	0.47	0.47	0.48	0.48
Observations	11004	11004	11004	11004	11004	11004

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

1.A Appendix

1.A.1 PASEC 2014 data

PASEC 2014 data are collected from a representative sample of primary schools. Schools are sampled in each country based on the official sampling frame of schools for the 2012-2013 year. In each country, schools were selected by a systematic sampling proportional to the number of students enrolled in 2nd grade and 6th grade. In other words, the more students in 2nd grade and 6th grade the school has, the larger the probability of being assigned to this school. In contrast, the probability to be selected within the school is lower for student in larger schools than those in smaller schools. The representativeness of the sample was enhanced by stratification within countries. PASEC defined stratum according to geographical boundaries and added a stratum for private schools for Togo, and the same for private schools for Cameroon in the English-speaking region.

Sampling was conducted within each stratum, and the number of schools selected in each stratum is proportional to its size. The total number of schools to be selected in a country is distributed among strata according to the weight of strata. A sampling step is defined for each stratum by dividing the total number of students enrolled in 6th grade and 2nd grade in the stratum by the number of schools to be sampled in the stratum. Thus, schools with number of students larger than the sampling step have a probability greater than one to be drawn. Then, a random number is drawn from a uniform distribution $[0;1]$. This number is multiplied by the sampling step and rounded up to the next unit. This product identifies student i , and the school containing student i is then selected (schools are sorted in advance). The other schools are selected according to the sampling step until the number of schools to be sampled is reached.

Proceeding this way, a sample of 180 schools was drawn in each country for 6th grade evaluation. For some cases, a larger sample of schools was selected in order to allow specific analysis. For Burkina Faso, Cameroun, and Togo, PASEC selected respectively 200, 280, and 190 schools. Thereafter, PASEC conducted the sampling of 2nd-grade schools. In each stratum, half of the sample is selected to be assessed for 2nd grade by a randomized sampling (each school has a probability of $\frac{1}{2}$ to be assessed for 2nd grade). Thus, each country has a subsample for 2nd grade composed of 90 schools except for Burkina Faso, Cameroon, and Togo that have respectively 100, 140, and 95 schools selected. It should be noted that some schools initially selected had not been surveyed, hence the total number of schools in Table

X differs from the number of schools that would have been sampled.

In each selected school, one 6th grade class was randomly selected, and one 2nd grade class was randomly selected if the school was chosen to be assessed for 2nd grade. If the school has only one class for 6th grade or 2nd grade this class is directly selected. Then, the sample of students that will be evaluated is drawn among students in the grade concerned in the selected class. As many schools contain multilevel classes. When a class was selected, the sample of student was drawn among students for the grade concern in this classroom. In the 6th grade class, twenty students were randomly selected to be assessed, and ten students for 2nd grade class. If the class has twenty students or less (ten or less for 2nd grade), all the students were directly selected to take the test. The sampling procedure ensures the representativeness of the sample and the randomness of which school has been assessed for both grades and which school has been assessed for 6th grade only. Hence, schools that have been selected for both grades do not differ from schools selected for 6th grade only.

1.A.2 Matching variables selected

Table 1.A.1: Matching variables selected

Variables	Benin	Burkina Faso	Burundi	Cameroon	Chad	Congo	Côte d'Ivoire	Niger	Senegal	Togo
Student var.										
Female	✓	✓	✓		✓	✓	✓	✓	✓	✓
Age	✓		✓			✓				
Preschool				✓			✓	✓	✓	
Have ever repeated	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Speaks French at home	✓	✓	✓		✓	✓	✓	✓	✓	✓
Father reads						✓		✓		✓
Mother reads		✓		✓		✓		✓		✓
Brother reads		✓					✓	✓	✓	✓
Books at home	✓		✓				✓	✓	✓	
Wealth index	✓			✓	✓		✓	✓	✓	
Teacher var.										
Female	✓	✓			✓	✓	✓	✓	✓	✓
Age		✓	✓	✓		✓	✓			
Contract teacher						✓			✓	
Years of education				✓		✓	✓		✓	✓
Years of experience			✓						✓	
Pedagogical training	✓	✓		✓		✓			✓	
Practical training				✓	✓				✓	
Monthly salary		✓				✓			✓	
School location	✓	✓	✓	✓			✓	✓		✓
Student is in Grade 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: Variables selected are those significant at the 10% level in OLS regression of language test scores, mathematics test scores or treatment assignment on all student and teacher characteristics for each country.

1.A.3 Wealth Score

I construct a wealth score based on the same method as the involvement score for each student of the database:

$$Wealth_i = \frac{1}{n} \sum_{k=1}^n \frac{X_{k,i} - \bar{X}_k}{\sigma_{X_k}} \quad (1.8)$$

Where $Wealth_i$ is the summary index for the wealth of the 6th-grade student's household i , $X_{k,i}$ is the value of variable k concerning material resources of the household for the student i , \bar{X}_k is the mean of the variable X_k and σ_{X_k} is the standard deviation of the variable X_k . The variables included in the index are answers to the question "Does your household own this equipment?". "No" is equal to one and "Yes" is equal to two. Here is the complete list of all the equipment included: TV, computer, radio, DVD, HIFI, phone, fridge, ventilator, air conditioner, stove, table, sewing machine, iron, car, tractor, moto, bike, boat, cart, toilets, flush, electricity, well, faucet. One variable concerning the wall of the house differs and has the following modalities: ground or sand is equal to one, bamboo or leaves are equal to two, metal is equal to three, wood is equal to four, and cement, bricks, or stone are equal to five.

1.A.4 Involvement score variation between students within stratum

To ensure that there is enough variation of the involvement score within each stratum, I estimate the following model:

$$PIS_{i,s,j} = \alpha + \beta Involved_s + \delta_j + \varepsilon_{i,s,j} \quad (1.9)$$

Where $PIS_{i,s,j}$ is the involvement score of the principal in the school s of the student i in the stratum j , α is the constant term, $Involved_s$ is the treatment variable that equals 1 if the principal in the s of the student i has an involvement score above the median in its country and 0 otherwise, being in the involved group equals 1 and being in the control group equals 0, δ_j is the strata fixed effect which is a dummy variable that is equal to 1 if the observation is in the stratum j and 0 otherwise, and $\varepsilon_{i,s,j}$ is the error term clustered at the school level.

Table 1.A.2: OLS estimate of involvement score on involved

Variable	PIS
Involved	0.48*** (0.01)
Constant	-0.01 (0.01)
Strata fixed effect	Yes
Observations	11,104
R-squared	0.78

Note: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Chapter 2

Assessing Competency-Based Approach
Reforms in French-Speaking Sub-Saharan
Africa

1 Introduction

As stated in the General Introduction, there was a large increase in primary school enrolment and primary school completion in sub-Saharan Africa. The rate of pupils completing primary education was about 45% in 1970 in sub-Saharan Africa (75% for the world average) and is now over 70% in the same region (around 90% for the world average)¹. This follows many recommendations and programs that have prompted developing countries to increase the demand for education and implement the appropriate policies to achieve it. However, the level of learning of primary school students remains very low with a large part of pupils that do not master basic knowledge in literacy and numeracy at the end of primary school. This situation is described by UNESCO (2013) as the *Global Learning Crisis*.

Numerous studies and interventions have sought to identify the determinants of student learning and the most effective approaches to improve student achievement. While the importance of teachers in student knowledge acquisition has been widely demonstrated in developed countries (Hanushek and Rivkin, 2006; Chetty, Friedman, et al., 2014 as well as in developing countries (De Talance, 2017), there is much left to know about what specific attributes make the quality of a teacher. Recent research indicates that teaching practices could be a key determinant of student learning (Hidalgo-Cabrillana and Lopez-Mayan, 2018, Briole, 2019) and, more broadly, social capital (Algan, Cahuc, et al., 2013). Nevertheless, teachers in Africa seem to drastically differ from their counterparts in developed countries. They are often characterized by low levels of training, high rates of absenteeism, and insufficient mastery of the subjects they teach (Bold, Filmer, et al., 2017). In addition, interventions focusing on teacher incentives aiming to increase teacher effort present mixed results (Glewwe, Ilias, et al., 2010; Duflo, Dupas, et al., 2011; Duflo, Dupas, et al., 2015).

In the late 1990s, a large number of French-speaking African countries have undertaken Competency-Based Approach reforms (often referred to as APC for *Approche par compétences* in French) to change teacher pedagogy with the financial support of multiple international organizations. It took several years for countries to generalize the reforms since reforms include not only modification of teachers' pedagogy but also of curricula, pedagogical support, training, and assessment of teachers. The nature of reforms also strictly differs across countries. Cameroon has adopted the Education Orientation Act (1998), which is a law that introduces

¹UNESCO Institute for Statistics

CBA in the educational system, whereas Senegal proceeded to the conception and implementation of CBA between 2000 and 2010 without a clear official reform but a sum of actions from operating in the government.

CBA reforms were designed to enhance student learning by modifying teacher pedagogy to *modern* teaching practices as opposed to *traditional* teaching practices. The aim of the pedagogy was to make pupils play an active role in the learning process. The role of teachers had to evolve toward a mediator and support student activity instead of simply giving a lecture class. According to Perrenoud et al. (2000) and Roegiers et al. (2008) CBA changed the content of lessons beyond knowledge and know-how, and aims to develop “life skills” or transversal competencies such as searching the information, communicating effectively, group work and individual projects. However, the effectiveness of CBA in improving student learning has been widely controversial. Some authors have argued that this type of pedagogy was not suitable for African countries considering the context of high pupil-teacher ratio and scarce material (Cros, Ketele, et al., 2010; Bernard, Nkengne, et al., 2007). School equipment does not allow teachers to teach with practical and didactic activities and high pupil-teacher ratios make it difficult to evolve towards a student-centered teaching style. Moreover, CBA requires additional effort from teachers to train themselves and to change their pedagogy while teacher effort is particularly low in many African countries (Glewwe, Ilias, et al., 2010, Bold, Filmer, et al., 2017). Eventually, we can wonder to what extent learning these new skills will improve basic knowledge in literacy and numeracy, and if these transversal competencies are overall a substitute or a complement to basic learning. The research question of this article is the following: what is the impact of the Competency-Based Approach on student learning in French-speaking African countries?

In this paper, I assess the impact of CBA on learning outcomes by conducting a double LASSO and a Kernel matching strategy using PASEC databases on six sub-Saharan French-speaking countries. First, I investigate the potential endogeneity of teacher training. The widespread adoption of the Competency-Based Approach (CBA) in teaching practices has been a lengthy process for countries that implemented it. Several years after its implementation, many teachers reported using CBA in their teaching, though only a small proportion at the national level received formal training. The training is a top-down process initiated by the government and thus may be influenced by specific regional characteristics or teacher motivation. Proceeding to several basic comparisons, I find that pupils of teachers who use CBA and were trained to it have higher levels of abilities at the beginning of the year and are wealthier than pupils who teachers who do not use the peda-

gogy on average. In addition, teachers who use CBA are younger, less experienced, slightly more trained, and are better equipped with teaching material compared to teachers who do not use the pedagogy. Second, I proceed to a Kernel matching strategy Using two metrics to measure students' similarity to address the potential endogeneity of teacher training, based on variables selected by a double selection LASSO procedure. Precisely, I pair each treated pupil with a theoretical control created by averaging all control pupils, with a weight based on the similarity with the treated concerns. Kernel matching estimates show that CBA has a positive and highly significant impact on both mathematics (1% level) and language (5% level) test scores with a significant rise ranging from 13% to 18% of a standard deviation. Finally, CBA appears to exacerbate within-classroom inequalities along with improving student outcomes, leaving aside low-achieving students and benefiting more to high-achieving ones. This result is contradictory with one of the primary objectives of the pedagogy, which was to support low-achieving students.

The contribution of this article pertains to several strands of the literature. First, it adds to the literature on education quality and interventions related to gains in student learning in sub-Saharan Africa. Kraft (2020) examined the distribution of approximately 750 randomized control trials and found a median impact of 10% of a standard deviation. Evans and Yuan (2022) provides a distribution of 234 studies in low and middle-income countries and also found a median impact of 10% of a standard deviation, and found that effects are larger and demonstrate higher variance for small-scale studies than for large-scale studies. Hence, the impact of CBA, which is a large-scale intervention, is relatively high (+13% to +0.16% of a standard deviation) compared to other interventions designed to raise learning outcomes. It also contributes to the literature on the impact of pedagogy and teaching practices on student learning. For instance, an intervention such as Teaching at the Right Level proves that training teachers to change their pedagogy might be highly effective in enhancing knowledge in language (Banerjee, Banerji, Berry, Duflo, Kannan, Mukherji, et al., 2016, Banerjee, Banerji, Berry, Duflo, Kannan, Mukerji, et al., 2017). Moreover, the results in this paper go in the same direction as those in Hidalgo-Cabrillana and Lopez-Mayan (2018), who find that teamwork and student discussions are better (*modern* practice) than individual and rote learning (*traditional* practice), as well as in Briole (2019) who find that the use of teaching practices emphasizing student active participation in the lesson improve student test scores. Finally, this paper is the first to quantitatively assess the impact of CBA on learning outcomes and thus belongs to CBA literature which is exclusively descriptive and qualitative. CBA was presented as a major solution to raise basic knowledge,

and consequently, financial resources were engaged in implementing it. Furthermore, CBA reforms have been widely controversial despite having any quantitative results.

The remainder of the paper is as follows. Section 1 summarizes the institutional context, the implementation of CBA reforms, and the pedagogy itself. In Section 2, I present the PASEC databases, the treatment variable and descriptive statistics on the sample. Section 3 details the empirical strategy, with potential endogeneity of training to CBA, and the double selection LASSO along with the Kernel matching strategy. Section 4 discusses the variables selected, the final sample used to assess the impact of CBA on test scores, and the matching estimates. Section 5 presents some robustness checks and, finally, Section 6 analyses the potential effect of CBA on test scores distribution before the conclusion.

2 Competency-Based Approach reforms

2.1 Institutional context and implementation of reforms

In its conference in 1996 in Yaoundé, the CONFEMEN² defines reforms of curricula and pedagogy as essentials in the development of basic education. A large number of French-speaking African countries have undertaken Competency-Based Approach (CBA) reforms with the support of the OIF³. The implementation process of CBA reforms (often referred to as APC for *Approche par compétences*) drastically differs across countries, and it took several years to generalize it since the reform does not include only modification of teachers' pedagogy but curricula adaptation pedagogical support, training, and assessment of teachers. The implementation of CBA has been largely supported and funded by international organizations such as the World Bank or UNESCO, and by the EU or its members. (Roegiers et al., 2008). More generally, funds allocated to CBA implementation were part of global funding aiming at developing educational systems. For instance, France has invested 2.4M€ between 1996 and 2003 for *Programme d'accompagnement du secteur éducatif camerounais*, and the World Bank has invested 13.7M€ in five years during this period (Cros, Ketele, et al., 2009). In Gabon, the FED⁴ invested 6M€ from 2002 to 2006, and France in partnership with UNICEF added 1.2M€ in 2008 for three years (Tagne, Asoh, et al., 2016). Overall, few countries such as Gabon and Tunisie have dedicated government spending to implement CBA, a large part being funding by

² *Conférence des Ministries de l'Éducation de l'État et des Gouvernements de la Francophonie*

³ *Organisation Internationale de la Francophonie*

⁴ *Fonds Européen de Développement*

NGOs. In addition, the share of funding directly allocated to CBA among these is unclear except for Mali, for which 80% of the 4.2M€ allocated between 2002 and 2006 by the Netherlands and the FEC⁵ went to teacher training (Cros, Ketele, et al., 2009).

For some countries, the shift in pedagogy towards the CBA is the result of an official text or law as it was the case in Cameroon with the Education Orientation Act (1998). This law was voted to change the school curriculum and to adopt CBA pedagogy. Nonetheless, facing difficulties in setting up the reform, a national committee, the CONAP⁶ was specifically created to ease the generalization in 2007. As shown in Table 2.1, 87% of the teachers in the country used CBA during the 2005-2006 year despite having only 26% of teachers in the country trained. Côte d'Ivoire initiated a Competency-Based Approach training reform in 2002-2003 and generalized it in 2004-2005 for second grade and in 2005-2006 for third and fourth grade. However, according to Roegiers (2008), Côte d'Ivoire had not finished spreading the reform all over the country in 2008 even though significant progress was made. During the 2008-2009 year, 80% of the teachers in the country used CBA (PASEC) with 69% of all teachers who attended training. According to Chraïti, Bahloul, et al. (2020), CBA was introduced in Senegal at the beginning of the 2000s. More precisely, interventions were implemented in 2003 but some preliminary actions were done between 2000 and 2003. The official law⁷ that mentioned CBA for the first time was officialized in 2006. PASEC statistics show that 75% of the teachers in the country used CBA during the 2006-2007 year and that 69% of teachers in the country were trained. These countries, especially Cameroon, were among the first to change their curriculum and to adopt CBA through an official text.

On the other side, CBA implementation was not always driven by an official reform or law, and often results from various actions conducted by officials in ministries of education. Millennium Development Goals emphasize education quality and prompted countries that do not have changed their curriculum yet to implement CBA. Burkina Faso implemented CBA reforms in 2007 (Destin, 2017), but 34% of teachers of the country already used CBA during 2006-2007 as actions to introduce CBA were made before the official reform. Chad proceeded to redesign the school curriculum in 2008 (Ahmat and Merci, 2021) due to the failure of precedent policies, and 77% of the teachers in the country used CBA during the 2009-2010 year. In the case of Congo, Roegiers et al., 2008 affirms that in 2008 the OIF did not have a

⁵ *Fonds d'Aide et de Coopération*

⁶ *Comité national d'action pédagogique*

⁷ *Loi d'Orientation Spécifique*

significant impact on the implementation of CBA because the discussions about the reforms were not advanced enough. The CONFEMEN, the OIF and the UNESCO organized a conference in Brazzaville in 2010 to discuss the implementation of CBA. PASEC statistics show that 63% of the teachers in the country used CBA during the 2008-2009 year, as preliminary actions to implement CBA were made as for Burkina Faso. The new curriculum and CBA were generalized to grades 1 and 2 in 2000, and extended to grade 5 in 2003 (Hounkpe, 2015). During the 2004-2005 year, almost 87% of teachers declared using CBA in their teaching while only 31% of teachers in the country were trained to it. These examples demonstrate a common pattern between countries that the generalization of the reform took a considerable time to be achieved after its adoption when it occurred. Overall, the change towards CBA pedagogy was adopted in almost all French-speaking African countries during the 2000s but large differences remain concerning its generalization to teaching practice and especially regarding teachers training.

2.2 Description of the pedagogy

Competency-Based Approach allows for numerous translations and interpretations across countries. CBA falls into the category of modern teaching practices as opposed to the prior pedagogy for which teachers were trained, the PPO (*Pédagogie par objectifs*) which can be considered as a traditional teaching practice. The PPO consists of dividing the knowledge to be transmitted within the different disciplines into several objectives to be achieved. It was characterized by the fragmentation of knowledge through the decomposition of learning content into very small units, where the teacher is not supposed to move on to the next sequence until the current one is not assimilated by pupils. Critics of PPO state that dividing contents of school curricula into multiple micro-objectives leads students to learn knowledge pieces without necessarily understanding their meaning or knowing how to establish a link between their learning and everyday life. CBA was designed to address this problem, aiming to make pupils play an active role in the learning process and acquire transversal "competencies" as it is defined by the CONFEMEN (1995): "*... a competency acquired at school allows pupils to solve problems and situations, in everyday life or at work, in a global perspective of development. Competency is the result of a learning process. The idea of competency is to make school knowledge tools to think and act in and out of the workplace*". According to Perrenoud et al., 2000 and Roegiers et al., 2008 the CBA changed the content of lessons beyond knowledge and know-how, and aims to develop "life skills" or cross-curricular com-

petencies such as searching the information, communicating effectively, group works and individual projects. To acquire these new skills, the role of the teacher has to evolve toward a mediator and support and motivate student activity instead of simply giving a lecture class. What's more, teachers have to provide support that is better adapted to the situation of students experiencing difficulties.

2.3 Controversy of Competency-Based Approach

CBA reforms were presented as a major solution to improve the low level of student learning in African countries. However, some authors have argued that this type of pedagogy was not suitable for the African educational landscape considering the context of scarcity of human resources and material resources, as well as low teacher effort (Cros, Ketele, et al., 2009; Bernard, Nkengne, et al., 2007). Firstly, the high pupil-teacher ratios prevalent in many African schools create an environment where personalized and interactive teaching, as required by CBA, becomes impractical. Teachers are often overwhelmed by large class sizes, making it difficult to engage each student actively and cater to their individual learning needs. Secondly, the lack of adequate school infrastructure, including access to technology and teaching materials, hampers the ability to conduct the practical and experiential learning activities that are central to CBA (Lauwerier and Akkari, 2013). Many schools in rural areas even struggle with basic amenities. Thirdly, the implementation of CBA demands a substantial change in teaching practices and mindset, requiring professional training and support for teachers. However, the reality in many African countries is that teachers receive minimal training and are often poorly motivated due to low salaries and challenging working conditions (Glewwe, Ilias, et al., 2010, Bold, Filmer, et al., 2017). Lastly, Tagne, Asoh, et al. (2016) argues that the CBA requires that students master basic knowledge and can consequently reach the objectives of learning (competencies) with a minimum of guidance. Eventually, one can wonder to what extent learning these new skills will improve basic knowledge in literacy and numeracy and whether they are a substitute and or a complement to basic learning in reading, writing, and arithmetic. On one hand, focusing on these new skills could detract from learning foundational knowledge. On the other hand, CBA could potentially address the deficiencies noted in traditional pedagogy by making learning more relevant and engaging for students, thereby improving both their basic skills and their broader competencies. These arguments collectively contribute to the argument that applying CBA effectively in African countries is a real challenge and could even be detrimental to pupils' learning.

3 Data and sample

3.1 Data

Table 2.1 summarizes information pertaining to the year of the reform and the year of PASEC data collection for each country of the database. For each country, the year of CBA reforms precedes the year of data collection except for Burkina Faso for which the data collection was made one year before the reform. Nevertheless, the implementation of CBA pedagogy and the change of curricula to match the new pedagogy began earlier in other countries, and the pedagogy was popular among French-speaking African countries. Some teachers, thus, have already been trained and used CBA before the reform was officially implemented. According to the PASEC data, almost 35% of teachers in Burkina Faso used CBA in the school year 2006-2007 despite having only 3% of teachers in the country who were trained to it. For the six other countries, the part of teachers who use CBA ranges between 63% in Congo and 86% in Benin and Cameroon according to PASEC data, and the share of teachers who were trained to CBA spans from 21% in Congo to 69% in Côte d'Ivoire and Senegal.

All PASEC data are diagnostic evaluations conducted in seven countries: Benin (2004-2005), Burkina Faso (2006-2007), Cameroon (2005-2006), Congo (2008-2009), Côte d'Ivoire (2008-2009), Senegal (2006-2007) and Chad (2009-2010). PASEC follows the same standardized sampling procedure for each country, randomly selecting schools at the regional level from the sampling frame of schools of the region concerned. Within each selected school, one grade 2 class and one grade 5 class are randomly chosen, and 15 students per class are randomly selected. Table 2.2 provides a detailed description of the PASEC 2000 samples at the national level. In each selected school, PASEC data provides language and mathematics test scores for students in grades 2 and 5 at the beginning and the end of the year⁸, along with detailed information on students, teachers of the class selected, and schools. Test scores designed by PASEC contain almost identical items across countries which allows comparability⁹. Table 2.2 also details the construction of the final sample for analysis. Burkina Faso was removed from the analysis since only 10 teachers out of 304 were trained (only 3% as aforementioned). PASEC sampled between 145 (Benin) to 174 (Cameroon) schools per country, resulting in a total of 1,819 teachers

⁸Test scores at the beginning of the year are also referred to as baseline test score and test scores at the end of the year as endline test scores.

⁹Some adjustments have been made to take into account country-specificity such as different languages for several regions of Cameroon (English) or Chad (Arab).

and 26,715 pupils surveyed for the six countries remaining.

3.2 Sample and treatment definition

Teacher use and training to CBA variables are self-declared by teachers. The survey asks "Do you use Competency-Based Approach in your teaching ?" and "Have you received a training in Competency-Based Approach ?". Here, the treatment variable is using CBA and having been trained to it for the treatment group, and not using CBA for the control group. First, I decided to impose having been trained to the pedagogy to be part of the treatment group since any teacher can declare using CBA without understanding it and knowing how to use it properly. What's more, given that CBA has been actively promoted, there might be a social desirability bias since the use of this pedagogy is self-declared. Conversely, some teachers may have independently learned the pedagogy and how to use it effectively, indicating a higher level of motivation and willingness to evolve their teaching practice to enhance student learning. Therefore, imposing having been trained ensures a more stable treatment across pupils of different teachers as teachers in the same countries should have received the same training, or at least guidelines, due to the top-down process. Second, I include in the treated group all teachers who declared using CBA and began to teach one year after the reform in the country concerned whether they declared having been trained or not, as training to CBA became part of teacher pedagogical training after reforms. Third, I decided to include teachers who have been trained to CBA but do not use it in the control group to gain statistical power which is necessary for a matching procedure¹⁰. Moreover, it enables to add teachers who do not use the pedagogy but have missing information for the training variable to the control group. Since the vast majority of teachers declare using CBA without having been trained to it, I dropped more than half of the teachers in our initial database for the main sample for analysis. Eventually, the share of treated teachers, i.e. that were trained to CBA and use it, ranges from 53% for Congo to 85% in Chad, and is 71% on the whole final sample. As a robustness check, I define a second treatment which is only using CBA, which leads to add 367 teachers to the treated group.

The two main outcomes of the analysis are test scores at the end of the year in

¹⁰One might question whether teachers in the treatment group could have inadvertently adopted aspects of the CBA teaching style, even if they were not explicitly using it. However, the highly positive and significant effect from matching estimates remains of the same magnitude, though standard errors are higher.

language and mathematics¹¹, and test scores at the beginning of the year are used as matching variables¹². Test scores are standardized on the control group within country and within grade to take into account specificities of tests. Consequently, observations for which there was no information on test scores at both the beginning and the end of the year were removed. In order to have a stable sample throughout the analysis, I also excluded students for which there was missing information on matching variables (which I explain further on), for teacher characteristics detailed in Table 2.5, and for classroom and school characteristics presented in Table 2.4, which amounts to drop a consequent number of observations but allows comparability of estimates. The final sample for analysis encompasses 1,023 teachers among which 728 were trained to CBA and used it in their teaching, for a total of 12,241 students in the treatment group.

4 Empirical Strategy

4.1 Endogenous training of teachers to CBA

The main issue regarding the identification of the effect of Competency-Based Approach on learning outcomes is the non-randomness of treatment, that is how teachers were trained to the pedagogy (since those who use it and were not trained were excluded in the main analysis). According to Cros, Ketele, et al., 2010, the implementation of CBA into teaching practices is a top-down process: curricula and effective pedagogy training are conceived by high-level decision-makers, transmitted to pedagogical inspectors (regional level), then to pedagogical advisors (local level), and finally to teachers. Two main concerns arise from this process. The first one is that some areas, especially urban areas, could better introduce CBA. These regions might be able to implement changes more effectively due to faster and more efficient information flow compared to isolated rural areas. These urban regions often benefit from better equipment and infrastructure, attract higher-quality teachers, and have high-achieving students. If teachers who are in the same schools as high-achieving students have easier access to training, a simple comparison would result in an overestimation of the effect of the pedagogy. On the opposite side, one might also think that some regions with more low-achieving students could have been selected to experiment CBA on purpose to raise their learning outcomes. The second concern

¹¹I also use learning gains over the year as a robustness check.

¹²Test scores at the beginning of the year are referred to as baseline test scores and test scores at the end of the year as endline test scores in subsequent sections.

that may ensue from the non-randomness of treatment is that the training to CBA may stem from teachers' own initiatives. It is not unlikely that motivated teachers manage to attend training whereas teachers with low effort do not. This would create a difference in observable characteristics such as age (the older may be more reluctant to change their teaching style) as well as unobserved characteristics such as motivation between those who engaged themselves to be trained and those who did not, leading once again to a positive bias of CBA coefficient in simple OLS estimates.

To investigate whether the use and training of CBA is endogenous to pupils' and schools' characteristics, I proceed to an OLS estimate of students' and schools' characteristics on the treatment variable for each country and for the whole sample. At the student level:

$$X_{i,j,s,g} = \alpha + \beta CBA_j + \delta_g + \varepsilon_{i,j,s,g} \quad (2.1)$$

Where $X_{i,j,s,g}$ is a specific student characteristic of the student i with the teacher j in the school s in the grade g , α is the constant term, CBA_j is a dummy variable that equals 1 if the teacher uses CBA and was trained to it and 0 otherwise, δ_g is a grade fixed effect that equals 1 if the teacher j is in grade 2 and 0 if he is in grade 5, and $\varepsilon_{i,j,s}$ is the robust error term clustered at the school level.

At the teacher level for school characteristics¹³:

$$X_{j,s,g} = \alpha + \beta CBA_j + \delta_g + \varepsilon_{j,s,g} \quad (2.2)$$

Where $X_{j,s,g}$ is a specific classroom or school characteristic of the teacher j in the school s teaching in the grade g , α is the constant term, CBA_j is a dummy variable that equals 1 if the teacher uses CBA and was trained to it and 0 otherwise, δ_j is a grade fixed effect that equals 1 if the teacher j is in grade 2 and 0 if he is in grade 5, and $\varepsilon_{j,s,g}$ is the robust error term clustered at the school level.

To investigate differences in teacher characteristics, I proceed to the same estimate as for classroom and school characteristics in (2.2). In this case, $X_{j,s}$ is a given characteristic of the teacher j in the school s . As training could be endogenous to unobservable characteristics such as motivation as aforementioned, I include teacher absenteeism (number of days absent in the last month) as a proxy for teacher effort.

¹³It should be noted that differences in schools' characteristics are estimated at the teacher level since some schools contain both treated and control teachers.

β is the coefficient of interest for all three estimates. A positive coefficient for students' household education would suggest that teachers who use CBA are more likely to be in the same schools as children with more educated parents. In this case, a significant and positive coefficient for characteristics would mean a sorting of teachers and students, thus resulting in an upward bias in estimating the impact of CBA on test scores with a simple OLS. Conversely, a negative coefficient could suggest that teachers who use CBA might have been trained before others to compensate for poor performance for example. Significant coefficients, whether it is positive or negative, would demonstrate that the use of CBA is endogenous and that one need to address this issue to properly estimate the impact of CBA on learning outcomes.

Table 2.3 summarizes the results for student characteristics. The first difference that stands out is the difference between baseline language test scores on the whole sample (+0.11), which is significant at the 10% level. This difference is mainly driven by Congo and Senegal, with a difference in initial abilities of +0.42SD and +0.20SD respectively. There is no significant difference in initial achievement in mathematics on the whole sample, but as in language Congo presents a consequent gap in test scores (+0.34SD). Appart from baseline scores, there are only four within-country differences that stand out significantly. The first is whether pupils speak French at home in Benin and Congo, with treated pupils being more likely to speak French (+0.07SD and +0.13SD respectively). The second is whether the father of the pupil can read in Cameroon, with treated pupils being more likely to have a father who can read (-0.07SD). The third is the age in Senegal, with treated pupils being older (+0.19SD), and having done preschool in Chad, treated pupils being more likely to have done preschool (+0.09SD). Considering the whole sample, there is a strong and significant difference in household wealth, with treated pupils being on average wealthier by 0.21SD. This result, which goes in the same direction as baseline scores, is somewhat contradictory to variables related to household education, which all have a coefficient close to zero (often negative) and not significant (having done preschool, having ever repeated, the frequency at which French is spoken at home, the ability of parents to read, parents' help for homework, and the fact that there are books at home). This global difference is driven mainly by Benin, Côte d'Ivoire, and Senegal for which treated students are wealthier by 0.11, 0.16, and 0.14 of a standard deviation respectively. Overall, students of teachers who were trained to CBA and who use it seem to be similar to those who do not use CBA, except for Congo where treated pupils seem to have a higher initial level of abilities as well as Senegal for language, and are wealthier on average.

Table 2.4 presents the results for classroom and school characteristics according to teacher treatment status. Concerning classroom characteristics, the teaching material index is significantly different on the whole sample, treated pupils having an index higher of +0.14SD. This variable is specifically highly positive and significant for Cameroon, with treated teachers having an index higher of 0.36 of a standard deviation than control teachers, but no difference emerged in the whole sample. The other two differences that arise are in Congo with treated pupils being in smaller classes (-12 students in average) with less absent pupils on survey day (-2 pupils absent in average) but no difference concerning the percentage of absent pupils.

For school-level variables, there are no clear differences between teachers of the two groups except for Congo. Treated teachers are more likely to work in private schools (-0.20), explaining the consequent gap in the number of pupils who belong in their school¹⁴ which drives the difference on the whole sample (-57 pupils per school on average), even if the average pupil-teacher ratio in the school is not different (though the number of pupils in classes survey is significantly lower). In Côte d'Ivoire, treated teachers seem to belong in schools with fewer pupils, but not with a significantly lower pupil-teacher ratio as in Congo. Overall, there is no clear evidence that the school environment of teachers of the opposite treatment arm is different on the whole sample, but Congo is the only exception with treated teachers being more likely to teach in private schools with fewer pupils as well as fewer pupils in their class.

Table 2.5 shows differences in teacher characteristics between treated and control teachers. There seems to be no difference in sex, education, type of contract, salary, and absenteeism between treated and control teachers on the whole sample. Nonetheless, there are significant differences in age and experience, with treated teachers being two years less and having two years less of experience compared to control teachers. This difference in age and experience is not associated with a lower salary on average, but is for Cameroon and Congo, treated teachers earning -15.5 and -11.9 thousands of FCFA respectively. In addition, teachers who use CBA and have been trained to it seem to have experienced significantly longer practical training (+0.37 month on average). Though the number of months of pedagogical training is not significant globally, there are large differences in Cameroon (+5.84) and Chad (+4.48). Regarding practical training, there is no within-country difference but overall treated teachers have approximately half a month more of training

¹⁴Teachers who use CBA and were trained to it have in average 477 pupils in their school while control teachers have 669 in average. This consequent difference mainly stem from schools with a high number of pupils. There are seventeen teachers who work in schools with more than 900 pupils and only five for control teachers.

(+0.47). Overall, treated teachers seem to be younger and less experienced while at the same time slightly more trained.

4.2 Identification Strategy

4.2.1 Preliminary estimates and matching variables selection

The main focus is to measure how Competency-Based Approach affects learning outcomes. First, I proceed to a standard comparison estimating a simple OLS model. This model gives us a basic difference of test scores according to the use of CBA, without taking into account differences in students' and schools' characteristics as well as intrinsic teacher characteristics:

$$TS_{i,j,g,c} = \alpha + \beta CBA_j + \delta_g + \gamma_c + \varepsilon_{i,j,g,c} \quad (2.3)$$

Where $TS_{i,j,g,c}$ is the test score at the end of the year of student i with teacher j in the country c , CBA_j is a dummy indicating if the teacher j was trained to APC and use it, δ_j is a grade fixed effect that equals 1 if the teacher j is in grade 2 and 0 if he is in grade 5, γ_c is a country fixed effect and $\varepsilon_{i,j,g,c}$ is the robust error term clustered at the school level.

Second, I conduct double selection LASSO developed by Belloni, Chernozhukov, et al. (2014). The aim of this procedure is twofold: select the most relevant controls for the matching procedure and provide estimates of CBA including the selected controls. Originally for high dimensional data, this procedure selects variables that are good predictors of the treatment variable as well as of the outcome, which is crucial in reducing bias (Stuart, 2010). Given the small number of observations in our sample and the high number of characteristics, conducting a matching strategy using all student, teacher, and school characteristics is difficult as the high number of characteristics would lead to a global balance but could lead to differences in specific characteristics. All the variables in Tables 2.3, 2.4 and 2.5 are included in the procedure except the fact that there are books at home, that parents help the student with homework and house material due to high number of missing values. This represents 27 potential controls. The first step of the double selection LASSO selects a set of control variables that are useful to predict our treatment (CBA_j), and the second step selects a set of control variables that predicts our main outcome ($TS_{i,j,s}$). The final step is estimating the treatment effect on our main outcome by linear regression using the union of the two sets of covariates:

$$TS_{i,j,s,g,c} = \alpha + \beta_1 CBA_j + \beta_2 X_{i,j,s} + \delta_g + \gamma_c + \varepsilon_{i,j,s,g,c} \quad (2.4)$$

Where $TS_{i,j,s,g,c}$ is the test score over the year of student i with teacher j in the school s in the grade g in the country c , CBA_j is a dummy indicating if the teacher j was trained to CBA and use it, $X_{i,j,s}$ is a set of control variables selected by the double selection LASSO procedure¹⁵ including student, teacher and school-level characteristics, δ_g is a grade fixed effect that equals 1 if the teacher j is in grade 2 and 0 if he is in grade 5, γ_c is a country fixed effect and $\varepsilon_{i,j,s,g,c}$ is the robust error term clustered at the school level.

4.2.2 Matching procedure

Given that the use and training of CBA is non-random, one need to address endogeneity to estimate the effect of the pedagogy effectively. In fact, pupils of teachers who use CBA and have been trained to have a higher level of initial achievement than pupils of teachers who do not use CBA at the beginning of the year and are wealthier. Moreover teachers, treated teachers seem to be younger while slightly more trained. It is thus important to control for student initial scores¹⁶ and characteristics, as well as for teacher characteristics. Explicitly, controlling for baseline score is crucial as it is significantly different in language, and that it allows to reduces the bias introduced by pre-existing differences, capturing differences in knowledge and ability of students. To strengthen the analysis, I conduct a Kernel matching using two measures of students' proximity, a Mahalanobis distance, and a propensity score. The Kernel matching procedure aims at pairing all control pupils to a treated pupil, giving weight to each control according to his similarity with the treated concerns (based on the Mahalanobis distance or the propensity score).¹⁷ The identification strategy for the matching procedure relies on the following assumption: conditional on matching variables, treatment assignment is as good as random, i.e. there is no difference in unobservable of pupils, teachers, and schools where they belong.

The first step of the matching strategy consists of computing the distance or similarity between each treated and control observation using all the variables selected by the double selection LASSO procedure. All the variables selected are

¹⁵Variables selected by the double selection LASSO are detailed in Table 2.6.

¹⁶Correlation coefficients of baseline and endline scores are 0.59 for language and 0.52 for mathematics, and are significant at the 1% level.

¹⁷An Epanechnikov kernel function is used to determine the weight of each control for each treated.

presented in Table 2.6. I compute the Mahalanobis distance Rubin, 1980 for each possible pair of treated and control pupils as follows:

$$MD(X_t, X_c) = \sqrt{(X_t - X_c)\varepsilon^{-1}(X_t - X_c)} \quad (2.5)$$

Where $MD(X_t, X_c)$ is the Mahalanobis distance between the vector of matching variables of treated observation t (X_t) and the vector of matching variables of control observations c (X_c), and ε^{-1} is the inverse of the covariance matrix. The inverse of the covariance matrix between matching variables reduces the weight of variables with higher correlation. Therefore, the Mahalanobis distance performs well when two or more variables are highly correlated as it is potentially the case within each set of variables for students' (wealth index and having ever repeated a class), schools', and teachers' characteristics¹⁸. I also compute a propensity score Rosenbaum and Rubin, 1983 for each observation using a logit estimate :

$$PS_{i,j,s} = Pr(CBA_{i,j,s} = 1) = CBA_{i,j,s}^* = \alpha + \beta X_{i,j,s} + \varepsilon_{i,j,s} \quad (2.6)$$

Where $PS_{i,j,s}$ is the propensity score of student i with teacher j in the school s , i.e. the probability of being treated. $CBA_{i,j,s}^*$ is the latent variable and $X_{i,j,s}$ is the vector of matching variables of student i with teacher j in the school s . One can wonder why only matching variables selected by the double selection LASSO were included to estimate the propensity score as they predict both the treatment and the outcome. In fact, as previously explained, including too many variables leads to a better explanation of treatment assignment but also to more post-matching differences in characteristics.

The second step of a matching strategy is the procedure to match treated and control observations. Kernel matching is a non-parametric matching estimators that use weighted averages of all individuals in the control group to construct the counterfactual outcome¹⁹. Hence, it does not result in a 1:1 match (a treated with its nearest controls). All control observations are matched to each treated within a pre-defined radius or bandwidth for the distance with the treated. I chose a bandwidth equal to 4 for the Mahalanobis distance insofar as this leads to having the best balance in matching variables without dropping a consequent number of observations. For the propensity score, the bandwidth has been automatically computed by Stata. I did not shrink the bandwidth since the characteristics are even better balanced

¹⁸See Stuart (2010) more detailed information on the Mahalanobis distance

¹⁹See Caliendo and Kopeinig (2008) for more detailed information about Kernel matching.

than with the Mahalanobis distance after matching. If the distance between a control student and a treated student is too high, i.e. if the control observation is not in the radius of the treated observation, the concerned control is removed from the pool of matched controls with this treated student. Thus, each control observation weights according to similarity with the concerned treated observation, resulting in a 'theoretical control' for each treated observation which is composed of all weighted control observations²⁰.

β corresponds to the Sample Average Treatment Effect (SATE). The value of theoretical control test scores is computed by a weighted average according to the similarity with the concerned treated observation:

$$TS_h = \frac{1}{C} \sum_{c=1}^C g(TS_c) \quad (2.7)$$

Where TS_h is the weighted test score of the theoretical control h which is compared to the treated t , C is the total number of control pupils, and $g(\cdot)$ is an Epanechnikov function which assigns a weight to the test score of the control c according to the similarity (based on the Mahalanobis distance or the propensity score) with the treated observation t concerned. The Sample Average Treatment Effect is a basic average of differences between treated test scores and theoretical test scores:

$$\widehat{SATE} = \frac{1}{T} \sum_{t=1}^T (TS_t - TS_h) \quad (2.8)$$

Where T is the total number of treated observations.

5 Results

5.1 Variables selected

The double-selection LASSO procedure selected 21 control variables. All the variables that are listed in Table 2.6, which present postmatching differences. All the variables of the tables have been selected except the sex of the student, whether his mother or father can read, and years of education of the teacher, which were

²⁰It should be noted that the Mahalanobis distance is used to compute the weight of observations and drop observations outside the radius, and not to directly match observations as each control is a potential match for treated in a Kernel matching.

included in post-matching differences to check the balance of the variables. Even if I control for students' prior achievements using baseline scores in mathematics and language as matching variables, the double selection LASSO procedure keeps the information about student repetition and age. Actually, the learning pace could be different between younger students with more educated households, hence the repetition and age variables could capture the ability to learn faster over the year which could interfere with the effect of CBA.

The procedure selected the age of the teacher as younger teachers may be more willing to learn new ways of teaching as opposed to older ones for whom it may be more difficult to change teaching habits. It also selected pedagogical and practical training since the latter was significantly different from treated and control students, and teachers with more training might be better qualified to teach. Matching accurately on these two variables is a key issue in identifying the effect of CBA and not the one of the initial training. The procedure also included the teaching material index and the number of pupils in the class as matching variables. As explained above, teaching students with more didactic activities and making them more autonomous are key factors underlying the proper use of CBA. Finally, 5 variables related to the school environment were selected. Being in a public school, the school location ²¹, the school infrastructure index, the number of pupils in the school, and the average pupil-teacher ratio in the school. Though there is no clear statistical difference in school environment between treated and control teachers (except for school size), it is important to match on these variables to keep them balanced in the final matched sample.

5.2 Matched samples

The two matching procedures result in samples of 8,708 and 10,981 observations respectively for the MDM and the PSM, out of the 12,241 observations of the initial sample. For the PSM, Figure 2.1 shows that the density of propensity score is quite close for treated and control observation, ensuring a high common support and thus more observations involved in the matching procedure. Table 2.6 shows that 1,260 observations are out of the common support or outside the radius and thus excluded from being matched for the PSM, and 3,533 observations for MDM. The two metrics used to measure students' similarity led to a good balance in matching variables, as presented in 2.6 and plotted in Figure 2.2 & 2.3. The post-matching differences in

²¹This variable has four categories from 1 to 4: 1 for small village, 2 for big village, 3 for suburban area, and 4 for town.

characteristics and the standard errors are computed as the ATE. It is the average of differences between each treated and its theoretical control²² for each matching variable. There is only one significant difference for the sex of the student (with a low difference of 0.04), and one difference above 0.1 which is teacher experience but not significant for PSM, and no significant difference between treated and theoretical control stands out for Mahalanobis distance²³.

5.3 Estimates of the effect of Competency-Based Approach on test scores

Table 2.7 presents estimates of the effect of Competency-Based Approach on endline test scores. First, the OLS estimates with grade and country fixed effect show a positive and highly significant effect with a rise of 31% of a standard deviation at the 1% level in language and in mathematics, though the specification does not control for possible endogeneity of the treatment variable, leading to a potential overestimate of the effect of CBA. The second column presents LASSO estimates after the double-selection procedure. Controlling for students, teachers, and schools' characteristics, the magnitude of coefficients is lower than for OLS estimates with a gain of 16% of a standard deviation for language and 7% of a standard deviation for mathematics. Eventually, the Kernel matching estimates show a positive and significant impact at the 5% level of CBA on language test scores with an increase of 0.15% and 0.17% of a standard deviation for MDM and PSM, respectively. CBA also has a positive effect on mathematics test scores with a raise of 0.13SD for MDM and 0.15SD for PSM. Overall, results seem to be robust in both mathematics and language considering the relative stable magnitude and the significance of the coefficient across the specifications used after controlling for observables. I also provide estimates by student grades to investigate the extent to which CBA is efficient according to student age. Results are detailed in Table 2.A.1. Findings suggest that the pedagogy is particularly effective at improving outcomes of students in grade 2 for PSM, and the opposite for MDM. Further research is needed to have more stable coefficients and to efficiently separate the impact according to student grade. According to those results, CBA seems to considerably contribute to enhance ba-

²²Where $X_h = \frac{1}{C} \sum_c g(X_c)$ where X_h is the weighted average value for a given characteristic X for the theoretical control h paired with the treated t , C is the total number of control pupils, and X_c is a given characteristic of the control pupil c .

²³It can be noted that coefficients associated to *Raw difference* column are different in magnitude and significance from Tables 2.3, 2.4 and 2.5 as it does not include a grade fixed effect and that the difference is estimated and the whole sample of pupils and not teachers as in Tables 2.4 and 2.5.

sic learning. One might wonder if this positive impact is solely the result of a new teaching style, more student-centred, which makes students more autonomous in the everyday learning process, or the result of new transversal competencies acquired, which are complementary to learning basic knowledge in literacy and numeracy.

6 Robustness checks

6.1 Alternative treatment definition

To investigate the extent to which results are robust, I provide additional estimates changing treatment definition. I include in the treatment group teachers who declared using CBA without having been trained to it, adding 364 teachers and growing the sample to 16,898 pupils. As previously said, these teachers can declare using CBA without understanding it and without knowing how to apply it effectively. On the other hand, they can be more motivated teachers who are willing to change their teaching practices without having the opportunity to receive training. Table 2.A.2 presents differences in characteristics between the teachers added to the treatment group compared to teachers in the control group and those already in the treated group and their students. Teachers added to the treated group seem to be older (+3.8 year), more experienced (+6.1 year), more paid (+10 thousands of FCFA monthly) and a bit less educated (-0.4 year) on average than those already on the treatment group. The characteristics of the students of these teachers, as well as their school environment, do not seem to differ from treated teachers according to the initial definition of treatment.

2.A.3 present the findings of the same estimates on the alternative treatment²⁴. Results are almost exactly the same as for the initial treatment definition, with matching coefficients for language test scores of 16%SD for MDM and 15%SD for PSM. Concerning mathematics, both MDM and PSM show a positive impact of CBA on test scores of 16%SD. These findings show the consistency of the results across treatment definitions and that CBA has a strong and significant impact on student achievement.

²⁴Matching variables are as well balanced as for the initial treatment definition and are available upon request.

6.2 Estimates on learning gains

As a second robustness check, I estimate the impact of CBA using both treatment definitions changing the main outcome to learning gains over the year, defined as the difference between endline and baseline test scores. Learning gains are a relevant measure to assess the impact of having been taught with CBA throughout the year since it reflects the progress made by the student during the school year. Nonetheless, it removed baseline scores from matching variables and thus the procedure does not take into account the prior achievement of students, just the evolution of the student over the year. Hence, treated students might be matched to less similar ones in terms of ability to learn. I estimate the same model with learning gains with an OLS, and with LASSO:

$$\Delta TS_{i,j,s,g,c} = \alpha + \beta_1 CBA_j + \beta_2 X_{i,j,s} + \delta_g + \gamma_c + \varepsilon_{i,j,s,g,c} \quad (2.9)$$

Where $\Delta TS_{i,j,s,c}$ is the learning gain over the year of student i with teacher j in the school s in the grade g in the country c , and $X_{i,j,s}$ are the same covariates as the previous LASSO model without baseline score as control. I finally estimate the Sample Average Treatment Effect with Kernel matching for both MDM and PSM:

$$\widehat{SATE} = \frac{1}{T} \sum_{t=1}^T (\Delta TS_t - \Delta TS_h) \quad (2.10)$$

Table 2.A.4 summarizes the findings²⁵. As one might have expected, results for the simple OLS are much lower in magnitude +0.20SD than for estimates on endline test scores (+0.31SD) without control, considering the change over the year and not just scores at the end of the year. The matching estimates are all positive and highly significant for PSM, with coefficients of +0.16SD in language and ranging from +0.12 to +0.18SD in mathematics. For MDM, coefficients are lower in magnitude (between +0.08SD and +0.11SD), and less significant, although there is only one insignificant coefficient for mathematics. Once again, these results support the previous findings and that CBA has a positive and significant effect on learning outcomes.

²⁵Matching variables are as well balanced as for the initial treatment definition and are available upon request.

7 Effect on test score distribution

7.1 Comparison of differences in within-classroom standard deviation

As the pedagogy was described as helping low-achieving students, one might question to what extent CBA helps to decrease students' learning inequalities. To investigate this point, I use the within-classroom standard deviation of test scores as a measure of educational achievement inequality. Figures 2.4 and 2.5 plot the density of variations in within-classroom standard deviation over the year for treated and control teachers and is thus an indicator of how CBA affects learning inequalities over the school year. Surprisingly, the density for treated teachers seems to be higher than the one for control teachers with more treated teachers with high value of increase in within classroom standard deviation. Table 2.8 presents the within-classroom standard deviation of test scores at the beginning of the year, at the end of the year, and the difference in within-classroom standard deviation between the beginning and the end of the year (plotted on Figures 2.4 and 2.5). First, there is a highly significant difference in within-classroom standard deviation of language test scores at the beginning of the year, with treated teachers facing students with more heterogenous abilities (+0.08). At the end of the year, one could observe that the difference in within-classroom inequalities between treated and control has improved with +0.12 in language and +0.06 in mathematics significant at the 1% level. The last part of the table informs us that inequalities in language and mathematics increased for both treated and control teachers during the year. However, teachers who use CBA seem to increase within-classroom inequalities consequently more than their counterparts in the control group, with a difference in increase of the within-classroom standard deviation over the year of 0.04 for language and mathematics, significant at the 5% level.

7.2 Quartile treatment effect

As CBA increases test scores at the end of the year and increases within-classroom standard deviation at the same time, one could assume that the pedagogy benefits more to high-achieving students. To investigate the impact of CBA across different levels of abilities, I proceed to a quantile treatment effect according to the quartiles in baseline test scores both in language and mathematics. Table 2.9

presents the results for each quartile of baseline test score²⁶, and Figures 2.6 to 2.9 show the mean pupils' test scores by quartiles of baseline test scores.

For each quartile, mean test scores are extremely close between treated and control pupils at the beginning of the year. Test scores of treated pupils are slightly higher on average for the second, third, and fourth quartiles and lower for the first quartile, supporting the larger inequalities previously described. Matching estimates show that there is a strong increasing effect of CBA according to the initial abilities in language. No significant effect of CBA is found for the first quartile, but there is a positive and significant effect spanning from +0.13SD to +0.16SD for the second and the third quartiles. For the fourth quartile, the coefficient for PSM is extremely high but goes along with the one for MDM indicating a higher effect on the fourth quartile. Results are less clear for mathematics. PSM shows a positive effect of CBA on the second and the third quartiles but no effect on the first quartile as for language with a coefficient close to zero, nor for the fourth quartile, although the coefficient is a bit higher (+0.08SD). For MDM, coefficients are increasing throughout quartiles but are insignificant, possibly due to the lack of statistical power. Overall, coefficients for the first quartiles are much lower than others and never significant, whatever the specification. Hence, CBA seems to be largely detrimental to low-achieving students and to benefit more to high-achieving students, especially in language. This finding is somewhat contradictory to the initial goal of the pedagogy that aims at giving special treatment to low-achieving students and reducing inequalities.

8 Conclusion

A large number of French-speaking African countries have undertaken Competency-Based Approach reforms following recommendations to improve basic knowledge acquisition, which remains particularly low on the international scale. Public organizations have promoted this pedagogy as a key solution to enhance primary student learning, investing substantial financial resources in curriculum changes and teacher training. However, the implementation of CBA has been controversial by some authors, arguing that African educational systems face challenges such as poorly trained teachers, high pupil-teacher ratio, and scarce material resources, which makes it difficult to change the pedagogy of teachers effectively. Despite this ongoing debate, the impact of CBA on student learning has never been quantitatively assessed, leaving questions about its effectiveness in improving student

²⁶Matching variables are as well balanced as for the initial treatment definition and are available upon request.

knowledge unanswered.

The generalization of CBA into teaching practices has been a long process for countries that implemented it. Several years after the implementation, a large part of teachers declared using CBA in their teaching, however a small share of teachers at the national level received training. In fact, the training of teachers has been a top-down process at the government level and might be endogenous to some regions' specificities or teachers' motivation. Comparing teachers who were trained to CBA and use it and those who do not use it, I find that they teach students who have higher levels of abilities at the beginning of the year and who are wealthier on average. In addition, teachers who use CBA are younger, less experienced, slightly more trained, and are better equipped with teaching material compared to teachers who do not use the pedagogy.

Conducting a double selection LASSO and a Kernel matching strategy with two metrics for students' similarity (Mahalanobis distance and propensity score), I find that the pedagogy is highly effective in improving student outcomes in language and mathematics, with a raise ranging from 13% to 16% of a standard deviation depending on the specification, significant at least the 5% level. Finally, CBA appears to exacerbate within-classroom inequalities along with improving student outcomes, leaving aside low-achieving students and benefiting more to high-achieving ones. This result is contradictory to one of the key features of the pedagogy, which aims to help low-achieving students.

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Figures

Figure 2.1: Propensity score of being treated according to treatment status

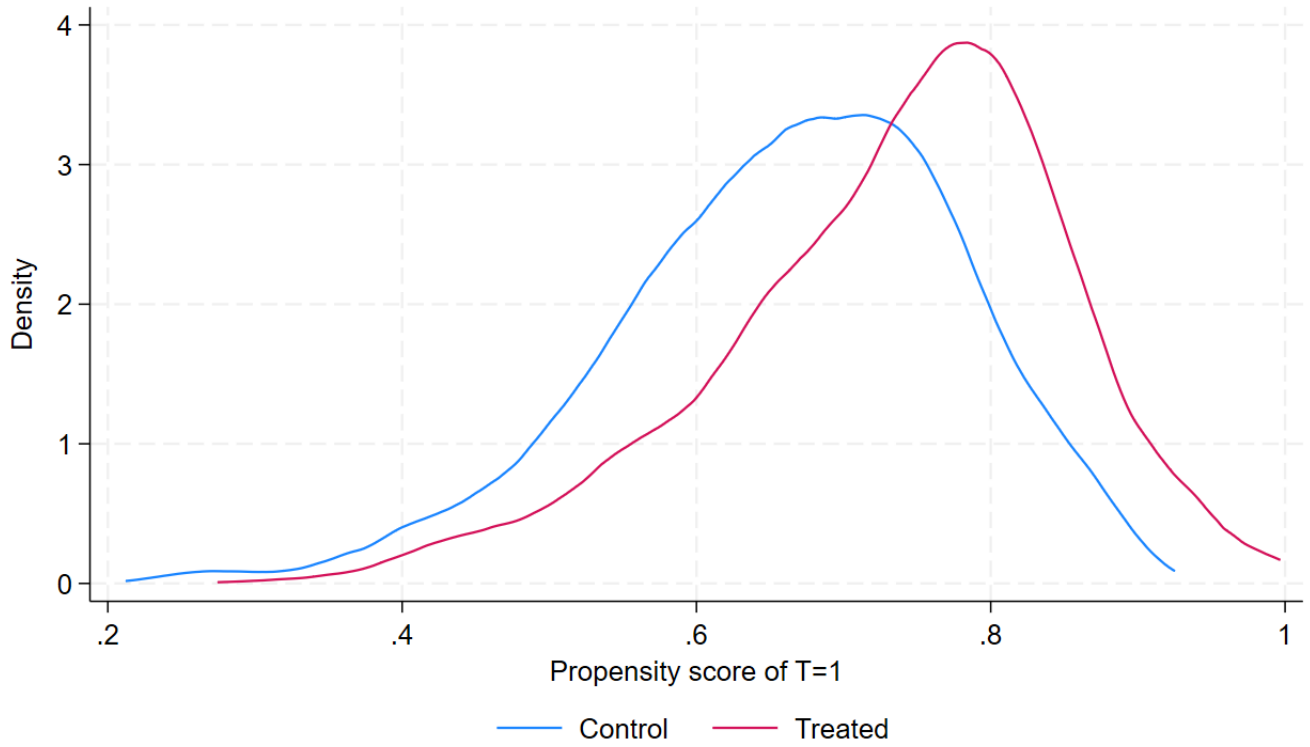


Figure 2.2: Post matching differences in student variables

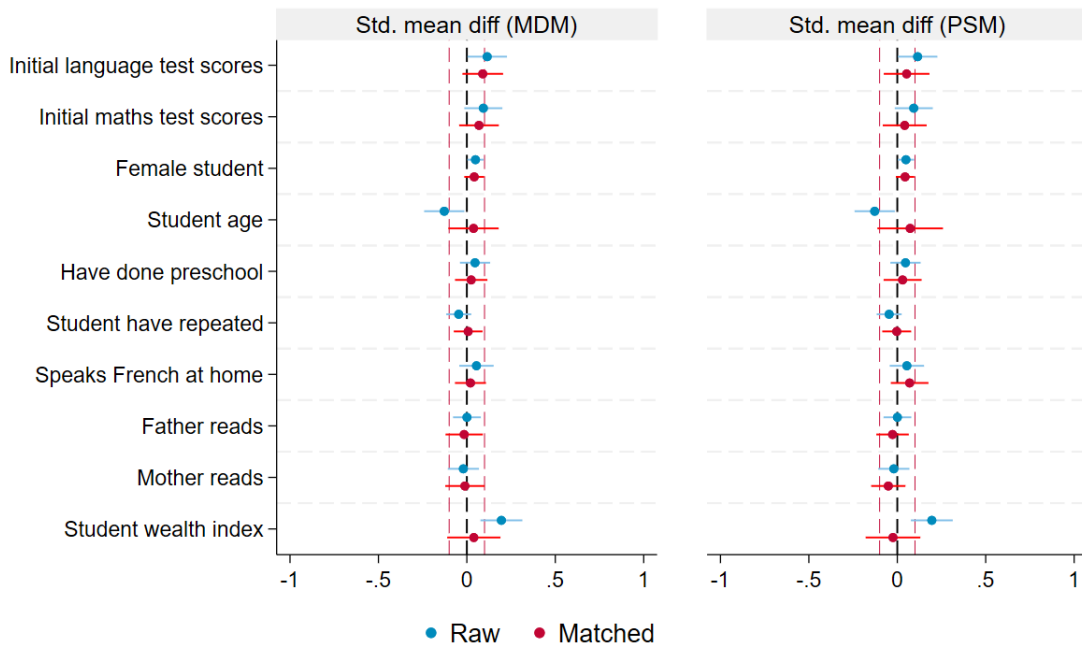


Figure 2.3: Post matching differences in teacher and school variables

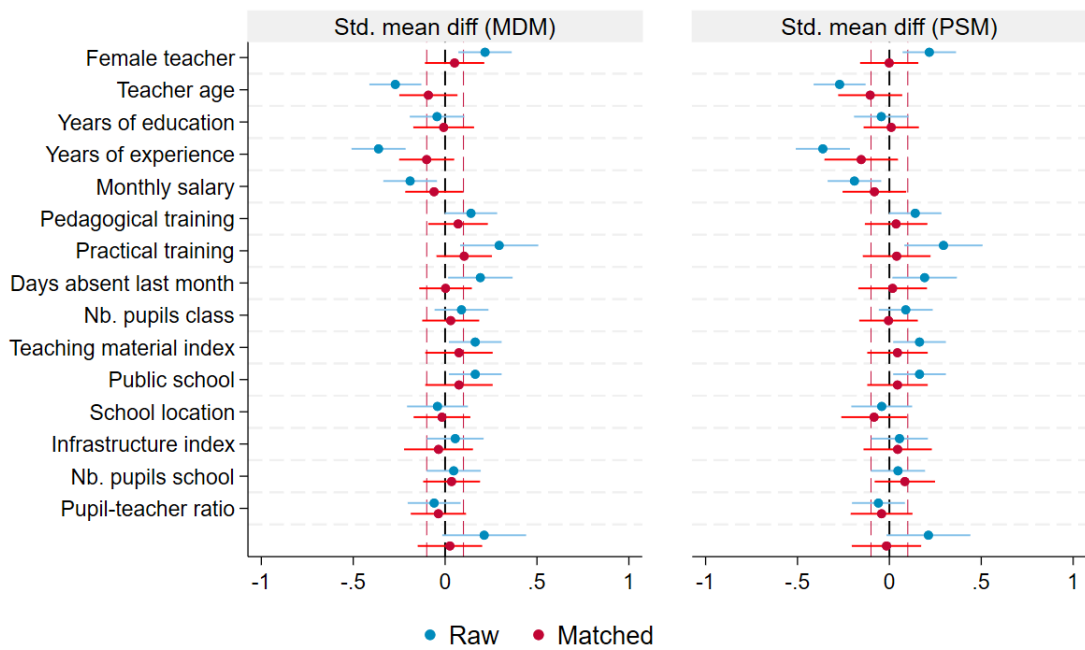


Figure 2.4: Within classroom language test scores SD variation

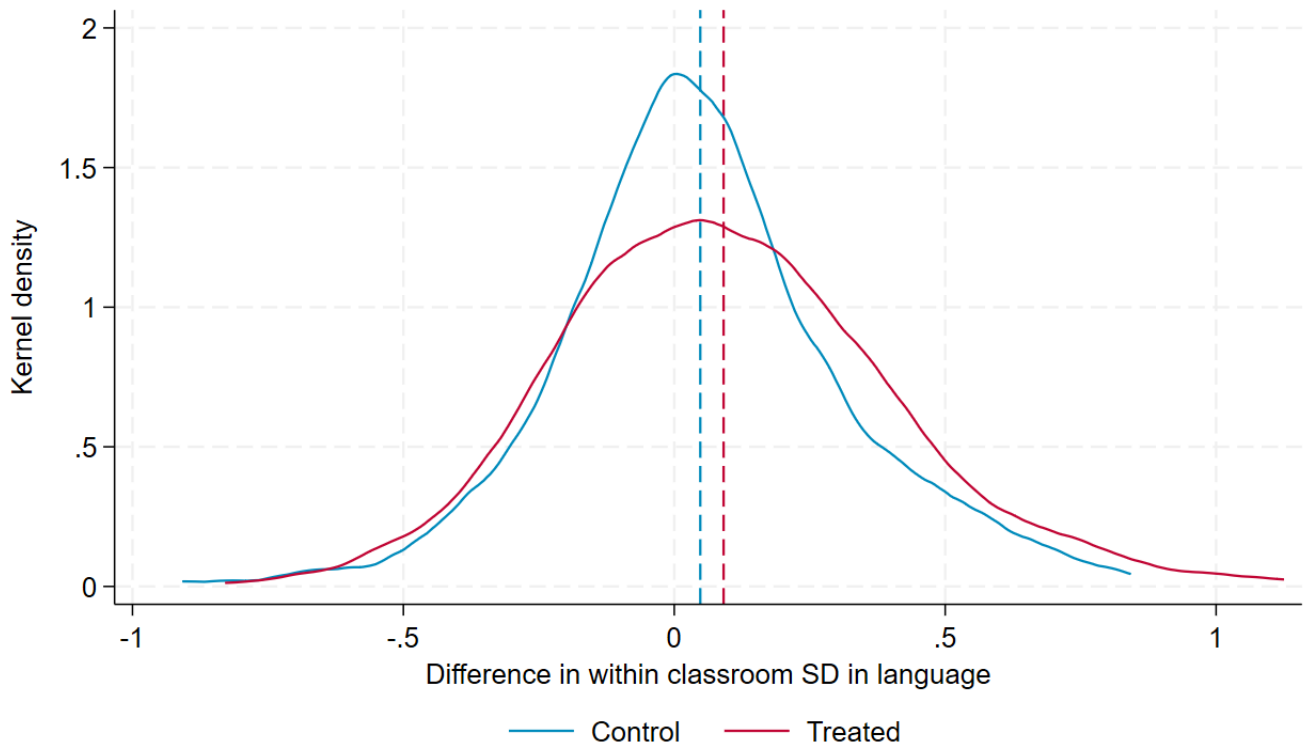


Figure 2.5: Within classroom mathematics test scores SD variation

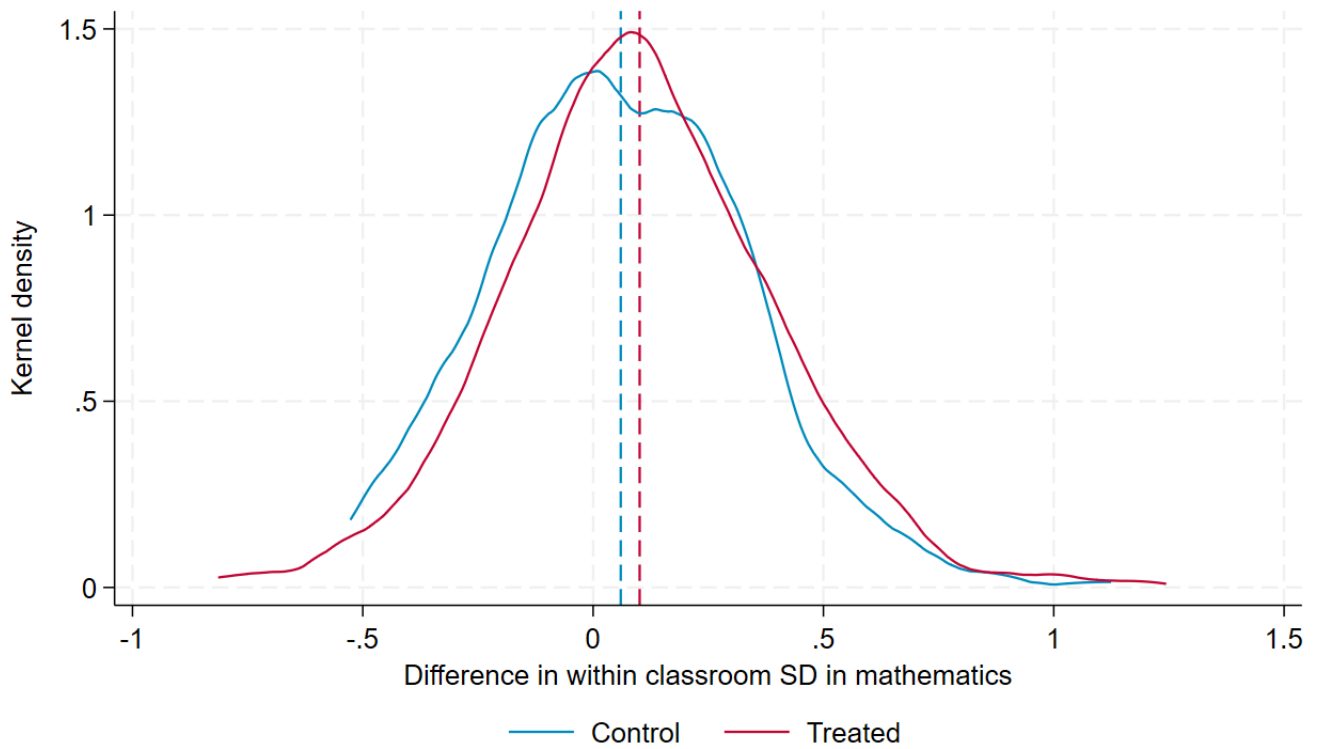


Figure 2.6: Mean of baseline language test scores by quartiles at the beginning of the year

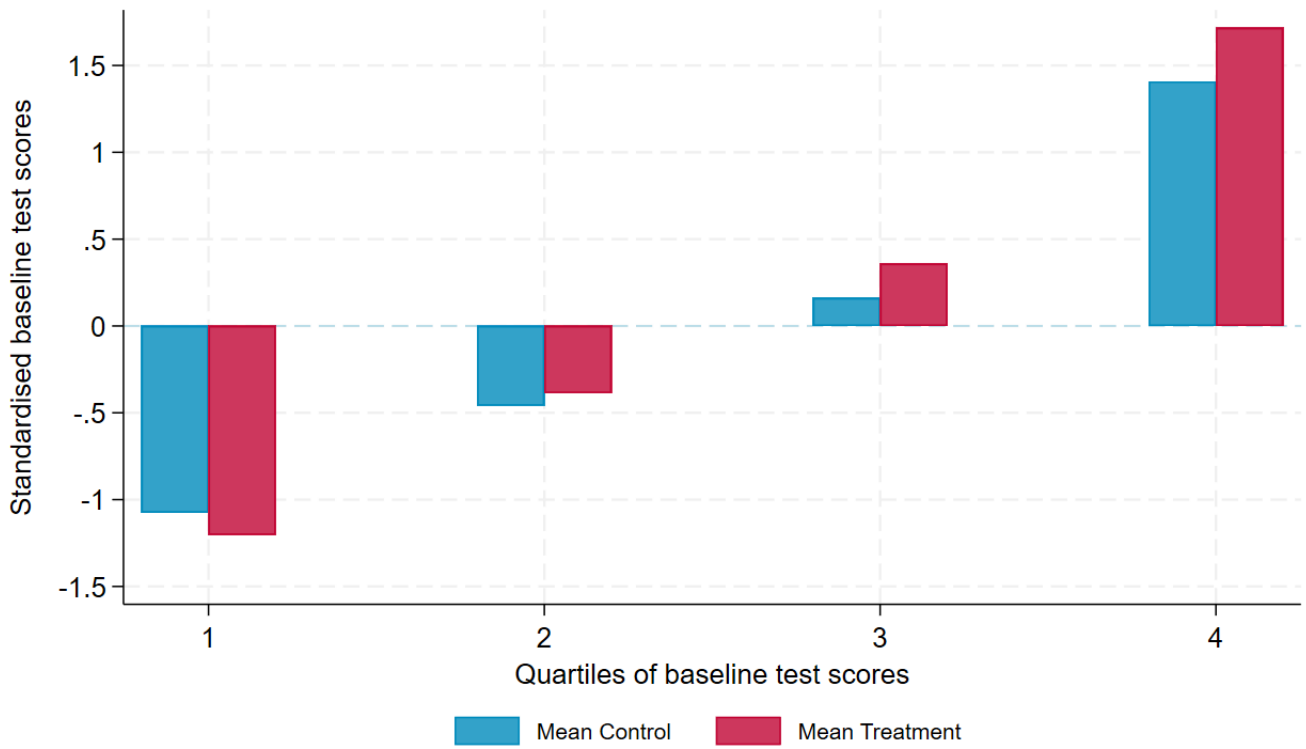


Figure 2.7: Mean of endline language test scores by quartiles at the beginning of the year

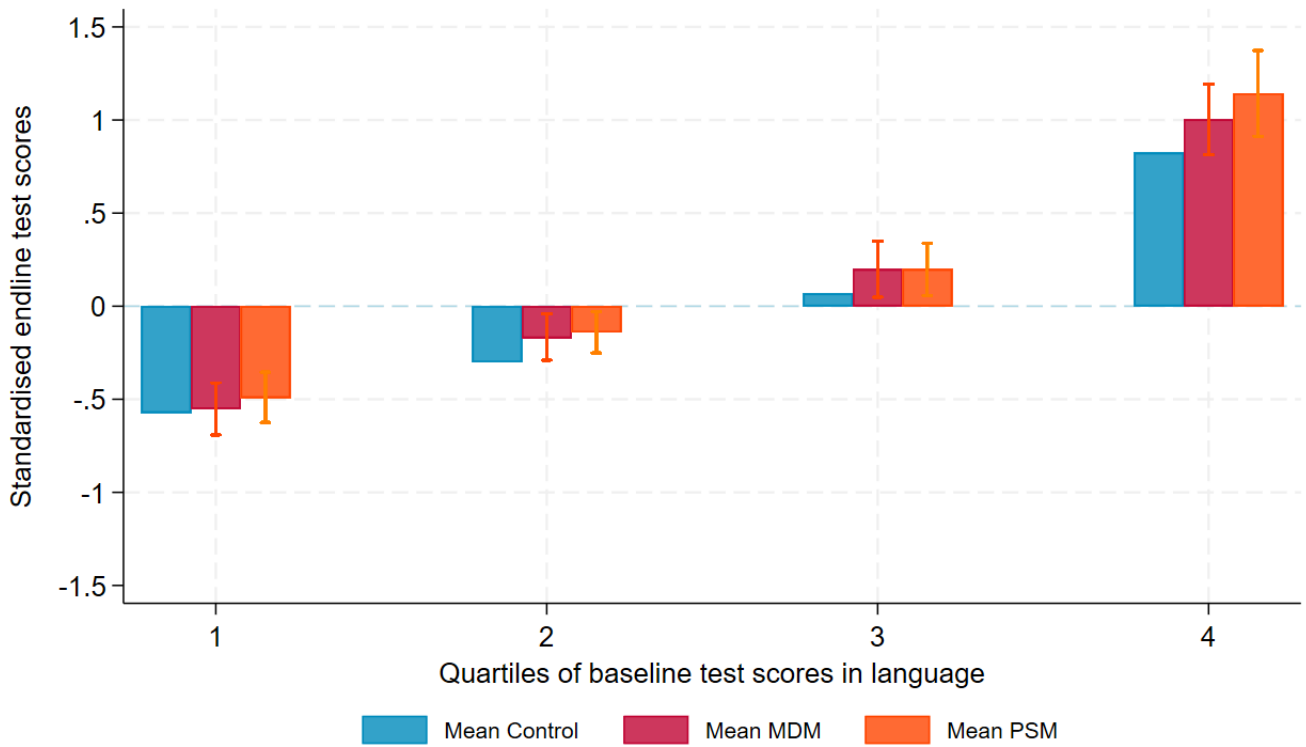


Figure 2.8: Mean of baseline mathematics test scores by quartiles at the beginning of the year

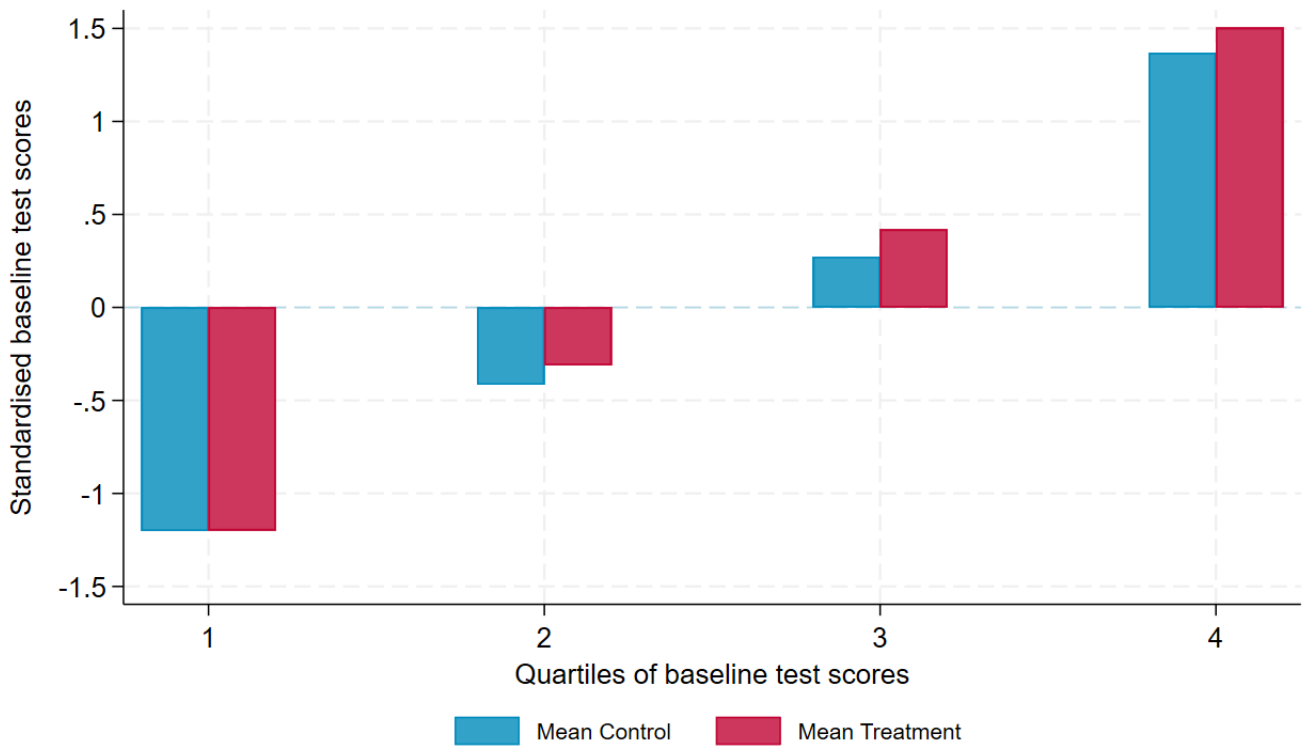
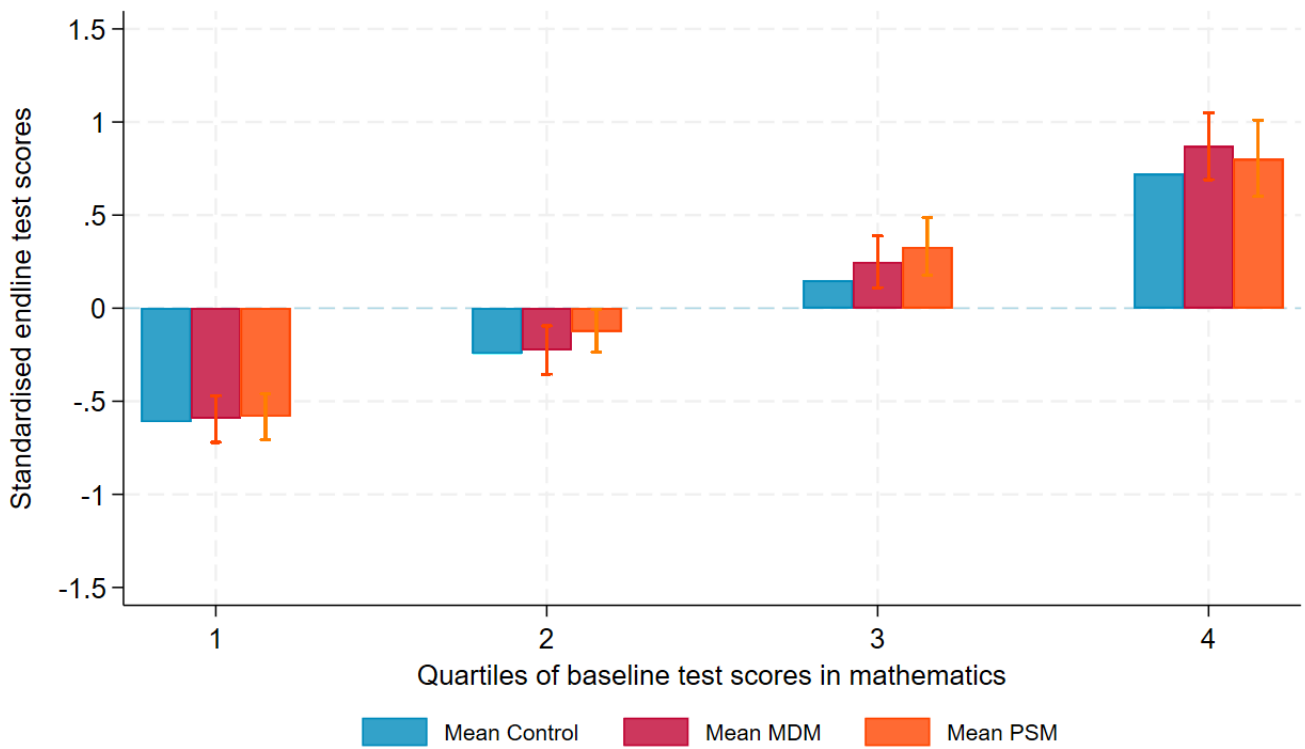


Figure 2.9: Mean of endline mathematics test scores by quartiles at the beginning of the year



Tables

Table 2.1: Country characteristics on CBA

COUNTRY	Year of the reform	Year of data collection	Teachers trained to CBA	Teachers who use CBA
Benin	2000	2004-2005	31.09%	86.54%
Burkina Faso	2007	2006-2007	3.18%	34.32%
Cameroon	1998	2005-2006	26.46%	86.83%
Chad	2006	2009-2010	27.98%	74.77%
Congo	/	2008-2009	20.88%	62.88%
Côte d'Ivoire	2003	2008-2009	69.32%	80.90%
Senegal	2000	2006-2007	69.45%	77.03%

Table 2.2: Sample for analysis

PASEC data	Benin	Cameroon	Chad	Congo	Côte d'Ivoire	Senegal	Total
Raw data							
Total teachers	283	339	316	289	287	305	1,819
Missing	48	30	116	54	47	32	327
Total pupils	4,137	4,958	4,646	4,201	4,285	4,488	26,715
Missing	635	480	1,795	1,817	1,053	937	6,717
Final sample							
Total teachers	114	190	142	158	197	223	1,023
Trained and use CBA	83	154	95	83	158	156	728
Do not use CBA	31	35	47	75	39	67	295
Total pupils	1,483	2,689	1,256	1,642	2,406	2,765	12,241
Robustness sample							
Total teachers	232	287	197	183	223	265	1,387
Use CBA	201	252	150	108	184	198	1,093
Do not use CBA	31	35	47	75	39	67	294
Total pupils	3,014	4,088	1,884	1,893	2,733	3,286	16,898

Note: The number reported for *Missing* are observations for which test scores teacher, student, and teacher characteristics or test scores are missing.

Table 2.3: Pupils' characteristics according to the use of CBA

Variables		Benin	Cameroon	Chad	Congo	Côte d'Ivoire	Senegal	All
Baseline lang. score	Mean C	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00
	T-C	0.16	-0.06	0.12	0.42**	-0.11	0.20*	0.11*
	SE	(0.16)	(0.15)	(0.16)	(0.16)	(0.13)	(0.10)	(0.06)
Baseline maths. score	Mean C	0.00	-0.00	-0.00	0.00	0.00	-0.00	0.00
	T-C	0.19	-0.02	0.03	0.34**	-0.19	0.10	0.09
	SE	(0.16)	(0.16)	(0.15)	(0.14)	(0.12)	(0.11)	(0.05)
Female	Mean C	0.39	0.43	0.57	0.47	0.41	0.51	0.47
	T-C	0.04	0.01	0.02	0.06	0.03	-0.01	0.01
	SE	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)	(0.01)
Age	Mean C	8.22	9.86	10.05	9.46	11.21	9.67	9.75
	T-C	0.00	-0.01	0.10	-0.06	0.10	0.19**	0.05
	SE	(0.22)	(0.20)	(0.20)	(0.16)	(0.17)	(0.09)	(0.07)
Preschool	Mean C	0.18	0.34	0.05	0.22	0.23	0.19	0.21
	T-C	0.02	-0.02	0.09**	0.02	-0.03	0.04	0.03
	SE	(0.06)	(0.06)	(0.04)	(0.04)	(0.04)	(0.03)	(0.02)
Have ever repeated	Mean C	0.42	0.65	0.62	0.49	0.54	0.44	0.52
	T-C	-0.02	-0.04	-0.08	0.00	0.03	-0.01	-0.00
	SE	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.02)
Speaks French at home	Mean C	0.03	0.23	0.14	0.21	0.19	0.02	0.14
	T-C	0.07**	-0.04	-0.05	0.13**	0.04	0.00	0.02
	SE	(0.03)	(0.07)	(0.05)	(0.06)	(0.05)	(0.01)	(0.02)
Father reads	Mean C	0.47	0.80	0.55	0.92	0.70	0.61	0.70
	T-C	0.05	-0.07*	0.01	-0.02	0.04	0.00	-0.01
	SE	(0.07)	(0.04)	(0.05)	(0.03)	(0.04)	(0.04)	(0.02)
Mother reads	Mean C	0.22	0.67	0.24	0.79	0.47	0.34	0.48
	T-C	-0.00	-0.11	0.05	-0.01	-0.01	0.03	-0.03
	SE	(0.05)	(0.07)	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)
Help for homework	Mean C	0.15	0.30	0.25	0.38	0.16	0.18	0.25
	T-C	0.00	-0.05	-0.04	0.03	0.02	0.01	-0.02
	SE	(0.03)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)
Books at home	Mean C	0.09	0.52	0.21	-	0.48	-	0.39
	T-C	0.11	-0.06	-0.03		-0.08		-0.02
	SE	(0.08)	(0.06)	(0.05)		(0.06)		(0.03)
House material	Mean C	1.64	1.58	1.08	2.25	2.34	2.53	2.05
	T-C	0.10	-0.15	0.03	0.13	0.13	-0.02	0.02
	SE	(0.18)	(0.15)	(0.15)	(0.16)	(0.13)	(0.09)	(0.07)
Wealth index	Mean C	0.00	-0.00	0.00	0.00	0.00	0.00	0.00
	T-C	0.11	-0.06	-0.01	0.16	0.04	0.14	0.21***
	SE	(0.14)	(0.15)	(0.16)	(0.13)	(0.14)	(0.11)	(0.06)
Country FE		No	No	No	No	No	No	Yes
Grade FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		1483	2689	1256	1642	2406	2765	12241

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Grade fixed-effect and constant terms are removed for readability.

Table 2.4: Schools' characteristics according to the use of CBA

Variables		Benin	Cameroon	Chad	Congo	Côte d'Ivoire	Senegal	All
Classroom level								
Teach. material index	Mean C	0.02	-0.01	-0.05	0.09	0.01	0.00	0.02
	T-C	0.17	0.36*	0.20	-0.12	0.25	0.18	0.14**
	SE	(0.20)	(0.20)	(0.21)	(0.10)	(0.20)	(0.13)	(0.07)
Nb. of pupils	Mean C	47.55	54.11	74.09	45.00	41.79	43.76	50.30
	T-C	4.75	-4.24	-4.33	-12.62*	1.11	4.48	-0.70
	SE	(3.70)	(6.03)	(10.61)	(7.48)	(2.99)	(3.26)	(2.67)
Nb. of pupils absent	Mean C	2.87	-	7.04	8.05	3.10	2.24	5.00
	T-C	0.38		2.11	-2.23*	-0.93	1.10	-0.63
	SE	(0.79)		(1.55)	(1.29)	(1.31)	(0.71)	(0.55)
% pupils absent	Mean C	0.06	-	0.13	0.12	0.07	0.05	0.09
	T-C	0.00		0.04	0.03	-0.02	0.04	0.01
	SE	(0.01)		(0.04)	(0.06)	(0.03)	(0.02)	(0.01)
Observations		114	189	142	158	197	223	1023
School level								
Public school	Mean C	0.97	0.71	0.66	0.79	0.87	0.90	0.81
	T-C	-0.06	0.10	0.01	-0.20**	0.02	0.00	0.00
	SE	(0.05)	(0.10)	(0.10)	(0.09)	(0.07)	(0.05)	(0.03)
Rural school	Mean C	0.65	0.60	0.68	0.28	0.64	0.43	0.50
	T-C	0.03	-0.04	-0.09	0.05	-0.14	0.07	0.03
	SE	(0.11)	(0.11)	(0.10)	(0.09)	(0.10)	(0.08)	(0.04)
Infrastructure index	Mean C	0.01	-0.00	-0.03	0.10	0.00	-0.02	0.02
	T-C	-0.03	0.09	0.24	-0.01	0.04	-0.05	0.03
	SE	(0.23)	(0.24)	(0.22)	(0.04)	(0.20)	(0.17)	(0.07)
Nb. of pupils	Mean C	299.06	461.66	477.23	669.40	325.97	523.46	496.09
	T-C	-0.76	4.35	47.90	-192.00**	-43.40*	41.60	-57.03*
	SE	(19.69)	(51.35)	(82.63)	(86.33)	(22.23)	(57.69)	(29.31)
Nb. of teachers	Mean C	5.81	8.11	6.85	8.43	6.72	10.34	8.07
	T-C	0.11	0.16	1.72	-1.21	-0.64*	0.09	-0.13
	SE	(0.38)	(1.15)	(1.34)	(0.87)	(0.37)	(0.73)	(0.39)
Pupil-teacher ratio	Mean C	57.46	57.59	69.62	71.50	48.66	46.36	59.30
	T-C	7.68	12.69**	-2.53	2.36	-0.51	4.28	0.77
	SE	(13.26)	(6.28)	(5.58)	(11.69)	(2.86)	(2.88)	(2.82)
Country FE		No	No	No	No	No	No	Yes
Grade FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		114	189	142	158	197	223	1023

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Grade fixed-effect and constant terms are removed for readability.

Table 2.5: Teacher characteristics according to the use of CBA

Variables		Benin	Cameroon	Chad	Congo	Côte d'Ivoire	Senegal	All
Female	Mean C	0.16	0.37	0.19	0.48	0.13	0.30	0.30
	T-C	0.01	-0.03	0.03	0.06	0.02	0.09	0.04
	SE	(0.08)	(0.09)	(0.07)	(0.07)	(0.07)	(0.06)	(0.03)
Age	Mean C	33.29	36.37	33.02	38.79	36.64	34.37	35.72
	T-C	-1.75	-4.06***	-1.01	-4.52***	0.69	0.35	-2.17***
	SE	(2.18)	(1.16)	(1.45)	(1.38)	(1.61)	(1.15)	(0.60)
Years of education	Mean C	11.45	10.74	10.88	12.01	12.10	12.07	11.64
	T-C	0.14	0.08	0.31	-0.01	-0.23	0.01	-0.11
	SE	(0.28)	(0.34)	(0.44)	(0.19)	(0.32)	(0.23)	(0.12)
Contract teacher	Mean C	0.65	0.46	0.75	0.41	0.00	0.69	0.51
	T-C	-0.02	0.30***	0.03	0.16*	0.00	-0.08	0.01
	SE	(0.12)	(0.09)	(0.09)	(0.09)	(0.00)	(0.07)	(0.04)
Pedagogical training	Mean C	1.87	12.27	5.42	20.67	15.72	6.81	11.42
	T-C	-0.13	5.84**	4.48**	-0.59	-0.33	0.63	0.74
	SE	(0.59)	(2.53)	(1.93)	(1.49)	(1.84)	(1.06)	(0.83)
Practical training	Mean C	0.81	1.97	0.69	3.60	3.76	2.24	2.35
	T-C	-0.15	0.53	1.19**	0.24	-0.01	0.49	0.37*
	SE	(0.21)	(0.46)	(0.59)	(0.38)	(0.68)	(0.49)	(0.21)
Years of experience	Mean C	13.19	10.00	8.21	10.00	11.41	8.66	9.95
	T-C	-2.77*	-3.93***	-3.67***	-3.37**	0.03	0.01	-2.28***
	SE	(1.57)	(1.20)	(1.20)	(1.34)	(1.76)	(1.15)	(0.55)
Monthly salary	Mean C	49.10	59.14	39.60	68.98	182.12	128.92	89.58
	T-C	0.61	-15.54**	4.07	-11.85*	-8.33	0.06	0.36
	SE	(8.48)	(7.74)	(11.11)	(6.18)	(10.47)	(6.98)	(4.73)
Days absent last month	Mean C	2.35	1.80	2.71	5.09	0.85	8.39	4.21
	T-C	-0.71	0.83*	1.77*	0.66	0.43	-0.49	-0.28
	SE	(0.75)	(0.49)	(0.98)	(1.52)	(0.35)	(1.00)	(0.45)
Country FE		No	No	No	No	No	No	Yes
Grade FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		114	189	142	158	197	223	1023

Note: Standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Grade fixed-effect and constant terms are removed for readability. Teacher's monthly salary unit is thousands of FCFA.

Table 2.6: Post matching differences in matching variables

Matching variables	Mean C	Mean T	Before matching		Kernel matching	
			T - C	Std. diff.	MDM	PSM
Student characteristics						
Baseline lang. score	0.00	0.12	0.12*** (0.06)	0.12*** (0.06)	0.09 (0.06)	0.05 (0.07)
Baseline maths score	0.00	0.09	0.09* (0.05)	0.09* (0.05)	0.07 (0.06)	0.04 (0.06)
Female	0.47	0.48	0.01 (0.01)	0.05*** (0.02)	0.04 (0.03)	0.04* (0.03)
Age	9.75	9.72	-0.03 (0.13)	-0.13*** (0.06)	0.04 (0.07)	0.07 (0.09)
Preschool	0.21	0.23	0.03 (0.02)	0.05 (0.04)	0.02 (0.05)	0.03 (0.05)
Have ever repeated	0.52	0.51	-0.01 (0.02)	-0.05 (0.04)	0.01 (0.04)	-0.00 (0.04)
Speaks French at home	0.14	0.15	0.02 (0.02)	0.05 (0.05)	0.02 (0.04)	0.07 (0.05)
Father reads	0.70	0.69	-0.01 (0.02)	0.00 (0.04)	-0.02 (0.05)	-0.03 (0.05)
Mother reads	0.48	0.46	-0.03 (0.03)	-0.02 (0.04)	-0.01 (0.06)	-0.05 (0.05)
Wealth index	0.00	0.20	0.20*** (0.06)	0.20*** (0.06)	0.04 (0.08)	-0.02 (0.08)
Teacher characteristics						
Female	0.29	0.35	0.05* (0.03)	0.22*** (0.07)	0.05 (0.08)	-0.00 (0.08)
Age	35.73	33.56	-2.18*** (0.58)	-0.27*** (0.07)	-0.09 (0.08)	-0.10 (0.09)
Years of education	11.70	11.53	-0.17 (0.13)	-0.04 (0.08)	-0.01 (0.08)	0.01 (0.08)
Years of experience	10.05	7.80	-2.26*** (0.54)	-0.36*** (0.07)	-0.10 (0.08)	-0.15 (0.10)
Monthly salary (in k FCFA)	92.37	90.15	-2.22 (4.89)	-0.19*** (0.07)	-0.06 (0.08)	-0.08 (0.09)

Table 2.6 continues on the next page.

Table 2.6 continued from previous page

Matching variables	Mean C	Mean T	Before matching		Kernel matching	
			T - C	Std. diff.	MDM	PSM
Pedagogical training (months)	11.44	12.22	0.78 (0.86)	0.14* (0.07)	0.07 (0.08)	0.04 (0.09)
Practical training (months)	2.35	2.69	0.34 (0.21)	0.29*** (0.11)	0.10 (0.08)	0.04 (0.09)
Days absent last month	4.18	3.75	-0.42 (0.44)	0.19*** (0.09)	0.00 (0.07)	0.02 (0.10)
Classroom characteristics						
Number of pupils in the class	48.91	49.13	0.22 (2.39)	0.09 (0.07)	0.03 (0.08)	-0.00 (0.08)
Teaching material index	0.00	0.16	0.16*** (0.07)	0.16*** (0.07)	0.08 (0.09)	0.04 (0.08)
School characteristics						
Public school	0.82	0.82	0.00 (0.03)	-0.04 (0.08)	-0.02 (0.08)	-0.08 (0.09)
School infrastructure index	0.00	0.05	0.05 (0.07)	0.05 (0.07)	0.04 (0.08)	0.08 (0.08)
School location	2.74	2.68	-0.07 (0.09)	0.06 (0.08)	-0.04 (0.10)	0.05 (0.09)
Nb. of pupils in the school	491.83	438.40	-53.42* (28.09)	-0.06 (0.07)	-0.04 (0.08)	-0.04 (0.09)
Pupil-teacher ratio in the school	58.42	59.19	0.77 (2.70)	0.21* (0.12)	0.03 (0.09)	-0.02 (0.10)
Observations	3518	8723	12241	12241	8708	10981

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance and automatic bandwidth computed by Stata for propensity score.

Table 2.7: Estimates of the impact of CBA

Var	Language test scores				Mathematics test scores			
	Kernel matching				Kernel matching			
	OLS	LASSO	MDM	PSM	OLS	LASSO	MDM	PSM
CBA	0.31*** (0.06)	0.16*** (0.02)	0.15** (0.07)	0.17** (0.07)	0.31*** (0.06)	0.07*** (0.02)	0.13** (0.06)	0.15** (0.07)
Obs	12241	12241	8708	10981	12241	12241	8708	10981
Grade FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	DS	DS	DS	No	DS	DS	DS

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in Tables 2.3, 2.4 and 2.5 have been included to be potential covariates for LASSO estimates and variables selected (DS) are detailed in Table 2.6. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance (MDM) and automatic bandwidth computed by Stata for propensity score (PSM). Exact match is imposed on country and grade variables.

Table 2.8: Comparison of within classroom inequalities

Within classroom SD of test scores	Language	Mathematics
Baseline		
Mean Control	0.67	0.71
Mean Treated	0.75	0.73
T-C	0.08***	0.02
SE	(0.02)	(0.02)
Endline		
Mean Control	0.72	0.77
Mean Treated	0.84	0.83
T-C	0.12***	0.06***
SE	(0.02)	(0.02)
Difference endline - baseline		
Mean Control	0.05	0.06
Mean Treated	0.09	0.10
T-C	0.04**	0.04**
SE	(0.02)	(0.03)

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2.9: Estimates of the impact of CBA by quartiles at the beginning of the year

	Language test scores				Mathematics test scores			
	Kernel matching				Kernel matching			
	OLS	LASSO	MDM	PSM	OLS	LASSO	MDM	PSM
<i>1st Quartile</i>								
CBA	0.03 (0.06)	0.03 (0.03)	0.02 (0.07)	0.08 (0.07)	0.03 (0.06)	0.04 (0.03)	0.02 (0.06)	0.03 (0.06)
Obs	3104	3104	2085	2836	3086	3086	2115	2811
<i>2nd Quartile</i>								
CBA	0.19*** (0.06)	0.16*** (0.03)	0.13** (0.06)	0.16*** (0.06)	0.12** (0.06)	0.08** (0.03)	0.02 (0.07)	0.12** (0.06)
Obs	3072	3072	2150	2809	3039	3039	2175	2784
<i>3rd Quartile</i>								
CBA	0.19*** (0.06)	0.16*** (0.04)	0.13* (0.08)	0.13* (0.07)	0.17*** (0.06)	0.08** (0.04)	0.08 (0.07)	0.16** (0.08)
Obs	3030	3030	2136	2804	3063	3063	2152	2798
<i>4th Quartile</i>								
CBA	0.42*** (0.11)	0.26*** (0.04)	0.18* (0.10)	0.32*** (0.12)	0.25*** (0.09)	0.14*** (0.04)	0.15 (0.09)	0.08 (0.10)
Obs	3035	3035	1957	2801	3053	3053	1965	2814
Grade FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	DS	DS	DS	No	DS	DS	DS

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in Tables 2.3, 2.4 and 2.5 have been included to be potential covariates for LASSO estimates and variables selected (DS) are detailed in Table 2.6. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance (MDM) and automatic bandwidth computed by Stata for propensity score (PSM). Exact match is imposed on country and grade variables.

2.A Appendix

Table 2.A.1: Estimates of the impact of CBA by student grade

	Language test scores				Mathematics test scores			
	<u>Kernel matching</u>				<u>Kernel matching</u>			
	OLS	LASSO	MDM	PSM	OLS	LASSO	MDM	PSM
<i>PANEL A: Grade 2</i>								
CBA	0.33*** (0.08)	0.17*** (0.03)	0.15 (0.11)	0.33*** (0.08)	0.33*** (0.07)	0.08*** (0.03)	0.11 (0.10)	0.20*** (0.06)
Obs	6143	6143	1927	5860	6143	6143	1927	5860
<i>PANEL B: Grade 6</i>								
CBA	0.18** (0.08)	0.13*** (0.02)	0.20** (0.08)	0.14 (0.09)	0.18** (0.08)	0.09*** (0.03)	0.16** (0.08)	0.12 (0.09)
Obs	6098	6098	6060	5606	6098	6098	6060	5606
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	DS	DS	DS	No	DS	DS	DS

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in Tables 2.3, 2.4 and 2.5 have been included to be potential covariates for LASSO estimates and variables selected (DS) are detailed in Table 2.6. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance (MDM) and automatic bandwidth computed by Stata for propensity score (PSM). Exact match is imposed on country and grade variables.

Table 2.A.2: Comparison of teachers according to CBA use and training

Variables	Mean T	Mean T'	Mean C	Comparison		
				T - C	T' - C	T' - T
Student characteristics						
Baseline lang. score	0.12	0.15	0.00	0.12*** (0.06)	0.23*** (0.06)	0.05 (0.06)
Baseline maths score	0.09	0.06	0.00	0.09* (0.05)	0.10* (0.06)	-0.04 (0.06)
Female	0.48	0.48	0.47	0.01 (0.01)	0.03*** (0.01)	0.01 (0.01)
Age	9.72	9.71	9.75	-0.03 (0.13)	0.02 (0.06)	-0.07 (0.06)
Preschool	0.23	0.24	0.21	0.03 (0.02)	0.03* (0.04)	0.02 (0.02)
Have ever repeated	0.51	0.53	0.52	-0.01 (0.02)	-0.01 (0.04)	-0.00 (0.02)
Mother reads	0.46	0.44	0.48	-0.03 (0.03)	0.02 (0.04)	0.04* (0.02)
Father reads	0.69	0.65	0.70	-0.01 (0.02)	0.01 (0.04)	0.00 (0.02)
Speaks French at home	0.15	0.16	0.14	0.02 (0.02)	0.03* (0.05)	0.02 (0.02)
Wealth index	0.20	0.39	0.00	0.20*** (0.06)	0.24*** (0.06)	-0.02 (0.06)
Teacher characteristics						
Female	0.35	0.28	0.30	0.05* (0.03)	0.04 (0.07)	0.00 (0.03)
Age	33.56	35.89	35.71	-2.18*** (0.58)	2.07*** (0.57)	3.76*** (0.57)
Years of education	11.53	11.01	11.65	-0.17 (0.13)	-0.33*** (0.12)	-0.40*** (0.12)
Years of experience	7.80	13.69	9.93	-2.26*** (0.54)	3.69*** (0.53)	6.14*** (0.53)
Monthly salary	90.15	73.72	89.78	-2.22 (4.89)	3.99 (3.18)	10.28*** (3.18)

Table 2.A.2 continues on the next page

Table 2.A.2 continued from previous page

Variables	Mean T	Mean T'	Mean C	Comparison		
				T - C	T' - C	T' - T
Pedagogical training	12.22	9.17	11.45	0.78 (0.86)	1.11* (0.67)	-1.04 (0.67)
Practical training	2.69	2.30	2.36	0.34 (0.21)	0.69*** (0.19)	0.25 (0.19)
Days absent last month	3.75	3.36	4.22	-0.42 (0.44)	0.33 (0.42)	0.00 (0.42)
Classroom characteristics						
Number of pupils in the class	49.13	55.34	50.30	0.22 (2.39)	3.25 (2.51)	4.53* (2.51)
Teaching material index	0.16	0.18	0.02	0.16*** (0.07)	0.09 (0.07)	-0.11 (0.07)
School characteristics						
Public school	0.82	0.80	0.81	0.00 (0.03)	-0.02 (0.03)	-0.01 (0.03)
School location	2.68	2.64	2.73	-0.07 (0.09)	0.16* (0.09)	0.09 (0.09)
School infrastructure index	0.05	0.03	0.02	0.05 (0.07)	0.06 (0.07)	-0.02 (0.07)
Nb. of pupils in the school	438.40	451.76	496.09	-53.42* (28.09)	37.23 (25.93)	39.69 (25.93)
Pupil-teacher ratio in the school	59.19	60.14	59.30	0.77 (2.70)	2.05 (3.02)	-2.97 (3.02)

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2.A.3: Robustness estimates with alternative treatment definition

Var	Language test scores				Mathematics test scores			
	OLS	LASSO	Kernel matching		OLS	LASSO	Kernel matching	
			MDM	PSM			MDM	PSM
CBA	0.31*** (0.06)	0.17*** (0.02)	0.16** (0.06)	0.15** (0.06)	0.31*** (0.05)	0.10*** (0.02)	0.16*** (0.06)	0.16*** (0.06)
Obs	16898	16898	12289	15216	16898	16898	12289	15216
Grade FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	DS	DS	DS	No	DS	DS	DS

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in Tables 2.3, 2.4 and 2.5 have been included to be potential covariates for LASSO estimates and variables selected (DS) are detailed in Table 2.6. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance (MDM) and automatic bandwidth computed by Stata for propensity score (PSM). Exact match is imposed on country and grade variables.

Table 2.A.4: Robustness estimates on learning gains

Var	Language test scores				Mathematics test scores			
	OLS	LASSO	Kernel matching		OLS	LASSO	Kernel matching	
			MDM	PSM			MDM	PSM
<i>Treatment:</i>								
<i>Use and trained to CBA</i>								
CBA	0.21*** (0.05)	0.19*** (0.02)	0.10* (0.06)	0.16*** (0.05)	0.21*** (0.05)	0.10*** (0.02)	0.08 (0.06)	0.12** (0.05)
Obs	12241	12241	8708	10981	12241	12241	8708	10981
<i>Treatment:</i>								
<i>Use CBA</i>								
CBA	0.20*** (0.05)	0.21*** (0.02)	0.11** (0.05)	0.16*** (0.05)	0.20*** (0.05)	0.12*** (0.02)	0.10** (0.05)	0.18*** (0.06)
Obs	16898	16898	12289	15216	16898	16898	12289	15216
Grade FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	DS	DS	DS	No	DS	DS	DS

Note: Robust standard error clustered at the school level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All variables in Tables 2.3, 2.4 and 2.5 have been included to be potential covariates for LASSO estimates and variables selected (DS) are detailed in Table 2.6. Epanechnikov function is used for Kernel matching with bandwidth = 4 for Mahalanobis distance (MDM) and automatic bandwidth computed by Stata for propensity score (PSM). Exact match is imposed on country and grade variables.

Chapter 3

Exploring the Effect of Contract Type on Teacher Productivity and Student Performance

CO-WRITTEN WITH ÉLISE HUILLERY

1 Introduction

Since the 1990s, rapid population growth together with increase in the proportion enrolled in primary school caused overcrowding in many schools and a sharp rise in the number of pupils per teacher across the various education levels. The resulting deterioration in the quality of public education and its declining capacity to absorb the increasing numbers of primary students resulted in an overhaul of teacher hiring practices. Governments shifted away from hiring relatively expensive civil servant teachers toward hiring contract teachers instead. The fast hiring of huge numbers of contract teachers around the world, in particular in sub-Saharan Africa, South Asia and Latin America, is one of the major changes of education systems of the past two decades. In a recent review of the use of contract teachers in sub-Saharan Africa, UNESCO shows that contract teachers represent up to 65% of teachers at the primary school level in some countries.¹ It is thus essential to understand its implications for teaching and learning.

Contract teachers differ fundamentally from regular teachers in that their job stability is not guaranteed. In fact, contract teachers can be dismissed by their employer, which is either the local school committee, the parent-teacher association, or the Ministry of Education. Besides job instability, contract teachers may also differ from regular teachers in the qualification requirements to enter the job and the remuneration profile. These features have *a priori* unclear consequences on student achievement because they may negatively affect the characteristics of entrant teachers but positively affect the effort that teachers invest in their job in order to be renewed or tenured Rothstein, 2015. In fact, contract teachers have higher incentives to invest effort because they can be dismissed if they under-perform. However, the effect of the contract arrangements on teachers' effort is theoretically unclear because, according to the efficiency wage theory, the lower salary may on the contrary decrease teacher motivation and effort to keep their position. From a conceptual point of view, the overall difference in productivity between regular and contract teachers is thus ambiguous, so it is unclear how this major change in education systems affected students' achievement.

In this paper, we assess the impact of contract teachers on student achievement in eight French-speaking African countries: Benin, Burkina Faso, Cameroon, Chad, Congo, Niger, Senegal, and Togo. These countries are those which participated in the PASEC program in the 2000s and/or in 2014 and where the proportions

¹<https://unesdoc.unesco.org/ark:/48223/pf0000374581.locale=en>

of contract teachers were at least 10% in the 2000s and in 2014. To answer our research question we proceed in three steps. First, we provide evidence on the differences in profiles between contract and regular teachers by looking at teachers' gender, age, qualification, and salary. Second, we provide evidence on differences in effort that can be observed between contract and regular teachers by examining average absences, working time, use of guides and manuals, and the completion of the curriculum. Third, we assess how *similar* students in *similar* classes and schools achieve when their teacher is a contract teacher compared to a regular teacher. We document the endogenous allocation of contract teachers to students using rich information on schools, classes, and family characteristics, and then resort to a matching strategy to neutralize this endogenous allocation and identify the effect of teacher contract on student learning. To the extent that students matched on observable characteristics would have reached the same level of learning had they have the same teacher, differences in student learning can thus be interpreted as the result of the differences in profiles and effort induced by contract arrangements.

We find that contract teachers differ from regular teachers in that they are younger and less experienced, and teach more often in the public sector and in rural areas. Although their level of education and training is rather similar to regular teachers, contract teachers are paid much less in all countries even after controlling for experience and qualification—except Burkina Faso, which is an exception². They do not seem to invest consistently more or less effort than regular teachers: based on self-report absenteeism, use of manuals and curriculum completion, contract teachers tend to exhibit more effort in Benin, Chad, Cameroon, and Togo, but less effort in Burkina Faso, Niger, and Senegal. Finally, contract teachers teach more disadvantaged students socially and economically than regular teachers in all countries.

However, the matching estimates show that students of contract teachers perform rather similarly to students of regular teachers. In Benin, students taught by contract teachers seem to be slightly more performing than students taught by regular teachers, whereas in Burkina Faso they seem slightly less performing, but these differences are limited and not consistently significant. In all other countries differences are small and never significant. The important lesson that we draw from this analysis is that contract teachers seem on average as productive as regular teachers. Interestingly, this result does not seem related to country-specific differences in profiles and effort between contract and regular teachers that we uncovered. These

²Incidentally, in Burkina Faso, all contract teachers were transferred to civil servant status as of 1 January 2016.

findings imply that, even if contract teachers have different contract arrangements than regular teachers, there is no detectable effect of these arrangements on teacher productivity. Therefore, in French-speaking sub-Saharan African countries over the past two decades, teacher status has not been an important determinant of student learning in itself.

The policy implication is that giving teacher contract more or less job security may not be a crucial component of education systems. In fact, the variations in teacher characteristics associated with teacher status such as age, experience, and salary do not seem to affect much student learning. We do not mean that extremely low salary or lack of training would have no consequences on students' learning, but that the variations induced by the change in status for contract teachers did not substantially affect student learning. These results suggest that teacher productivity may depend more heavily on unobserved qualities of teachers such as their personality traits or pedagogical skills, and that these unobserved qualities may not differ on average between contract teachers and regular ones.

This paper primarily contributes to the literature on teacher contracts. Some data and information has been collected to provide evidence on how the change in teacher contract changes teacher profiles and effort and the resulting student achievement. Bold, Filmer, et al. (2017) show that, in seven sub-Saharan African countries, contract teachers possess equivalent pedagogical knowledge or classroom skills than regular teachers despite having less training and experience. Regarding the productivity of contract teachers, there is evidence in India, and Kenya that contract teachers may produce higher student learning than regular teachers due to lower absence rates and effort (Atherton and Kingdon, 2010; Duflo, Dupas, et al., 2015). Other papers such as Bourdon, Frölich, et al. (2010) show that the effects of contract teachers on student learning is context-specific (positive in Mali, somewhat mixed in Togo, and negative in Niger). Bau and Das (2020) and Muralidharan and Sundararaman (2013) find that contract teachers in India and Pakistan, while receiving less training and lower wages, are no less effective at improving student learning than regular civil-service teachers. Finally, Vegas and De Laat (2003) show that students of contract teachers systematically underperform compared to those of regular teachers, with the potential explanation that the quality of teacher supply has declined following the change in hiring practices. Our paper adds to this literature by providing a more systematic analysis on profiles, effort, and relative productivity of contract teachers using data from seven sub-Saharan African countries. Our analysis reveals that, contrary to the common wisdom, contract teachers are not always less trained and paid than civil servants. We also find that the differ-

ences in profiles and effort between contract and regular teachers do not translate into differences in production of student learning.

More generally, this paper speaks to the literature on teacher incentives. The important question of how to attract quality teachers and motivate them remains largely open. Some papers study teacher performance-based payment schemes and show that financial incentives may increase teacher quality and student achievement (Biasi, 2021; Leaver, Ozier, et al., 2021; Mbiti, Muralidharan, et al., 2019). Estrada and Lombardi (2024) and Jacob (2013) study job protection in Chile and in the USA respectively, showing that high job protection can make it more difficult to separate and motivate low-performing teachers, and may favor teacher absenteeism. Our paper moderates these results by showing that hiring teachers in short-term contracts with the possibility to dismiss them does not seem to change much teacher absenteeism and productivity.

Finally, this paper speaks to the vast literature on teacher quality. Although teachers are the key input in education, the relationship between their characteristics and student outcomes has been difficult to establish empirically. In fact, the literature provides evidence that observed classical characteristics of teachers such as education or experience explain little of their productivity. Bau and Das (2020) estimate teacher value added in Pakistan and show that observed teacher characteristics account for less than 5 percent of the variation in teacher value added. Rivkin, Hanushek, et al. (2005) also show that teachers have powerful effects on reading and mathematics achievement but little of the variation in teacher quality is explained by observable characteristics such as education or experience. Our results are consistent with the teacher quality “puzzle” as we find no difference in student learning associated with differences in teacher status such as difference in age, experience, education, training, salary, absences, or use of manuals and guides. This finding reinforces the idea that teacher quality mostly depends on other dimensions such as personality traits or pedagogical skills, which are poor across most developing countries and whose development is particularly cost-effective (Bold, Filmer, et al., 2017; Glewwe and Muralidharan, 2022).

The rest of the paper is structured as follows. Section 2 presents the institutional context of the teacher contract reforms initiated by most African countries in the late 1990s. Section 3 presents the data used in this paper. Section 4 presents how contract teachers compare to civil-servant teachers in terms of profiles, effort, students, classes, and schools. Section 5 presents the identification strategy and estimates of the effects of contract teachers on student learning, and Section 6 con-

cludes.

2 Institutional context

The broad consensus that teachers are central in the provision of quality education for all was confirmed in the creation of Sustainable Development Goal (SDG) in the 2030 Agenda according to which “by 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries”. In most developing countries, hundreds of millions of children enrol in school systems, creating a tremendous demand for teachers.

Because these governments face tight budget constraints, many of them have initiated teacher contract reforms since the late 1990s to face the increasing demand for schooling and meet the goal of universal primary education. They have resorted to hiring contract teachers with varying qualification levels who place less strain on their recurrent education budgets.

2.1 What is a contract teacher?

Contract teachers differ fundamentally from non-contract teachers in that their job stability is not guaranteed. In fact, their contract is subject to renewal by the community or by educational authorities. Regarding other aspects of the contract such as qualification requirement, remuneration, and ways in and out of contract teacher status, there is large variation across countries so it is difficult to establish a global picture. What is meant by ‘contract teacher’ and what contract arrangements look like differ across countries, as shown in the review published in 2018 by UNESCO mentioned above.

First, contract teachers have different denominations and statuses across countries, and this is also true for non-contract teachers. Therefore, in this paper, we classify all teachers in two groups depending on whether they are tenured: the group of “non-contract” teachers (whom we also refer to as “regular” teachers) comprises all teachers with an open-ended contract whose job security is guaranteed, such as civil servants and permanent work contract teachers, in both the public and private sector. In contrast, the group of “contract” teachers comprises all teachers who have a short-term contract and whose job stability is not guaranteed, denominated as “contract”, “community”, or “volunteer” teachers. Among them, “community” and “volunteers” teachers are locally hired by school management committees or

parent-teacher associations, while “contract” teachers strictly speaking are generally hired by the central government. Locally- and centrally-hired teachers coexist in many countries with large variations in the proportion of locally- *versus* centrally-hired contract teachers. Figure 3.2 shows the distribution of the statuses of both regular and contract teachers in the countries included in our analysis. For instance, Chad, Benin, and Congo have a majority of locally-hired contract teachers, whereas Senegal, Cameroon, Burkina Faso, and Niger, have a majority (if not all) contract teachers hired by the Ministry of education.

Second, education and teacher qualification levels of contract teachers are quite different from one country to another. In some countries such as Congo, Kenya and Senegal, similar qualifications are required from all teachers regardless of their contract status or the type of school (public or private). Contract teachers thus attended regular teacher training institutes and have the same level of qualification as regular teachers. For instance in Kenya, contract teachers—called Parent-Teacher Association teachers—are fully qualified but hired by school committees using funds raised from parents, paid much less than their civil servant counterparts, and effectively at will employees of the school committee (Duflo, Dupas, et al., 2015). In this case, contract teachers may get tenured after a few years so the system works as a probationary period. But in other countries such as Congo-Brazzaville, contract teachers refer to community-based low-qualified volunteers whose level of experience and education is way lower than with civil servant teachers.

Third, there are important cross-country variations in the remuneration policy of contract teachers. In general, contract teachers receive lower pay than their civil service counterparts. The lowest salaries tend to go to contract teachers hired directly by schools or communities who raise the necessary funds to pay them. Locally hired contract teachers may not receive travel allowances or payments for additional work or additional qualifications as do civil servant teachers. However, in African countries such as Benin and Mali, teacher unions are active and obtained upward revisions of contract teachers’ salaries. In the extreme case of Mali, teacher unions even lobbied for the regularization of contract teachers within the civil service so that the government decided in 2009 to grant civil service status to all contract teachers.

Finally, countries also differ in the ways in and out of contract teacher status. In Eritrea, Ethiopia, and Mozambique, contract teachers move to civil service after a legally set period of contract (90 consecutive days in Eritrea, 6 months in Ethiopia, and 2 years in Mozambique). In countries such as the Gambia, Niger, Senegal and

Togo, contract teachers have to take courses and pass a degree to move to civil service contract. Finally, in countries such as Benin, Burkina Faso up until the end of 2015, and Kenya, there is just a system of competitive applications to both statuses.

Despite these cross-national variations, the core difference between contract and regular teachers is job insecurity: whether they can continue to serve as a contract teacher or become a regular teacher depends on their performance and the assessment of their employer—be it the local community or the central government. This difference, together with the other aspects of the contract mentioned above, likely affects student learning.

2.2 How may the contract of the teacher affect students' learning?

The characteristics of the contract offered to the teachers likely affect student learning in two important ways: the effort invested by the teachers in their job on the one hand, and the profiles of the teachers on the other hand.

First, the contract may change teacher effort, but the direction of the change is ambiguous. The fact that contract teachers face the threat of non-renewal should result in greater effort than tenured teachers because contract teachers have a stronger incentive to perform to be renewed or tenured. However, in cases where contract teachers are fully qualified but receive lower salaries than regular teachers, the efficiency wage theory posits that workers proportionally withdraw effort as their actual wage falls short of their perceived fair wage. Lower-paid contract teachers may consider their wage unfair given that their work is the same as the job of higher-paid regular teachers, and thus withdraw effort accordingly.

Second, the contract characteristics presumably affect the profiles of teachers by inducing variation among entrant teachers in their qualification and productivity. In fact, contract reforms change the opportunity cost of alternative employment opportunities. In particular, the more productive individuals whose reservation wage is between contract teacher wage and regular teacher wage would apply for a regular position but not for a contract teacher position. This implies that a reduction in teacher compensation will likely reduce the supply of qualified teachers and result in lower student learning - keeping alternative employment opportunities constant.

In this paper, we aim to go beyond country reviews of teacher contract principles by providing statistical evidence on the differences in profiles between contract

and regular teachers in ten French-speaking African countries, corresponding to all countries which participated in the PASEC program in the 2000s and/or in 2014, after the introduction of the teacher contract reforms. We also aim at shedding light on differences in effort that can be observed between contract and regular teachers. In the end, if contract teachers have in fact different profiles and different levels of effort than regular teachers, we also want to know how these differences affect student achievement.

3 Data

3.1 Source

Our analysis is based on several PASEC databases from two waves of data collection: we use PASEC diagnostic evaluation data from the 2000s wave and from the 2014 wave. Eight countries participated in the 2000s round: Benin, Burkina Faso, Burundi, Cameroon, Chad, Congo, Côte d'Ivoire, Senegal. Ten countries participated in the 2014 round: the same countries as in the 2000s plus Niger and Togo.

The 2000s wave was implemented in the following years: Benin (2004-2005), Burkina Faso (2006-2007), Burundi (2009-2009), Cameroon (2005-2006), Chad (2009-2010), Congo (2008-2009), Côte d'Ivoire (2008-2009), and Senegal (2006-2007). The PASEC 2000 data includes language and mathematics test scores for students in grades 2 and 5, along with surveys of students, teachers, and school principals. PASEC follows a standardized sampling procedure for each country, randomly selecting schools at the regional level. Within each selected school, one grade 2 class and one grade 5 class are randomly chosen, and 15 students per class are randomly selected. Table 3.1 provides a detailed description of the PASEC 2000 samples at the national level. A notable issue is the significant number of pupils with missing test scores, resulting in a consequent number of observations being removed from the final sample.

The second wave of PASEC data collection was implemented in 2014 in all participating countries. Similar to the first wave, primary schools are randomly selected in each region to ensure regional representativeness. In each selected school, one grade 6 class is randomly chosen for the survey, and in half of these schools, an additional grade 2 class is randomly selected. Twenty students were selected to take the test in the 6th-grade class, and ten students for the 2nd-grade class. Table 3.1

also presents the PASEC 2014 samples at the national level.

3.2 Sampling Strategy

Figure 3.1 shows the proportion of contract teachers among sampled teachers by country and year. We exclude teachers for whom we have no information on whether they are tenured or not, which is often the case in the private sector except in Benin 2004-2005 and in Cameroon 2005-2006 where we know whether the contract is short-term and open-ended even in the private sector. For the rest of the analysis, we selected country-year pairs with at least 10% of contract teachers to ensure sufficient representation in both the contract teacher group and the non-contract teacher group. This selection criteria excludes Burundi and Côte d'Ivoire. Pooling the two waves of data at the country level, the proportions of contract teachers in the final sample range from 42% in Congo to 69% in Chad.

Table 3.1 details the steps to achieve the final sample used in our analysis: we removed pupils for whom test scores or teacher status or matching variables (described below) are missing to create a stable sample throughout the analysis. The stability of our sample ensures the comparability of the coefficients obtained across the various methods used to assess the impact of contract teachers on test scores.

3.3 Variables of interest

Student learning The main outcomes of our analysis are pupils' language³ and mathematics test scores. The PASEC 2000 diagnostic evaluation is designed to assess pupils in grades 2 and 5 at the beginning and end of the year⁴ in both mathematics and language and to ensure comparability across countries. The grade 5 mathematics test includes items that assess students' knowledge of number properties and their ability to perform simple calculations such as addition and subtraction. Tests also include items that ask students to use addition, subtraction, multiplication and division to solve problems. Other items assess knowledge of decimals, fractions and basic geometry concepts. The language test includes items that assess students' reading comprehension, vocabulary, orthography and syntax. Test scores for each

³All language test scores are in French except for Cameroon which includes English tests as language test scores for the English-speaking part of the country. None of the pupils in Cameroon have English test scores for PASEC 2000 due to missing information, and 1% for PASEC 2014, resulting in a total of 0.6% of English test scores in the final sample for Cameroon.

⁴We only use test scores at the end of the year in our analysis.

pupil in PASEC 2000 are computed as the sum of all items in mathematics and same for language items. The PASEC 2014 survey assesses grades 2 and 6 students at the end of the year in both mathematics and language. The tests include items very similar to those in PASEC 2000. Since our final sample differs substantially from the raw data, we standardized test scores within each country and for each wave of data collection after having removed observations to obtain our final main outcomes.

Teacher status The treatment variable in our analysis is whether a teacher is a contract teacher or not. As explained above, we define contract teachers as teachers with a short-term contract, as opposed to non-contract teachers who have an open-ended contract. Specifically, the non-contract group includes civil-servant teachers, teachers with a permanent contract, and private teachers with a permanent contract. The contract group includes contract teachers, community teachers, and volunteer teachers in both public and private sectors. The composition of each group is described in Table 3.2 and shown in Figure 3.2.

Teacher profile Characteristics of teachers are female (binary), age (continuous), years of education (continuous), months of pedagogical training and practical training (continuous), years of experience as a teacher (continuous), and the monthly salary in thousand of FCFA (continuous).

Teacher effort Variables concerning teacher effort are the number of days absent last month (continuous), the hours of lesson per week (continuous), the use of language and mathematics guides to prepare lessons as well the use of language and mathematics guide with pupils⁵, the percentage of curriculum done in language and mathematics (continuous) for PASEC 2000 and if the curriculum is completely done (binary) for PASEC 2014.

Student characteristics Pupils' variables are the sex, the fact that a pupil has done preschool, that he had ever repeated a class⁶, if the student speaks French at home, whether his father and mother can read, whether they help the pupil with homework, and if there are books at home. All of these variables are binaries. We

⁵0 is never, 1 is sometimes, 2 is often and 3 is always for PASEC 2000, and 0 is never, 1 is one time per month, 2 is one time per week and 3 is every day for PASEC 2014.

⁶Repeated grade 1 or grade 2 for grade 2 students, repeated at least one class between grade 1 and grade 5 for grade 5 pupils in PASEC 2000, and repeated at least one class between grade 1 and grade 6 for grade 6 pupils in PASEC 2014.

also use student age (continuous), house material (0 for straw, 1 for clay, 2 for semi-hard materials, and 3 for hard materials), and a wealth index (z-score computed on household facilities).

School and class characteristics Classroom characteristics are the availability of language and mathematics guides to prepare lessons (binaries), the availability of language and mathematics curricula (binaries), the number of pupils per language manual and per mathematics manual (categorical⁷), a teaching material index (z-score computed on teaching equipment available in the classroom), the number of pupils in the class (continuous), the number of pupils absent on survey day (continuous), and the percentage of pupils absent on survey day (continuous). Concerning school characteristics, we use school status (1 for public school and 0 for others), and school location (categorical⁸), the number of pupils in the school (continuous), the number of teachers in the school (continuous), and the average pupil-teacher ratio in the school (continuous).

4 Comparison of contract and non-contract teachers

In this section, we compare contract and non-contract (regular) teachers' profile, effort, and working environment. The objective is two-fold: first, this analysis provides evidence on how contract arrangements may affect the productivity of teachers by changing their profiles and effort. Second, this analysis documents the endogeneity bias arising from the non-random allocation of contract teachers to specific types of schools, classes and students.

4.1 Method

First, we examine differences in profiles and effort between contract and regular teachers by looking at teachers' gender, age, qualification, absences, working time, use of guides and manuals, and completion of the curriculum. To test the null hypothesis that contract teachers' profiles and effort is similar to regular teachers' ones, we run the following regression:

⁷1 is one pupil per manual, 2 is two pupils per manual, until 6 which is more than 5 pupils per manual or no manual at all.

⁸We use two variables for school location. The first one is *Rural school* which equals one if the school is located in a small or a big village and 0 if it is located in a suburban area or a town. The second one is *School location* which equals 1 if the school is located in a small village, 2 in a big village, 3 in a suburban area, and 4 in a town.

$$Y_{is} = \alpha + \beta C_{is} + \epsilon_{is} \quad (3.1)$$

where Y_{is} is a variable measuring the profile or effort of teacher i in school s , C_{is} is a dummy that equals 1 if teacher i in school s is in a contract teacher and 0 otherwise, and ϵ_{is} is the error term. The estimated β is the parameter of interest measuring the average difference in Y between contract and regular teachers. The equation is estimated via OLS, and standard errors are robust to heteroscedasticity and are clustered at the school level.

Second, we document the endogenous allocation of contract teachers to schools, classes, and students by comparing the characteristics of students, classes and schools taught by contract *versus* regular teachers. To test the null hypothesis that contract teachers teach similar classes and schools than regular teachers, we run the same regression as equation (1) replacing teacher characteristics by their class and school characteristics as dependent variable. Besides, to test the null that contract teachers teach similar students as regular teachers, we run the following regression:

$$Y_{jis} = \alpha + \beta C_{is} + \epsilon_{jis} \quad (3.2)$$

where Y_{jis} is a characteristic of student j of teacher i in school s , C_{is} is a dummy that equals 1 if teacher i in school s is in a contract teacher and 0 otherwise, and ϵ_{jis} is the error term. The estimated β is the parameter of interest measuring the average difference in students' characteristic Y between contract and regular teachers. The equation is estimated via OLS, and standard errors are robust to heteroscedasticity and are clustered at the school level.

4.2 Results

Contract *versus* regular teachers' profile

Table 3.3 shows how contract teachers compare to regular teachers in terms of sex, age, experience, and qualification. We find no significant difference in gender between contract and regular teachers in any country. However, there are large differences in age and experience: contract teachers are consistently younger and/or less experienced than regular teachers in all countries. The average age of regular teachers lies between 36 in Chad to 45 in Togo, and contract teachers are 3 to 11 years

younger (except in Congo where they are equally young). Similarly, regular teachers have on average between 7 and 18 years of experience as a teacher, while contract teachers 4 to 12 years less (except in Chad where they are equally experienced).

Yet, if contract teachers are typically younger and less experienced, they are not always less educated than regular teachers. The average number of years of education of contract teachers is generally close to regular teachers' one, between 10 and 12 years on average. In five out of eight countries (Benin, Cameroon, Congo, Senegal and Togo) contract teachers have on average the same number of years of education than regular teachers, whereas in the three other countries (Burkina Faso, Chad, and Niger) they have significantly less education, between half a year to a bit more than a year less. Overall, the typical teacher completed upper secondary education, as do regular teachers.

The picture is more mixed regarding teacher training. In Benin, Chad, Congo, and Niger, contract teachers were trained less than regular teachers—the difference is particularly large in Benin and Chad where contract teachers' pedagogical training is less than half as long as regular teachers' one. In contrast, in Burkina Faso and Cameroon, contract teachers are trained more than regular teachers, by about 3 to 7 months respectively (adding up the pedagogical and practical components). Finally, in Senegal and Togo, there is no difference in the duration of teacher training between contract and regular teachers. Therefore, while contract teachers are younger and less experienced than regular ones, there is no rule such that contract teachers are systematically less qualified than regular ones. In fact, the relative level of qualification of contract teachers varies from one country to another.

Finally, contract teachers are generally less paid than regular teacher, even after adjusting for the gap in experience, education, and training. This is true in all countries but Burkina Faso which is a distinctive case with respect to teacher remuneration: in this country, contract teachers were paid on average similarly to regular teachers—which means that they are paid *more* conditional on experience and qualification (28% more after controlling for experience, 26% more after controlling for experience, education, and training). In all other countries, the remuneration of contract teachers is much lower than that of regular teachers: the PASEC data show that, on average, contract teachers are paid 25% less than regular teachers in Senegal, 45% less in Niger, 52% less in Congo, 53% less in Benin, 57% less in Togo, 63% less in Cameroon, and up to 81% less in Chad. Gaps in salary are thus massive and only partly explained by the difference in experience: they remain significant and large even after controlling for experience. The salary gaps are also not

explained by differences in qualifications since they remain stable when we control for the number of years of education and the duration of the training (last row in Table 3.3).

Contract *versus* regular teachers' effort

Table 3.4 compares the effort invested by contract teachers relative to regular teachers. The results are mixed so there does not seem to be a clear link between teacher status and effort.

Regarding absenteeism, the comparison of contract and regular teachers varies across countries. In Benin and Togo, contract teachers report fewer days of absence in the last month than regular teachers (respectively -40 and -46 percent). On the contrary, in Niger, contract teachers report more days of absence (+67 percent). In other countries there is no significant difference in absenteeism between contract and regular teachers.

The number of hours of teaching per week, which is available only in PASEC 2014 data, is about 30 hours for regular teachers in all countries (from 27 in Cameroon and Togo to 33 in Burkina Faso). It is generally similar between contract and regular teachers, except in Niger and Senegal where contract teachers teach about 1.2 hours (4 percent) less than regular teachers. The differences are thus nonexistent or small so they are unlikely to affect pupils' learning substantively.

Regarding the use of guides and manuals, which we interpret as an expression of pedagogical effort, there is also little differences between contract and regular teachers. In Benin, contract teachers are slightly less likely to use manuals in language and mathematics than regular teachers, while in Cameroon we find the opposite. One may think that teachers need guides and manuals more when they are less experienced, but it does not seem to be the case as contract teachers are younger and less experienced everywhere but do not always use manuals and guides more than regular teachers. However, the relative use of manuals may be related to the duration of the pedagogical training: contract teachers are less trained than regular teachers in Benin and use less the manuals, whereas they are more trained than regular teachers in Cameroon and use more the manuals.

Finally, regarding the level of completion of language and mathematics curricula, there is no systematic advantage or disadvantage of contract teachers with respect to regular teachers. In Burkina Faso, the first wave of PASEC data shows that contract teachers completed a smaller proportion (about 10 percent less) of

both the language and mathematics curricula than regular teachers. In contrast, in Benin and Chad, the second wave of PASEC data shows that contract teachers are respectively 46 and 87 percent more likely to complete the curriculum. In Benin, this finding may be related to the fact that absenteeism is smaller in contract teachers.

To conclude, the evidence on teacher effort shows a large variety of situations indicating no systematic link between teacher status and effort. In some countries, we observe signals of greater effort of contract teachers relative to regular teachers: in Benin they are less absent and more likely to complete the curriculum, in Chad they are more likely to complete the curriculum, in Cameroon they are more likely to use the manuals, and in Togo they are less likely to be absent. On the contrary, in other countries, there are signals of smaller effort of contract teachers relative to regular teachers: in Burkina Faso they complete a smaller part of the curriculum, in Niger they are more likely to be absent and teach less hours per week, and in Senegal they teach fewer hours per week. From a suggestive point of view, one may note the link between teacher effort and the type of contract: countries where contract teachers seem to exert less effort than regular teachers are the countries with the highest proportion of centrally-hired (Burkina, Niger, and Senegal), whereas in Benin, Chad, Cameroon and Togo where they seem to exert more effort than regular teachers, some contract teachers are locally-hired by the community. The control by the community may thus play a role in explaining the differences in effort, but this needs to be further investigated in future research.

Contract *versus* regular teachers' students, classes, and schools

We now examine the characteristics of students, classes, and schools by teacher status. The objective is different from the previous analysis: while profiles and effort are endogenous to teacher status and thus inherent to opting for one status or the other, differences in students, classes, and schools characteristics result from the decision of educational authorities and communities to allocate contract teachers to specific schools and classes, *i.e.*, non-randomly.

Table 3.5 compares the characteristics of the students of contract *versus* regular teachers. We find evidence that, in seven out of eight countries, contract teachers teach students who are on average socially and/or economically worse off than those taught by regular teachers. For instance in Benin, students of contract teachers are less likely to speak French at home, to receive help from their parents to do homework, and their house material and wealth indices are significantly lower than students of regular teachers. In Cameroon, students of contract teachers are less

likely to have attended preschool, to speak French at home, fathers and mothers are less likely to read, help with homework, and have books at home, and the wealth index is lower. Similar pictures emerge for Chad, Niger, and Senegal. In Congo and Togo, students taught by contract teachers also seem more disadvantaged than those taught by regular teachers but only one difference is statistically significant so the contrast is less pronounced. Finally, in Burkina Faso, the picture is unclear since students of contract teachers are more likely to speak French at home and receive help from parents for homework, but they are less likely to have attended preschool, fathers and mothers are less likely to read, and the house material index is lower.

Table 3.6 does the same exercise for class characteristics and equipment. In all countries, contract teachers teach smaller classes than regular teachers and the difference is significant in Burkina Faso, Niger, and Senegal. This result is probably related to the fact that, as shown in the next paragraph, contract teachers are more likely to be appointed in rural areas than regular teachers. Pupils absenteeism does not seem differential, except in Burkina Faso where pupils of contract teachers are a bit more absent than those of regular teachers. In terms of teaching equipment and material, the relative situation of contract teachers compared to regular teachers is unclear: it is positive in Congo (more teaching material, less pupils per manual) and in Niger (teaching material), mixed in Burkina Faso (more teaching material but less mathematics guides), negative in Benin, Chad, and Cameroon, and there is no difference in Senegal and Togo. Therefore, there is heterogeneity across countries regarding the relative level of teaching equipment, and the only common feature is that contract teachers teach rather smaller classes than regular teachers.

Finally, Table 3.7 compares schools' characteristics of contract and regular teachers. We find that contract teachers are generally less likely to teach in public schools than regular teachers, except in Congo where it is the opposite. Note that the proportion of regular teachers in the public sector is above 90% in most countries, and even 100% in Niger, and even contract teachers are mostly in the public sector. Chad and Cameroon stand out. In Chad, the difference between contract and regular teachers is massive: 94% of regular teachers teach in public schools, while only 54% of contract teachers. In Cameroon, only 48% of regular teachers and 39% of contract teachers belong to the public sector, which is linked to the English-speaking part of the country where the private sector is much more developed than in the French-speaking part.

Besides, contract teachers are generally more likely to teach in rural areas compared to regular teachers (except in Benin and in Togo where the difference is not

significant). This may contribute to the fact that contract teachers' students are socially and economically worse off compared to regular teachers' ones, as noted above. The quality of school infrastructure is not consistently better or worse for contract teachers relative to regular teachers. However, schools of contract teachers have consistently fewer pupils and fewer teachers than schools of regular teachers (except in Togo where school sizes are similar), which is clearly related to the fact that they are more often in rural areas. Finally, pupil-teacher ratios do not show a consistent correlation with teacher status.

Conclusions of the comparison of contract *versus* regular teachers

To sum up the previous findings, contract teachers differ from regular teachers mostly in that they are younger, less experienced, and less paid (conditional on experience and qualification). They also tend to teach more often in the private sector and in rural areas, so to smaller classes in smaller schools. Finally, they generally teach more disadvantaged students. In terms of qualification, contract teachers have generally similar levels of education than regular teachers except in Burkina Faso, Chad and Niger where they are slightly less educated. Also, they receive less training than regular teachers in Benin, Chad, Congo and Niger. Finally, there is no clear association between teacher status and effort in the data.

What do these results imply for the comparison of the productivity between contract and regular teachers? First, given the variety of situations across countries, we need to compare teacher productivity at the country level and relate it to country-specific profiles and efforts of contract *versus* regular teachers. Second, the non-random distribution of contract teachers across schools and pupils implies an important bias in favor of regular teachers who teach less disadvantaged students in more urban environments compared to contract teachers. In the rest of the analysis, we will thus implement an empirical strategy to address this selection bias.

5 Effects of contract teachers on student learning

5.1 Identification strategy

Our objective is to measure how *similar* students in *similar* classes and schools achieve when their teacher is a contract teacher compared to a regular teacher. However, as shown in the previous section, the characteristics of students taught by

contract *versus* regular teachers are different, as well as their working environment (school and class infrastructure, size, and equipment).

Because teachers and students are not distributed randomly across schools, it is difficult to identify the effects of teacher status on student learning. High-performing students are on average from wealthier families and live more frequently in urban areas than low-performing students who tend to be over-represented in low-income families and in rural areas. To the extent that the allocation of regular *versus* contract teachers is not orthogonal to pupils', classes', and schools' characteristics, the comparison in student achievement between regular and contract teachers suffers from severe omitted variable biases.

Our identification strategy is based on a matching using rich information on a wide variety of school, class, and family characteristics. As a starting point, we estimate a simple OLS regression of test scores on a dummy indicating that the teacher is a contract teacher with only grade and year fixed effects. This first specification provides raw differences in test scores among same-year same-grade students who have different teacher types, contract *versus* regular. As explained above, this raw comparison encompasses differences in pupils', classes' and schools' characteristics together with differences in teachers' productivity.

Second, we estimate the same regression adding covariates selected by the double-LASSO selection procedure. The procedure includes all individual variables of Table 3.5 except three variables with many missing observations (parents' help for homework, whether there is books at home, and house material), so as to keep a sufficiently large sample. It also includes all classroom-level variables⁹ but the number and percentage of pupils absent on survey day due to potential endogeneity. Finally, the LASSO procedure includes all school-level variables of Table 3.7. We end up including 16 covariates in the LASSO selection procedure. We estimate the following equation:

$$TS_{i,j,s,g} = \alpha + \beta C_j + \lambda X_{i,j,s} + \delta_g + \varepsilon_{i,j,s} \quad (3.3)$$

Where $TS_{i,j,s,g}$ is the test score of student i with teacher j in school s in grade g , C_j is a dummy indicating whether the teacher j is a contract teacher, $X_{i,j,s}$ is a set of LASSO-selected control variables including student, classroom and school-level characteristics, δ_g is a grade fixed effect that equals 1 if the pupil is in grade 2 and 0

⁹We create two new variables based on existing ones: *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3.6 on classroom-level characteristics.

if s/he is in grade 5 (PASEC 2000) or 6 (PASEC 2014), and $\varepsilon_{i,j,s}$ is the robust error term clustered at the school level.

Third, for students in the same grade in the same year, we estimate the effect of contract teachers using two main matching methods: a Kernel matching based on a Mahalanobis distance, and a nearest neighbours matching based on a propensity score. The baseline variables used to match are the same as those used in the LASSO regression above. Our main specification is based on a bandwidth of 3 for the Mahalanobis distance in the Kernel matching, and on 5 nearest neighbours for the nearest neighbour matching. For both methods, the Sample Average Treatment Effect is a basic difference between treated test scores and theoretical control test scores:

$$\widehat{SATE} = \frac{1}{T} \sum_{t=1}^T (TS_t - TS_h) \quad (3.4)$$

Where T is the total number of treated observations, TS_t is the test score of the treated observation t , and TS_h is the test score of the theoretical control h associated to the treated t . For the Kernel matching strategy, the theoretical control is a weighted average¹⁰ of all the controls within in bandwidth of 3. For the nearest neighbours strategy, the theoretical control is the average of the 5 nearest neighbours¹¹ of the treated observations.

In Appendix, we also present additional matching estimates using several bandwidths (2.5 and 3.5) for the Kernel matching and several numbers of nearest neighbours (1 and 10) as robustness checks. Besides grade and year for which we impose an exact match, the matching variables are exactly the same 16 variables as those included in the double-LASSO selection procedure discussed above. This empirical strategy relies on the idea that the PASEC data are rich enough to reduce a lot (but unfortunately not completely eliminate) the chances that the identification of the teacher contract effect suffers from an omitted variable bias.

Tables 3.A.2-3.A.9 show the balancing of observable characteristics between contract and regular teachers before and after the matching procedures (Kernel and Nearest Neighbour). Before matching, there are many differences in covariates between contract and regular teachers: a minimum of 5 differences out of 16 tests

¹⁰Weights are computed based on the similarity with the treated (Mahalanobis distance) using an Epanechnikov function.

¹¹Nearest neighbours are found using a propensity score. A treated unit can be associated with more than five neighbors if the most distant one has observations that are exactly similar to its own. The maximum number of neighbors for a treated observation is 11.

in Congo and Togo, and a maximum of 11 differences out of 16 tests in Chad—we already commented on these differences in the previous section. After matching, whatever the method, there is almost no significant differences between students, classes and schools of contract and regular teachers (only 5 significant differences out of 128 tests), which indicate that common supports are sufficiently large so that the two procedures were able to create a theoretical control (Kernel) / find neighbours (Nearest Neighbours) that looks similar to the contract teacher group. Figures 3.A.1-3.A.8 provide a visual representation of the quality of the matching procedure: for each covariate, the blue dot represent the raw difference between the contract teacher group and the regular teacher group, while the red dot represent the difference after matching. We can see that all differences in covariates after matching are small, less than 10 percent of a standard deviation.

Therefore, our identification strategy relies on the assumption that students matched on observable characteristics would have reached the same average level of learning had they have the same teacher. To the extent that this assumption holds, differences in student learning can be interpreted as the result of the differences in teacher productivity (profiles and effort) induced by contract arrangements.

5.2 Results

5.2.1 Students' learning with contract *versus* regular teachers

Table 3.8 presents the differences in language and mathematics achievement between students of contract *versus* regular teachers. Column (1) reports the raw difference controlling only for year and grade fixed effects. In all countries but Benin and Burkina Faso, pupils of contract teachers perform equally to pupils of regular teachers in language and maths. In Burkina Faso, they perform worse (-0.26 standard deviations in language and -0.32 standard deviations in maths), whereas in Benin they perform better (+0.12 SD, non significant, in language and +0.13 SD in maths) than pupils of regular teachers. Since these estimates do not control for the fact that contract teachers teach different pupils in different environments, we cannot disentangle the effect of contract teachers from underlying selection biases.

In column (2) with covariates selected by a double-LASSO procedure, standard errors are much smaller so covariates reduce variance in test scores. Controlling for student, class and school characteristics, students of contract teachers perform as well as students of regular teachers in Cameroon, Chad, Congo, Niger, and Senegal. In Burkina Faso and in Togo, students of contract teachers under-perform compared

to students of regular teachers (-0.09 SD in language, -0.19 and -0.09 SD in maths respectively). On the contrary, in Benin, students of contract teachers perform better than students of regular teachers (+0.08 SD in language and +0.13 SD in maths). However, controlling linearly for covariates may not get rid of selection biases as well as matching estimates.

In columns (3) and (4), the matching estimates show that, in most countries, students of contract teachers perform similarly to students of regular teachers, with both the Nearest Neighbour approach and the Kernel matching. However, in Benin, we find that students of contract teachers perform better than students of regular teachers in maths: the difference is significant at about +0.15 SD. In language, the point estimates are in the same range as in Column (2) with the LASSO-selected covariates, but less precisely estimated and insignificant. On the contrary, in Burkina Faso, students of contract teachers seem to perform worse in maths than students of regular teachers, and in language the difference is of the same size as in Column (2) but not significant due to a loss in precision.

In Table 3.A.1, we find similar results with different bandwidth (2.5 and 3.5 instead of 3) and number of neighbours (1 and 10 neighbours instead of 5). In all countries but Benin and Burkina Faso, the data shows no achievement gap between students of contract teachers and students of regular teachers. In Benin and Burkina Faso, there are still significant differences in favor of contract teachers in Benin and in favor of regular teachers in Burkina Faso—although not always robust. Note that point estimates are always a bit smaller when we use the Nearest Neighbour method compared to the Kernel matching with Mahalanobis distance, which suggests that the Nearest Neighbour matching is more efficient at eliminating the omitted variable bias than the Kernel matching. Incidentally, we should also note that the raw estimates presented in Column (1) in Table 3.8 are generally larger than the estimates adjusted by LASSO-selected covariates in Column (2) and the matching estimates in Column (3) and (4) and in Appendix Table 3.A.1, which reflects the selection biases due to differences in pupil, class, and school characteristics observed in Tables 3.5, 3.6, and 3.7. However, differences between raw and adjusted estimates are not huge, which means that observable characteristics are not associated with massive differences in language and maths test scores in our sample.

5.2.2 Discussion

The important lesson that we draw from this analysis is that, once we correct as much as possible for selection biases, there is no important differences in learning

between students of contract teachers and students of regular teachers. In two countries out of eight there are some differences in productivity, but these differences remain small, inconsistent, and not very robust. Hence, the average contract teacher seems to be roughly as productive as the average regular teacher. Interestingly, the lack of difference in student learning contrasts with large differences in profiles between contract and regular teachers as uncovered in the previous section. We showed that contract teachers are younger, less experienced, and less paid (even after controlling for experience and qualification). Thus, one could reasonably expect that students learn less when taught by contract teachers than by regular teachers, but it is not the case. One interpretation might be that job insecurity may spur greater motivation that compensates lower experience, resulting in similar productivity as regular teachers.

This finding has two important implications. First, teacher status does not seem to be a strong determinant of student learning in itself. In fact, even if contract teachers have different contract arrangements than regular teachers—with some variations from one country to another—there is no detectable effect of these arrangements on teacher productivity. The policy implication is that making teacher contracts more flexible may not be high stakes for education systems. Second, the more general implication of our findings is that simple observable teacher characteristics such as age, experience, level of training, and salary, do not affect much student learning *per se*. In fact, we observe differences in these characteristics between contract and regular teachers, yet student learning is found rather independent of teacher status. In no case does this imply that teachers could be absent all the time, receive very low salary, or receive no training, which would obviously have detrimental effects on learning and reduce to nothing the supply of teachers. However, since variations observed in this paper do not translate in differences in student learning, it seems that the combination of variations in teacher profiles and effort associated with teacher status balance each other out. An alternative interpretation is that the characteristics of teachers that predict the most their productivity are not the classic variables collected in teacher surveys such as age, experience, and qualification. The most important characteristics may be rather related to personal qualities such as personality traits, enthusiasm, motivation, charisma, and mindset, or to pedagogical skills such as ability to instruct and manage a classroom, communication, adaptability, collaboration, compassion, or the use of resources like student evaluations. If these important unobserved factors were equally distributed across contract and regular teachers, that would explain their similar productivity.

6 Conclusion

This paper provides the first systematic analysis on how the change in teacher contract initiated in the late 1990s affected teacher profiles, effort, and student learning. We use data from eight sub-Saharan African countries where the proportions of contract teachers were at least 10% in the 2000s and in 2014. We show that the change in teacher contract was associated with lower experience and lower salary, and that contract teachers teach more often disadvantaged students and students in rural areas than regular teachers. Differences in education, training, absences, used of manuals, and curriculum completion vary from one country to another so there is not systematic link between teacher status and their qualification and effort. Using a matching strategy to neutralize the non-random allocation of contract teachers, we find that students of contract teachers tend to perform similarly to *similar* students of regular teachers, which suggest that contract teachers are on average as productive as regular teachers.

This paper makes an important contribution to the economics of education literature by showing that the teacher contract reform did not affect substantially teacher productivity. It also shows that the variations in teacher profiles and effort induced by the change in teacher contract did not affect student learning, which means that these characteristics either balance each other out, or do not contribute much to the education production function as already pointed out in the teacher value added literature. Future research should investigate further the determinants of teacher productivity, which are probably related to other characteristics than those commonly collected in administrative and survey data such as age, experience, education, or training. Important characteristics in the education production function may be rather personality traits and pedagogical skills, that future research should help uncover.

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Figures

Figure 3.1: Percentage of contract teachers in PASEC databases

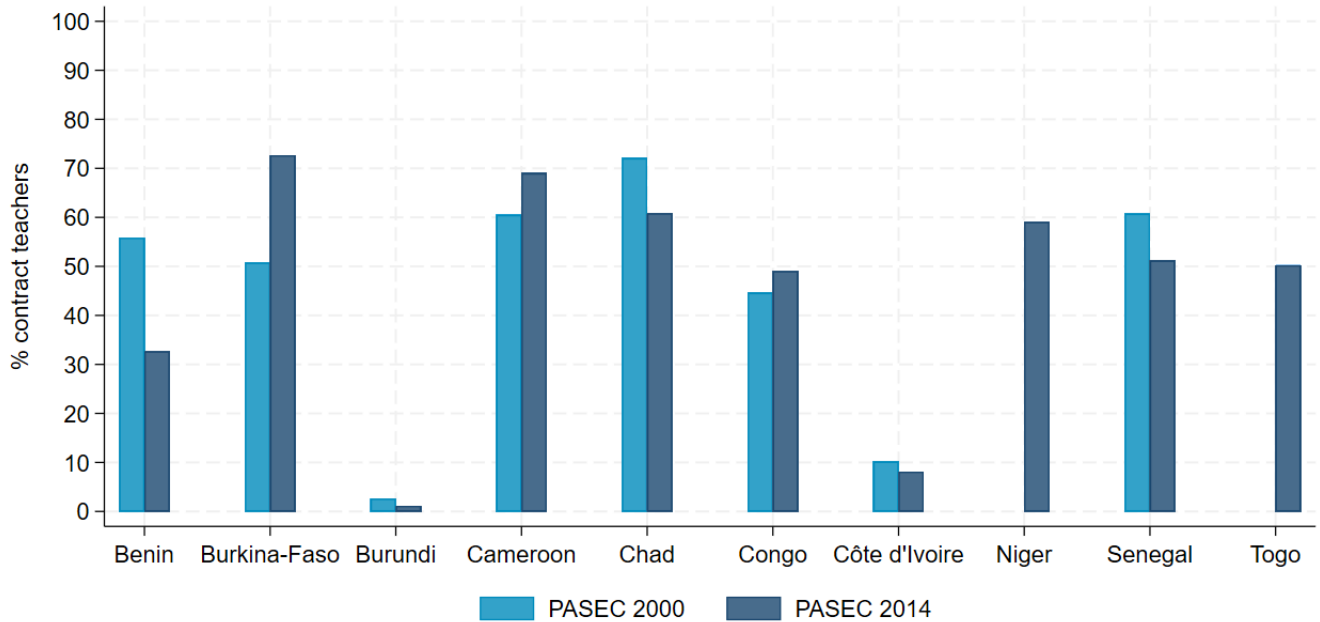
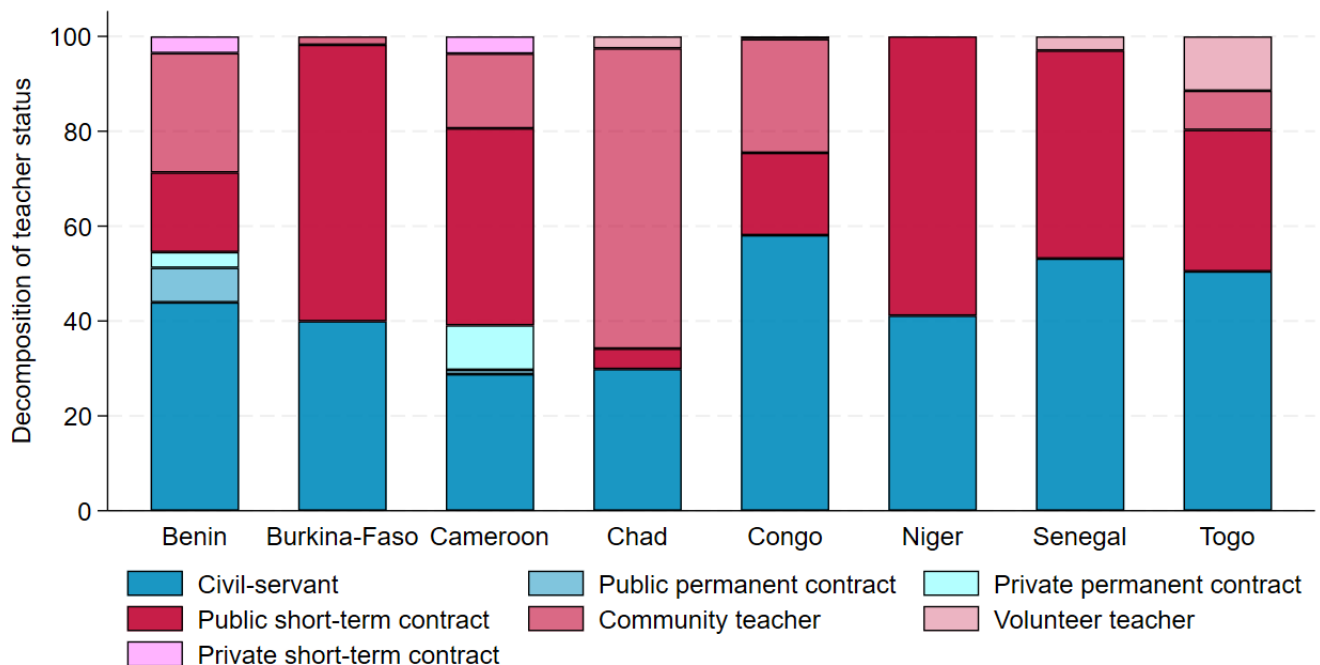


Figure 3.2: Distribution of status in final sample



Tables

Table 3.1: Sample for PASEC databases

Data	Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
PASEC 2000								
Total teachers	283	314	339	316	289	-	305	-
Missing status	0 (0%)	42 (13%)	0 (0%)	17 (5%)	67 (23%)	-	30 (10%)	-
Total pupils	4,137	4,648	4,958	4,646	4,201	-	4,488	-
Missing	730 (18%)	1,935 (42%)	1,740 (35%)	2,283 (49%)	3,594 (86%)	-	2,959 (66%)	-
PASEC 2014								
Total teachers	245	282	400	245	254	262	243	284
Missing status	49 (20%)	37 (13%)	271 (68%)	23 (9%)	101 (40%)	8 (3%)	30 (12%)	55 (19%)
Total pupils	3,765	4,385	4,888	3,297	3,544	4,009	3,712	4,167
Missing	1,221 (32%)	1,594 (36%)	3,984 (82%)	1,616 (49%)	2,450 (69%)	1,338 (33%)	1,450 (39%)	1,393 (33%)
Final sample								
Total teachers	453	393	330	395	167	214	301	218
Total pupils	5,951	5,504	4,122	3,944	1,701	2,671	3,791	2,774

Note: The *Missing* row for pupils are observations for which test scores, matching variables, or teacher status are missing.

Table 3.2: Distribution of teachers in the final sample

Data	Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo	Total
Total teachers	453	393	330	395	167	214	301	218	2,471
Non-contract teachers	54%	40%	39%	30%	58%	41%	53%	50%	45%
Civil-sevant	44%	40%	29%	30%	58%	41%	53%	50%	42%
Public permanent contract	7%	0%	1%	0%	0%	0%	0%	0%	1%
Private permanent contract	3%	0%	9%	0%	0%	0%	0%	0%	2%
Contract teachers	46%	60%	61%	70%	42%	59%	47%	50%	55%
Public short-term contract	17%	58%	42%	4%	17%	59%	44%	30%	33%
Community teacher	25%	2%	16%	63%	24%	0%	0%	8%	19%
Volunteer teacher	0%	0%	0%	3%	1%	0%	3%	11%	2%
Private short-term contract	4%	0%	4%	0%	0%	0%	0%	0%	1%

Table 3.3: Teacher profile according to status

Variables		Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
Female	Mean C	0.20	0.27	0.37	0.14	0.38	0.33	0.15	0.06
	T-C	-0.04	0.03	-0.02	-0.05	-0.12	-0.02	0.03	-0.05
	S.E.	(0.04)	(0.05)	(0.06)	(0.04)	(0.08)	(0.07)	(0.04)	(0.03)
Age	Mean C	41.35	37.86	42.62	36.19	41.23	40.08	39.33	44.92
	T-C	-11.33***	-5.35***	-9.70***	-2.69***	-0.36	-7.24***	-6.99***	-9.74***
	S.E.	(0.80)	(0.56)	(0.92)	(0.78)	(1.28)	(1.03)	(0.67)	(0.93)
Years of education	Mean C	11.40	11.95	10.66	12.34	12.12	11.53	12.33	11.59
	T-C	-0.11	-0.48**	0.32	-1.35***	0.24	-0.59**	0.19	-0.31
	S.E.	(0.19)	(0.22)	(0.20)	(0.18)	(0.17)	(0.25)	(0.14)	(0.23)
Pedagogical training (months)	Mean C	15.39	13.23	13.86	16.27	23.51	18.20	9.84	6.16
	T-C	-8.28***	2.51**	5.77***	-9.07***	-6.24***	-5.00***	-0.99	-0.14
	S.E.	(1.41)	(1.08)	(1.55)	(1.16)	(1.72)	(1.38)	(0.71)	(1.18)
Practical training (months)	Mean C	4.38	4.75	2.17	2.81	4.28	3.41	2.48	1.27
	T-C	-2.13***	0.35	0.92**	-0.92**	-1.41***	-0.77*	-0.08	-0.36
	S.E.	(0.39)	(0.45)	(0.37)	(0.45)	(0.43)	(0.45)	(0.26)	(0.22)
Years of experience	Mean C	15.96	13.85	17.91	6.54	12.80	15.74	13.80	17.45
	T-C	-4.78***	-7.35***	-11.66***	1.08	-4.21***	-9.55***	-8.17***	-9.11***
	S.E.	(0.67)	(0.51)	(0.95)	(0.66)	(1.28)	(0.73)	(0.54)	(0.84)
Monthly salary	Mean C	149.44	140.70	137.42	200.22	162.73	152.99	195.98	146.36
	T-C	-79.20***	-10.57	-85.81***	-161.99***	-83.63***	-68.62***	-49.34***	-82.92***
	S.E.	(7.63)	(9.80)	(8.19)	(8.06)	(10.23)	(5.18)	(5.86)	(6.31)
<i>Conditional on experience</i>	T-C	-55.09***	40.16***	-36.95***	-162.85***	-73.50***	-43.52***	-30.88***	-64.77***
	S.E.	(7.15)	(11.59)	(8.63)	(7.99)	(8.62)	(6.53)	(8.01)	(7.41)
<i>Conditional on experience, education and training</i>	T-C	-50.73***	36.86***	-40.82***	-164.06***	-66.90***	-40.90***	-28.32***	-50.29***
	S.E.	(8.06)	(11.69)	(7.90)	(8.93)	(9.68)	(6.66)	(7.92)	(7.15)
Observations		453	393	330	395	167	214	301	218

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Niger and Togo estimates solely on PASEC 2014 data. *Monthly salary* unit is thousands of FCFA, and salaries for the 2000 wave have been adjusted to inflation to match 2014 level using World Delivery Indicators.

Table 3.4: Teacher effort according to status

Variables		Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
Days absent last month	Mean C	2.66	1.83	2.23	3.17	2.04	1.32	5.05	1.05
	T-C	-1.06**	-0.42	-0.03	-0.18	-0.49	0.87**	-0.75	-0.48**
	S.E.	(0.42)	(0.31)	(0.37)	(0.54)	(0.40)	(0.44)	(0.65)	(0.19)
Hours of lesson per week ^a	Mean C	27.82	32.54	26.57	28.32	27.25	29.85	29.28	27.15
	T-C	-0.03	0.45	1.50	-0.79	-0.24	-1.17*	-1.20*	0.26
	S.E.	(0.31)	(0.83)	(2.13)	(1.07)	(2.04)	(0.61)	(0.64)	(0.73)
Use of language guide	Mean C	2.67	2.75	2.14	1.25	2.84	2.99	2.56	2.79
	T-C	-0.14	-0.13	0.01	-0.22	-0.02	0.00	-0.02	0.01
	S.E.	(0.09)	(0.09)	(0.17)	(0.20)	(0.17)	(0.02)	(0.10)	(0.07)
Use of mathematics guide	Mean C	2.66	2.70	1.81	0.90	2.84	3.00	2.46	2.85
	T-C	-0.12	-0.19*	-0.02	0.11	0.08	-0.02	0.02	-0.04
	S.E.	(0.08)	(0.11)	(0.17)	(0.19)	(0.12)	(0.01)	(0.11)	(0.06)
Use of language manual	Mean C	2.93	2.59	2.08	2.08	2.59	3.00	2.56	2.96
	T-C	-0.11**	-0.14	0.33**	-0.22	0.13	-0.02	0.12	-0.03
	S.E.	(0.05)	(0.10)	(0.14)	(0.17)	(0.13)	(0.02)	(0.08)	(0.04)
Use of mathematics manual	Mean C	2.93	2.55	2.02	2.03	2.54	2.98	2.60	2.97
	T-C	-0.10*	-0.11	0.37***	-0.15	0.13	-0.05	-0.01	-0.01
	S.E.	(0.05)	(0.11)	(0.14)	(0.17)	(0.14)	(0.05)	(0.09)	(0.03)
% of language curriculum done ^b	Mean C	49.80	76.02	79.55	63.29	69.59	-	68.60	-
	T-C	2.94	-7.05***	-4.95	-3.16	-4.59		0.62	
	S.E.	(2.80)	(2.57)	(3.35)	(4.13)	(6.26)		(3.80)	
% of mathematics curriculum done ^b	Mean C	54.02	76.02	79.37	62.41	69.59	-	68.60	-
	T-C	3.51	-7.05***	-3.95	-0.15	-4.59		0.62	
	S.E.	(2.70)	(2.57)	(3.53)	(4.41)	(6.26)		(3.80)	
Curriculum completely done ^c	Mean C	0.37	0.50	0.44	0.23	0.45	0.68	0.40	0.37
	T-C	0.17**	0.11	0.06	0.20***	-0.05	0.02	0.09	0.07
	S.E.	(0.08)	(0.08)	(0.11)	(0.07)	(0.10)	(0.07)	(0.07)	(0.07)
Observations		453	393	330	395	167	214	301	218

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Niger and Togo estimates solely on PASEC 2014 data.^a: only available for PASEC 2014 and Benin 2004-2005, ^b: only available for PASEC 2000, ^c: only available for PASEC 2014.

Table 3.5: Pupils' characteristics according to teacher status

Variables		Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
Female	Mean C	0.50	0.47	0.47	0.43	0.47	0.47	0.53	0.44
	T-C	-0.05***	0.01	-0.03	0.06**	-0.01	-0.06**	-0.01	0.01
	S.E.	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
Age	Mean C	10.67	11.18	9.79	12.24	11.94	12.87	11.71	12.12
	T-C	-0.24**	0.50***	0.38***	-0.24**	0.10	-0.09	0.06	-0.09
	S.E.	(0.10)	(0.09)	(0.12)	(0.11)	(0.19)	(0.11)	(0.09)	(0.09)
Preschool	Mean C	0.23	0.10	0.44	0.13	0.22	0.17	0.30	0.25
	T-C	-0.02	-0.03**	-0.14***	-0.03	-0.03	-0.04	-0.10***	-0.07*
	S.E.	(0.03)	(0.01)	(0.04)	(0.02)	(0.04)	(0.03)	(0.03)	(0.04)
Have ever repeated	Mean C	0.58	0.42	0.59	0.61	0.59	0.38	0.44	0.63
	T-C	-0.05**	0.01	0.02	-0.02	0.05	-0.01	0.04	-0.01
	S.E.	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)	(0.03)	(0.03)
Speaks French at home	Mean C	0.45	0.38	0.43	0.46	0.53	0.51	0.44	0.74
	T-C	-0.10***	0.13***	-0.08*	-0.11**	-0.09	-0.05	-0.04	-0.01
	S.E.	(0.04)	(0.04)	(0.05)	(0.05)	(0.07)	(0.06)	(0.05)	(0.04)
Father reads	Mean C	0.57	0.51	0.82	0.56	0.88	0.50	0.64	0.61
	T-C	-0.02	-0.07***	-0.13***	0.00	-0.03	-0.09*	-0.10***	0.01
	S.E.	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
Mother reads	Mean C	0.27	0.30	0.75	0.28	0.77	0.31	0.38	0.31
	T-C	-0.02	-0.08***	-0.20***	-0.05	-0.04	-0.09**	-0.10***	-0.03
	S.E.	(0.02)	(0.02)	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Parents help for homework	Mean C	0.57	0.43	0.44	0.60	0.65	0.78	0.60	0.98
	T-C	-0.13***	0.16***	-0.07*	-0.07	0.02	0.05	0.01	0.01
	S.E.	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.06)	(0.06)	(0.01)
Books at home	Mean C	0.42	0.58	0.47	0.26	0.45	0.33	0.64	0.57
	T-C	0.01	-0.07	-0.11***	-0.04	-0.13**	-0.03	-0.17***	-0.05
	S.E.	(0.04)	(0.06)	(0.04)	(0.04)	(0.06)	(0.06)	(0.05)	(0.06)
House material	Mean C	1.92	2.22	1.74	1.49	2.21	1.36	2.46	1.75
	T-C	-0.15*	-0.31***	-0.15	-0.32***	0.03	-0.22*	-0.37***	-0.08
	S.E.	(0.08)	(0.05)	(0.11)	(0.11)	(0.15)	(0.13)	(0.11)	(0.12)
Wealth index	Mean C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	T-C	-0.12*	0.10	-0.18*	-0.26***	-0.03	-0.27**	-0.23***	-0.11
	S.E.	(0.06)	(0.08)	(0.09)	(0.08)	(0.13)	(0.13)	(0.08)	(0.10)
Observations		5951	5504	4122	3944	1701	2671	3791	2774

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Niger and Togo estimates solely on PASEC 2014 data. *Parents help for homework*, *Books at home*, and *House material* are missing for respectively, 3,379, 7,321, and 6,525 observations of the final sample, hence the number of observations in the regression is lower than for other variables.

Table 3.6: Classroom-level characteristics according to teacher status

Variables		Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
Has the language guide	Mean C	0.98	0.96	0.76	0.38	0.76	0.82	0.90	0.75
	T-C	0.01	-0.02	-0.06	-0.02	0.03	0.00	0.00	-0.02
	S.E.	(0.01)	(0.02)	(0.05)	(0.06)	(0.07)	(0.06)	(0.03)	(0.06)
Has the mathematics guide	Mean C	0.98	0.90	0.67	0.35	0.85	0.94	0.85	0.85
	T-C	-0.01	-0.09***	-0.10*	0.00	0.06	0.03	0.00	-0.03
	S.E.	(0.02)	(0.03)	(0.06)	(0.06)	(0.06)	(0.03)	(0.04)	(0.05)
Has the language curriculum	Mean C	0.89	0.79	0.97	0.63	0.96	0.70	0.87	0.66
	T-C	-0.09***	-0.02	-0.06**	-0.02	-0.01	-0.09	0.03	-0.02
	S.E.	(0.03)	(0.05)	(0.03)	(0.06)	(0.03)	(0.07)	(0.04)	(0.07)
Has the mathematics curriculum	Mean C	0.88	0.78	0.95	0.57	0.96	0.76	0.85	0.75
	T-C	-0.09***	-0.02	-0.10***	0.02	0.01	-0.08	0.03	-0.03
	S.E.	(0.03)	(0.05)	(0.04)	(0.06)	(0.03)	(0.07)	(0.04)	(0.06)
Pupils per language manual	Mean C	2.20	2.64	3.02	4.78	3.01	3.14	2.57	2.19
	T-C	0.07	-0.25	0.44**	-0.06	-0.46*	0.07	0.06	0.09
	S.E.	(0.09)	(0.17)	(0.22)	(0.20)	(0.27)	(0.27)	(0.22)	(0.23)
Pupils per mathematics manual	Mean C	2.25	3.39	3.88	4.97	3.86	2.81	3.01	1.80
	T-C	0.01	-0.17	0.29	-0.14	-0.64**	0.34	-0.09	0.30
	S.E.	(0.09)	(0.15)	(0.22)	(0.20)	(0.32)	(0.30)	(0.24)	(0.25)
Teaching material index	Mean C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	T-C	-0.44***	0.60***	0.17	-0.29**	0.33**	0.42***	0.06	0.08
	S.E.	(0.09)	(0.12)	(0.12)	(0.13)	(0.14)	(0.14)	(0.10)	(0.12)
Nb. pupils class	Mean C	45.70	69.41	49.57	57.88	40.47	38.76	43.58	31.05
	T-C	-1.30	-8.36***	-3.85	-3.17	-5.86	-6.05**	-10.44***	-2.32
	S.E.	(1.87)	(3.18)	(3.41)	(4.70)	(6.06)	(2.38)	(2.45)	(2.58)
Pupils absent on survey day	Mean C	3.41	1.44	6.73	7.87	6.52	1.92	1.65	1.34
	T-C	-0.59	0.58*	1.02	0.13	-2.14	-0.06	-0.05	0.01
	S.E.	(0.46)	(0.30)	(2.46)	(1.08)	(1.31)	(0.57)	(0.51)	(0.46)
Percentage of pupils absent on survey day	Mean C	0.08	0.02	0.20	0.15	0.12	0.05	0.04	0.04
	T-C	-0.02**	0.02**	0.04	0.01	-0.03	0.01	0.02	0.01
	S.E.	(0.01)	(0.01)	(0.06)	(0.02)	(0.03)	(0.01)	(0.03)	(0.01)
Observations		453	393	330	395	167	214	301	218

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Niger and Togo estimates solely on PASEC 2014 data.

Table 3.7: School characteristics according to teacher status

Variables		Benin	Burkina Faso	Cameroon	Chad	Congo	Niger	Senegal	Togo
Public school	Mean C	0.93	0.99	0.48	0.94	0.86	1.00	0.98	0.92
	T-C	-0.06*	-0.03*	-0.09	-0.40***	0.11**	-0.06**	-0.02	-0.02
	S.E.	(0.03)	(0.02)	(0.06)	(0.04)	(0.05)	(0.03)	(0.02)	(0.05)
Rural school	Mean C	0.66	0.52	0.47	0.41	0.57	0.70	0.53	0.82
	T-C	-0.05	0.26***	0.22***	0.38***	0.25***	0.15**	0.27***	0.05
	S.E.	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)	(0.07)	(0.06)	(0.06)
School infrastructure index	Mean C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	T-C	-0.43***	0.61***	0.22*	-0.25**	0.27*	0.07	0.13	0.11
	S.E.	(0.09)	(0.11)	(0.13)	(0.13)	(0.14)	(0.15)	(0.11)	(0.15)
Nb. pupils school	Mean C	313.91	441.06	421.34	580.92	573.12	396.83	683.94	256.94
	T-C	-16.24*	-42.73*	-22.62	-155.19**	-118.40*	-74.59	-274.41***	4.72
	S.E.	(9.58)	(22.97)	(37.07)	(63.96)	(69.62)	(48.57)	(53.39)	(29.37)
Number of teachers in the school	Mean C	5.83	7.36	8.57	8.44	7.22	9.89	11.82	5.22
	T-C	-0.02	-0.80**	-1.70*	-1.65*	-0.98	-2.24**	-2.86***	0.02
	S.E.	(0.19)	(0.34)	(0.88)	(0.85)	(0.79)	(0.89)	(0.60)	(0.25)
Pupil-teacher ratio school	Mean C	58.64	60.33	52.64	72.36	77.54	40.16	53.34	48.17
	T-C	1.48	-0.39	12.30***	-6.99*	-7.76*	-1.80	-9.05**	1.96
	S.E.	(4.53)	(1.90)	(3.16)	(4.13)	(4.60)	(2.57)	(4.11)	(4.72)
Observations		453	393	330	395	167	214	301	218

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Niger and Togo estimates solely on PASEC 2014 data.

Table 3.8: Estimates for contract teachers

Country		Language test scores				Mathematics test scores			
		OLS	LASSO (2 selec.)	Kernel matching (Maha. dist.)	NN matching (Prop. score)	OLS	LASSO (2 selec.)	Kernel matching (Maha. dist.)	NN matching (Prop. score)
Benin	β	0.12	0.08***	0.13	0.08	0.13*	0.09***	0.16**	0.14**
	S.E.	(0.08)	(0.03)	(0.08)	(0.08)	(0.07)	(0.03)	(0.07)	(0.07)
	Obs	5951	5951	5173	5951	5951	5951	5173	5951
Burkina Faso	β	-0.26***	-0.09***	-0.11	-0.08	-0.32***	-0.19***	-0.18**	-0.10
	S.E.	(0.07)	(0.03)	(0.07)	(0.08)	(0.07)	(0.03)	(0.07)	(0.09)
	Obs	5504	5504	4497	5504	5504	5504	4497	5504
Cameroon	β	-0.10	0.03	0.03	0.04	-0.02	0.02	0.02	0.01
	S.E.	(0.08)	(0.03)	(0.10)	(0.09)	(0.07)	(0.02)	(0.11)	(0.11)
	Obs	4122	4122	3235	4122	4122	4122	3235	4122
Chad	β	-0.04	0.00	-0.05	0.07	-0.04	-0.01	-0.04	0.12
	S.E.	(0.09)	(0.04)	(0.11)	(0.09)	(0.09)	(0.04)	(0.10)	(0.11)
	Obs	3944	3944	2921	3944	3944	3944	2921	3944
Congo	β	-0.14	-0.05	-0.13	-0.03	0.07	0.12***	0.09	0.07
	S.E.	(0.13)	(0.05)	(0.12)	(0.15)	(0.12)	(0.05)	(0.15)	(0.15)
	Obs	1701	1701	1187	1701	1701	1701	1187	1701
Niger	β	-0.06	0.05	0.11	0.06	-0.04	0.01	0.07	-0.01
	S.E.	(0.11)	(0.04)	(0.11)	(0.13)	(0.08)	(0.04)	(0.09)	(0.13)
	Obs	2671	2671	1697	2671	2671	2671	1697	2671
Senegal	β	-0.11	0.02	0.03	0.04	-0.07	0.02	0.07	0.02
	S.E.	(0.08)	(0.03)	(0.09)	(0.09)	(0.08)	(0.03)	(0.08)	(0.08)
	Obs	3791	3791	3249	3791	3791	3791	3249	3791
Togo	β	-0.11	-0.09**	-0.04	-0.09	-0.11	-0.09**	-0.04	-0.11
	S.E.	(0.10)	(0.03)	(0.10)	(0.10)	(0.09)	(0.04)	(0.11)	(0.10)
	Obs	2774	2774	2159	2774	2774	2774	2159	2774
Grade FE	Yes	Yes	Exact match	Exact match	Yes	Yes	Exact match	Exact match	
Year FE	Yes	Yes	Exact match	Exact match	Yes	Yes	Exact match	Exact match	
Covariates	No	DS	All	All	No	DS	All	All	

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors used for nearest neighbor matching. Niger and Togo estimates solely on PASEC 2014 data.

3.A Appendix

Table 3.A.1: Additional estimates for contract teachers

Country		Language test scores				Mathematics test scores			
		Kernel with Maha. dist.		NN with Prop. score		Kernel with Maha. dist.		NN with Prop. score >	
		BW=2.5	BW=3.5	1 neigh.	10 neigh.	BW=2.5	BW=3.5	1 neigh.	10 neigh.
Benin	β	0.12	0.12	0.06	0.08	0.16**	0.16**	0.11	0.13*
	S.E.	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
	Obs	4298	5603	5951	5951	4298	5603	5951	5951
Burkina Faso	β	-0.11	-0.12*	-0.12	-0.08	-0.17**	-0.20***	-0.11	-0.13
	S.E.	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)	(0.09)	(0.08)
	Obs	3502	5019	5504	5504	3502	5019	5504	5504
Cameroon	β	0.05	0.01	0.06	0.05	0.04	0.02	0.01	0.01
	S.E.	(0.10)	(0.09)	(0.09)	(0.09)	(0.12)	(0.10)	(0.10)	(0.11)
	Obs	2385	3730	4122	4122	2385	3730	4122	4122
Chad	β	-0.01	-0.08	0.07	0.07	-0.05	-0.06	0.12	0.10
	S.E.	(0.13)	(0.11)	(0.09)	(0.09)	(0.11)	(0.10)	(0.11)	(0.10)
	Obs	2138	3450	3944	3944	2138	3450	3944	3944
Congo	β	-0.15	-0.13	-0.11	-0.04	0.11	0.06	0.09	0.10
	S.E.	(0.13)	(0.12)	(0.14)	(0.15)	(0.18)	(0.16)	(0.15)	(0.16)
	Obs	787	1462	1701	1701	787	1462	1701	1701
Niger	β	0.12	0.04	0.06	0.05	0.05	-0.01	-0.05	0.00
	S.E.	(0.12)	(0.11)	(0.15)	(0.12)	(0.11)	(0.10)	(0.15)	(0.12)
	Obs	1095	2100	2671	2671	1095	2100	2671	2671
Senegal	β	0.07	-0.01	0.06	0.03	0.09	0.03	0.07	0.02
	S.E.	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.08)	(0.09)	(0.08)
	Obs	2657	3538	3791	3791	2657	3538	3791	3791
Togo	β	0.00	-0.06	-0.10	-0.08	0.02	-0.06	-0.10	-0.10
	S.E.	(0.10)	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)	(0.09)	(0.10)
	Obs	1530	2471	2774	2774	1530	2471	2774	2774

Note: Clustered robust standard error, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Epanechnikov function is used for Kernel matching. Niger and Togo estimates solely on PASEC 2014 data.

Table 3.A.2: Differences in matching variables for Benin

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.50	0.45	-0.05*** (0.02)	-0.10*** (0.03)	-0.01 (0.04)	-0.01 (0.04)
Age	10.67	9.40	-1.27*** (0.21)	-0.50*** (0.08)	-0.03 (0.09)	0.05 (0.09)
Preschool	0.23	0.22	0.00 (0.03)	-0.01 (0.06)	0.00 (0.06)	0.00 (0.06)
Have ever repeated	0.58	0.45	-0.13*** (0.03)	-0.27*** (0.05)	-0.01 (0.06)	0.01 (0.06)
Speaks French at home	0.45	0.27	-0.18*** (0.04)	-0.36*** (0.08)	0.00 (0.09)	-0.03 (0.08)
Father reads	0.57	0.53	-0.03 (0.03)	-0.07 (0.05)	0.00 (0.06)	0.00 (0.06)
Mother reads	0.27	0.25	-0.03 (0.02)	-0.06 (0.05)	0.00 (0.06)	0.00 (0.05)
Wealth index	0.09	-0.36	-0.44*** (0.08)	-0.44*** (0.08)	-0.02 (0.10)	0.02 (0.10)
Teacher has guides/curric	3.73	3.55	-0.17** (0.07)	-0.25** (0.10)	-0.04 (0.09)	-0.02 (0.10)
Pupils per manual	2.18	2.29	0.11 (0.09)	0.11 (0.10)	-0.04 (0.09)	0.02 (0.10)
Teaching material index	0.00	-0.51	-0.51*** (0.09)	-0.51*** (0.09)	-0.01 (0.11)	-0.01 (0.10)
Nb. pupils class	44.48	46.88	2.39 (1.80)	0.13 (0.10)	-0.07 (0.09)	-0.03 (0.10)
School location	2.30	2.47	0.17 (0.11)	0.15 (0.10)	0.04 (0.11)	0.02 (0.11)
School infrastructure index	0.00	-0.51	-0.51*** (0.09)	-0.51*** (0.09)	0.00 (0.11)	-0.01 (0.10)
Nb. pupils school	320.71	300.19	-20.53** (9.75)	-0.18** (0.09)	-0.06 (0.07)	-0.02 (0.09)
Pupil-teacher ratio school	60.13	59.42	-0.71 (4.39)	-0.02 (0.13)	-0.06 (0.08)	0.02 (0.10)
Observations	2659	3292	5951	5951	5173	5951

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.3: Differences in matching variables for Burkina Faso

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.47	0.47	0.01 (0.02)	0.01 (0.03)	0.00 (0.04)	-0.12** (0.05)
Age	11.18	11.26	0.09 (0.22)	0.04 (0.10)	0.00 (0.12)	0.08 (0.12)
Preschool	0.10	0.07	-0.03** (0.01)	-0.10** (0.04)	0.00 (0.03)	-0.02 (0.05)
Have ever repeated	0.42	0.39	-0.02 (0.03)	-0.05 (0.05)	-0.02 (0.07)	-0.01 (0.07)
Speaks French at home	0.38	0.48	0.10** (0.05)	0.20** (0.10)	0.00 (0.12)	0.01 (0.11)
Father reads	0.51	0.44	-0.08*** (0.03)	-0.15*** (0.05)	0.00 (0.05)	-0.01 (0.06)
Mother reads	0.30	0.22	-0.08*** (0.02)	-0.17*** (0.05)	0.00 (0.05)	0.00 (0.06)
Wealth index	0.07	0.16	0.10 (0.09)	0.00 (0.09)	-0.01 (0.11)	-0.06 (0.11)
Teacher has guides/curric	3.42	3.27	-0.15 (0.11)	-0.17 (0.12)	-0.07 (0.12)	-0.08 (0.13)
Pupils per manual	2.88	2.87	0.00 (0.18)	0.00 (0.11)	0.02 (0.14)	0.01 (0.13)
Teaching material index	0.00	0.48	0.48*** (0.12)	0.48*** (0.12)	-0.01 (0.14)	0.00 (0.13)
Nb. pupils class	69.47	62.83	-6.64** (3.12)	-0.22** (0.10)	-0.06 (0.09)	-0.05 (0.11)
School location	2.68	2.23	-0.45*** (0.14)	-0.35*** (0.11)	-0.05 (0.12)	-0.07 (0.12)
School infrastructure index	0.00	0.50	0.50*** (0.12)	0.50*** (0.12)	0.00 (0.13)	0.01 (0.13)
Nb. pupils school	449.21	405.02	-44.19** (22.33)	-0.20** (0.10)	-0.08 (0.10)	-0.07 (0.10)
Pupil-teacher ratio school	60.87	60.18	-0.69 (1.87)	-0.04 (0.10)	-0.03 (0.10)	0.01 (0.13)
Observations	3243	2261	5504	5504	4497	5504

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.4: Differences in matching variables for Cameroon

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.47	0.44	-0.03 (0.02)	-0.06 (0.04)	-0.02 (0.05)	0.01 (0.04)
Age	9.79	10.13	0.34 (0.23)	0.13 (0.09)	-0.01 (0.10)	0.01 (0.10)
Preschool	0.44	0.30	-0.14*** (0.04)	-0.28*** (0.07)	-0.02 (0.09)	0.03 (0.08)
Have ever repeated	0.59	0.61	0.02 (0.03)	0.04 (0.06)	-0.01 (0.08)	0.03 (0.07)
Speaks French at home	0.43	0.34	-0.09* (0.05)	-0.17* (0.10)	0.00 (0.11)	0.00 (0.11)
Father reads	0.82	0.69	-0.13*** (0.03)	-0.34*** (0.08)	0.00 (0.10)	0.04 (0.09)
Mother reads	0.75	0.55	-0.20*** (0.04)	-0.47*** (0.10)	0.00 (0.11)	0.06 (0.10)
Wealth index	0.06	-0.09	-0.15 (0.10)	-0.19* (0.10)	-0.03 (0.11)	-0.01 (0.11)
Teacher has guides/curric	3.39	3.10	-0.28** (0.11)	-0.35** (0.14)	-0.16 (0.12)	-0.07 (0.16)
Pupils per manual	3.31	3.76	0.45** (0.20)	0.28** (0.13)	0.02 (0.13)	-0.05 (0.14)
Teaching material index	0.00	0.16	0.16 (0.12)	0.16 (0.12)	-0.03 (0.12)	-0.02 (0.14)
Nb. pupils class	51.79	48.64	-3.15 (3.54)	-0.11 (0.12)	-0.07 (0.11)	-0.02 (0.13)
School location	2.88	2.38	-0.50*** (0.17)	-0.40*** (0.13)	-0.04 (0.15)	-0.01 (0.14)
School infrastructure index	0.00	0.17	0.17 (0.13)	0.17 (0.13)	-0.03 (0.12)	-0.03 (0.15)
Nb. pupils school	441.43	427.91	-13.51 (40.03)	-0.05 (0.14)	0.04 (0.14)	-0.06 (0.17)
Pupil-teacher ratio school	52.72	66.49	13.77*** (3.38)	0.63*** (0.15)	0.24* (0.13)	0.02 (0.17)
Observations	2456	1666	4122	4122	3235	4122

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.5: Differences in matching variables for Chad

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.43	0.51	0.08*** (0.02)	0.16*** (0.05)	0.01 (0.06)	-0.03 (0.08)
Age	12.24	11.10	-1.14*** (0.22)	-0.50*** (0.10)	0.00 (0.13)	0.01 (0.14)
Preschool	0.13	0.09	-0.04* (0.02)	-0.12* (0.06)	0.00 (0.06)	0.02 (0.06)
Have ever repeated	0.61	0.55	-0.06* (0.03)	-0.12* (0.06)	-0.05 (0.08)	-0.06 (0.08)
Speaks French at home	0.46	0.29	-0.18*** (0.05)	-0.36*** (0.11)	0.00 (0.12)	0.03 (0.12)
Father reads	0.56	0.55	-0.02 (0.03)	-0.04 (0.07)	0.01 (0.07)	0.05 (0.09)
Mother reads	0.28	0.22	-0.05* (0.03)	-0.12* (0.07)	0.01 (0.08)	0.06 (0.07)
Wealth index	0.09	-0.29	-0.38*** (0.09)	-0.41*** (0.09)	-0.02 (0.09)	0.04 (0.11)
Teacher has guides/curric	2.00	1.89	-0.11 (0.19)	-0.08 (0.13)	-0.05 (0.15)	-0.03 (0.20)
Pupils per manual	4.97	4.79	-0.18 (0.18)	-0.13 (0.14)	0.08 (0.15)	-0.03 (0.16)
Teaching material index	0.00	-0.49	-0.49*** (0.13)	-0.49*** (0.13)	-0.04 (0.15)	-0.02 (0.15)
Nb. pupils class	57.64	60.44	2.80 (4.91)	0.07 (0.13)	-0.02 (0.16)	-0.05 (0.21)
School location	3.01	2.26	-0.75*** (0.14)	-0.67*** (0.13)	-0.20 (0.16)	0.02 (0.15)
School infrastructure index	0.00	-0.44	-0.44*** (0.13)	-0.44*** (0.13)	0.01 (0.15)	0.02 (0.15)
Nb. pupils school	585.61	431.97	-153.63** (62.03)	-0.32** (0.13)	-0.05 (0.08)	0.04 (0.12)
Pupil-teacher ratio school	68.31	66.10	-2.21 (3.71)	-0.07 (0.11)	0.02 (0.09)	-0.07 (0.14)
Observations	2747	1197	3944	3944	2921	3944

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.6: Differences in matching variables for Congo

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.47	0.47	-0.01 (0.03)	-0.01 (0.06)	0.01 (0.07)	0.01 (0.07)
Age	11.94	11.48	-0.46 (0.31)	-0.23 (0.15)	-0.08 (0.17)	0.05 (0.17)
Preschool	0.22	0.19	-0.03 (0.04)	-0.08 (0.09)	0.00 (0.10)	-0.08 (0.09)
Have ever repeated	0.59	0.57	-0.02 (0.05)	-0.05 (0.10)	0.01 (0.11)	0.00 (0.11)
Speaks French at home	0.53	0.40	-0.13* (0.07)	-0.25* (0.13)	-0.03 (0.17)	0.01 (0.13)
Father reads	0.88	0.84	-0.05 (0.03)	-0.14 (0.09)	0.00 (0.08)	-0.07 (0.11)
Mother reads	0.77	0.71	-0.06 (0.04)	-0.13 (0.09)	-0.01 (0.11)	-0.03 (0.11)
Wealth index	0.15	0.10	-0.05 (0.13)	-0.21 (0.15)	-0.01 (0.18)	-0.02 (0.17)
Teacher has guides/curric	3.55	3.69	0.14 (0.12)	0.17 (0.15)	0.04 (0.13)	-0.09 (0.17)
Pupils per manual	3.34	2.77	-0.57** (0.26)	-0.33** (0.15)	-0.10 (0.17)	0.00 (0.17)
Teaching material index	0.00	0.39	0.39** (0.16)	0.39** (0.16)	0.05 (0.18)	0.07 (0.19)
Nb. pupils class	42.89	36.80	-6.09 (6.36)	-0.15 (0.16)	-0.01 (0.19)	-0.02 (0.16)
School location	2.63	1.93	-0.69*** (0.21)	-0.52*** (0.16)	-0.06 (0.19)	-0.16 (0.17)
School infrastructure index	0.00	0.31	0.31* (0.17)	0.31* (0.17)	0.03 (0.20)	0.05 (0.19)
Nb. pupils school	600.48	502.98	-97.50 (74.38)	-0.22 (0.17)	0.10 (0.20)	-0.14 (0.17)
Pupil-teacher ratio school	78.21	71.69	-6.52 (5.02)	-0.19 (0.15)	-0.02 (0.14)	-0.07 (0.15)
Observations	718	983	1701	1701	1187	1701

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.7: Differences in matching variables for Niger

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.47	0.43	-0.04* (0.03)	-0.09* (0.05)	-0.02 (0.07)	-0.05 (0.08)
Age	12.87	11.38	-1.50*** (0.19)	-1.19*** (0.15)	-0.08 (0.14)	0.18 (0.31)
Preschool	0.17	0.19	0.02 (0.03)	0.05 (0.09)	0.00 (0.09)	-0.02 (0.12)
Have ever repeated	0.38	0.27	-0.11*** (0.04)	-0.23*** (0.08)	-0.02 (0.12)	0.10 (0.11)
Speaks French at home	0.51	0.36	-0.15** (0.06)	-0.29** (0.12)	0.00 (0.15)	0.06 (0.15)
Father reads	0.50	0.40	-0.09** (0.04)	-0.19** (0.09)	0.00 (0.11)	0.08 (0.12)
Mother reads	0.31	0.23	-0.08** (0.04)	-0.18** (0.08)	0.00 (0.09)	0.06 (0.11)
Wealth index	0.03	-0.17	-0.20* (0.11)	-0.71*** (0.12)	-0.03 (0.14)	0.08 (0.17)
Teacher has guides/curric	3.25	3.14	-0.11 (0.17)	-0.10 (0.15)	-0.04 (0.17)	0.02 (0.18)
Pupils per manual	2.93	3.07	0.14 (0.24)	0.09 (0.15)	0.06 (0.18)	0.07 (0.18)
Teaching material index	0.00	0.88	0.88*** (0.14)	0.88*** (0.14)	0.29* (0.15)	0.02 (0.17)
Nb. pupils class	40.20	38.29	-1.92 (2.15)	-0.13 (0.15)	-0.04 (0.17)	-0.03 (0.20)
School location	2.40	2.06	-0.34** (0.16)	-0.31** (0.14)	-0.03 (0.18)	-0.16 (0.23)
School infrastructure index	0.00	-0.01	-0.01 (0.14)	-0.01 (0.14)	-0.07 (0.15)	0.04 (0.15)
Nb. pupils school	406.29	371.52	-34.77 (42.00)	-0.13 (0.16)	-0.05 (0.19)	-0.05 (0.24)
Pupil-teacher ratio school	41.17	39.02	-2.15 (2.29)	-0.13 (0.14)	0.00 (0.14)	0.04 (0.16)
Observations	1371	1300	2671	2671	1697	2671

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.8: Differences in matching variables for Senegal

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.53	0.51	-0.02 (0.02)	-0.03 (0.04)	0.00 (0.04)	-0.03 (0.05)
Age	11.71	11.56	-0.16 (0.14)	-0.09 (0.09)	0.02 (0.09)	0.02 (0.12)
Preschool	0.30	0.20	-0.10*** (0.03)	-0.22*** (0.06)	-0.01 (0.06)	0.01 (0.06)
Have ever repeated	0.44	0.46	0.02 (0.03)	0.04 (0.06)	0.01 (0.06)	0.00 (0.07)
Speaks French at home	0.44	0.38	-0.06 (0.05)	-0.12 (0.10)	0.00 (0.11)	0.04 (0.12)
Father reads	0.64	0.54	-0.10*** (0.03)	-0.21*** (0.06)	-0.01 (0.06)	0.00 (0.06)
Mother reads	0.38	0.28	-0.10*** (0.03)	-0.21*** (0.05)	-0.01 (0.06)	0.00 (0.06)
Wealth index	0.15	-0.08	-0.23*** (0.08)	-0.32*** (0.09)	-0.05 (0.10)	0.06 (0.11)
Teacher has guides/curric	3.43	3.48	0.05 (0.13)	0.05 (0.13)	0.01 (0.10)	-0.08 (0.20)
Pupils per manual	2.79	2.82	0.03 (0.22)	0.02 (0.13)	0.03 (0.12)	0.05 (0.16)
Teaching material index	0.00	0.06	0.06 (0.12)	0.06 (0.12)	0.00 (0.13)	-0.01 (0.14)
Nb. pupils class	44.00	34.39	-9.61*** (2.45)	-0.45*** (0.12)	-0.15 (0.10)	-0.07 (0.12)
School location	2.63	1.98	-0.65*** (0.14)	-0.56*** (0.12)	-0.16 (0.13)	0.03 (0.15)
School infrastructure index	0.00	0.13	0.13 (0.13)	0.13 (0.13)	0.03 (0.14)	0.05 (0.14)
Nb. pupils school	689.80	428.17	-261.62*** (51.90)	-0.56*** (0.11)	-0.21** (0.10)	-0.02 (0.13)
Pupil-teacher ratio school	52.55	46.23	-6.32 (4.52)	-0.24 (0.17)	-0.16* (0.08)	-0.02 (0.15)
Observations	1713	2078	3791	3791	3249	3791

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Table 3.A.9: Differences in matching variables for Togo

Matching variables	Mean C	Mean T	Before matching		Kernel	Near. neigh.
			Raw diff.	Std. diff.	MD	PSM
Female	0.44	0.45	0.01 (0.02)	0.02 (0.04)	-0.01 (0.05)	-0.01 (0.05)
Age	12.12	11.35	-0.77*** (0.19)	-0.36*** (0.09)	-0.05 (0.09)	0.02 (0.09)
Preschool	0.25	0.19	-0.06* (0.04)	-0.14* (0.08)	0.00 (0.08)	0.00 (0.09)
Have ever repeated	0.63	0.54	-0.09*** (0.03)	-0.18*** (0.07)	-0.03 (0.08)	0.00 (0.07)
Speaks French at home	0.74	0.64	-0.10** (0.04)	-0.22** (0.10)	0.00 (0.12)	0.01 (0.10)
Father reads	0.61	0.59	-0.01 (0.04)	-0.03 (0.09)	0.01 (0.10)	-0.01 (0.08)
Mother reads	0.31	0.26	-0.04 (0.04)	-0.10 (0.08)	0.00 (0.08)	-0.02 (0.08)
Wealth index	0.16	0.04	-0.12 (0.10)	-0.33*** (0.11)	-0.02 (0.11)	0.02 (0.12)
Teacher has guides/curric	2.96	2.91	-0.05 (0.20)	-0.04 (0.16)	-0.03 (0.16)	-0.03 (0.16)
Pupils per manual	2.06	2.17	0.11 (0.23)	0.07 (0.16)	0.03 (0.16)	0.01 (0.16)
Teaching material index	0.00	0.31	0.31** (0.14)	0.31** (0.14)	0.10 (0.14)	0.01 (0.14)
Nb. pupils class	31.51	32.01	0.50 (2.59)	0.03 (0.15)	0.05 (0.12)	-0.02 (0.15)
School location	1.83	1.80	-0.04 (0.17)	-0.04 (0.16)	0.02 (0.14)	0.01 (0.17)
School infrastructure index	0.00	0.11	0.11 (0.15)	0.11 (0.15)	0.01 (0.15)	0.05 (0.15)
Nb. pupils school	270.85	274.78	3.94 (33.73)	0.02 (0.19)	0.03 (0.08)	0.02 (0.19)
Pupil-teacher ratio school	49.83	50.89	1.06 (5.52)	0.05 (0.24)	-0.03 (0.09)	0.02 (0.24)
Observations	1320	1454	2774	2774	2159	2774

Note: Robust standard error clustered at the school-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Matching variables are standardized within each country and each period on pupils of regular teachers to compute the standardized difference and post-matching differences. Epanechnikov function is used for Kernel matching with bandwidth = 3 for Mahalanobis distance, and 5 neighbors are used for nearest neighbor matching. *Pupils per manual* is the average number of pupils per language manual and pupils per mathematics manual, and *Teacher has guides/curric.* is the sum of the first four variables of Table 3 on classroom-level characteristics.

Figure 3.A.1: Differences in characteristics after matching for Benin

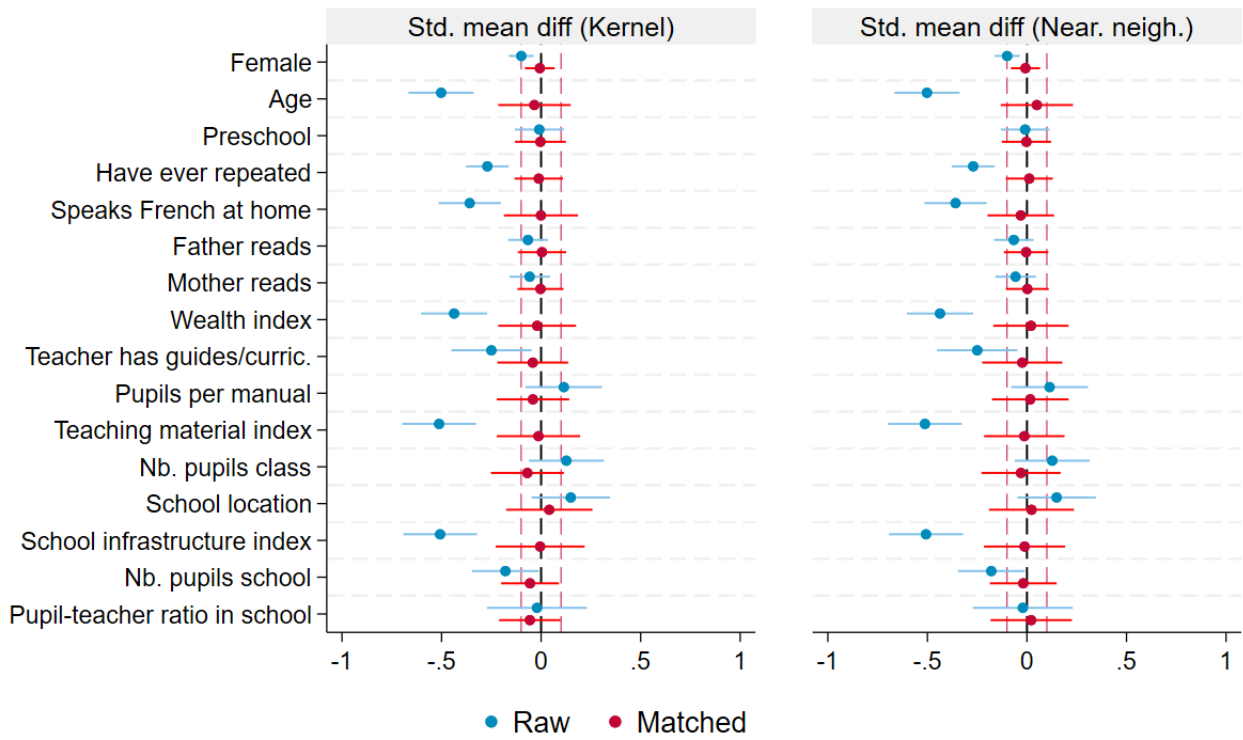


Figure 3.A.2: Differences in characteristics after matching for Burkina Faso

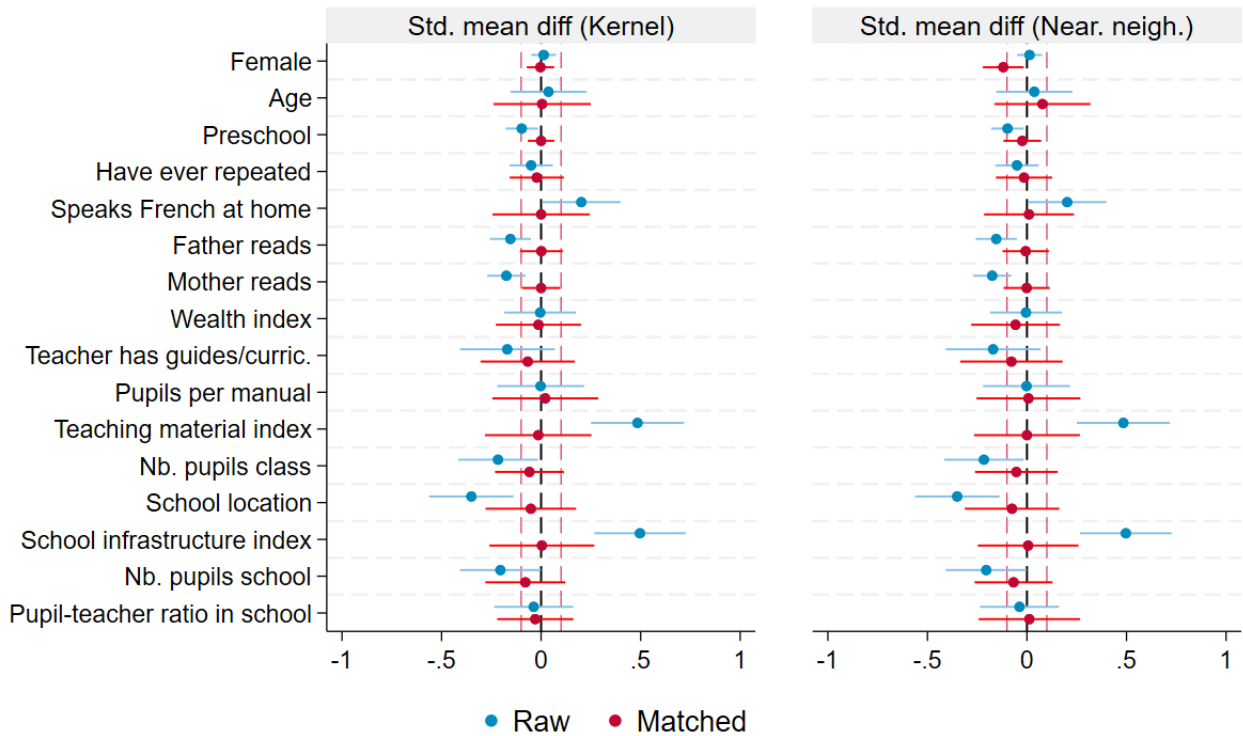


Figure 3.A.3: Differences in characteristics after matching for Cameroon

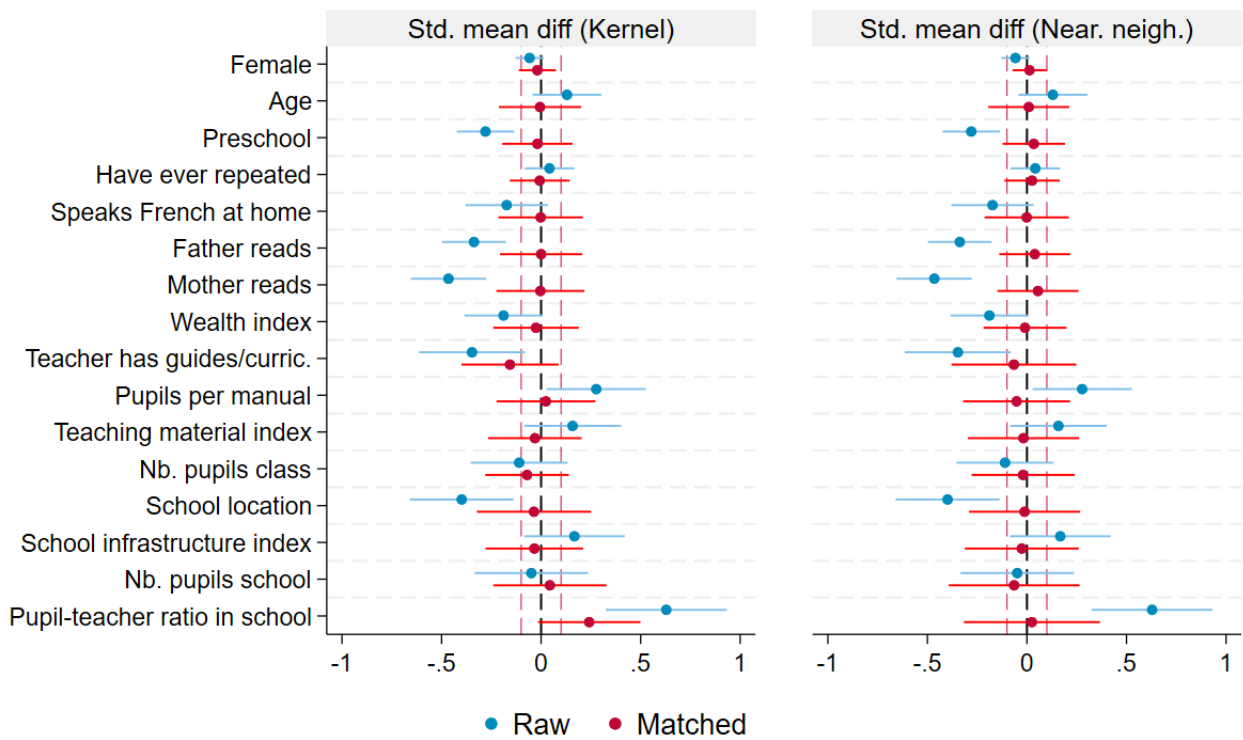


Figure 3.A.4: Differences in characteristics after matching for Chad

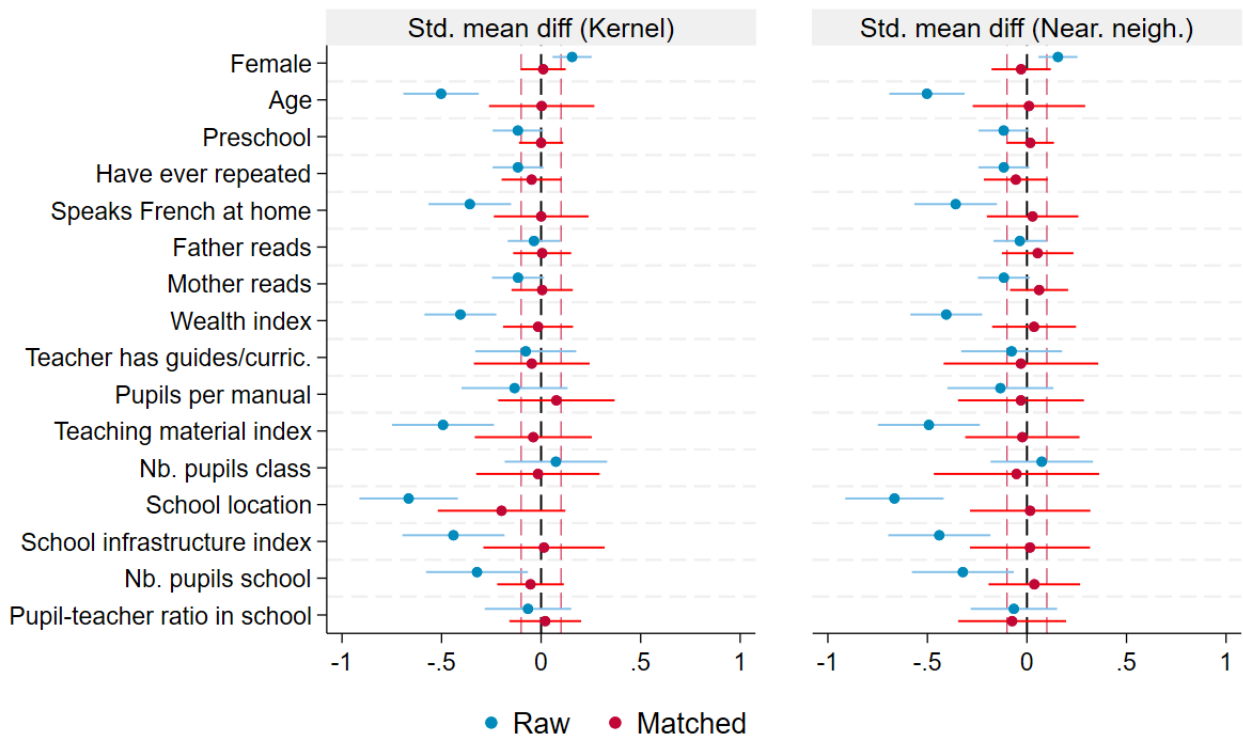


Figure 3.A.5: Differences in characteristics after matching for Congo

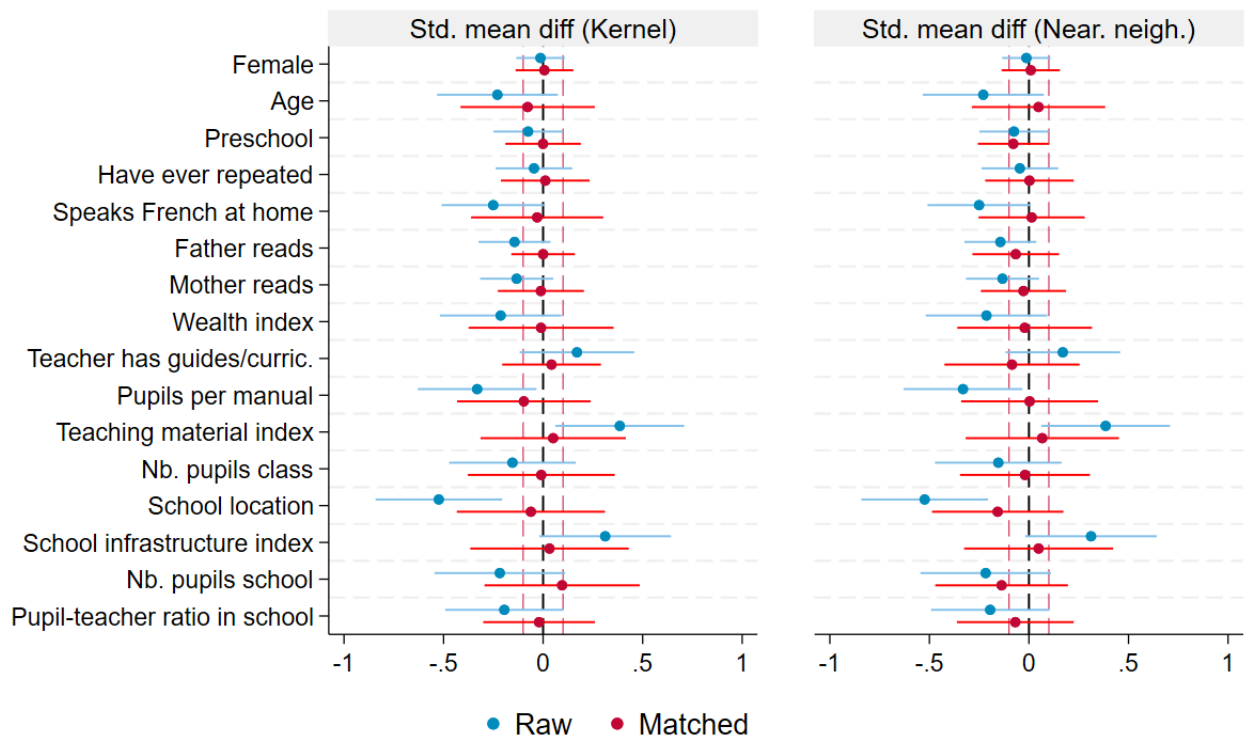


Figure 3.A.6: Differences in characteristics after matching for Niger

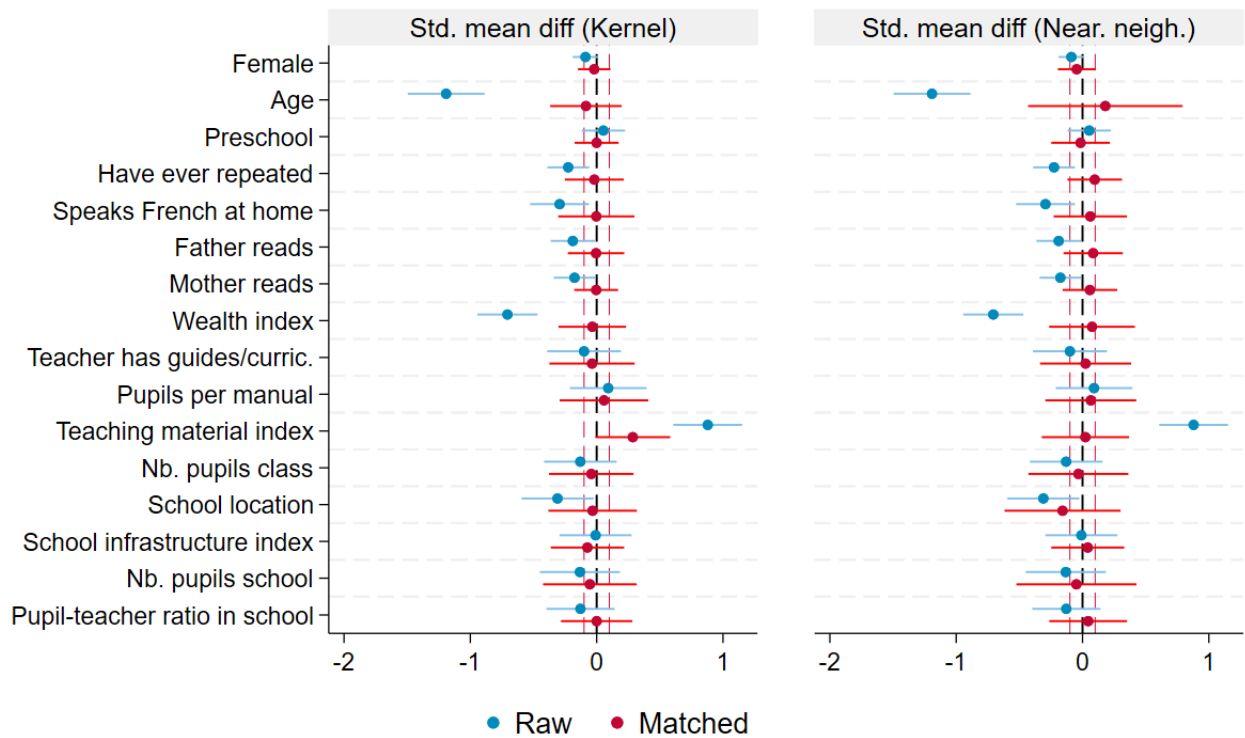


Figure 3.A.7: Differences in characteristics after matching for Senegal

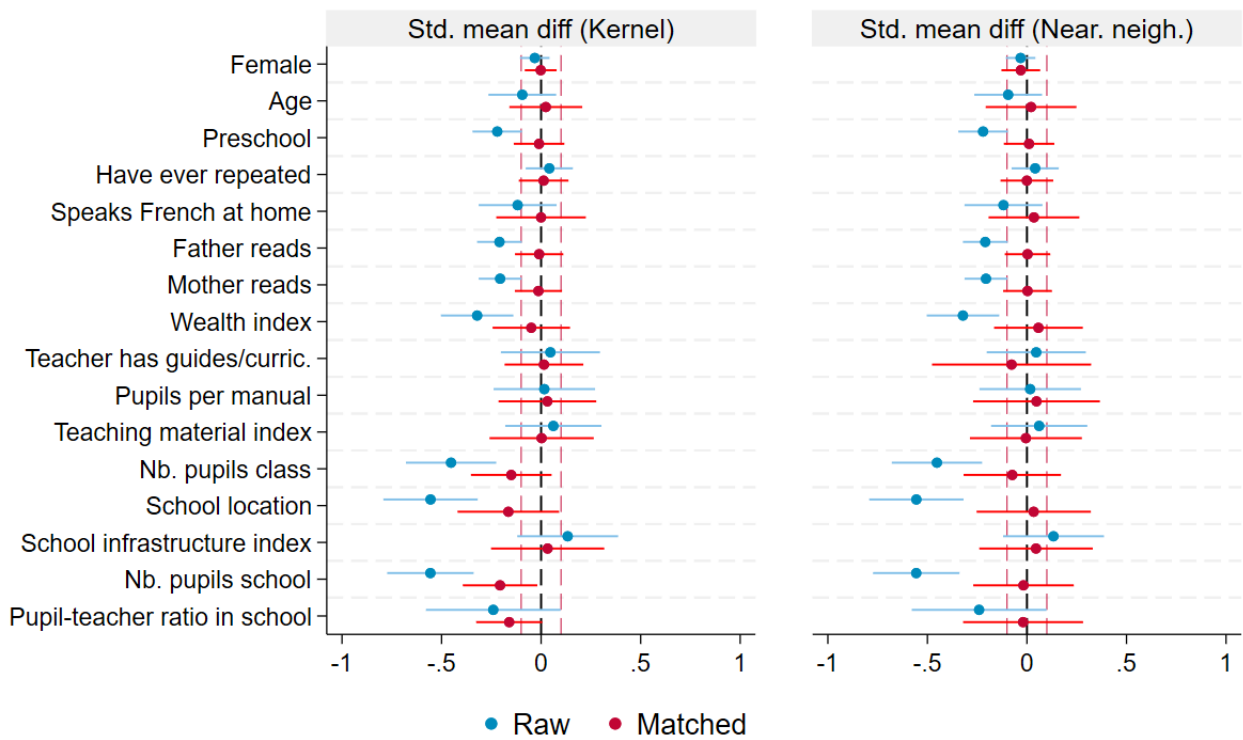
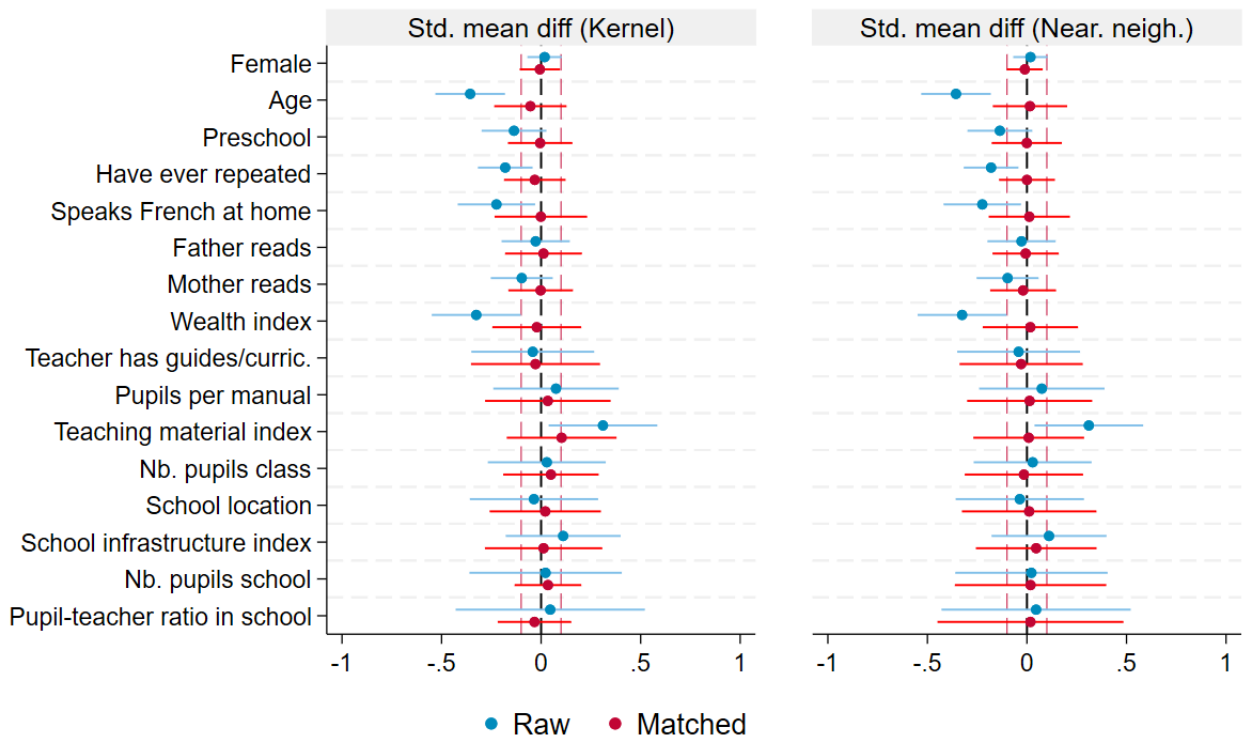


Figure 3.A.8: Differences in characteristics after matching for Togo



General Conclusion

This thesis contributes to the growing body of literature on education quality and student achievement in sub-Saharan Africa. The three empirical studies provide valuable insights into key determinants of student learning, including school management, pedagogical reforms, and teacher employment conditions.

First, the results show that more involved principals are more likely to have received training in management but are less likely to teach than those less involved ones. Principals with higher involvement are also linked to less absent teachers. In addition, the direct involvement of principals—measured through their engagement in tasks such as teacher supervision, parent meetings, and classroom support does not have a statistically significant impact on student learning outcomes. This suggests that simply increasing the administrative involvement of principals may not be sufficient to improve student performance. This has policy implications in terms of training and selection of school principals. Eventually, the study raises important questions about the potential influence of the leadership abilities of school principals, which could play a more important role in school management and deserve further investigation. Considering that principals could have a substantial effect on learning outcomes and that descriptive studies depict them as lacking leadership abilities, changing appointment criteria and giving better training could be a key to enhance learning achievement.

Second, the findings indicate that despite teachers who use competency-based approach being younger and less experienced, the pedagogy have a significant and positive effect on students' performance both in language and mathematics. This suggests that making students more autonomous in their learning process, as well as changing the role of teachers toward a more student-centered approach, is highly effective in improving learning outcomes. This result highlights the potential benefits of pedagogical innovation in teaching practices. However, competency-based approach appears to exacerbate within-classroom inequalities along with improving student outcomes. In addition, the pedagogy increased test scores for almost all

students of the distribution except for low-achieving ones. These results are contradictory to one of the key features of the pedagogy, which aims to help low-achieving students.

Eventually, the last findings reveal that the change in teacher contract is associated with lower experience and that contract teachers teach more often disadvantaged students and students in rural areas than regular teachers, and are paid much less than regular ones. The differences observed in education, training, absences, use of manuals, and curriculum completion vary from one country to another so there is no systematic link between teacher status and their qualification and effort. Finally, students of contract teachers tend to perform similarly to students of regular teachers, which suggests that contract teachers are, on average, as productive as regular teachers. It also shows that the variations in teacher profiles and effort induced by the change in teacher contract did not affect student learning, which means that these characteristics either balance each other out or do not contribute much to the education production function, as already pointed out in the teacher value-added literature.

RÉSUMÉ

Depuis plusieurs décennies, la scolarisation à l'école primaire a beaucoup augmenté en Afrique subsaharienne. Néanmoins, une grande partie des élèves ne maîtrisent pas les savoirs fondamentaux (lire, écrire, compter) à la fin du cycle primaire. Pour améliorer l'apprentissage des élèves, de nombreuses études se sont concentrées sur la qualité des enseignants ou encore la gouvernance de l'école. L'objectif de cette thèse est de faire avancer la compréhension de la qualité de l'éducation et des résultats scolaires à travers trois études distinctes. La première porte sur le rôle des directeurs d'école et leur implication dans la gestion de l'école. Les résultats montrent que l'implication des directeurs d'école n'a pas d'impact sur les résultats scolaires des élèves, et que d'autres caractéristiques, telles que le leadership, pourraient jouer un rôle plus important. Le second chapitre se penche sur les réformes d'approche par compétences qui ont modifié la pédagogie des enseignants dans de nombreux pays d'Afrique francophone. Cette étude montre que l'approche par compétences a un impact positif sur les résultats en français des élèves. Enfin, la dernière étude analyse la relation entre le type de contrat des enseignants et les résultats scolaires. Il apparaît que les enseignants contractuels sont aussi productifs que les enseignants titulaires, et que le type de contrat de l'enseignant n'affecte pas significativement les résultats scolaires des élèves.

MOTS CLÉS

Qualité de l'éducation primaire, Résultats des élèves, Afrique subsaharienne, Gestion de l'école, Pédagogie des enseignants, Contrat des enseignants

ABSTRACT

Over the past decades, primary school enrollment has significantly increased in Sub-Saharan Africa. Nevertheless, a large proportion of students do not master basic skills (reading, writing, arithmetic) by the end of the primary cycle. To improve student learning, numerous studies have focused on teacher quality or school governance. The objective of this thesis is to advance the understanding of education quality and student achievement through three distinct studies. The first focuses on the role of school principals and their involvement in school management. The results show that the involvement of school principals has no impact on student achievement, and that other characteristics, such as leadership, might play a more important role. The second chapter examines the competency-based reforms that have changed teaching practices in many Francophone African countries. This study shows that the competency-based approach has a positive impact on students' language test scores. Finally, the last study analyzes the relationship between teacher contract types and student outcomes. The results suggest that contract teachers are as effective as tenured teachers, and that the type of teacher contract may not significantly impact student outcomes.

KEYWORDS

Primary education quality, Student achievement, Sub-Saharan Africa, School management, Teaching practices, Teacher contract