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Literacy, numeracy skills and free basic education in Ghana *

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Abstract

Literacy and numeracy unarguably are at the heart of human and economic development and, as a result, have received widespread attention in recent decades. Yet, there are still issues related to the effective strategies of creating such basic skills. In this paper, I show how a free compulsory universal basic education (FCUBE) policy in Ghana helped improve skills attainment. I employ difference-in-differences strategy to assess the long-term causal impact of FCUBE using the Ghana Living Standard Survey 2012-2017. Overall, I find that FCUBE increased literacy and numeracy by 4.6 and 3.0 p.p respectively, but had a larger effects for urban and less disadvantaged students, thereby exacerbating inequality in skills attainment. Additionally, my results show that only the lower secondary education, and not primary education, was sufficient to guarantee skills attainment.

Keywords: Literacy, numeracy, human capital accumulation, education policy, Ghana

JEL Codes: I21, I24, I28, J24, O15

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1 Introduction

A growing literature in economics shows that differences in human capital account for a large part of cross-country variations in both pecuniary and non-pecuniary outcomes (Pritchett, 2013; Kaffenberger and Pritchett, 2021). Especially cognitive skills, as measured by student performance on international standardized test scores, are a crucial driver of individual earnings and economic growth (Hanushek and Woessmann, 2008). In developing countries, where school quality is highly variable, achievements on these scores have, however, been abysmally low (Pritchett, 2013). Consequently, interest in understanding the effects of cognitive skills has been on basic literacy and numeracy. Indeed, the education research has found such basic skills also as a distinct element of human capital and more essential than school attainment per se. Being able to read and write, for instance, enable women to improve children's health and reduce child mortality (Blunch, 2013; Smith-Greenaway, 2013). Literacy and numeracy skills also influence parental involvement in children's education broadly (Banerji et al., 2017) and researchers have argued that these basic skills act as a "catalyst" by helping students to perform better on high-stakes testing (Caponera et al., 2016). Moreover, individual productivity, labor market earnings and poverty are documented to be strongly associated with the stock of basic skills individuals possess, and not merely the number of school-years attained (Wedgwood, 2007; Nordtveit, 2008; World Bank, 2011b).

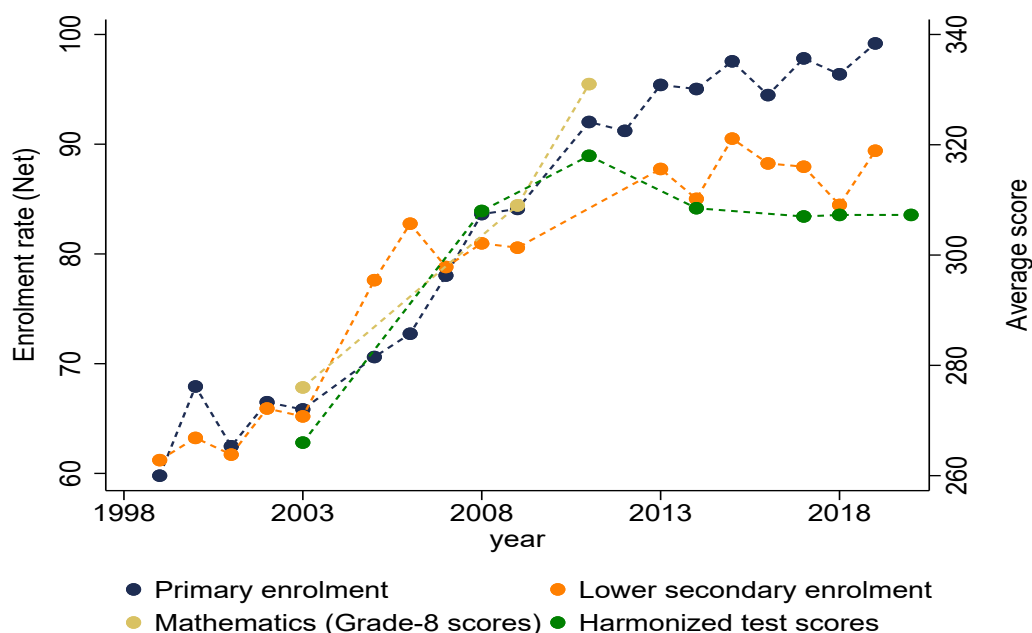
In response to these benefits, recent years have seen increased call to countries to improve basic literacy and numeracy. This call not only seeks to raise awareness that such basic skills are human rights but also that their improvements are essential to achieve the sustainable development goals (SDGs). However, despite considerable concern about this in policy circles, there are still issues related to the creation of literacy and numeracy that have only received limited attention and, therefore, are still poorly understood (Blunch, 2014). Literacy and numeracy unarguably are created through the formal and non-formal education - adult literacy programs. In the developing world, where the latter has failed to equip parents, and in particular mothers, with skills to facilitate children's learning at home and foster an interest in children's education (Abadzi, 1994; Blunch and Pörtner, 2011; Banerji et al., 2017), formal education represents the only avenue of acquiring basic skills. Within the formal education system, one important issue is the interplay of the different levels of education in creating skills. Knowledge about the relative productivity of these different levels of education help inform policy makers, especially in developing countries, in terms of how most efficiently to allocate resources so as to improve the skills stock in the economy (Blunch, 2014). Another issue is the effect of free universal education policy reforms. Presumably, free education reforms aim at improving the quality of education with the ultimate goal of improving students' outcomes such as basic skills. But do these policies work as intended? There are several reasons why they might not work. The cost intervention

measures undertaken may simply be inadequate in and of themselves, so that there is no impact of the reform change at all. For example, there may be no demand response in terms of enrollment and participation to a change in tuition-fees and levies if the economy's expenditure upon schooling does not completely remove the non-economic costs of households of their children's attendance (Angrist et al., 2023; Colclough et al., 1993; Govinda, 2003). Alternatively, supply-side-policy interventions such as enough school facilities may be insufficient due to limited resources leading to limited access or longer distance to school (Nishimura et al., 2008). Further, rapid enrollment growth may affect the quality of the learning environment via pupil-teacher ratio, teacher quality and students composition which may lead to poor acquisition of basic skills (Valente, 2019). Nevertheless, in many cases, the effect of free universal education policy reforms on skills acquisition has not been examined, leaving policy makers with little information as to whether free education reforms worked as intended. In this paper, I address these issues of the possible effect from free education reform in creating basic literacy and numeracy and of the interplay of the different levels of education. Here, focusing on measures of literacy and numeracy is not only motivated by the aforementioned benefits of these cognitive skills, but also recent education policy attention to accountability in schools - along with parents' acceptance that skills are the most important outputs of education - reinforce giving more attention to literacy and numeracy skills acquisition (UNESCO, 2005; Van der Gaag and Adams, 2010). Moreover, such skills capture the quality of the learning environment as well as differences in the ability that education systems strive to produce with existing curricula and thus relate these outcomes of schooling to labor market success (Hanushek and Woessmann, 2008).

To this end, I focus on Ghana, a country that is particularly interesting for my purpose. Like many other Sub-Saharan African (SSA) countries, Ghana experienced a substantial free compulsory universal basic education (FCUBE) reform in 1996, primarily targeted at making easy access to education by eliminating school fees and levies, and also improving the quality of schooling via provision of school inputs, curricula improvement as well as teacher quality enhancement. However, unlike other free education programs, Ghana aimed at improving basic schooling - primary and lower secondary education, not just the primary education. This provides a unique opportunity to investigate the impact of this policy intervention on literacy and numeracy, in particular to examine whether there were differential impacts from different levels of education. Additionally, the country has made a deliberate effort to invest in education in the past few decades, which has resulted in substantial gains in human capital outcomes (see Figure 1 and Figure A1 of the Online Appendix).¹ Notably, basic school enrollments increased, with the fastest growth in primary enrollment rate. Moreover, even in the face of increasing schooling enrollment, which led to the influx of students from the bottom of the

¹Figure 1 does not show enrollment rates before 1996 due to missing observations. In Figure A1 of the Online Appendix, I plot enrollment among basic school age children before and after the FCUBE program to show households education decisions around the reform.

Figure 1: Trends in human capital outcomes



Source: World Bank WDI Database (2023); World Bank HCI Database (2023); Trends in International Mathematics and Science Study (TIMSS, 2011)

Notes: The years with observations for the Mathematics scores are 2003, 2007 and 2011. Harmonized test scores measure how much children learn in school based on countries' relative performance on international student achievement tests. The score is computed by Altinok et al. (2018) and Patrinos and Angrist (2018) from major international student achievement testing programs: TIMSS/PIRLS, PISA, PASEC, EGRA and made available in the World Bank HCI Database.

skills distribution, this does not appear to have led to worsening of test scores averages.² Hence, while the economy experienced positive changes in school enrollment (quantity), it simultaneously experienced improved learning outcomes (quality).³ The improvement in students' scores are a signal of possibly an improvement in basic literacy and numeracy skills. In this context, I empirically examine the skills attainment effect of the FCUBE reform. First, I am interested in understanding if basic literacy and numeracy skills outcomes improved following the reform. Second, which level of the basic education was effective enough to guarantee skills attainment. This latter aim is not only of intellectual interest, but have important practical implications as well: given the higher number of years it takes to develop basic literacy and numeracy in low and middle income countries (Fasih, 2008; Hanushek and Woessmann, 2008).⁴ As noted, while eliminating basic education fees and levies was the principal component of FCUBE, there were other elements of the program such as construction and rehabilitation of classrooms, textbooks provision, supply of teachers, and curricula improvement.

²Akyeampong (2009) also found passing rate scores in Basic Education Certificate Examination (Grade nine leaving examination) to have surged from 60.4 in 1998 to 62.2 in 2008.

³Mechanically speaking, there must always be a tradeoff between school enrollment and learning or skills outcomes. However, an important question is how strong that tradeoff is in practice. In Kenya, Atuhurra (2016), Bold et al. (2011) and Lucas and Mbiti (2012a) show that implementation of universal primary education has led to declines in national standardized test scores of both Grade-6 and Grade-8 primary school children

⁴According to UNESCO (2006), primary education - which takes six years of school in SSA countries —is the level at which competencies in basic literacy and numeracy should be mastered. However, Fasih (2008) and Hanushek and Woessmann (2008) suggest that often even nine years of schooling in an average developing country does not necessarily mean that students have become functionally literate and numerate.

Consequently, the analysis in this paper focuses on FCUBE.

I estimate a series of difference-in-differences models of skills production that exploit the timing of the FCUBE program and variations across districts (and by gender) in pre-program literacy and numeracy levels -proxied by proportion of individuals failing to complete primary education. I rely on the Ghana Population and Housing Census (GPHC) data conducted in 2010 for estimates on pre-FCUBE skills levels for each district. I then map the data on pre-program skills levels by current district of residence with individual level data from the Ghana Living Standard Survey 2012-2017 eliciting information on skills proficiency using literacy and numeracy tests. To explore possible heterogeneities, I use gender and wealth dimensions to understand whether the program affected the skills levels of males and females differently, and whether poorest households reacted differently than richest households. I also allow the geographical location, namely rural and urban, where an individual lives to influence the skills impact. Indeed, it is not clear a priori who would benefit most from a nationwide free basic education program. On the one hand, binding credit constraints could mean that implementing a free universal education program would allow female, rural and lower-income students to participate in school. For such children, FCUBE represents the only avenue of acquiring skills. On the other hand, if female, rural and lower-income students are less likely to be able to attend basic school even with free tuition (e.g., due to high travel cost, negative attitudes towards female schooling, lower quality of educational facilities in rural areas), a nationwide free basic education reform would disproportionately benefit male, urban and higher-income students. Overall, I find that the FCUBE program increased basic literacy and numeracy by 4.6 and 3.0 percentage points, respectively. However, estimates show that the program widened the urban-rural gap in skills attainment, and that FCUBE had no effect on skills acquisition of children from the poorest households. This suggests that FCUBE was not a strong pro-poor policy and this has an important implications for policy stakeholders in Ghana. Furthermore, I find that only lower secondary education, and not primary education, was effective to guarantee literacy and numeracy following the program.

It is worth mentioning that, despite having achieved a net enrollment rate of over 85 percent (World Development Indicators, 2023), the FCUBE program has never been rigorously evaluated. By rigorous I mean evidence that allows for the causal attribution of the observed effect to FCUBE, which at a minimum requires a deliberate attempt to account for confounding factors, for example by creating a control or comparison group. This study provides the first thorough assessment of FUCBE and one of the first to draw basic education policy lessons - on basic literacy and numeracy creation - relevant to several countries from the SSA region. It therefore contributes to three strands of literature. First, it fills a gap in existing literature by providing an evaluation of the impact of free education policy on basic literacy and numeracy outcomes, thereby moving the discourse beyond enrollment and school attainment. While we know that enrollment and grade-completion achievements have improved in

SSA region (Deininger, 2003; Grogan, 2009; Nishimura et al., 2008; Kan and Klasen, 2021 for Uganda; Al-Samarrai and Zaman, 2007 for Malawi; Lucas and Mbiti, 2012a and Bold et al., 2015 for Kenya; and Hoogeveen and Rossi, 2013 for Tanzania, among others), little is known about the impact of free education on basic learning outcomes. Part of the reason for this knowledge gap is due to data limitations. With sufficient data and enough time since Ghana’s FCUBE, I can better examine the impact of this intervention and find that it had significantly improved basic literacy and numeracy.

Second, my work relates to a limited literature that traces the effect of free universal education programs on learning outcomes, which has so far focused primarily on high-stakes standardized test scores, whose outcome are of great future consequence for all involved actors (Bold et al., 2011; Lucas and Mbiti, 2012a; Atuhurra, 2016). This literature, however, has documented significant negative impacts of free education reform on students’ test scores. One possible reason for this abysmal achievement is that once in school, many children fail to achieve levels of competence expected of their grade (Uwezo, 2015; Gove and Cvelich, 2011; Bietenbeck et al., 2019). This is particularly disturbing in the case of basic reading, writing and mathematics in the early grades. This suggests that improving the chances of children to be better readers, writers and to develop into skilled basic calculation is among the first steps to be taken if improvement in high-stakes tests is to seen. With this paper, I contribute to this literature by considering basic literacy and numeracy as the foundation upon which later progress in learning is achieved.

Finally, this paper is relevant to the literature examining the impacts of other initiatives on literacy and numeracy. Earlier studies have grown around the idea of improving teacher and classroom practices, curriculum, and instruction methods in the formal education to enhance basic reading, writing and numeracy (Piper et al., 2014, 2015; Jukes et al., 2017; Hirata and Rocha e Oliveira, 2019). Others have examined how introduction of cost recovery measures at higher levels of education improve literacy and numeracy skills stock in lower levels of education using third-party reported literacy and numeracy measures (Blunch, 2014). First, I bring to this literature, the first evidence, to the best of my knowledge, of the effect of free education program as an effective strategy to enhance basic literacy and numeracy given it aim at improving quality of education. Second, I employ direct and non-subjective literacy and numeracy measures to examine the impact that free education reform has on basic skills therefore going beyond self-reported or third-party assessed measures used in earlier studies.⁵

The remainder of my paper is structured as follows. Section 2 provides an overview of basic education reform policies in Ghana, focusing particularly on the 1996 FCUBE program. Section 3

⁵Blunch (2014), for instance, measure individuals’ skills using third-party assessed (household head reported) literacy and numeracy measures which are not very informative indicators of human capital stock acquired in school. Unarguably, such measures tell little about the actual skills of individuals and, in many ways, incomplete depictions of skills levels. Moreover, they can produce overestimation of a student skills stock. The measures used in this paper provide a more realistic picture of an individual’s literacy and numeracy levels and their distribution in society (UNESCO, 2006).

presents the data and the descriptive analysis. Section 4 details the identification strategy. Sections 5 and 6 discuss the results, while Section 7 concludes.

2 Basic education in Ghana

2.1 *Pre-1996 education*

Prior to Ghana's independence in 1957, European-style education was the primary source of formal education in Ghana, although, this was provided mainly by Merchants and Christian missionaries financed partially by the British colonial government (Graham, 1971; Akyeampong, 2011). Under the British government, basic education comprised only primary education. This lasted 6 years and students entered school at age six. Every Ghanaian child qualified to have a basic education (McWilliam and Kwamena-Poh, 1975), however education was neither compulsory nor free. While the South was relatively densely populated by both colonial authorities and missions, the North was restrained from education expansion because of its low population density (McWilliam and Kwamena-Poh, 1975; Akyeampong, 2009) and perhaps due to the lack of interest by colonial authorities and missions to interfere with Islamic practices - which was then predominant in the North.

During this period, Ghana's education system was one of the highly developed in SSA. In 1961, it introduced an Education Act that aimed to prohibit tuition fees (though textbooks, stationary, and equipment were charged for) and make the six-year primary education compulsory.⁶ In the five years between 1961 and 1966, enrollment in basic school more than doubled (Little, 2010). Nevertheless, free compulsory education was not practical in all locations as many fees and other schooling-related costs remained (McWilliam and Kwamena-Poh, 1975; World Bank, 2004a). Between late 1960s and early 1980s, basic education programs became very hard to continue as Ghana suffered from chronically poor economic performance and political instability (World Bank, 1989a). The education system experienced funding crises, lacked trained and qualified teachers, and faced poor supervision and ineffective management (World Bank, 1989a, 2004a). By early 1980s, deterioration had reached the extent that primary school enrollment remained low; enrollment fell from over 2.3 million in 1975 to a little over one million in early 1980s (World Bank, 2004a). Children and parents found little value in continuing education - particularly in rural areas - as quality and returns to schooling sharply plummeted (Glewwe and Ilias, 1996; Glewwe, 1999). Figures 2 and 3 show significant variation across districts in the proportion of illiterates and students failing to complete primary education for both males and females in the twenty cohort preceding the implementation of the program evaluated in this paper. Using representative district data from the 2010 Ghana Population and Housing Census

⁶Primary school fees were first abolished in 1952 under the 1951 Accelerated Development Plan (ADP) (Graham, 1971). The Education Act of 1961 confirmed this development and further made primary schooling compulsory.

(GPHC)⁷, the figures indicate that illiteracy and primary school incompleteness were very high in the northern half of the country, which was both economically and educationally underdeveloped until recently.

Figure 2: Share of cohorts born 1950 to 1969 who are illiterate. by districts

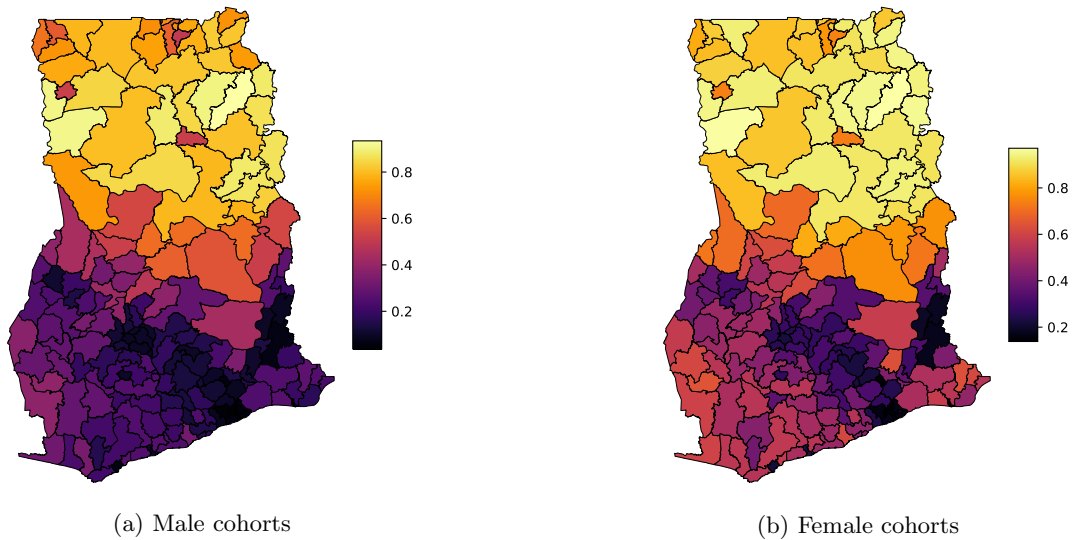
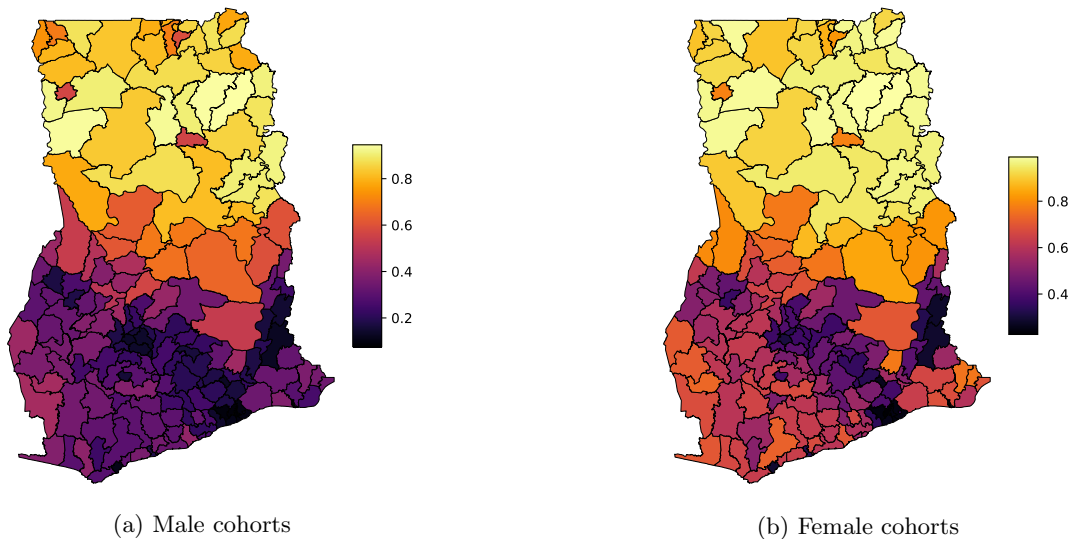


Figure 3: Share of cohorts born 1950 to 1969 not completing primary education. by districts



2.2 1996 free basic education

With a strong commitment to making education a right for all children, a constitutionally backed and nationwide free compulsory universal basic education (FCUBE) was launched in 1996 (MoE/GES, 2001; World Bank, 2004a). During this period, Ghana's basic education system included 6 years of primary school and 3 years of lower secondary school. Students entered school at age six, a starting age that remains unchanged today. Beginning September 1, 1996, the FCUBE policy removed school fees

⁷The data is retrieved from the Integrated Public Use Microdata Series (IPUMS) and was implemented by both the Ghana Statistical Service and University of Minnesota Population Centre.

and levies for grade one through nine. Unlike other free universal education policies that have been implemented in other SSA countries, FCUBE eliminated fees and levies for all pupils at the basic level, not just for those who entered primary school after its implementation. This implies that all children enrolled in primary and lower secondary school in 1996 and onwards benefited from the program.⁸ With over 30 percent of school-age children not in school (Birger and Craissati, 2009), the overarching target of FCUBE was universal enrollment within the first ten-year period. The government sets five grand objectives for the FCUBE curriculum: inculcating literacy in students' ethnic language, a second Ghanaian language, English, and numeracy; modern and basic agricultural skills; manual dexterity; developing positive character and attitude to hard work; and skills to contribute to national development (Little, 2010).

Government investment, especially in classroom capacity, teacher training, and teaching equipment was required to implement FCUBE. By 2000, the number of basic schools had increased from 12,997 in 1980 to 18,374 (World Bank, 2004a). About 3,727 school pavilions with a budget cost of US\$36 million were provided for 2,178 least endowed primary schools nationwide. As a result of the reform, 2,178 houses were established for headteachers, and roofing and other rehabilitation of about 3,300 already existing improved classrooms also occurred. Direct contribution by communities to physical infrastructure development increased, and accordingly, 2,908 school pavilions were cladded by local communities. World Bank (2004a) report shows that through two projects, directly linked to FCUBE reform, approximately 11 million textbooks were supplied. Between 1996 and 2002, bilateral and international agencies - in particular World Bank's - budgetary allocation for basic education textbooks, teaching equipment, and school furniture totalled US\$25.8 million (World Bank, 2004b). Despite efforts to shift to and increase in-service teacher training, less progress was recorded country-wide. Notwithstanding this, continuing investments increased the supply of basic education teachers; primary (lower secondary) school teachers rose from 47,900 (22,500) in 1980 to 84,400 (43,000) in 2001. In addition, the proportion of trained teachers increased in all regions by early 2000s, compared to the early 1980s proportions (World Bank, 2004a). The early period of implementation of the reform increased basic education enrollment, although this did not exceed government expectations. Primary school gross enrollment rates went from 74.6 percent in 1995 to 83.3 percent in 2004. For lower secondary school the rates were 58.7 percent and 70.2 percent respectively (Thompson and Casely-Hayford, 2008). Given the extensive regional disparities, significant differences were also noticeable across regions, with the largest enrollment increases in the Northern half of the country (Thompson and Casely-Hayford, 2008). Iddrisu (2016), Akyeampong (2009) and Thompson and Casely-Hayford

⁸As at FCUBE implementation, formal education in Ghana begins with 2 years of kindergarten, 6 years of primary school, and 3 years of lower secondary school. The primary school and lower secondary school comprised the basic education. At the end of lower secondary education, students take the Basic Education Certification Examination (BECE) and those with high enough grades qualify for senior secondary school (for 3 years study).

(2008) provide a descriptive analysis of the effect of FCUBE on school attendance and educational attainment, and found increase in these outcomes, with disparities across especially wealth quintile. For instance, school attendance and educational attainment were low among children from the lowest wealth quintile (Akyeampong, 2009). On average, out of every 1000 students who enrolled in first grade, just a little over half (56 percent) progressed to grade six and about 16 percent dropped out before completing primary school (MoE, 2006). Children from lowest quintile are more likely to drop out due to late school entry and combination of schooling with work (Akyeampong et al., 2007; Akyeampong, 2009). Evaluating the impact of the program on fertility and health, Adu Boahen and Yamauchi (2018) and Aboyadana (2023) found that girls who were exposed to the reform attained more years of education, higher age at first marriage, low fertility and better health. This paper focuses on quantifying the impact of FCUBE on skills attainment, an important output of education and driver of labor market success and economic well-being (Hanushek and Woessmann, 2008; Van der Gaag and Adams, 2010).⁹ As the FCUBE program had as part of its component not only removal of fees and levies but provision of books and other learning materials, make disentangling the possible impacts of these components more difficult. Thus, the focus of this paper is on the FCUBE program.

3 Data and descriptive statistics

3.1 Data

The data used in the construction of FCUBE’s intensity measure is taken from the 2010 Ghana Population and Housing Census (GPHC). These data were collected by the Ghana Statistical Service, and made available as part of the Integrated Public Use Microdata Series (IPUMS) International by the Minnesota Population Center. Using birth year and district of residence information, the intensity is merged with individual outcome data to estimate the effect of the FCUBE reform.

Individual-level outcomes draw from the Ghana Living Standard Survey (GLSS), which provides information on literacy and numeracy skills as well as socio-demographic factors such as birth date, age, gender, residence, educational attainment, wealth quintile, ethnicity and religious association of individuals aged 11 and above. I pool the most recent two rounds which cover 2012/2013 to 2016/2017 (GLSS 6 and 7, respectively). The two household surveys are nationally representative and contain information on the district of residence - which is key to the analyses in this paper. Unlike the previous rounds, these surveys are ideal to examine FCUBE as a determinant of basic literacy and numeracy skills. In particular, the skills measures are not self-reported or third-party assessed as appropriate literacy and numeracy tests are administered to determine each respondent’s actual skill proficiency.

⁹While the focus of the current paper is primarily on learning/skills outcomes, I also estimated the impact of FCUBE on educational attainment. Section B of the Online Appendix presents the results.

The literacy and numeracy proficiency modules contains a total of five different tests. The tests on literacy proficiency include English reading and writing proficiency tests and Ghanaian reading and writing proficiency tests while numeracy proficiency comprises arithmetic calculations like addition, and subtraction tests.¹⁰ It is worth noting that, unlike self-reported and third-party assessed measures, the use of flash cards with literacy and numeracy questions seems more appropriate for two reasons. First, the literacy and numeracy measures are non-subjective. Second, the measures are devoid of a potential overestimation of an individual's skills levels since the mode of reporting is not based on the head of the household or a knowledgeable adult member response. Nevertheless, the main shortcoming is that there are no scores on such tests which is, perhaps, due to the target of many household members and the focus to gather literacy and numeracy statistics in a cost-effective way, which is common also in many other developing countries.¹¹ Consequently, a concern is whether binary coded literacy and numeracy fairly reflect individual variation in cognitive skills proficiency. Below I provide two evidences that alleviate this concern. In Table 1, I provide a consistency check on the binary recorded nature of the reading, writing and numeracy measures. Two findings from Table 1 give some level of confidence in the data. First, reading, writing and numeracy incidence, as one would probably expect, increase with the level of education completed. Second, very few individuals who have never attended school can read, write and do simple written calculations.¹² While these findings are reassuring, the possibility that binary coded measures reflect variations in cognitive skills may still be a concern. In particular, it would be useful to know whether; (i) test score measures would be fairly correlated with the binary recorded skills incidence; and the distribution of these scores significantly differ between individuals who are illiterate/innumerate and literate/numerate. Fortunately, this can be explored, at least to some extent, by examining English and Mathematics tests administered to a subsample of respondents in GLSS 2 (1988/1989).¹³ Specifically, if the association between the test score and binary coded skills measures is positive and fairly high or literate/numerate individuals score significantly higher on these tests, this should provide an additional confidence in the validity of the

¹⁰Questions and flash cards that contained English reading, Ghanaian reading and written calculations were used to determined reading and numeracy skills. Writing skills, on the other hand, were determined with questions and empty flash cards that required writing the same sentence read earlier on in English and Ghanaian language. Interestingly, while this exercise checked individuals' writing ability it also, to a greater extent, checked their recall ability and how well respondents even understood phrase read previously which are also very crucial in the human capital process. The question on English reading (writing) skills is: 'Can "Name" read (write) a sentence in English - show flash card (administer empty flash card)?' while the question on Ghanaian reading (writing) skills is: 'In what Ghanaian language can "Name" read (write) a sentence - show flash card (administer empty flash card)?' The question on numeracy skills is: 'Can "Name" do written calculations - use flash cards?'

¹¹Availability of test scores data on literacy and numeracy in pre-and post-reform would have deepen our understanding of the cognitive impact of the FCUBE for Ghana. However, since such data is not available, I rely on the above described household surveys that use direct measures (e.g., reading aloud a short sentence) to determine literacy and numeracy proficiency.

¹²While not expected, the latter - in principle - may be legitimate, for example, resulting from home schooling or participation in adult literacy programs.

¹³The GLSS 2 survey randomly sampled about 3129 households in 1988-1989. Of these households, one half were randomly selected to participate in an English reading and a mathematics test exercises. These tests were administered to individuals between ages 9 and 55.

Table 1: Distribution of the reading, writing and numeracy skills, all observations and across highest education completed

	English reading	English writing	Ghanaian reading	Ghanaian writing	Written calculations
All observations	0.527	0.508	0.397	0.358	0.637
Never attended school	0.012	0.012	0.025	0.015	0.132
Some primary school	0.230	0.206	0.127	0.096	0.475
Primary school	0.636	0.602	0.411	0.360	0.800
Lower secondary school	0.858	0.825	0.647	0.590	0.930
Secondary school and above	0.991	0.982	0.819	0.765	0.988

Source: Ghana Living Standard Surveys 2012/2013 and 2016/2017

Notes: The sample contains 69,566 observations of respondents aged 15 and above

binary recorded measures used in this analysis. The results reported in Tables 2 and 3 help strengthen the case that binary recorded skills measures do pick up individual variation in literacy and numeracy proficiency across the sample.

Based on these tests, I construct four main outcomes: overall literacy; English literacy; Ghanaian literacy and numeracy. The overall literacy measure indicates whether an individual was able to both fully read and write sentences in any language - English or Ghanaian - or not. The English literacy indicates whether an individual was able to both fully read and write sentences in English or not, while Ghanaian literacy measures whether an individual was able to both fully read and write sentences in Ghanaian language or not.¹⁴ Individuals are considered numerate if they provided exact answers to all written calculations.¹⁵ As noted, to the extent that the different levels of basic education are likely to play a key role in skills creation following the program, I also examine whether there were differential effects on literacy and numeracy from the different levels of the basic education. In this regard, education is measured as the highest level completed and the analysis is performed separately for those with some primary completed, primary completed, and lower secondary education.

In all, I consider three cohorts based on the timing of the reform program. In general, basic education lasts for nine years in Ghana, and students start school at age 6. By noting that FCUBE occurred in 1996, it should have primarily affected cohort born in 1990 or later. However, the program may have affected students outside the main age range to have enrolled or stayed in school and/or

¹⁴The literacy definition used here reflects that used by UNESCO (1958, 1978): a literate person is one who can, with understanding, both read and write a short simple statement on his or her everyday life. While the term is evolving and sometimes refers to only reading, the ability to write is recognized as an essential part of an active learning process (UNESCO, 2006).

¹⁵The English and Ghanaian language reading tests contain one sentence per test. The sentence must be read in full before a Yes is coded. Similarly, a Yes is recorded if a respondent fully write the sentence read earlier on in English or Ghanaian language. Two questions are administered to each respondent on the written calculations: one addition and one subtraction. The correct answers to these questions must be provided for a Yes to be recorded.

progressed to the lower secondary school. Thus, the first cohort (pre-reform cohort) I consider as the main control group include students born between 1974 and 1981. These individuals were age 15 to 22 when the reform was launched and thus were less susceptible to have benefited from the program. I code students born between 1982 and 1989 (and were age 7 to 14 in 1996) as partially eligible as they may have enjoyed some years of free education because FCUBE may have caused them to enrol or remain in school and/or make headway to the lower secondary school. I also examine the effect of the program on these cohort. The third cohort (post-reform cohort) include individuals who were born in 1990 or later. For this analysis, I consider students born between 1990 and 1997 as the main post-reform cohort. Here, the assumption is that the program may have taken some time to show appreciable effect. Besides, I expand the post-reform (and pre-reform) cohort by additional five years. It should be noted that the emphasis on free education of the present paper implies that the focus is on the skill productivity of the formal education. While it would also be relevant, and particularly again for Ghana, to understand to what extent participants of non-formal education such as adult literacy programs acquire literacy and numeracy skills, such analysis is not the focus of this paper. As a result, individuals who have ever participated in adult literacy programs are excluded from all samples.

3.2 *Descriptive statistics*

Table 4 shows the descriptive statistics broken down by reform treatment group. As Table 4 shows, on average, educational attainment increased after the reform, however, this was modest overall. Relative to the pre-reform period, primary school completion as the highest level of education completed, for example, increased by 6 percentage points. On average, lower secondary school completion increased by 1 percentage point, although FCUBE had a larger impact on reducing no education; 18 percentage points from pre-reform to the post-reform. The large decline in no education and the modest increase in school attainment in lower education suggest that transition and progression through to completion of basic education is a critical issue. In addition, it implies that FCUBE did not adequately address school dropout problems (Akyeampong, 2009).¹⁶ However, the increase in the completion of senior secondary school indicates that FCUBE either induced students to continue past the lower secondary school or encouraged students who would have only obtained lower secondary education to obtain more education. Note that, the statistics on skills outcomes display large increases in skills levels for all four skills between the pre-and post-reform cohorts. For example, as clearly shown, literacy and numeracy skills increased by more than 15 percentage points. On average, literacy increased by 27 percentage points while numeracy increased by 18 percentage points from pre-reform to post-reform

¹⁶Transitioning from one level of education to the other is also a matter of ability. In general, low-achieving individuals or students with less ability are less likely to progress, and more likely to drop out of school.

Table 2: Pairwise correlation of binary recorded reading, writing, numeracy skills and test scores from GLSS 2

	English reading, binary recorded	English writing, binary recorded	Math, binary recorded	Easy English reading, test score	Advanced English reading, test score	Easy math, test score	Advanced math, test score
English reading, binary recorded	1.000 [9066]						
English writing, binary recorded	0.944 [9057]	1.000 [9057]					
Math, binary recorded	0.730 [9066]	0.698 [9057]	1.000 [9066]				
Easy English reading, test score	0.423 [1594]	0.506 [1593]	0.165 [1594]	1.000 [1595]			
Advanced English reading, test score	0.152 [997]	0.262 [996]	0.018 [997]	0.318 [989]	1.000 [997]		
Easy math, test score	0.495 [2088]	0.527 [2088]	0.153 [2086]	0.648 [1592]	0.398 [993]	1.000 [2089]	
Advanced math, test score	0.317 [1274]	0.367 [1273]	0.092 [1274]	0.361 [1120]	0.637 [937]	0.431 [1267]	1.000 [1275]

Source: Ghana Living Standard Survey 1988/1989

Notes: Observations are reported in brackets. The sample contains respondents aged 11 and above. All pairwise correlation are significant at 1%, except that between Math, binary recorded and Advanced English reading, test score ($\rho = 0.579$)

Table 3: Distribution of test scores by literacy and numeracy, and test of difference between means, GLSS 2

	Easy English reading, test score (1)	Advanced English reading, test score (2)	Easy Math reading, test score (3)	Advanced Math reading, test score (4)
Cannot read (1)	2.171	11.205	3.879	5.834
Can read (2)	5.918	15.857	6.132	11.144
(1) - (2)	-3.746***	-4.652***	-2.253***	-5.310***
Cannot write (3)	2.437	9.818	3.988	5.831
Can write (4)	6.162	16.085	6.279	11.426
(3) - (4)	-3.725***	-6.267***	-2.291***	-5.595***
Not literate (5)	2.437	9.818	3.988	5.831
Literate (6)	6.162	16.085	6.279	11.426
(5) - (6)	-3.725***	-6.267***	-2.291***	-5.595***
Not Numerate (7)	1.964	14.200	3.725	6.091
Numerate (8)	5.541	15.682	5.513	10.389
(7) - (8)	-3.577***	-1.482	-1.788***	-4.298***

Source: Ghana Living Standard Survey 1988/1989

Notes: The values are means. The sample contains respondents aged 11 and above.

period. Also, English literacy skills surged more than Ghanaian literacy skills; 28 percentage points against 14 percentage points for Ghanaian literacy. Of course, while appealing, these figures do not differentiate the impact of FCUBE from other potential nationwide changes or incidental trends. To formally examine the extent to which this crude comparison is the case or whether the FCUBE program potentially affected skills production, the empirical analysis involves exploiting variation in the intensity of the program, captured by variation in pre-reform literacy and numeracy skills across districts and by gender in the estimation of a difference-in-differences model.

4 Identification strategy

The key conceptual concern in examining the effect of FCUBE on basic literacy and numeracy skills is its simultaneous launch across the entire Ghanaian economy in 1996. My identification method follows that used in many studies, including Duflo (2001), Osili and Long (2008), Bleakley (2010), Lucas and Mbiti (2012a,b), Larreguy and Marshall (2017). The strategy relies on pre-reform region- or district-level heterogeneity: these regions or districts are all subject to the same intervention, but the effect varies based on the pre-reform differences. In the present paper, pre-reform differences in literacy and numeracy across districts (and by gender) create spatial variation that I combine with the timing of the

Table 4: Descriptive statistics

	Pre-FCUBE (1974-1981)		Post-FCUBE (1990-1997)	
	N	Mean	N	Mean
Education variables				
No education	7,808	0.30	9,617	0.12
Some primary education	7,808	0.11	9,617	0.10
Primary education	7,808	0.12	9,617	0.18
Lower secondary education	7,808	0.28	9,617	0.29
Senior secondary education	7,808	0.14	9,617	0.29
Literacy and numeracy				
Literacy	7,813	0.47	9,627	0.74
English literacy	7,813	0.42	9,627	0.70
Ghanaian literacy	7,813	0.32	9,627	0.46
Numeracy	7,813	0.61	9,627	0.79
Other variables				
Age	7,813	35.26	9,627	21.79
Female	7,813	0.54	9,627	0.52
Urban	7,813	0.45	9,627	0.43
Non-Akan	7,813	0.62	9,627	0.61
Christian	7,813	0.68	9,627	0.72
Muslim	7,813	0.21	9,627	0.21
Traditionalist	7,813	0.05	9,627	0.03

reform to identify the effect of FCUBE.¹⁷ The first dimension I exploit is related to pre-reform district level heterogeneity in the (male or female) proportion of a district's population that was illiterate and innumerate. If individuals were illiterate and innumerate at a high rate in the pre-reform period, then that district would be treated more intensely by the FCUBE relative to a district where the proportion of illiteracy and innumeracy was low. While Figure 2 demonstrates a considerable variation in skills productivity potential of the program across districts (and by gender), the intensity measure correlates - possibly in a negative way - with the effectiveness of the program. More specifically, it is possible that younger cohort exposed to the program significantly gained basic skills and these cognitive benefits of literacy and numeracy were shared with others in the household. In a comprehensive paper, Basu et al. (2001) note that to the extent that members of the household have similar preferences or that the bargaining power within the family does not alter much for the illiterate or innumerate person when these skills benefits are shared, literate (and/or numerate) individuals will share the benefits of

¹⁷There is no well-established best practice in defining the predicted intensity using information on pre-reform in the literature. The crucial thing is to find a way to vary the predicted intensity across geographical units. Here, I added gender to capture important variation across districts. Such approach is common in the applied literature (Larreguy and Marshall, 2017; Lucas and Mbiti, 2012b).

these skills.¹⁸ In this case, it can be argued that such skills sharing may be so complete in certain instances that previously illiterate (and/or innumerate) individuals become literate (and/or numerate). In the present context, while this may have occurred between the younger children exposed to the program and older cohort, a priori, it is not common for these older individuals to become literate and/or numerate this way. Generally, literacy and numeracy are acquired through formal education. Nevertheless, I address this concern using pre-reform primary school completion to capture pre-reform literacy and numeracy competencies. In particular, I define FCUBE intensity as the male or female proportion of a district population born between 1950 and 1969 that had not completed primary education: the schooling and skills characteristics used from these cohorts to compute the intensity measures is to reduce the likelihood that FCUBE had an impact on these pre-reform levels of schooling and basic skills. The choice of the incomplete primary education relies on two reasons. First, as it is well known, access to primary education is an opportune time for basic cognitive skills development. Nevertheless, a growing body of research suggests that successful completion is a critical threshold for acquisition and sustainable mastery of basic competencies, such as literacy and numeracy.¹⁹ For instance, mounting evidence in developing countries, Ghana included, suggests that a large proportion of individuals with less than primary completed education remain illiterate and/or innumerate for the rest of their lives (Chowdhury, 1995; Bruns and Rakotomalala, 2003). Second, considering that individuals with less than primary completed education seems to be more at a disadvantage in terms of cognitive skills, such as literacy and numeracy, for developing nations, adult literacy programs are targeted at these individuals. Therefore, the use of pre-reform variation in the proportion of cohort failing to complete primary education as an intensity measure seems warranted. Figure 3 displays this intensity.²⁰

The second dimension I exploit is time. Here, the year of birth determines an individual's exposure. As FCUBE's target group were students aged 6 in 1996, individuals born in 1989 or before should not have been eligible for the program as they were older than six when the reform was launched. However, as noted before, delayed school entry could lead some of these students to enjoy free education. Here, rather than using individuals just a little older, I use those born in 1981 or before as the control group. These individuals were 15 or older in 1996 and thus were less likely to have enrolled or been in school. I consider individuals born between 1982 and 1989 as partially treated since they may have enjoyed some periods of free schooling due to late entry or later years of schooling. All students born in 1990 or later

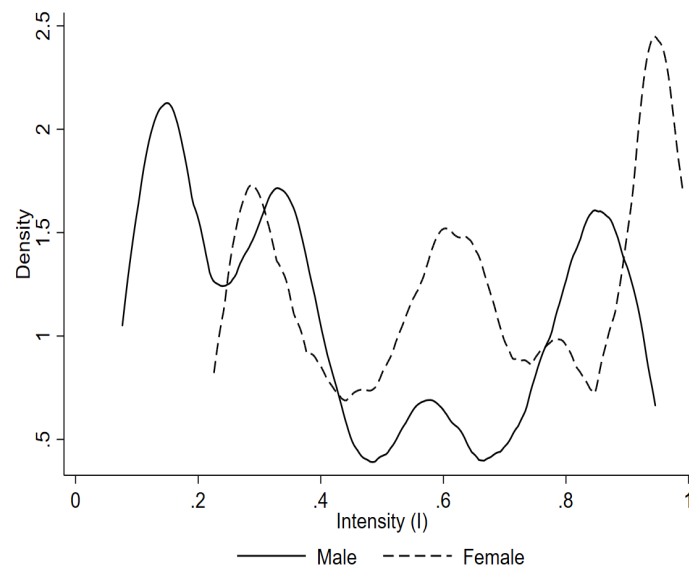
¹⁸Existing evidence from Bangladesh shows that an old illiterate worker who occasionally need an assistance with tasks that require reading and writing benefits from easy access to a young/an old literate person in the household. The former, then, earns more in the labor market (Basu et al., 2001). However, it is not clear whether such an illiterate member become literate this way.

¹⁹By UNESCO's standards, basic literacy and numeracy should be completely mastered by the end of the primary school cycle, that is, with six years of education (UNESCO, 2006).

²⁰Notice that Figures 2 and 3 show a near-complete overlap: districts with high fraction of individuals who have not completed primary education also have high illiteracy and innumeracy rate. The two figures are perfectly correlated (0.99).

are considered fully treated. As discussed, the intensity is computed separately for each district using data from the 2010 Ghana PHC. To match this intensity with individual survey data, information on the current district of residence of each individual is used. Figure 4 affirms that respondents in the sample lived in districts with large proportion of individuals with incomplete primary education, and thus illiterates and innumerates for both genders, although a high fraction are females. Note that, I would ideally like to have information on each respondent's childhood district of education and skills

Figure 4: FCUBE intensity distribution across districts and by gender



Source: 2010 GPHC

Notes: The figure shows the kernel density distribution of the intensity separately for men and women in the sample.

gains. Nevertheless, since such data is not explicitly available, I assume that respondents education and skills gains occurred in their current district of residence. A crucial concern is that if migrants and non-migrants have significant differences especially in their literacy and numeracy skills, this could bias the estimates in particular if the former sorted into certain types of districts. However, district of birth data in the GLSS suggests that one's current residence is a good approximation of his or her childhood district of education and skills gains. The GLSS data indicates that more than three-fifths of the sample still lives in their district of birth.²¹ In the robustness checks, I use this information to show that results for the full sample are not different from those obtained for the sample who did not move from the district in which they were born.

The difference-in-differences specification below formally estimates the impact of the FCUBE program:

²¹The GLSS only provides data on current district of residence plus information on whether the respondent has ever moved from this district. I consider the districts of all respondents who reported that they have never moved as the district of birth.

$$\begin{aligned}
y_{icdrt} = & \beta_1 intensity_d + \beta_2(post-FCUBE_c \times intensity_d) + X'_{ic}\theta + \delta_c + \delta_r + \delta_t \\
& + \lambda_{pre,r}birthyear_c + \lambda_{post,r}(post-FCUBE_c \times birthyear_c) + v_{icdrt}
\end{aligned} \tag{1}$$

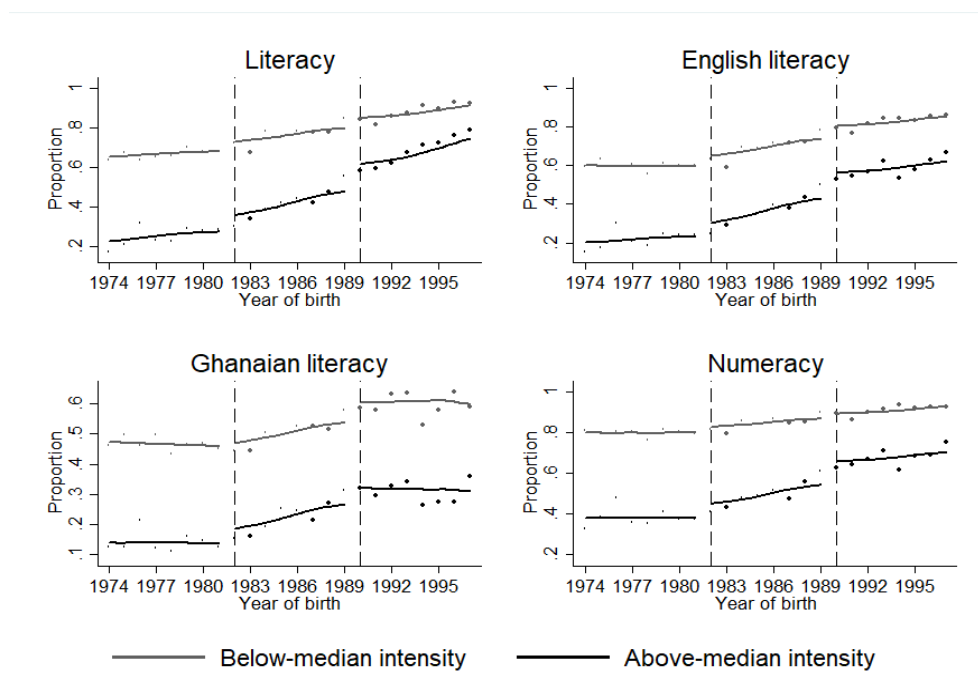
where y_{icdrt} is a vector of outcomes - literacy, English literacy, Ghanaian literacy and numeracy for individual i from cohort c in district d , within region r at time t . $intensity$ is a district specific computed intensity of the reform described in Section 4 and $post-FCUBE$ is a dummy variable indicating whether an individual was born in 1990 or later. δ_c denotes cohort fixed effects and it accounts for programs and policies that took place during the period of the FCUBE program. I include region fixed effects, δ_r , to control for school availability and quality that are crucial for literacy and numeracy skills achievement. As North-South divide the Ghanaian economy, with most regions of the south being relatively more well-off, this also controls for initial conditions. The survey fixed effects, δ_t , absorb the period effect across surveys. I control for region-specific trends, $birthyear_c$ and $post-FCUBE_c \times birthyear_c$, to account for differential trends across cohorts that benefit and did not benefit from the FCUBE reform in different regions. Here, this ensures that a program effect is being identified separately from incidental trends. Note that, the robustness tests do not show different estimates when using district fixed effects and district-specific cohort trends instead to address a more general trends concerns. Finally, I control for a rich set of background variables that are important for human capital achievement analyses in X_{ic} vector, comprising age, age squared, gender, urban, religion, and ethnic association. In all estimations, standard errors are clustered at region and year of birth level.

My key identifying assumption requires that without the FCUBE reform, trends in literacy and numeracy skills would not have differed across districts with different reform intensities. Figure 5 broadly supports such parallel trends, showing similar trends in all four skills across above and below-median FCUBE intensities before the reform. However, I include region-specific cohort trends to ensure that this does not mask a subtle heterogeneous trends. In addition, I perform a placebo test using cohort unaffected by the program.

5 Results

In Table 5, I present the estimation results from the difference-in-differences model of skills production for all four outcomes. The results in Panel A of Table 5 confirm that FCUBE increased skills levels more in districts with low prior rates of literacy and numeracy. Columns 1 and 2 show a significant positive effect for the interaction between the post-FCUBE period indicator and intensity: for a 10 percentage points increase in the intensity, FCUBE program increased literacy and numeracy by about 4.6 and 3.0 percentage points respectively. The point estimates in Columns 3 and 4 reinforce the impact on the overall literacy by showing that FCUBE increased literacy both in English and Ghanaian language.

Figure 5: Trends in literacy and numeracy, by FCUBE intensity



Source: GLSS and 2010 GPHC

Notes: Each dot on the graph is the average of a particular skills outcome by cohort in below- and above-median FCUBE intensity value. The size of a dot indicates the quantity of data in the sample. I overlay local polynomial curves bandwidth of 2 to show trends in literacy and numeracy outcomes across the treatment intensity. The first cut-off line in each graph differentiates trends in outcomes between cohorts that partially benefited and the control group. The second cut-off separates FCUBE-fully affected cohorts from the above two groups.

In all, the impact on English literacy was higher: about two-fold that on Ghanaian literacy, which perhaps is due to the importance of English as a language of instruction and the increased demand for English literacy skills on the labor markets (Blunch, 2014). In Panels B and C, I examine whether other cohorts, beyond the main cohort that was eligible during FCUBE, also benefited from the program. If FCUBE indeed caused the above effects on skills levels, we should find a smaller positive impact for additional cohorts (the farther away from 1990, the smaller the effect). Panel B presents the results for students born between 1986 and 1989 who would have been between the ages of seven and ten when the program began in 1996. This group is particularly interesting as they may have enrolled or stayed in school because of the FCUBE program in their transition to the lower secondary education. From Panel B, Columns 1-4, I find some evidence that these cohorts who schooled in high intensity FCUBE districts also experienced higher literacy and numeracy skills levels compared to those of the unaffected cohorts. In line with previous hypothesis, the effects are lower than for the fully affected cohorts. Table 5, Panel C, focuses on cohorts born between 1982 and 1985 and were age eleven to fourteen when the program was launched. To the extent that the program may have caused them to have remained, especially in the lower secondary school, these individuals may have benefited from FCUBE. In Panel C, although the coefficients are positive (only positive and significant for literacy, though weakly), the impacts are not as strong as it is for cohorts born between 1986 and 1989. It should be noted that these findings in Panels B and C justify previous decision

Table 5: FCUBE impact on skills outcomes - main results

A. Treatment: born 1990-1997; Control: born 1974-1981				
	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
Intensity	-0.719*** (0.042)	-0.666*** (0.046)	-0.518*** (0.037)	-0.519*** (0.048)
Post-FCUBE $\times$ intensity	0.457*** (0.046)	0.375*** (0.050)	0.175*** (0.041)	0.290*** (0.055)
Observations	17440	17440	17440	17440
R^2	0.30	0.29	0.21	0.28
B. Treatment: born 1986-1989; Control: born 1974-1981				
	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
Intensity	-0.655*** (0.041)	-0.576*** (0.042)	-0.500*** (0.038)	-0.474*** (0.045)
Post-FCUBE $\times$ intensity	0.229*** (0.050)	0.200*** (0.048)	0.109** (0.043)	0.159*** (0.056)
Observations	13901	13901	13901	13901
R^2	0.30	0.28	0.20	0.30
C. Treatment: born 1982-1985; Control: born 1974-1981				
	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
Intensity	-0.639*** (0.037)	-0.574*** (0.036)	-0.493*** (0.035)	-0.447*** (0.039)
Post-FCUBE $\times$ intensity	0.067* (0.036)	0.028 (0.037)	0.054 (0.033)	0.053 (0.037)
Observations	13667	13667	13667	13667
R^2	0.31	0.28	0.20	0.31
D. False treatment: born 1974-1981; Control: born 1970-1973				
	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
Intensity	-0.703*** (0.050)	-0.637*** (0.058)	-0.497*** (0.046)	-0.527*** (0.056)
Post-FCUBE $\times$ intensity	0.019 (0.040)	0.029 (0.046)	-0.013 (0.045)	0.062 (0.047)
Observations	10613	10613	10613	10613
R^2	0.32	0.29	0.22	0.31

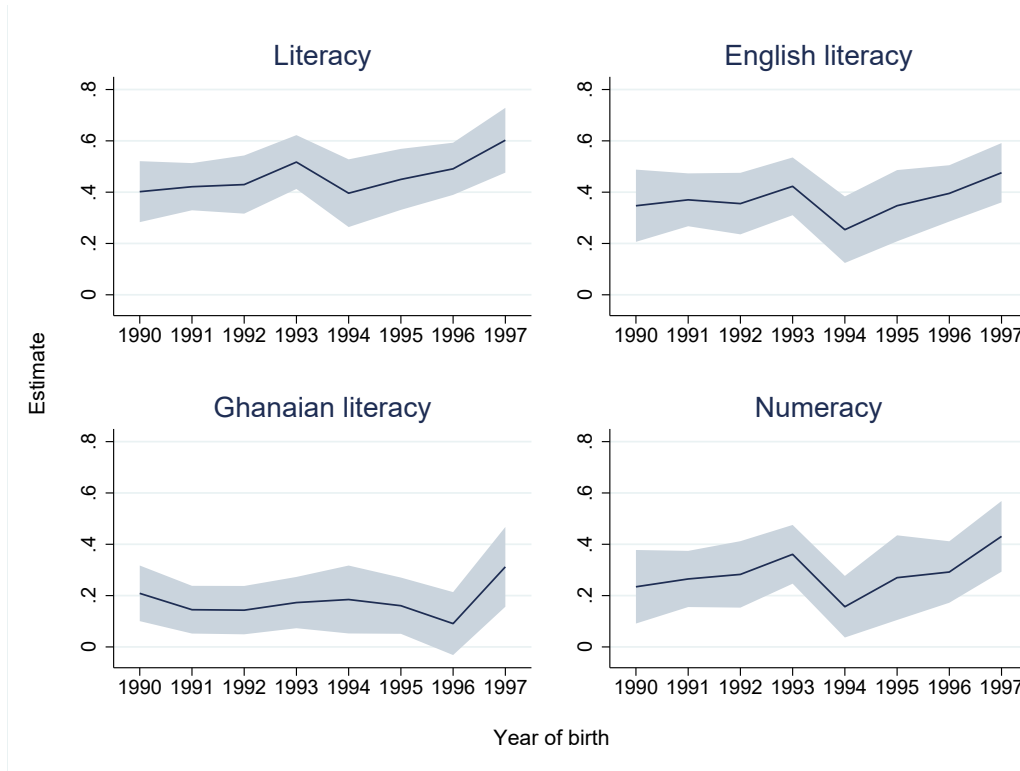
All models include age, age squared, gender, urban-rural, ethnicity, religion, cohort, region, survey dummies, and region-specific cohort trends for cohort affected and unaffected by the reform. Robust standard errors clustered by region-year of birth shown in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

not to include these cohorts as control group for the main results presented in Panel A. In Panel D, I provide further evidence in support of the identification assumption that underlies my estimates. Beyond the inclusion of region-specific trends on either side of the reform, the panel checks for equal

trends using placebo test. In particular, it compares cohorts born 1974-1981 to those born 1970-1973. Neither cohorts should have been affected by FCUBE. Nevertheless, if skills levels were increasing faster in high intensity districts than low intensity districts prior to FCUBE, I should find a spurious significant effect for 1974-1981 cohort in high intensity areas. As evident in Panel D, when I compare these successive cohort of individuals who were unaffected by the program, I find no evidence that skills levels was increasing faster thus suggesting equal trends prior to the reform. Moreover, Panel D shows that no respondents born 1974-1981 could have even benefited from the program.

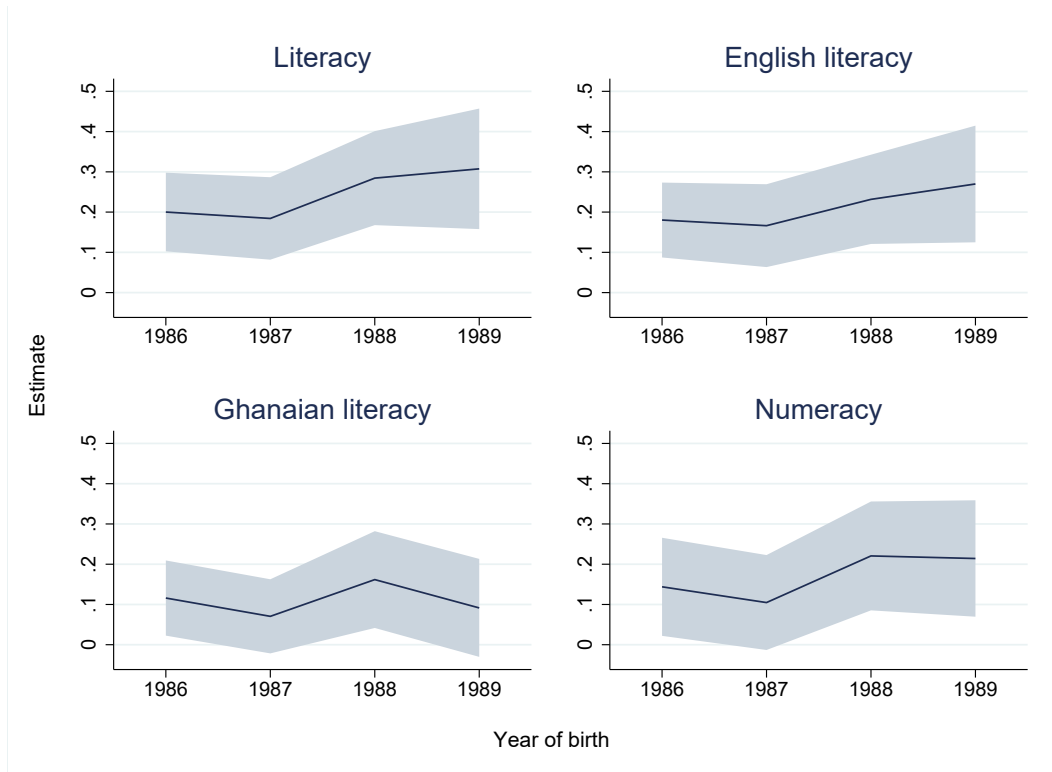
It is worthy to note that the specification in equation (1) constrains the estimated effect of FCUBE, β_2 , to be constant across all birth cohorts. If instead the effects of the program vary by birth year, estimating the specification with a single coefficient could conceal important heterogeneities. Therefore, Figures 6 through 8 estimate birth year-specific effects of the program by replacing the term, $\beta_2(post-FCUBE_c \times intensity_d)$ in equation (1) with a full set of birth year-specific exposure to FCUBE and coefficients, $\sum_c \beta_c(post-FCUBE_c \times intensity_d)$ for fully treated cohorts $c \in [1990, 1997]$ and partially treated cohorts $c \in [1982, 1989]$. Figure 6 displays the results for individuals who were fully eligible after the implementation of the program. As shown, the coefficients are more precisely estimated across all birth cohorts. The figure shows that exposure to the FCUBE reform increased literacy and numeracy skills levels in each year, and the estimates are statistically significant at conventional

Figure 6: FCUBE impact on skills outcomes - 1990-1997 cohort



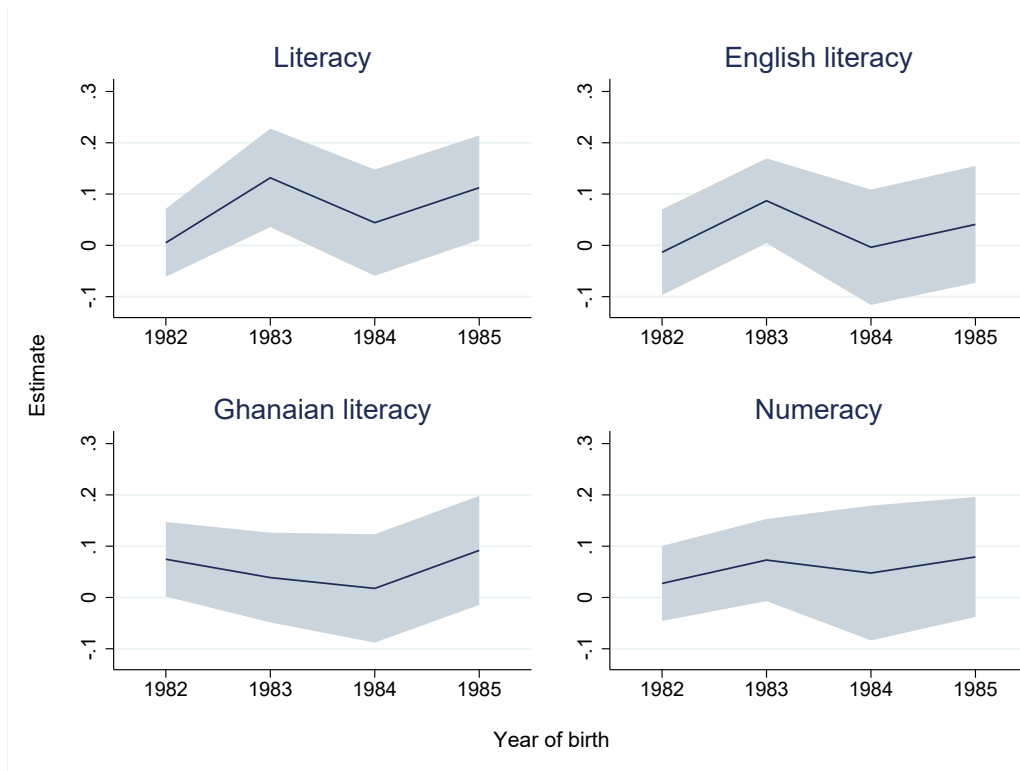
Notes: Coefficients and 95 confidence intervals. Full treatment: born 1990-1997; Control: born 1974-1980. Controls are similar to Table 5.

Figure 7: FCUBE impact on skills outcomes - 1986-1989 cohort



Notes: Coefficients and 95 confidence intervals. Partial treatment: born 1986-1989; Control: born 1974-1980. Controls are similar to Table 5.

Figure 8: FCUBE impact on skills outcomes - 1982-1985 cohort



Notes: Coefficients and 95 confidence intervals. Partial treatment: born 1982-1985; Control: born 1974-1980. Controls are similar to Table 5.

confidence level. The estimates of this effect range between 4.0 and 6.0 percentage points for literacy

skills, and 1.6 and 4.3 percentage points for literacy and numeracy skills. For children born between 1986 and 1989 who were aged between seven and ten when the program was implemented, the coefficients are also positive, and if anything, more precisely estimated (Figure 7). The impact on literacy and numeracy increased in each year and the estimates are statistically significant. As expected, the estimated impact are smaller than for the fully eligible cohorts. While the results in Panel C of Table 5 shows a limited impact on skills outcomes when the individuals born between 1982 and 1989 are pooled, Figure 8 depicts that FCUBE increased both literacy and numeracy for some birth cohorts. Cohorts born in 1983 experienced increased literacy (at 1%) and numeracy (at 10%). Additionally, those born in 1982 and 1985 had improvements in their literacy and Ghanaian literacy skills.

5.1 Robustness

The basic identifying assumption that underlies the validity of the above estimates is common trends in skills levels before the introduction of FCUBE. In this section, I show that the estimates are robust to two possible violations. Additionally, I demonstrate that results are similar when alternative definitions of reform intensities are used. A key concern is that my estimates reflect long-run trends in literacy and numeracy skills levels. In particular, high intensity districts may exhibit a catch-up due to convergence rather than because of improved literacy and numeracy due to the FCUBE program. To test for this convergence concern, I restrict the sample to students born after 1990 and examine the correlation between their skills levels and the intensity measure in Panel A of Table 5. If convergence possibly caused the above significant impacts, I should find a non-correlation or strong positive correlation. The results in Panel A nevertheless show that pre-reform skills levels negatively correlate with skills outcomes among those affected by FCUBE. Thus, suggesting no issue of convergence as cohort born after 1990 become less literate and numerate in the highest-intensity districts. Further, Panel B uses district fixed effects and pre-and post-FCUBE district-specific cohort trends to address the more general equal trend concern that the above effects could capture differential district-level cohort trends that cannot be probably pick-up by the region-specific cohort trends. As the panel shows, results for cohort that were of eligible age during FCUBE are robust to the controlling for district-specific cohort trends.

In Panels C and D, I also experiment with alternative definitions of the FCUBE intensity. First, Panel C uses intensity defined as the proportion of cohort born 1950-1959 with less than completed primary schooling (and thus illiterate and innumerate), and hence too old to be affected by FCUBE's literacy and numeracy skills opportunities. Using this intensity, the four point estimates in Panel C show similar impacts. As noted, an important obstacle to using variations in Figure 2 as the main intensity measure is that pre-reform skills levels are correlated with the effectiveness of the FCUBE program. In particular, younger cohort that were potentially affected by the reform may have shared

their literacy and numeracy with older cohort, including those born 1950-1969. However, and as argued before, on a priori grounds, I do not think it is - especially in a developing country context - common to become literate and/or numerate this way; literacy and numeracy skills are gained via formal schooling. Using this intensity, I find that, contrary to this skills sharing concern, point estimates are essentially unaffected. Intriguingly, Panel D provides similar results with no influence on the precision of the estimates. But could other important factor be biasing estimates? One key concern is that since individuals are matched to districts based on their current district of residence, selective internal migration could bias previous estimates. While a little over three-fifths of the individuals in the sample still live in their district of birth, among those who do not live in their birth district I do not know

Table 6: FCUBE impact on skills outcomes - robustness check

	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
A: Correlation with intensity, born after 1990 only				
Intensity	-0.308*** (0.038)	-0.352*** (0.042)	-0.365*** (0.043)	-0.269*** (0.031)
Observations	9627	9627	9627	9627
R^2	0.19	0.18	0.17	0.19
B: District fixed effect and district-specific trends				
Post-FCUBE $\times$ intensity	0.565*** (0.066)	0.555*** (0.069)	0.295*** (0.074)	0.360*** (0.072)
Observations	17440	17440	17440	17440
R^2	0.34	0.32	0.24	0.32
C: Ten periods (1950-1959) pre-FCUBE variations				
Post-FCUBE $\times$ intensity	0.444*** (0.044)	0.368*** (0.048)	0.174*** (0.041)	0.285*** (0.054)
Observations	17440	17440	17440	17440
R^2	0.31	0.29	0.21	0.28
D: pre-FCUBE literacy and numeracy variations				
Post-FCUBE $\times$ intensity	0.450*** (0.050)	0.361*** (0.054)	0.164*** (0.042)	0.291*** (0.060)
Observations	17440	17440	17440	17440
R^2	0.30	0.29	0.21	0.28
E: Non-migrants only				
Post-FCUBE $\times$ intensity	0.525*** (0.061)	0.452*** (0.063)	0.226*** (0.055)	0.325*** (0.062)
Observations	10712	10712	10712	10712
R^2	0.30	0.29	0.22	0.27

All models include age, age squared, gender, urban-rural, ethnicity, religion, cohort, region, survey dummies, and region-specific cohort trends for cohort affected and unaffected by the reform. Region*Year of birth-clustered standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

where these individuals were educated and thus acquired basic skills. Therefore, the estimates in Panel

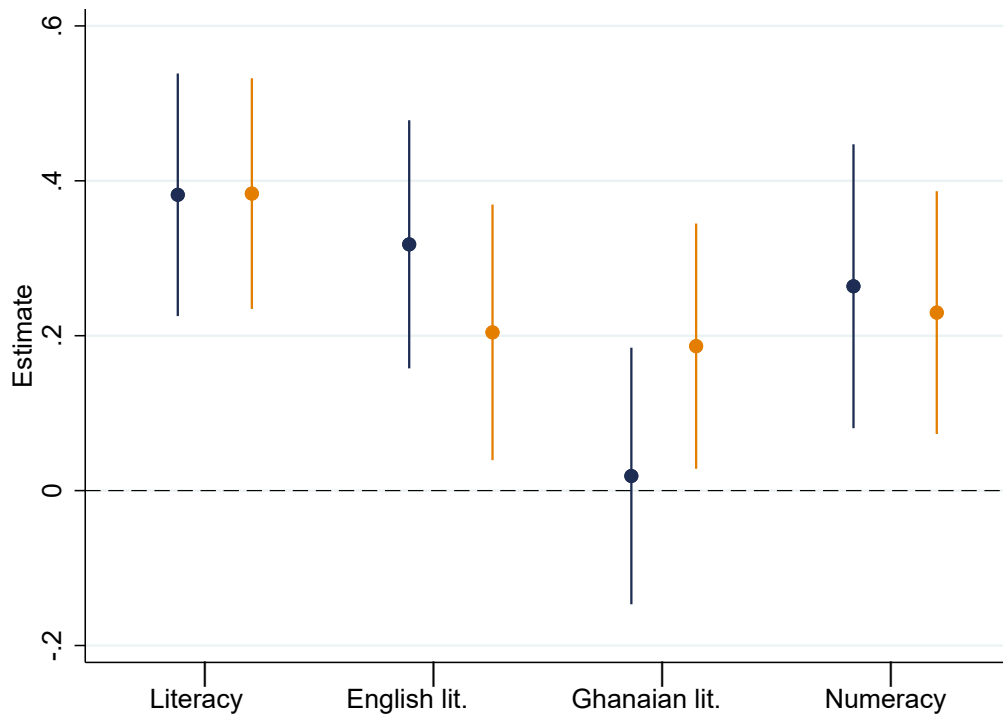
E include only individuals who never moved from their district of birth. As evident from Panel E, the effects are statistically significant and similar to the main effects. Once individuals who did not remain in their birth district are excluded, all four skills levels increase considerably. In the Appendix, I investigate the issue of sample selection. In section 3, I argued that FCUBE program may have taken some time to show appreciable impact on skills creation, thus opting to use cohort of individuals born between 1990 and 1997 as the main treated cohorts. To demonstrate that the main results are not dependent on this assumption or do not reflect sample ranged used, I expand the range of the birth cohorts included in the sample by an additional year in either direction. The point estimates are shown in Table A1 of the Online Appendix. Across all four panels, estimates remain positive and statistically significant at the one percent level for all four skills levels.²²

6 Heterogeneity in FCUBE Impact

Gender differences

In this subsection, I investigate whether there is a strong gender dimension, whereby all the reform

Figure 9: FCUBE impact on skills outcomes - gender



Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for males (dark navy) and females (dark orange) separately. Controls are similar to Table 5. The males estimation sample contains a total of 8229 observations, while that of females is 9211 observations.

impact gains observed above are coming from a particular gender. Overall, it is not obvious which

²²The large increase in the magnitude of the impact once the sample is expanded is due, perhaps, to the improvement of the program through capitation grant. As the grant covered non-salary costs and particularly targeted at enhancing educational inputs and quality, this may have generated a more favorable learning environment for these cohorts.

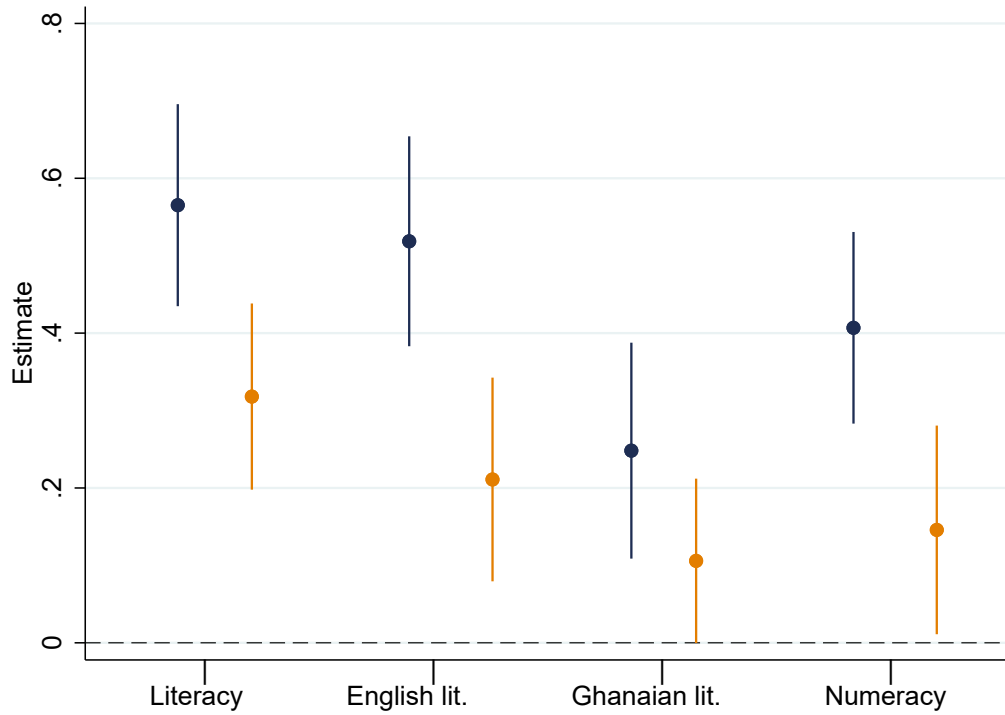
gender will benefit most as there are two competing factors. On the one hand, there could be more females with families on the margin of changing investment in their education and skills levels. On the other hand, gender roles, social norms or household response to perceived returns to skills may indicate that males benefited more than females. For example, parents' may see males as future providers or to retain close connections with household especially after marriage allowing the family to recoup the full returns to investment in their human capital (Garg and Morduch, 1998) or the returns to males' skills and schooling may be larger than to females' skills and schooling. Then males will acquire more education and skills than females. If the former effect dominates, we would then see that this gender-neutral education reform benefited females more than males. I test this heterogeneity by re-estimating a version of equation (1) for males and females separately and thus perform a test of significant difference in the coefficients of the respective skills levels. Figure 9 reports the estimates obtained when investigating the reform impact for both genders. Beginning with the males sample, except for the finding that the reform did not have a significant impact on Ghanaian literacy, results are similar to the overall average effects reported in Section 5. In the females sample, the evidence suggests that all four skills increased. Nevertheless, a test of statistical difference reveals that both genders are not statistically different in terms of all four skills levels: literacy (*p-value*: 0.987), numeracy (*p-value*: 0.766), English literacy (*p-value*: 0.278) and Ghanaian literacy (*p-value*: 0.193). This suggest that FCUBE reform did not produce any significant male-female gap in skills acquisition.

Location differences

I also examine heterogeneity in treatment effect by splitting the sample between rural and urban areas, as urban areas have an advantage in basic skills at baseline (literacy: 66.9 percent -urban versus 31.4 percent - rural; numeracy: 79.3 percent -urban versus 45.7 percent - rural, in the raw data). Thus, one may expect rural areas to gain more skills than urban areas, signaling a reduction in skills inequality. Nevertheless, the disproportionately low levels of supply side factors (e.g. travel cost and distance to school) in many rural developing countries means that the higher gains may be limited.

And these supply side constraints may have differential impacts on gender among rural populations as especially females' education are sensitive to these constraints (Glick and Sahn, 2000; Glick, 2008; Lavy, 1996; Lloyd e al., 2005). As before, I produce estimates of the policy effect depending on the geographical characteristics - (i) all urban and (ii) all rural - of the individuals in the sample, and perform a test of statistical difference in the coefficients of the respective skills levels. I report the results in Figure 10. As clearly evident, the point estimates for both urban and rural individuals show an increase in all skills. However, the pattern that emerges is that the reform impact is mainly driven by changes in skills levels among individuals from urban areas. For both literacy and numeracy, the estimates for urban individuals are strongly, (*p-value*: 0.004) and (*p-value*: 0.001) respectively,

Figure 10: FCUBE impact on skills outcomes - location



Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for urban (dark navy) and rural (dark orange) cohorts separately. Controls are similar to Table 5. The number of observations is 7630 for urban and 9810 for rural.

larger than for rural individuals.²³ This is true for the full sample as well as when I stratify the sample by location and gender (see Figures A2 and A3 in the Online Appendix). It should be noted that given the considerable skills gap already observed - in the pre-reform - between urban and rural populations (UNESCO, 1995; World Bank, 1989b, Windborne, 2004), this indicates that the FCUBE program led to a widening of the existing geographical disparities in skills levels. On the one hand, this may be explained by the uneven distribution and lower quality of educational facilities and resources. Compared to urban Ghana, rural Ghana suffers more from less availability as well as lower quality of educational resources (Hedges, 2002; Iddrisu et al., 2016; Takyi et al., 2021). On the other hand, the significant difference may be due to travel time or distance to the nearest basic schools. Earlier studies provide support in this direction and show how longer distance to school affect school participation among rural children (Gaddah et al., 2016; Fentiman et al., 1999; Lavy, 1996).²⁴

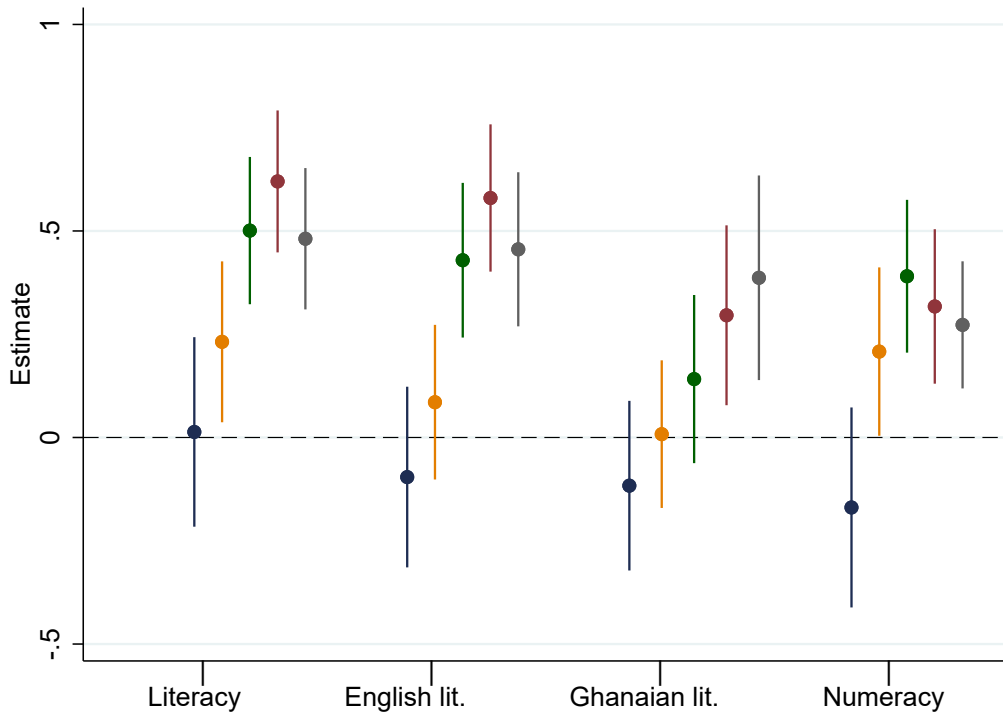
²³I also find English literacy skills to be higher in urban areas (p -value: 0.000) than rural areas. The results show no strong difference in Ghanaian literacy, however (p -value: 0.105)

²⁴Figure A4 of the Online Appendix shows the travel distance to and from school among basic school age children. In general, distance to and from school is higher for rural children than for urban children. Further, Figure A5 shows that rural children spend more hours on both economic and domestic activities, which suggest that a higher opportunity cost of schooling for these children.

Wealth differences

In Figure 11, I use wealth dimensions to understand whether poorest households reacted differently to the program than richest households. Even though these types of policies are often proposed as a way to reduce socioeconomic inequalities, it is not obvious to predict which income group stands to benefit the most. If the policy leads to changes in investment in the education of the marginal child driven by cost considerations, we would expect stronger impacts for children from families with such background characteristics. On the other hand, poor households determination of investment risk in education may play a vital role in determining a significant program impact. For example, there may be no behavioral response - in the first place - in terms of enrollment to a change in school fees if poor parents do not perceive education primarily as a worthwhile economic investment. Besides, if the opportunity costs of schooling, which are usually greater for poor families, outweigh the cost of school participation, the program may not have expected impact on these households (Akyeampong, 2009; Gaddah et al., 2016). I use the wealth quintile provided in the household data

Figure 11: FCUBE impact on skills outcomes - wealth dimension



Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for (i) lowest quintile - 4234 obs (dark navy), (ii) second quintile- 3324 obs (dark orange), (iii) middle quintile- 3191 obs (dark green), (iv) fourth quintile- 3241 obs (maroon), and highest quintile- 3450 obs (grey) cohorts separately. Controls are similar to Table 5.

described above to identify the heterogeneous effects by income.²⁵ In Figure 11, while the estimates show strong impact on literacy and numeracy for the second wealth quintile (poor) households, I find

²⁵The wealth quintile groups provided in the surveys are defined based on households' consumption expenditure levels. For comparability, these groups are defined at the national level. The lowest quintile group represents the poorest 20% of individuals in the population, the second quintile the next 20% and so on until the highest quintile which contains the richest 20% (GLSS, 2012/13; 2016/17).

no evidence that the program affected children from the bottom wealth quintile (poorest) households: in 3 out of 4 cases, estimates show that FCUBE led to a reduction in skills levels of these children, although these are not statistically different from zero. In contrast, results reveal that children from the middle-highest wealth quintile households significantly attained literacy and numeracy due to the reform. As noted, one possibility might be that, as the opportunity costs for poorest children going to school are often higher, even when fees were abolished, children from the bottom wealth quintile ended up not participating in school regularly to acquire basic skills. This supports Akyeampong (2009) and World Bank (2011a) observation that the poorest families' need for child labor posed a potential threat for poorest children to benefit from the program as children's work prevented regular attendance and increased pressure to drop out of school, with the result being a limit in learning outcomes.²⁶ Furthermore, to the extent that socioeconomic status is a good indicator of inheritable parents' ability (Hilmer, 1997), such disadvantaged children would be expected to have lower levels of ability, which could explain the absence of increased learning.

6.1 *Skills productivity of the basic education*

Thus far the estimates in previous section indicate that the FCUBE program led to an increase in skills levels of cohort entering school at the time of the program implementation. In this section, I examine whether there were differential effects on skills improvement depending on the different levels of the basic education completed. Here, the research question is that, if such skills achievements occurred, were both primary and lower secondary education levels enough to acquire literacy and numeracy following the launch of the program? To identify the existence of these different impacts on the outcomes by the different levels of basic education, the models are re-estimated creating three sets of specifications: one for individuals with less than primary education, second for primary education, and third for lower secondary education.²⁷ Estimates from the difference-in-differences models are shown in Table 7. I find no evidence of an increase in skills for individuals with less than primary completed education (Panel A). The impact of the program on skills levels of this post-reform primary school incomplete cohort is mostly about the same, sometimes even decreasing although not statistically significant at any conventional percent level. Similarly, the skills effects of the program did not improve for those with primary completed education (Panel B). These results contrast those reported by Blunch (2014) who find in a linear probability model a significant increase in skills levels for individuals with less than primary and primary completed education following the 1987 Ghana Education Sector Reform. However, these results are not directly comparable as the current estimates identify the

²⁶Figure A6 of the Online Appendix shows the hours worked on economic and domestic activities across wealth quintile for basic school age children. Children from the bottom of the wealth distribution spend more time working.

²⁷I focus on primary and lower secondary education since the FCUBE program mainly targeted these levels of education.

Table 7: FCUBE impact on skills outcomes - highest education level completed

	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
A: Some primary education				
Post-FCUBE $\times$ intensity	0.065 (0.117)	0.035 (0.103)	0.115 (0.082)	-0.044 (0.159)
Observations	1748	1748	1748	1748
R^2	0.12	0.13	0.07	0.10
B: Primary education				
Post-FCUBE $\times$ intensity	0.160 (0.118)	0.164 (0.112)	0.034 (0.112)	0.157 (0.110)
Observations	2701	2701	2701	2701
R^2	0.19	0.22	0.14	0.09
C: Lower secondary education				
Post-FCUBE $\times$ intensity	0.359*** (0.065)	0.245*** (0.092)	0.118 (0.086)	0.116** (0.053)
Observations	5048	5048	5048	5048
R^2	0.16	0.12	0.09	0.05

All models include age, age squared, gender, urban-rural, ethnicity, religion, cohort, region, survey dummies, and region- specific cohort trends for cohort affected and unaffected by the reform. Robust standard errors clustered by region-year of birth shown in parentheses. *p<0.1, **p<0.05, ***p<0.01.

skills effect of the 1996 free basic education program. The lack of significant skills effect for the primary education system here could be due to the fact that primary education was not enough to acquire literacy and numeracy, which signals lack of improved quality after the introduction of the FCUBE reform. Further, since the fees and levies elimination feature of the reform affords students the chance to attend lower secondary education, students who only attained primary education as the highest level of schooling after the reform were plausibly less able. To the extent that poor quality education system has little to offer to such students, one would expect primary education individuals to have limited improvement in skills attainment. Focusing on the lower secondary school system, results show that skills productivity largely increased (Panel C). The productivity in terms of literacy, for instance, surged by about 3.6 percentage points whereas that in terms of numeracy increased by about 1.2 percentage points, for a 10 percentage points increase in the intensity. This suggests that for developing countries, different levels of basic education may lead to different levels of basic cognitive skills development across individuals. In Ghana, this indicates that basic literacy and numeracy skills production may not be limited to the primary school system but could continue into the lower secondary education. This support Kingdon and Soderbom (2007)'s claim that, if the quality of education is possibly low especially at lower levels of education, it may take many years of schooling to develop literacy and numeracy, a reality that highlights the importance of schooling quality.

7 Conclusion

Literacy and numeracy unarguably are at the heart of human and economic development and, as a result, have received widespread attention in recent decades. Yet, there are still issues related to the effective strategies of creating such basic skills. In Sub-Saharan Africa, where a significant fraction of adults are currently illiterate, parents make no or limited decisions to improve their children's basic skills at home. Consequently, the formal education system is the only avenue for children to attain literacy and numeracy. In this paper, the main goal has been to evaluate the effect of the Ghanaian free compulsory universal basic education program introduced in 1996 on literacy and numeracy skills production. The FCBUE program is a particularly interesting case as evidence based on descriptive data shows that it increased learning/skills outcomes despite the influx of entrants from the lowest of the skills distribution and, among human capital policies implemented over the past years, it acted as the main inflection point for the economy's improved human capital outcomes. For this purpose, I constructed a series of literacy and numeracy skills outcome models, where the focal explanatory variable is the interaction of the program's intensity and post-program dummy.

By employing a difference-in-differences approach which exploited variation in pre-program literacy and numeracy skills paired with differences across cohorts induced by the timing of the program, I find that, the FCUBE program increased literacy and numeracy skills. This finding indicates that the post-reform quality of the basic education remained sufficiently high to lead to improved skills that would have not otherwise materialized. However, results show that the program widened the geographical gap in skills production. While results depict impacts on children from second wealth quintile households, I find negligible impacts on bottom quintile households children. In contrast, estimates indicate that the program impact manifested itself strongly and particularly among children from the middle-highest wealth quintile households. In addition, while it increased overall skills levels, I find that it produced large differentials between the different levels of the basic education. More specifically, the skills productivity of the lower secondary school system improved considerably, while that of the primary education remained unchanged. Therefore, overall, these findings on the one hand indicate that the FCUBE program was indeed skills enhancing and that appropriate measures that encourage continued quality should be enacted to ensure that skills acquisition is not compromised. On the other hand, the results also highlight the possible danger of the program not ensuring significant skills acquisition at lower levels of the basic education - primary education. In addition, the negligible effects for poorest children indicate that FCUBE did not seem to have been a strong pro-poor in general, which basically hints that its input did not go far enough to offset the opportunity costs of schooling for the poorest households. Awareness about the presence of this trade-off is crucial for Ghana. This indicates that, going forward, free education programs in Ghana and elsewhere might

consider giving priority and providing complementary initiatives that would seem more likely to offset the opportunity costs and reduce these gaps.

A limitation here, of course, is that while I argued that the literacy and numeracy tests measures used in this study are accurate and provide a realistic picture of actual literacy skills than self-assessed measures, it would be preferable if future works could consider collecting and examining test scores data to supplement the current study and enhance our understanding of the cognitive skills impacts of the program.

References

- Abadzi, H. (1994). *What we know about acquisition of adult literacy: is there hope?* World Bank Discussion Paper No. 245. Washington, DC: World Bank.
- Aboyadana, G. (2023). Education and health in developing countries: Evidence from Ghana's FCUBE. *World Development Sustainability*, 2:100041.
- Adu Boahen, E. and Yamauchi, C. (2018). The effect of female education on adolescent fertility and early marriage: evidence from free compulsory universal basic education in Ghana. *Journal of African Economies*, 27(2):227–248.
- Agbaglo, E., Agbadi, P., Tetteh, J. K., Ameyaw, E. K., Adu, C., and Nutor, J. J. (2022). Trends in total fertility rate in Ghana by different inequality dimensions from 1993 to 2014. *BMC Women's Health*, 22(1):49.
- Akyeampong, K. (2009). Revisiting free compulsory universal basic education (FCUBE) in Ghana. *Comparative Education*, 45(2):175–195.
- Akyeampong, K. (2011). *Assessing the impact of school capitation grants on educational access in Ghana*. CREATE Pathways to Access Research Monograph No. 71.
- Akyeampong, K., Djangmah, J., Oduro, A., Seidu, A., and Hunt, F. (2007). *Access to Basic Education in Ghana: The evidence and the issues*. Country Analytic Report.
- Al-Samarrai, S. and Zaman, H. (2007). Abolishing school fees in Malawi: The impact on education access and equity. *Education Economics*, 15(3):359–375.
- Angrist, N., Aurino, E., Patrinos, H. A., Psacharopoulos, G., Vegas, E., Nordjo, R., and Wong, B. (2023). Improving learning in low-and lower-middle-income countries. *Journal of Benefit-Cost Analysis*, pages 1–26.
- Atuhurra, J. F. (2016). Does community involvement affect teacher effort? Assessing learning impacts of free primary education in Kenya. *International Journal of Educational Development*, 49:234–246.
- Banerji, R., Berry, J., and Shotland, M. (2017). The impact of maternal literacy and participation programs: Evidence from a randomized evaluation in India. *American Economic Journal: Applied Economics*, 9(4):303–337.
- Basu, K., Narayan, A., and Ravallion, M. (2001). Is literacy shared within households? Theory and evidence for Bangladesh. *Labour Economics*, 8(6):649–665.
- Bietenbeck, J., Ericsson, S., and Wamalwa, F. M. (2019). Preschool attendance, schooling, and cognitive skills in east africa. *Economics of Education Review*, 73:101909.
- Birger, F. and Craissati, D. (2009). *Abolishing school fees in Africa: Lessons learned in Ethiopia, Ghana, Kenya and Mozambique*. Washington, DC: World Bank.
- Bleakley, H. (2010). Malaria eradication in the Americas: A retrospective analysis of childhood exposure. *American Economic Journal: Applied Economics*, 2(2):1–45.
- Blunch, N.-H. (2013). Staying alive: Adult literacy programs and child mortality in rural Ghana. *World Development*, 42:114–126.
- Blunch, N.-H. (2014). Literacy and numeracy skills and education sector reform: Evidence from Ghana. *Education Economics*, 22(2):209–235.
- Blunch, N.-H. and Pörtner, C. C. (2011). Literacy, skills, and welfare: Effects of participation in adult literacy programs. *Economic Development and Cultural Change*, 60(1):17–66.
- Bold, T., Kimenyi, M., Mwabu, G., and Sandefur, J. (2011). Does abolishing fees reduce school quality? Evidence from Kenya.
- Bold, T., Kimenyi, M., Mwabu, G., and Sandefur, J. (2015). Can free provision reduce demand for public services? Evidence from Kenyan education. *The World Bank Economic Review*, 29(2):293–326.
- Bruns, B. and Rakotomalala, R. (2003). *Achieving universal primary education by 2015: A chance for every child*, volume 1. Washington, DC: World Bank.
- Caponera, E., Sestito, P., and Russo, P. M. (2016). The influence of reading literacy on mathematics and science achievement. *The Journal of Educational Research*, 109(2):197–204.

- Chowdhury, K. P. (1995). *Literacy and primary education*. Human Resources Development and Operations Policy Working Paper No. 50. Washington, DC: World Bank.
- Colclough, C., Lewin, K. M., et al. (1993). *Educating all the children: Strategies for primary schooling in the South*. Clarendon Press.
- Deininger, K. (2003). Does cost of schooling affect enrollment by the poor? Universal primary education in Uganda. *Economics of Education Review*, 22(3):291–305.
- Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia: Evidence from an unusual policy experiment. *American Economic Review*, 91(4):795–813.
- Fasih, T. (2008). *Linking education policy to labor market outcomes*. World Bank Publications. Washington, DC: World Bank.
- Fentiman, A., Hall, A., and Bundy, D. (1999). School enrolment patterns in rural Ghana: A comparative study of the impact of location, gender, age and health on children’s access to basic schooling. *Comparative Education*, 35(3):331–349.
- Gaddah, M., Munro, A., and Quartey, P. (2016). Education subsidy and school enrollments in rural Ghana. *International Journal of Educational Development*, 46:143–152.
- Garg, A. and Morduch, J. (1998). Sibling rivalry and the gender gap: Evidence from child health outcomes in Ghana. *Journal of Population Economics*, 11:471–493.
- GES (2005). *Guidelines for the distribution and utilisation of capitation grants to primary schools*. Accra, Ghana: Ghana Education Service.
- Glewwe, P. (1999). *The economics of school quality investments in developing countries: An empirical study of Ghana*. Hampshire RG21 6XS and London: Macmillan Press Limited.
- Glewwe, P. and Ilias, N. (1996). The determinants of school attainment in sub-Saharan Africa: A case study of Ghana. *Journal of International Development*, 8(3):395–413.
- Gove, A. and Cvelich, P. (2011). Early reading: Igniting education for all. a report by the early grade learning community of practice. *RTI International*.
- Govinda, R. (2003). Making basic education work for the poor: experiences from the south. in: Subrahmanian, r., et al. (eds.), *ids bulletin, special issues on education inclusion and exclusion: Indian and south african perspectives*, vol. 23(1).
- Graham, C. K. (1971). *The history of education in Ghana: From the earliest times to the declaration of independance*. Number 108. Oxon: Frank Cass and Company Limited.
- Grogan, L. (2009). Universal primary education and school entry in Uganda. *Journal of African Economies*, 18(2):183–211.
- Hanushek, E. A. and Woessmann, L. (2008). The role of cognitive skills in economic development. *Journal of Economic Literature*, 46(3):607–668.
- Hilmer, M. J. (1997). Does community college attendance provide a strategic path to a higher quality education? *Economics of Education Review*, 16(1):59–68.
- Hirata, G. and Rocha e Oliveira, P. (2019). Lasting effects of promoting literacy—do when and how to learn matter? *Education Economics*, 27(4):339–357.
- Hoogeveen, J. and Rossi, M. (2013). Enrolment and grade attainment following the introduction of free primary education in Tanzania. *Journal of African economies*, 22(3):375–393.
- Iddrisu, I. (2016). Universal basic education policy: Impact on enrolment and retention. *Journal of Education and Practice*, 7(17):141–148.
- Jukes, M. C., Turner, E. L., Dubeck, M. M., Halliday, K. E., Inyega, H. N., Wolf, S., Zuilkowski, S. S., and Brooker, S. J. (2017). Improving literacy instruction in Kenya through teacher professional development and text messages support: A cluster randomized trial. *Journal of Research on Educational Effectiveness*, 10(3):449–481.
- Kaffenberger, M. and Pritchett, L. (2021). Effective investment in women’s futures: Schooling with learning. *International Journal of Educational Development*, 86:102464.

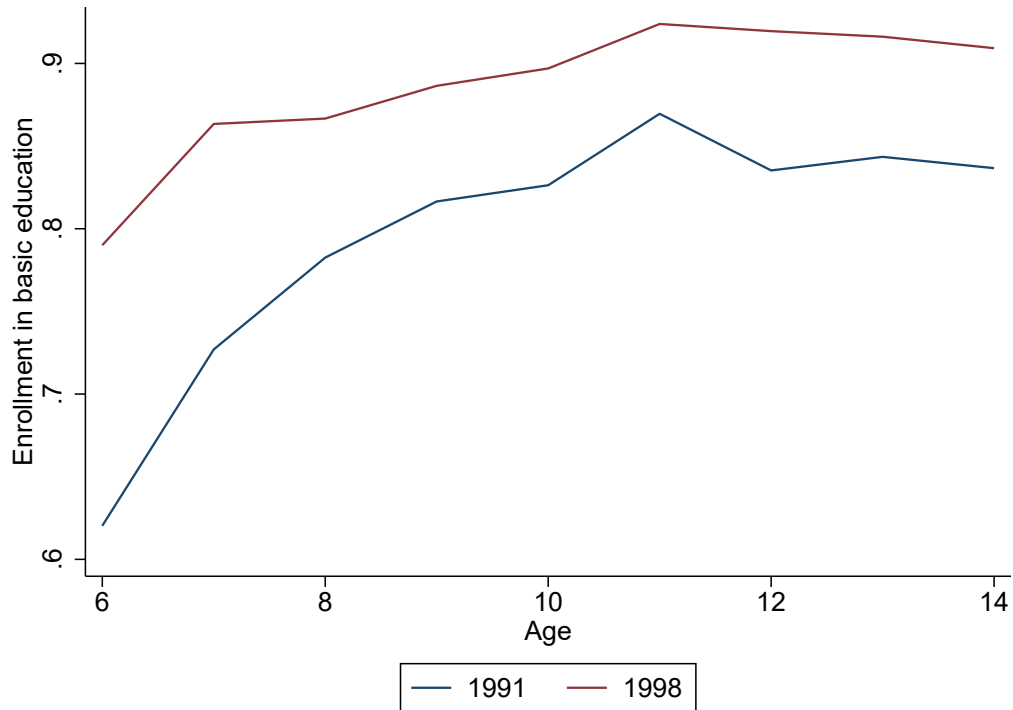
- Kan, S. and Klasen, S. (2021). Evaluating universal primary education in Uganda: School fee abolition and educational outcomes. *Review of Development Economics*, 25(1):116–147.
- Kingdon, G. and Soderbom, M. (2007). Education, skills and labor market outcomes: Evidence from Ghana. *Background paper prepared for the World Bank study, Linking Education Policy to Labor Market Outcomes*. Washington, DC: World Bank.
- Larreguy, H. and Marshall, J. (2017). The effect of education on civic and political engagement in non-consolidated democracies: Evidence from Nigeria. *Review of Economics and Statistics*, 99(3):387–401.
- Lavy, V. (1996). School supply constraints and children’s educational outcomes in rural Ghana. *Journal of Development Economics*, 51(2):291–314.
- Little, A. (2010). *Access to basic education in Ghana: Politics, policies and progress*. CREATE Pathways to Access Research Monograph No. 42.
- Lloyd, C. B. and Gage-Brandon, A. J. (1994). High fertility and children’s schooling in Ghana: Sex differences in parental contributions and educational outcomes. *Population Studies*, 48(2):293–306.
- Lucas, A. M. and Mbiti, I. M. (2012a). Access, sorting, and achievement: The short-run effects of free primary education in Kenya. *American Economic Journal: Applied Economics*, 4(4):226–253.
- Lucas, A. M. and Mbiti, I. M. (2012b). Does free primary education narrow gender differences in schooling? evidence from Kenya. *Journal of African Economies*, 21(5):691–722.
- Martin, M. O., Ina, V. S. M., Foy, P., Olson, J. F., Erberber, E., Preuschoff, C., and Galia, J. (2008). *TIMSS 2007: International science report: findings from IEA’s trends in international mathematics and science study at the fourth and eighth Grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.
- McWilliam, H. O. A. and Kwamena-Poh, M. A. (1975). *The development of education in Ghana: An outline*. London: Longman.
- MoE (2003). *Education strategic plan 2003-2015*. Accra, Ghana: Ministry of Education.
- MoE (2006). *Education sector performance report*. Accra, Ghana: Ministry of Education.
- MoE/GES (2001). *Report of the study on the constitutional and legal framework for the right to pre-tertiary education*. Accra, Ghana: Ministry of Education and Ghana Education Service.
- Nishimura, M., Yamano, T., and Sasaoka, Y. (2008). Impacts of the universal primary education policy on educational attainment and private costs in rural Uganda. *International Journal of Educational development*, 28(2):161–175.
- Nordtveit, B. H. (2008). Poverty alleviation and integrated service delivery: Literacy, early child development and health. *International Journal of Educational Development*, 28(4):405–418.
- Osili, U. O. and Long, B. T. (2008). Does female schooling reduce fertility? Evidence from Nigeria. *Journal of Development Economics*, 87(1):57–75.
- Piper, B., Jepkemei, E., and Kibukho, K. (2015). Pro-poor primr: Improving early literacy skills for children from low-income families in Kenya. *Africa Education Review*, 12(1):67–87.
- Piper, B., Zuilkowski, S. S., and Mugenda, A. (2014). Improving reading outcomes in Kenya: First-year effects of the primr initiative. *International Journal of Educational Development*, 37:11–21.
- Pritchett, L. (2013). *The rebirth of education: Schooling ain’t learning*. Center for Global Development (CGD) Books.
- Smith-Greenaway, E. (2013). Maternal reading skills and child mortality in Nigeria: A reassessment of why education matters. *Demography*, 50(5):1551–1561.
- Takyi, S. A., Amponsah, O., Asibey, M. O., and Ayambire, R. A. (2021). An overview of Ghana’s educational system and its implication for educational equity. *International Journal of Leadership in Education*, 24(2):157–182.
- Tenikue, M. and Verheyden, B. (2010). Birth order and schooling: Theory and evidence from twelve sub-saharan countries. *Journal of African Economies*, 19(4):459–495.

- Thompson, N. M. and Casely-Hayford, L. (2008). The financing and outcomes of education in Ghana. Technical Report, Recoup Working Papers No. 16. Cambridge: University of Cambridge, Faculty of Education, Research Consortium on Educational Outcomes and Poverty (RECOUP). <https://nbn-resolving.org/urn:nbn:de:0168-ssoar-68683>.
- UNESCO (2005). *Education for all global monitoring report: The quality imperative*. United Nations Educational, Scientific and Cultural Organization, Paris.
- UNESCO (2006). *Education for all global monitoring report: Literacy for life*. United Nations Educational, Scientific and Cultural Organization, Paris.
- UNESCO (2012). *Youth and skills: Putting education to work*. United Nations Educational, Scientific and Cultural Organization, Paris.
- Uwezo (2015). Are our children learning? Literacy and numeracy across east africa 2014. nairobi: Twaweza East Africa.
- Valente, C. (2019). Primary education expansion and quality of schooling. *Economics of Education Review*, 73:101913.
- Van der Gaag, J. and Adams, A. (2010). *Where is the learning?: Measuring schooling efforts in Developing Countries. Policy Brief 2010-04*. Brookings Institution Washington, DC.
- Wedgwood, R. (2007). Education and poverty reduction in Tanzania. *International journal of educational development*, 27(4):383–396.
- World Bank (1989a). *Basic education for self-employment and rural development: A sub-sector study*. World Bank Report No. 7593-GH. Africa Country Department IV, Population and Human Resources Division, Washington, DC: World Bank.
- World Bank (1989b). *Basic education for self-employment and rural development: A sub-sector study*. Africa Country Department IV Population and Human Resources Division. Washington, DC: World Bank.
- World Bank (2004a). *Books, buildings, and learning outcomes: An impact evaluation of World Bank support to basic education in Ghana*. World Bank Operations Evaluation Department, Washington, DC: World Bank.
- World Bank (2004b). *Project performance assessment report Ghana*. World Bank Report No. 29581. Thematic and Global Evaluation Operations Evaluation Department, Washington, DC: World Bank.
- World Bank (2011a). *Education in Ghana: Improving equity, efficiency and accountability of education service delivery*. Bank Report No. 59755-GH, Africa Region. Washington, DC: World Bank.
- World Bank (2011b). Learning for all: Investing in people’s knowledge and skills to promote development.
- World Bank (2019). *Ghana accountability for learning outcomes project*. World Bank Report No. PIDA26704. Washington, DC: World Bank.

Online Appendix

A FCUBE impact on skills outcomes: Additional figures and tables

Figure A1: Basic school enrollment by age



Source: Ghana Living Standard Surveys 1991 and 1998

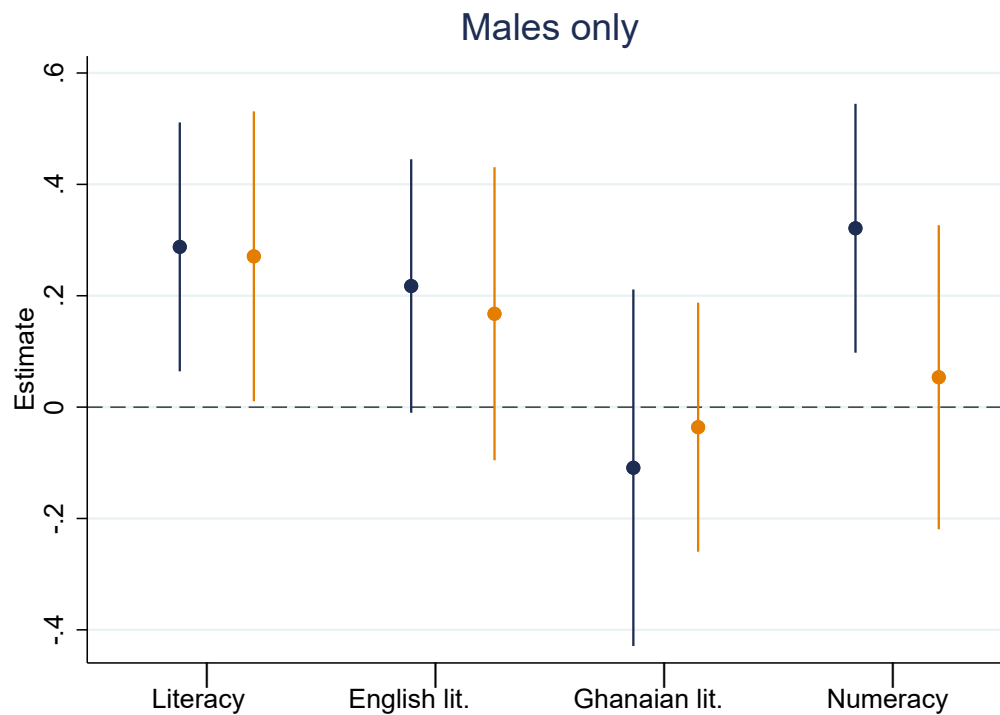
Notes: The figure plots the enrollment rate among basic school age children before and after FCUBE implementation in 1996.

Table A1: FCUBE impact on skills outcomes - alternative sample

	Literacy (1)	English literacy (2)	Ghanaian literacy (3)	Numeracy (4)
A: Treatment: born 1990-1998, Control: born 1973-1981				
Post-FCUBE $\times$ intensity	0.469*** (0.043)	0.392*** (0.045)	0.183*** (0.039)	0.342*** (0.051)
Observations	20949	20949	20949	20949
R^2	0.31	0.30	0.21	0.28
B: Treatment: born 1990-1999, Control: born 1972-1981				
Post-FCUBE $\times$ intensity	0.512*** (0.040)	0.442*** (0.043)	0.212*** (0.036)	0.374*** (0.048)
Observations	24485	24485	24485	24485
R^2	0.31	0.30	0.21	0.28
C: Treatment: born 1990-2000, Control: born 1971-1981				
Post-FCUBE $\times$ intensity	0.542*** (0.039)	0.475*** (0.042)	0.225*** (0.037)	0.400*** (0.046)
Observations	26277	26277	26277	26277
R^2	0.31	0.30	0.21	0.28
D: Treatment: born 1990-2002, Control: born 1970-1981				
Post-FCUBE $\times$ intensity	0.624*** (0.036)	0.562*** (0.039)	0.284*** (0.034)	0.480*** (0.043)
Observations	33878	33878	33878	33878
R^2	0.29	0.29	0.21	0.27

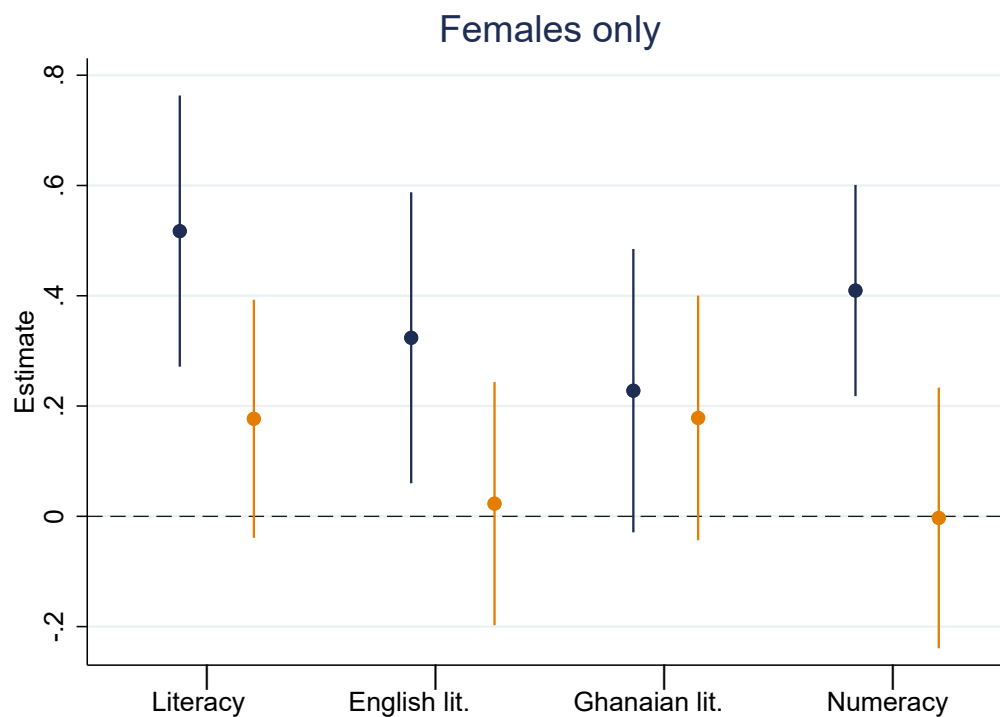
All models include age, age squared, gender, urban-rural, ethnicity, religion, cohort, region, survey dummies, and region-specific cohort trends for cohort affected and unaffected by the reform. Region*Year of birth-clustered standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure A2: FCUBE impact on skills outcomes - location and gender



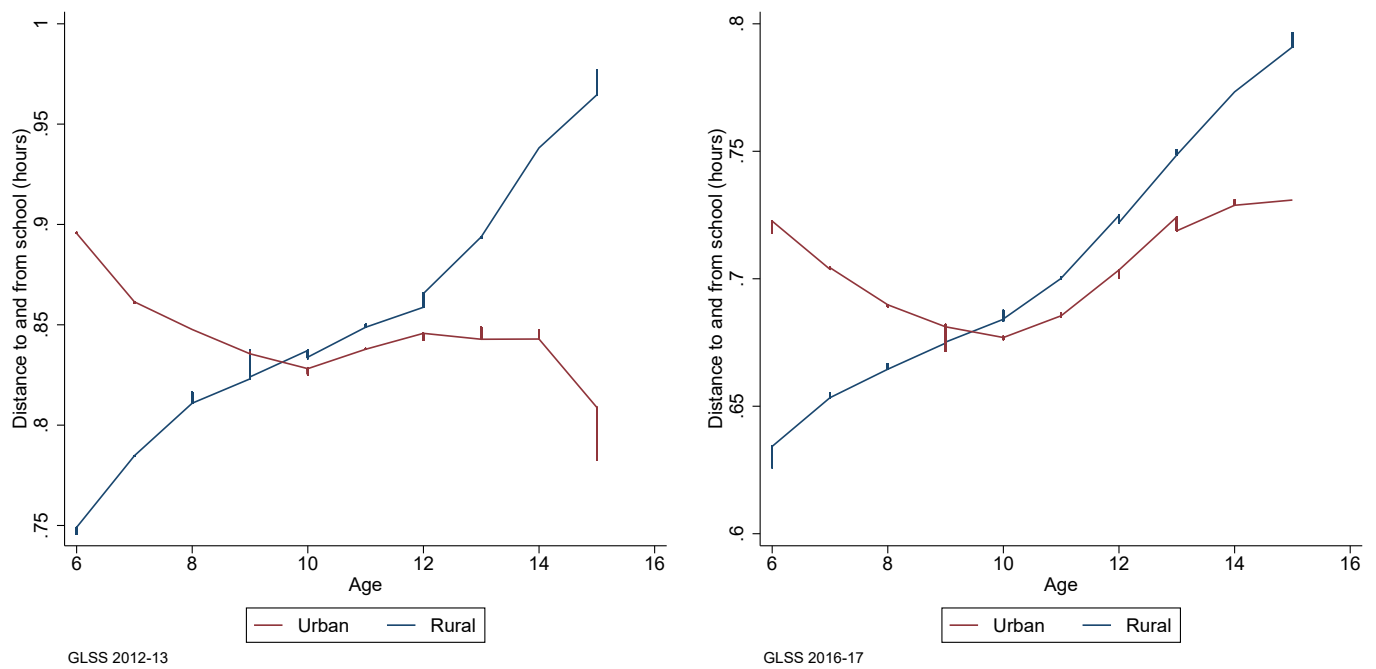
Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for urban (dark navy) and rural (dark orange) separately. Controls are similar to Table 5. The estimation sample contains 3571 observations for urban and 4658 for rural.

Figure A3: FCUBE impact on skills outcomes - location and gender



Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for urban (dark navy) and rural (dark orange) separately. Controls are similar to Table 5. The estimation sample contains 4059 observations for urban and 5152 for rural.

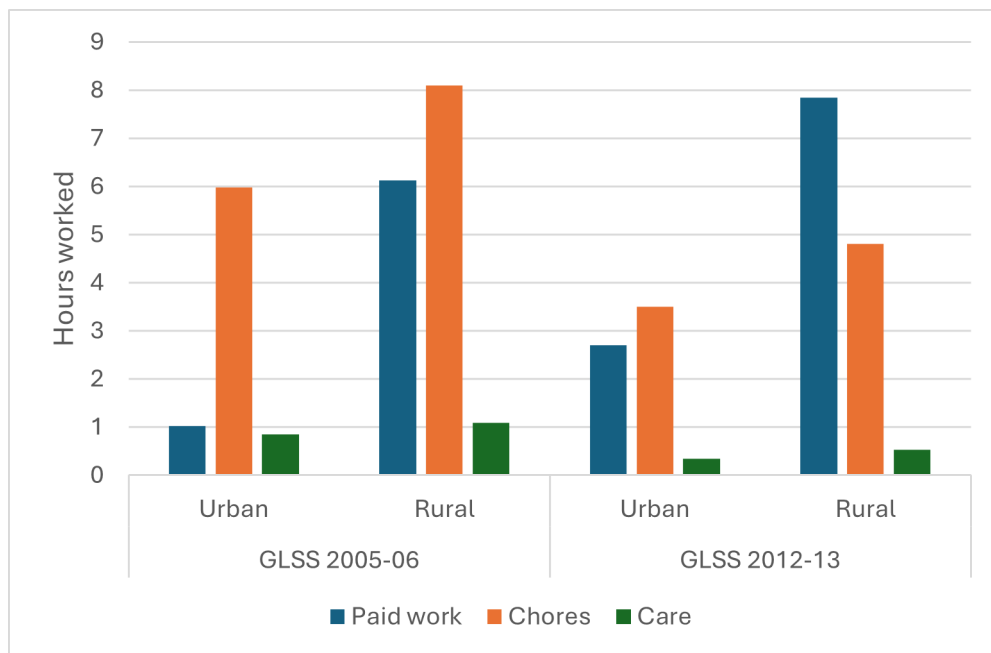
Figure A4: Travel distance to and from school by location



Source: Ghana Living Standard Surveys 2012-13 and 2016-17

Notes: The figure plots the daily distance to and from school (in hours) among basic school age children in urban and rural areas.

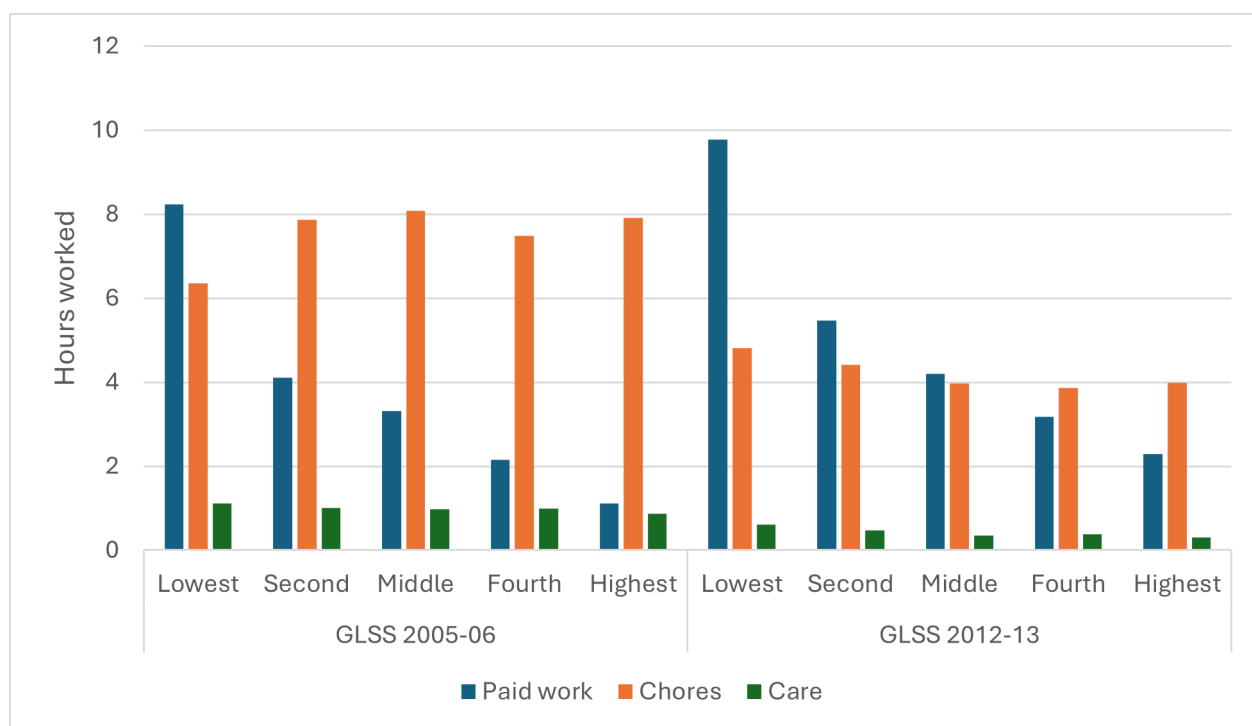
Figure A5: Hours worked on economic and domestic activities by location



Source: Ghana Living Standard Surveys 2005-06 and 2012-13

Notes: The figure plots the hours worked on economic and domestic activities in the last 7 days among basic school age children (7-15 years old) in urban and rural areas. Paid work refers to work for pay, profit or family gain. Chores refer to activities on fetching water, firewood, cleaning, cooking, washing, shopping, etc. Care activities includes caring for younger children, elderly and ill household members.

Figure A6: Hours worked on economic and domestic activities by wealth



Source: Ghana Living Standard Surveys 2005-06 and 2012-13

Notes: The figure plots the hours worked on economic and domestic activities in the last 7 days among basic school age children (7-15 years old) across wealth quintile. Paid work refers to work for pay, profit or family gain. Chores refer to activities on fetching water, firewood, cleaning, cooking, washing, shopping, etc. Care activities includes caring for younger children, elderly and ill household members.

B FCUBE impact on school completion: Figures and tables

B.1 FCUBE impact: School completion

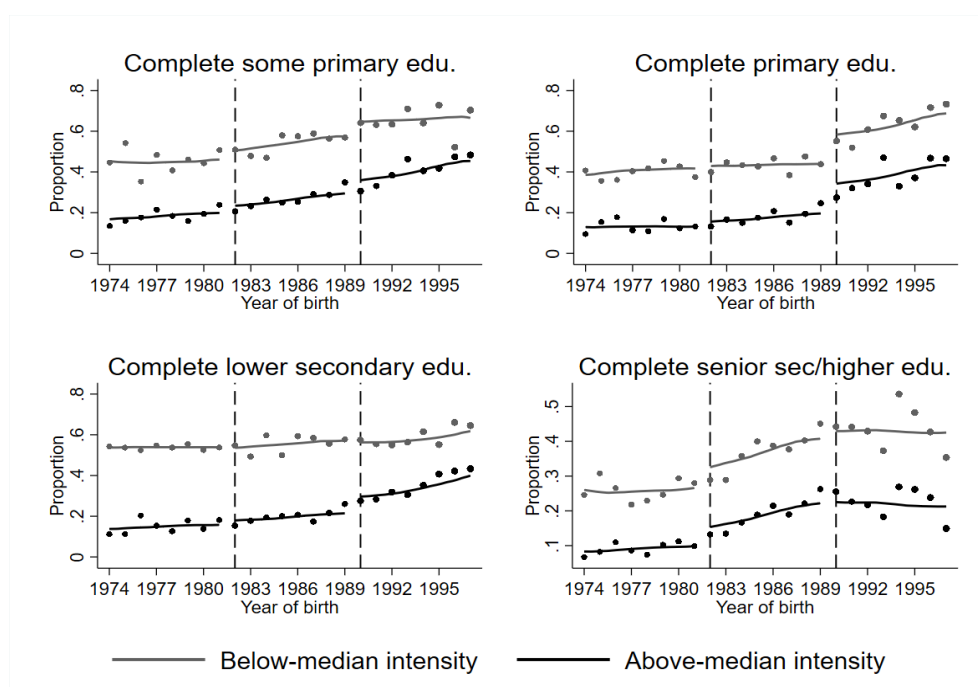
This section presents the results of the effect of FCUBE on school completion. This aims to complement the main analysis and also check the ability of the different levels of basic education to have guarantee completion of school. The estimated equation is equivalent to specification (1). In this case, I estimate the impact of the program on the likelihood of completing (i) some primary education; (ii) primary education; (iii) lower secondary education; and (iv) senior secondary/higher education. Education is measured as the highest level completed. Identification requires that without the reform, trends in school completion would not have differed across districts with different reform intensities. Figure B1 supports the common trends assumption, showing similar trends in school completion across above and below median FCUBE intensities before the reform.

Table B1 shows the estimated effect of the program on school completion. As in the main section, I present the results for cohort that were fully affected by the program and cohort that partially benefited from FCUBE. From Panel A, results show that the program did not impact completion of some primary education and primary education. Compared to individuals who never attended school, results show no program impact for students who completed some primary education (Column 1). Similarly, relative to no education and incomplete primary individuals, there is no effect on the likelihood of completing the primary education (Column 2). However, I find a strong positive impact on the completion of lower secondary education, relative to those those with primary, incomplete primary and no education as the highest level of education; for a 10 percentage points increase in the intensity, the program increased lower secondary school completion by about 2.8 percentage points (Column 3). The positive coefficient on completion of senior secondary/higher education suggests that the reform did encourage individuals who would have only received lower secondary education to receive more education, however this is not significantly different from zero. In Panels B and C, results also show a limited impact on some primary education, primary education and senior secondary/higher education for cohort beyond the main individuals who were fully affected by the program. For cohort born between 1986 and 1989, Column 3 of Panel B shows some evidence of an increase in lower secondary education, which signals that FCUBE induced these cohort to remain in school and even continue past the primary education. Figures B2 through B4 estimate birth cohort-specific effects of exposure to the program. For cohort who were fully treated by the program, Figure B2 shows that FCUBE exposure increased the probability of completing lower secondary education in each year. The estimates range between 2.0 and 3.6 percentage points, and are statistically significant at conventional confidence level. The results in Figures B3 and B4 also show that cohort who received some years of free education and schooled in high intensity districts also experienced an increase in lower secondary education due to

the program.

As before, I also test whether the impact I find on school completion mask heterogeneous treatment effects across diverse dimensions. I focus on the sample of the cohort (i.e., cohort born 1990-1997) who were fully eligible for the program. First, I test whether the effect of the program on school completion differ by gender. Figure B5 plots the coefficients and the 95% confidence intervals of the estimated impact of FCUBE on school completion by gender. For the males sample and the females sample, the results show that exposure to the reform did not increase primary education and lower secondary education. While the estimates However, I find evidence that female cohort who schooled in high intensity FCUBE districts were less likely to transition to the senior secondary/higher education. Contrasting urban individuals with rural individuals, some differences also emerge (Figure B6). While exposure to the reform increased lower secondary education for both urban and rural individuals, impact is mainly driven by changes in school completion among individuals from urban areas. The estimate on completion of lower secondary education for urban individuals is significantly higher (p-value: 0.045) than for rural individuals. The effect of FCUBE exposure on senior secondary/higher education is statistically significant for urban individuals, while it has no effect on rural individuals. I also test whether heterogeneity in treatment occurs across wealth quintile. Figure B7 plots the coefficients and the 95% confidence intervals of the estimated impact of FCUBE on school completion by wealth. For some primary education and primary education, almost all coefficients are imprecisely estimated across all the wealth quintile groups. I find evidence of an increase in lower secondary education due to the program. For bottom wealth quintile individuals, the estimated effect is 2.2 percentage points. The estimated impact is statistically significant at 10%. The effect for the second-highest wealth quintile are also positive, with the estimated coefficient being 3.1 percentage points for children from the highest quintile and statistically significant at 5%. However, the results show that individuals from the bottom and second wealth quintile were less likely to experience increase in senior secondary/higher education due to FCUBE. In contrast, I find evidence that the program increased completion of senior secondary/higher education.

Figure B7: Trends in school completion, by FCUBE intensity



Source: GLSS and 2010 GPHC

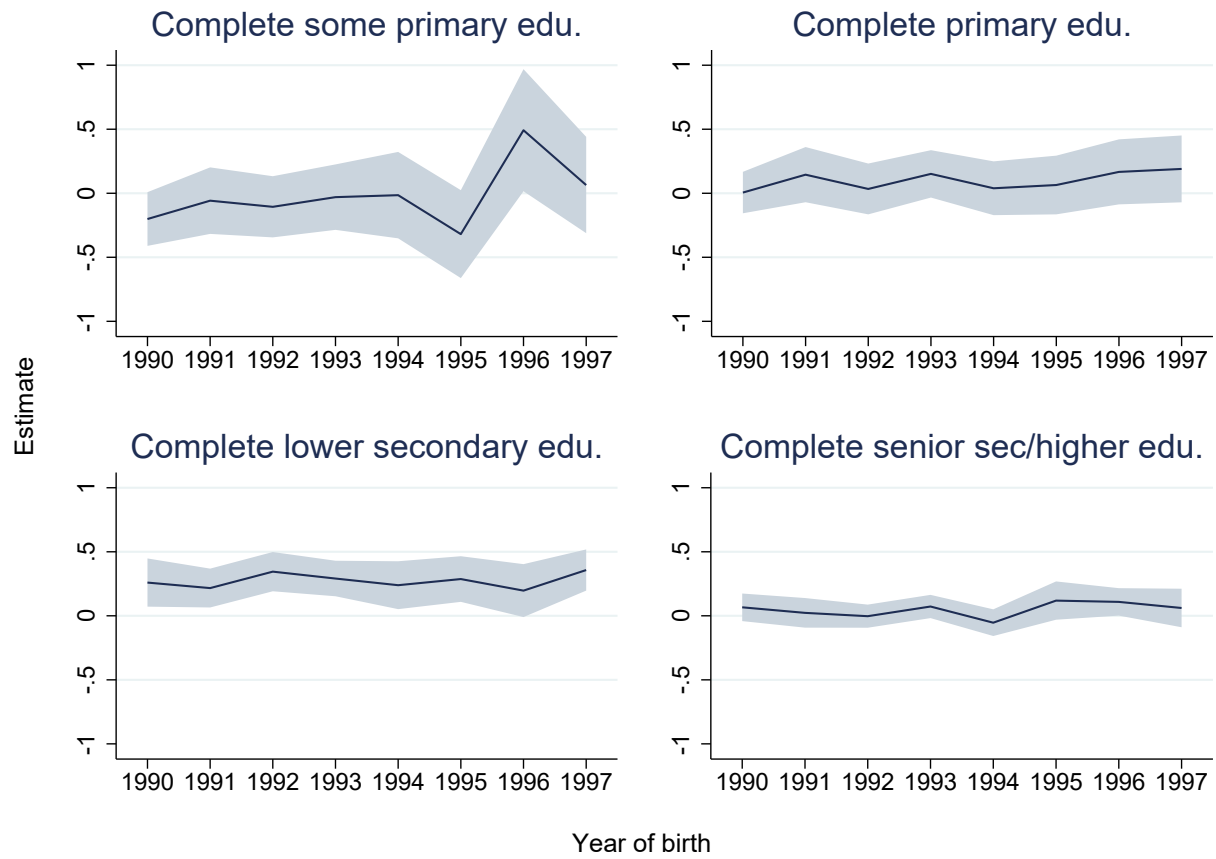
Notes: Each dot on the graph is the average of the school completion outcome by cohort in below- and above-median FCUBE intensity value. The size of a dot indicates the quantity of data in the sample. I overlay local polynomial curves bandwidth of 2 to show trends in completion outcomes across the treatment intensity. The first cut-off line in each graph differentiates trends in outcomes between cohorts that partially benefited and the control group. The second cut-off separates FCUBE-fully affected cohorts from the above two groups.

Table B2: FCUBE impact on school completion outcomes

	Complete some primary (CSP) education	Complete primary (CP) education	Complete lower secondary (CLS) education	Complete senior secondary or higher (CSS/H) education
	(1)	(2)	(3)	(4)
A: Treatment: born 1990-1997, Control: born 1970-1981				
Post-FCUBE × intensity	-0.079 (0.100)	0.093 (0.075)	0.282*** (0.059)	0.046 (0.040)
Observations	5211	7912	12960	17425
R ²	0.19	0.22	0.21	0.17
B: Treatment: born 1986-1989, Control: born 1971-1981				
Post-FCUBE × intensity	-0.075 (0.092)	0.099 (0.072)	0.091* (0.051)	-0.005 (0.042)
Observations	5038	6681	10494	13891
R ²	0.16	0.17	0.26	0.17
C: Treatment: born 1982-1985, Control: born 1970-1981				
Post-FCUBE × intensity	0.052 (0.074)	0.018 (0.055)	0.065 (0.042)	-0.028 (0.038)
Observations	5267	6944	10725	13656
R ²	0.14	0.18	0.26	0.17

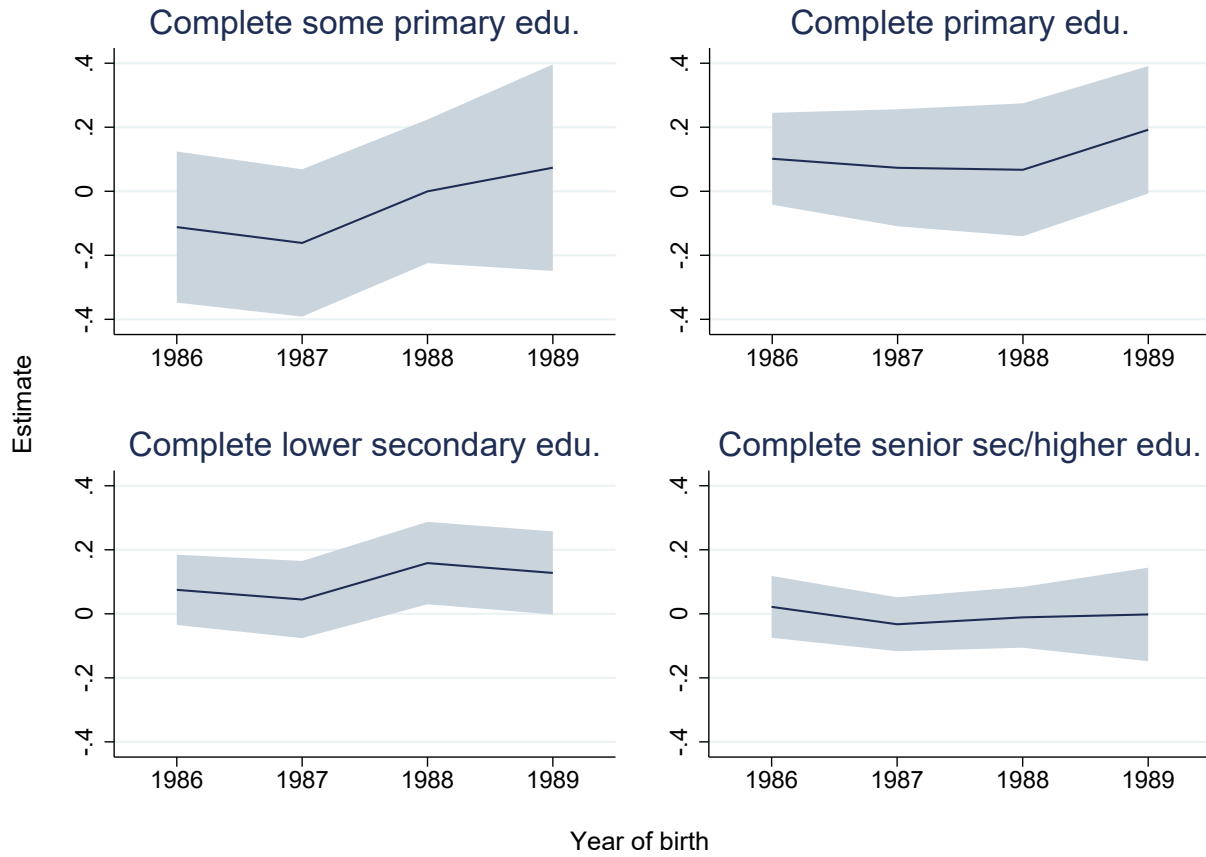
All models include age, age squared, gender, urban-rural, ethnicity, religion, cohort, region, survey dummies, and region-specific cohort trends for cohort affected and unaffected by the reform. Robust standard errors clustered by region-year of birth shown in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure B8: FCUBE impact on school completion - 1990-1997 cohort



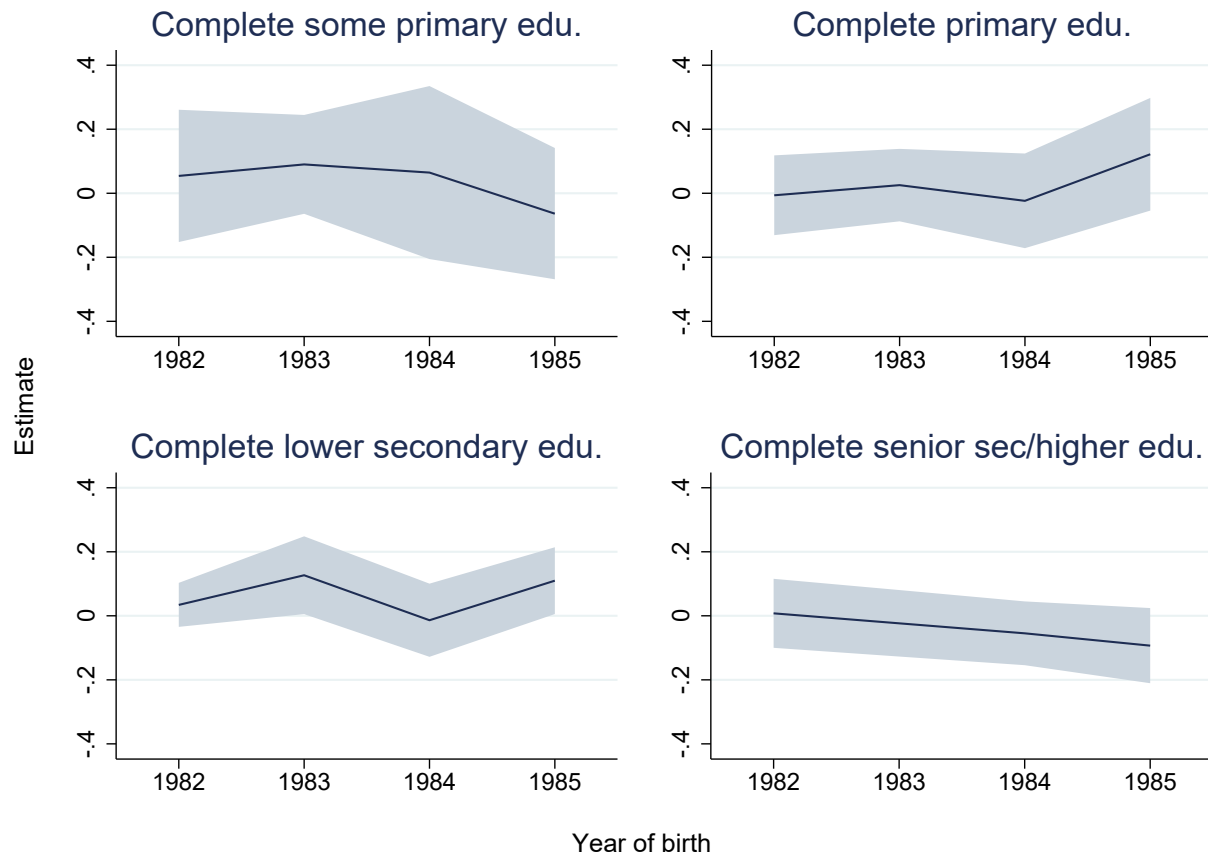
Notes: Coefficients and 95 confidence intervals. Full treatment: born 1990-1997; Control: born 1974-1980. Controls are similar to Table 5.

Figure B9: FCUBE impact on school completion - 1986-1989 cohort



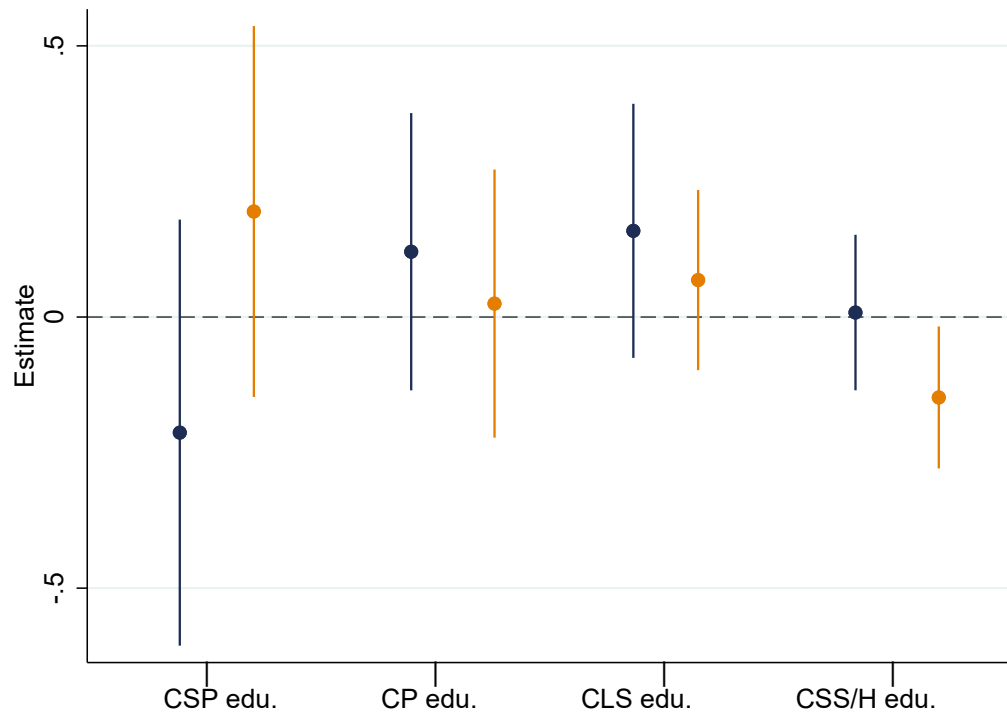
Notes: Coefficients and 95 confidence intervals. Partial treatment: born 1986-1989; Control: born 1974-1980. Controls are similar to Table 5.

Figure B10: FCUBE impact on school completion - 1982-1985 cohort



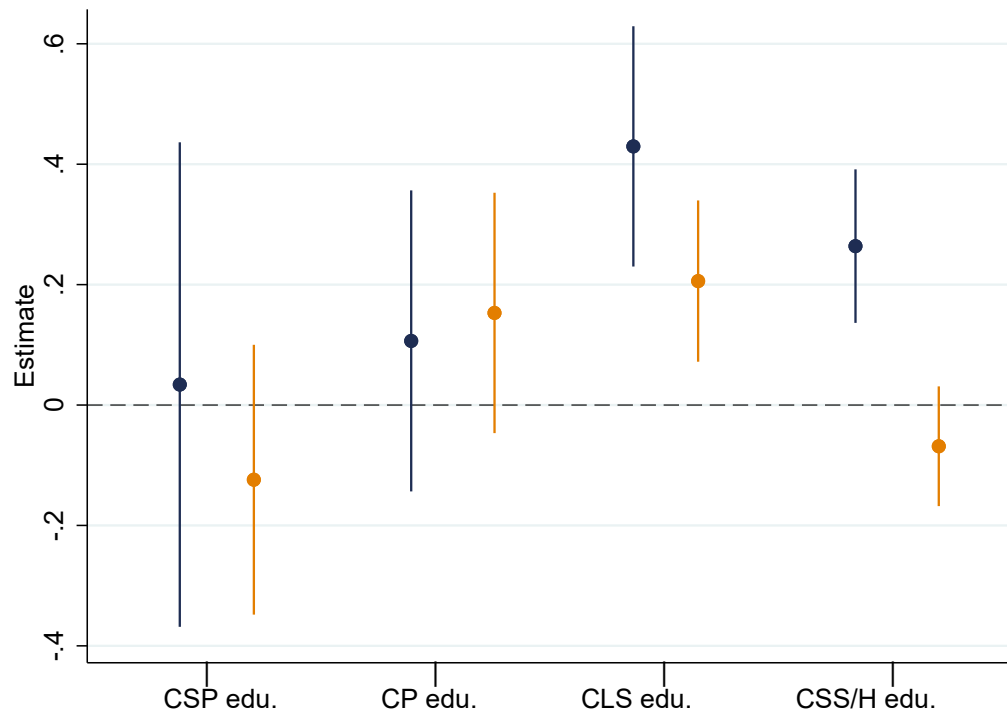
Notes: Coefficients and 95 confidence intervals. Partial treatment: born 1982-1985; Control: born 1974-1980. Controls are similar to Table 5.

Figure B11: FCUBE impact on school completion - gender



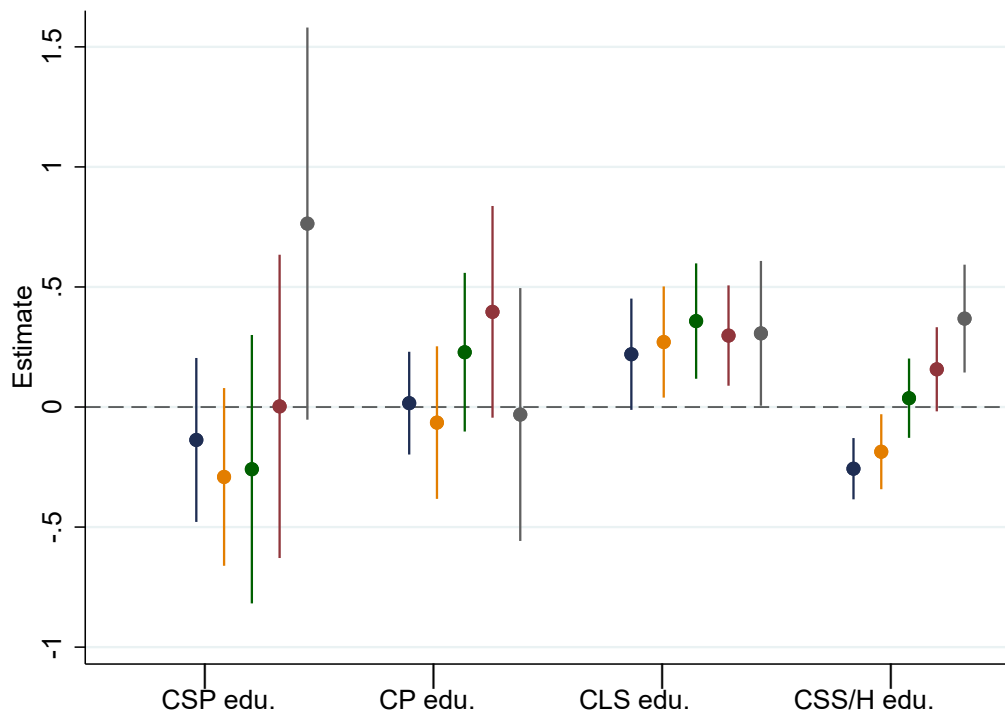
Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for urban (dark navy) and rural (dark orange) separately. Controls are similar to Table 5.

Figure B12: FCUBE impact on school completion - location



Notes: Coefficients and 95 percent confidence intervals for estimating equation (1) for urban (dark navy) and rural (dark orange) separately. Controls are similar to Table 5.

Figure B13: FCUBE impact on school completion - wealth dimension



Notes: Coefficients and 95 percent confidence intervals for (i) lowest quintile - (dark navy), (ii) second quintile- (dark orange), (iii) middle quintile- (dark green), (iv) fourth quintile- (maroon), and highest quintile- (grey) cohorts separately. Controls are similar to Table 5.