The Impact of Learning in Mother Tongue First: Evidence from a Natural Experiment in Ethiopia

Yared Seid[a]

[a]*International Growth Center, LSE, Addis Ababa, Ethiopia; e-mail: Y.Seid@lse.ac.uk*

May 2017

Abstract

This study explores the effect of learning in mother tongue first on students' academic achievement later after they transition to English instruction. Even if Ethiopia has adopted mother-tongue instruction in primary school, its states have discretion to choose when students transition to English instruction. This results in a variation in the timing of the transition to English instruction across states in Ethiopia. Southern Nations, Nationalities, and People's (SNNP) state, for instance, has legislated for students to transition to English instruction in grade 5 whereas students in other states in Ethiopia, except those in Gambella, do so either in grade 7 or 9. Due to the ethno-linguistic diversity of SNNP state, however, when students in the state progress from grade 4 to 5, the medium of instruction changes from mother tongue to English for language-majority students and from second language to English for language-minority students. This results in a variation in the intensity of the impact of the transition to English instruction by language group. Exploiting these two plausibly exogenous sources of variations (across state and language group) across grades 4 and 5 students and using data from Young Lives' 2012-2013 Ethiopian school survey, we provide empirical evidence on the causal effect of learning in mother tongue first by estimating triple-differences model. The estimate from our preferred specification suggests that learning in mother tongue first (in grades $1-4$) improves normalized scores in mathematics tests, which are administered after students transition to English instruction (in grade 5), by 0.114 standard deviations. This finding is consistent with the argument that students taught in their mother tongue first learn in English better after they transition to English-instruction classrooms.

Keywords: Medium of instruction, Primary school education, Triple-differences model, Ethiopia

JEL: I25, O10, O12

1. Introduction

A large number of countries in the developing world have made tremendous effort to make education more and more inclusive and accessible to historically marginalized groups. Adopting mother-tongue instruction in primary school has played a role in this regard as it motivates children from language-minority groups to attend school (Cummins, 1999). Though the adoption of mother-tongue instruction in primary school has increased enrollment in primary school and performance at school (e.g., Seid, 2016), it has a potential to limit students' labor market opportunities later in life as it makes students less proficient in both national and international languages (Angrist and Lavy, 1997). As a result, many governments in developing countries design their education language policies in such a way that students transition from mother-tongue to English (or other foreign-language) instruction after completing few years of primary schooling.

Consider Ethiopia, which is also the focus of the present study, as an example. Ethiopia has adopted mother-tongue instruction in primary school following the signing of the Education and Training Policy into law in 1994 (Ministry of Education, 1994). The same policy document, on the other hand, states that mother-tongue languages should be used as media of instruction up to only a certain grade, after which students have to transition to English instruction.[1] However, we have a limited understanding of the effect of learning in mother tongue first (relative to learning in non-English second language first) on students' academic achievement later after they transition to English instruction.

Exploring the effect of learning in mother tongue first on the performance of students from different language groups (i.e., those taught in their mother tongue first versus their peers taught in their second language first) is particularly important for a multilingual country like Ethiopia where, in some states,[2] a large number of ethnic groups live in close geographic proximity to each other, but speak different languages. This implies that it is difficult to ensure that a great majority of students learn in their mother tongue as there are practical limitations on the number of languages that

[1]The 1994 education reform also prescribes the introduction of teaching English as a subject starting from grade 1 in all schools in Ethiopia.

[2]Ethiopia is a federal country with three levels of government: federal, state (or regional), and local. The country has nine states and two chartered cities.

can feasibly be adopted as media of instruction, particularly in a resource-constrained country like Ethiopia.

By 2007, about 25 languages were adopted as media of instruction in primary schools in Ethiopia (Seidel and Moritz, 2007), which is a huge improvement, particularly considering that Amharic[3] was the only medium of instruction in primary school in 1990. Comparing the number of languages used as media of instruction with the number of languages that are being spoken in the country,[4] however, reveals that a large number of students are still learning in their second language in primary school.

The challenge in ensuring that a great majority of students learn in their mother tongue is sever in states that are ethnically more diverse. In the most ethnically diverse state of Ethiopia, Southern Nations, Nationalities, and People's (SNNP) state,[5] for instance, it is estimated that about 56 languages are being spoken while only 13 languages have been adopted as media of instruction in the first cycle of primary education[6] by 2007 (Heugh et al., 2007). Partly due to the extraordinary ethnolinguistic diversity of people in SNNP state, the state, following the 1994 Ethiopian education reform, has legislated that students have to transition to English instruction in grade 5.[7] This is contrary to the fact that Addis Ababa, Afar, Amhara, Oromiya, Somali, and Tgray states (hereafter other states in Ethiopia) have legislated that students have to transition to English instruction either in grade 7 or 9.

The fact that students in SNNP state transition to English instruction earlier (relative to their peers in other states in Ethiopia) makes SNNP state unique. Within the state itself, however, it is reasonable to assume that there is a variation in the intensity of the impact of the transition to English instruction among grade 5 students who come from different language group. This is primarily because language-majority students are taught in their mother tongue first (in grades $1-4$)[8]

[3]Amharic has been the only official language of the federal government of Ethiopia since the Ethiopian history has been recorded.

[4]It has been estimated that more than 90 languages are being spoken in Ethiopia (Bamgbose, 1991).

[5]The 2007 Ethiopian population census shows that SNNP state is the third largest state in Ethiopia in terms of population size, with a total population of about 14 million and accounts for about 19 percent of the population in Ethiopia.

[6]Primary education in Ethiopia covers 8 years of schooling which are equally divided into two: the first (i.e., grades $1-4$) and second (i.e., grades $5-8$) cycles of primary education.

[7]Students in Gambella state also transition to English instruction in grade 5. However, we do not focus on Gambella state in this paper since the state is not surveyed in the Young Lives' 2012-2013 Ethiopian school survey which is the primary source of data in this paper.

[8]Hereafter, we use the word "first" in phrases like "students are taught in their mother tongue

whereas their language-minority peers are taught in their second language first. That is, when students in SNNP state progress from grade 4 to grade 5, it is a transition from mother-tongue to English instruction for language-majority students while it is a transition from second-language to English instruction for language-minority students. This provides a natural experiment to explore whether learning in mother tongue first (relative to learning in second language first) help students learn better after they transition to English-instruction classrooms.

From a policy perspective, understanding whether the advantage that mother-tongue students enjoy in gains in academic achievement while learning in their mother tongue will carry over to later years in school after they transition to English instruction is crucial. The findings from this kind of study, for instance, highlight whether the choice of medium of instruction in primary school sets students from different language groups to different trajectories in their academic achievement in later years in school and, hence, in their labor market outcomes later in life.

Though there is a growing evidence on the role mother-tongue instruction plays in performance in primary school, we have a limited understanding on whether students taught in their mother tongue first learn in English (or other foreign languages) better than their peers taught in their second language first. A priori it is not clear whether students taught in their mother-tongue first will be at disadvantage later when they transition to English-instruction classrooms.

On the one hand, students taught in their mother tongue first seem to be better off since subject contents/concepts that are first learned through mother tongue can easily be transferred to English (Brock-Utne, 2007) as long as students have reached a certain threshold in their proficiency in English (Cummins, 2000). On the contrary, students taught in their second language first seem to be better off since they have had experience in learning in a language different from their mother tongue by the time they transition to English-instruction classrooms. Thus, it might be easier for these students to quickly adapt to English-instruction classrooms relative to their peers taught in their mother tongue first.

The literature on the role of English instruction in primary school focuses on comparing the relative effectiveness of bilingual education and English-immersion programs. The vast majority of prior studies on the topic come from the US, partly

(or second language) first" to refer to grades $1-4$.

because many primary schools in the US enroll a large number of immigrant students with limited English proficiency. It is typical for US primary schools to adopt either bilingual education or English-immersion program as a solution (Slavin et al., 2011).[9]

The findings from prior studies on the relative effectiveness of the two programs, however, are mixed, ranging from documenting no significant differences in the two programs (e.g., Rossell and Baker, 1996) to the superiority of bilingual education program (e.g., Cheung and Slavin, 2012; Slavin and Cheung, 2005). Some studies, on the other hand, has indicated that English-immersion program improves educational outcomes of students with limited English proficiency (e.g., Kuziemko, 2014). Even if prior studies differ in the spectrum of their findings on the relative effectiveness of bilingual education and English-immersion programs, the majority of the studies on the topic share a common feature: they consider language-minority students with limited English proficiency as if they come from the same language group. In the US, the primary focus is on Spanish-speaking students even if a reasonable number of language-minority students from other language groups also enroll in the US primary schools every year.

On the other hand, the literature on alternative language-of-instruction regimes from developing countries, especially those from Sub-Saharan Africa, is limited. However, it is not uncommon for students in developing countries to transition to English instruction after completing few years of primary schooling. The transition to English instruction is believed to be necessary to prepare students for further education since the medium of instruction in high school and college is, for the most part, English.

The limited studies from developing countries find out that mother-tongue instruction improves performance in primary school (e.g., Hynsjö and Damon, 2016; Piper et al., 2016; Seid, 2016) and mother-tongue instruction in early grades improves English acquisition later in grades $4-6$ (e.g., Taylor and von Fintel, 2016). However, we are not aware of studies that empirically document whether students taught in their mother tongue first learn in English better (than their peers taught in their non-English second language first) after they transition to English-instruction classrooms, except anecdotal evidence that suggests concepts that are first learned in mother tongue can be transferred to English (e.g., Brock-Utne, 2007).

[9] In bilingual education program, students with limited English proficiency learn in their native language first whereas in English-immersion program they are expected to learn in English from the beginning.

The present study, therefore, builds on the literature on the role of mother-tongue instruction and attempts to fill this gap in the literature by exploring whether learning in mother tongue first improves students' academic achievement (measured by mathematics tests scores) later after they transition to English-instruction classrooms. It is worth mentioning that our econometric analysis takes into account, in fact exploits, students' heterogeneity in their language group. As discussed earlier, this is in contrast to the vast majority of studies from developed countries, particularly those from the US, that assume language-minority students who are expected to pass through bilingual/English-immersion programs come from common language group. This paper, thus, also highlights the possibility that a transition to English instruction can have differential impact on academic achievement of students from different language groups.

Our identification strategy in this paper relies on two sources of plausibly exogenous variations. We first exploit the fact that students in SNNP state transition to English instruction in grade 5 whereas their peers in other states in Ethiopia do so when they progress to either grade 7 or 9. Hence, we consider SNNP state as *experimental* state and the other states in Ethiopia as *non-experimental* states.

The second source of variation comes from the difference in the intensity of the impact of the transition to English instruction across grade 5 students in SNNP state who come from different language groups, where language-majority students transition from mother-tongue to English instruction and language-minority students transition from second-language to English instruction. Thus, we assign students taught in their mother tongue first into *treated* group and students taught in their second languages first into *control* group. As part of our identification strategy, we further assign grades 4 and 5 students into *pre-treatment* and *after-treatment* groups, respectively, since English is used as the medium of instruction for only grade 5 students in SNNP state.

Using data from the Young Lives' 2012-2013 Ethiopian school survey, which administers mathematics and literacy tests[10] to grades 4 and 5 students both at the beginning and end of the 2012-13 school year[11] and the assignment of states into experimental and non-experimental along with the assignment of students into

[10]Even if Young Lives has administered both mathematics and literacy tests, we exclusively focus on mathematics tests scores – see the discussion in Section 4 and the footnotes there for our justification for this.

[11]In Ethiopia, the school year begins in September and ends in June.

treated, control, pre-, and after-treatment groups, we provide empirical evidence on the causal effect of learning in mother tongue first on students' academic achievement later after they transition to English instruction (in grade 5) by estimating triple-differences model for a sample of grades 4 and 5 students in Ethiopia.

Estimate from our preferred specification suggest that grade 5 students who were taught in mother tongue first (in grades $1-4$) have gained 0.114 standard deviations in normalized mathematics tests scores relative to their peers who were first taught in their second language. We also find out that these effects are stronger for students in rural areas relative to those in urban areas. Falsification tests, on the other hand, suggest that our results are not confounded by other factors. This finding is consistent with the argument that, compared to their peers taught in their second language first, students taught in their mother tongue first learn in English better after they transition to English-instruction classrooms.

The remainder of the paper is organized as follows. The following section provides a brief background on schooling and language in Ethiopia. Section 3 describes the data, while Section 4 discusses the estimation strategy and presents the econometric results. The final section concludes the study.

2. Schooling and Language in Ethiopia

The Ethiopian education sector has gained the attention of the government since the change in government in May 1991. Among the many changes the sector has experienced in the 1990s, the most notable changes include restructuring the education system and adopting mother-tongue instruction in primary school following the signing of the Education and Training Policy into law in 1994.

Prior to the 1994 education reform, the education system consisted of six years of primary education (i.e., grades $1-6$) and two years of junior secondary education (i.e., grades $7-8$) where students seat for national school exit exams at the end of grades 6 and 8. After the 1994 education reform, primary education covers 8 years of schooling which are equally divided into two: the first (i.e., grades $1-4$) and second (i.e., grades $5-8$) cycles of primary education. The restructuring has abolished the national school exit exam that students used to take at the end of grade 6. Students, however, still have to seat for a national school exit exam at the end of grade 8.

In addition to restructuring the education system, the 1994 education reform has provided opportunity to states in Ethiopia to adopt as many languages as they choose as media of instruction in primary schools located in their jurisdictions (Ministry of Education, 1994). Following this discretion, states in Ethiopia have adopted mother-tongue instruction in primary schools, resulting in an increase in the number of languages used as media of instruction from using Amharic as the only medium of instruction in 1990 to about 25 languages by 2007 (Seidel and Moritz, 2007).[12] This, of course, does not necessarily guarantee that all primary-school students learn in their mother tongue. This is particularly because of the ethno-linguistic diversity of people in Ethiopia, and there are practical limitations on the number of languages that can feasibly be adopted as media of instruction, particularly in a resource-constrained country like Ethiopia.

Due to the variation in the extent of ethno-linguistic diversity across states in Ethiopia, the challenges of ensuring that language-minority students learn in their mother tongue in primary school are sever in relatively more diverse states. Consider SNNP state, the most diverse state in Ethiopia, as an example. In SNNP state, it is estimated that about 56 languages are being spoken within its geographic boundary whereas the state has adopted only 13 languages as media of instructions in primary school by 2007 (Heugh et al., 2007). This suggests that a large number of students in primary school in SNNP state have continued to learn in languages that are different from their mother tongue even long after the 1994 education reform.

Even though the 1994 education reform has provided states the opportunity to adopt mother-tongue instruction in primary school, it is important to note that it also mandates that mother-tongue languages should be used as media of instruction up to only a certain grade, after which students have to transition to English instruction. As a result of this specific mandate and partly due to the extraordinary ethno-linguistic diversity of people in SNNP state, the state has legislated that students have to transition to English instruction in grade 5.[13] This is contrary to the fact that other states in Ethiopia have legislated that students have to transition to English instruction either in grade 7 or 9.

Differences in the timing of the transition to English instruction between students in SNNP state and other states in Ethiopia provide a natural experiment to

[12] See Seid (2016) for further discussion on the 1994 Ethiopian education reform and its effect on educational outcomes in primary school in Ethiopia.

[13] As mentioned earlier, Gambella state also mandates students to transition to English instruction in grade 5. In this paper, however, we do not focus on Gambella state since the state is not surveyed in Young Lives' 2012-2013 Ethiopia school survey which is the primary source of data in this paper.

explore the causal effect of learning in mother-tongue first on the performance of students later after they transition to English instruction.

Transition to English Instruction as Exogenous Source of Variation

As discussed earlier, students in SNNP state transition to English instruction in grade 5 whereas students in other states in Ethiopia do so either in grade 7 or 9. This means that the medium of instruction changes for students in SNNP state when they progress from grade 4 to grade 5 whereas it continues to be the same for students in other states in Ethiopia when they progress from grade 4 to grade 5. Since grade 5 students in SNNP state transition to English instruction, which is a plausible exogenous shock,[14] we consider SNNP state as *experimental* state and the other states in Ethiopia as *non-experimental* states.

Though all students in SNNP state transition to English instruction in grade 5, there is a variation in the intensity of the impact of the transition to English instruction across students from different language groups. This is primarily because language-majority students are taught in their mother tongue first while their language-minority peers are taught in their second language. As a result, when students in SNNP state progress from grade 4 to 5, the medium of instruction changes from mother tongue to English for language-majority students and from second language to English for language-minority students.

In order to capture the potential variation in the intensity of the impact of the transition to English instruction across students from different language groups, we assign language-majority students into *treated* group and language-minority students into *control* group. Note that this assignment of students into treated and control

[14] If there is endogenous migration (say, for instance, parents who value their kids' education more move to states to ensure that their kids are taught in their mother tongue first), then the coefficient estimates of the effect of learning in mother tongue first on students' performance later after they transition to English instruction will be biased upward. However, this is not a serious concern in our case since internal migration is not a common phenomenon in Ethiopia. Data from the 2007 Ethiopian population census, for instance, reveal that about 87 percent of the respondents have reported that they have lived in their current state of residence since birth. Only about 10 percent of the population have migrated internally in the last 10 years. Disaggregating the internal migration that happened in the 10 years prior to the 2007 census by selected household demographic characteristics (i.e., by language group and whether the family has primary-school-age child) shows that there is no systematic differences in migration rates by these selected household demographic characteristics. On the other hand, anecdotal evidence suggests that looking for better economic opportunities (rather than looking for better primary schools) is the primary reason for inter-state migration in Ethiopia. All these highlight that bias due to self-selection through migration is not a serious concern in our paper.

groups is based on the medium of instruction they were exposed to while they were in grades $1-4$. Even if only language-majority students have received the "treatment" of learning in mother tongue first, it must be noted that the medium of instruction changes for both group of students when they progress from grade 4 to 5. This suggests that it is reasonable to assume that the intensity of the impact of the transition to English instruction is different for students in the treated and control groups.[15]

As part of our identification strategy, we further assign grades 4 and 5 students into *pre-treatment* and *after-treatment* groups, respectively, since English is used as the medium of instruction for only grade 5 students in SNNP state.

The assignment of states into experimental and non-experimental states along with the assignment of students into treated, control, pre-, and after-treatment groups enables us to identify the causal effect of learning in mother tongue first on the performance of students later after they transition to English instruction using triple-differences approach.

It is worth mentioning that the adoption of mother-tongue instruction in primary school as well as the legislation passed by SNNP state that mandates students in SNNP state to transition to English instruction in grade 5 were implemented immediately after the 1994 education reform. Since the data used in this paper[16] were collected long after the 1994 education reform, the possibility that the temporary disruption associated with implementing the 1994 education reform may bias our estimates is not a concern here.

It is well known that one of the identifying assumptions of the triple-differences approach is the absence of differential macroeconomic trends between SNNP state (i.e., experimental state) and other states in Ethiopia (i.e., non-experimental states) during the period of analysis. If this assumption is violated, the triple-differences estimates confound the effect of learning in mother tongue first with the effect of differential macroeconomic trends on students' performance that would have been observed even in the absence of the treatment.

In the literature, this concern is referred to as common/parallel trend assump-

[15] Alternatively, we can think of the treatment as having two components in SNNP state. The first one is exposure to mother-tongue instruction for 4 years, where only language-majority students are exposed to it. The second treatment is English instruction in grade 5 where both language-majority and language-minority students are exposed to it, but its intensity varies by language group.

[16] The data used in this paper come from the Young Lives' 2012-2013 Ethiopian school survey which administers mathematics and literacy tests to grades 4 and 5 students. See Section 3 for further discussion on the data used in this paper.

tion. This, however, does not create a major concern in the present study as the cross-section data used in this paper were collected in the 2012-2013 school year. Specifically, information was gathered on grades 4 and 5 students in Ethiopia in the 2012-2013 school year where, for the purpose of this study, we assign grades 4 and 5 students into *pre-treatment* and *after-treatment* groups, respectively. Since pre- and after-treatment groups are constructed using a cross-section data collected in the 2012-2013 school year, the bias due to potential differences in macroeconomic trends between experimental and non-experimental states is not a serious concern in our paper.

By the same token, we do not have to worry about potential biases of our estimates from the introduction of new education policy that could potentially affect schools in experimental and non-experimental states differently during the period of analysis. This is partly because, as discussed earlier, we use a cross-section data collected in a given school year and partly due to the fact that no new education policy was introduced in the 2012-2013 school year that could potentially affect schools in experimental and non-experimental states differently.

A related concern could be the fact that we do not observe the same set of students when they are in grades 4 and 5. Even if we do not observe the same set of students when they are in grades 4 and 5, the method employed in this paper can be considered as triple-differences as long as the mean baseline response of grade 4 students in experimental and non-experimental states is the same as the mean baseline response of grade 5 students in experimental and non-experimental states. If the experimental and non-experimental states attract the "same type" of grades 4 and 5 students, then the estimates from our triple-differences model capture the causal effect of learning in mother tongue first on the performance of students later after they transition to English-instruction classrooms (see Lee and Kang, 2006, for furher discussion on using cross-section data in the difference-in-differences approach).

If, however, the treatment is substantial enough to change the composition of grades 4 and 5 students in the experimental and non-experimental states, then our results from the triple-differences model will be biased. Since there is no evidence that suggests that the treatment has substantially altered the composition of grades 4 and 5 students in the experimental and non-experimental states in Ethiopia, it is appropriate to employ triple-differences approach here – see Section 4 for further detail on the identification strategy used in this paper.

3. Data

The data used in this paper come from Ethiopian school survey which was administered by Young Lives (YL), an international research project based in the University of Oxford. In its household surveys, YL has collected data on children from four low income countries – Ethiopia, India (in the Andhra Pradesh state), Peru, and Vietnam. During the first household survey round of data collection in 2002, two thousand one-year-old children (hereafter “younger” cohort) and one thousand eight-years-old children (hereafter “older” cohort) were surveyed in each country. In follow-up surveys conducted in 2006, 2009, and 2013 the same children were tracked and surveyed when the younger cohort children turned to five, eight, and twelve years old, and the older cohort children turned to twelve, fifteen, and nineteen years old, respectively.

In the Ethiopian part of the survey, children were randomly sampled from 20 semi-purposively selected sentinel sites in the largest five states of the country (see Wilson et al., 2006, for a discussion on the sampling design). In addition to the longitudinal household surveys, YL conducted a school survey in Ethiopia in 2012-2013 school year – which is used as a primary source of data in this paper.[17]

In the school survey, information was gathered on YL’s younger cohort children and their peers who were in grades 4 and 5 in 2012-2013 school year. The survey was conducted in two ‘Waves,’ at the beginning of the school year (i.e., Wave 1) and towards the end of the same school year (i.e., Wave 2). In Wave 1, YL’s younger cohort children and their non-YL’s peers who attend schools located in YL’s sentinel sites were surveyed. In Wave 2, a follow-up survey was administered on all children who have been surveyed in Wave 1.

A total of 11,982 students (of whom 493 are YL’s younger cohort children[18]) in 94 schools who were in grades 4 and 5 in 2012-2013 school year were surveyed in Wave 1. Students who were surveyed in Wave 1 but were not present in school on

[17]Using data from YL’s 2012-2013 school survey has an important advantage since information on both students’ mother tongue and the languages schools use as media of instruction are collected. This enables us to develop an identification strategy that exploits the differential impact of a transition to English instruction across language groups.

[18]Only a fraction of YL’s younger cohort children surveyed in the longitudinal household surveys were also surveyed in the school survey. This is partly because some of the YL’s younger cohort children were attending neither grade 4 nor grade 5 in the 2012-2013 school year and partly because some of the other YL’s younger cohort children attend schools located outside of the YL’s sentinel sites.

days where the survey fieldwork of Wave 2 was conducted was dropped from Wave 2, resulting in a total of 10,030 students surveyed in both waves. The tests were administered both at the beginning and end of the 2012-2013 school year with the aim of enabling value-added analysis.

As mentioned earlier, five states (i.e., Addis Ababa, Amhara, Oromiya, SNNP, and Tigray states) were surveyed in YL's Ethiopian household surveys. Similarly, YL has surveyed the same five states and additional two states (i.e., Afar and Somali states) in its 2012-2013 Ethiopian school survey. In this paper, however, we drop observations from Addis Ababa from the sample of analysis. This is mainly because Addis Ababa is uniquely heterogeneous where people from almost all ethnic groups live together. Moreover, the majority of its residents speak Amharic well,[19] implying that it is not reasonable to group students in Addis Ababa by language group and exploit this grouping in the identification strategy as suggested in this paper.

We also restrict our sample to students who attend public schools. This restriction is mainly because the 1994 education reform, which has introduced mother-tongue instruction in primary schools in Ethiopia, applies only to public schools. This restriction should not cause a serious concern in our paper since data from the YL's 2012-2013 Ethiopian school survey show that a great majority (about 89 percent) of students in Ethiopia attend public schools. On the other hand, it is important to note that public schools in Ethiopia generally perform poorly (relative to private schools) and, hence, their students receive low quality education and face weak labor market prospects later in life. Therefore, focusing on public schools and exploring factors that improve the quality of education in public schools in Ethiopia is an important contribution.

Finally, we further restrict the sample of analysis to students who have attended the same school since grade 1, which constitutes about 91 percent of students in YL's data. This sample restriction is imposed because, for students who have changed schools, we do not observe the media of instruction they were exposed to in their former schools. If students who have changed schools have been exposed to different media of instruction in their former and current schools, including these students in the sample of analysis may bias our estimates. For instance, if some students

[19] This, along with the fact that Addis Ababa is the seat of the federal government, explains why Addis Ababa has adopted Amharic as its official language as well as the medium of instruction in primary schools located within its boundary.

have changed their schools to ensure that they are taught in their mother tongue, then this will bias our estimates upward. Since we do not observe why students in our data change their schools, it is not possible to rule out the possibility that these students self-select themselves into schools that could teach them in their mother tongue. Thus, we have dropped students who have not attended the same school since grade 1. However, it is fair to say that dropping these students from our sample of analysis should not cause a serious concern in our paper since our data do not show any systematic difference in the fraction of students who have changed schools in experimental and non-experimental states.[20]

These sample restrictions leave us with a final sample size of 3,197 grade 4 students and 3,057 grade 5 students in 167 classrooms across 65 schools in Ethiopia.

The outcome variable used in this paper is the difference in students' mathematics tests scores between the tests administered at the end and the beginning of the 2012-2013 school year (i.e., $\Delta Score = Score_{wave2} - Score_{wave1}$). Following Banerjee et al. (2007), in what follows, all scores are normalized relative to the distribution of the pretest (i.e., Wave 1) scores in the control group to make scores comparable across states, grades, and language groups.[21]

The tests focus on curriculum-related assessment[22] and were administered in the language of instruction the school uses in grades $1-4$. Even for grade 5 students in SNNP state, who have just switched to English instruction, the tests were administered not in English but in a majority language the school uses as medium of instruction in grades $1-4$, implying that the tests were administered in the same language for grades 4 and 5 students.[23]

The organization that administers the school survey, Young Lives, argues that conducting the tests to grade 5 students in SNNP state in a language of instruction the school uses in grades $1-4$ would better enable students to answer to the best

[20] Our data shows that about 7 and 10 percent of students in experimental and non-experimental states have, respectively, changed schools, but this difference is not statistically significant.

[21] Scores are normalized for each grade, language group, and state such that the mean and standard deviation of the control group in the pretest are zero and one, respectively.

[22] The tests aimed at assessing competencies on grades 4 and 5 curricula, but some questions related to target competencies for grades $1-3$ were included in the tests since evidence suggests that some grades 4 and 5 students in Ethiopia perform below the curricular expectations for those grades.

[23] The tests are also similar across states except that they differ in the language in which they were administered across states, which mirrors differences in the languages used as media of instruction across states.

of their ability (since grade 5 students have just switched to English instruction). Besides, this makes comparison of mathematics tests scores between grades 4 and 5 students straightforward. Thus, it is fair to say that differences in mathematics test scores between grades 4 and 5 students (both in SNNP and other states) cannot be attributed to differences in the language in which the tests were administered, but to other factors, including exposure to mother-tongue instruction in grades $1-4$.

Table 1 presents the descriptive statistics for a sample of students used in the econometric analysis.[24] The table shows that there are no striking differences (along a range of student-, school-, and household-level characteristics) by language group and the state's experimental status. However, Table 1 confirms our a priori expectation that mother-tongue students (i.e., those taught in their mother tongue in grades $1-4$) perform better in mathematics tests relative to their peers taught in their second language.[25] In the next section, we assess whether learning in mother tongue first (in grades $1-4$) has played any role in the differences in mathematics (wave 2) tests scores of grade 5 students by their language group.

Table 1: Summary Statistics of Variables used in the Econometric Analysis by Experimental State and Language Group

	Experimental State		Non-experimental States	
	MT‡ students	Non-MT students	MT students	Non-MT students
Math Z-score - Wave 2	0.192	0.018	0.144	0.051
	(0.691)	(0.061)	(0.465)	(0.045)
Math Z-score - Wave 1	0.091	0.009	0.131	0.007
	(0.123)	(0.012)	(0.218)	(0.701)
Student's age (in years)	11.689	11.713	11.209	12.265
	(1.900)	(1.848)	(1.576)	(2.769)
Dummy for female student	0.501	0.524	0.498	0.505

[24]See A.1 in Appendix A for descriptive statistics of students' mathematics tests scores by experimental state, language group, and grade.

[25]It is not surprising that test scores vary by language group since it has been documented that students in Ethiopia who are taught in their mother tongue perform better (see, e.g., Seid, 2016). This should not, however, affect our identification strategy since we are here interested in exploring whether this difference in test scores continues in grade 5 after students transition to English instruction.

	(0.500)	(0.498)	(0.500)	(0.500)
Dummy for student's preschool attendance	0.479	0.439	0.458	0.453
	(0.500)	(0.481)	(0.479)	(0.498)
Dummy for grade repetition	0.266	0.249	0.287	0.224
	(0.342)	(0.327)	(0.319)	(0.392)
Dummy for student's participation in paid work	0.222	0.193	0.179	0.240
	(0.445)	(0.351)	(0.366)	(0.439)
Dummy for female math teacher	0.341	0.359	0.386	0.371
	(0.355)	(0.400)	(0.387)	(0.315)
Dummy for post-secondary educ - math teacher	0.668	0.686	0.643	0.653
	(0.496)	(0.466)	(0.479)	(0.404)
Years of experience - math teacher	12.646	12.161	11.026	11.698
	(3.893)	(3.019)	(3.935)	(3.390)
Dummy for post secondary educ - principal	0.310	0.328	0.292	0.291
	(0.313)	(0.359)	(0.406)	(0.343)
Years of experience - principal	3.596	2.888	3.162	3.513
	(1.886)	(1.563)	(2.140)	(2.063)
Dummy for the school has library	0.525	0.514	0.483	0.464
	(0.380)	(0.301)	(0.365)	(0.282)
Dummy for the school has access to electricity	0.518	0.514	0.488	0.474
	(0.386)	(0.401)	(0.363)	(0.369)
Dummy for the school is in urban area	0.404	0.410	0.388	0.404
	(0.357)	(0.401)	(0.400)	(0.395)
Number of siblings	4.124	4.502	4.067	4.817
	(2.125)	(2.079)	(1.981)	(2.143)
Dummy for literate mother	0.365	0.348	0.317	0.323
	(0.400)	(0.386)	(0.395)	(0.378)
Dummy for literate father	0.492	0.482	0.471	0.484
	(0.392)	(0.394)	(0.389)	(0.398)
Number of rooms in the household	2.199	2.291	2.538	2.758
	(1.265)	(1.394)	(1.283)	(1.396)
Dummy for household has access to electricity	0.541	0.534	0.469	0.457
	(0.497)	(0.477)	(0.499)	(0.497)
Number of meals a student eats per day	2.656	2.484	2.778	2.742

	(0.606)	(0.648)	(0.504)	(0.573)
Observations	1642	698	3122	792

Notes: Standard deviations are reported in parentheses.

‡ MT and non-MT denote language-majority and language-minority students, respectively, where the former are taught in their mother tongue in grades $1-4$ whereas the later are taught in their second language in grades $1-4$.

4. The Effect of Learning in Mother Tongue First

Our primary objective in this paper is estimating the causal effect of learning in mother tongue first (in grades $1-4$) on academic achievement later after the student transition to English instruction (in grade 5). The unique nature of the Ethiopian education system and data from the YL's Ethiopian school survey, which administers mathematics tests to grades 4 and 5 students in the 2012-2013 school year, help us identify the causal effect of learning in mother tongue first on students' performance later after they transition to English instruction. In this section, we discuss the empirical strategy, present the results from the econometric analysis, run falsification tests, and, finally, explore whether there is heterogeneity in treatment effect.

4.1. Empirical Strategy

As discussed earlier, we exploit two sources of plausibly exogenous variations. First, we employ the fact that students in SNNP state transition to English instruction in grade 5 while their peers in other states in our sample do not transition to English instruction until they progress to either grade 7 or 9. Second, we exploit the variation in the intensity of the impact of the transition to English instruction across grade 5 students in SNNP state who come from different language groups.

Using these two sources of variations and data from the YL's Ethiopian school survey on grades 4 and 5 students, we estimate the following triple-differences model:

$$
\begin{aligned}
\Delta Score_{igs} = {} & \beta_0 + \beta_1 Exp_s + \beta_2 After_{igs} + \beta_3 Treated_{igs} \\
& + \beta_4 (Exp_s * After_{igs}) + \beta_5 (Exp_s * Treated_{igs}) + \beta_6 (After_{igs} * Treated_{igs}) \\
& + \beta_7 (Exp_s * After_{igs} * Treated_{igs}) \\
& + \mathbf{X}_{igs} \boldsymbol{\gamma} + \phi + \psi + \epsilon_{igs},
\end{aligned} \tag{1}
$$

where i, g, and s index individuals, grades, and states, respectively. $\Delta Score$ is the difference in normalized mathematics tests scores between tests administered at the end and the beginning of the 2012-2013 school year (i.e., $\Delta Score = Score_{wave2} - Score_{wave1}$); Exp is a binary indicator for whether a state is experimental (i.e., equals 1 for SNNP state, and 0 for other states in our sample); $After$ is a binary indicator for whether a student is in grade 5 (i.e., equals 1 for grade 5 students, and 0 for grade 4 students); $Treated$ is a binary indicator for whether a student is taught in her/his mother tongue in grades $1-4$; $\mathbf{X}$ is a vector of control variables; ϕ and ψ are class and school fixed effects, respectively; and ϵ_{igs} is idiosyncratic error term.

The other fixed effects control for the characteristics of the experimental state (β_1), changes in test scores as students progress from grade 4 to grade 5 (β_2), and the characteristics of the treated group (β_3). The second-level interactions control for changes in the experimental state as students progress from grade 4 to grade 5 (β_4), characteristics of the treated group in the experimental state (β_5), and changes as students progress from grade 4 to grade 5 for the treated group nationwide (β_6). The third-level interaction (β_7) captures all variations in test score specific to grade 5 students (relative to grade 4 students) who were taught in their mother tongue in grades $1-4$ (relative to students taught in their second language in grades $1-4$) in the experimental state (relative to the non-experimental state). This is a triple-differences estimate of the causal effect of learning in mother tongue first on academic achievement later after the student transition to English instruction (in grade 5).

In Equation 1, if there are any systematic differences in students' innate abilities and other unobservable characteristics by language group that may not be differenced out by estimating the triple-differences equation, the coefficient estimates of the third-level interaction (β_7) will be biased. This is not, however, a serious concern in our triple-differences model since we expect any potential systematic differences in students' abilities and other unobservable characteristics by language group to be constant across states and grade levels, which the triple-differences approach is proved to effectively control for.[26]

[26]Moreover, the way the dependent variable is constructed (i.e., $\Delta Score = Score_{wave2} - Score_{wave1}$) helps mitigate potential biases due to omitted information on historical education inputs and family- and student-level characteristics, including students' innate abilities (Todd and Wolpin, 2003).

4.2. Results

In the triple-differences model, which is summarized in Equation 1, the primary (explanatory) variable of interest is the third-level interaction, i.e., "$Exp * After * Treated$," where β_7 captures the effect of learning in mother tongue first on academic achievement (measured by mathematics tests scores) later after students transition to English instruction (in grade 5).

Selected coefficients estimates from the tripe-differences regressions are presented in Table 2.[27] The results reported in column 1 of the table show that the coefficient estimates of the treatment effect, i.e., "$Exp * After * Treated$" variable, is positive and statistically significant. This suggests that students taught in their mother tongue first perform better (than their peers taught in their second language first) after they transition to English-instruction classrooms.

As in many other school surveys, the YL's Ethiopian school survey primarily focuses on collecting information on school inputs, and, hence, it has collected limited information on the demographic characteristics of students' families by directly asking students about their families.[28]

Exploiting the limited household demographic information gathered in YL's Ethiopian school survey, we further control for basic household demographic characteristics and present the results in column 2 of Table 2. As can be seen from the table, controlling for basic household demographic characteristics does not change the sign and significance level of the treatment effect, suggesting, again, that learning in mother tongue first improves the performance of students later after they transition to English-instruction classrooms. To be exact, our preferred specification, presented in column 2 of Table 2, shows that students taught in their mother tongue first have gained 0.114 standard deviations in scores in their mathematics tests that were administered after students transition to English instruction (i.e., in grade 5) relative to their peers taught in their second language first.

The results from the triple-differences regressions presented here can be interpreted as the causal effect of learning in mother tongue first on students' achievement

[27]The complete regression results from the triple-differences regressions that are presented in Table 2 are reported in Table A.2 in Appendix A.

[28]Even if YL has also administered separate longitudinal household surveys that can provide a wide range of information on household-level characteristics in Ethiopia, we have chosen not to use information gathered in the YL's household survey. This is because only 493 students were surveyed both in the YL's Ethiopian household and school surveys, implying that the small sample size does not allow precise estimation.

Table 2: Triple-differences Estimates of the Effect of Learning in Mother Tongue First on Students' Mathematics Tests Score Later after They Transition to English Instruction

	(1)	(2)
Exp	0.113	0.101
	(0.162)	(0.153)
After	0.153***	0.150***
	(0.013)	(0.038)
Treated	0.163*	0.147*
	(0.096)	(0.077)
$Exp * After$	0.200***	0.183***
	(0.018)	(0.026)
$Exp * Treated$	0.215**	0.193**
	(0.089)	(0.096)
$After * Treated$	0.228***	0.219*
	(0.071)	(0.116)
$Exp * After * Treated$	0.125***	0.114***
	(0.026)	(0.022)
Student- & school-level controls	Yes	Yes
Household-level controls	No	Yes
Observations	6254	6254
R-squared	0.511	0.538

Notes: *p < 0.10, ** p < 0.05, *** p < 0.01.
Robust standard errors are reported in parentheses. The additional regression controls are student-level characteristics (i.e., student's age in years and binary indicators for whether the student is female, has attended preschool, has ever repeated grade, and has participated in paid work), school-level characteristics (i.e., years of experience of mathematics teacher and the principal; binary indicators for whether the mathematics teacher and the principal have post-secondary education and whether the mathematics teacher is female; binary indicators for whether the school has library, access to electricity, and is found in urban area), household-level characteristics (i.e., binary indicators for whether the student's mother and father are literate, binary indicator for whether the household has access to electricity, number of rooms in the household, number of siblings, and the number of meals the student eats in a typical day), and classroom and school fixed effects.

later after they transition to English instruction under the assumption that students taught in their mother tongue first and those taught in their second language first are not inherently different. If this assumption is not satisfied, the results from the triple-differences regressions presented here cannot be interpreted as a "true" causal effect of learning in mother tongue first. If, for instance, parents who value their kids' education more move to states that teach their kids in their mother tongue first, then the coefficient estimates of the effect of learning in mother tongue first will be biased upward. However, this is not a serious concern in our case since, as discussed earlier, internal migration is not a common phenomenon in Ethiopia.

Another concern is related to the language in which the mathematics tests were administered to grade 5 students in SNNP state. Even if the medium of instruction in grade 5 in SNNP state is English, the language in which the mathematics tests were administered to grade 5 students in SNNP state is not English. Rather, it is administered in a language that the school has adopted as medium of instruction in grades $1-4$. This makes comparison in mathematics tests scores between grades 4 and 5 students straightforward since both groups of students took the tests in the same language, implying performance in the mathematics tests is not influenced by students' English proficiency.

On the other hand, the level of mastery of the majority language, which was used to administer the mathematics tests, can potentially influence students' mathematics tests scores. However, the role of language proficiency in influencing mathematics tests scores is limited to the extent that whether the student has basic understanding of the language to understand the questions clearly. It is worth mentioning that the nature of numerical questions, such as $2+3=?$ and $15+12-3=?$, included in the mathematics tests require only a limited understanding of the majority language, which was used to administer the tests, to understand the questions clearly. Besides, these students had already been exposed to the same majority language for four years while they were in grades $1-4$ since the language is adopted as medium of instruction in these grades. Therefore, the role of the majority language, which was used to administer the mathematics tests, in explaining differences in tests scores by language group is very limited.[29] Taking all these together, we believe that bias due

[29]It is, however, difficult to extend this argument to literacy tests, where reading comprehension is part of the literacy tests that YL has administered and also where grade 5 students are being taught the majority language, Amharic, and English as subjects. Generally speaking, the language in which the literacy tests are administered may interact significantly with the contents of the tests

to the language in which the mathematics tests were administered is not a serious concern in our paper.[30]

A related concern is whether some grade 5 mathematics teachers in SNNP state informally use the majority language (instead of using English exclusively) in classrooms to explain mathematics concepts further.[31] If so, then the gain in mathematics tests scores by language-majority (grade 5) students can partially be attributed to the informal instruction they receive in their mother tongue in grade 5 (in addition to being formally instructed in their mother-tongue while they were in grades $1-4$). We have checked the sensitivity of our results to a possibility that grade 5 students may be informally instruction in majority language. This is done by estimating the triple-differences model for subsamples of students where their mathematics teacher can (and cannot) speak[32] the language of instruction the school has adopted as medium of instruction in grades $1 - 4$.

The results from these regressions (which are not reported here for the interest of space) suggest that our results are not sensitive to whether grade 5 mathematics teacher can speak the language the school has adopted as medium of instruction in grades $1 - 4$.[33] Thus, it is fair to say that there is no evidence that supports the argument that language-majority (grade 5) students perform relatively better in their mathematics tests because they are being informally instructed in their mother tongue in grade 5.

4.3. Falsification Tests

In the main analysis presented here above, we have documented a positive effect of learning in mother tongue first on students' performance later after they

themselves, making it difficult to interpret the coefficient estimates of the third-level interaction in our triple-differences regressions where the dependent variable is literacy tests scores. Thus, we choose to focus on and report results from where the dependent variable is mathematics tests scores.

[30] If, in fact, the language in which the mathematics tests was administered plays a major role in explaining differences in test scores of students who come from different language groups, then this will bias our results upward and, hence, our results should be interpreted carefully.

[31] This concern assumes that grade 5 mathematics teachers in SNNP state can speak the majority language (i.e., the language the school uses as medium of instruction in grades $1-4$). This, however, is not a necessarily accurate assumption. The language requirement to be qualified as grade 5 mathematics teacher in SNNP state is ability to teach mathematics concepts in English, not in a language the school uses as medium of instruction in grades $1 - 4$.

[32] In our data, we observe both the mother tongue of mathematics teachers and the languages schools use as media of instruction in grades $1 - 4$.

[33] In these regressions, however, the coefficients are not precisely estimated due to small sample size.

transition to English-instruction classrooms. This implicitly assumes that the triple-differences estimates that are presented in this paper pick up the effect of learning in mother tongue first, not the effect of other potential factors that may have *differential* effect on the performance of students from different language groups across states in Ethiopia.

To assess the validity of this claim, we conduct falsification tests by restricting our sample to students in *non-experimental* states and randomly assigning them into *placebo* experimental and non-experimental states. As mentioned earlier, the YL's Ethiopian school survey samples from 6 states (i.e., Afar, Amhara, Oromiya, SNNP, Somali, and Tigray states) and Addis Ababa, the federal capital, but we have excluded Addis Ababa from our sample of analysis. In the falsification test analysis, we further drop SNNP state (the true experimental state) and randomly assign the remaining 5 non-experimental states into placebo experimental and non-experimental states.

To ensure that the assignment of states into placebo experimental and non-experimental states is random, we exploit the administrative numbers (such as 01, 02, 03, etc) that states are assigned to by the federal government for administrative convenience. Specifically, we assign odd-numbered states into placebo experimental state and even-numbered states into non-experimental states.[34] Since such assignment of states into experimental and non-experimental is random, we expect to find no treatment effect in the falsification test analysis if the positive treatment effect documented in Table 2 is driven by the fact that language-majority students are taught in their mother tongue first, and not by other confounding factors.

The results from these falsification tests of the triple-differences estimations are presented in Table 3. As can be seen from the table, the coefficient estimates of the third-level interaction, "$Exp{*}After{*}Treated$," are insignificant in both specifications. This confirms that the positive treatment effect presented in the main analysis is driven by the fact that language-majority students in SNNP state are taught in their mother tongue first, and not by other confounding factors.

4.4. Heterogeneity

So far we have documented the positive effect of learning in mother tongue first on the performance of students later after they transition to English-instruction

[34] This leads to assigning Amhara, Somali, and Tigray states into placebo experimental states and Afar and Oromiya states into non-experimental states.

Table 3: **Falsification Test:** Triple-differences Estimates of the Effect of Learning in Mother Tongue First on Students' Mathematics Tests Score Later after They Transition to English Instruction

	(1)	(2)
Exp, placebo	0.055	0.062
	(0.162)	(0.105)
After	0.076**	0.082**
	(0.037)	(0.039)
Treated	0.079*	0.080
	(0.042)	(0.056)
$Exp, placebo * After$	0.089	0.165
	(0.100)	(0.109)
$Exp, placebo * Treated$	0.117	0.104
	(0.095)	(0.090)
$After * Treated$	0.063*	0.082
	(0.038)	(0.053)
$Exp, placebo * After * Treated$	-0.018	0.006
	(0.021)	(0.016)
Student- & school-level controls	Yes	Yes
Household-level controls	No	Yes
Observations	3914	3914
R-squared	0.231	0.255

Notes: *p < 0.10, ** p < 0.05, *** p < 0.01.
Robust standard errors are reported in parentheses. The additional regression controls are student-level characteristics (i.e., student's age in years and binary indicators for whether the student is female, has attended preschool, has ever repeated grade, and has participated in paid work), school-level characteristics (i.e., years of experience of mathematics teacher and the principal; binary indicators for whether the mathematics teacher and the principal have post-secondary education and whether the mathematics teacher is female; binary indicators for whether the school has library, access to electricity, and is found in urban area), household-level characteristics (i.e., binary indicators for whether the student's mother and father are literate, binary indicator for whether the household has access to electricity, number of rooms in the household, number of siblings, and the number of meals the student eats in a typical day), and classroom and school fixed effects.

classrooms. While our research is unable to identify the exact mechanisms of the treatment effect, prior studies suggest that mother-tongue instruction improves performance at school because mother-tongue instruction facilitates adjustment between home and school (e.g., Trudell, 2005); mother-tongue instruction helps students express themselves well which, in turn, helps them develop higher level of cognitive skills relatively quickly (e.g., Sonaiya, 2002); students strongly identify themselves with teachers who come from the same language group (e.g., Klaus, 2003); and teachers who come from the same language group are more trustworthy and more subject to social control, reducing the risk that they will abuse their students sexually or otherwise (e.g., Benson, 2005).

Given the documented positive effect of learning in mother tongue on students' performance in primary school in the literature, the finding documented in the present study that suggests that learning in mother tongue *first* improves students' performance later after they transition to English-instruction classroom supports the argument that subject contents/concepts that are first learned through mother tongue can be transferred to English.

In addition to exploring the effect of learning in mother tongue first, it is interesting to further explore whether the results documented in the present study are heterogeneous across different groups. One way to do this is to look at the differences in the results for rural and urban subsamples. Since there is evidence that supports that the 1994 education reform (which has led to mother-tongue instruction for many primary school students in Ethiopia) has had stronger positive effect for kids in rural areas relative to those in urban areas (Seid, 2016), we would expect that the coefficients for the rural subsample would be larger.

Table 4 presents the coefficient estimates of selected variables from the triple-differences regressions that are run separately for rural and urban subsamples. Across all specifications in the table, the treatment effect is positive and statistically significant, but the magnitude of the coefficient estimates of the "$Exp * After * Treated''$ variable is higher for the rural subsample. This suggests that learning in mother tongue first, as expected, has stronger effect for kids in rural areas relative to those in urban areas.

We have also conducted a similar experiment to investigate whether the results are heterogeneous by gender by running the triple-differences regressions separately for the boys and girls subsamples. The coefficient estimates of the "$Exp * After *$

$Treated''$ variable (which are not reported here for the interest of space) are not systematically different for the boys and girls subsamples, implying that there is no heterogeneity in treatment effect by gender.

5. Conclusions

Achieving universal primary education has been a priority to developing countries for a long time. As part of this objective, many developing countries have put in a lot of effort to make primary education accessible to traditionally marginalized groups. Adopting mother-tongue instruction has played its own role in improving primary school enrollment among kids from marginalized groups and performance at school. Though mother-tongue instruction has a positive effect on improving enrollment and students' performance in primary school, it is not clear whether the gain in academic achievement carries over to later years in school after students transition from mother-tongue to English-instruction classrooms.

In this paper, thus, we attempt to fill this gap in the literature by exploring whether learning in mother tongue first improves students' academic achievement (measured by mathematics tests scores) later after they transition to English-instruction classrooms. To document the causal relationship between learning in mother tongue first and academic achievement later, we exploit the unique nature of the Ethiopian primary education system and the country's ethno-linguistic diversity.

Ethiopia has adopted mother-tongue instruction in primary school following the signing of the 1994 education reform into law, but states in Ethiopia have discretion to choose when students transition to English instruction. Following this discretion, SNNP state has legislated for students to transition to English instruction in grade 5 whereas students in other states in Ethiopia transition to English instruction either in grade 7 or 9. It is important to note that SNNP state is the most diverse state in Ethiopia. Thus, a large number of students in SNNP state still learn in their second language in the first cycle (i.e., grades $1-4$) of primary education. As a result, grade 5 student in SNNP state are composed of two groups of students: those who were first (i.e., in grade $1-4$) taught in their mother tongue and their second language. This implies a variation in the intensity of the impact of the transition to English instruction across grade 5 students in SNNP state by their language group.

Our identification strategy in this paper relies on these two sources of plausibly exogenous variations. Specifically, we first exploit the fact that students in SNNP

Table 4: Triple-differences Estimates of the Effect of Learning in Mother Tongue First on Students' Mathematics Tests Score Later after They Transition to English Instruction by Location of Residence

	Rural Subample		Urban Subsample	
	(1)	(2)	(3)	(4)
Exp	0.116	0.090	0.139	0.128
	(0.098)	(0.099)	(0.102)	(0.106)
After	0.152**	0.149**	0.158**	0.150**
	(0.069)	(0.063)	(0.064)	(0.060)
Treated	0.142***	0.136***	0.168*	0.151**
	(0.044)	(0.043)	(0.098)	(0.062)
$Exp * After$	0.210***	0.196***	0.218*	0.180*
	(0.066)	(0.067)	(0.112)	(0.095)
$Exp * Treated$	0.193**	0.188*	0.220***	0.191***
	(0.096)	(0.103)	(0.085)	(0.072)
$After * Treated$	0.213***	0.206**	0.200***	0.221**
	(0.076)	(0.082)	(0.063)	(0.093)
$Exp * After * Treated$	0.138***	0.130***	0.110***	0.107***
	(0.013)	(0.014)	(0.025)	(0.019)
Student- & school-level controls	Yes	Yes	Yes	Yes
Household-level controls	No	Yes	No	Yes
Observations	3943	3943	2311	2311
R-squared	0.381	0.376	0.340	0.397

Notes: *p < 0.10, ** p < 0.05, *** p < 0.01.
Robust standard errors are reported in parentheses. The additional regression controls are student-level characteristics (i.e., student's age in years and binary indicators for whether the student is female, has attended preschool, has ever repeated grade, and has participated in paid work), school-level characteristics (i.e., years of experience of mathematics teacher and the principal; binary indicators for whether the mathematics teacher and the principal have post-secondary education and whether the mathematics teacher is female; binary indicators for whether the school has library, access to electricity, and is found in urban area), household-level characteristics (i.e., binary indicators for whether the student's mother and father are literate, binary indicator for whether the household has access to electricity, number of rooms in the household, number of siblings, and the number of meals the student eats in a typical day), and classroom and school fixed effects.

state transition to English instruction in grade 5 whereas their peers in other states in Ethiopia do so when they progress either to grade 7 or 9. Therefore, we consider SNNP state as *experimental* state and the other states in Ethiopia as *non-experimental* states.

The second source of variation comes from a variation in the intensity of the impact of the transition to English instruction across grade 5 students in SNNP state who come from different language groups, where language-majority students transition from mother-tongue to English instruction and language-minority students transition from second-language to English instruction. Hence, we assign students who are first taught in their mother tongue and second language into *treated* and *control* groups, respectively. As part of our identification strategy, we further assign grades 4 and 5 students into *pre-treatment* and *after-treatment* groups, respectively, since English is used as the medium of instruction for only grade 5 students in SNNP state.

Using data from YL's 2012-2013 Ethiopian school survey, which administers mathematics tests to grades 4 and 5 students both at the beginning and end of the 2012-2013 school year, and the assignment of states into experimental and non-experimental along with the assignment of students into treated, control, pre-, and after-treatment groups, we provide empirical evidence on the causal effect of learning in mother tongue first on students' academic achievement later after they transition to English instruction (in grade 5) by estimating triple-differences model for a sample of grades 4 and 5 students in Ethiopia.

Estimate from our preferred specification suggest that grade 5 students who were taught in mother tongue first (in grades $1-4$) have gained 0.114 standard deviations in mathematics tests scores relative to their peers who were first taught in their second language. We also find out that these effects are stronger for students in rural areas relative to those in urban areas. Falsification tests, on the other hand, suggest that our results are not confounded by other factors.

The findings in our paper are consistent with the argument that, compared to their peers taught in their second language first, students taught in their mother tongue first learn in English better after they transition to English-instruction classrooms. However, these findings should be treated carefully since they only document the short-term effect of learning in mother tongue first on students' academic achievement later after they transition to English-instruction classroom. It is not clear whether the gain in academic achievement due to learning in mother tongue first fades away as students progress through grades. Research on whether gains in academic achievements in primary school due to learning in mother tongue first are translated to better labor market outcomes later in life would be a valuable contribution to the literature.

Bibliography

Angrist, Joshua D and Victor Lavy, "The Effect of a Change in Language of Instruction on the Returns to Schooling in Morocco," *Journal of Labor Economics*, 1997, pp. S48–S76.

Bamgbose, Ayo, *Language and the Nation: The Language Question in Sub-Saharan Africa*, Edinburgh University Press, 1991.

Banerjee, Abhijit V, Shawn Cole, Esther Duflo, and Leigh Linden, "Remedying Education: Evidence from Two Randomized Experiments in India," *The Quarterly journal of economics*, 2007, *122* (3), 1235–1264.

Benson, Carol, "Girls, Educational Equity and Mother Tongue-Based Teaching.," *UNESCO Bangkok*, 2005.

Brock-Utne, Birgit, "Learning Through a Familiar Language versus Learning Through a Foreign Language – A Look into Some Secondary School Classrooms in Tanzania," *International Journal of Educational Development*, 2007, *27* (5), 487–498.

Cheung, Alan CK and Robert E Slavin, "Effective Reading Programs for Spanish-dominant English Language Learners (ELLs) in the Elementary Grades: A synthesis of Research," *Review of Educational Research*, 2012, pp. 351–395.

Cummins, Jim, "Alternative Paradigms in Bilingual Education Research: Does Theory have a Place?," *Educational Researcher*, 1999, pp. 26–41.

_ , *Language, Power, and Pedagogy: Bilingual Children in the Crossfire*, Vol. 23, Multilingual Matters, 2000.

Heugh, Kathleen, Carol Benson, Berhanu Bogale, and Mekonnen Alemu, "Study on Medium of Instruction in Primary Schools in Ethiopia," *Ministry of Education, Federal Democratic Republic of Ethiopia*, 2007.

Hynsjö, Disa and Amy Damon, "Bilingual Education in Peru: Evidence on how Quechua-medium Education Affects Indigenous Children's Academic Achievement," *Economics of Education Review*, 2016.

Klaus, David, "The Use of Indigenous Languages in Early Basic Education in Papua New Guinea: A Model for Elsewhere?.," *Language and Education*, 2003, *17* (2), 105.

Kuziemko, Ilyana, "Human Capital Spillovers in Families: Do Parents Learn from or Lean on their Children?," *Journal of Labor Economics*, 2014, *32* (4), 755–786.

Lee, Myoung-jae and Changhui Kang, "Identification for Difference in Differences with Cross-section and Panel Data," *Economics letters*, 2006, *92* (2), 270–276.

Ministry of Education, "Education and Training Policy," *Ministry of Education, Federal Democratic Republic of Ethiopia*, 1994.

Piper, Benjamin, Stephanie S Zuilkowski, and Salome Ongele, "Implementing Mother Tongue Instruction in the Real World: Results from a Medium-Scale Randomized Controlled Trial in Kenya," *Comparative Education Review*, 2016, *60* (4), 776–807.

Rossell, Christine H and Keith Baker, "The Educational Effectiveness of Bilingual Education," *Research in the Teaching of English*, 1996, pp. 7–74.

Seid, Yared, "Does Learning in Mother Tongue Matter? Evidence from a Natural Experiment in Ethiopia," *Economics of Education Review*, 2016, *55*, 21 – 38.

Seidel, Katrin and Janine Moritz, "Changes in Ethiopia's Language and Education Policy–Pioneering Reforms?," in "Proceedings Paper: 16th International Conference of Ethiopian Studies, Trondheim" 2007, pp. 2–7.

Slavin, Robert E and Alan Cheung, "A Synthesis of Research on Language of Reading Instruction for English Language Learners," *Review of Educational Research*, 2005, *75* (2), 247–284.

_ , Nancy Madden, Margarita Calderón, Anne Chamberlain, and Megan Hennessy, "Reading and Language Outcomes of a Multiyear Randomized Evaluation of Transitional Bilingual Education," *Educational Evaluation and Policy Analysis*, 2011, *33* (1), 47–58.

Sonaiya, Remi, "Autonomous Language Learning in Africa: A Mismatch of Cultural Assumptions," *Language, Culture and Curriculum*, 2002, *15* (2), 106–116.

Taylor, Stephen and Marisa von Fintel, "Estimating the Impact of Language of Instruction in South African Primary Schools: A Fixed Effects Approach," *Economics of Education Review*, 2016, *50*, 75–89.

Todd, Petra E and Kenneth I Wolpin, "On the specification and estimation of the production function for cognitive achievement," *The Economic Journal*, 2003, *113* (485), F3–F33.

Trudell, Barbara, "Language Choice, Education and Community Identity," *International Journal of Educational Development*, 2005, *25* (3), 237–251.

Wilson, Ian, Sharon R. A. Huttly, and Bridget Fenn, "A Case Study of Sample Design for Longitudinal Research: Young Lives," *International Journal of Social Research Methodology*, 2006, *9* (5), 351–365.

Appendices

Appendix A. Additional Tables

Table A.1: Summary Statistics of the Outcome Variables used in the Econometric Analysis by Experimental State, Language Group, and Grade

	Experimental State				Non-experimental States			
	MT‡ Students		Non-MT Students		MT Students		Non-MT Students	
	Grade 4	Grade 5	Grade 4	Grade 5	Grade 4	Grade 5	Grade 4	Grade 5
Math Z-score - Wave 2	0.122	0.266	0.006	0.032	0.122	0.167	0.008	0.096
	(0.239)	(0.758)	(0.026)	(0.081)	(0.288)	(0.624)	(0.041)	(0.048)
Math Z-score - Wave 1	0.070	0.113	0.003	0.014	0.118	0.145	0.000	0.015
	(0.136)	(0.102)	(0.011)	(0.020)	(0.276)	(0.124)	(0.996)	(0.043)
Observations	841	801	363	335	1593	1529	400	392

Notes: Standard deviations are reported in parentheses.
‡ MT and non-MT denote language-majority and language-minority students, respectively, where the former are taught in their mother tongue in grades $1-4$ whereas the later are taught in their second language in grades $1-4$.

Table A.2: Triple-differences Estimates of the Effect of Learning in Mother Tongue First on Students' Mathematics Tests Score Later after They Transition to English Instruction

	(1)	(2)
Exp	0.113	0.101
	(0.162)	(0.153)
After	0.153***	0.150***
	(0.013)	(0.038)
Treated	0.163*	0.147*
	(0.096)	(0.077)
$Exp * After$	0.200***	0.183***
	(0.018)	(0.026)
$Exp * Treated$	0.215**	0.193**
	(0.089)	(0.096)
$After * Treated$	0.228***	0.219*
	(0.071)	(0.116)
$Exp * After * Treated$	0.125***	0.114***
	(0.026)	(0.022)
Student's age (in years)	0.028	0.033
	(0.091)	(0.080)
Dummy for female student	0.035	0.030
	(0.034)	(0.036)
Dummy for student's preschool attendance	0.084**	0.089**
	(0.035)	(0.039)
Dummy for grade repetition	0.003	-0.005**
	(0.003)	(0.002)
Dummy for student's participation in paid work	-0.021***	-0.012
	(0.008)	(0.009)
Dummy for female math teacher	0.288	0.290
	(0.291)	(0.305)
Dummy for post-secondary educ - math teacher	0.047**	0.059**
	(0.022)	(0.030)
Years of experience - math teacher	0.155	0.138
	(0.156)	(0.141)

Dummy for post secondary educ - principal	0.201	0.223
	(0.144)	(0.166)
Years of experience - principal	0.200	0.191
	(0.284)	(0.244)
Dummy for the school has library	0.008***	0.006***
	(0.001)	(0.002)
Dummy for the school has access to electricity	0.052	0.057
	(0.048)	(0.060)
Dummy for the school is in urban area	-0.012***	-0.009***
	(0.002)	(0.003)
Number of siblings		0.110
		(0.186)
Dummy for literate mother		0.012***
		(0.003)
Dummy for literate father		0.020
		(0.028)
Number of rooms in the household		0.014*
		(0.008)
Dummy for household has access to electricity		0.021
		(0.020)
Number of meals a student eats per day		0.040**
		(0.019)
Observations	6254	6254
R-squared	0.511	0.538

Notes: *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Robust standard errors are reported in parentheses. The regressions also control for classroom and school fixed effects.