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# Colonial Origins and Quality of Education Evidence from Cameroon

Yasmine Bekkouche<sup>1</sup> and Yannick Dupraz<sup>2 3</sup>

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## Abstract

We revisit the question of colonial legacies in education by focusing on quality rather than quantity. We study Cameroon, a country where a Francophone education system with French colonial origins coexists with an Anglophone system with British colonial origins. This allows us to investigate the impact of different teaching practices on students' test scores. We find that pupils schooled in the Francophone system perform better in mathematics in Grade 5, with test scores higher by two thirds of a standard deviation. Thanks to detailed school survey data, we are able to account for a wide array of inputs of the education production function, such as the economic and social conditions of students, the material conditions of the schools and classrooms, as well as some information on the teachers' practices and pedagogical culture. We find that Francophone schools have better classroom equipment and that Francophone teachers use more vertical teaching methods, but that these differences cannot explain why Francophone students perform better in mathematics. In the end, we cannot pin down the exact mechanism behind our result.

*Keywords:* Education, School quality, Colonial legacies, Africa.

*JEL Classification:* I25, , I28, N37.

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## 1. Introduction

In many developing countries, contemporary school systems bear the legacies of their colonial origins. On the African continent, the British colonizer devolved educational investments to Christian (mostly Protestant)

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missions, which used mass education as a tool for mass conversion, while the French colonizer hampered missionary efforts without providing mass public education (Gifford and Weiskel, 1971; Woodberry, 2004). As a result, enrollment rates were higher in British colonies during the colonial period (Benavot and Riddle, 1988). Several studies using colonial borders as natural experiments confirm that this difference can indeed be attributed to differences in colonial education policies (Cogneau and Moradi, 2014; Dupraz, 2019). The educational advantage of former British colonies seems to have persisted to this day, though there is important heterogeneity (Brodeur et al., 2020). Grier (1999) argued this could account for differences in economic growth between former French and British colonies, while, more recently, Guarnieri and Rainer (2021) explore the legacies of this history for women empowerment.

The overwhelming majority of research on colonial legacies in education has relied on quantitative measures, like years of schooling, school attendance, or primary enrollment rates. However, as underlined by the 2018 World Bank Development Report, “schooling is not the same as learning”: if enrollment rates have increased a lot in developing countries over the last decades, improvements in student learning has, overall, been disappointing (World Bank, 2018). In fact, in the presence of limited resources, expanding enrollment might come at the cost of student learning, in other words, there might be a trade-off between quantity and quality of education (Bekkouche, 2021). While building schools and hiring teachers has been important for increasing attendance in the developing world, test scores are not very responsive to additional inputs (teachers, textbooks), and improving teaching methods appears crucial for improving students’ learning (Kremer et al., 2013). In this paper, we propose to revisit the question of colonial legacies in education by focusing on quality rather than quantity of education. To do so, we use representative school survey data from Cameroon, a country where a Francophone education system with French colonial origins coexists with an Anglophone system with British colonial origins.

The historical origins of education systems did not only matter for the number of schools built, but also for pedagogical culture and teaching practices. According to Woodberry (2004), the educational virtues of Protestant missions in British colonies were not only quantitative (they taught a large number of children), but also qualitative: missionary education “emphasized critical thinking rather than the rote memorization of classic texts”, and this “influenced the teaching style in later systems” (p. 48). More generally, teaching practices in

colonial school systems seemed to mirror teaching practices in the colonizing country. To describe the differences between teaching practices in France and the United Kingdom (at least before the educational reforms that started in the 1980s), it is useful to use the “horizontal”/“vertical” dichotomy introduced by [Algan et al. \(2013\)](#). The French education system traditionally favored vertical teaching practices, centered around the lecture and the vertical transmission of a predetermined curriculum, while the British education system traditionally favored horizontal teaching practices, with students more often asked to work in group, less emphasis put on the curriculum, and teachers more attentive to the specific needs of each student.<sup>4</sup> This dichotomy appears quite consistently in the research comparing French and British education systems (though the words “horizontal” and “vertical” are not always used). In their qualitative study of teachers’ interviews, [Osborn et al. \(1997\)](#) described French teachers as “focusing on the acquisition of basic skills and academic knowledge by their pupils” and emphasising “the need to treat all children in exactly the same way”, while English teachers were more keen on adapting teaching to the perceived needs of children, putting less emphasis on academic knowledge. According to [Meuret and Duru-Bellat \(2003\)](#), in the 1970s, “the English and French educational systems were considered, and were to some extent as opposite as possible. The English system was devoted to the personal and social development of children while the French was devoted to teaching a strong, academically oriented curriculum.” (p. 463).<sup>5</sup> These differences in teaching style are reflected in more quantitative surveys of teaching practices: [Algan et al. \(2013\)](#), find that Mediterranean countries such as France put more emphasis on vertical teaching while Nordic and English-speaking countries put more emphasis on horizontal teaching.<sup>6</sup> Another difference between French and British teaching practices that does not completely correspond to the vertical/horizontal dichotomy is the greater focus on abstract reasoning rather than applied problems in the French education system ([Cogan and Schmidt, 1999](#); [Klieme and Baumert, 2001](#)). In general, the French teaching culture is characterized by the high value placed by parents and teachers on mathematics achievements ([Fowler and Poetter, 2004](#); [Zeldin, 1983](#)). Perhaps because of the emphasis it puts on the vertical transmission

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<sup>4</sup>The horizontal/vertical dichotomy corresponds approximately to the modern/traditional dichotomy of [Lavy \(2016\)](#).

<sup>5</sup>These differences were attenuated in subsequent decades, when various education reforms made French teaching more sensitive to the needs of each student and English teaching more academically-focused ([Meuret and Duru-Bellat, 2003](#)). However, as formal colonization ended in the 1960s, the pedagogical culture and teaching practices that influenced the education systems of former colonies were the traditional pedagogical culture and teaching practices of the colonizer.

<sup>6</sup>[Algan et al. \(2013\)](#) use the 1999 Civic Education Study (CES) and the 1995 Trends in International Mathematics and Science Study (TIMSS), but the same pattern shows up in the 2003 TIMSS survey, where it also appears that vertical teaching is more prevalent in the Canadian Francophone province of Quebec than in the Anglophone province of Ontario ([Mullis et al., 2004](#)).

of an academic body of knowledge, the French education system has traditionally made heavy use of grade retention (or grade repetition): students are held back in their grade level until they are deemed to master the curriculum. Still today, grade repetition is much more common in France than in other OECD countries (OECD, 2012).

Are these differences between traditional French and British teaching practices found in the education systems of formerly colonized countries on the African continent sixty years after independence? Work on the subject is quite rare, but Nana (2013), in a qualitative study, finds that the differences between the Francophone and Anglophone school systems in Cameroon mirror the differences between the English and French education systems described by Meuret and Duru-Bellat (2003). On grade repetition, Ndaruhutse et al. (2008) find that it is much more common in Francophone than in Anglophone education systems on the African continent, and Dupraz (2019) uses the history of Cameroon to confirm the causal link between high rates of grade repetition and French colonial origins.

If the literature on colonial legacies has focused on the quantity of education and largely ignored students' test scores and teachers' practices, it is not because of lack of interest, but because of lack of data. Nationally representative, internationally comparable, high-quality school surveys exist on the African continent, but they have been undertaken by two different organisations: the SACMEQ (*Southern and Eastern Africa Consortium for Monitoring Educational Quality*), whose member countries are predominantly Anglophone, and the PASEC (*Programme d'Analyse des Systèmes Educatifs de la CONFEMEN*) whose member countries are predominantly Francophone.<sup>7</sup> Because the PASEC and SACMEQ surveys, and in particular test scores, are not directly comparable, it is usually impossible to use these surveys to compare education systems with French and British colonial origins.<sup>8</sup>

In this paper, we study Cameroon, a country divided between France and the United Kingdom during the

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<sup>7</sup>The member countries of SACMEQ are Angola, Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, the Seychelles, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Angola and Mozambique have Portuguese colonial origins. The member countries of the PASEC on the African continent are Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Djibouti, Gabon, Guinea, Madagascar, Mali, Mauritania, Niger, the Central African Republic, the Republic of the Congo, Senegal, Chad, Togo, Mauritius and the Comoros (all former French colonies), as well as the Democratic Republic of the Congo and Burundi (former Belgian colonies). The PASEC also has member countries in Asia: Lebanon, Cambodia, Laos, and Vietnam, all former colonies or protectorates of France.

<sup>8</sup>Recent efforts have been made to harmonize different international learning assessments. The harmonized learning outcome database (Angrist et al., 2021) develops a methodology to combine and make comparable assessments over more than 70 countries, thanks to the use of a conversion method across tests. This database can help to draw insightful comparisons between countries, but does not contain individual level data.

colonial period, before being reunited, and where today a Francophone education system with French colonial origins coexists with an Anglophone education system with British colonial origins. Cameroon is a member of the PASEC and in 2004-2005, the PASEC school survey and standardized test were administered to a representative random sample of Cameroonian schools, both Francophone and Anglophone (the survey and test were translated in English to be administered in Anglophone schools). This allows us to directly compare student performance in primary school in a system with British colonial origins and a system with French colonial origins. The second advantage of studying Cameroon is that the border between the Francophone and Anglophone regions was drawn in an arbitrary fashion, separating regions that were initially very similar in terms of geography, history and culture (Lee and Schultz, 2012; Dupraz, 2019; Guarnieri and Rainer, 2021). This allows us to use border discontinuity analysis to identify the differential impact of French and British colonial legacies on students' performance in primary school. This amounts to comparing the test scores of students living very close to the border between French-speaking and English-speaking Cameroon, on both sides of the border.

We find no differences in languages scores between the two systems. In mathematics, students schooled in the Francophone system do not perform better in Grade 2, but they clearly perform better in Grade 5, with test scores higher by two thirds of a standard deviation. Our border discontinuity estimates are robust to a variety of specifications, bandwidths, and samples. To show that the advantage of Francophone students in mathematics is not explained by the fact that the worst-performing Francophone students are held back in earlier grades, we investigate the sensitivity of our results to the trimming procedure of Lee (2009), excluding the best Anglophone students from the sample.

Cameroon's Francophone and Anglophone education sub-systems are different in many aspects, as are Cameroon's Francophone and Anglophone societies more generally. In the last section of the paper, we try to understand the mechanisms explaining the advantage of Francophone Grade 5 students in mathematics. We take advantage of the wealth of information contained in the 2004-2005 PASEC school survey on the economic and social conditions of students, the material conditions of the schools and classrooms, as well as some information on the teachers' practices and pedagogical culture. We use this information to undertake mediation analysis, following the framework of Imai et al. (2010a) and Imai et al. (2010b). We try to identify the observed variables that were influenced by colonial origins and could explain why students in the Francophone system

perform better in mathematics. We start by showing that the border discontinuity in mathematics test scores is unlikely to be explained by economic and social factors outside of the school system. We then turn to the quantitative inputs of the education production function, like teacher number and pay, school and class equipment. We find that schools in the Francophone system have better class equipment. This is however unlikely to explain the Francophone advantage in mathematics scores, as the quality of class equipment is not correlated with mathematics test scores. Finally, we turn to teaching practice and pedagogical culture. We find that teachers in the Francophone sub-system use more vertical teaching practices and cover a larger portion of the official curriculum, confirming the qualitative observations of [Nana \(2013\)](#). However, mediation analysis reveals that none of the observed mediating variables explains a significant fraction of the Francophone advantage in mathematics. One possible explanation is that the teaching practices that are relevant for students' learning are not captured in the PASEC teacher survey.

This paper contributes to three main strands of the literature. First, it contributes to the literature in development and economic history on colonial legacies in education ([Grier, 1999](#); [Cogneau and Moradi, 2014](#); [Dupraz, 2019](#); [Brodeur et al., 2020](#); [Guarnieri and Rainer, 2021](#)), and in particular expands on the work of [Dupraz \(2019\)](#) who uses different waves of census data to estimate a border discontinuity in education at several points in the 20th century. He finds that a British advantage in years of education emerged after the partition of Cameroon between the two colonizers, but that this advantage quickly disappeared as the French, and then Cameroon's independent government started investing in primary education. He also finds that the Anglophone advantage in years of education re-emerged more recently, pushed by higher dropout rates in secondary school in Francophone Cameroon. [Dupraz \(2019\)](#), like the vast majority of papers in this literature, considers only the quantity of education received, measured by years of schooling or educational attainment. One important contribution of our paper is that we are able to look at the impact of colonial legacies not only on quantity of education, but also on student performance in primary school. Second, our paper contributes to the literature in economics of education and education sciences on the impact of different national educational systems on students' outcomes ([Cogan and Schmidt, 1999](#); [Klieme and Baumert, 2001](#); [Algan et al., 2013](#); [Lavy, 2015](#)). We contribute to this literature by studying a case where two different subsystems co-exist within the same country and where the initial assignment of a region to one sub-system or the other was quasi random. Third, this paper

contributes to a smaller literature on the colonial origins of educational policies and teaching practices on the African continent today (Woodberry, 2004; Ndaruhutse et al., 2008; Nana, 2013; Dupraz, 2019). On this last point, our contribution is more modest: our border discontinuity analysis suggests that the differences in repetition rate and teaching practices observed between Francophone and Anglophone systems in Africa at least partly find their origins in differences in the identity of the colonizer (though we cannot completely exclude the possibility that these differences emerged over time).

The paper is organized as follows. We start by briefly presenting the historical background and institutional setting of Cameroon (section 2), before describing our data (section 3). We then lay out our empirical strategy (section 4). We present our results in section 5, and a few robustness tests in section 6. Section 7 is devoted to mechanisms and mediation analysis. Section 8 concludes.

## 2. Historical background and institutional setting

Following World War I, the German colony of Cameroon was divided between the British and the French (Figure 1). The two parts became mandates of the League of Nations and were *de facto* colonies of France and the United Kingdom — British Cameroon became a part of Nigeria. In both mandates, the colonizers initially built only a handful of public schools and education was mostly provided by private mission schools. However, the two colonizers differed in the way they regulated missionary education: while the British tried to improve the overall quality of the missionary education sector by setting up a system of incentives where schools reaching a certain threshold of quality were subsidized, the French largely turned a blind eye to the missionary sector, recognizing and subsidizing only a tiny percentage of missionary schools (Fonkeng, 2007; Fafunwa, 1974; Dupraz, 2019). These different policies mattered for enrollment rates: Dupraz (2019) finds that children born just after the partition of Cameroon between the British and the French had about one more year of schooling if they were born on the British side of the border. Education policies changed drastically after the Second World War, in the last 15 years of colonization. Both the British and the French increased massively their education expenditure, building public schools and hiring public school teacher (especially in French Cameroon) and increasing subsidies to private missionary schools (especially in British Cameroon). For cohorts born in the 1940s and 1950s, there was no difference any more between the French and British parts



of Cameroon in terms of years of schooling (Dupraz, 2019).

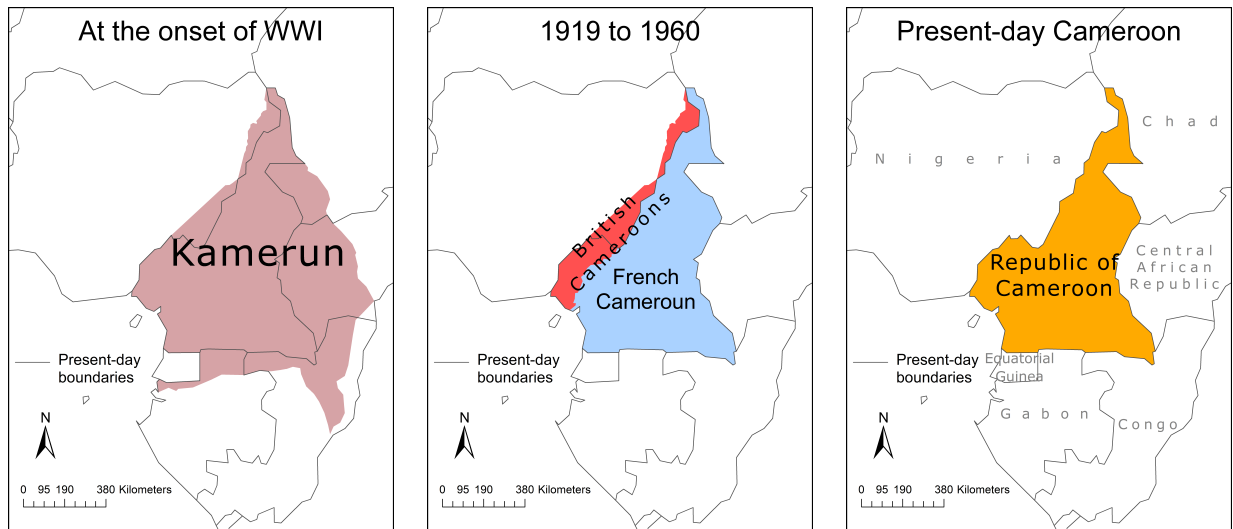


Figure 1: The evolution of Cameroon's boundaries

Sources: Dupraz (2019).

Nigeria and French Cameroon obtained their independence in 1960. In 1961, after a plebiscite, the Southern part of former British Cameroon was reunited with former French Cameroon (see Figure 1). The reunited country was initially a federation, but became a unitary state in 1972. In 1976, the education systems of the former British and French parts were merged, but the existence of two “sub-systems” was recognized, each using a different language of instruction. Since then, primary education policy has been designed at the Ministry of Basic Education in the capital Yaounde (in the Francophone part), with policy documents written in both English and French, and sometimes marginally adapted to each sub-system (Nana, 2013).<sup>9</sup> The duration of the primary cycle in the two sub-systems was harmonized by the law of 1998 (the Anglophone primary cycle was shortened from 7 to 6 years, equaling the duration of the Francophone cycle).<sup>10</sup> Despite these harmonization efforts, each sub-system retains its specificity in evaluation methods and in qualifications.<sup>11</sup> At the end of primary school, Francophone students take the CEP (*Certificat d'Etudes Primaires*), while Anglophone students take the FSLC (First School-Leaving Certificate).<sup>12</sup> Teacher training is the responsibility of the central Ministry of Basic

<sup>9</sup>As explained by Nana (2013) p.479: “Policy and other important educational decisions are taken at the Ministry and are written in English and French. They are generally the same for both sub-systems, although there may be some peculiarities for each of them.”

<sup>10</sup>Law 98/004 of April 14th 1998, article 16. The law was implemented in 2000. All children who entered primary school in 2000 or after followed a 6-year cycle. Our data is from 2004-2005, hence Grade 2 students who did not repeat a grade entered school in 2003-2004 and Grade 5 students who did not repeat a grade entered school in 2000-2001, the first year of implementation of the new cycle duration.

<sup>11</sup>Law 98/004 of April 14th 1998, article 15.

<sup>12</sup>These two exams are conferred centrally by the Ministry of Basic Education in Yaounde. It is not the case for the end-of-secondary exams:

Education, but there are two distinct networks of 3-year teacher training colleges, one Anglophone and one Francophone.<sup>13</sup> Though Cameroon's education system is very centralized on paper, the decentralized nature of policy implementations contributes to each sub-system retaining its peculiarities.<sup>14</sup> The Anglophone specificity in education is a contentious issue in Cameroon. Anglophone Cameroonians are particularly worried that the central government is trying to impose French in the educational and legal systems of West Cameroon. Protests of teachers and barristers began in October 2016 and have since turned into a violent conflict. Some West Cameroonians are now demanding independence.<sup>15</sup>

The two sub-systems are not purely geography based: in 2003, 5% of schools in West (former British) Cameroon belonged to the Francophone system and 4% of schools in East (former French) Cameroon belonged to the Anglophone system. These schools are mostly located in urban areas and allow migrants from one part of Cameroon to the other to continue educating their children in the same language. There are also in Cameroon a number of "bilingual" schools with reinforced language classes in the other official language, but each school belongs to one system or the other. In contrast to many former British colonies with a legacy of missionary education, local languages are not used in the primary education system of Anglophone Cameroon, except in a handful of experimental schools not in our sample (Laitin et al., 2019).

Both sub-systems have public and private schools. About 20% of Francophone primary school students attend a private schools, versus 28% of Anglophone students.<sup>16</sup> School fees were abolished in the public sector in 2000. The gross primary enrollment rate was slightly above 100% in 2000-2001, with no major difference between the two sub-systems in the South of the country.<sup>17</sup>

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the Francophone *Baccalauréat* is conferred by the *Office du Baccalauréat* based in Yaounde, while the General Certificate of Education Ordinary and Advanced Levels is conferred by the GCE Board based in Buea. Both the *Office du Baccalauréat* and the GCE Board are independent structures from the Ministry of Secondary Education (Nana, 2013).

<sup>13</sup>Teacher training colleges are called ENIEG (*Ecoles Normales d'Instituteurs pour l'Enseignement Général*) for general teaching and ENIET (*Ecoles Normales d'instituteurs pour l'Enseignement Technique*) for vocational teaching.

<sup>14</sup>As explained by Nana (2013) p. 479: "Policy documents are channelled to Francophone and Anglophone schools through regional, divisional, sub divisional and district delegations. Education delegations at the various levels serve as relay institutions for the channelling of these measures from the Ministry to the classrooms, although they may often decide on local educational issues unrelated to the measures or of lesser policy relevance."

<sup>15</sup>The Economist (9 Nov. 2019). "How to stop Cameroon collapsing into a full-fledged civil war?" Retrieved from [www.economist.com](http://www.economist.com).

<sup>16</sup>These figures come from the 2004/2005 PASEC survey, which is nationally representative. According to Cameroon Government et al. (2003), 23% of primary school students were attending the private sector in 2002/2003, but the report does not give the breakdown by sub-system.

<sup>17</sup>Using 2005 census data, we find very similar primary school attendance rates in Anglophone and Francophone Cameroon within 100 km of the border between the two regions. In the generation born between September 1996 and August 1997 (of Grade 2 age in 2004-2005), the school attendance rate is 88% on the Anglophone side and 89% on the Francophone side (excluding Douala). In the generation born between September 1993 and August 1994 (of grade 5 age in 2004-2005), the school attendance rate is 86% on the Anglophone side and 88% on the Francophone side (excluding Douala). Attendance rates are lower in the North of the country.

How different is the content of primary education in the two sub-systems? Official curricula are determined centrally: each sub-system devotes the same number of hours to each subject. For each subject, the syllabus is comparable, though the English version is not a word for word translation of the French. In Table [Appendix B.1](#), we map each skill taught in the Francophone Grade 2 mathematics syllabus to its equivalent in the Anglophone syllabus (Table [Appendix B.2](#) does the same for Grade 5). Overall, most topics covered by the Francophone syllabus find an equivalent in the Anglophone syllabus and vice versa, but there are exceptions: two topics are taught exclusively in the Anglophone syllabus (“Graphs and statistics” in Grades 2 and 5 and “Sets and Logic” in Grade 5), while the Francophone syllabus is more thorough in geometry in Grade 5.<sup>18</sup> When building test scores for each student below, we are very careful to only consider questions covering topics and skills explicitly taught in both sub-systems.

### 3. Data

We use the 2004-2005 school survey data from the *Programme d'Analyse des Systèmes Educatifs de la CONFEMEN* (PASEC), administered in 13 countries of Francophone West Africa. The PASEC dataset comprises a stratified random sample of schools in French and English-speaking Cameroon.<sup>19</sup> In sample schools, one class of Grade 2 and one class of Grade 5 were randomly selected.<sup>20</sup> 15 students were then randomly drawn from each class to be interviewed and tested.

*Student test scores and characteristics.* PASEC tests aim at assessing proficiency in language and mathematics through a series of multiple choice questions. These tests were designed to allow for system and time comparisons. They are not specific to the curriculum of any given country. They were administered to students in identical conditions, and the marking was centralized. It is of utmost importance for us that tests administered in Anglophone and Francophone schools measure learning outcomes in the same way. Because PASEC is a Francophone organization, the test questions were originally designed in French and had to be translated for the

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<sup>18</sup>We do not compare the skills taught in the English and French syllabuses, because the two languages have different grammars and involve different skills and learning processes. For example, the skill “use of modals in an affirmative sentence” is very specific to the English language, while the skill “feminine plural agreement of qualifying adjectives” (“*l'accord féminin/pluriel des adjectifs qualificatifs*”) is very specific to the French language. Hence it does not make sense to compare those specific skills between languages. Instead, we focus on general writing and reading skills.

<sup>19</sup>All regions are represented as well as public and private schools since the strata were chosen according to those two dimensions.

<sup>20</sup>Grades 2 and 5 are in the beginning and end of the 6-year primary cycle, without being extreme grades with special characteristics. 5 schools out of the 172 in the sample do not have a Grade 5 class, 2 in the Anglophone part and 3 in the Francophone part.

Anglophone sub-system. To ensure comparability of learning outcomes, we meticulously compared the English and French versions of every question — Figures [Appendix A.1](#) and [Appendix A.2](#) show a comparison of the same question in the English and French-speaking Grade 5 test in language and mathematics. We constructed a new standardized test score for each student, excluding 1) questions present in the French and not in the English test, 2) questions for which the English version was slightly different from the French version, and 3) questions on topics not explicitly covered in both syllabuses.<sup>21</sup> Our results are robust to using the PASEC test scores directly without removing any question, as shown in Tables [Appendix B.9](#).

In each subject (mathematics and language) and each Grade, students were tested twice: at the beginning of the school-year (pre-test) and at the end (post-test). To reduce noise and boost statistical power, we computed for each student the average of the start-of-year and end-of-year scores, in the spirit of [McKenzie \(2012\)](#).<sup>22</sup> For ease of interpretation, we transformed all test scores into z-scores with unit variance and zero mean.

The survey also contains socioeconomic characteristics of the pupils, including the literacy of their parents, and questions about the assets present in their household, that we used to construct a wealth index by principal component analysis.<sup>23</sup> The bottom panel of Table [Appendix B.4](#) shows summary statistics for all student-level variables in Grades 2 and 5.

*Class and teacher characteristics.* The PASEC survey also provides information on class and teacher characteristics. Information on the class includes the number of students, as well as information on the material of the classroom, the proportion of pupils seated comfortably, and the presence of different items of equipment (board, chalk, ruler, map, etc.) that we used to build an index of classroom equipment by principal component analysis.<sup>24</sup>

Teachers were asked about their education, experience, and salary. Their absenteeism was measured using

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<sup>21</sup>This did not affect the Grade 2 language tests, nor the Grade 2 mathematics post-test. We removed 3 questions out of 15 in the Grade 2 mathematics pre-test. We removed 3 questions out of 16 in the Grade 5 language pre-test, and 3 questions out of 12 in the Grade 5 language post-test. We kept all questions in the Grade 5 mathematics pre-test, and removed 2 questions out of 13 in the Grade 5 mathematics post-test.

<sup>22</sup>There was moderate attrition between the start-of-year and end-of-year tests. In Grade 2, 3.5% of Anglophone and 3.7% of Francophone pupils attended the start-of-year test but not the end-of-year test. In Grade 5, 4.7% of Anglophone and 2.5% of Francophone pupils attended the start-of-year test but not the end-of-year test. For reasons we ignore, the detailed breakdown of start-of-year test scores by question is not available for students who were absent for the end-of-year test, even though they took the start-of-year test. Gender information is also missing for these students. Attrition is unlikely to be an issue because (i) rates are very low and similar in the two sub-systems, (ii) we obtain results very similar to our main estimates when focusing on PASEC raw start-of-year test scores (Table [Appendix B.10](#)).

<sup>23</sup>Table [Appendix B.3](#) lists the asset variables used.

<sup>24</sup>Table [Appendix B.3](#) lists the variables used.

records held by the principal of the school. Teachers were also asked their degree of agreement with sentences describing pedagogical practices, such as “When the topic is new, it is impossible to let the pupils learn in groups” or “Time devoted to lazy pupils delays the progression of lessons.” We used the questions of the teacher module to build two indices by principal component analysis: an index of the intensity of textbook use, and an index of the teacher’s use of vertical teaching methods.<sup>25</sup> The middle panel of Table [Appendix B.4](#) shows summary statistics for all class and teacher-level variables in Grades 2 and 5.

*School and locality characteristics.* Finally, the PASEC survey interviewed school principals to provide information on school management (parent’s associations, frequency of staff meetings, of inspections, etc.), as well as school equipment (presence of a library, of a canteen, etc.) and the infrastructure present in the locality of the school (road, electricity, telephone, etc.). We used principal component analysis to build a school equipment index, a quality of school management index, and an infrastructure index for the locality of the school.<sup>26</sup>

We geolocated schools in the 2004-2005 survey from the name of the town in which each school was located. Figure 2 displays the geographical distribution of schools. They are densely distributed close to the border between the Francophone and Anglophone parts.

In addition to latitude, longitude, and distance to the border, we computed various geographical variables for the location of each school: distance to the coast, to the closest main river, to the capital Yaounde and the economic capital Douala, average temperature and precipitation, elevation, ruggedness, a malaria stability index, agricultural suitability, and light density at night.<sup>27</sup> We also overlaid the map of schools over Murdock’s map of African ethnic groups ([Murdock, 1959](#)) to join each location with variables coming from the Ethnographic Atlas ([Murdock, 1967](#); [Gray, 1999](#)): dependence on agriculture, mean size of local community, and

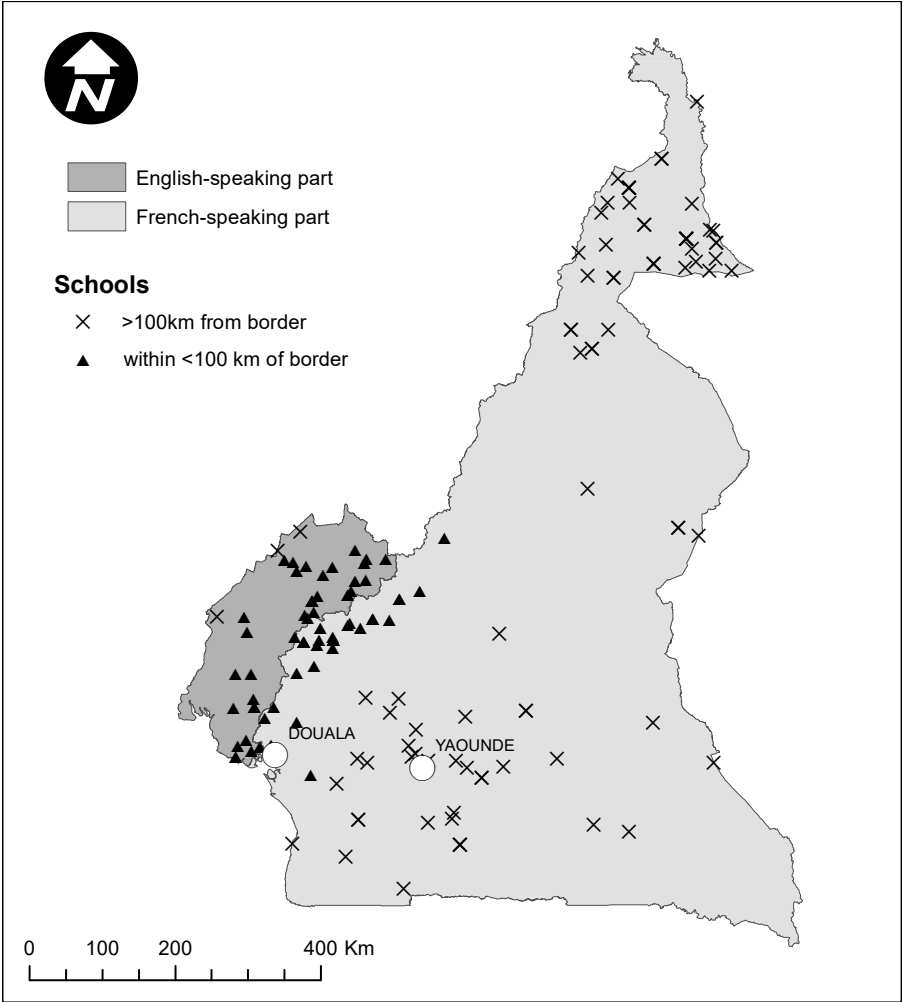
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<sup>25</sup>Table [Appendix B.3](#) lists the variables used for each index.

<sup>26</sup>Table [Appendix B.3](#) lists the variables used for each index. For the school quality of school management index, we chose the second component of the PCA as the index and not the first, because the variables used contributed to the second component in the expected directions, but did not contribute to the first component in the expected directions.

<sup>27</sup>Data on the location of rivers come from [www.naturalearthdata.com/downloads/10m-physical-vectors/](http://www.naturalearthdata.com/downloads/10m-physical-vectors/). Temperature and precipitation data is from WorldClim, which provides gridded data on average temperature and precipitation over 1950-2000: <http://worldclim.org>. Elevation is from NASA Shuttle Radar Topography Mission: <http://srtm.csi.cgiar.org>. Ruggedness is computed from elevation using the slope tool in ArcGIS. The malaria stability index comes from [Kiszweski et al. \(2004\)](#) and can be downloaded on <https://sites.google.com/site/gordoncmccord/datasets>. The stability of malaria transmission is the prevalence pattern of the disease. In regions with very stable transmission, there is little variations in transmission from year to year. In regions with unstable transmission, there is large variation. Agricultural suitability is suitability for rainfed crops excluding forest ecosystems, from Global Agro-Ecological Zones: <http://webarchive.iiasa.ac.at/Research/LUC/GAEZ/index.htm>. The index goes from 0 (low suitability) to 11 (high suitability). Light density at night in 2004 is from Version 4 DMS-OLS Nighttime Lights Time Series: <https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html>. For all these geographical variables, we average the raster data over 10 × 10 km cells and attribute a location the value of the cell it falls in.

Figure 2: Sampled schools in 2004-2005



political centralization. Finally, we constructed a variable for the presence of a school in 1911 within 5 km of the present-day school location using data from [Schlunk \(1914\)](#) digitized by [Dupraz \(2019\)](#). The top panel of Table [Appendix B.4](#) shows summary statistics for all school and locality variables.

#### 4. Empirical strategy

To identify the comparative effect of different colonial origins on student test scores, we use a discontinuity analysis at the historical border between the Anglophone and the Francophone parts. Our empirical strategy relies on the fact that the precise delineation of the border was arbitrary, so that whether a village or a town fell on one side of the border or the other was quasi-random. [Lee and Schultz \(2012\)](#) and [Dupraz \(2019\)](#) discuss extensively the arbitrary nature of the historical border, which cut across ethnic groups and geographical zones.<sup>28</sup>

The arbitrary nature of the colonial border allows us to identify the overall effect of having been colonized by the British or the French on student test scores today. Identifying the precise mechanisms explaining why colonial origins matter is more challenging. Though the persistence of different colonial pedagogical practices within each sub-system is a likely mechanism to explain differences between the two sub-systems today, it is not the only one. Colonization mattered for many dimensions of social, cultural, and economic life that could influence student test scores. In section 7 below, we discuss the different possible mechanisms and use mediation analysis to try to disentangle them.

For our identification strategy to be valid, the forcing variable, place of birth, should determine whether children attend the Francophone or the Anglophone sub-system of education. Selective migration across the border is therefore a concern. Because Cameroon is a majority French-speaking country, there may be additional returns to being educated in French, and one might conceive that families with high expectations for their children send them to be educated in Francophone Cameroon. Anecdotal evidence also points at Francophone students being sent to be educated in Anglophone Cameroon to learn English, an international language. We use a representative 10% extract of the 2005 population census of Cameroon to show that cross-border migration of

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<sup>28</sup>[Dupraz \(2019\)](#) notes that, in the northern part, the border seems to have respected the boundaries between ethnic groups, which is why we show the robustness of our results to excluding the northern part of our sample (the North-West, Ouest, and Adamaoua regions, to focus on the South-West and Littoral region).

school-age children is a negligible phenomenon.<sup>29</sup> Table Appendix B.5 shows that, within 100 km of the border, only 1.43% of school-age (6-12) children living in Francophone Cameroon in 2005 were born in Anglophone Cameroon, and only 2.03% of children living in Anglophone Cameroon were born in Francophone Cameroon.<sup>30</sup>

We identify the effect of the colonial origins of an education system by using discontinuity analysis, estimating the following equation on a sample of schools located close to the border:

$$score_{is} = \alpha + \beta WEST_s + f(\text{geographic location}_s) + \delta g_i + Z'_s \gamma + \epsilon_{is} \quad (1)$$

Where  $score_{is}$  is the (normalized) test score of individual  $i$  in school  $s$ ,  $WEST_s$  is a binary variable equal to one if the school is located in West Cameroon (the Anglophone part),  $f(\text{geographic location}_s)$  is a function of the geographic location of the school,  $g_i$  is a binary for the gender of individual  $i$ ,  $Z_s$  is a vector of geographic characteristics of the school's location (temperature, precipitation, elevation, slope, malaria stability index, and agricultural suitability).  $\beta$  estimates the border discontinuity, that is the effect of colonial origins on test scores today — since we defined the treatment variable as belonging to Anglophone Cameroon, positive coefficients indicate that students in Anglophone Cameroon are faring better, while negative coefficients indicate that students in Francophone Cameroon are faring better. To control for geographic location, we use a local linear non-parametric function of distance to the border, with a triangular kernel and mean squared error (MSE) bandwidth (Cattaneo et al., 2020).<sup>31</sup> We show the robustness of our results to varying the bandwidth (Figure Appendix A.5) and to controlling for geographic location with a polynomial in latitude and longitude like Dell (2010) (Table Appendix B.7). We cluster standard errors at the school level; we also show standard errors clustered by a larger geographical unit (the *préfecture*)<sup>32</sup>, and the robust non-parametric confidence interval proposed by Calonico et al. (2014).

We estimate equation (1) separately for each subject (mathematics and language), and for each Grade (2

<sup>29</sup>The source for the census data is the Integrated Public Use Microdata Series: <https://international.ipums.org/international/>

<sup>30</sup>Even assuming that Anglophone migrants to the Francophone part have average test scores one standard deviations above the mean, and that Francophone migrants to the Anglophone part have test scores one standard deviations below the mean, selective migration would explain a difference of only  $0.0143 + 0.0203 = 0.0346$  standard deviations.

<sup>31</sup>We use the package `rdrobust` in Stata (Calonico et al., 2018). Gelman and Imbens (2019) warn against high order polynomial in RDD. Pei et al. (2022) propose a method to compare the MSE of linear versus quadratic non-parametric estimations. Their Stata package `rdmse_cct2014` does not allow us to replicate exactly our specification with controls and weights, but in a simpler specification we obtain a smaller MSE with the linear non-parametric specification for all outcomes. In Table Appendix B.7, we show the robustness of our results to using a local quadratic non-parametric function of distance to the border.

<sup>32</sup>There are 57 *préfectures* in our sample, 25 within 100 km of the border, with an average number of 3 sampled schools by *préfecture*.



and 5). We weight each observation by its probability sampling weight.<sup>33</sup> We exclude from the sample schools located in Douala, the largest city and economic capital of Cameroon (see Figure 2).<sup>34</sup>

Geographic location strongly predicts, but does not perfectly determines school system. Indeed, in our sample, five schools of the Anglophone system are located in East (Francophone) Cameroon. Three of them are located in Douala, which is in any case excluded from our main sample. Though in principle we could do fuzzy RD and use geographic location as an instrument for school system, for simplicity we do sharp RD, which means estimated border discontinuities need to be interpreted as an intent-to-treat (ITT).

Tables 1 shows balance tests for the control variables of equation (1): gender and the geographic characteristics of the school location. The first two columns present averages on the Anglophone and Francophone sides within 100-km of the border.<sup>35</sup> The third column presents differences, and the fourth column presents discontinuities — we estimate equation (1) replacing the left-hand side variable by the balance test variable (and without controlling for the other balance test variables). All variables are balanced, except for ruggedness, higher on the Anglophone side of the border.<sup>36</sup> In Table Appendix B.6, we regress Grade 2 and Grade 5 mathematics scores on gender and geographical characteristics, in the whole sample and in the sample of schools located within 100 km of the border. The coefficient on ruggedness is always small and never statistically significant at conventional levels. Additionally, our main estimates control for geographic characteristics (including ruggedness), and we show that the addition of these controls does not attenuate estimated discontinuities (Table 4).

Table 2 displays additional balance tests for pre-partition historical characteristics of the school location. Such historical variables are hard to find, because the German colonial administration produced almost no spatially disaggregated statistics for German Kamerun. We use two sources: a database of German schools in 1911 compiled by Schlunk (1914) and digitized by Dupraz (2019), allowing us to construct a binary variable

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<sup>33</sup>These weights make the sample representative of schools in Cameroon. The PASEC documentation gives the probability for a school to be sampled in each of 4 regions (Grand Nord, Grand Sud, Grand Ouest, and Anglophone Cameroon). We built weights as the inverse of this sampling probability. In each school, 15 students are sampled at random in Grade 2, and 15 in Grade 5. As schools have different populations, the probability for a student to be sampled differs by school. Unfortunately, PASEC documentation does not provide the information necessary to build weights making the sample representative of students in Cameroon. This is however a minor issue, since the school, not the student, is the unit of treatment and of clustering. Table Appendix B.8 shows that unweighted results are very similar to weighted results.

<sup>34</sup>Our results are robust to the inclusion of Douala as shown in Tables Appendix B.7.

<sup>35</sup>We chose 100 km because it is a round number close to the optimal MSE bandwidth in most specifications.

<sup>36</sup>Figure Appendix A.3 gives a visual representation of the discontinuities in geographic characteristics.

Table 1: Balance test on gender and geographic characteristics

	(1)	(2)	(3)	(4)
	Average within <100km of the border			Border discontinuity
	Anglophone	Francophone	Difference	
<b>GENDER</b>				
<b>Student is a girl</b>	0.49	0.47	0.02 (0.02)	-0.06 (0.04) [-0.18, 0.01]
Bandwidth (km)				92
Observations (effective)	1,077	883	1,960	1,960
<b>GEOGRAPHIC CHARACTERISTICS</b>				
<b>Temperature (° celsius)</b>	21.86	22.40	-0.55 (0.68)	-1.55 (1.42) [-4.70, 2.06]
Bandwidth (km)				101
Observations (effective)	39	32	71	72
<b>Precipitations (mm)</b>	195.16	178.95	16.21* (9.53)	-8.81 (20.49) [-63.81, 28.42]
Bandwidth (km)				89
Observations (effective)	39	32	71	71
<b>Elevation (m)</b>	1024.93	972.92	52.00 (137.60)	360.18 (327.54) [-353.67, 1235.80]
Bandwidth (km)				80
Observations (effective)	39	32	71	70
<b>Ruggedness</b>	8.67	5.29	3.38*** (0.68)	3.54*** (1.36) [0.70, 8.08]
Bandwidth (km)				102
Observations (effective)	39	32	71	73
<b>Malaria stability</b>	9.98	9.83	0.15 (1.55)	-4.30 (3.05) [-11.68, 2.15]
Bandwidth (km)				89
Observations (effective)	39	32	71	71
<b>Agricultural suitability</b>	6.19	5.46	0.73** (0.34)	-0.88 (1.06) [-3.74, 1.08]
Bandwidth (km)				59
Observations (effective)	39	32	71	63

**Notes:** The first two columns present the average of the variables over school locations on the two sides of the border, within 100 km of the border. The third column presents the difference. The fourth column presents the border discontinuity (a positive coefficient favors the Anglophone side), estimated using a local linear non-parametric function of distance to the border, with a triangular kernel and MSE optimal bandwidth. Observations are weighted by their probability sampling weight. Standard errors clustered by school location in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Robust Calónico et al. (2014) 95% confidence interval in [ ].

**Sources:** Temperature and precipitation data is from WorldClim, which provides gridded data on average temperature and precipitation over 1950-2000: <http://worldclim.org>. Elevation is from NASA Shuttle Radar Topography Mission: <http://srtm.csi.cgiar.org>. Ruggedness is computed from elevation using the slope tool in ArcGIS. The malaria stability index comes from Kiszweski et al. (2004) and can be downloaded on <https://sites.google.com/site/gordoncmccord/datasets>. Agricultural suitability is suitability for rainfed crops excluding forest ecosystems, from Global Agro-Ecological Zones: <http://webarchive.iiasa.ac.at/Research/LUC/GAEZ/index.htm>. The index goes from 0 (low suitability) to 11 (high suitability). For all these variables, we average the raster data over  $10 \times 10$  km cells and attribute a location the value of the cell it falls in.

Table 2: Balance test on historical characteristics

	(1)	(2)	(3)	(4)
	Average within <100km of the border			Border
	Anglophone	Francophone	Difference	discontinuity
<b>PRE-PARTITION SCHOOLING</b>				
<b>German school in 1911<sup>(a)</sup></b>	0.57	0.51	0.06 (0.12)	-0.40 (0.30) [ -1.34, 0.17]
Bandwidth (km)				61
Observations (effective)	39	32	71	63
Observations (total)				161
<b>ETHNOGRAPHIC ATLAS</b>				
<b>Dependence on agriculture<sup>(b)</sup></b>	6.74	7.55	-0.80 (0.46)	-1.20 (0.81) [ -3.00, 1.10]
Bandwidth (km)				109
Observations (effective)	35	21	56	57
Observations (total)				129
<b>Mean size of local community<sup>(c)</sup></b>	3.24	3.15	0.10 (0.91)	0.14 (1.07) [ -143.16, 46.54]
Bandwidth (km)				605
Observations (effective)	22	3	25	57
Observations (total)				58
<b>Political centralization<sup>(d)</sup></b>	1.94	2.80	-0.86* (0.41)	-0.55 (0.72) [ -2.28, 1.54]
Bandwidth (km)				68
Observations (effective)	30	20	50	48
Observations (total)				119

**Notes:** The first two columns present the average of the variables over school locations on the two sides of the border, within 100 km of the border. The third column presents the difference. The fourth column presents the border discontinuity (a positive coefficient favors the Anglophone side), estimated using a local linear non-parametric function of distance to the border, with a triangular kernel and MSE optimal bandwidth. Observations are weighted by their probability sampling weight. Standard errors clustered by school location in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Robust [Calonico et al. \(2014\)](#) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth. (a) binary variable for presence of a German school (whether public or missionary) in 1911 within 10 km of the location. (b) dependence on agriculture, relative to other subsistence activities. Ordinal variable from 0 (0 to 5% dependence) to 9 (86 to 100% dependence). (c) average population of local communities, whatever the pattern of settlement, computed from census data or other evidence. ordinal variable from 1 (fewer than 50 persons) to 8 (one or more indigenous cities with more than 50,000 inhabitants). (d) number of jurisdictional levels beyond the local community. Ordinal from 1 (autonomous bands or villages) to 4 (complex state).

**Sources:** for school data in 1911, [Schlunk \(1914\)](#) digitized by [Dupraz \(2019\)](#). For ethnographic variables, corrected version of [Murdock \(1967\)](#) by [Gray \(1999\)](#).

for the presence of a 1911 German school within 10 km of the 2005 school location, and the *Ethnographic Atlas* (Murdock, 1967; Gray, 1999). We overlay the map of schools over Murdock's map of African ethnic groups (Murdock, 1959) to join each location with ethnic group variables from the *Ethnographic Atlas*: dependence on agriculture, mean size of local community and political centralization. Results using these variables are to be interpreted with caution because the map of ethnic groups is imprecise, because some ethnic groups were actually observed after World War I, and because information is often missing.<sup>37</sup> As shown in Table 2, none of the historical variables considered jump discontinuously at the border.

We leave the discussion of whether the sample is balanced in terms of economic variables (like light intensity at night or infrastructure) for the mechanisms section, because economic variables measured today are best thought of as outcomes of the partition and differences in colonial regimes. We will show later that we do not estimate any significant discontinuity in these variables and that they are unlikely mechanisms to explain differences in test scores.

## 5. Results

We start by presenting differences in mathematics and language scores between the two systems across all 172 schools in the survey (Table 3). Average language test scores are higher in the Francophone system in Grades 2 and 5 by about a third of a standard deviation (Panel A, column 3), but these differences disappear when we take into account observed geographic differences between the Anglophone and Francophone regions (Panel A, column 4).<sup>38</sup> Average mathematics test scores are higher in the Anglophone system at the end of Grade 2 by about a quarter of a standard deviation, but in Grade 5, average mathematics test scores are higher in the Francophone system by about two thirds of a standard deviation (Panel B, column 3). Contrary to language scores, the difference in mathematics test scores between the two systems survive the inclusion of geographic controls (Panel B, column 4).

Next, we present border discontinuity estimates, which confirm the absence of effect in language and the advantage of the Francophone system in Grade 5 math scores, but not the advantage of the Anglophone system

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<sup>37</sup>Of the 17 ethnic groups within 100 km of the border, only 14 can be found in the *Ethnographic Atlas*. Of these 14 groups, 3 were observed before World War I, 5 in the interwar period, and 6 in the 1950s.

<sup>38</sup>Geographic controls of the school location are temperature, precipitation, elevation, ruggedness, malaria stability index, agricultural suitability, log distance to the coast, to the nearest main river, to Yaounde and to Douala.

Table 3: Differences in scores between Anglophone and Francophone systems

	(1)	(2)	(3)	(4)
	Average Anglophone	Average Francophone	Difference	Regression with controls
<b>Panel A: Language scores</b>				
Grade 2				
Language score	-0.25	0.08	-0.33*** (0.12)	0.02 (0.16)
Observations	593	1,834	2,427	2,427
Number of Schools	42	130	172	172
Grade 5				
Language score	-0.23	0.11	-0.35*** (0.13)	-0.09 (0.20)
Observations	557	1,782	2,339	2,338
Number of Schools	40	125	165	165
<b>Panel B: Mathematics scores</b>				
Grade 2				
Mathematics score	0.16	-0.07	0.23** (0.10)	0.37** (0.15)
Observations	593	1,834	2,427	2,427
Number of Schools	42	130	172	172
Grade 5				
Mathematics score	-0.48	0.16	-0.64*** (0.12)	-0.55*** (0.18)
Observations	557	1,782	2,339	2,338
Number of Schools	40	125	165	165
Controls				✓

**Notes:** For each subject and grade, each individual student's score is computed as the average of the start-of year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation. The first column displays average scores in schools located in Anglophone Cameroon, the second column average scores in schools located in Francophone Cameroon. The third column displays the difference. The fourth column displays the output of a regression of scores on a dummy for being located in Anglophone Cameroon, controlling for gender and geographic characteristics of the school location: temperature, precipitation, elevation, ruggedness, malaria stability index, agricultural suitability, log distance to the coast, to the nearest main river, to Yaounde and to Douala. Observations are weighted by their probability sampling weight. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

in Grade 2 math scores. In Tables 4, columns (1) and (2) display average test scores in the Anglophone and Francophone systems for school located within 100 km of the border, and column (3) displays the difference.<sup>39</sup> Column (4) estimates the border discontinuity controlling only for gender. Column (5) also controls for geographic characteristics, both to increase precision and to show that the lack of balance in ruggedness is not an issue. There are no border discontinuities in language scores neither in Grade 2, nor in Grade 5 (Table 4). As for mathematics, in Grade 2 Anglophone students within 100 km of the border have higher test scores by 0.3 standard deviations (statistically significant), but the estimate discontinuity is smaller and not statistically different from zero (Table 4, columns 4 and 5). This indicates that, all other things equal, Francophone and Anglophone students start primary school with comparable mathematics skills (if anything, Anglophone students fare better), which makes it likely that the Francophone advantage emerging in Grade 5 is due to characteristics of the school systems rather than to other differences between the Francophone and Anglophone regions of Cameroon. We will come back to this point in the mechanism section. In Grade 5, Francophone students outperform Anglophone students in mathematics. The discontinuity is large and precisely estimated. In our preferred specification, with geographic controls, it is equal to 0.7 standard deviations and significant at the one percent level (Table 4, column 5).<sup>40</sup>

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<sup>39</sup>We chose 100 km because it is a round number close to the optimal MSE bandwidth in most specifications.

<sup>40</sup>Figure Appendix A.4 gives a visual representation of the discontinuities in language and mathematics scores in Grades 2 and 5.

Table 4: Border discontinuity estimates

	(1)	(2)	(3)	(4)	(5)
	Average within <100km of the border			Border discontinuity	
	Anglophone	Francophone	Difference		
<b>Panel A: Language scores</b>					
<b>Grade 2</b>					
Language score	-0.24	-0.11	-0.13 (0.14) < 0.10	-0.15 (0.23) < 0.23 [ -0.84, 0.40]	-0.06 (0.21) < 0.19 [ -0.71, 0.42]
Bandwidth (km)				110	118
Observations (effective)	555	447	1,002	1,025	1,068
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Language score	-0.23	-0.21	-0.02 (0.13) < 0.13	0.06 (0.20) < 0.19 [ -0.38, 0.63]	0.13 (0.21) < 0.18 [ -0.35, 0.69]
Bandwidth (km)				109	111
Observations (effective)	523	436	959	978	1,007
Observations (total)				2,180	2,179
<b>Panel B: Mathematics scores</b>					
<b>Grade 2</b>					
Mathematics score	0.15	-0.18	0.33*** (0.12) < 0.11	0.15 (0.22) < 0.24 [ -0.53, 0.66]	0.19 (0.21) < 0.20 [ -0.49, 0.68]
Bandwidth (km)				109	113
Observations (effective)	555	447	1,002	1,025	1,053
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Mathematics score	-0.49	0.02	-0.51*** (0.15) < 0.16	-0.55** (0.26) < 0.23 [ -1.01, 0.24]	-0.70*** (0.22) < 0.18 [ -1.27, -0.11]
Bandwidth (km)				101	107
Observations (effective)	523	436	959	968	977
Observations (total)				2,180	2,179
Geographic controls					✓

**Notes:** For each subject and grade, each individual student's score is computed as the average of the start-of year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation. The first 2 columns display average scores in Anglophone and Francophone Cameroon within 100 km of the border. The third column displays the difference. The last two columns present border discontinuities (a positive coefficient favors the Anglophone side), estimated using a local linear non-parametric function of distance to the border, with a triangular kernel and MSE optimal bandwidth. In column (4), gender is the only additional covariate. In column (5), we also control for geographic characteristics of the school location: temperature, precipitation, elevation, ruggedness, malaria stability index, and agricultural suitability. Observations are weighted by their probability sampling weight. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Standard errors clustered by *préfecture* in angle brackets (there are 57 *préfectures* in our sample, 25 within 100 km of the border, with an average number of 3 sampled school by *préfecture*). Robust Calonico et al. (2014) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth.

## 6. Robustness and additional results

*Robustness to other specifications and samples.* Table [Appendix B.7](#) displays discontinuities in language and mathematics scores obtained with alternative specifications and samples. Column (1) displays our baseline estimate (like in Table 4, column 5). In column (2), we control for geographic location using a local quadratic non-parametric function of distance to the border. In columns (3) and (4), we control for geographic location with a polynomial in latitude and longitude (linear in column 3 and quadratic in column 4) using a 100 km bandwidth on either side of the border. Column (5) shows that results are barely affected when we include Douala, the economic capital of Cameroon, located in the Francophone part. Column (6) shows that results are very similar when we exclude the northern part of our sample, where the randomness of the border is more disputable.<sup>41</sup>

Figure [Appendix A.5](#) shows that the discontinuity in Grade 5 mathematics scores is stable to varying the size of the bandwidth from 20 to 140 km. Panel (a) controls for geographic location with a local linear non-parametric function of distance to the border (like in our main specification). Panel (b) uses a linear function of latitude and longitude.

Table [Appendix B.8](#) displays unweighted estimates to show that results are insensitive to the weighting regime.

*Results using raw PASEC scores.* As explained in the data section, to ensure that the tests administered in the Anglophone and Francophone systems measure learning outcomes in the same way, we constructed new standardized test scores for each students excluding certain mistranslated questions, as well as questions on topics not explicitly covered in both syllabuses. In Tables [Appendix B.9](#), we show that this precaution, though a priori justified, is quite innocuous since we obtain very similar results using the raw PASEC scores.

*Start and end-of year scores.* The PASEC tested students twice, at the beginning and at the end of the school year. To increase statistical power, our main results use the average of the two tests. In Table [Appendix B.10](#), we distinguish between the start-of-year score (columns 1 and 2) and end-of-year score (column 3 and 4). We

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<sup>41</sup>Excluding the North-West, Ouest, Adamaoua, North, and Extreme North regions. A discontinuity favoring the Anglophone side emerges in Grade 5 language scores when we focus on the Southern sample. This is likely due to the fact we exclude Douala from the sample, therefore comparing rural areas in Francophone Cameroon with urban areas in Anglophone Cameroon. This discontinuity disappears when we include Douala in the sample.



present results using both corrected scores and raw PASEC scores. The advantage of Francophone students is present both at the start and at the end of the year. Considering raw PASEC scores at the start of the school year (column 3) allows us to include in the sample the small percentage of students who did not take the end-of-year test (detailed breakdown of the scores by questions are not available for these students). Results are very similar when including these students, which reassures us that attrition is not an issue.

*Grade repetition and sample selection.* Grade repetition (or grade retention) is much more common in Francophone than in Anglophone education systems, in Africa in general (Ndaruhutse et al., 2008), and in Cameroon in particular. Using 2005 census data, Dupraz (2019) shows that Cameroonian pupils are 20 percentage points more likely to have repeated at least one grade in primary or secondary school if they were born in Francophone Cameroon. In our sample, 42% of pupils have repeated at least one grade in the Francophone system, versus 31% in the Anglophone system. We are saving for the mechanism section a discussion of the potential merits of grade retention and the role of this pedagogical practice in explaining our results. In this section, we show that the advantage of Grade 5 Francophone pupils is not explained by a problem of sample selection because of grade retention.

Let us start by explaining the problem. If, in Francophone Cameroon, the weakest students are held back in the early grades of primary school or exit the education system because they cannot progress to more advanced grades, this creates negative selective attrition — the sample of student observed in Grade 5 in the Francophone system is positively selected.<sup>42</sup> This could create a border discontinuity in test scores in Grade 5 even in the absence of an actual treatment effect. Ideally, to compare the two education sub-systems, we would want to subject to a standardized test a cohort of children of the same age, regardless of the grade they are currently attending (and regardless of whether they dropped out of school). This kind of data, unfortunately, does not exist, and we are instead using a sample of pupils attending Grade 5 in 2004-2005. Some of these pupils should normally be in a more advanced grade, but were held back, and some of them who should normally be in Grade

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<sup>42</sup>Grade repetition can create selective attrition if students stay in school but are held back a grade, or if students who cannot progress to the next grade drop out of the school system. Though the trimming exercise we present in this section tackles both issues, we are not really worried about the second issue. Using 2005 census data, we find very similar primary school attendance rates in Anglophone and Francophone Cameroon within 100 km of the border. If anything, attendance rates are higher in Francophone Cameroon. For the generation born between September 1996 and August 1997 (of Grade 2 age in 2004-2005), the school attendance rate is 88% on the Anglophone side and 89% on the Francophone side (excluding Douala). For the generation born between September 1993 and August 1994 (of Grade 5 age in 2004-2005), the school attendance rate is 86% on the Anglophone side and 88% on the Francophone side (excluding Douala).

5 were held back in less advanced grades and are not observed.

To show that the advantage of students in the Francophone system is not explained by sample selection, we follow Lee (2009) and investigate the sensitivity of our results to a trimming procedure where the best students in the Anglophone system are excluded from the sample. We start by restricting the Grade 5 sample to students who never repeated a grade (Table [Appendix B.11](#), panel A). Because grade repetition is very prevalent in Cameroon, the sample size is divided by four (599 instead of 2,270 students). The Francophone system, where repetition is more prevalent, is under-sampled. Calling the probability to be sampled on the Anglophone side of the border  $p_a$ , and on the Francophone side  $p_f$ , we have  $p_f = 0.17\%$  and  $p_a = 0.30\%$ .<sup>43</sup> This is an issue, as students who are excluded from the sample because they are held back in previous grades might perform worse in standardized tests.

In column (1) of Table [Appendix B.11](#), we estimate the border discontinuity in Grade 5 math score on this selected sample. The estimate of 0.77 is not too different from our baseline estimate of 0.70, which already reassures us that sample selection is not a major issue (if it was, we would expect the discontinuity to favor the Francophone side even more). In the rest of the table, we use the trimming procedure of Lee (2009) to provide worst-case-scenario bounds of the treatment effect (the border discontinuity) in the presence of sample selection. We remove a proportion  $p_0$  of students from the Anglophone sample, where  $p_0 = \frac{p_a - p_f}{p_a} = 43\%$  is the extent of oversampling on the Anglophone side. To obtain a lower bound of the effect of being schooled in the Anglophone system, we remove the 43% best performing students according to the Grade 5 start-of-year mathematics test. To obtain an upper-bound, we remove the 43% worst performing students. We perform this trimming exercise on the entire distribution of students, and also class by class, because teachers do not observe the entire distribution of students' score but the distribution of scores in their class (we remove 43% of the best or worse performing students in each class). We are interested in the magnitude of the upper bound and whether it still estimates a discontinuity favoring the Francophone system. We should note that this upper bound is obtained under the very extreme assumption that grade repetition systematically selects away the least

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<sup>43</sup>To compute these probabilities, we use Census data from 2005. The cohort supposed to attend Grade 5 in 2004-2005 (born between September 1993 and August 1994) counts 69,360 children in Anglophone Cameroon within 100 km of the border, and 56,190 children in Francophone Cameroon within 100 km of the border (excluding Douala). In our data, the sample of Grade 5 students who never repeated a grade is composed of 211 students in the Anglophone part within 100 km of the border and 97 students in the Francophone part within 100 km of the border. We therefore estimate  $p_a = 211/69,360 = 0.30\%$  and  $p_f = 97/56,190 = 0.17\%$ .

performing students. In reality, previous studies have shown that, in African Francophone education systems, a teacher's decision to have a student repeat a grade bears little relation to the student's ability measured by standardized test scores (Bernard et al., 2005), maybe because teachers are biased in their evaluation of student's abilities (Jarousse and Suchaut, 2002).<sup>44</sup>

Panel A of Table Appendix B.11 shows that, when performing the trimming on the entire distribution of students, the upper bound for the discontinuity in Grade 5 mathematics score is still  $-0.31$  standard deviations, but it is not significant. When performing the trimming on each class's distribution, the upper bound is lower at  $-0.46$  and statistically significant at conventional levels. In panel B, we repeat the same trimming exercise, but, to increase statistical power, we start with the baseline sample of students who never repeated or repeated exactly one grade.<sup>45</sup> We obtain tighter bounds, with an upper bound of  $-0.50$  standard deviations when trimming on the entire distribution, and an upper bound of  $-0.58$  standard deviations when trimming on each class's distribution.

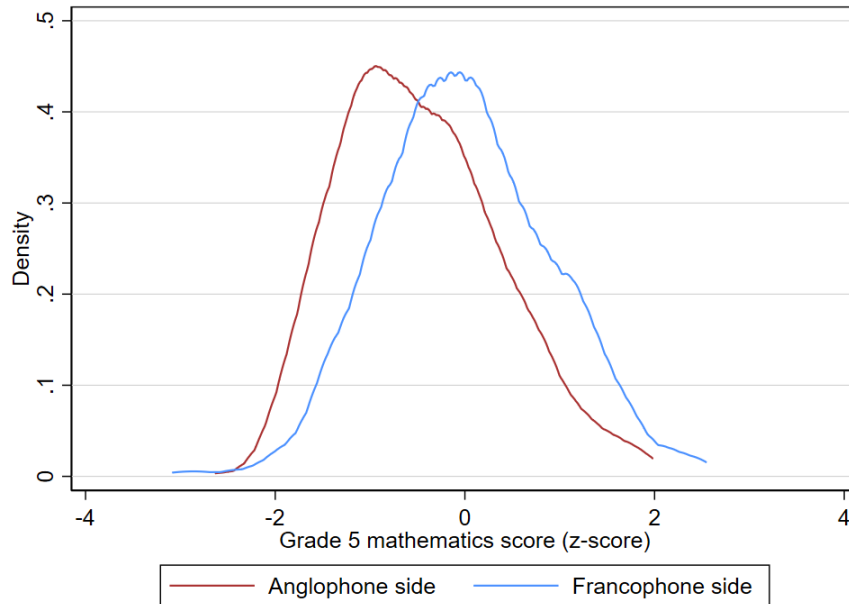
*Education quality and student performance.* In this paper, we implicitly assume that the performance of students on the PASEC test can be used as a measure of their proficiency in language and mathematics. But it could be the case that differences between the Francophone and Anglophone systems actually reflect differences in how seriously students take the test: maybe Anglophone students did not take the PASEC tests as seriously as Francophone students? A first answer is that we estimate no difference in language tests, and there is no reason to believe that students would take one test more seriously than the other. We also look, in Figure 3, at where in the distribution of test scores the Francophone advantage is apparent. If the effect was coming from some Anglophone students not putting in any effort, we would expect the Anglophone disadvantage to come from the bottom of the distribution. However, Figure 3 displays the distributions of Grade 5 mathematics scores in Anglophone and Francophone Cameroon within 100-km of the border and shows that the effect comes from an

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<sup>44</sup>In panel A of Table Appendix B.12, we regress the teacher's opinion on whether a student will repeat a grade on the student's end-of-year PASEC score in mathematics (and teacher fixed effects). Though it goes in the expected direction and is precisely estimated, the correlation between test scores and repetition is not as high as one might expect (an increase of one standard deviation in the end-of-year mathematics score decreases the likelihood of repeating a grade by 10 percentage points). In panel B of Table Appendix B.12, we show the percentage of predicted repeaters for each within-class quartile of the end-of-year mathematics score distribution. Though the percentage of repeaters is higher in the bottom of the distribution, what is striking is the very large percentage of repeaters in the top: in Grade 5, for example, 23% of the top 25% best students are expected to repeat (versus 39% of the bottom 25% least performing students). The assumption that selection systematically selects away the least performing students is indeed quite extreme.

<sup>45</sup>Even when considering students who repeated exactly one grade, it is still the case that the Francophone system under-samples children with respect to the Anglophone system, because there are many more students who repeated more than one grade in the Francophone system: 14.63% versus 3.6% only in the Anglophone system.

Figure 3: Distribution of Grade 5 mathematics scores within 100 km of the border on both sides



**Notes:** kernel density estimation. Sample: schools located within 100-km of the border, excluding Douala. The Grade 5 mathematics score is computed as the average of the start-of-year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation.

overall shift to the right of the Francophone distribution and not from a mass at the bottom in the Anglophone distribution.

## 7. Mechanisms

We find that pupils schooled in Cameroon’s Francophone sub-system tend to perform better in mathematics in Grade 5. The natural experiment created by Cameroon’s partition between the British and the French allows us to claim that this difference is a causal effect of the difference in colonial origins. With our border discontinuity exercise, we are comparing schools located in villages close to the border between Francophone and Anglophone Cameroon. Whether one village ended up in the Francophone or the Anglophone region ultimately depended on whether a border drawn in Paris without knowledge of local conditions was drawn a little bit more to the East or to the West. However, many mechanisms could explain why different colonial histories resulted in differences in test scores almost a century later. Because we are looking at test scores, it is tempting to look for explanations in the differences between the two education sub-systems, all the more because we identify

no discontinuity in test scores in Grade 2, but the explanation could also lie in broader social and economic differences between the Francophone and Anglophone regions of Cameroon.

In this section, we explore the mechanisms behind our results. We start by showing that the discontinuity is unlikely to be explained by economic and social factors outside of the education system. Next, we investigate the role of inputs of the education production function. We start with quantitative inputs, what [Kremer et al. \(2013\)](#) call “more-of-the-same” inputs, that can easily be quantified and straightforwardly increased by spending more, like the number of teachers, their pay, class, and school equipment. Finally, we explore the role of pedagogical culture and practices.

To better understand mechanisms, we undertake mediation analysis in a linear structural equation model ([Baron and Kenny, 1986](#); [Imai et al., 2010a,b](#)). We consider a large set of mediator variables  $m_{is}$ , inputs of the education production function that could be influenced by differences in colonial origins and that could explain why students schooled in the Francophone system perform better in mathematics. We consider measures of the general economic environment of the school (like lights at night), indicators of the student’s socioeconomic situation (like father and mother literacy), quantitative inputs of the production function (like class equipment), and qualitative inputs of the production function (like an index of “vertical” teaching practices). We start by estimating whether colonial origins have an effect on the mediator considered, that is we estimate a border discontinuity in the mediator with the following equation:

$$m_{is} = \alpha_2 + \beta_2 WEST_s + f(\text{geographic location}_s) + \delta_2 g_i + Z'_s \gamma_2 + \eta_{is} \quad (2)$$

then we estimate the border discontinuity in test score controlling for the mediator:

$$score_{is} = \alpha_3 + \beta_3 WEST_s + f(\text{geographic location}_s) + \delta_3 g_i + Z'_s \gamma_3 + \theta_3 m_{is} + \nu_{is} \quad (3)$$

The average causal mediation effect (ACME) is  $\beta_2 \times \theta_3$ . It is the effect of the mediator on test scores ( $\theta_3$ ) multiplied by the change in the mediator caused by differences in colonial origins ( $\beta_2$ ). To infer the ACME, we estimate (2) and (3) jointly by seemingly unrelated regression (SUR) and we use the delta method to compute standard errors. For the ACME to be identified and given by  $\beta_2 \times \theta_3$ , the sequential ignorability assumption

needs to be satisfied (Imai et al., 2010b): (i) the treatment (colonial origins) must be as good as random given the pre-treatment controls (geographic location), (ii) the mediator  $m_{i,s}$  must be as good as random given the treatment and the pre-treatment controls.<sup>46</sup> (i) is the standard assumption of spatial discontinuity design, but (ii) is harder to argue for. Potential mediators are likely correlated, meaning that it is in practice very hard to identify the precise contribution of each. At the end of this section, we estimate equation (3) controlling for the full set of observable mediators, but controlling for the entire set of mediators, some of which are unobserved, is of course impossible.

In this framework, based on a system of linear equations, we cannot control for geographic location with a non-parametric function of distance to the border. We instead control for a parametric linear function of distance to the border (whose slope is allowed to vary on either side), restricting the sample to schools located within 100 km of the border (a bandwidth very similar to the optimal MSE bandwidth of our main specification). OLS allows estimating the system of equations by SUR, and the constant bandwidth facilitates comparisons.

### 7.1. Mechanisms outside of the education system

Before studying differences in the education systems, we start by investigating whether the advantage of Francophone students in mathematics is explained by the overall effect of colonial origins on economic development. If Francophone regions of Cameroon were more economically developed, then Francophone students could have access to better nutrition and better material resources at home, which could favorably affect their test scores at the end of primary school. This mechanism is, however, unlikely as the literature on colonialism's long-run impact on development tends to underline the relatively more favorable legacy of British colonialism. In Cameroon, Lee and Schultz (2012) find that households located in the former British part have a higher asset-based measure of wealth and better access to piped water; Dupraz (2019) finds the same (though he argues this is explained by the migration of wealthier individuals away from the border rather than by strong institutional legacies), but finds no difference in night light per capita or industrialisation, and finds that the Francophone

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<sup>46</sup>The sequential ignorability assumption alone is needed for the ACME to be non-parametrically identified. For the ACME to be parametrically identified using the system of equations (2) and (3), we need to assume that there is no interaction between the treatment and the ACME. All the results presented below are robust to non-parametric estimations of the ACME and direct effect using the Stata package `mediation` of Raymond Hicks and Dustin Tingley (2011). Another obvious requirement of mediation analysis is that mediators are not perfectly (or almost perfectly) correlated with the treatment. For all the mediators we consider, there is significant within school-system variation. Even for grade repetition, which is a well known characteristic of the Francophone school system, there is a lot of within-system variation: the school-average number of classes repeated in the Francophone system varies between 0.24 and 1.6 (with a standard deviation of 0.29).

side is more urbanized; [Guarnieri and Rainer \(2021\)](#) find that women living in the Anglophone regions are more likely to work for a wage and have greater control over household resources. Given the large literature showing that female control over household resources increases expenditures on children ([Duflo, 2003](#); [Qian, 2008](#); [Bobonis, 2009](#)), this former result could explain higher test scores in the Anglophone system, but not the opposite.

In [Table 5](#) we consider variables measuring the economic development of the school's locality (light density at night, an index of the infrastructure present in the school's locality, and a binary for schools located in urban areas) and variables measuring the socioeconomic environment of each pupil (an asset based wealth index for the household of each pupil, binaries indicating if the father and mother of the pupil are literate, and the time it takes the pupil to go to school). Column (1) displays border discontinuity in each mediator. The discontinuity in the start of Grade 5 mathematics score (Column 2) is then divided into the part explained by a change in the mediator (ACME, Column 3) and the residual (direct effect, Column 4).<sup>47</sup> As can be seen in Column (1), there is no border discontinuity in any of the mediators. It follows naturally that the corresponding mediation effects are all small and not statistically distinguishable from zero (Column 3).<sup>48</sup>

## 7.2. Quantitative inputs of the education production function

We now investigate differences between the Francophone and Anglophone systems in various quantitative inputs of the education production function. These are “more-of-the-same” inputs ([Kremer et al., 2013](#)) that can be easily quantified and straightforwardly increased by spending more. In [Table 6](#), we consider whether the pupil went to preschool, an index of school equipment, an index of class equipment, school budget per pupil, class size, and teacher variables: years of education, years of experience, salary, and the number of days of absence during the year (reported by the director of the school). The only statistically significant difference at the border is in the class equipment index (Column 1): schools of the Francophone system have better classroom equipment (the discontinuity of  $-1.3$  standard deviations is statistically significant at the 1% level).<sup>49</sup>

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<sup>47</sup>The total effect in Column (2) is not exactly the same in each line because the number of observations for each line varies, as the mediator variables sometimes have missing information.

<sup>48</sup>For the infrastructure index, none of the binary infrastructure variables display a discontinuity: presence of a paved road, of electricity, of running water, of a middle school, of a high school, of a health center, of a telephone connection, of a bank, of a police station.

<sup>49</sup>Within 100 km of the border, 11% of classes have a desk for the teacher in the Anglophone system, versus 74% in the Francophone system, 49% have chalk, versus 73% in the Francophone system, 12% have a square, versus 61% in the Francophone system.

Table 5: Mediation analysis for mediators outside the school system

	(1)	(2)	(3)	(4)	(5)
	Border discontinuity in Grade 5 mathematics score				
	Border disc. in mediator	total effect	ACME	direct effect	Observations
Log of night light	-0.174 (0.372)	-0.791*** (0.244)	-0.016 (0.044)	-0.774*** (0.235)	958
Infrastructure index	-0.374 (1.001)	-0.791*** (0.244)	0.009 (0.028)	-0.800*** (0.242)	958
Urban	-0.191 (0.226)	-0.791*** (0.243)	0.015 (0.035)	-0.806*** (0.246)	944
Family wealth index	0.255 (0.587)	-0.791*** (0.244)	-0.002 (0.008)	-0.789*** (0.243)	958
Father literate	0.042 (0.051)	-0.784*** (0.243)	0.003 (0.006)	-0.787*** (0.244)	949
Mother literate	-0.091 (0.089)	-0.751*** (0.241)	0.015 (0.018)	-0.766*** (0.242)	942
Time to go to school	-0.203 (0.255)	-0.789*** (0.243)	-0.001 (0.011)	-0.789*** (0.243)	954

**Notes:** column (1) presents the border discontinuity (a positive coefficient favors the Anglophone side) in the potential mediator, estimated using a bandwidth of 100-km and controlling for a linear function of distance to the border (whose slope is allowed to differ on either side), gender, and the geographic controls of Table 1. Columns (2) to (4) present a parametric decomposition of the border discontinuity in Grade 5 mathematics score (total effect) between the average causal mediation effect (ACME) and the direct effect. The number of observations in column (5) varies because the mediator variables sometimes have missing observations. Standard errors clustered by school in parentheses.  $*p < 0.1$ ,  $**p < 0.05$ ,  $***p < 0.01$ . The standard errors of the ACME are computed using the delta method. Log night light is the inverse hyperbolic sine transform ( $\log(x + \sqrt{x^2 + 1})$ ) of light density at night in 2004, from Version 4 DMSP-OLS Nighttime Lights Time Series: <https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html>. Using the hyperbolic sine transform allows us to interpret coefficients as if the variable was a log without discarding the zeros (50% of observations). The infrastructure index is built by PCA using information on the infrastructure present in the locality of the school (see Table Appendix B.3). Urban is a dummy variable equal to one if the school is located in a town or in the suburbs of a big town. The family wealth index is built by PCA using information on the assets present in the pupil's household (see Table Appendix B.3). Time to go to school is an ordinal qualitative variable with the following values: 1 (the student lives <15 minutes walking from school), 2 (between 15 and 30 minutes), 3 (between 30 minutes and 1 hour), 4 (more than one hour).



Why do Francophone classrooms have better equipment? We do not estimate a statistically significant border discontinuity in school budget per pupil (the school budget does not include teachers' wages), but this variable is missing for a third of schools. Lower school budgets in Anglophone Cameroon could come from lower local financing: in a 2003 report of Cameroon's school system (Cameroon Government et al., 2003), we learn that the education expenditure of municipalities per inhabitant (which mostly finances current material expenditure) is lower in the Anglophone provinces of Cameroon.<sup>50</sup> However the expenditure of municipalities represents less than 1% of total education expenditure. In any case, better class equipment does not seem to explain why Francophone students perform better in mathematics. The mediation effect for the class equipment index is small and statistically non-distinguishable from zero. This is because class equipment is not correlated with test scores: when estimating equation (3), we find that a one standard deviation increase in the class equipment index increases start of Grade 5 test scores by 1.7% of a standard deviation (standard error of 7% of a standard deviation). This is in line with a literature finding that in the developing world, test scores are unresponsive to increasing material inputs like textbooks, flipcharts or computers (Kremer et al., 2013).

### 7.3. Pedagogical culture and practices

We now turn to pedagogical culture and teaching practices, which find their roots in colonial history. One defining characteristic of British colonial education systems in Africa was the predominant role given to Christian missionaries (Gifford and Weiskel, 1971; Cogneau and Moradi, 2014). Missionary origins left their imprint on many Anglophone school systems, even though, after independence, these systems started relying increasingly on public schools. For example, today, primary school teaching is much more likely to be undertaken in a local African language in former British colonies, a legacy of Protestant missionaries' practice of preaching the Bible in the vernacular. In Cameroon, however, since reunification, official teaching languages are restricted to French and English, except in a couple of experimental schools studied by Laitin et al. (2019). Beyond language of instruction, missionary education could have influenced teaching styles. According to Woodberry (2004), "missionaries were especially important in introducing education that emphasized critical thinking rather than rote memorization of classic texts" (p. 48). Overall, differences in teaching practices between former French

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<sup>50</sup>In 1998/99, education expenditure of municipalities (*communes*) per inhabitant averaged 3 CFA francs (0.015 2010 USD) in the Anglophone North-West province and 1.5 CFA francs (0.008 2010 USD) in the South-West province, versus 5 CFA francs (0.026 2010 USD) in the Francophone Ouest province and 43 CFA francs (0.22 2010 USD) in the Littoral province.

Table 6: Mediation analysis for quantitative inputs of the education production function

	(1)	(2)	(3)	(4)	(5)
		Border discontinuity in Grade 5 mathematics score			
	Border disc. in mediator	total effect	ACME	direct effect	Observations
Went to preschool	0.021 (0.088)	-0.781*** (0.242)	-0.001 (0.003)	-0.781*** (0.242)	939
School equipment (index)	0.556 (0.404)	-0.791*** (0.244)	0.020 (0.060)	-0.811*** (0.241)	958
Class equipment (index)	-1.315*** (0.396)	-0.790*** (0.244)	-0.022 (0.093)	-0.768*** (0.262)	943
School budget per pupil (yearly - 2010 USD)	-8.802 (9.081)	-0.594* (0.316)	-0.006 (0.022)	-0.588* (0.319)	693
Class size	5.446 (14.019)	-0.836*** (0.245)	-0.028 (0.075)	-0.808*** (0.225)	931
Teacher education (years)	-0.182 (0.685)	-0.791*** (0.244)	0.007 (0.028)	-0.798*** (0.241)	958
Teacher experience (years)	-4.364 (3.658)	-0.791*** (0.244)	0.008 (0.034)	-0.799*** (0.246)	958
Teacher salary (monthly - 2010 USD)	1.008 (86.099)	-0.742*** (0.249)	-0.000 (0.015)	-0.742*** (0.246)	932
Absenteeism (days)	-1.474 (1.039)	-0.742*** (0.249)	0.028 (0.035)	-0.771*** (0.248)	932

**Notes:** column (1) presents the border discontinuity (a positive coefficient favors the Anglophone side) in the potential mediator, estimated using a bandwidth of 100-km and controlling for a linear function of distance to the border (whose slope is allowed to differ on either side), gender, and the geographic controls of Table 1. Columns (2) to (4) present a parametric decomposition of the border discontinuity in Grade 5 mathematics score (total effect) between the average causal mediation effect (ACME) and the direct effect. The number of observations in column (5) varies because the mediator variables sometimes have missing observations. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . The standard errors of the ACME are computed using the delta method. All indices (school equipment, school management, class equipment, and working conditions) are built using PCA (see Table [Appendix B.3](#)).

and former British colonies tend to reflect differences between France and the United Kingdom. In a qualitative study of two Francophone and two Anglophone schools in Cameroon, [Nana \(2013\)](#) underlines differences in teaching practices between the two sub-systems. Studying the teaching of literacy in Grade 1, Nana opposes the use of rote learning in Francophone schools to the use of story telling in Anglophone schools, where students are encouraged to use language to talk about themselves.<sup>51</sup> Overall, the author finds that the differences between the Anglophone and Francophone sub-systems mirror the differences between the English and French education system in the 1970s as described by [Meuret and Duru-Bellat \(2003\)](#), with an English system “devoted to the personal and social development of children while the French was devoted to teaching a strong academically oriented national curriculum”.<sup>52</sup> Finally, colonial origins strongly influenced the use of grade repetition (or grade retention) in African school systems: rates of grade repetition are much higher in France than in other OECD countries ([OECD, 2012](#)), and on the African continent, they are much higher in former French than in former British colonies ([Bernard et al., 2005](#); [Ndaruhutse et al., 2008](#)). In Cameroon, [Dupraz \(2019\)](#) showed that grade repetition is more prevalent in the Francophone system, using an indirect measure of grade repetition from the 2005 population census. Grade repetition has negative consequences in that it sends students a signal of low ability and encourages them to drop out of school early, something that seems to be happening in Cameroon at the secondary school level ([Dupraz, 2019](#)). In section 6 above, we showed that our finding of a better performance of Francophone students in mathematics in Grade 5 was not explained by a problem of sample selection because of grade repetition. Beyond sample selection, students who repeated a grade might perform better because they are older and spent more time in school.<sup>53</sup> Finally, higher rates of repetition at the school-system level could theoretically have a positive effect on the test scores of non-repeating students if grade repetition acted as a deterrent to poor school performance ([Manacorda, 2012](#)).

Pedagogical culture and teaching practices are much harder to measure than more quantitative inputs of the education production function — class size, for example, is more easily summarized as a number that the

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<sup>51</sup>Unfortunately, Nana does not study the teaching of mathematics.

<sup>52</sup>p. 463 in [Meuret and Duru-Bellat \(2003\)](#), p. 488 in [Nana \(2013\)](#). Nana underlines other differences between the two sub-systems, for example in uniform wearing practices (in Francophone schools, pupils are allowed in class without their uniform), or in the practice of prayer and gospel (a characteristic of Anglophone schools, even when non-religious).

<sup>53</sup>As we are considering one mediator at a time, it is not really possible to distinguish the pure effect of age from the effect of spending more time in school. In Table 8 below, which controls for all mediators, we can look separately at the effects of age and number of classes repeated (a causal interpretation is however difficult).

Table 7: Mediation analysis for qualitative inputs of the education production function

	(1)	(2)	(3)	(4)	(5)
		Border discontinuity in Grade 5 mathematics score			
	Border disc. in mediator	total effect	ACME	direct effect	Observations
Private school	0.133 (0.232)	-0.791*** (0.244)	0.024 (0.050)	-0.815*** (0.242)	958
School management (index)	-0.720 (0.498)	-0.753*** (0.247)	-0.028 (0.059)	-0.725*** (0.255)	901
Vertical teaching Grade 2 (index)	-0.984* (0.540)	-0.799*** (0.245)	-0.071 (0.073)	-0.728*** (0.264)	915
Vertical teaching Grade 5 (index)	-0.643 (0.429)	-0.844*** (0.239)	-0.064 (0.063)	-0.780*** (0.238)	928
Proportion of curriculum covered Grade 2 (%)	-7.585 (10.886)	-0.696*** (0.250)	-0.048 (0.068)	-0.648*** (0.240)	873
Proportion of curriculum covered Grade 5 (%)	-15.731** (6.870)	-0.857*** (0.251)	0.029 (0.046)	-0.886*** (0.275)	918
Intensity of textbook use Grade 2 (index)	-0.570 (0.454)	-0.791*** (0.244)	0.048 (0.054)	-0.839*** (0.244)	958
Intensity of textbook use Grade 5 (index)	-0.478 (0.521)	-0.829*** (0.250)	0.055 (0.066)	-0.885*** (0.239)	944
Age	-0.847** (0.380)	-0.795*** (0.244)	0.017 (0.025)	-0.812*** (0.244)	957
Primary school entry age	-0.350 (0.350)	-0.795*** (0.244)	0.004 (0.011)	-0.798*** (0.244)	957
Number of repeated classes	-0.497*** (0.165)	-0.791*** (0.244)	0.026 (0.022)	-0.816*** (0.244)	958
Nb. of repeated classes (school average)	-0.358*** (0.122)	-0.791*** (0.244)	0.138 (0.095)	-0.928*** (0.242)	958

**Notes:** column (1) presents the border discontinuity (a positive coefficient favors the Anglophone side) in the potential mediator, estimated using a bandwidth of 100-km and controlling for a linear function of distance to the border (whose slope is allowed to differ on either side), gender, and the geographic controls of Table 1. Columns (2) to (4) present a parametric decomposition of the border discontinuity in Grade 5 mathematics score (total effect) between the average causal mediation effect (ACME) and the direct effect. The number of observations in column (5) varies because the mediator variables sometimes have missing observations. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . The standard errors of the ACME are computed using the delta method. All indices (pedagogical material use and use of new teaching methods) are built using PCA (see Table Appendix B.3).

pedagogical practice of a teacher. However, the very precise questions contained in the PASEC survey allow us to have a look at some of the more qualitative inputs of the education production function. In Table 7, we start by looking at variables at the school level: today, in contrast with the colonial period, there is no border discontinuity in the proportion of private schools; there is no border discontinuity either in an index of the quality of school management.<sup>54</sup> We then consider variables proxying for the practices of teachers. We base our analysis on the dichotomy between “horizontal” and “vertical” teaching practices, that we borrow from [Algan et al. \(2013\)](#).<sup>55</sup> Vertical teaching practices are centered around the lecture and the vertical transmission of a predetermined curriculum. The main relationship in the classroom is between the teacher and students. With horizontal teaching practices, students are asked to work in groups and do projects together, the curriculum is less important, and the teacher is more attentive to the specific needs of students. We use questions on the opinion of teachers about various pedagogical statements to build an index of the verticality of teaching practices.<sup>56</sup> Admittedly, this is an imperfect measure of teaching practices, as it is based on teachers’ opinions rather than on classroom observation. We also consider the proportion of the official curriculum covered by the teacher and the intensity of textbook use (self-declared), which are indicators of the importance of vertical transmission of a predetermined body of knowledge. For all these pedagogical variables, we consider both the pupils’ Grade 5 teacher, and the Grade 2 teacher in the same school, because teaching practices in earlier grades could matter for later test scores (80% of schools in our sample have only one class of Grade 2, we assume that the current Grade 2 teacher was already teaching when current Grade 5 students were in Grade 2). In line with the qualitative observations of [Nana \(2013\)](#), we find that teachers in the Francophone system use more vertical teaching practices: the border discontinuity in the vertical teaching index is about one standard deviation in Grade 2 (significant at the 10% level) and 0.6 standard deviations in Grade 5 (not significant).

However, the mediation effects for the Grade 2 and Grade 5 vertical teaching indexes, though they go in the right direction, are not statistically different from zero (Table 7, Column 3).<sup>57</sup> We also find that teachers

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<sup>54</sup>The index is build by principal component analysis using four variables: the frequency of staff meetings, the degree of parents’ involvement in school activities, the frequency of interaction between colleagues, and the quality of the relationship between teachers and parents.

<sup>55</sup>The horizontal/vertical dichotomy reflects more or less the modern/traditional dichotomy of [Lavy \(2016\)](#).

<sup>56</sup>We use principal component analysis. Teachers are asked their agreement, on a scale of 1 to 4, with various statements. We use the following statements: “With the number of pupils more than 50, it is impossible to accept interaction between the pupils”, “When the topic is new, it is impossible to let the pupils learn in group”, “Time devoted to lazy pupils delays the progression of lessons”, “Beating method is sometimes necessary on certain pupils”.

<sup>57</sup>When we estimate equation (3), we find that the use of vertical teaching methods is positively, but not significantly, correlated with

in the Francophone system cover a larger share of the official curriculum, with a border discontinuity of 7.6 percentage points in Grade 2 (non significant) and 16 percentage points in Grade 5 (significant at the 5% level). The discontinuity in textbook use is not statistically distinguishable from zero, neither in Grade 2 nor in Grade 5, but it goes in the direction of Francophone teachers using textbooks more. However, none of these mediators seem to explain the advantage of Francophone students in mathematics (Table 7, Column 3). Finally, we look at grade repetition: as expected, students schooled in the Francophone system are older (discontinuity of  $-0.8$  years, significant at the 5% level). This is partly because they start school later, though the difference is not statistically significant, and mostly because the repeat more classes, with a border discontinuity of  $-0.5$  classes, significant at the 5% level. However, the corresponding mediation effect is positive, small, and insignificant. That is because students who have repeated one or several grades do not have higher test scores than students who did not repeat (admittedly though, repeating students are negatively selected). We then look at the mediation effect of the school average number of repeated classes, in order to take into account the possibility that high repetition rates have a deterrent effect on non-repeaters. School-average repetition rates do not contribute to explaining the advantage of Francophone students in mathematics, as the mediation effect actually goes in the wrong direction.

#### 7.4. Taking all observed mediators into account

We failed to find a single mediator that could explain a significant share of the Francophone advantage in Grade 5 mathematics score. Could taking all of them into account explain a larger share of the effect? In this section, we estimate the effect of all observed mediators on test scores with the following equation:

$$score_{is} = \alpha_4 + \beta_4 WEST_s + f(\text{geographic location}_s) + \delta_4 g_i + Z'_s \gamma_4 + M'_{is} \theta_4 + \nu_{is} \quad (4)$$

where  $M_{is}$  is a vector of mediators. We start by considering all the mediators considered in Table 5, then we also add the mediators of Table 6, and finally we add the mediators of Table 7. Because of missing observations for each of the mediators, considering all mediators results in a smaller sample size. To limit the problem,

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mathematics scores. A one standard deviation increase in the Grade 5 vertical teaching index increases start of Grade 5 mathematics scores by 0.10 standard deviations (standard error 0.07).

we do not consider the school budget per pupil, a variable missing for a third of schools. A concern is that the mediators we are considering have little explanatory power for test scores, maybe because they are poorly measured, or because test scores are poorly measured. Therefore, we report three measures of the explanatory power of mediators: the adjusted  $R^2$ , the Akaike information criterion (AIC), and the Bayesian information criterion (BIC).

Table 8 presents the result of this exercise. Column (1) replicates our baseline estimate on the sample for which all mediators are observed. The border discontinuity in Grade 5 math score is  $-0.79$  standard deviation. In column (2), we control for a vector of mediators outside of the school system. The Francophone advantage attenuates slightly to  $-0.7$ . The adjusted  $R^2$  increases from 12% to 18% indicating that these variables have explanatory power. The AIC and BIC correspondingly decrease. In column (3), we add a vector of quantitative inputs of the education production function. The Francophone advantage does not attenuate, but actually increases (discontinuity of  $-0.9$ ). The adjusted  $R^2$  increases to 25%, indicating that these variables also have some explanatory power. We should remark that the coefficients of the mediators cannot be interpreted causally: for example, teacher education and experience appear to significantly decrease test scores, but it might be because more experienced teachers are allocated to more challenging classes. Finally, in column (4), we add the full vector of mediators. The Francophone advantage increases again (discontinuity of  $-0.99$ ), while the adjusted  $R^2$  increases to 32%, indicating that qualitative inputs of the education production function also have explanatory power. Taking all observed mediators into account fails to explain the Francophone advantage.

Though we identify several differences between the Francophone and Anglophone education system in Cameroon, and are able to confirm, using representative school survey data, some of the qualitative observations of Nana (2013), we are unable to identify the mediators of the Francophone advantage. How do we interpret this admittedly frustrating result? It could be that the main mechanism is one that is perfectly predicted by assignment to the Francophone or Anglophone system (like language of instruction or curriculum). In the absence of within system variation, mediation analysis is unable to help in tracking mechanisms. However, in both Anglophone and Francophone Cameroon, the language of instruction is the language of the former colonizer (French or English), very different from local languages, and spoken as a mother tongue by only a

Table 8: Mediation analysis with all potential mediators

	(1)		(2)		(3)		(4)	
	Grade 5 math score		Grade 5 math score		Grade 5 math score		Grade 5 math score	
WEST (border discontinuity)	-0.79***	(0.26)	-0.70**	(0.28)	-0.91***	(0.28)	-0.99***	(0.22)
Log of night lights			0.11	(0.10)	0.16*	(0.08)	-0.02	(0.09)
Infrastructure index			-0.10*	(0.06)	-0.08	(0.06)	-0.19***	(0.04)
Urban			0.52**	(0.26)	0.39	(0.26)	0.16	(0.23)
Family wealth index			0.01	(0.03)	0.01	(0.03)	0.03	(0.03)
Father literate			0.13	(0.10)	0.14	(0.09)	0.20**	(0.08)
Mother literate			-0.18*	(0.09)	-0.14**	(0.07)	-0.16**	(0.07)
Time to go to school			0.09	(0.06)	0.09	(0.06)	0.14***	(0.04)
Went to preschool					0.09	(0.10)	0.02	(0.09)
School equipment (index)					0.05	(0.08)	0.03	(0.07)
Class equipment (index)					0.01	(0.10)	0.09	(0.08)
Class size					-0.00	(0.00)	0.00	(0.00)
Teacher education (years)					-0.10**	(0.05)	-0.16***	(0.04)
Teacher experience (years)					-0.03**	(0.01)	-0.05***	(0.01)
Teacher salary (monthly 2010 USD)					-0.00	(0.00)	0.00**	(0.00)
Absenteeism (days)					-0.04	(0.02)	-0.03	(0.02)
Private school							0.40***	(0.14)
School management (index)							0.12*	(0.07)
Vertical teaching Grade 2 (index)							-0.04	(0.06)
Vertical teaching Grade 5 (index)							0.15*	(0.09)
Proportion of curriculum covered Grade 2 (%)							0.01	(0.00)
Proportion of curriculum covered Grade 5 (%)							0.00	(0.00)
Intensity of textbook use Grade 2 (index)							-0.23***	(0.08)
Intensity of textbook use Grade 5 (index)							0.01	(0.08)
Age							-0.04*	(0.02)
Number of repeated classes							0.01	(0.05)
Number of repeated classes (school average)							-0.35	(0.27)
Observations	668		668		668		668	
Number of schools	49		49		49		49	
Adjusted R <sup>2</sup>	0.120		0.183		0.248		0.324	
AIC	1,637		1,595		1,547		1,486	
BIC	1,687		1,676		1,664		1,652	

**Notes:** column (1) presents the border discontinuity (a positive coefficient favors the Anglophone side) in Grade 5 mathematics score, estimated using a bandwidth of 100-km and controlling for a linear function of distance to the border (whose slope is allowed to differ on either side), gender, and the geographic controls of Table 1. Column (2) presents the same specification, but controlling for mediators outside of the school system. Column (3) adds quantitative inputs of the education production function, and column (4) adds qualitative inputs of the education production function. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .



small minority of the population.<sup>58</sup> As for the curriculum, it is determined centrally and we showed in section 2 that syllabuses were very similar in the two sub-systems. Another possibility is that the mechanism explaining the Francophone advantage is a mechanism we have not explored — but the richness of the PASEC survey allowed us to be quite exhaustive and to consider most of the classical inputs of the education production function. Finally, it could be that the main mechanisms are ones we have explored, but for which we had only badly measured proxies. “Qualitative” inputs of the education production function are in particular much more difficult to measure than quantitative inputs, especially because most of our measures rely on self-declaration rather than a direct measure of teachers’ practices. Future research should try to improve these measures.

## 8. Conclusion

In this paper, we revisited the question of colonial legacies in education by focusing on quality rather than quantity. To do so, we studied Cameroon, a country where a Francophone education system with French colonial origins coexists with an Anglophone system with British colonial origins. We used spatial discontinuity analysis at the border between former French and former British Cameroon to identify the causal effect of colonial origins on test scores. Given the literature’s insistence on the virtues of the teaching style of Protestant missions in British colonies (Woodberry, 2004), one might have expected to find a better performance of pupils schooled in the Anglophone system, but we found the opposite. In mathematics, Francophone students perform better in Grade 5 by more than half of a standard deviation in test scores. It is important to stress here that one very important specificity of education systems with a British colonial origin, the use of local languages as a medium of instruction (Laitin et al., 2019), is not present in Cameroon’s Anglophone system.

In a second part of the paper, we explored the mechanisms behind our results. We showed that differences in economic development between Anglophone and Francophone Cameroon could not explain the better mathematics performance of Francophone students. Turning to the quantitative inputs of the education production function, we found that Francophone schools had better class equipment, but that this did not explain their advantage in mathematics scores. Turning to teaching practices, we found that Francophone teachers taught more vertically, and covered more of the curriculum, but that this did not explain our results either. What,

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<sup>58</sup>In contrast to many former British colonies with a legacy of missionary education, there is no local language instruction in Cameroon, except in a handful of experimental schools not in our sample (Laitin et al., 2019).

then, explains the difference in math scores at the end of primary school? It is unlikely that the reason the main mechanism cannot be captured by mediation analysis is that it is perfectly predicted by assignment to the Francophone or Anglophone system: the curriculum is centrally determined; though the teaching language differs systematically, it is, in both regions, the language of the former colonizer, spoken as a mother tongue by only a minority. It is likely however that our failure to identify mechanisms comes from the very coarse way we are able to measure teaching practices. Future research could try to build a measure of teachers' practices based on the actual observation of teachers rather than on self-declaration.

One question that our paper is not able to answer is whether the better performance of Francophone primary school students in mathematics actually matters, for example on the labor market. The literature often insists on the greater focus of education systems with French origins on abstract reasoning and academic knowledge, while education systems with British origins are more pragmatic and problem based. It is conceivable that the academically oriented approach is better at increasing test score, while the pragmatic approach is better at equipping children with useful tools and skills. Answering this question is beyond the scope of this paper, and we leave it for future research.

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# Appendix

## Appendix A. Additional Figures

Figure Appendix A.1: Sample of the Grade 5 test in Mathematics

<p>Circle the smallest fraction in each series :</p> <p><math>\frac{8}{4}</math>      <math>\frac{8}{32}</math>      <math>\frac{8}{16}</math>      <math>\frac{8}{2}</math></p> <hr/> <p><math>\frac{21}{7}</math>      <math>\frac{3}{7}</math>      <math>\frac{9}{7}</math>      <math>\frac{14}{7}</math></p> <hr/> <p><math>\frac{3}{5}</math>      <math>\frac{17}{5}</math>      <math>\frac{30}{5}</math>      <math>\frac{24}{5}</math></p> <hr/> <p><math>\frac{35}{35}</math>      <math>\frac{35}{16}</math>      <math>\frac{35}{45}</math>      <math>\frac{35}{70}</math></p>	<p>U <input type="checkbox"/></p> <p>V <input type="checkbox"/></p> <p>W <input type="checkbox"/></p> <p>X <input type="checkbox"/></p>	<p>Entoure la plus petite fraction de chaque série :</p> <p><math>\frac{8}{4}</math>      <math>\frac{8}{32}</math>      <math>\frac{8}{16}</math>      <math>\frac{8}{2}</math></p> <hr/> <p><math>\frac{21}{7}</math>      <math>\frac{3}{7}</math>      <math>\frac{9}{7}</math>      <math>\frac{14}{7}</math></p> <hr/> <p><math>\frac{3}{5}</math>      <math>\frac{17}{5}</math>      <math>\frac{30}{5}</math>      <math>\frac{24}{5}</math></p> <hr/> <p><math>\frac{35}{35}</math>      <math>\frac{35}{16}</math>      <math>\frac{35}{45}</math>      <math>\frac{35}{70}</math></p>	<p>Z <input type="checkbox"/></p> <p>AA <input type="checkbox"/></p> <p>AB <input type="checkbox"/></p> <p>AC <input type="checkbox"/></p>
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Test at the end of the fifth year - MATHEMATICS 17 Test de fin de deuxième année - MATHÉMATIQUES 18



Figure Appendix A.2: Sample of the Grade 5 test in Language

Dans une boîte de médicaments, on trouve la notice suivante : lisez-la attentivement et répondez aux propositions

**PRIMALAN**

**INDICATIONS :**

- *Dérangements intestinaux et plus spécialement :*
- diarrhées
- vomissements.

**POSOLOGIE:**

- *Adultes :* 1 à 6 comprimés par jour.
- *Enfants :* de 3 à 5 ans ½ comprimé deux fois par jour;
- au dessus de 5 ans: ½ comprimé 2 à 4 fois par jour.

- *A prendre au début des repas en avalant avec un peu d'eau, sans croquer.*

**PRECAUTIONS D'EMPLOI :**

*L'usage prolongé de ce médicament peut entraîner des maladies du rein.*

**PROPOSITIONS :**

1. Est-ce que ce médicament guérit la diarrhée ?  
( *Mets une croix en face de la bonne réponse* )

- oui
- non
- le texte ne le dit pas

Z

2. Un adulte peut prendre 8 comprimés par jour.  
( *Mets une croix en face de la bonne réponse* )

- oui
- non
- le texte ne le dit pas

AA

tournez la page...

Inside a packet of drug, we see a notice as follows : Read it carefully and give answers to the propositions.

**PRIMALAN**

**INDICATIONS :**

- *Stomach pains and specially :*
- diarrhoea
- vomiting

**DOSAGE:**

- *Adult :* 1 to 6 tablets a day .
- *Children :* From 3 to 5 years old, ½ tablet two times a day;
- above 5 years old,½ tablet 2 to 4 times a day .
- *To be taken at the beginning of lunch by swallowing it with a bit of water without breaking .*

**PRECAUTION FOR USAGE :**

*A prolonged usage of this medicine, can develop to joint pains.*

**PROPOSITIONS :**

1. Does this medicine treat diarrhoea ?  
( *Put a cross opposite the right answer* )

- yes
- no
- the text does not say so

Z

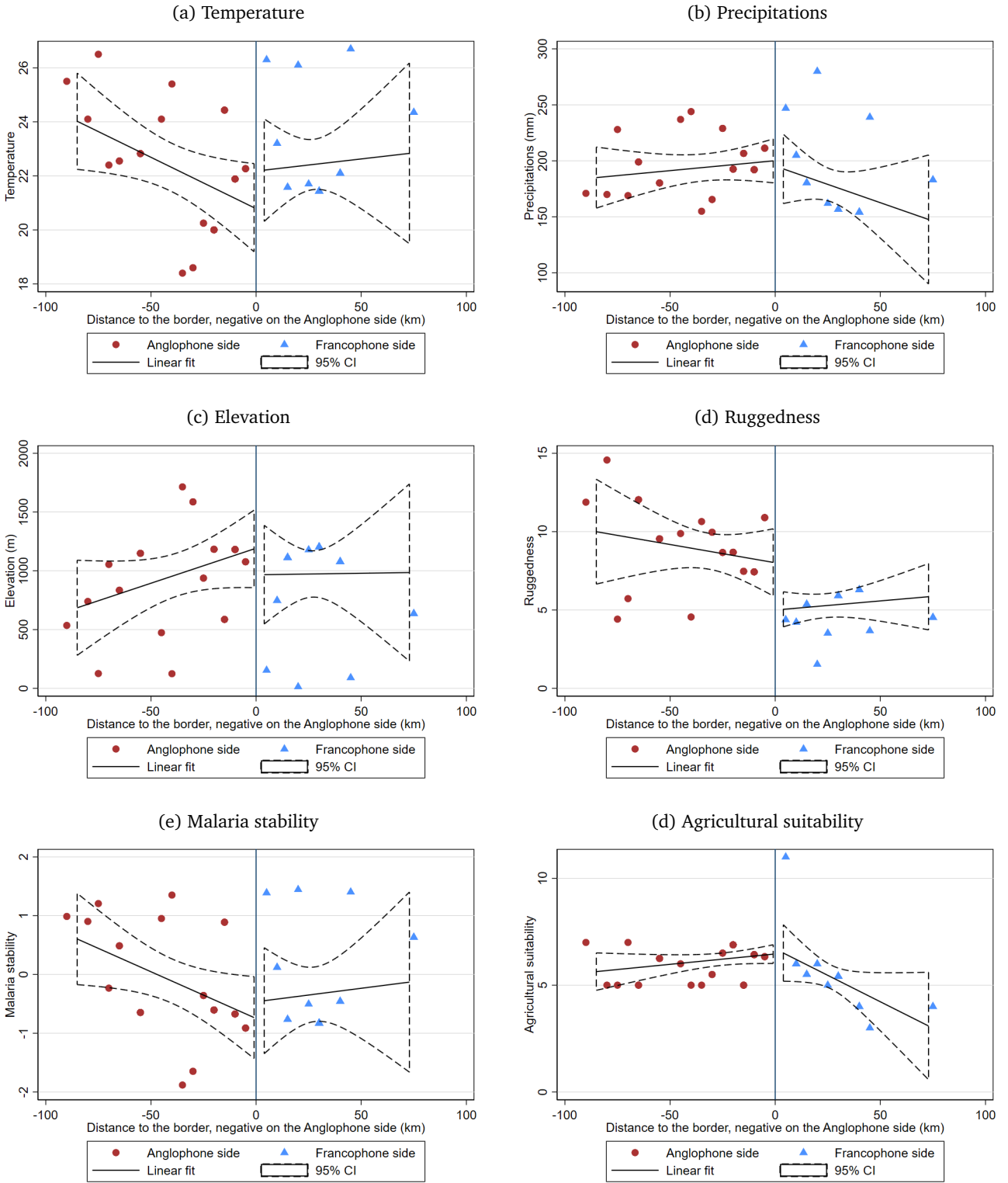
2. An adult can take 8 tablets a day.  
( *Put a cross opposite the right answer* )

- yes
- no
- The text does not say so

AA

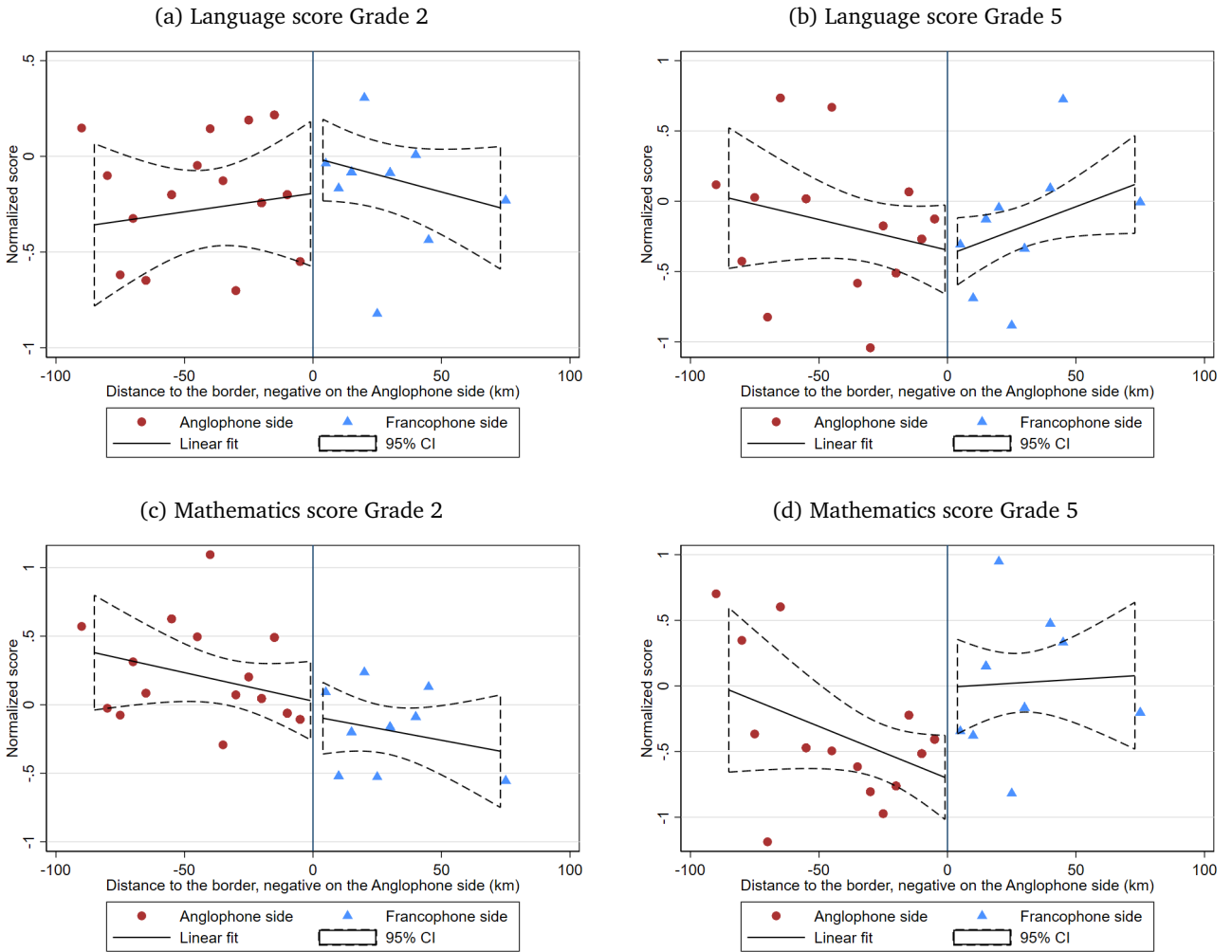
Turn over the page...

Figure Appendix A.3: Visual representation of discontinuities in geographic characteristics



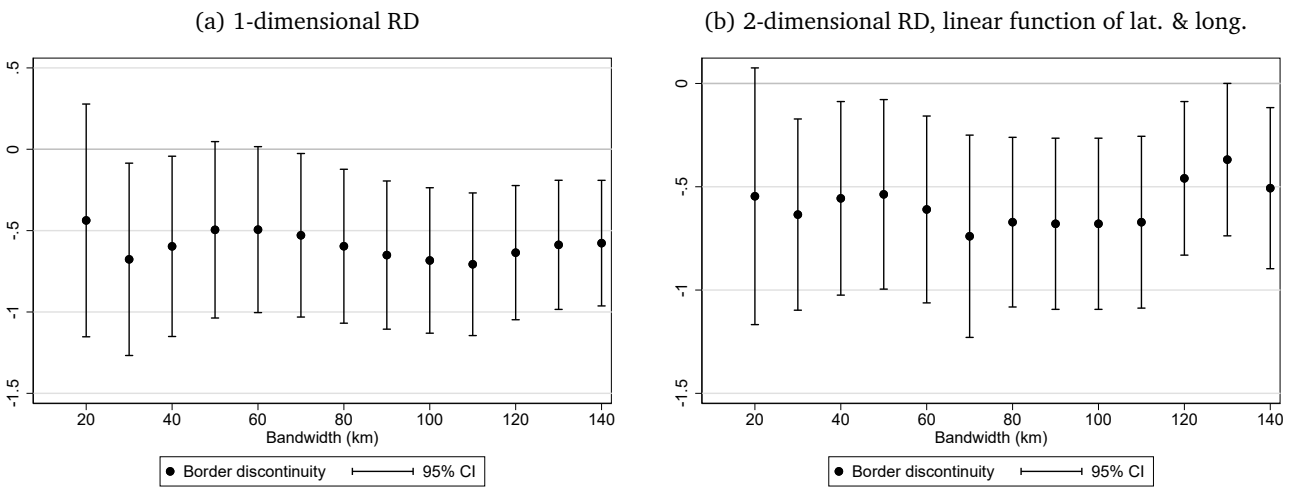
**Note:** Each panel graphs the average value of the variable for each 5 km bin on both sides of the border. The line on either side is fitted on observations collapsed by school (since this is the unit of treatment and the unit of clustering) and weighed by their probability sampling weight. Distances are negative on the Anglophone (Western) side and positive on the Francophone (Eastern) side and the border corresponds to a distance of zero.

Figure Appendix A.4: Visual representation of discontinuities in test scores



**Note:** Each panel graphs the average value of the test score for each 5 km bin on both sides of the border. The line on either side is fitted on observations collapsed by school (since this is the unit of treatment and the unit of clustering) and weighed by their probability sampling weight. Distances are negative on the Anglophone (Western) side and positive on the Francophone (Eastern) side and the border corresponds to a distance of zero. For each subject and grade, each individual student's score is computed as the average of the start-of-year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation.

Figure Appendix A.5: Robustness of Grade 5 mathematics score discontinuities to varying the bandwidth



**Note:** these graphs plot estimated discontinuities in mathematics scores (a positive coefficient favors the Anglophone side) against the size of the bandwidth. In panel (a), the border discontinuity is estimated using a local linear non-parametric function of distance to the border with a triangular kernel. In panel (b), the border discontinuity is estimated controlling for a linear function of latitude and longitude.

## Appendix B. Additional Tables

Table Appendix B.1: Comparison of Francophone and Anglophone Mathematics Grade 2 Syllabus

Francophone Grade 2 Syllabus		Anglophone Grade 2 Syllabus	
Contenu	Objectif	Content	Objectives
		Set and Logic	a) Revise class 1 work b) Classify objects using 2 or 3 attributes c) Identify the common objects in two sets d) Use the symbol U and to combine two sets
<b>Préliminaires</b>			
Comparer des quantités - plus de ... que, moins de ... que, autant de ... que - "plus petit que", "plus grand que"	Employer correctement les expressions ci-après dans des situations concrètes : - plus de ... que, moins de ... que, autant de ... que - "plus petit que", "plus grand que" Comparer une quantité, une mesure par rapport à une autre		
<b>Nombres et Numération</b>			
- Les nombres de 10 à 20	- Classer les nombres de 0 à plusieurs objets et écrire le nombre correspondant en chiffres et en lettres	Number and numeration	f) Write in words 1 to 10
- Les nombres de 21 à 29 Construction des nombres (notion de quantité associée à un nombre)	- Constituer des collections correspondant à un nombre donné et associer un nombre à une collection donnée		
- Rangement des nombres dans l'ordre croissant et décroissant : introduction des symboles > et < (notion d'ordre)	- Comparer des nombres à partir de manipulations de collections en utilisant les signes < et > - Ranger, nommer et écrire les nombres de 0 à 100	Number and numeration	a) Count, read and write numbers 0 - 100 c) Compare two numbers using the symbols (>,<)
- Pratique de l'addition : addition sans retenue addition avec retenue	- Calculer la somme de deux nombres en abandonnant progressivement le petit matériel au profit de l'utilisation de schématisations. - Effectuer correctement une addition sans retenue. - Effectuer correctement une addition avec retenue (résultat inférieur à 100) - Utiliser la technique opératoire pour résoudre des problèmes additifs.	Basic number operations	a) Carry out horizontal and vertical addition of 2 or 3 numbers up the 99 without carrying. b) Add two numbers vertically under H, T, U
- Pratique de la multiplication	- Calculer un produit par dénombrement (comptage) - Calculer un produit en effectuant des additions de nombres égaux. - Effectuer correctement une multiplication sans retenue (résultat inférieur à 100)	Basic number operations	f) Multiply a number with two or three digits by a one-digit number
- Pratique de la soustraction	- Trouver le nombre manquant (ou caché) d'une addition à deux nombres - Effectuer correctement une soustraction sans retenue puis avec retenue (nombres inférieurs à 100)	Basic number operations	d) Perform subtraction without carrying involving numbers up to 100
- Partage en parts égales	- Résoudre des situations de partage exact en utilisant le signe divisé ":" pour coder le partage (pas de technique opératoire de la division à ce niveau) - Trouver le nombre de parts et la valeur d'une part.	Number and numeration	d) Find $1/2$ , $1/4$ , $1/3$ , of suitable numbers up to 20 g) Shade $1/2$ , $1/4$ , $3/4$
- Construction des tables d'addition puis de multiplication (résultat inférieur ou égal à 100)	- Compléter et utiliser les tables d'addition et de multiplication.	Basic number operations	e) Construct and use multiplication tables 2, 4, 5, 10.
- Les nombres de 30 à 70 - Les nombres de 70 à 100	- Addition et soustraction des nombres avec des résultats inférieurs à 70 - Addition et soustraction des nombres avec des résultats inférieurs à 100		a) Carry out horizontal and vertical addition of 2 or 3 numbers up the 99 without carrying. d) Perform subtraction without carrying involving numbers up to 100
- Pratique du calcul mental	- Calculer mentalement des opérations simples d'addition, de multiplication et de soustraction		
- Suite des nombres	- Définir une série en citant des nombres qui constituent (définition en extension) ou en donnant l'un des termes et la raison (nombre ajouté, nombre retranché) de cette suite.		
- Opérateurs numériques le double, la moitié d'un nombre Chaîne d'opérateurs	- Compter de 2 en 2, de 5 en 5, de 10 en 10. - Trouver le double ou la moitié d'un nombre - Ecrire, schématiser, réduire des chaînes d'opérateurs	Number and numeration	e) Count in 2s, 4s, 5s, and 10, up to 100;
		Number and numeration	b) Interpret a number under tens and units; h) Interpret a number under H, T, U

		Basic number operations	c) Recognise and illustrate the commutative property of addition ( $a+b = b+a$ ) g) Recognise and illustrate the commutative property of multiplication ( $a.b = b.a$ ) h). Carry out division without remainders of numbers less than 100 by 2, 5 and 10.
<b>Mesures : unités du système métrique</b>			
- Utilisation d'unités naturelles ou arbitraires puis universelles dans des situations de vie courante (intérêt de la mesure-unité).	- utiliser des unités de mesure arbitraires. - Se construire une règle graduée et l'utiliser pour évaluer des longueurs (fabriquer un outil de mesurage pour pouvoir comparer des grandeurs entre elles - Reconnaître et utiliser correctement les unités de longueur universelles (m, dm, cm). - Additionner correctement des mesures de longueur.	Measurement	a) Measure length using metre b) Measure capacity using litre c) Measure mass using gram d) Recognise and use money up to 100frs
- Lecture de l'heure, de la demi-heure.	- Lire exactement l'heure et la demi-heure, telles qu'indiquées sur la montre. - Confectionner une horloge à aiguilles mobiles.	Measurement	e) Draw and label the clock face
- Usage du calendrier : jours de la semaine.	- Indiquer le jour qu'il était, le jour qu'il est et le jour qu'il sera dans la semaine. - Confectionner un calendrier.	Measurement	f) Name days of the week g) Determine how many weeks in the month
- Comparaison de grandeurs	- Comparer entre elles des mesures de longueur, de masse, de temps.		
<b>Géométrie</b>			
- Identification des solides géométriques simples	- Manipuler et classer les solides selon certaines de leurs propriétés - Identifier les faces et les bases du cube, du pavé droit, du prisme et de la pyramide à base triangulaire par l'observation de leurs empreintes'	Geometry	a) Review class 1 work b) Recognise and draw circle, triangle, rectangle square
- Le carré, le rectangle, le triangle	- Identifier ces figures et les distinguer parmi d'autres. - Construire un carré, un rectangle, un triangle par pliage et découpage.'		
- Le cercle	- Identifier un cercle. - Fabriquer un cercle (disque) par découpage.		
- Pliage, recouvrement, déplacement, superposition (réalisation de pavage, de mosaïque, de puzzles).	- Composez un pavage, un mosaïque, '- Reconstituer un puzzle figuratif.		
- Cheminement, labyrinthe	- Suivre correctement le chemin qu'il faut dans un labyrinthe		
		Graphs and statistics	a) Draw the number line 1- 100 b) Locate points on the number line with respect to reference point c) Draw line segment to scale
<b>Problèmes</b>			
- Problèmes faisant intervenir la somme de deux ou plusieurs nombres (résultat inférieur à 100) ou la différence de deux nombres.	- Analyser des problèmes de recherche simples et choisir les données nécessaires à leur résolution. - Exposer clairement des résultats - Evaluer l'ordre de grandeur d'un résultat.	Problem solving	a) Interpret real life problem mathematically b) Determine what operation to use in simple story problem c) Play shopping games, number games and do number puzzles
- Problèmes faisant intervenir une grandeur.	- résoudre des problèmes pratiques faisant référence aux notions de longueur, de masse, de temps.		
- Activités liées au rythme et à la périodicité	- Poursuivre une frise, un pavage à motif simple, en utilisant un quadrillage, - Reproduire des figures sur un quadrillage ou avec des instruments de géométrie (règle, équerre, compas).		

Table Appendix B.2: Comparison of Francophone and Anglophone Mathematics Grade 5 Syllabus

Francophone Grade 2 Syllabus		Anglophone Grade 2 Syllabus	
Contenu	Objectif	Content	Objectives
		Sets and Logic	a) Revise class 4 work b) Identify the universal set in a set situation. c) Construct subsets from a universal set. d) Determine the complement of a given set and denote correctly e) Find the intersection of three sets. f) Define null/empty set as the intersection of disjoint sets and denote correctly g) Represent disjoint sets, intersection set, complement of a set etc by a Venn diagram. h) Interpret expressions such as A or B; A and B.
<b>Opérations et opérateurs</b>			
Calcul mental	- découvrir et appliquer les propriétés de distributivité de la multiplication par rapport à l'addition. Exemple: $24 \times 15 = 24 \times (10 + 5) = (24 \times 10) + (24 \times 5) = 240 + 120 = 360$ - découvrir et appliquer les propriétés de distributivité de la multiplication par rapport à la soustraction. Exemple: $24 \times 19 = 24 \times (20 - 1) = (24 \times 20) - (24 \times 1) = 480 - 24 = 456$ - multiplier par 10, 100, 1000 - multiplier par 0,25, 0,50, 0,75 - utiliser les caractères de divisibilité par 5, 10, 100, 1000 - diviser par 25, 50, 75	Basic number operations	d) Use the long division method to divide one number by another with and without remainder. e) Demonstrate the distributive law of multiplication over addition ( $a(b+c) = ab+ac$ ) i) Find LCM and HCF by factors. j) Introduce and use of calculators in a four rules. Carry out addition, subtraction, multiplication and division using a calculator. k) Recall and memorize
Opérations avec des nombres entiers	- additionner des nombres entiers - soustraire des nombres entiers - multiplier des nombres entiers (trois produits partiels) - effectuer la division d'un entier avec un nombre de 2 ou 3 chiffres au diviseur - prendre l'ordre de grandeur d'un résultat - s'assurer de la vraisemblance d'un résultat - contrôler un résultat	Basic number operations	a) Carry out addition of four and five-digit numbers whose sum is up to 1,000,000. b) Build and use the multiplication tables 11 and 12. c) Multiply 3-or 4-digit numbers with product up to 1,000,000.
Opérations avec des nombres décimaux (connus à 0,01 près)	- additionner des nombres décimaux - soustraire des nombres décimaux - multiplier des nombres entiers (trois produits partiels) - prédire l'ordre de grandeur d'un résultat - s'assurer de la vraisemblance d'un résultat - contrôler un résultat	Basic number operations	h) Carry out multiplication, subtraction, addition and division in the decimal notation.
Opérations avec des nombres entiers et des nombres décimaux	- additionner un nombre entier et un nombre décimal (et inversement) - soustraire un nombre entier et un nombre décimal (et inversement) - multiplier un nombre entier et un nombre décimal (et inversement) - prédire l'ordre de grandeurs d'un résultat - s'assurer de la vraisemblance d'un résultat - contrôler un résultat	Basic number operations	n) Divide decimals by whole numbers
Opérations avec des nombres fractionnaires	- additionner des fractions de même dénominateur - soustraire des fractions de même dénominateur - prendre une fraction d'un nombre entier - calculer le produit d'une fraction par un nombre entier (et inversement) - diviser un nombre entier par une fraction - prédire l'ordre de grandeur d'un résultat - s'assurer de la vraisemblance d'un résultat - contrôler un résultat	Basic number operations	f) Perform addition and subtraction of mixed fractions. g) Divide fractions and whole numbers by fractions.
		Measurement	e) Differentiate between vulgar fraction, decimal fraction and percentage. g) Differentiate between simple direct proportion and inverse proportion and solve problems.
Opérations dans le système sexagésimal	- appliquer les techniques d'addition dans le système sexagésimal (heure, minute, seconde) - appliquer les techniques de soustraction dans le système sexagésimal (heure, minute, seconde)	Measurement	h) Tell time in hours, minutes, seconds and perform calculation involving time.
Les pourcentages	- appliquer un pourcentage dans diverses situations - calculer un pourcentage dans le cadre des activités agricoles, industrielles, commerciales, sociales et scolaires, épargne, capital, intérêt, achat, vente, bénéfice, perte, frais, % de réussite à un examen.	Basic number operations	o) Find given fraction or percentage of a number.
		Measurement	j) Define C.P.; S.P.; Profit and loss. k) Determine profit and loss given C.P. and S.P. f) Establish the relationship between principal, time, rate, simple interest and amount.
<b>Nombres et Numération</b>			
Nombres entiers naturels	- lire et écrire en chiffres ou en lettre n'importe quel nombre de 0 à un million - décomposer ces nombres en classes - appliquer les caractères de divisibilité par 3 et par 9	Number and numeration	a) Revise the notions in class 4 work b) Read and write numbers up to 1,000,000 c) Write numbers in words up to 1,000,000 using notion of place value. h) Carry out numeration in base 2 and base 5 i) Modular arithmetic 2, and 5.



Nombres décimaux	<ul style="list-style-type: none"> <li>- découvrir les nombres décimaux à partir des mesures de longueurs</li> <li>- lire et écrire des nombres (connus de 0,1 à 0,01 près) à partir des mesures de longueurs, de capacités, de masses</li> <li>- placer des décimaux sur une demi-droite graduée en unités entières</li> <li>- comparer deux décimaux à l'aide d'une droite numérique</li> <li>- ranger des nombres décimaux dans l'ordre croissant ou décroissant à l'aide d'une droite numérique</li> <li>- placer un décimal entre deux décimaux à l'aide d'une droite numérique</li> </ul>	Number and numeration	d) Convert from the vulgar to decimal notation and vice versa.
Nombres fractionnaires	<ul style="list-style-type: none"> <li>- coder un partage en parts égales à l'aide de fractions</li> <li>- comparer des fractions de même dénominateur</li> <li>- ranger des fractions de même dénominateur</li> <li>- placer une fraction entre deux entiers consécutifs</li> <li>- écrire un nombre décimal sous forme fractionnaire</li> <li>- reconnaître deux fractions égales</li> <li>- simplifier une fraction pour la rendre irréductible</li> </ul>	Operations	l) Convert vulgar fractions to the decimal notation. m) Express a number as a fraction of another.
<b>Mesures : unités du système métrique</b>			
Unités de longueur, de surface, de capacité, de masse, de temps	<ul style="list-style-type: none"> <li>- convertir les unités de longueur, surface, capacité, masse, temps</li> </ul>	Measurement	a) Revise time, length, area, capacity. d) Build and use table of length from mm to m. e) Perform measurements and calculations involving the different units above. f) Build metric table of weight from mg to kg.
Périmètres (triangle carré, rectangle, parallélogramme, losange)	<ul style="list-style-type: none"> <li>- retrouver et appliquer la formule du calcul du périmètre du triangle</li> <li>- retrouver et appliquer la formule du calcul du périmètre du rectangle</li> <li>- retrouver et appliquer la formule du calcul du périmètre du carré</li> <li>- découvrir et appliquer la formule du calcul du périmètre du parallélogramme</li> <li>- calculer une dimension du rectangle connaissant le périmètre (ou l'aire) de ce rectangle et l'autre dimension</li> <li>- calculer le coté du carré connaissant le périmètre de ce carré</li> </ul>	Measurement	i) Establish formulae for perimeter of square, and rectangle; circumference of circle.
Aires (carré, rectangle, triangle, parallélogramme, losange)	<ul style="list-style-type: none"> <li>- retrouver et appliquer la formule du calcul de l'aire du triangle</li> <li>- retrouver et appliquer la formule du calcul de l'aire du rectangle</li> <li>- retrouver et appliquer la formule du calcul de l'aire du carré</li> <li>- découvrir et appliquer la formule du calcul de l'aire du parallélogramme</li> <li>- calculer une aire par somme de différence d'aire de figures simples</li> <li>- réaliser des pavages d'une surface à l'aide de polygones usuels (triangles, carrés, rectangle, parallélogrammes) pour en calculer l'aire</li> </ul>	Measurement	b) Find area of square, rectangle using formula c) Find area of right angled triangle g) Find area of trapezium, parallelogram.
Volumes (cube et pavé droit)	<ul style="list-style-type: none"> <li>- découvrir et appliquer la formule de calcul du volume du cube</li> <li>- découvrir et appliquer la formule de calcul du volume du pavé droit</li> </ul>		
Repérage dans le temps	<ul style="list-style-type: none"> <li>- repérer un événement dans le temps et schématiser la situation sur une droite chronologique</li> <li>- lire et écrire l'heure exacte</li> <li>- utiliser le calendrier</li> </ul>	Measurement	l) Carry out calculations involving distance, speed and time
Instruments de mesures	<ul style="list-style-type: none"> <li>- utiliser systématiquement des instruments de mesure : double-décimètre, compas, horloge, balance...</li> </ul>		
<b>Géométrie</b>			
Constructions géométriques	<ul style="list-style-type: none"> <li>- construire une figure d'après une description</li> <li>- reproduire à l'identique une figure existante</li> <li>- distinguer et tracer différents types d'angles</li> </ul>		
Symétrie par rapport au plan (miroir)	<ul style="list-style-type: none"> <li>- observer et décrire l'image d'un objet placé devant un miroir et les effets obtenus à la suite de déplacements de cet objet devant le miroir</li> </ul>		
Symétrie par pliage et quadrillage	<ul style="list-style-type: none"> <li>- obtenir par pliage la symétrie d'une figure simple par rapport à une droite (pli)</li> <li>- tracer sur quadrillage la symétrie d'une figure simple par rapport à une droite</li> </ul>		

Symétrie par rapport à une droite	<ul style="list-style-type: none"> <li>- reconnaître deux figures symétriques par rapport à une droite</li> <li>- construire le symétrique d'une figure par rapport à une droite à l'aide des instruments de géométrie</li> <li>- faire le lien entre axe de symétrie et médiatrice du segment joignant deux points symétriques</li> <li>- retrouver l'axe de symétrie de deux figures symétriques</li> <li>- tracer la médiatrice d'un segment avec la règle graduée et l'équerre</li> </ul>		
Hauteur, médianes et bissectrices dans un triangle	<ul style="list-style-type: none"> <li>- construire à la règle graduée et à l'équerre, une hauteur, une médiane d'un triangle</li> <li>- construire à la règle et au rapporteur la bissectrice d'un angle</li> <li>- reproduire un angle à l'aide d'un calque, d'un gabarit ou du compas</li> </ul>		
Le prisme et le cylindre droit	<ul style="list-style-type: none"> <li>- reconnaître et préciser les caractéristiques du prisme droit</li> <li>- reconnaître et préciser les caractéristiques du cylindre droit</li> <li>- fabriquer les patrons d'un prisme droit, d'un cylindre droit</li> </ul>	Geometry	<ul style="list-style-type: none"> <li>a) Identify rhombus, trapezium, and parallelogram.</li> <li>b) Identify sphere, prism, cone.</li> <li>c) Identify the different pieces in a maths set.</li> <li>d) Draw straight line and plane shape to scale.</li> </ul>
		Graphs and statistics	<ul style="list-style-type: none"> <li>a) Review notion of class 4 work</li> <li>b) Locate a point using its co-ordinates</li> <li>c) Determine co-ordinates of a marked point.</li> <li>d) Read and interpret information from a simple bar graph</li> <li>e) Represent information on a simple bar graph.</li> </ul>
<b>Résolution méthodique de problème</b>			
Varier les énoncés - texte, - calendrier, - schémas, - frises, quadrillages, - graphiques...	<ul style="list-style-type: none"> <li>- repérer la question,</li> <li>- distinguer les questions qui nécessitent un calcul et celles qui n'en nécessitent pas,</li> <li>- distinguer les questions auxquelles on peut répondre de celles auxquelles on ne peut pas répondre,</li> <li>- inventer les questions et les ranger pour aboutir à une résolution du problème</li> <li>- trouver les questions intermédiaires à la résolution d'un problème (une seule question apparaissant dans l'énoncé), sélectionner les informations utiles à la résolution du problème</li> <li>- trouver les informations manquantes</li> <li>- sélectionner la ou les opérations utiles à la résolution du problème,</li> <li>- évaluer l'ordre de grandeur d'un résultat, s'assurer de la vraisemblance d'un résultat</li> </ul> <p>Quel que soit l'objectif d'apprentissage visé:</p> <ul style="list-style-type: none"> <li>- l'énoncé doit faire l'objet, par l'élève, d'une lecture et d'une reformulation (oralement, en jouant la scène, en dessinant, en schématisant) pour montrer qu'il a compris la situation</li> <li>- l'élève doit communiquer sa démarche de résolution et argumenter à propos de la validité d'une solution</li> </ul>	Problem solving	<ul style="list-style-type: none"> <li>a) Find out what is required from a question or problem</li> <li>b) Choose a method of solving problem</li> <li>c) Determine the materials to be used to solve problem.</li> <li>d) Determine when the problem is solved.</li> <li>e) Write out the solution of a problem.</li> </ul>

Table Appendix B.3: Description of the indices

Index	Variables used	Component used	Proportion of variability explained
<b>Wealth</b>	faucet; toilet; well; electricity; petrol lamp; gas lamp; fridge; gas cooker; television; sewing machine; computer; telephone; radio; books; car; motorbike	1	0.29
<b>Class equipment</b>	teacher's desk; teacher's chair; closet; board; chalk; ruler; square; compass; dictionary; map; electricity; proportion of pupils seated comfortably (none, some, half, almost all, all); classroom material (hard, half-hard, wood, other)	1	0.21
<b>Intensity of textbook use</b>	frequency of the use of textbooks (language and mathematics)	1	0.95
<b>Vertical teaching</b>	"With the # of pupils > 50, it is impossible to accept interaction betw. pupils"; "When the topic is new, it is impossible to let the pupils learn in group"; "Time devoted to lazy pupils slows down the progression of lessons"; "Beating method is sometimes necessary on certain pupils";	1	0.33
<b>School equipment</b>	library; free canteen; fee-paying canteen; electricity; road access	1	0.31
<b>Quality of school management</b>	frequency of staff meetings; quality of the relationship with parents; parents' involvement	2	0.26
<b>Infrastructure of the locality</b>	paved road; electricity; running water; middle school; high school; health center; telephone; bank; savings bank; police station	1	0.48

**Notes:** all indices are built using principal component analysis. This table indicates the variables used for each index, the component used (typically the first component, except in the case of school management quality, because the variables used contributed to the second component in the expected directions, but did not contribute to the first component in the expected directions), and the proportion of variability explained by the chosen component.

Table Appendix B.4: Descriptive statistics

	Obs	Min	Mean	s.d.	Max					
<b>School and locality</b>										
Locality is in urban area	170.00	0.00	0.43	0.50	1.00					
Private	171.00	0.00	0.22	0.41	1.00					
School equipment (index)	171.00	-1.68	-0.02	1.00	2.95					
School management (index)	161.00	-2.49	-0.01	0.94	2.77					
School budget per pupil (yearly - 2010 USD)	143.00	0.00	12.91	27.21	225.88					
Infrastructure index	171.00	-2.91	-0.06	2.20	3.64					
Temperature (° celsius)	174.00	16.20	24.19	2.88	28.30					
Precipitations (mm)	174.00	40.00	151.66	64.28	292.00					
Elevation (m)	174.00	11.88	691.61	498.24	2,192.80					
Ruggedness	174.00	0.18	4.80	3.69	16.69					
Malaria stability	174.00	2.25	13.29	5.45	24.53					
Agricultural suitability	174.00	1.00	5.09	2.78	11.00					
Luminosity at night	174.00	0.00	4.28	10.58	38.09					
Dependence on agriculture (Ethnographic Atlas)	141.00	2.00	6.24	1.31	9.00					
Mean size of local community (Ethnographic Atlas)	59.00	2.00	2.76	0.97	5.00					
Political centralization (Ethnographic Atlas)	131.00	1.00	1.76	0.90	3.00					
German school in 1911	174.00	0.00	0.25	0.44	1.00					
<hr/>										
<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <b>Second grade</b> </div> <div style="text-align: center;"> <b>Fifth grade</b> </div> </div>										
	Obs	Min	Mean	s.d.	Max	Obs	Min	Mean	s.d.	Max
<b>Class and Teacher</b>										
Class size	164.00	9.00	55.26	32.11	158.00	161.00	1.00	53.89	31.76	161.00
Class equipment (index)	170.00	-1.85	-0.23	0.88	2.09	164.00	-1.78	0.23	1.07	2.53
Teacher education (years)	172.00	6.00	11.24	2.28	18.00	167.00	6.00	12.29	1.68	17.00
Teacher experience (years)	170.00	1.00	10.06	8.17	40.00	167.00	0.00	9.96	8.33	43.00
Teacher salary (monthly 2010 USD)	170.00	38.72	240.54	218.29	813.18	164.00	38.72	316.87	244.73	813.18
Proportion of curriculum covered (%)	162.00	1.00	69.23	26.76	100.00	161.00	0.00	75.13	21.90	100.00
Absenteeism (days)	168.00	0.00	2.79	3.01	16.00	162.00	0.00	2.75	3.01	16.00
Intensity of textbook use (index)	170.00	-1.31	-0.04	1.03	1.05	161.00	-1.31	0.05	0.97	1.05
Vertical teaching (index)	168.00	-2.85	-0.00	1.07	1.37	162.00	-2.04	-0.00	0.93	1.37
<hr/>										
<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <b>Second grade</b> </div> <div style="text-align: center;"> <b>Fifth grade</b> </div> </div>										
	Obs	Min	Mean	s.d.	Max	Obs	Min	Mean	s.d.	Max
<b>Individual</b>										
Age in years	2,410.00	4.00	7.66	1.51	14.00	2,358.00	7.00	11.41	1.80	20.00
Student is a girl	2,427.00	0.00	0.46	0.50	1.00	2,360.00	0.00	0.45	0.50	1.00
Parental wealth (index)	2,426.00	-1.00	-0.07	0.97	3.76	2,361.00	-1.00	0.07	1.03	3.76
Father reads	2,381.00	0.00	0.73	0.45	1.00	2,296.00	0.00	0.76	0.43	1.00
Mother reads	2,400.00	0.00	0.60	0.49	1.00	2,305.00	0.00	0.64	0.48	1.00
Number of repeated classes	2,427.00	0.00	0.55	0.57	2.00	2,361.00	0.00	0.95	0.79	5.00
Private school	2,504.00	0.00	0.22	0.41	1.00	2,409.00	0.00	0.22	0.41	1.00
Has attended preschool	2,394.00	0.00	0.29	0.45	1.00	2,324.00	0.00	0.33	0.47	1.00
Mathematics z-score	2,427.00	-2.73	0.00	1.00	2.25	2,361.00	-3.09	-0.00	1.00	3.45
Mathematics z-score, start-of-year	2,427.00	-2.34	0.00	1.00	1.69	2,361.00	-2.64	0.00	1.00	2.72
Mathematics z-score, end-of-year	2,427.00	-2.60	-0.00	1.00	1.96	2,361.00	-2.85	-0.00	1.00	3.00
Language z-score	2,427.00	-2.52	-0.00	1.00	2.35	2,361.00	-2.55	-0.00	1.00	3.17
Language z-score, start-of-year	2,427.00	-1.56	-0.00	1.00	2.21	2,361.00	-2.24	-0.00	1.00	3.23
Language z-score, end-of-year	2,427.00	-2.70	0.00	1.00	1.72	2,361.00	-2.59	-0.00	1.00	2.66

Table Appendix B.5: Cross-border migration among school-age children in the 2005 census

	Living in Francophone Cameroon		Living in Anglophone Cameroon	
Born in Francophone Cameroon	43,683	98.57%	1,089	2.03%
Born in Anglophone Cameroon	632	1.43%	52,606	97.97%
Total	44,315	100%	53,695	100%

**Notes:** Figures obtained on a 10% extract of the 2005 Cameroonian population census. The sample is restricted to children living outside Douala and within 100 km of the border to stay as close as possible to our main specification, but migration is also low when we consider the full sample. We obtain similarly low migration rates when we consider only the children currently attending school.

Table Appendix B.6: Regression of mathematics score on gender and geographical variables

	(1)	(2)	(3)	(4)
	Whole country		Within <100km of border	
	Grade 2 math score	Grade 5 math score	Grade 2 math score	Grade 5 maths score
<b>Individual variables</b>				
Girl	-0.12** (0.05)	-0.09* (0.05)	0.02 (0.06)	-0.03 (0.07)
<b>Geographical variables</b>				
Temperature (° celsius)	0.13** (0.06)	0.05 (0.07)	0.03 (0.08)	0.07 (0.09)
Precipitations (mm)	0.00** (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.01)
Elevation (m)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Ruggedness	0.02 (0.02)	-0.02 (0.02)	0.02 (0.02)	-0.00 (0.03)
Malaria stability	-0.02* (0.01)	-0.01 (0.02)	-0.04*** (0.01)	-0.03 (0.02)
Agricultural suitability	-0.03* (0.02)	-0.02 (0.02)	-0.04 (0.04)	-0.10** (0.04)
Observations	2,270	2,179	1,002	958
Number of schools	161	154	71	67
Adjusted R <sup>2</sup>	0.03	0.05	0.04	0.11

**Notes:** this table presents regression of the Grade 2 and Grade 5 math scores on all the variables used as controls in the main specification. In columns (1) and (2), we consider all schools in the sample, and in columns (3) and (4), we restrict the sample to schools located within <100-km of the border. The coefficient on ruggedness, the only unbalanced geographic characteristic in Table 1, is small and never statistically significant.

Table Appendix B.7: Robustness to various specifications and samples

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Variations in specifications			Variations in samples	
		1-dimensional RD 2d degree polynomial in distance to border	2-dimensional RD linear function of lat. & long.	2-dimensional RD 2d degree polynomial in lat. & long.	Including Douala	Excluding the North
<b>Language scores</b>						
<b>Grade 2</b>						
Language score	-0.06 (0.21) [-0.71, 0.42]	-0.19 (0.30) [-1.15, 0.51]	0.01 (0.20)	-0.09 (0.23)	-0.29 (0.22) [-0.94, 0.26]	-0.31 (0.20) [-0.97, -0.17]
Bandwidth (km)	118	129	100	100	112	80
Observations (effective)	1,068	1,083	1,002	1,002	1,210	325
Observations (total)	2,270	2,270	2,270	2,270	2,427	895
<b>Grade 5</b>						
Language score	0.13 (0.21) [-0.35, 0.69]	0.26 (0.28) [-0.27, 1.03]	0.01 (0.18)	0.11 (0.20)	-0.09 (0.25) [-0.62, 0.61]	0.64*** (0.18) [0.36, 1.31]
Bandwidth (km)	111	121	100	100	107	62
Observations (effective)	1,007	1,022	958	958	1,136	255
Observations (total)	2,179	2,179	2,179	2,179	2,338	861
<b>Mathematics scores</b>						
<b>Grade 2</b>						
Mathematics score	0.19 (0.21) [-0.49, 0.68]	0.13 (0.32) [-0.74, 0.96]	0.27 (0.19)	0.29 (0.20)	0.05 (0.21) [-0.61, 0.56]	0.01 (0.17) [-0.56, 0.29]
Bandwidth (km)	113	121	100	100	110	81
Observations (effective)	1,053	1,068	1,002	1,002	1,210	325
Observations (total)	2,270	2,270	2,270	2,270	2,427	895
<b>Grade 5</b>						
Mathematics score	-0.70*** (0.22) [-1.27, -0.11]	-0.59* (0.30) [-1.19, 0.26]	-0.68*** (0.21)	-0.57** (0.23)	-0.83*** (0.26) [-1.49, -0.17]	-0.64*** (0.20) [-1.01, 0.07]
Bandwidth (km)	107	124	100	100	111	81
Observations (effective)	977	1,037	958	958	1,166	296
Observations (total)	2,179	2,179	2,179	2,179	2,338	861

**Notes:** This table shows the robustness of the border discontinuity estimates in language and mathematics scores in Grades 2 and 5 to various specifications and samples. A positive discontinuity favors the Anglophone side. All scores are z-scores, normalized to have zero mean and unit variance. Observations are weighted by their probability sampling weight. All regressions control for gender and geographic controls (temperature, precipitation, elevation, ruggedness, malaria stability index, and agricultural suitability). Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Robust [Calonico et al. \(2014\)](#) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth. Column (1): baseline specification, like in Table 4, column (5). Column (2) and (3): discontinuities estimated with a 100-km bandwidth on either side of the border controlling for a linear (2) or quadratic (3) function of latitude and longitude. Column (4): like the baseline, but including the 8 schools located in Douala. Column (5): like the baseline, but excluding schools located in the North (regions of Nord-Ouest, Ouest, Adamaoua, Nord and Extrême-Nord).

Table Appendix B.8: Border discontinuity estimates without using sampling weights

	(1)	(2)	(3)	(4)	(5)
	Average within <100km of the border			Border discontinuity	
	Anglophone	Francophone	Difference		
<b>Panel A: Language scores</b>					
<b>Grade 2</b>					
Language score	-0.22	-0.11	-0.11 (0.14) < 0.11)	-0.13 (0.24) < 0.24) [ -0.85, 0.44]	-0.10 (0.21) < 0.21) [ -0.79, 0.39]
Bandwidth (km)				112	117
Observations (effective)	555	447	1,002	1,053	1,068
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Language score	-0.22	-0.21	-0.02 (0.13) < 0.14)	0.07 (0.21) < 0.21) [ -0.42, 0.65]	0.12 (0.21) < 0.19) [ -0.36, 0.69]
Bandwidth (km)				110	108
Observations (effective)	523	436	959	978	977
Observations (total)				2,180	2,179
<b>Panel B: Mathematics scores</b>					
<b>Grade 2</b>					
Mathematics score	0.16	-0.19	0.36*** (0.13) < 0.12)	0.17 (0.23) < 0.25) [ -0.55, 0.71]	0.17 (0.21) < 0.21) [ -0.53, 0.67]
Bandwidth (km)				109	113
Observations (effective)	555	447	1,002	1,025	1,053
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Mathematics score	-0.48	0.00	-0.48*** (0.15) < 0.16)	-0.56** (0.27) < 0.25) [ -1.06, 0.25]	-0.70*** (0.23) < 0.19) [ -1.27, -0.10]
Bandwidth (km)				101	108
Observations (effective)	523	436	959	968	977
Observations (total)				2,180	2,179
Geographic controls					✓

**Notes:** This table reproduces the results of Table 4 without weighting observations by their probability sampling weight. For each subject and grade, each individual student's score is computed as the average of the start-of year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation. The first 2 columns display average scores in Anglophone and Francophone Cameroon within 100 km of the border. The third column displays the difference. The last two columns present border discontinuities (a positive coefficient favors the Anglophone side), estimated using a local linear non-parametric function of distance to the border, with a triangular kernel and MSE optimal bandwidth. In column (4), gender is the only additional covariate. In column (5), we also control for geographic characteristics of the school location: temperature, precipitation, elevation, ruggedness, malaria stability index, and agricultural suitability. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Standard errors clustered by *préfecture* in angle brackets (there are 57 *préfectures* in our sample, 25 within 100 km of the border, with an average number of 3 sampled school by *préfecture*). Robust Calonic et al. (2014) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth.



Table Appendix B.9: Border discontinuity estimates using PASEC raw scores

	(1)	(2)	(3)	(4)	(5)
	Average within <100km of the border			Border discontinuity	
	Anglophone	Francophone	Difference		
<b>Panel A: Language scores</b>					
<b>Grade 2</b>					
Language score	-0.24	-0.11	-0.13 (0.14) < 0.10	-0.15 (0.23) < 0.23 [ -0.84, 0.40]	-0.06 (0.21) < 0.19 [ -0.71, 0.42]
Bandwidth (km)				110	118
Observations (effective)	555	447	1,002	1,025	1,068
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Language score	-0.17	-0.25	0.09 (0.13) < 0.13	0.12 (0.20) < 0.19 [ -0.37, 0.63]	0.22 (0.20) < 0.18 [ -0.28, 0.74]
Bandwidth (km)				110	112
Observations (effective)	523	436	959	978	1,007
Observations (total)				2,180	2,179
<b>Panel B: Mathematics scores</b>					
<b>Grade 2</b>					
Mathematics score	0.10	-0.16	0.26** (0.12) < 0.11	0.11 (0.22) < 0.23 [ -0.57, 0.62]	0.13 (0.21) < 0.20 [ -0.55, 0.61]
Bandwidth (km)				110	113
Observations (effective)	555	447	1,002	1,038	1,053
Observations (total)				2,270	2,270
<b>Grade 5</b>					
Mathematics score	-0.65	0.02	-0.67*** (0.14) < 0.15	-0.77*** (0.25) < 0.22 [ -1.28, -0.08]	-0.87*** (0.22) < 0.17 [ -1.47, -0.37]
Bandwidth (km)				105	106
Observations (effective)	523	436	959	978	977
Observations (total)				2,180	2,179
Geographic controls					✓

**Notes:** This table reproduces the results of Table 4 using the raw scores from the PASEC school survey without adjusting for differences between the English and French version of the test. For each subject and grade, each individual student's score is computed as the average of the start-of year and end-of-year scores. Scores are then transformed into z-scores by subtracting the country-wide mean and dividing by the standard deviation. The first 2 columns display average scores in Anglophone and Francophone Cameroon within 100 km of the border. The third column displays the difference. The last two columns present border discontinuities (a positive coefficient favors the Anglophone side), estimated using a local linear non-parametric function of distance to the border, with a triangular kernel and MSE optimal bandwidth. In column (4), gender is the only additional covariate. In column (5), we also control for geographic characteristics of the school location: temperature, precipitation, elevation, ruggedness, malaria stability index, and agricultural suitability. Observations are weighted by their probability sampling weight. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Standard errors clustered by *préfecture* in angle brackets (there are 57 *préfectures* in our sample, 25 within 100 km of the border, with an average number of 3 sampled school by *préfecture*). Robust Calonic et al. (2014) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth.

Table Appendix B.10: Border discontinuity estimates without averaging start- and end-of-year scores

	(1)	(2)	(3)	(4)
	Start-of-year score		End-of-year score	
	corrected	PASEC raw	corrected	PASEC raw
<b>Panel A: Language scores</b>				
<b>Grade 2</b>				
Language score	-0.05 (0.24) [ -0.64, 0.65]	-0.04 (0.24) [ -0.63, 0.68]	-0.16 (0.26) [ -0.95, 0.32]	-0.16 (0.26) [ -0.95, 0.32]
Bandwidth (km)	113	113	93	93
Observations (effective)	1,053	1,097	1,002	1,002
Observations (total)	2,270	2,356	2,270	2,270
<b>Grade 5</b>				
Language score	0.30 (0.24) [ -0.20, 1.06]	0.32 (0.24) [ -0.21, 1.05]	-0.05 (0.20) [ -0.57, 0.39]	0.11 (0.19) [ -0.41, 0.51]
Bandwidth (km)	96	102	108	110
Observations (effective)	958	1,013	977	977
Observations (total)	2,179	2,251	2,179	2,179
<b>Panel B: Mathematics scores</b>				
<b>Grade 2</b>				
Mathematics score	-0.23 (0.27) [ -1.06, 0.41]	-0.31 (0.27) [ -1.12, 0.36]	0.32 (0.20) [ -0.31, 0.80]	0.32 (0.20) [ -0.31, 0.80]
Bandwidth (km)	104	102	115	115
Observations (effective)	1,025	1,067	1,053	1,053
Observations (total)	2,270	2,356	2,270	2,270
<b>Grade 5</b>				
Mathematics score	-0.63*** (0.24) [ -1.21, 0.00]	-0.58** (0.23) [ -1.14, 0.06]	-0.49** (0.20) [ -1.00, -0.01]	-0.81*** (0.19) [ -1.35, -0.47]
Bandwidth (km)	102	102	110	98
Observations (effective)	977	1,013	977	958
Observations (total)	2,179	2,251	2,179	2,179
Geographic controls				✓

**Notes:** This table reproduces the results of Table 4 distinguishing between the start-of-year and end-of-year score of each student. Column (1) displays results for corrected start-of-year scores (corrected to ensure the comparability of the Anglophone and Francophone tests). Column (2) displays results for PASEC raw start-of-year scores. Column (3) display results for corrected end-of-year scores. Column (4) display results for PASEC raw end-of-year scores. For reasons we ignore, the detailed breakdown of start-of-year scores by question is not available for students who were absent for the end-of-year test, even though they took the start-of-year test. Gender is also missing for these students. Therefore, if we want to include in the start-of-year regressions the small percentage of students who were absent at the end-of-year test, we should look at PASEC raw scores rather than corrected scores, and we should not controls for gender. Therefore, we do not control for gender in column (2). The fact that we estimate very similar coefficients in column (1) and column (2) reassures us that our results are not driven by differential attrition between the start and the end of the year. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Robust Calonic et al. (2014) 95% confidence interval in [ ].

Table Appendix B.11: Lee bounds

	(1)	(2)	(3)	(4)	(5)
	Border Discontinuity	Trimming on entire distribution		Within-class trimming	
		Lower bound	Upper bound	Lower bound	Upper bound
<b>Panel A: students who never repeated a grade</b>					
Grade 5 mathematics score	-0.77*** (0.23) [ -1.34, -0.10]	-1.48*** (0.19) [ -2.03, -1.00]	-0.29 (0.18) [ -0.79, 0.17]	-1.06*** (0.24) [ -1.61, -0.32]	-0.46** (0.23) [ -1.03, 0.18]
Bandwidth (km)	136	122	125	138	137
Observations (effective)	330	206	211	230	230
Observations (total)	599	487	487	499	499
<b>Panel B: never repeated a grade or repeated exactly once</b>					
Grade 5 mathematics score	-0.69*** (0.22) [ -1.20, -0.06]	-0.94*** (0.20) [ -1.43, -0.45]	-0.50** (0.22) [ -0.97, 0.14]	-0.85*** (0.22) [ -1.37, -0.22]	-0.58*** (0.22) [ -1.09, 0.05]
Bandwidth (km)	112	105	110	112	112
Observations (effective)	857	737	743	783	783
Observations (total)	1,759	1,659	1,659	1,683	1,683

**Notes:** Panel A restricts the sample to students who never repeated a grade and panel B to students who never repeated a grade or repeated exactly once. All scores are z-scores, normalized to have zero mean and unit variance. The first column displays the border discontinuity (a positive coefficient favors the Anglophone side) estimated using the same specification as in Table 4 column (5). Columns (2) to (5) use the trimming procedure of Lee (2009) to obtain a lower and an upper bound of the treatment effect/discontinuity. In columns (2) and (3), the trimming is applied to the entire distribution of test score. In columns (4) and (5), it is applied to each within-class distribution. Observations are weighted by their probability sampling weight. Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Robust [Calonico et al. \(2014\)](#) 95% confidence interval in [ ]. Effective observations are observations within the bandwidth.

Table Appendix B.12: Grade repetition and selection

	(1)	(2)
Panel A		
	Grade 2	Grade 5
	Dep. var.: predicted grade retention?	
end-of-year maths score	-0.10*** (0.02)	-0.10*** (0.02)
Observations	987	942
Teacher fixed effects	✓	✓
Panel B: predicted retention by quartile of end-of-year maths score distribution		
	Grade 2	Grade 5
Bottom quartile	0.305	0.387
Second quartile	0.247	0.317
Third quartile	0.139	0.259
Top quartile	0.125	0.225

**Notes:** In panel A, a binary variable giving the teacher's opinion on whether a student will repeat the grade is regressed on the student's end-of-year mathematics score (and teacher fixed effects). Standard errors clustered by school in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ . Panel B gives the percentage of predicted repeaters by quartile of the end-of-year mathematics score distribution.