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Education returns to a public health insurance programme: Evidence from Rwanda

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Education returns to a public health insurance programme

Evidence from Rwanda

Aimable Nsabimana¹ and Chingwere Fadzayi²

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Abstract: We study the spillover effects of a large-scale public health insurance programme on early learning outcomes in Rwanda. The policy, the community based health insurance programme, which expands affordable healthcare services especially among rural and low-income families, was introduced in different district hospitals at different times. Leveraging detailed administrative data covering the universe of primary school national exam test scores in Rwanda and a difference-in-difference approach that exploits within-region variation in exposure to the reform across district hospitals, we document robust evidence that early life exposure to public health insurance leads to a 0.064σ (approximately 3.4 per cent) increase in student performance. We show that the increase in student test scores is mainly driven by the reduction of household health costs, substantial increase in prenatal care services, and improvement in household education expenditure.

Key words: community based health insurance, learning outcomes, Rwanda

JEL classification: I11, I13, I18, I21

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1 Introduction

If access to health care is a human right, who is considered human enough to have that right? (Paul Farmer, 2003, quoted in Forbes 2023)

In many low- and middle-income countries (LMICs), the high cost of healthcare services significantly impedes access to medical care. Individuals in these regions often live on low incomes and cannot afford the out-of-pocket expenses for treatment, medications, and hospital stays. This financial burden often forces families to choose between healthcare and other essential needs, such as food and education. The lack of health insurance and social safety nets exacerbates the situation, leaving many without financial protection against medical costs (Das and Do 2023). Consequently, preventable diseases go untreated and health outcomes remain poor, perpetuating a cycle of poverty and ill health (Kinnan et al. 2024). Addressing this issue requires policies that reduce healthcare costs, expand insurance coverage, and improve the affordability and accessibility of essential medical services (Layton et al. 2022). In most developing countries, and especially in Sub-Saharan Africa (SSA), high poverty rates, limited financial resources, and underdeveloped public health infrastructure exacerbate health inequities (Das and Do 2023). Vulnerable communities often face barriers to accessing essential health facilities, leaving them exposed to preventable diseases (Kinnan et al. 2024).

To mitigate these challenges, affordable health insurance has emerged as a key policy tool that can reduce out-of-pocket expenditures and improve access to healthcare, thus providing financial protection and enhancing household welfare (Hsiao and Shaw 2007; World Health Organization 2002). Improved access to healthcare can ultimately have profound implications for educational outcomes, as poor health hinders cognitive and physical growth, hence reducing the ability to thrive academically (Cohodes et al. 2016). Healthy students are able to concentrate, actively participate in class, and perform academically (Raghupathi and Raghupathi 2020). For example, school-based health centres (HCs) have been shown to reduce absenteeism and improve academic performance by addressing health issues that might otherwise keep students out of school (Lovenheim et al. 2014). Furthermore, access to healthcare reduces the financial burden on families, allowing them to allocate more resources towards education (Fonseca et al. 2020). Improved access to healthcare creates a more conducive learning environment, fostering better educational outcomes.

This study investigates whether early life exposure to health insurance programmes generates broader socio-economic benefits, including human capital development, in developing country income settings using the case of Rwanda. We hypothesize that, in the low-income environment, public health insurance would expand access to healthcare by reducing the economic burden of illness, particularly among rural and low-income populations. The improved access to health services—especially prenatal care—would then improve physical development and

cognitive ability, hence laying the foundation for better educational outcomes. This alleviation of financial stress through public health insurance could allow households to allocate more resources towards other socio-economic development aspects, including education.

In an attempt to improve financial access and utilization of public healthcare services, Rwanda introduced a (community) public health insurance programme, known as Community Based Health Insurance (CBHI). The policy aimed at increasing community participation in the design and management of prepayment health schemes and strengthening the financial capacity of local health facilities through mobilization of sustainable additional resources (Schneider and Diop 2001). In the pilot phase of the CBHI, which lasted five years (1999–2004), about 52 HCs from three district hospitals (Byumba, Kabgayi, and Kabutare) implemented the CBHI (Figure 1).

In this paper, we exploit the universe of administrative data on grade six national primary school exam test scores, timing of students' births, and the staggered implementation of CBHI across district hospitals to identify the effects of early life exposure to community health insurance on students' learning outcomes. To do this, we leverage the variations in phased rollout of the CBHI programme across district health facilities in relation to the timing of students' births.¹ Based on a conservative 4 km radius from a HC in the CBHI pilot area, we estimate the early life exposure to public health insurance for children born in the pilot area after the introduction of the policy. Our empirical estimation is basically a difference-in-differences (DiD) approach comparing the learning outcomes of students in the pilot area born after the introduction of the health reform with those in the pilot area born before the reform and those born in the control area.

The main identification assumption of this study is that in the absence of this health reform, the learning outcomes of treated and untreated students would have evolved with similar patterns. With event-study analysis, our results back this assumption based on the Borusyak et al. (2024) estimator, which accounts for the heterogeneous treatment effects in analysis with phased treatment. The study results show that early life exposure to the CBHI significantly improves students' standardized test scores. In particular, the study shows that the overall test scores of students born in the pilot area of the CBHI programme after the introduction of the health policy are about 0.064σ (around 3.4 per cent) higher than the untreated group without early life exposure to the CBHI. The effects remain qualitatively similar across different specifications and various subject groups (STEM and non-STEM).

We also conducted heterogeneous analyses to assess the effects of policy on learning out-

¹ In Rwanda, local administration entities such as districts and municipalities are mostly related to the local health facilities. For example, each district has at least one public district hospital while each municipality contains at least one HC.

Map of Uganda showing districts and pilot health centers (HC) in 1999. The map includes a scale bar (0-25 km) and a north arrow. Districts are color-coded: light blue for 'Other district' and pink for 'Pilot district'. Pilot districts include Burera, Musanze, Gakenke, Rulindo, Kamonyi, Ruhango, Nyanza, Nyanaguru, and Gisagara. Blue squares with an 'H' represent 'Piloted HC (1999)'. Other districts shown include Nyagatare, Gatsibo, Kayonza, Gasabo, Kicukiro, Rwamagana, Ngoma, Kirehe, Bugesera, Ngororero, Rubavu, Nyabihu, Rubiro, Karongi, Nyamasheke, Rusizi, and Nyanagabe.

Source: authors' compilation based on data from Ministry of Health (1999–2022) and Rwanda Social Security Board (1999–2022).

To validate our findings, we further investigate the mechanisms driving the positive effects of

the CBHI programme on educational outcomes. First, we find that the CBHI led to improved health facility utilization, particularly for prenatal and preventive care, which plays a critical role in enhancing children's health and cognitive development. Second, we establish that the CBHI reform reduces household out-of-pocket (OOP) health expenditures. This provides suggestive evidence that the relief of the financial health burden may allow (poor) families to reallocate their resources towards their children's education when they possess CBHI membership. Third, we establish that health insurance payouts increased significantly after the introduction of the CBHI, while OOP vaccination costs strongly decreased, suggesting the further alleviation of financial burdens on CBHI member households. The programme is also associated with a reduction in school dropout rates, further plausible evidence that improved household financial stability and better child health contribute to sustained school attendance. These findings highlight the dual benefits of CBHI in expanding access to healthcare and supporting human capital development through improved education outcomes.

Our study is related to the following strands of the literature. First, it contributes to the extant growing literature on public health reforms, healthcare systems, and economic outcomes (Almond and Mazumder 2011; Avdic et al. 2024; Bi and Zubairy 2023; Card et al. 2008; Chou et al. 2014; Cohodes et al. 2016; Dias and Fontes 2024; Huang and Liu 2023). For example, Bi and Zubairy (2023) examined the plausible effects of structural pension policies on pension expenditure and labour markets. The study specifically shows that a pension reform implemented without long lags may stimulate people close to retirement to remain in the labour force for longer, reducing public fiscal sustainability concerns. On other hand, Dias and Fontes (2024) evaluated a psychiatric reform that reorganized public mental healthcare systems in Brazil through community-based mental HCs; they find that the reform improved the supply of outpatient mental care and shifted care away from inpatient to outpatient settings. The CBHI programme in Rwanda was introduced in response to the severe disruptions in public healthcare provision resulting from numerous sources. First, economic recession and structural adjustment programmes in the 1980s led to a decline in health service utilization and increased poverty and poor health outcomes, particularly after the 1994 genocide. The CBHI programme aimed to guarantee access to public health systems, including for poor families, by decentralizing healthcare management and introducing user fees to improve financial sustainability (Preker and Carrin 2004; Schneider et al. 2001). Evaluating such government health programmes is crucial as it provides robust evidence of their broader socio-economic impacts (Cohodes et al. 2016; Layton et al. 2022). For example, Fletcher and Marksteiner (2017) demonstrated that health interventions can lead to substantial spillover effects within households, particularly between spouses, by reducing substance use and improving overall health behaviours. Our study contributes to this body of literature by demonstrating the multifaceted benefits of the CBHI programme in Rwanda.

Our study also makes a significant contribution to the literature on human capital development

by demonstrating the positive spillover effects of the CBHI programme on early learning outcomes. This aligns with the broader literature on human capital development, which emphasizes the interconnectedness of health and education in enhancing individual and societal well-being (Cohodes et al. 2016; Huang and Liu 2023; Jedwab et al. 2023). Recently, for instance, Huang and Liu (2023) showed that early childhood exposure to public health insurance in rural China significantly improved health and cognitive outcomes during adolescence, while Cohodes et al. (2016) explored the impact of child health insurance access on educational attainment in the United States. Jedwab et al. (2023) documented the importance of human capital accumulation at work and its implications for economic development, emphasizing the role of education and health in enhancing productivity. By focusing on the specific mechanisms through which the CBHI improves educational outcomes, such as reduced household health costs and increased prenatal care services, our study offers valuable insights into the pathways through which health insurance can enhance overall well-being. For instance, Layton et al. (2022) found that Medicaid's shift to managed care and the relaxation of drug caps increased access to high-value drugs and outpatient services, reducing avoidable hospitalizations. This comprehensive approach provides a nuanced understanding of the broader impacts of health insurance programmes.

Finally, our study provides new insights into the mid-term implications of public health insurance in a developing country context such as in SSA, which is particularly important given the unique challenges faced by health systems in the region. Unlike developed countries, where health insurance uptake is relatively high and health infrastructure is well established, many African countries struggle with low enrolment in health insurance programmes and inadequate health facilities. For instance, only a few SSA countries have implemented national public health insurance programmes, and these often face challenges such as low enrolment and poor financial sustainability (Das and Do 2023). The limited health infrastructure in many African countries exacerbates these challenges. Health facilities are often poorly equipped, and there is a significant shortage of medical supplies and trained healthcare professionals (Brickstone Africa 2024). This has led to the emergence of unregulated black market health facilities, which pose significant risks to public health due to the provision of substandard and unsafe medical care (Aminu et al. 2017). By focusing on Rwanda, our study provides valuable insights into the effectiveness of health insurance programmes in a context where health infrastructure is limited and the need for financial protection against medical costs is critical. This contrasts with similar studies in developed countries, where the health systems are more robust and the challenges are different. For example, in two studies on the United States, Layton et al. (2022) examined the effects of Medicaid on healthcare access and outcomes, while Cohodes et al. (2016) explored the impact of child health insurance access on educational attainment for low-income children. Our research contributes to the literature by demonstrating the multifaceted benefits of the CBHI programme in Rwanda, particularly its positive spillover effects on early

learning outcomes. This comprehensive approach fills a critical gap in the literature on health and education policy interactions, providing a nuanced understanding of the broader impacts of health insurance programmes in developing countries.

The remainder of the paper is structured as follows: Section 2 describes the institutional background of the CBHI in Rwanda. Section 3 outlines the data sources and description. Section 4 presents the empirical strategy. Section 5 discusses the results. Heterogeneity analysis is done in Section 6. Mechanisms are discussed in Section 7. Section 8 discusses policy implications and concludes.

2 Historical setting

At the time of independence in the 1960s, Rwanda, as most other African countries, committed to providing free healthcare services to all. The following two decades saw the country recording significant progress in terms of public health infrastructure and increase in health access. However, in the 1980s, economic recession and structural adjustment programmes seriously disrupted the provision of public healthcare. There was a massive slump in public social service spending, especially on health, and this led to enormous resource shortages in health systems in most African countries. As a result, public health systems became poorly managed and biased towards centralized services, with only people in large cities able to access basic care (Asila Pangu 1997). This also caused a massive increase in (unauthorized) private and informal drug and injections dealers who offered poor-quality healthcare at high prices. To deal with these challenges, the health ministers of African governments met at a conference in Mali in 1987, in what was then termed the Bamako Initiative. The aim of the conference was to ensure that whole population would have access to basic and affordable healthcare. Among the resolutions of the Bamako Initiative is a rationalized and decentralized healthcare system at district and community levels to allow local populations to directly participate in health resource mobilization and management. User fees were also introduced for public health facilities (Kanji 1989; Knippenberg et al. 2003). At this time, the CBHI programmes were started in the form of local associations with specific health goals, with members having access to any type of health facility. Members were usually reimbursed based on invoices (Kalisa et al. 2015).² Nonetheless, due to difficulties in affording these fees, many people were still unable to access health facilities and services.

In late 1980s and early 1990s, these local associations were replaced by health prepayment schemes (PPS) that were organized and led by faith-based care providers who covered the operating costs. Organized and managed at the community level, these PPS aimed at reim-

² Those local associations also included non-health household expenses such as for weddings and funerals.

bursing healthcare costs, such as for drugs, HCs, hospital services, and ambulances (Schneider and Diop 2001). Such prepayment programmes included Kayove and Rukoma, both in 1991, in the western and central regions of Rwanda, respectively. In 1994, the country suffered a genocide that caused massive loss of life and the destruction of social infrastructure, include health services. The post-genocide period left most Rwandans in extreme poverty, with limited resources for health services. This forced the new government, together with development partners, to offer free health services until 1996. In 1996, the Rwandan Ministry of Health (MoH) reintroduced health service user fees. However, between 1997 and 1999, the utilization of basic healthcare services fell significantly, from 0.3 to 0.2 national annual per capita health facility use, far below WHO standards. To deal with this sharp decline in healthcare utilization, alongside growing concerns about post-genocide poverty and poor health outcomes, the republic of Rwanda initiated the CBHI programme to guarantee access to public health systems, including for poor families (Preker and Carrin 2004; Schneider and Diop 2001). In 1999, the Rwandan MoH, together with development partners (USAID—funded Partnerships for Health Reforms project (PHR), the WHO, the World Bank, and local communities), implemented a pilot test for PPS in three district hospitals. The pilot lasted five years (1999–2004), after which the programme was extended to the national level.

2.1 Pilot and evolution of the CBHI in Rwanda

Since early 1999, the Rwandan MoH, in collaboration with USAID, started a pilot to test the PPS in three district health hospitals. These hospitals are Byumba in the north and Kabgayi and Kabutare in the south.³ The pilot aimed at improving financial access and utilization of public healthcare services in the country. The authority also targeted increased community participation in the design and management of PPS as well as strengthening the financial capacity of local health facilities through mobilization of additional resources. In total, 52 HCs participated in the pilot: 20 in Byumba, 17 in Kabgayi, and 15 in Kabutare, as indicated in Figure 1. The PPS programme started with public awareness campaigns and sensitization in the first six months of 1999 through radio, newspapers, community, and church gatherings to inform the local population about the PPS (Schneider and Diop 2001). From July 1999, the PPS was formed in each of the pilot HCs. The CBHI schemes are considered to be mutual health associations according to Rwandan law. Every PPS was headed by an executive committee of four people (president, vice president, secretary, and treasurer) elected by a general assembly of community members.⁴ For every HC, each PPS signed a memorandum of understanding

³ According to Kalisa et al. (2015), the three pilot district hospitals were selected based on the health infrastructure in place and the high demand for technical support by local populations to develop and implement the CBHI programme.

⁴ It is important to note that although different CBHI reports (Kalisa et al. 2015; Schneider and Diop 2001) have mentioned that the pilot CBHI programme started with 54 HCs, only 52 have been reported by Schneider et al.

(MoU) with the HC, and the head of the HC was automatically considered a vice president on the PPS executive committee. At the district hospital level, all PPS were put together to form a federation bureau. Like the executive committee at the HC level, the federation bureau is managed by a president, vice president, secretary, treasurer, and the medical director of the district hospital in each of the three pilot areas (Kalisa et al. 2015; Preker and Carrin 2004). Each district federation is a partner to the district hospital and other district authority. Every PPS federation bureau signed contracts with all affiliated HCs. The PPS scheme has 17 articles that govern the collaboration between the insurer and provider, which constitute the CBHI programme. The members of each PPS scheme are invited to a general assembly at least once each year.

2.2 PPS health finance and revenue collection

During the pilot phase, the contributions and enrolment into PPS were either based on individual contributions or a household lump sum payment.⁵ The premium rates were initially set based on the existing user charges. A household that wished to be insured paid an annual premium of RWF2,500 (equivalent to US\$7.50 at the start of the pilot) for a family of up to seven people. An individual enrolment cost RWF2,000 per year and an enrolment for a group of eight or more individuals would cost RWF530 per person per year. The premium was paid to the CBHI affiliated with the preferred HC that covered the community where the family usually lived.

Under the CBHI, when a member is sick the family contacts their preferred HC. The latter has a gatekeeper role to ensure that the enrolled members are taken care of in a timely fashion. The district hospital services are covered only if the member is transferred by the preferred HCs. This is to discourage PPS members or providers from unnecessary utilization of expensive hospital services. Once the premium is paid, the members were entitled to primary health-care services covering all medical services and drugs offered by their preferred HC, including ambulance transfers to the district hospital. A copayment of RWF100 (US\$0.3) is required at the HC for each visit. At every HC, each month the prepayment committee disburses one-twelfth of its accumulated premium, of which 5 per cent is retained to cover the administrative costs, 10 per cent is paid to the district PPS federation, and the rest is allocated to the partnering HC as a capitation payment. The federation bureau then reimburses the district hospital for the covered services provided to PPS members (Schneider and Diop 2001). The payment is done per episode of sickness, which can include C-sections, malaria, paediatrics, services for overnight stays, and physician consultations for all kinds of sickness.

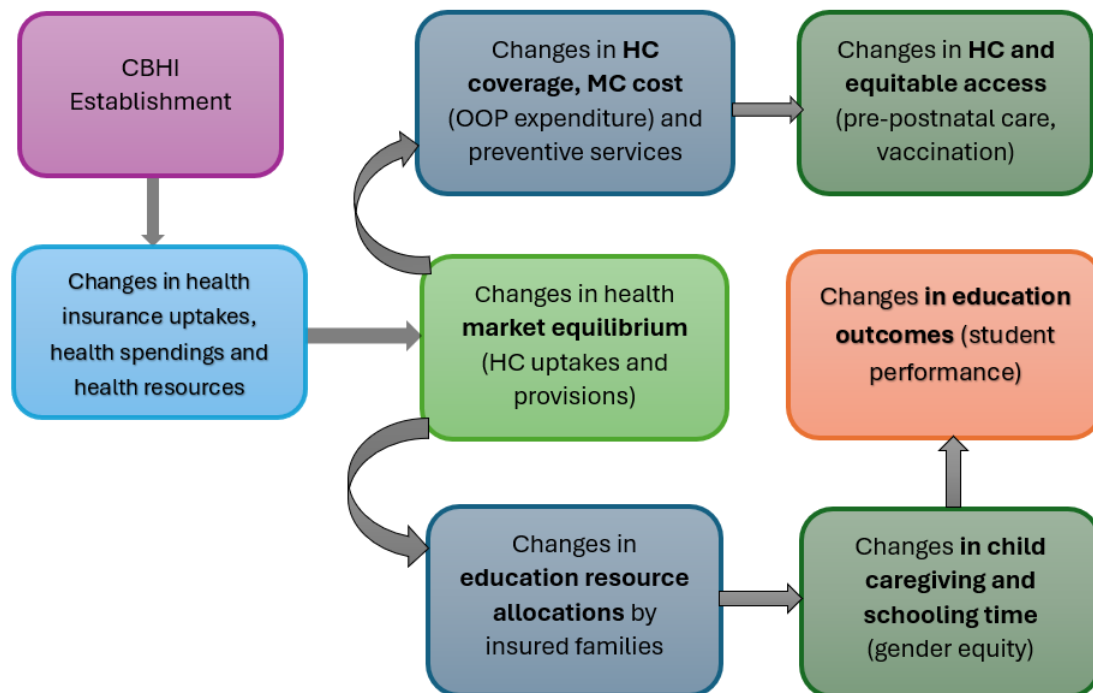
(2001). Therefore, in this study we use 52 HCs and their catchment areas as the pilot.

⁵ Under the CBHI programme, a household is a family of two adults and all children under 18 years old living in same household. Other members older than 18 years are to enrol individually or as group.

2.3 Theory of change

In this section we explain how the CBHI affects the outcomes of interest. To do so, we conceptualize the theory of change (ToC) that provides predictions about the impacts of public health insurance. It also leads the subsequent section on our analysis of measurement and limitations of the data. Figure 2 depicts our understanding of the plausible channels through which the CBHI reform should affect our outcome variables.

Figure 2: CBHI theory of change



Note: this figure provides the ToC of our study. It shows the expected changes in health and education outcomes of CBHI members following the establishment of the CBHI programme. MC = medical care.

Source: authors' compilation.

The goal of the CBHI programme was to expand healthcare PPS and reduce financial health stress, especially in rural areas where financial constraints are particularly binding. Under this scheme, the reform became the primary source of better healthcare for insured household members, especially vulnerable people such as children and pregnant women (Kalisa et al. 2015; Schneider et al. 2000). Therefore, we expect this reform to result in changes to household health insurance uptake and access to healthcare for families, especially previously uninsured households.

We expect those changes in the health sector to move the market to a new equilibrium, with changes to different aspects, such as healthcare uptake, household expenditure, and public health facility utilization. Essentially, our theoretical predictions set two parsimonious assumptions for the CBHI reform. First, the policy should affect the demand for healthcare services, especially for those previously uninsured families. This demand would eventually necessi-

tate the expansion of the health facilities and medical care provisions. Second, conditional on households possessing CBHI membership, treatment and other health-related expenditure should change. Specifically, after the policy reform, we expect the OOP household health expenditure to reduce and possibly be reallocated towards other areas.

With these changes, CBHI member families can decide to spend more resources on the education of their children. Essentially, we assume that once households are less burdened by health expenditures, they will be able to spend more on education for their children (including school fees, purchase of books and uniforms, or school meal contributions). Under the CBHI policy, children from insured households would have better access to healthcare services, thus being healthy and able to learn more effectively. This could have positive implications for the learning outcomes of the children from CBHI-insured families.⁶

Putting all this together, we can say that the public health insurance programme relaxes financial stress for programme members and eventually improves healthcare uptake (Camacho and Conover 2013; Cesur et al. 2017; Chou et al. 2014). This is particularly important in the context of developing countries, such as Rwanda, where the high incidence of poverty and limited financial resources exacerbate health inequities (Das and Do 2023). The policy should improve access to pre- and postnatal care services for women and children, as well as vaccinations against dangerous diseases such as measles, which would ultimately influence children's lives and later economic outcomes (Atwood 2022; Barteska et al. 2023; Goodman-Bacon 2018). The CBHI will also reduce the high OOP health expenditure among the insured members and enable them to allocate more resources towards education. Our analysis predicts that this public health reform would affect insured members directly and indirectly through improving healthcare uptake and reducing financial stress related to healthcare costs. Our estimation models induced large maternal health benefits, and the programme generated spillover effects on children's learning outcomes among the insured families.

3 Data sources and description

This section explores the various datasets used to answer the research question in this study. The key datasets used are students' test scores in a primary school national exam matched with spatially explicit data on health facilities in Rwanda. We also use several other datasets,

⁶ There are two things to highlight here. First, due to data limitations we research this mechanism using regions, known as 'prefectures'. This is because, in the Rwandan Households Surveys, there is no geolocation for granular records that could be associated with the pilot HCs. Second, to explore this mechanism, we need data on treated and control areas for the pre- and post-treatment periods. However, in the context of Rwanda, we were unable to obtain a full pre-treatment sample since the first Rwandan household survey was collected at the same time that the CBHI pilot was introduced (1999–2000). Nevertheless, using 1999/2000 as a pre-treatment sample, we show that there are significant differences between education and health outcomes between the treated and controls regions, as indicated in Table 2, suggesting the validity of our pre-treatment sample.

as discussed in the subsequent subsections.

3.1 Outcomes: learning test scores

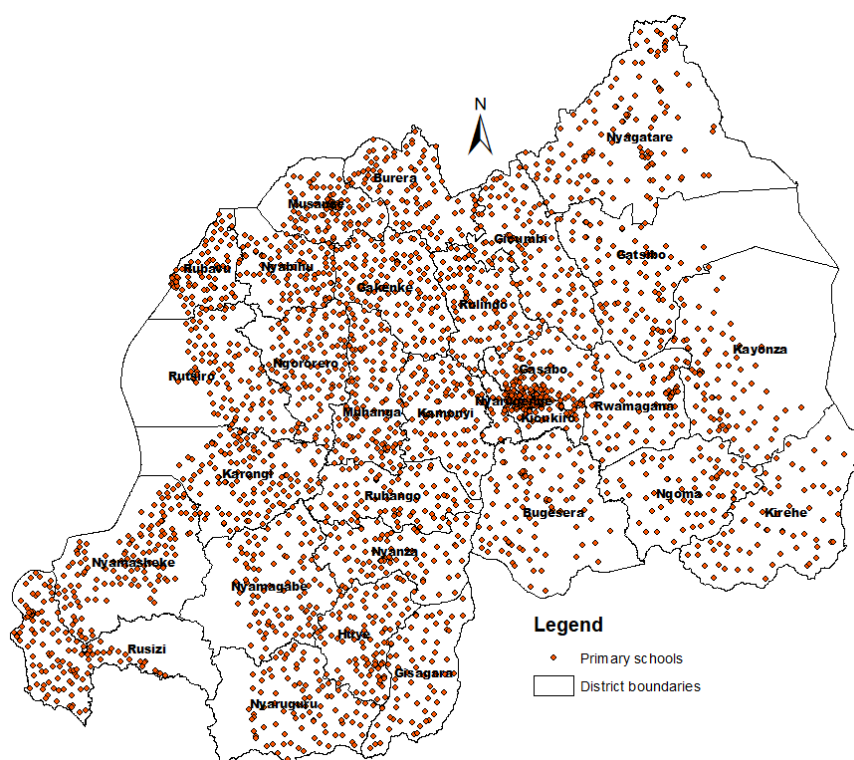
Rwanda uses a 3-6-3-3 basic education system, with three years of pre-primary school, six years of primary school, and six years of high school. High school is split into two: three years of lower/ordinary level and three years of upper/advanced level. There are around 2,850 primary schools spatially distributed across the country, as indicated in Figure 3a. In the final year of primary school (grade 6), students undertake a mandatory national exam in five subjects (mathematics, sciences, social studies, Kinyarwanda, and English). This study uses those administrative test score records as our main outcomes. The data comes from the National Examination and School Inspection Authority (NESA), which administers the primary school national examinations every year. The results from those exams are usually used as the metric for progression into the lower high school.⁷ Our test score records are repeated cross-sectional data at the school level, and contain information on students who undertook the national exam during the sample period.

The test score records contains the universe of primary school students, approximately 1.38 million, who sat the national exams between 2012 and 2019. The dataset contains two measures of student outcomes. First, the standardized test scores of each student for the respective subjects. For every year, test scores in the five subjects are aggregated into aggregate (all subjects), STEM (math and science), and non-STEM (social studies, Kinyarwanda, and English) and are standardized with mean 0 and standard deviation 1. Hence, each data point measures the standard deviations from the mean. Second, the corresponding grade points, ranging from 1 to 9, with 1 being the highest grade and 9 the lowest grade. These grade points are usually aggregated to determine a student's overall performance in the exam, such that the top-rank student obtains an aggregate of 5 while the bottom-rank student obtains an aggregate of 45. Since we are interested in students' aggregate performance in all subjects, we use the grades in the respective subjects to generate a standardized aggregate grade point. Specifically, we create a modified aggregate grade point by reversing the scale (ranking) of the grades such that 1 means *poor* and 9 means *excellent*. We then aggregate these (rescaled) grades to obtain our 'modified' aggregate grade points, ranging from 5 (worst) to 45 (best). We also compute the total grade points for STEM and non-STEM subjects. For ease of interpretation and to ensure consistency with the test scores of the individual subjects, we standardized the grade points for the aggregate, STEM, and non-STEM subjects.

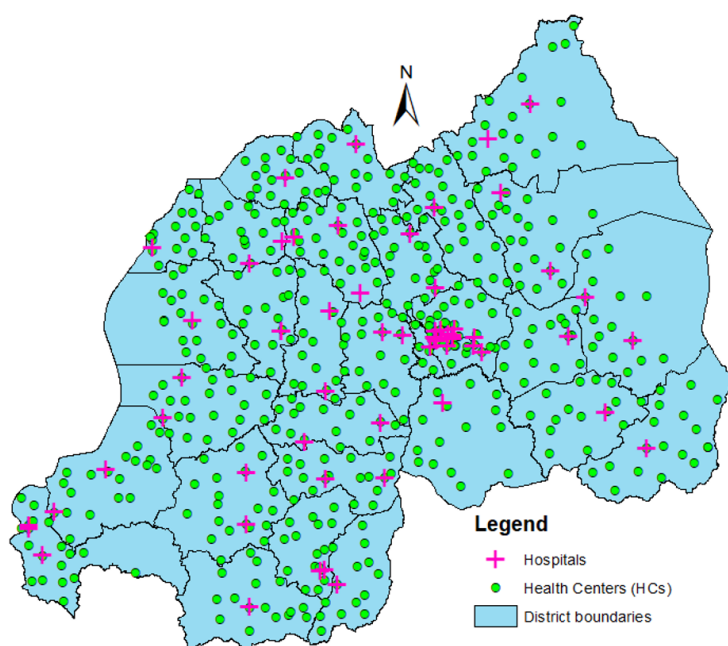
⁷ It is important to mention that although all students in grade 6 are eventually promoted to lower high schools, the best-performing students in the national exams are automatically given places in boarding schools while low-performing students are promoted into the same schools in what is commonly known as 12 years basic education (12YBE).

Figure 3: Primary schools, hospitals and HCs

(a) Primary school locations across districts



(b) Spatial distribution of hospitals and HCs



Source: authors' compilation based on data from NESA (2012–19).

The dataset also provides the gender and age of exam candidates. We complement the data with geo-coordinates of all primary schools in Rwanda, as shown in Figure 3a. Table 1 provides descriptive summary statistics of the key variables used in the study. The table shows that the majority (54 per cent) of the primary school students are female and the average age

at exam time is 14.4 years old. It is also noteworthy that more than 86 per cent of primary school students are based in rural schools.

Table 1: Summary statistics

Variable	Mean	Std dev.	Min.	Max.	N
Female students	0.542	0.498	0	1	1388786
Student age (2012–19)	14.476	1.598	10	25	1,388,787
Rural area students (schools)	0.86	0.347	0	1	1,388,031
Schools within HC catchment area	0.856	0.351	0	1	1,388,787
Catchment area $\times$ post	0.159	0.366	0	1	1,388,787
<i>Standardized grade points</i>					
Aggregate	0	1	−1.459	5.962	1,388,783
STEM	0	1	−1.049	7.427	1,388,786
Non-STEM	0	1	−1.677	4.817	1,388,782
<i>Non-standardized grade points</i>					
Aggregate	15.494	7.808	5	45	1,388,783
STEM	4.915	3.229	2	18	1,388,786
Non-STEM	10.58	4.862	3	27	1,388,782
<i>Standardized test scores</i>					
Maths	−0.046	0.953	−1.295	8.511	1,388,787
Science	−0.045	0.962	−1.542	7.121	1,388,787
Social studies	−0.042	0.967	−1.436	5.102	1,388,787
English	−0.048	0.958	−2.226	6.826	1,388,787
Kinyarwanda	−0.039	0.998	−3.406	3.801	1,388,787
<i>Controls</i>					
Road density (m/km ²)	13.101	9.848	0	34.835	1,388,787
Malaria incidence (2000)	0.268	0.07	0.154	0.433	1,388,787
Annual mean temperature (C)	19.313	1.822	12.241	23.368	1,388,787

Source: authors' compilation.

3.2 Rwandan household surveys

Another dataset in the analysis comprises the Rwandan Integrated Household Living Conditions Surveys (EICVs), which we use to examine potential channels that explain the spillover effects of the CBHI on learners' performance. The EICV is a nationally representative survey of households in the country and covers a wide array of issues relating to the socio-economic conditions of households. The surveys are conducted by the National Institute of Statistics of Rwanda (NISR). We used two survey waves, 1999/2001 and 2005/06.⁸ Specifically, we utilized data on household expenditures on health and education, prenatal healthcare services, school absenteeism for 6–18-year-olds, socio-economic attributes, etc.

Table 2 provides a summary of household demographic and expenditure statistics based on

⁸ It is important to highlight that the two waves were conducted very close to key stages of the CBHI. For instance, the pilot phase was officially launched in July 1999. However, we believe that this would not affect our results since those national surveys are randomly conducted across the entire country.

the EICV for 1999/2001 and 2005/06, offering insights into changes over time. The age of household heads increased marginally, though not significantly, while the proportion of female household heads declined significantly by 3.5 percentage points. Household size remained relatively stable, but there was a significant reduction in school-age dependents (ages 6–18), dropping by 4 percentage points. The number of school dropouts decreased markedly, by 9.4 percentage points of dependents per household, reflecting an improvement in education retention. Urban households increased significantly, indicating ongoing urbanization during this period. Women of childbearing age receiving prenatal care increased by 26.6 percentage points during the same period.

Table 2: Summary statistics from the EICVs

Variable	1999/2001	2005/06	Diff.	t-test
<i>Household demographics</i>				
Age of household head	43.758	44.06	0.309	1.177
Female household head	0.317	0.282	−0.035	−4.386
Household size	5.008	5.041	0.033	0.811
Dependents < 5 years old (pre-school age)	0.173	0.179	0.006	1.891
Dependents 6–18 years old (school age)	0.342	0.302	−0.040	−9.617
Urban household	0.179	0.235	0.056	7.950
<i>Mechanisms outcome variables</i>				
Insurance payments	116.51	581.90	465.38	5.358
OOP health expenditure	2,160.76	1,275.16	−885.60	−6.117
Prenatal care	0.083	0.349	0.266	61.039
No. school dropouts	0.252	0.158	−0.094	−15.001
OOP education expenditure	27,721.69	42,083.29	14,361.60	5.296
No. observations	6,420	6,900		

Note: the surveys contain information on changes in the welfare of Rwandan citizens, including poverty and inequality indicators, employment, living conditions, education, household consumption, health, and housing conditions.

Source: authors' compilation based on the EICV 1999/2000 and 2005/06 (National Institute of Statistics for Rwanda 2000, 2005).

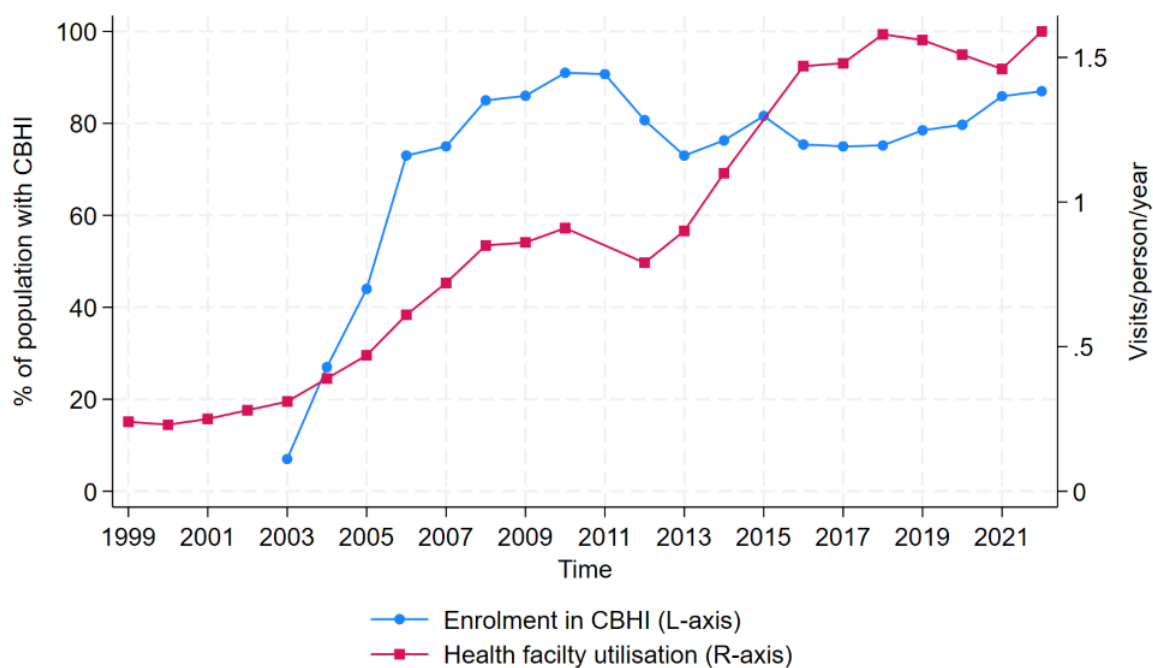
In terms of household expenditure, total OOP health spending decreased significantly by RWF885.60. Conversely, OOP education expenditure increased by RWF14,361.60, signalling greater household investment in education. Total insurance payments saw a substantial rise, from RWF116.51 to RWF581.90, demonstrating expanded participation in the CBHI insurance programme. These changes underscore shifts in household priorities and reflect the impact of policy interventions, particularly in health and education sectors, between the two periods.

3.3 Other datasets

To conduct our study, we complement our analysis with additional datasets. First, we use HCs from the Rwanda Biomedical Center (RBC). Figure 3b depicts the distribution of health facilities in Rwanda. In 2019, Rwanda had around 514 HCs and 52 hospitals distributed across the country. The number of health facilities has consistently increased across the country, possibly to meet the increased demand for healthcare services. The number of HCs expanded signifi-

cantly during the time of the CBHI implementation (see Figure A6 in the Appendix). Other relevant documents from the Rwandan MoH have also been used. For instance, we constructed measures of per capita health facility use and CBHI uptake using annual health sector performance reports by the MoH (Figure 4). Second, we obtained Rwanda shapefiles from the NISR. Those shapefiles were very important for our analysis as they enabled us to build our core datasets by combining the 1999 pilot HCs with schools in catchment areas. Figure 1 shows the spatially distributed HC that were piloted in the 1999 CBHI programme. In the end, for the regression analysis, we also control for baseline characteristics such as malaria incidence (Weiss et al. 2019), temperature (Li et al. 2022), and road density (Meijer et al. 2018), interacted with time trends.

Figure 4: Per capita utilization rate and share of CBHI uptakes



Note: this figure shows the CBHI uptake and health facility utilization in Rwanda. The left side indicates the distribution of rate of CBHI enrolment by the Rwandan population between 2003 and 2022. The figure indicates a sharp increase in the early period, from 7 per cent in 2003 to 90 per cent in 2010, then subsequently a stable trend of around 78 per cent of CBHI uptake each year. The right side of the figure depicts the per capita utilization of health facilities in the country between 1999 and 2022. The figure also indicates a consistent increase in health facility utilization from around 0.17 in 1999 to 1.6 in 2019. Since 2011, Rwanda has moved the health insurance enrolment process from calendar to fiscal years (e.g. 2011 becomes 2011/12).

Source: authors' compilation based on data from the Ministry of Health (1999–2022) and Rwanda Social Security Board (1999–2022).

4 Estimation strategy

This section presents the identification strategies used to derive the causal effects of the CBHI reform on human capital and learning outcomes. To do this, we use a DiD framework that lever-

ages the quasi-experimental setup and regional variations of the CBHI programme in Rwanda.

4.1 Defining treatment and control groups

To evaluate the various ways through which the public CBHI reform may affect human capital development, we construct two groups of communities. The first group is the community in the health district zones that were directly exposed to the 1999 CBHI pilot (Byumba, Kabgayi, and Kabutare district hospitals), as indicated in Figure 1 in pink. We call these areas ‘pilot areas’. The second group is the communities in the health district zones that did not participate in the CBHI pilot, shown in blue in Figure 1. We call these areas ‘control areas’.⁹

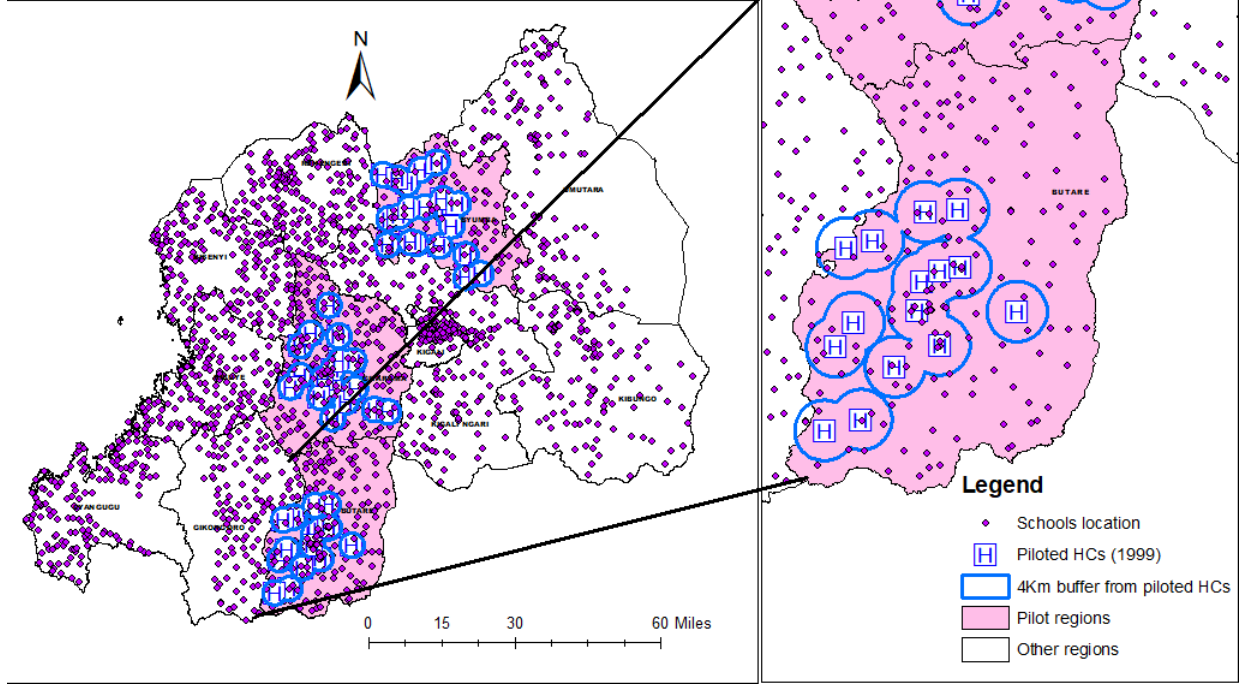
To define a health district zone, we exploit the geographical variations of public health facilities (hospitals and HCs) that provide healthcare services to people within their respective regional administration.¹⁰ A district hospital catchment area comprises several HCs within same local administrative region. The HCs within a given district hospital catchment area have a gate-keeper function, since the CBHI services cover members at the district hospital only if they are referred by the HC where they have CBHI membership.

Based on these district hospital zones and pilot areas, we define three forms of catchment area. First, treated pilot areas, which are within the neighbourhood of the piloted HCs. Second, referral pilot areas, which are in proximity to the neighbourhood of the piloted HCs. Third, control areas, which are the untreated zones during the CBHI pilot phase. Figure 5 depicts the geographical location of treated pilot areas, referral pilot areas, and control catchment areas. The figure highlights the schools within and outside a 4 km buffer from the catchment areas of the 52 piloted HCs. The left side indicates the combined piloted HCs and primary school locations. The right side is a zoomed image of a region (Butare). Blue circles depict the 4 km radius catchment area around a pilot HC; purple dots indicate school locations; and white boxes show the pilot HCs. Based on our baseline measure of a 4 km catchment area of the pilot HC, the blue circles represent treated locations while the zones outside the blue circles are control locations.

⁹ It is important to note that during the pilot phase (1999–2004) CBHI members could get medical treatment under PPS only from the HC through which they paid their premiums. This validates our exclusion restriction assumption.

¹⁰ Before 2006, Rwanda was divided into 12 regions (also called prefectures), 122 districts (locally known as communes), and about 1,576 municipalities (also called sectors). In 2006, the government of Rwanda oversaw local administrative reform and changed the administrative units: now the country has 5 provinces, 30 districts, and 416 municipalities.

Figure 5: Piloted HCs and schools in buffered regions



Note: this figure indicates the schools within and outside the 4 km buffer from the catchment areas of the 52 piloted HCs. The left side indicates the combined piloted HCs and primary school locations. The right side is a zoomed image of Butare prefecture. Blue circles depict the 4 km radius catchment area around a pilot HC; purple dots indicate school locations; and white boxes show the pilot HCs. Based on our baseline measure of a 4 km catchment area of the pilot HC, the blue circles represent treated locations while the zones outside the blue circles are control locations.

Source: authors' compilation.

4.2 Empirical model

To causally derive the impact of the CBHI programme on outcomes, we leverage a quasi-experimental health policy shock of community health insurance that occurred in three health district zones (Byumba, Kabgayi, and Kabutare) between 1999 and 2004. We compare the outcomes of children exposed to the CBHI pilot to their counterparts without exposure to the pilot in a DiD framework. To do this, we combine data on the timing of the pilot across different locations with the timing of births to measure early life exposure to the CBHI. Our baseline equation is as follows:

$$Y_{ictj} = \theta_c + \delta_t + \lambda_j + \alpha \cdot \text{PilotingZone}_c \times D_{it} + \mathbf{X}_{ict}\gamma + \varepsilon_{ictj} \quad (1)$$

where the outcome variable, Y_{ictj} , is the performance of student i in school (community) c , born in year t , and sitting for the exam in year j . PilotingZone_c is a dummy variable set equal to 1 if the student lives in a community that is within the piloted zone of the CBHI reform, and 0 otherwise. D_{it} is a dummy variable set equal to 1 if the student was born after the introduction of the CBHI and 0 otherwise. Hence, $\text{PilotingZone}_c \times D_{it}$ is an indicator variable for students living within the CBHI pilot zone and born after the start of the reform. $\mathbf{X}_{ict}$ is a vector of con-

trols, including gender of the student, average annual temperature in the community during the exam year, and baseline characteristics (malaria incidence and road density) interacted with time trends. As the CBHI programme was implemented at different times, we compare the outcomes of students with and without exposure to the CBHI at birth of their community and date of birth. We control for community (school) fixed effect, θ_c , birth year (cohort) fixed effect, δ_t , and exam year fixed effect, λ_j . Standard errors are clustered at the district level.

It is important to note that Rwanda is mountainous terrain, which may limit access to health facilities. Therefore, it is reasonable to assume that due to topographic variance within a pilot HC area, some communities may decide to delay CBHI membership due to accessibility challenges. Such families would rather use traditional medicines or informal drug dealers for cases of illness. Therefore, after a certain distance threshold, the net benefits from CBHI membership reduces with distance. Hence, for our baseline estimate, we decide to use a conservative distance threshold of 4 km as the optimal size of the treated pilot areas. We consider students living within a 4 km radius of a CBHI pilot HC as treated, and students living beyond the 4 km buffer as controls. The left side of Figure 5 shows the demarcations of the treated and control areas.

Another important point to highlight is that we use the location of the school as a proxy for a student's place of residence, largely because we do not have data on students' residences and places of birth. Although this is a strong assumption, school location is a reasonable approximation of students' residence.¹¹ Because of this, the main parameter of interest $\hat{\alpha}$, basically measures an intent-to-treat (ITT) estimate of the medium-term effect of early life exposure to the CBHI on student performance. By estimating Equation 1, we indirectly assume that the effects of the CBHI pilot on the human capital development of children is mostly present during the time of birth. Therefore, only children born during or after the start of the CBHI are likely to benefit from these positive impacts. However, when a community starts the CBHI programme, it continues and does not stop. Hence, for identification purposes, all students born after 2005 were dropped from the analysis as there would be no variation as the CBHI programme was nationally launched in 2005.

4.3 Event study

Finally, the validity of our research design rests on the assumption of (plausibly) exogenous rollout of the CBHI across locations. We address this concern in two ways. First, we control for trends in observable determinants of the CBHI pilot phase and national rollout by including baseline malaria incidence interacted with linear time trends. This is expected to purge our es-

¹¹ The World Bank reveals that most primary school students in Rwanda live within 2 km of their school (Kwakwa 2003).

timates of the direct effects of key local diseases on our outcome. In addition, since we focus on students born during the pilot phase, we control for possible confounders such as access to transport infrastructure with the inclusion of road density interacted with time trends (Hoynes et al. 2016).

We present event-study results to show that, absent the CBHI, the performance of students in treated and control locations would evolve along a similar trend by estimating the following specification:

$$Y_{ictj} = \theta_c + \delta_t + \lambda_j + \sum_{\tau=-5; \tau \neq -1}^5 \alpha_\tau \cdot \text{PilotingZone}_c \times D_{it}^\tau + \mathbf{X}_{ict} \gamma + \varepsilon_{ictj} \quad (2)$$

However, the recent wave of literature on DiD with staggered treatment, as in the case of our study, suggests that using the conventional two-way fixed effects (TWFE) estimators for models with staggered treatment may lead to biased estimates due to the presence of negative weighting and heterogeneity in the treatment effects (Borusyak et al. 2024; Callaway and Sant’Anna 2021; De Chaisemartin and d’Haultfoeuille 2024; Goodman-Bacon 2021). To address these challenges and ensure the robustness of our estimates, we use the ‘imputation’ estimator by Borusyak et al. (2024) to estimate our event study. This estimator ensures consistency in the presence of the TWFE and also deals with issues of negative weighting (De Chaisemartin and d’Haultfoeuille 2024).

5 Results and discussion

This section presents our main results on the impact of public health insurance on education outcomes in the context of low-income environments in Rwanda. Our results are reported in figures and tables at their respective 95 per cent confidence intervals (CIs). We provide estimates on STEM subjects (math and science), and for non-STEM subjects (social studies, English, and Kinyarwanda) in the main results and add the individual subject estimations in the Appendix.

5.1 CBHI and learning outcomes: baseline

Table 3 presents the estimated impact of early life exposure to the CBHI reform on the learning outcomes using three indicators of student standardized grade performance (all subjects, STEM, and non-STEM). For each of the indicator outcomes we estimate three alternative specifications. In this paper, we essentially prefer results discussion in columns 3, 6, and 9. The analysis reveals that exposure to the CBHI programme significantly improves overall student performance. Specifically, early exposure to the CBHI programme led to an increase of 0.064

standard deviations (σ). This result underscores the positive relationship between access to public health insurance and cognitive performance.

Table 3: Early life exposure to the CBHI and learning outcomes

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI $\times$ Post	0.0770*** (0.0113)	0.0472*** (0.0139)	0.0640*** (0.0117)	0.0563*** (0.0112)	0.0274** (0.0136)	0.0448*** (0.0116)	0.0860*** (0.0114)	0.0572*** (0.0141)	0.0728*** (0.0118)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam-year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI-year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.3903	0.4240	0.4241	0.3761	0.4064	0.4065	0.3692	0.4053	0.4053
Observations	1,388,769	1,388,351	1,388,351	1,388,772	1,388,354	1,388,354	1,388,768	1,388,350	1,388,350

Note: *, **, *** Significant at 10, 5, and 1 per cent level, respectively. The test scores were shared by NESAC. Munic. stands for *municipality*. Dependent variables are standardized test scores (grades) categorized into three groups. Grades are standardized for each exam year. The first three columns provide the estimates on combined grades from five subjects (maths, science, social studies, English, and Kinyarwanda) conducted by grade 6 students in Rwanda. Columns 4–6 report the estimates for STEM subjects (maths and sciences), and columns 7–9 report estimates for non-STEM subjects (social studies, English, and Kinyarwanda). CBHI $\times$ Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations.

Breaking down the results into subject groups, we observe varying impacts. STEM subjects (maths and science) show a smaller but statistically significant improvement of 0.044σ , while non-STEM subjects (social studies, English, and Kinyarwanda) exhibit a larger effect, with test scores increasing by 0.072σ . We also estimate unstandardized grade points and the results remain the same (Table 4). The findings reflect that early exposure to the CBHI programme led to a 0.533 increase in grade points relative to those in the control group. In relation to the mean, the results reflect a 3.4 per cent increase in overall student performance.¹² The performance is 3.3σ and 3.4σ for STEM and non-STEM subjects, respectively.

We further provide estimates of the impact of CBHI reform on student performance using individual subjects (maths, science, social studies, English, and Kinyarwanda) as shown in Table 5. The results affirm the robust spillover impact of the CBHI programme on student test scores. We show that exposure to the public health programme led to an increase of 0.031σ and 0.055σ for maths and science, respectively. The impact on test scores in social studies, English, and Kinyarwanda is 0.064σ , 0.062σ , and 0.0724σ , respectively. Overall, these results, which are robust to various specifications, indicate that the CBHI programme plays a critical

¹² Derived from: $0.5333/15.4949 = 0.034$.

role in fostering human capital development by enhancing early learning outcomes. The findings also underline the broader socio-economic implications of health insurance programmes, as improved educational performance would eventually lead to better long-term economic opportunities for children in low-income settings.

Table 4: Early life exposure to health insurance and learning outcomes (grade points)

	All grade points			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.6196*** (0.0848)	0.3867*** (0.1023)	0.5333*** (0.0915)	0.1802*** (0.0342)	0.1009** (0.0401)	0.1647*** (0.0372)	0.4394*** (0.0543)	0.2859*** (0.0662)	0.3687*** (0.0579)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam–year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI–year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcomes	15.4940	15.4940	15.4940	4.9145	4.9145	4.9145	10.5795	10.5795	10.5795
R-squared	0.4338	0.4672	0.4672	0.4328	0.4633	0.4634	0.4016	0.4378	0.4378
Observations	1,388,769	1,388,351	1,388,351	1,388,772	1,388,354	1,388,354	1,388,768	1,388,350	1,388,350

Note: *, **, *** significant at 10, 5, and 1 per cent level, respectively. The test scores were shared by NESA.

Dependent variables are students grade points categorized into three groups. The first three columns provide the estimates for combined grade points from five subjects (maths, science, social studies, English, and Kinyarwanda) conducted by grade 6 students in Rwanda; columns 4–6 report the estimates from grade points in STEM subjects (maths and science), while columns 7–9 report grade points estimates from non-STEM subjects (social studies, English, and Kinyarwanda). CBHI × Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km of the closest pilot HC after the start of the CBHI programme and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, as well as baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESA test scores.

Table 5: Early life exposure to CBHI learning outcomes: across subjects

	All subjects			STEM					
	Total			Maths			Science		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.0770*** (0.0113)	0.0472*** (0.0139)	0.0640*** (0.0117)	0.0459*** (0.0108)	0.0140 (0.0128)	0.0318*** (0.0115)	0.0592*** (0.0103)	0.0381*** (0.0126)	0.0557*** (0.0108)
R-squared	0.3903	0.4240	0.4241	0.3578	0.3848	0.3848	0.3942	0.4294	0.4295
Observations	1,388,769	1,388,351	1,388,351	1,388,773	1,388,355	1,388,355	1,388,773	1,388,355	1,388,355
	Non-STEM								
	Social			English			Kinyarwanda		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.0760*** (0.0105)	0.0480*** (0.0132)	0.0643*** (0.0113)	0.0634*** (0.0095)	0.0495*** (0.0118)	0.0626*** (0.0101)	0.0929*** (0.0127)	0.0613*** (0.0147)	0.0724*** (0.0129)
R-squared	0.3976	0.4315	0.4316	0.4346	0.4691	0.4691	0.2365	0.2767	0.2767
Observations	1,388,773	1,388,355	1,388,355	1,388,773	1,388,355	1,388,355	1,388,773	1,388,355	1,388,355
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam-year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Treatment × exam-year FE	No	No	Yes	No	No	Yes	No	No	Yes

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESA. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI × Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESA test scores (NESA 2012–19).

5.2 CBHI and learning outcomes: event study

We also conduct an event-study analysis of the effects of early exposure to the CBHI programme on student performance using the Borusyak et al. (2024) estimator. Based on the event study, we are able to evaluate the validity of the parallel trends assumption, and examine how the effects of the CBHI programme evolve and vary over time.

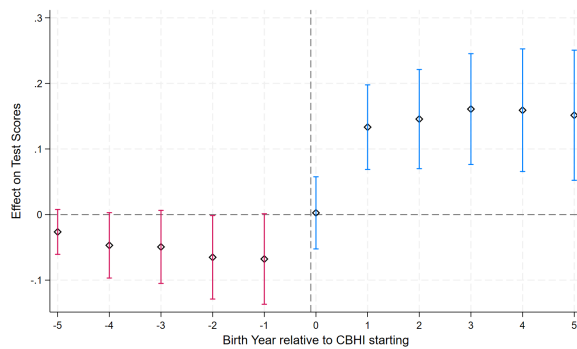
Figure 6 presents the event-study estimates of the impact of early exposure to the CBHI programme on test scores. Figure 6a exhibits relatively similar trends in student performance in both treated and control groups in piloted zones and control communities born before the start of the CBHI programme, as the pre-implementation estimates are more or less statistically insignificant at the 95 per cent CI. However, the figure reveals a clear upward trajectory and significant estimates in learning outcomes following the introduction of the CBHI, suggesting a positive and growing impact of health insurance on students' academic performance.

Estimations from STEM and non-STEM subjects yield similar results, (Figure Figure 6b and c, respectively). In all specifications, the post-treatment events exhibit a gradual and sustained

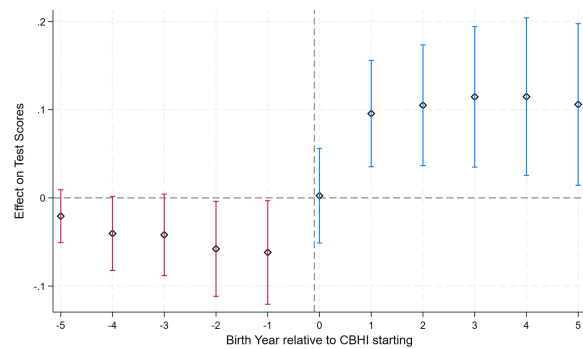
improvement in test scores, with statistically significant effects emerging in the years following CBHI exposure. Overall, the estimates from the event study provide suggestive evidence in line with our identifying assumptions. The findings suggest the cumulative nature of the CBHI's impact, as prolonged access to health insurance likely contributes to improved child health, cognitive development, and educational investments over time. Individual subject estimates also show similar results, as provided in Figures A1 and A2. An alternative event-study estimate using the TWFE estimator (Figures A3–A5) leads to the same conclusion. Overall, the findings from the event study support our identification assumptions.

Figure 6: Event study: exposure to early health insurance and learning outcomes

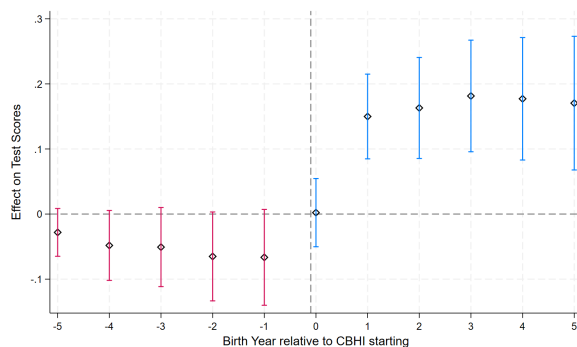
(a) All subjects



(b) STEM



(c) Non-STEM



Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95% CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the imputation estimator of Borusyak et al. (2024). *All subjects* combines maths, science, social studies, English and Kinyarwanda.

Source: authors' compilation based on test scores from NESA (2012–19).

6 Heterogeneity analysis

To better understand the differential impact of the CBHI programme, we conduct a heterogeneity analysis focusing on gender and geographic location. Specifically, we examine how the CBHI influences learning outcomes across male and female students and compare its ef-

fects in rural and urban areas, while also analysing outcomes excluding Kigali.¹³ This analysis provides valuable insights into whether and how the programme's benefits vary across demographic and geographic subgroups, shedding light on potential disparities and guiding targeted policy interventions.

6.1 Effects of CBHI across gender

Tables 6 and 7 present the estimated effects of early life exposure to the CBHI programme on standardized test scores for male and female students, respectively. While both groups benefit significantly from the CBHI, notable differences emerge in the magnitude and distribution of the impacts across subject categories.

Table 6: Early life exposure to the CBHI and learning outcomes: male students

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.0822*** (0.0139)	0.0522*** (0.0178)	0.0746*** (0.0162)	0.0594*** (0.0139)	0.0311* (0.0180)	0.0524*** (0.0165)	0.0919*** (0.0138)	0.0628*** (0.0176)	0.0846*** (0.0160)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam–year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI–year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.3768	0.4138	0.4139	0.3601	0.3943	0.3943	0.3598	0.3990	0.3990
Observations	636,654	636,259	636,259	636,654	636,259	636,259	636,653	636,258	636,258

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESA. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI × Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESA test scores (NESA 2012–19).

¹³ Kigali is the capital city of Rwanda and contains most of the formal employment opportunities with formal health insurance. In 2005, the city housed around 46 per cent of the total urban population (16 per cent of the total country population), according to United Nations population data and the Macrotrends World Bank dataset (Macrotrends 2025).

Table 7: Early life exposure to the CBHI and learning outcomes: females students

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI $\times$ Post	0.0718*** (0.0113)	0.0414*** (0.0135)	0.0532*** (0.0116)	0.0524*** (0.0110)	0.0220* (0.0130)	0.0369*** (0.0114)	0.0803*** (0.0115)	0.0515*** (0.0139)	0.0611*** (0.0119)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam-year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.-YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI-year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.4067	0.4450	0.4450	0.3903	0.4254	0.4254	0.3836	0.4243	0.4243
Observations	752,093	751,786	751,786	752,096	751,789	751,789	752,093	751,786	751,786

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESA. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI $\times$ Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESA test scores (NESA 2012–19).

For male students (Table 6), early exposure to the CBHI leads to an overall improvement in test scores of approximately 0.0746 standard deviations (σ). The effect is more pronounced for non-STEM subjects, with a statistically significant increase of 0.0846σ , compared to a smaller but still significant 0.0524σ increase in STEM subjects. For female students (Table 7), the overall impact of the CBHI is slightly smaller, with an improvement of 0.0532σ in combined test scores. Similar to their male counterparts, female students experience greater gains in non-STEM subjects, with an increase of 0.0611σ , compared to 0.0369σ in STEM subjects.

These findings suggest that male students may derive relatively greater benefits from the CBHI impact on learning outcomes compared to female students. The heterogeneity between male and female students underscores the importance of considering demographic differences when assessing the broader impacts of health insurance programmes.

6.2 Effects of the CBHI across location

The analysis of Tables 8–10 highlights significant heterogeneity in the impact of early life exposure to the CBHI programme on learning outcomes across rural, urban, and non-Kigali student populations. These results highlight the differential effects of the CBHI, depending on geographic and socio-economic contexts, with important implications for policy targeting and resource allocation.

Table 8: Early life exposure to the CBHI and learning outcomes: rural students

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.0676*** (0.0122)	0.0383*** (0.0142)	0.0594*** (0.0118)	0.0445*** (0.0119)	0.0176 (0.0138)	0.0394*** (0.0117)	0.0790*** (0.0123)	0.0493*** (0.0144)	0.0690*** (0.0120)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam–year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI–year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.2918	0.3349	0.3350	0.2782	0.3167	0.3168	0.2775	0.3229	0.3229
Observations	1,193,984	1,193,596	1,193,596	1,193,987	1,193,599	1,193,599	1,193,983	1,193,595	1,193,595

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESAs. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI × Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESAs test scores (NESAs 2012–19).

Table 9: Early life exposure to the CBHI and learning outcomes: urban students

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI × Post	0.1228*** (0.0295)	0.2736*** (0.0844)	0.0895* (0.0460)	0.1195*** (0.0309)	0.3153*** (0.1120)	0.1035 (0.0637)	0.1151*** (0.0285)	0.2299*** (0.0713)	0.0788* (0.0421)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam–year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI–year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.5514	0.5717	0.5721	0.5264	0.5472	0.5476	0.5326	0.5537	0.5542
Observations	194,028	193,960	193,960	194,028	193,960	193,960	194,028	193,960	193,960

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESAs. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI × Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESAs test scores (NESAs 2012–19).

Table 10: Early life exposure to the CBHI and learning outcomes: excluding Kigali

	All subjects			STEM			Non-STEM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CBHI $\times$ Post	0.0557*** (0.0111)	0.0538*** (0.0112)	0.0507*** (0.0089)	0.0443*** (0.0106)	0.0437*** (0.0107)	0.0479*** (0.0090)	0.0598*** (0.0114)	0.0565*** (0.0115)	0.0499*** (0.0089)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exam–year	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
YOB FE	Yes	No	No	Yes	No	No	Yes	No	No
Munic.–YOB FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
CBHI–year FE	No	No	Yes	No	No	Yes	No	No	Yes
Health facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.3336	0.3722	0.3723	0.3208	0.3549	0.3550	0.3154	0.3566	0.3566
Observations	1,266,470	1,266,083	1,266,083	1,266,473	1,266,086	1,266,086	1,266,469	1,266,082	1,266,082

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. The test scores were shared by NESA. The dependent variable is the standardized test scores from the Rwanda Primary School National Progressive Exam for grade 6. The subjects in STEM are maths and science, while non-STEM courses are social studies, English, and Kinyarwanda. CBHI $\times$ Post is a dummy variable equal to 1 if a student was born after the introduction of the CBHI and took exams in a school located within 4 km from the closest pilot HC after the start of the CBHI programme, and 0 otherwise. Controls include gender of the student, average annual temperature in the exam year, and baseline controls such as road density and malaria incidence interacted with time trends. Robust standard errors are clustered at the school level in parentheses.

Source: authors' calculations based on NESA test scores (NESA 2012–19).

For rural students (Table 8), early exposure to the CBHI is associated with an overall improvement of 0.0594σ in test scores across all subjects. The gains are more pronounced in non-STEM subjects (0.069σ) compared to STEM subjects (0.0394σ). This discrepancy suggests that the cognitive benefits fostered by improved health and reduced financial stress may have a more immediate or pronounced impact on language and comprehension skills, which are fundamental to non-STEM subjects, than on the numerical and analytical reasoning required for STEM subjects.

Urban students (Table 9) showed substantially larger benefits from early exposure to the CBHI, with an overall improvement of 0.0895σ in test scores. The magnitude of improvement in urban areas was greater than that observed in rural areas, highlighting the influence of superior baseline infrastructure and accessibility to educational and health resources in amplifying the benefits of the CBHI. Interestingly, the gains in STEM (0.1035σ) were more pronounced than in non-STEM (0.0788σ) subjects, which is the opposite to rural students. The magnitude of the improvement in test scores as a result of early exposure to the CBHI is more pronounced in urban areas than in rural areas, suggesting that urban environments may enable students to better capitalize on the health improvements facilitated by the CBHI across a broader range of cognitive and skill domains.

Excluding Kigali (Table 10) reveals a moderate yet significant impact of the CBHI, with an overall improvement of 0.0507σ in test scores. The smaller magnitude of the effects compared to urban students, including those in Kigali, underscores the unique advantages associated with the capital city in terms of access to health and educational resources. The pattern of larger

effects in non-STEM subjects (0.0499σ) relative to STEM subjects (0.0479σ) remains consistent. These results further emphasize the importance of considering regional heterogeneity in evaluating the effectiveness of health insurance programmes.

Overall, the findings reveal substantial geographical disparities in the educational benefits of the CBHI, with urban students—particularly those in Kigali—experiencing the largest gains. The consistently higher impact on non-STEM subjects across all subgroups (except for urban students, with higher impact on STEM subjects) suggests that improvements in cognitive function and household stability resulting from the CBHI play a crucial role in fostering learning outcomes. These results call for targeted interventions to bridge the urban–rural divide and ensure equitable access to the benefits of health insurance programmes. By addressing these disparities, policy-makers can enhance the role of health interventions in promoting inclusive human capital development.

7 Mechanisms

In this section we analyse the channels underlying the observed improvements in student performance associated with early life exposure to the CBHI. Our investigation primarily attributes these educational gains to the alleviation of household health restrictions, both access and affordability. Using the hypothetical assumptions in Figure 2, we essentially explore the following channels: school dropout rates, access to prenatal care, household spending on education and health, OOP costs for vaccinations and health insurance, and utilization of health facilities. We believe this analysis provides a comprehensive understanding of the pathways through which the CBHI contributes to better learning outcomes and provides valuable information on the broader socio-economic benefits of health insurance programmes. To do this, we use a pooled household survey dataset from NISR to explore the relationships between exposure to public health insurance on household health and education outcomes, using the following expression:

$$Y_{hrt} = \alpha \cdot PilotRegion_h \times D_t + \beta \cdot Z_{hrt} + \Gamma_r + \delta_t + \varepsilon_{hrt} \quad (3)$$

where Y_{hrt} is a placeholder for the outcome of interest for the individual (household) h in region r , surveyed in year t . $PilotRegion_c$ is a dummy variable set equal to 1 if the individual (household) lives within the CBHI pilot region, and 0 otherwise. D_{it} is a dummy variable set equal to 1 if the sample individuals (households) are surveyed in 1999/2000, and 0 otherwise. $PilotRegion_h \times D_t$ is essentially a dummy set equal to 1 for individuals (households) living in pilot regions during the survey year 1999/2000, and 0 otherwise. Z_{hrt} represents a vector of household controls (age and gender of household head and household size); Γ_r and δ_t represent location and time fixed effects, respectively.

7.1 The CBHI and household education and health expenditure

The hypothetical assumption is that the CBHI leads to household education and health income shocks within the pilot region, resulting from the plausible reduction of household health costs. We hypothesize that the CBHI could trigger direct effects on household health costs and a spillover effect on education expenditures. We empirically test this using rich households' health and education expenditures from Rwanda EICVs. Panel A of Table 11 explores the impact of exposure to the CBHI programme on household expenditures, with a focus on educational spending and OOP health costs. The results provide valuable insights into how the CBHI alleviates financial barriers and supports human capital development through resource reallocation.

Table 11: Early Exposure to CBHI, Health and Education outcomes

	Panel A: Education and health expenditures					
	Education			OOP health		
	(1)	(2)	(3)	(4)	(5)	(6)
Treated area $\times$ Post	0.1476 (0.1193)	0.3453*** (0.0945)	0.4191*** (0.1304)	-0.2357*** (0.0905)	-0.2180** (0.0894)	-0.4986*** (0.1244)
R-squared	0.0086	0.3656	0.3655	0.0141	0.0570	0.0568
Observations	13,319	13,319	13,319	13,320	13,320	13,320
	Panel B: OOP expenditure on vaccination and health insurance					
	Vaccination			Insurance		
	(7)	(8)	(9)	(10)	(11)	(12)
Treated Aarea $\times$ Post	-0.2513*** (0.0378)	-0.1860*** (0.0373)	-0.3235*** (0.0575)	0.3786*** (0.0553)	0.3685*** (0.0555)	0.5446*** (0.0605)
R-squared	0.0403	0.0872	0.0866	0.0177	0.0324	0.0328
Observations	13,320	13,320	13,320	13,320	13,320	13,320
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Survey period	Yes	Yes	No	Yes	Yes	No
Regions FE	Yes	Yes	Yes	Yes	Yes	Yes
Treatment by time trends	No	No	Yes	No	No	Yes

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. In the Panel A, the dependent variables are the (logs) real values of education and OOP health household expenditures expressed in RWF. The OOP is 15 per cent of the total costs of healthcare services under the CBHI. Panel B provides the (logs) real values of annual OOP vaccination costs by household members and the annual average health insurance expenditures expressed in RWF. The insurance health costs refer to the health contributions paid by the insurance programme. The cost is normally 85 per cent of the total healthcare services to each CBHI member who was treated. Treated region $\times$ Post is a dummy variable equal to 1 for the individuals (households) living in pilot regions during the survey year of 1999/2000, and 0 otherwise. Controls include age and gender of household head and household size. Robust standard errors are clustered at the household level in parentheses.

Source: authors' calculations.

The findings indicate a positive education expenditure effect of the CBHI programme on treated households. Households living in the CBHI pilot region experience a massive increase of 42 per cent in their education expenditures (column 3), and a huge and significant effect of 50 per

cent decrease in the OOP household expenditure (column 6). These findings highlight the redistributive effect of the CBHI, wherein the reduction of health-related financial burdens allows households to allocate more resources towards their children's education. This reallocation likely stems from decreased financial stress associated with unexpected medical costs, enabling families to invest in tuition fees, learning materials, and other educational necessities. The results underscore the role of health insurance in facilitating educational investments, which are critical for long-term socio-economic mobility, particularly in low-income contexts (Hsiao and Shaw 2007; Layton et al. 2022; World Health Organization 2002).

Conversely, a significant decline of OOP health expenditures reflects the protective effect of CBHI reform in shielding households from the financial risks associated with healthcare costs. By covering a substantial portion of medical expenses, the CBHI reduces the economic burden on families, particularly those with limited financial resources. This financial relief not only enhances household welfare but also ensures more predictable spending patterns, fostering economic stability.

7.2 The CBHI, OOP vaccination, and insurance costs

We further examine the effects of the vaccination expenditures and health insurance expenditure. Table 11 shows a significant reduction for vaccination expenses and an improvement for health insurance expenses for households in the CBHI pilot region. The results highlight the CBHI's significant role in reducing financial barriers to healthcare access and its broader implications for household welfare. Specifically, OOP vaccination costs saw a substantial and statistically significant reduction of around 32 per cent (column 9). This decrease underscores the programme's effectiveness in alleviating direct medical expenses associated with preventive health measures. We assume that by reducing vaccination costs, the CBHI likely improves vaccine uptake rates, particularly among low-income households that might otherwise forego preventive care due to financial constraints. Enhanced access to vaccinations therefore has long-term benefits, including improved public health outcomes and reduced susceptibility to preventable diseases, both of which are critical for fostering healthy cognitive and physical development in children. The results also indicate a significant increase in household insurance coverage, with a 54 per cent (column 12) increase among household in the pilot region relative to the control group. This finding suggests the CBHI incentivizes insurance payments, thereby extending financial protection and reduction of health costs by households. Broader insurance coverage mitigates the economic shocks of medical emergencies, ensuring more predictable household spending patterns. Moreover, greater insurance penetration enhances the accessibility of healthcare services, including preventive and curative interventions, which are essential for improving overall health outcomes. The interplay between reduced OOP vaccination costs and increased insurance payments reflect the CBHI's dual function of addressing imme-

diate health financial barriers and insuring livelihoods among the treated households.

7.3 The CBHI, school dropout, and prenatal care

Having seen that the CBHI reform exerts significant effects on health and education expenditures, we analyse how such economic shocks may translate into education attainment, as reported in Panel A of Table 12 (columns 1–3). Hypothetically, we assume that a household income shock resulting from the CBHI reform enables families to improve their educational investment in their children and allows the children to attend school. To test this hypothesis requires detailed data on student dropout and attendance at the school level before and after the CBHI reform. This data is unavailable in the study context. The only data available on school dropout is aggregated at the regional level,¹⁴ thereby affecting its use for this study. We opt to rely on proximate measures of dropout from EICVs questions, asking whether a person abandoned school during the current school year. We further restrict the sample to family children of school age (7–18) in Rwanda. Admittedly, this measure is imperfect as it may not reflect the true picture of dropouts and whether the person could have returned to school. It also does not share insights about attendance, but because of limited granular data on schooling, we use it as a proxy for attendance.

The results show the CBHI's role in reducing school dropout among families in the pilot region relative to controls. Specifically, the CBHI reform induced significant spillover reduction of dropouts of around 3 per cent (Panel A of Table 12, column 3). In columns 4–6 we show that CBHI exposure is also associated with a significant increase in access to prenatal care, with improvements reaching around 28 per cent in terms of increased prenatal care health services within pilot regions relative to control regions. This finding highlights the CBHI's effectiveness in removing financial barriers to essential maternal health services. Improved prenatal care access is critical for maternal and child health, as it facilitates early detection of complications, ensures proper nutritional guidance, and provides critical health interventions. These findings also underscore the importance of integrating health insurance programmes into broader social protection frameworks. The CBHI's dual impacts on education and health provide further evidence of the interconnectedness of these domains and the need for holistic policy approaches to address structural inequalities in low-income settings.

¹⁴ We use the term *region* to refer to the prefecture, the first administrative unit of Rwanda before 2006, when they become provinces.

Table 12: Early exposure to the CBHI: share of health and education access

Panel A: share of school dropout and access to prenatal care						
	School dropout			Prenatal care		
	(1)	(2)	(3)	(4)	(5)	(6)
Piloted region $\times$ Post	-0.0193*** (0.0031)	-0.0131*** (0.0030)	-0.0308*** (0.0045)	0.1383*** (0.0076)	0.1549*** (0.0070)	0.2792*** (0.0083)
R-squared	0.0050	0.0701	0.0716	0.0416	0.1048	0.1217
Observations	13,320	13,320	13,320	12,605	12,605	12,605
Panel B: Share of household members visiting public health facilities						
	Extensive margin			Intensive margin		
	(7)	(8)	(9)	(10)	(11)	(12)
Piloted region $\times$ Post	0.0135*** (0.0032)	0.0128*** (0.0032)	0.0191*** (0.0040)	0.1179*** (0.0250)	0.1163*** (0.0250)	0.1348*** (0.0378)
R-squared	0.0036	0.0084	0.0092	0.0185	0.0268	0.0331
Observations	13,320	13,320	13,320	3,141	3,141	3,141
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Survey period	Yes	Yes	No	Yes	Yes	No
Regions FE	Yes	Yes	Yes	Yes	Yes	Yes
Treatment by time trend	No	No	Yes	No	No	Yes

Note: *, **, *** significant at the 10, 5, and 1 per cent level, respectively. In Panel A, the dependent variables are the shares of school dropout among household members of school age (7–18 years) and the share of female households who had access to prenatal care. Panel B shows the share of household members visiting public health facilities. The extensive margin reflects the ratio of household members using public health facilities relative to household size, and the intensive margin indicates the ratio of individuals within households that visited the public health facilities relative to those that consulted a physician within the last two weeks of the interview. Piloted region $\times$ Post is a dummy variable equal to 1 for the individuals (households) living in the pilot region during the survey year of 1999/2000, and 0 otherwise. Controls include age and gender of household head and household size. Robust standard errors are clustered at the household level in parentheses.

Source: authors' calculations.

7.4 The CBHI and access to household healthcare

We also explore the healthcare access effect of the CBHI programme by looking at how frequently family members visit public health facilities. The results in Panel B of Table 12 reflect the impact of the CBHI programme on household access to public health facilities, on both extensive and intensive margins. These findings provide critical insights into the programme's ability to enhance healthcare utilization across different dimensions of access.

First, the extensive margin, which examines the ratio of household members using public health facilities relative to household size, showed a significant increase (around 2 per cent, column 9) in the pilot region compared to the control group. This improvement underscores the CBHI's role in expanding access to healthcare at the household level, particularly by enabling a larger proportion of family members to seek medical care. Such an outcome likely stems from the programme's ability to reduce financial barriers to healthcare utilization. The increase in extensive margin access is particularly important for larger households, where the cost of healthcare services often imposes a significant financial strain. By addressing these barriers, the CBHI

facilitates equitable access to healthcare services within families, ensuring that all members, including vulnerable groups such as children, pregnant women, and the elderly, receive the care they need.

Second, intensive margin, measured as the ratio of individuals using public health facilities relative to those who consulted a physician within the last two weeks of the interview, also experienced a significant rise (about 13.5 per cent, column 12). This result indicates that the CBHI not only increases the breadth of healthcare access but also improves the frequency and immediacy with which individuals engage with health services. The rise in intensive margin utilization reflects the programme's success in fostering timely healthcare-seeking behaviour, which is critical for the early diagnosis and management of illness. This effect is particularly beneficial in low-income and emerging economies where delays in seeking care can lead to worse health outcomes and higher treatment costs in the long run (Chou et al. 2014; Dias and Fontes 2024; Huang and Liu 2023). Together, the improvements in both extensive and intensive margins demonstrate the CBHI's effectiveness in enhancing access to public health facilities at both the household and individual levels. By reducing financial constraints, the programme ensures broader and more frequent utilization of healthcare services, contributing to improved health outcomes.

8 Conclusion and implications

In 1999, the Rwandan government started a pilot phase of a national health PPS aimed at improving financial access and utilization of public healthcare services in the country. Mostly known as the CBHI programme, the reform was initially implemented in three district hospitals (Byumba, Kabgayi, and Kabutare) covering Byumba, Gitarama, and Butare prefectures, before being extended to the national level five years later. In this study, we investigate the effects of PPS reform on human capital accumulation by examining the impact of the CBHI on learning outcomes of primary school students who were exposed to the CBHI programme in early life. We also analyse the potential channels that explain our results. To do this, we leverage unique administrative data on test scores of the universe of primary school students sitting for a high-stakes national exam between 2012 and 2019. To identify the causal effect of health reform on education outcomes, we exploit the rollout of the CBHI in a DiD framework. The study finds a significant positive effect of exposure to the CBHI on learning.

Specifically, we find that test scores of students born within the CBHI pilot area are about 0.07 standard deviations (3 per cent) higher relative to their counterparts in control areas. The study provides suggestive evidence of massive improvement in prenatal child healthcare, per capita utilization of health facilities, household education expenditures, and school attendance as plausible channels. To the best of our knowledge, this study provides the first causal effects of

a large-scale health insurance programme in a developing country, at least in SSA.¹⁵ Hence, our findings are informative for poor countries in SSA with the highest public health insurance deficits,¹⁶ where following the Bamako Initiative, most countries in the region have yet to achieve universal health coverage, especially in rural poor communities.

Such a large-scale health insurance programme aimed at improving financial access to health facilities and quality public healthcare services has many facets. The Rwandan CBHI programme has proved to require consistent collaborative efforts between communities and policy-makers, where households need to pay annual premiums to keep members insured against illness. The findings from Rwanda show that providing such public health insurance for all can have long-lasting positive impacts in social gains through massive increases in health access for the general population and disease control in communities. Finally, it is crucial to mention a few more aspects from our context that give more insights for future programmes in other contexts. The implementation of the CBHI in Rwanda happened in late 1999 as the country was facing serious socio-economic challenges following the 1994 genocide. In addition, the country was facing sharp declines in health service use coupled with unprecedented rising poverty among Rwandans. Poor health outcome indicators inspired the republic of Rwanda to introduce the CBHI to enable inclusive access to modern health systems in the country (Schneider and Diop 2001). The CBHI enabled the country to achieve almost all UN Millennium Development Goals, and positioned Rwanda at the forefront of the SSA region in terms of public health insurance coverage (Barasa et al. 2021). From less than 7 per cent population CBHI enrolment in 2003 to about 80 per cent in 2023, most Rwandans are now able to get treatment for illness of any kind (Preker and Carrin 2004; Schneider and Diop 2001). This has led to about 30 per cent increase in prenatal care and 3 per cent reduction in school dropout five years after the start of the reform. Further work on the long-term labour market effects of community health insurance could improve policy outcomes, at least in developing countries where unemployment remains a critical challenge. Considering private health providers in CBHI settings could improve health policy insights. Further studies can evaluate such interventions.

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¹⁵ So far we are aware of only a few studies by Huang and Liu (2023), Chen and Jin (2012), Khiem and Kuo (2022), and Alcaraz Pribaz et al. (2017) that evaluated the effects of early life exposure to health insurance on later child outcomes in China, Vietnam, and Mexico.

¹⁶ According to the recent study by Barasa et al. (2021), only four African countries have health insurance coverage of any kind above 20 per cent. These are Rwanda (78.7 per cent), Ivory Coast (77.5 per cent), Ghana (58.2 per cent) and Gabon (40.8 per cent).

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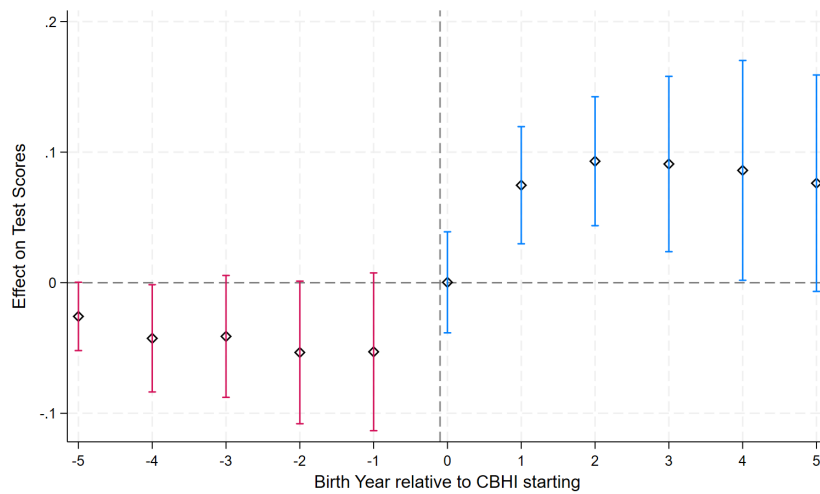
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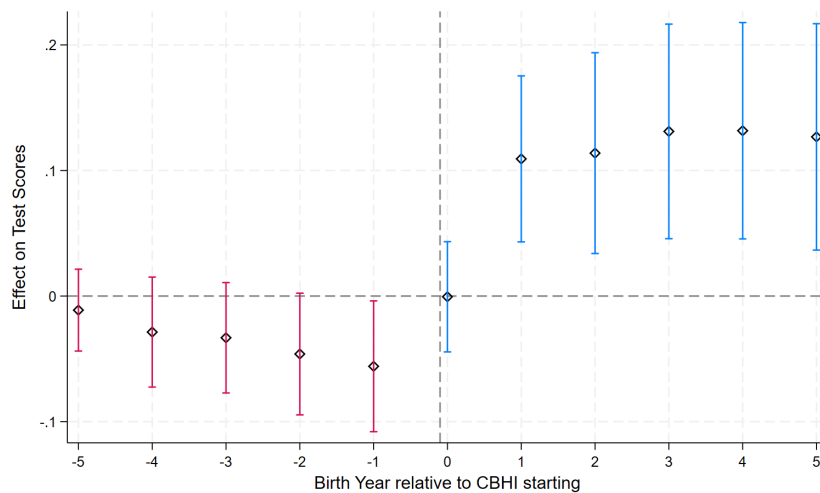
Appendix A

Figure A1: Event study: exposure to early health insurance and learning outcomes

(a) Mathematics



(b) Sciences

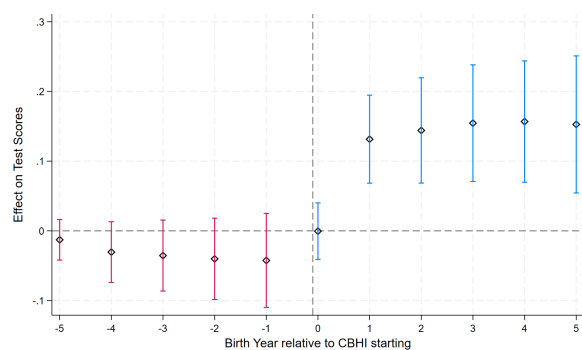


Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95 per cent CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the imputation estimator of Borusyak et al. (2024).

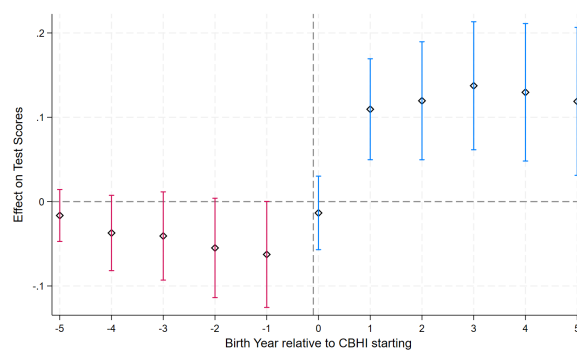
Source: authors' compilation based on data from NESa (2012–19).

Figure A2: Event Study: exposure to early health insurance and learning outcomes

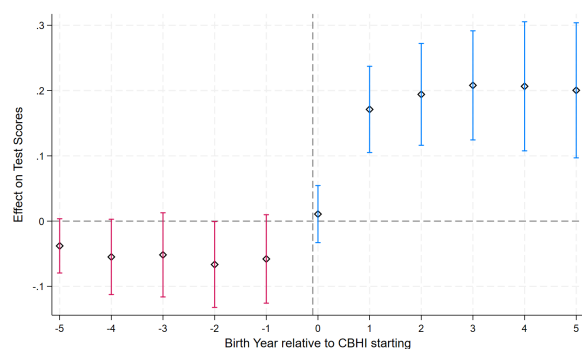
(a) Social



(b) English



(c) Kenya

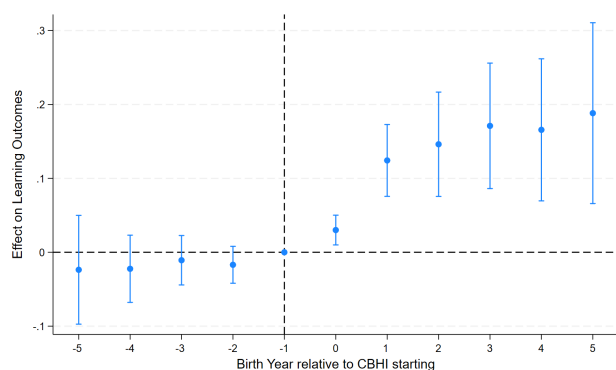


Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95 per cent CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the imputation estimator of Borusyak et al. (2024).

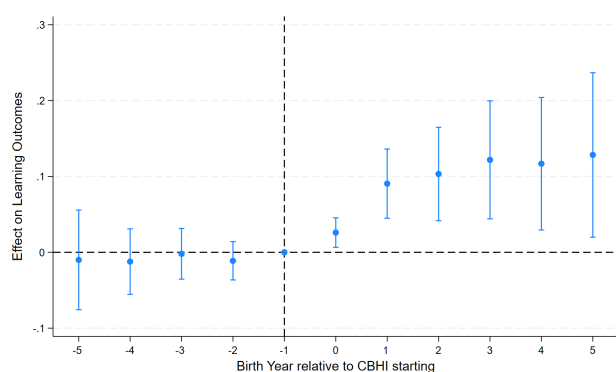
Source: authors' compilation based on data from NESA (2012–19).

Figure A3: Event study: exposure to early health insurance and learning outcomes

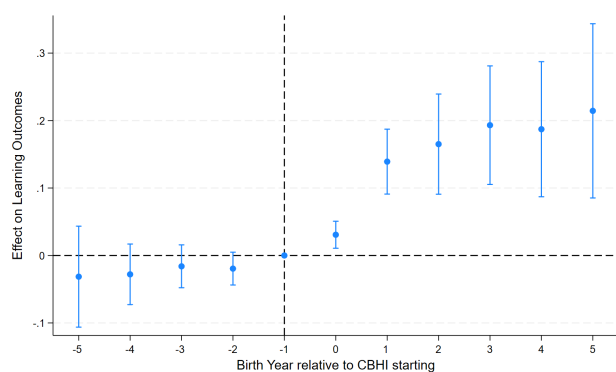
(a) All subjects



(b) STEM



(c) Non-STEM

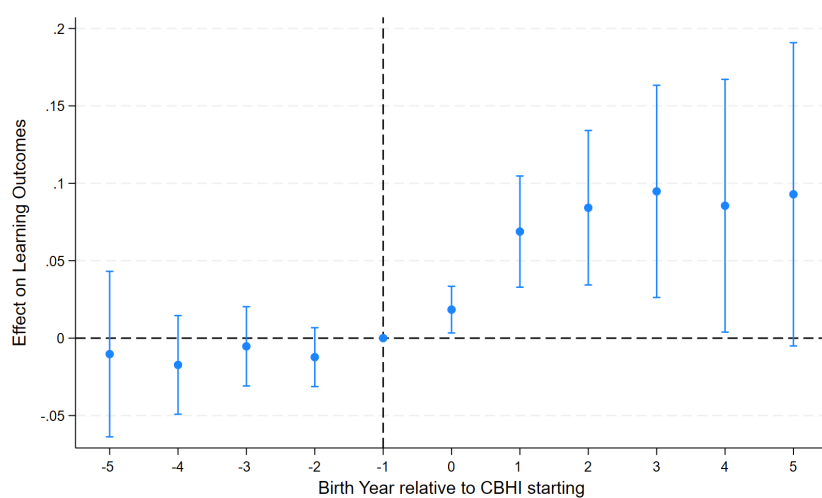


Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95 per cent CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the TWFE approach. *All subjects* combines mathematics, sciences, social studies, English and Kinyarwanda.

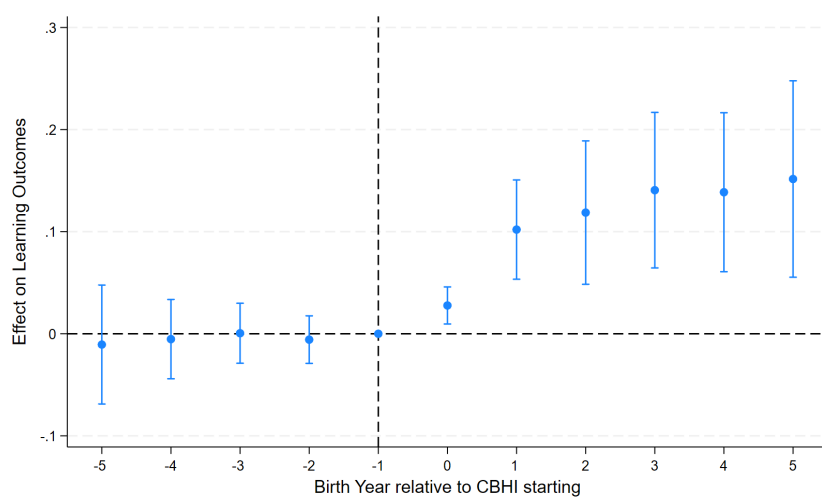
Source: authors' compilation based on data from NESA (2012–19).

Figure A4: Event study: exposure to early health insurance and learning outcomes

(a) Mathematics



(b) Sciences

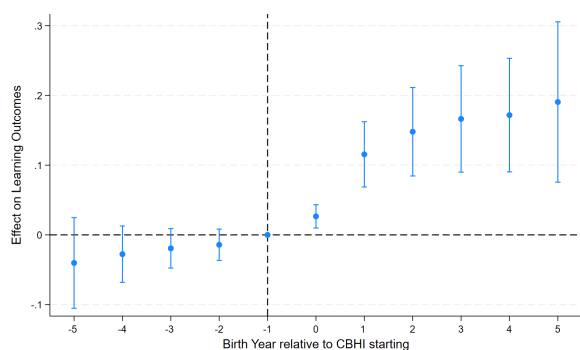


Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95 per cent CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the TWFE approach.

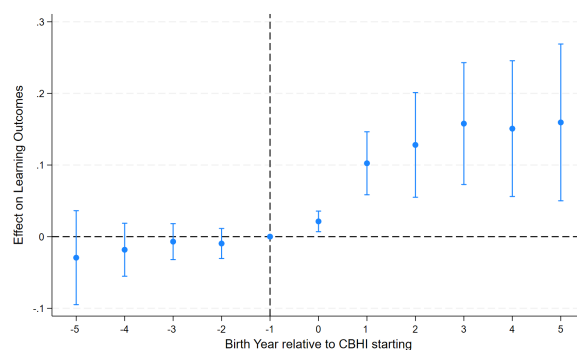
Source: authors' compilation based on data from NESA (2012–19).

Figure A5: Event study: exposure to early health insurance and learning outcomes

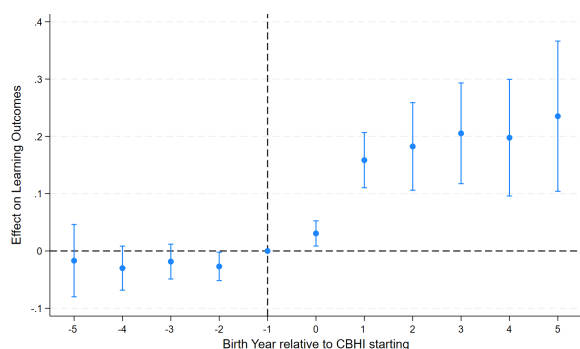
(a) Social



(b) English



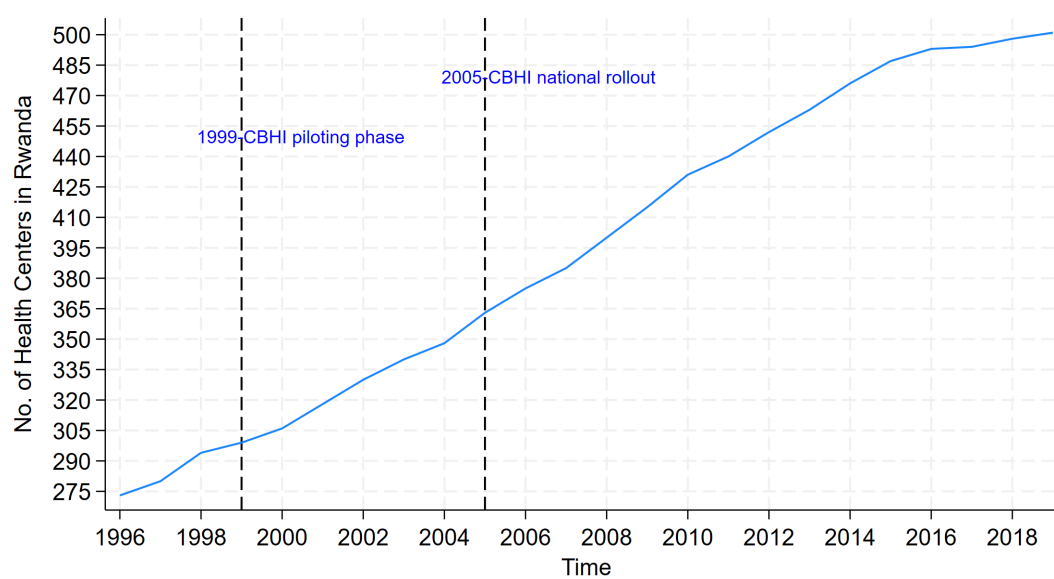
(c) Kinyua



Note: the analysis sample is based on the universe of grade 6 national exam test scores conducted between 2012 and 2019 across 2,841 schools. The figures represent the standardized estimates (and 95 per cent CIs, based on standard errors clustered at the district level) measuring the effects of early life exposure to public health insurance on learning outcomes based on the TWFE approach.

Source: authors' compilation based on data from NESA (2012–19).

Figure A6: Evolution of HC facilities in Rwanda (1996–2019)



Note: the figure shows the evolution of health facilities in Rwanda. Between 2000 and 2019, the country has increased the number of public HCs from 306 to 503, an increase of approximately 64 per cent in 20 years.

Source: authors' compilation based on data from Ministry of Health (1999–2022).

Table A1: Rwanda grade six national exam table (2012–19)

Mathematics		Social studies		Science		English		Kinyarwanda	
Date	Time	Date	Time	Date	Time	Date	Time	Date	Time
2019-11-04	9:00-11:00	2019-11-04	13:30-15:30	2019-11-05	9:00-11:00	2019-11-06	9:00-11:00	2019-11-05	13:30-15:30
2018-11-12	9:00-11:00	2018-11-12	13:30-15:30	2018-11-13	9:00-11:00	2018-11-14	9:00-11:00	2018-11-13	13:30-15:30
2017-11-07	9:00-11:00	2017-11-07	13:30-15:30	2017-11-08	9:00-11:00	2017-11-09	9:00-11:00	2017-11-08	13:30-15:30
2016-11-01	9:00-11:00	2016-11-01	13:30-15:30	2016-11-02	9:00-11:00	2016-11-03	9:00-11:00	2016-11-02	13:30-15:30
2015-11-03	9:00-11:00	2015-11-03	13:30-15:30	2015-11-04	9:00-11:00	2015-11-05	9:00-11:00	2015-11-04	13:30-15:30
2014-10-21	9:00-11:00	2014-10-21	13:30-15:30	2014-10-22	9:00-11:00	2014-10-23	9:00-11:00	2014-10-22	13:30-15:30
2013-10-22	9:00-11:00	2013-10-22	13:30-15:30	2013-10-23	9:00-11:00	2013-10-24	9:00-11:00	2013-10-23	13:30-15:30
2012-11-06	9:00-11:00	2012-11-06	13:30-15:30	2012-11-07	9:00-11:00	2012-11-08	9:00-11:00	2012-11-07	13:30-15:30

Note: the table reports exam dates and times for each subject that students sat from 2012 to 2019.

Source: authors' compilation.