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The Impact of Eliminating Secondary School Fees: Evidence from Tanzania*

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Abstract

In January 2016, Tanzania implemented a fee-free secondary school reform. Using variation in district and cohort exposure to the reform, we employ a difference-in-differences strategy to estimate the short-term impacts of the reform. Despite a relatively small drop in user costs, the reform substantially increased enrolment into secondary education. While these enrolment effects were predominantly driven by an increase in public school enrolment, there was also a delayed positive effect on private school enrolment. Districts most exposed to the reform experienced a significant drop in exam scores relative to less-exposed districts, which cannot be explained by academic abilities of new students. These findings are in line with a theoretical school choice model, where fee elimination loosens enrolment constraints, and increased enrolment harms the quality of public education. (*JEL* I21, I24, I28)

*We wish to thank Youdi Schipper, Sam Jones, Thomas Markussen, Patricia Justino, and Lant Pritchett for providing excellent comments on the paper. Further thanks go to the National Examinations Council of Tanzania for providing public access to a large and useful database on student exam records.

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I. INTRODUCTION

In 2016, Tanzania implemented a nationwide policy of eliminating a relatively small secondary school yearly fee of 20,000 Tanzanian shillings, corresponding to approximately 2 percent of median household consumption per adult. To compensate schools, the government now pays the 20,000 shillings fee and an additional capitation grant to cover recurrent expenses apart from salaries. Similar nationwide reforms are seen in recent years in other countries in Sub-Saharan Africa.[1] Due to the recency of these reforms, the evaluated impacts are limited. At the primary school level, research demonstrates that eliminating fees have a huge impact on enrolment, usually at the cost of worsening the quality of education.[2] Whether the same effects take place at the secondary school level is of utmost importance for education finance and allocation of resources. To uphold the same level of quality, schools need more teachers and classrooms. The magnitude of these required investments depends crucially on the local enrolment response.

In the present paper, we set up a difference-in-differences framework to estimate how the fee-free secondary school reform in Tanzania impacted progression rates between primary and secondary education, the relative composition of public and private secondary school students, and secondary school exam scores. Identification relies on district and cohort variation in exposure to the reform. Districts with low pre-reform progression rates were more exposed, as the pool of applicants

[1] These countries include Rwanda (2007 and 2012), Uganda (2007), Burundi (2012), Namibia (2016), Kenya (2018), Malawi (2018), Sierra Leone (2018), and Ghana (2019). Other countries have eliminated school fees for targeted groups.

[2] A positive effect on enrolment is found in Ethiopia (Moussa and Omoeva 2020), Kenya (Lucas and Mbiti 2012), Malawi (Al-Samarrai and Zaman 2007), Tanzania (Hoogeveen and Rossi 2013), and Uganda (Deininger 2003; Nishimura, Yamano, and Sasaoka 2008; Grogan 2009). Worsening effects are found on: 1) test scores for students unaffected by the reform in Kenya (Lucas and Mbiti 2012); 2) grade achievement in Tanzania (Hoogeveen and Rossi 2013); 3) student-teacher ratios in Uganda and Ethiopia (Deininger 2003; Moussa and Omoeva 2020); and 4) teacher quality in Malawi (Moussa and Omoeva 2020).

potentially affected by the reform was larger. Student cohorts were either not exposed, partially exposed, or fully exposed to the reform, depending on years of enrolment in lower secondary school after the announcement of reform plans. We demonstrate that enrolment trends prior to the announcement of reform plans were not significantly correlated with district exposure to the reform.

We show that the fee-free secondary school reform in Tanzania had a substantial impact on progression to secondary school. Between 2014 and 2019, the progression rate increased by an estimated 12 percentage points for the district at the 80th percentile, in terms of district exposure, relative to the district at the 20th percentile.[3] These enrolment effects are robust to controlling for district-specific pre-trends, allowing post-trends to deviate from pre-trends dependent on district exposure, and controlling for potential determinants of the pre-reform differences in progression rates. While the dominant driver of the enrolment effect was progression to public schools, there was also a delayed positive effect on private school enrolment two years after implementation.

The improvements in enrolment, however, came at a cost of learning unrelated to academic abilities of new students. Between 2015 and 2019, exam scores dropped by an estimated 0.10 to 0.15 standard deviation for students in the district at the 80th percentile, in terms of district exposure, relative to students in the district at the 20th percentile. Students induced by the reform to progress performed significantly better in primary school compared to students expected to progress even without the reform. This finding is in line with a theoretical framework, where fee elimination loosens enrolment constrains related to, for example, credit or social norms for a large fraction of new students. Districts more exposed to the reform further experienced an increase in the share of students failing relative to less-exposed districts. The estimated number of students failing due to the reform, however, is substantially lower than the estimated increase in enrolment.

[3] Districts at the 80th and 20th percentiles had pre-reform progression rates of 33 and 70 percent, respectively.

The primary contribution of our paper is to estimate the educational impacts of a nationwide policy to reduce user costs of secondary education. Existing evidence on the impacts of fee-free secondary education tends to rely on randomized control trials (RCTs) or policies targeting specific groups.[4] These studies find positive enrolment effects, but the magnitude appears to be both context-specific and heterogeneous across different groups of children. Moreover, these RCTs and analyses of specific groups do not provide a consistent answer on potential spillover effects to other students when implementing universal fee-free secondary education.

While two other studies evaluate nationwide policies on eliminating or reducing secondary school fees for all students in Uganda and Kenya, respectively (Masuda and Yamauchi 2018; Brudevold-Newman 2019), we are able to utilize more detailed information from individual-level exam scores to examine learning effects. Masuda and Yamauchi (2018) also examine the impacts on enrolment, changes in public-private market structure, and exam scores. Their analysis on exam scores, however, relies on school-level data, thereby preventing them from matching students over time and controlling for pre-secondary school academic abilities. They find that fee elimination led to a surge in secondary school exam takers. Moreover, exam scores remained unharmed, potentially attributed to the public-private partnership scheme implemented simultaneously to comply with increased demand, or, in line with our findings, academically stronger students entering secondary school. Brudevold-Newman (2019) demonstrates that a fee-reduction reform in Kenya increased progression to secondary education, delayed age of first intercourse, first marriage, and first birth, and shifted employment from agriculture to skilled work.

[4] See Khandker, Pitt, and Fuwa (2003) for girls in rural Bangladesh; Barrera-Osorio et al. (2011) for an RCT in Colombia; Baird, McIntosh, and Özler (2011) for an RCT in Malawi with female students; Borkum (2012) and Garlick (2019) for poor communities in South Africa; Gajigo (2016) and Blimpo, Gajigo, and Pugatch (2019) for girls in The Gambia, and Duflo, Dupas, and Kremer (2019) for an RCT in Ghana.

The current paper provides a theoretical framework for studying the impacts of eliminating school fees (Section II), describes the Tanzanian education system and the applied data (Section III), describes the strategy for identifying the impacts of the secondary school fee-free reform on enrolment, changes in public-private market structure, and learning (Section IV), presents the results (Section V), discusses the implications of the results (Section VI), and concludes (Section VII).

II. THEORETICAL FRAMEWORK

This section provides a theoretical framework for schooling and innate ability of students. The framework leans on Lochner and Monge-Naranjo (2011), but further adds a public-private school distinction and a quality of education dimension. A baseline model assumes individuals always enrol in school when the return is higher than working. Next, we add enrolment constraints for some individuals to the model. In a third model, we allow a public school price reduction to affect the quality of public education. Three key results emerge from these models when evaluating a school fee elimination reform. First, total enrolment increases. Second, the impact on average innate ability of students becomes ambiguous when allowing enrolment constraints. Third, the impact on the relative composition of public and private school students becomes ambiguous when including quality effects.

Basic model

The theoretical framework follows a basic two-period model:

$$U = u(c_0) + \delta u(c_1), \tag{1}$$

where individuals receive utility from consumption based on a concave utility function, $u(\cdot)$. A time discount factor is represented by δ. An individual has three options to choose from: 1) enrol in public school in period 0 and get a medium-wage job in period 1; 2) enrol in private school in period 0 and get a high-wage job in period 1; or 3) work in both periods for a low wage normalized to one. The individual gets a high-wage job after private education due to differences in quality of education. The return to education is *not* additively separable, meaning that we assume high-ability individuals have a higher return to quality of education.[5] The individual obtains the following utility from each option:

$$\begin{aligned} U_{pub} &= \delta u(h(a, q_{pub}) - (1+r)P_{pub}) \\ U_{pri} &= \delta u(h(a, q_{pri}) - (1+r)P_{pri}) \\ U_w &= u(1) + \delta u(1) \end{aligned} \tag{2}$$

where $h(a,q)$ is the return to education conditional on student innate ability, a, and quality of education, q. The parameter r refers to the interest rate of borrowing for education, and P is the price of attending public or private school. At specific levels of a, q_{pub}, and P_{pub}, individuals are indifferent between working and attending public education. Likewise, at specific levels of a, q_{pub}, q_{pri}, P_{pub}, and P_{pri}, individuals are indifferent between public and private education. Assuming quality and prices are independent of innate ability (that is, students have the same options), low-ability students work in both periods, medium-ability students enter public education, and high-ability students opt for private education.

[5] For instance, Glewwe, Kremer, and Moulin (2009) demonstrate that providing free text books in Kenya only had a learning impact on high-ability students.

Reducing the price on public education

This subsection analyses the effects on enrolment and innate ability of individuals in school when the price of public education is reduced. We analyse three different models: 1) a baseline model without any enrolment constraints and no quality effects caused by increased enrolment; 2) a model allowing enrolment constraints related to, for example, credit or social norms; and 3) a model allowing for both enrolment constraints and public education quality effects caused by increased enrolment.

A public school price reduction induces both low- and high-ability students to enrol in public school when no one is constrained to enrol and there are no public school quality effects from increased enrolment. Figure 1 illustrates what happens to the public education utility curve when the price is reduced. The cut-off point for choosing public education instead of working declines from b_0^* to b_1^*. Thus, more low-ability individuals enter public education. At the other end of the ability spectrum, the cut-off point for choosing public education instead of private education increases from a_0^* to a_1^*. Thus, also more high-ability students enter public education. The baseline model predicts that total enrolment increases, public school enrolment increases, private school enrolment decreases, average innate ability for all students decreases, the change in average innate ability for public school students is ambiguous, and average innate ability for private school students increases.

When some individuals are constrained by, for example, lack of credit or social norms, the expected implications of a public education price reduction change.[6] Figure 2 illustrates the

[6] The impact of social norms is perhaps most notable in the absence of any user costs of education. If the government provides education for free, households may infer that it is very important, thereby establishing a social norm stipulating that everyone should go to secondary school. Reducing the price to zero may further activate an endowment effect, as households then have to dismiss a right rather than buying a service (Kahneman, Knetsch, and Thaler 1990).

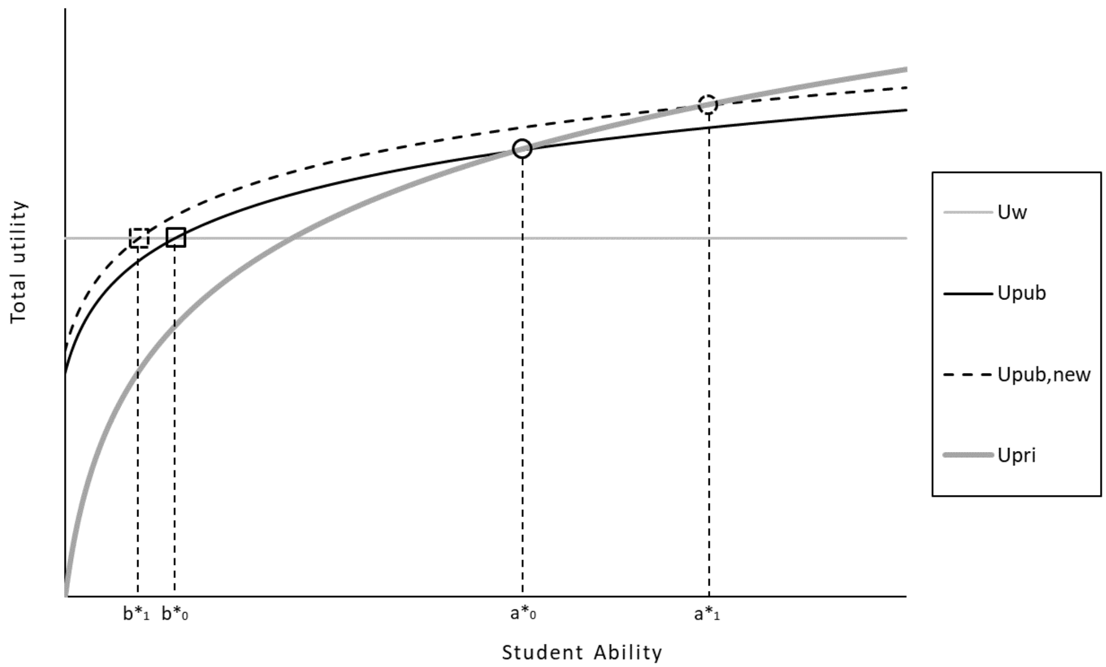

Figure 1: *Baseline model with no enrolment constraints and no quality effects*

Notes: The model assumes no one is constrained to enrol in secondary school and there are no quality effects caused by higher enrolment in public schools. *Uw* represents utility from working in both time periods. *Upub* and *Upub,new* represent utility from enrolling in public school before and after reducing the price on public education, respectively. *Upri* represents utility from enrolling in private school. The solid square and circle represent the ability cut-off points, where individuals are indifferent between working or public education and public education or private education, respectively, before reducing the price on public education. The dashed square and circle represent equivalent ability cut-off points after reducing the price on public education.

implications of reducing the price on public education under the assumption that non-constrained individuals are represented for the entire ability spectrum and constrained individuals are low-ability only.[7] Individuals right above a_0^* and non-constrained individuals between b_0^* and b_1^* change preference to public education. In addition, constrained individuals between $b_0^* + \eta$ and b_1^* enrol in public education, as the new public education utility curve is unlimited for everyone. The effect on average innate ability for individuals in public schools depends on the distribution of constrained

[7] The assumption of constrained individuals being low-ability individuals can be justified by a financial market lending money to high-ability individuals only. In Appendix B, we analyse the model under the assumption that individuals are randomly constrained.

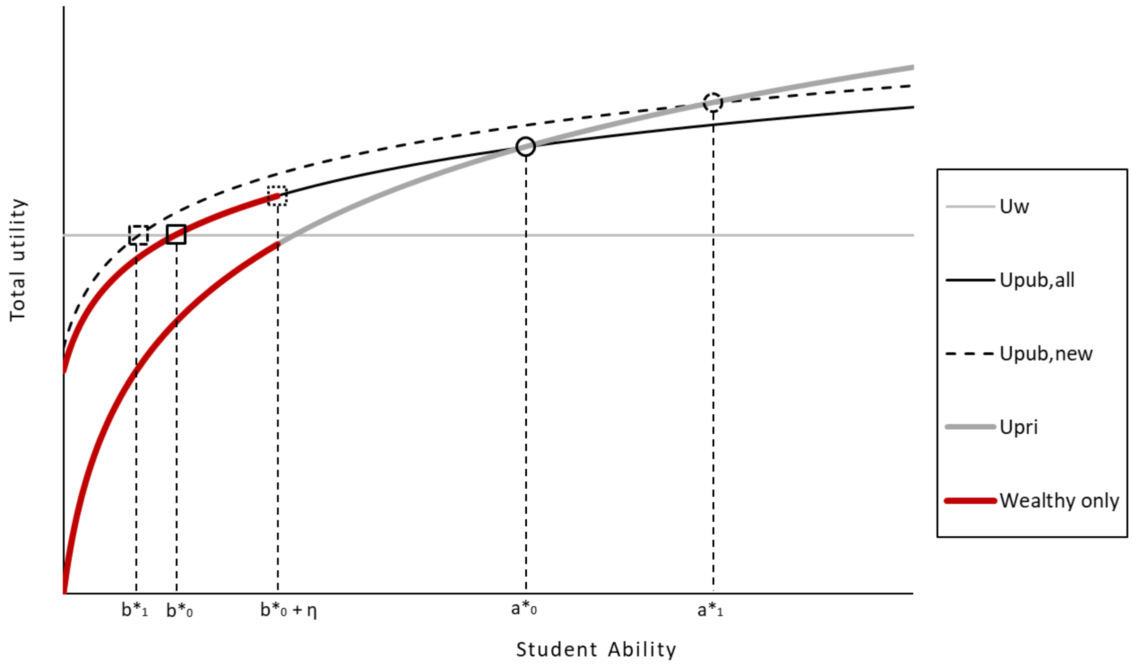

Figure 2: *Enrolment constraints for poor and low-ability individuals*

Notes: The model assumes low-ability individuals can be either non-constrained ("wealthy") or constrained ("poor"), whereas high-ability individuals cannot be constrained, and there are no quality effects caused by higher enrolment in public schools. *Uw* represents utility from working in both time periods. *Upub,all* and *Upub,new* represent utility from enrolling in public school before and after a public education price reduction, respectively. *Upri* represents utility from enrolling in private school. *Wealthy only* represents utility from enrolling in public or private school for non-constrained individuals only. The solid square and circle represent the ability cut-off points, where individuals are indifferent between working or public education and public education or private education, respectively, before reducing the price on public education. The dashed square and circle represent equivalent ability cut-off points after reducing the price on public education. The dotted square represents the ability cut-off point between working and public education for constrained individuals prior to a public school price reduction.

and non-constrained individuals.[8] While the effect on average ability in public schools is ambiguous, average ability for individuals in private schools increases as individuals just above a_0^* enrol in public education.

Relaxing the assumption of no public school quality effects following a price reduction further

[8] Average innate ability in public schools increases when relatively few individuals have an ability level between b_1^* and b_0^*, there is a large number of constrained individuals just below $b_0^* + \eta$, and there are few individuals in school with ability level above $b_0^* + \eta$. The probability of seeing an increase in average ability is higher when assuming individuals are randomly constrained (see Appendix B).

changes the predictions on the composition of public and private school students. Instead of no public school quality effects, we assume the quality of public schools is harmed due to increased enrolment.[9] If there was no change in enrolment for low-ability individuals when reducing the price on public education, the new ability cut-off point for individuals being indifferent between public and private education would lie in between a_0^* and a_1^* in Figure 1. Hence, quality effects act as a moderating factor on enrolment. As more low-ability and initially constrained individuals also enrol in public education, the quality of public education might drop enough to make the highest ability public school students switch to private education. Figure 3 illustrates this case.[10] The only certain prediction from this model is that total enrolment increases. The impacts on the relative composition of public and private school students and the average innate ability of individuals in school are ambiguous.

III. Context and data

Tanzanian education system

The Tanzanian education system consists of seven years of primary education, followed by two years of lower secondary education, and two years of upper secondary education. After four years of secondary education, students can enrol in vocational or technical educations, or they can proceed with two years of advanced secondary education and university education thereafter. The school year follows the Gregorian calendar and the Primary School Leaving Examination (PSLE) and the Form Two National Assessment (FTNA) exams are taken from medio to ultimo November. The

[9] One could also incorporate quality effects to private education. To keep things simple, however, this is not pursued.

[10] Appendix Figure A1 illustrates a case in which the quality of public education is not severely harmed.

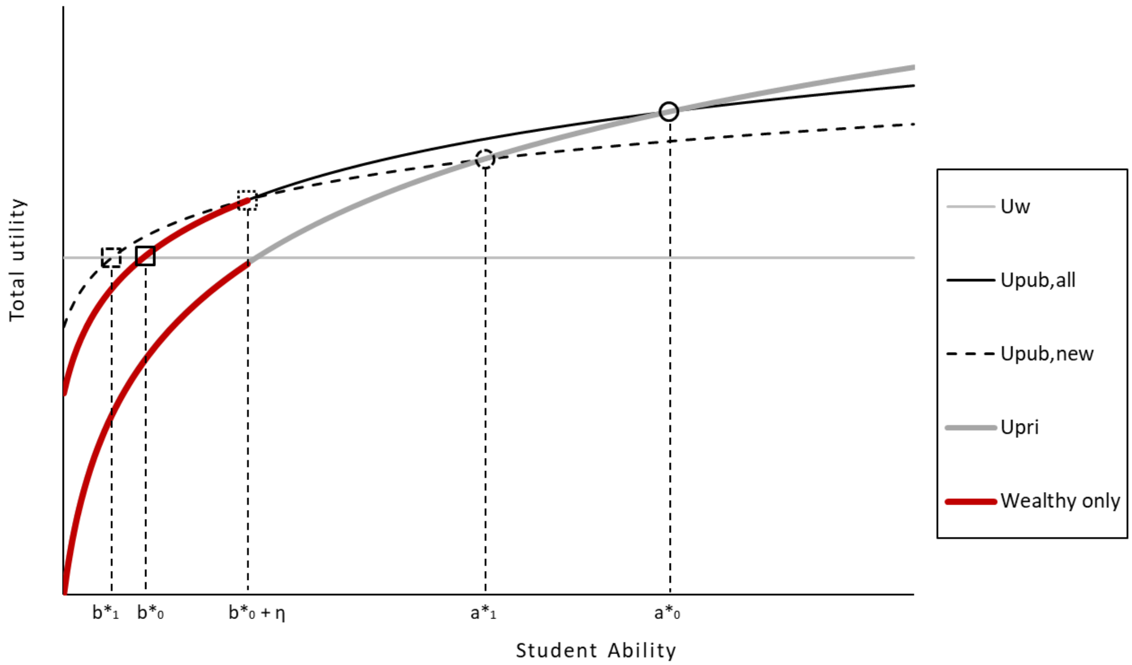

Figure 3: *Enrolment constraints and public education quality effects*

Notes: The model assumes low-ability individuals can be either non-constrained ("wealthy") or constrained ("poor"), whereas high-ability individuals cannot be constrained, and there *are* quality effects caused by higher enrolment in public schools. *Uw* represents utility from working in both time periods. *Upub,all* and *Upub,new* represent utility from enrolling in public school before and after a public education price reduction, respectively. *Upri* represents utility from enrolling in private school. *Wealthy only* represents utility from enrolling in public or private school for non-constrained individuals only. The solid square and circle represent the ability cut-off points, where individuals are indifferent between working or public education and public education or private education, respectively, before reducing the price on public education. The dashed square and circle represent equivalent ability cut-off points after reducing the price on public education. The dotted square represents the ability cut-off point between working and public education for constrained individuals prior to a public school price reduction.

PSLE cannot be retaken and students who fail the PSLE cannot enrol in public secondary education. To gain access to Form 3 in secondary education, students must pass the FTNA. At the PSLE and FTNA, students are tested in five and eight mandatory subjects, respectively. At the FTNA, students may further be tested in elective subjects.

After 14 years of fee-free primary education, the Government of Tanzania announced in February 2015 a new policy plan to make four years of secondary education fee-free. At the time, the fee was

20,000 Tanzanian shillings per student per year.[11] This fee covered costs of operating the school, except staff salaries. During the 2015 presidential election campaign, Dr. John Magufuli, who won the presidency, promised to implement the policy plan if elected. After his election as president, the government implemented the policy in November 2015, taking effect from January 2016. The fees previously paid by students are now paid by the government directly to the bank accounts of schools.[12] Other expenses still paid by students include school uniforms, transport, meals, and writing materials. In anticipation of increased enrolment, the government further raised funding for staff. While the key component of the reform was fee-free secondary education, an additional component included voluntary language of instruction.[13] Except for the subject Kiswahili, exams are still in English.

Relative to countries in the region, a high proportion of Tanzanian children persist until the final grade in primary school and an increasing share of students make the transition to secondary education. In 2017, 92 percent of children in a cohort persisted until the final grade in primary school, which is on a par with Kenya and substantially higher than Rwanda, Burundi, and Uganda. (UNESCO 2020). Before 2016, however, the progression rate to secondary education was low in Tanzania relative to countries in the region. Only 56 percent of students finishing primary education progressed to secondary education in 2012 (UNESCO 2020).[14] After the implementation of the

[11] On January 1 2016, 20,000 Tanzanian shillings had a value of USD 9.2, equivalent to approximately 2 percent of median household consumption per adult equivalent household member.

[12] A qualitative study of secondary schools across Tanzania finds that all visited schools indicated that they received the monthly payment (HakiElimu 2017). A challenge for schools with increasing enrolment, however, is that the payment is based on enrolment in the previous year.

[13] Previously, the official language of instruction was English. Conversations with school principals and researchers in the field, however, suggest many schools were already teaching in Kiswahili.

[14] The high persistence rate until the end of primary education and the low progression rate to secondary education were arguably legacies of Julius K. Nyerere, the first President of Tanzania, who desired a system of equality and practicality (Nyerere 1967).

secondary school fee-free reform in 2016, the progression rate rose substantially. By 2017, the progression rate had reached 71 percent. Compared to neighbouring countries, Tanzania exceeded the rate in Uganda and came close to the rates in Burundi and Rwanda (UNESCO 2020).

Data sources

The empirical analysis relies on student-level exam records at two different levels of study and aggregation. Table 1 provides an overview of the applied sources of data. First, student-level exam records from the PSLE in each year between 2013 and 2017. While individual exam records from the PSLE are not available in 2011 and 2012, district-level records are available. Second, student-level exam records from the FTNA in each year between 2014 and 2019. Moreover, FTNA enrolment numbers for students in Form 2 in 2013 are used to predict the number of students who took the FTNA exams the same year.[15] This information results in district-level information on progression between the PSLE and FTNA for students who took the FTNA exams in 2013 to 2019. As students spend at least two years in secondary school before taking the FTNA exams, a value-added model can only be used for students who took the FTNA exams in 2015 to 2019. The exams are assessed by a centralized group of examiners.[16]

In order to create a panel at the student level, we match FTNA takers with PSLE takers two years before based on the exact and full name of the student. Students with a name duplicate in either the PSLE or the FTNA are excluded (2.0 percent of PSLE students and 1.5 percent of FTNA

[15] District-level dropout rates in Form 2 are calculated using years where both enrolment numbers and number of students who took the FTNA exams are available. Next, enrolment numbers in Form 2 in 2013 are adjusted for the district-level dropout rates to obtain the predicted number of students who took the FTNA exams.

[16] The National Examinations Council of Tanzania (NECTA) administers both exams. The exam documents are always either locked up or guarded by police and NECTA employees. On the day of the exam, appointed invigilators ensure students follow the exam regulations.

Table 1: *Data availability for individual exam records, district averages, and years of exams*

Level of aggregation	Level of study	Exam years applied
Individual exam records	PSLE	2013–2017
	FTNA	2015–2019
District-level exam takers	PSLE	2011–2017
	FTNA	2013–2019

students). Of all FTNA students without a name duplicate, 66.9 percent are uniquely identified in the PSLE records two years before. As a placebo test, matching records based on a one year interval between PSLE and FTNA should result in near to zero matches.[17] As expected, only 1.5 percent of FTNA students are matched with a PSLE record one year before. In total, 1,537,231 FTNA students between 2015 and 2019 are uniquely matched with their PSLE record two years before.

Two additional sources of data employed are the President's Office, Regional Administration and Local Government (PO-RALG 2020), and the Visible Infrared Imaging Radiometer Suite (VIIRS) (Earth Observation Group, NOAA 2020). The former contains information on school ownership, which is used to separate enrolment figures into public and private schools. The latter data source contains night-time radiance (light intensity), which is used as a proxy for economic activity (Henderson, Storeygard, and Weil 2012).[18]

[17] Despite having no name duplicate within one year, a student may have a name duplicate over time. This could lead some of the FTNA students to be matched with a PSLE student the year before.

[18] A monthly panel is created for each 750×750 meters cell and cell-specific trends are estimated. Outlier observations more than three standard deviations from the trend are excluded. Next, district-level averages are calculated for each month. As data is available from April 2012 to April 2019, monthly averages in January to March 2012 are based on the district-level yearly growth rate in the subsequent year and light intensities in January to March 2013. Monthly district-level light intensities for May to December 2019 are predicted in a similar manner. Finally, yearly radiance averages are calculated to fit the panel structure of the empirical models.

Descriptive statistics

Table 2 presents the variables applied and the sample means. As the empirical strategy is split into a district-level analysis and an individual-level analysis, the first seven rows (panel a) are district-level variables used in the analysis of enrolment. The last two variables (panel b) are individual grade point averages (GPAs) at the PSLE and the FTNA used in the analysis of learning. The columns present the sample means for the entire sample, the pre-reform cohort that took the FTNA exams in November 2014, and the most recent cohort that took the FTNA exams in November 2019. Due to changes in administrative boundaries over time and geographical precision of data sources, some districts are merged to ensure they cover the same geographical area over time.[19]

The first four rows of Table 2 show that district-year cells, on average, have a progression rate of 56 percent between the PSLE and the FTNA, which increases over time.[20] The number of PSLE students is lagged two years in order to compare the same cohort. The numbers of FTNA students do not include students who repeat Form 2. We create a measure of reform exposure defined as one minus the progression rate for the cohort that took the FTNA exams in 2014. Figure 4 illustrates the progression rate over time for the four quantiles in terms of reform exposure. After the announcement of the plan to eliminate fees, progression rates kept declining as was the case prior to the announcement. Between 2015 and 2018, however, the progression rates increased substantially, in particular for districts highly exposed to the reform.

While Figure 4 suggests a relative improvement for the districts with the lowest pre-reform

[19] Appendix Table A1 presents the list of districts used for the analysis and how they have been merged.

[20] The applied measure for progression is not the official measure for progression between primary and secondary education. The official measure is the number of new students enrolling in Form 1 in secondary school relative to the number of students in the final grade of primary school one year before. Hence, the applied measure may understate the official measure due to students dropping out before taking the FTNA.

Table 2: *Descriptive statistics*

	Full sample	Cohort 2014	Cohort 2019
Panel (a): district-year cells			
PSLE students (2 year lag)	6,526	6,658	6,999
FTNA students	3,616	3,295	4,466
Progression rate	0.562	0.496	0.641
Reform exposure (1 – pre-reform progression rate)	0.504	0.504	0.504
FTNA fail share	0.102	0.100	0.095
Secondary schools	35.6	34.9	36.9
Night-time radiance	0.304	0.207	0.407
N	910	130	130
Panel (b): individual cells			
PSLE scores	2.26		2.31
FTNA scores	1.37	1.52	1.28
N		See notes	

Notes: Cohort 2014 and Cohort 2019 refer to the cohorts that took the FTNA exams in 2014 and 2019, respectively. The number of observations for *FTNA fail share* in the full sample is 780 as information is not available in 2013. *PSLE students* refers to the number of students who took the PSLE between 2011 and 2017, whereas *FTNA students* refers to the number of students who took the FTNA exams between 2013 and 2019. *Progression rate* refers to the district-level progression rate between the PSLE and the FTNA two years later, and *Reform exposure* is the reciprocal of the progression rate for the cohort that took the FTNA exams in 2014. *FTNA fail share* is the share of FTNA students who failed the exams. *Secondary schools* is the number of schools, and *Night-time radiance* is the average light intensity. *PSLE scores* and *FTNA scores* are average individual scores. In the empirical analysis, they are standardized within each year. Individual PSLE records are only available for the 2015 FTNA cohort and onwards. In the full sample, there are 2,745,810 students with an FTNA exam record, of which 1,538,721 have a matched PSLE exam record. In 2014 and 2019, there are 411,091 and 570,730 students with an FTNA exam record, respectively, and 525,157 students have a matched PSLE exam record in 2019.
Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

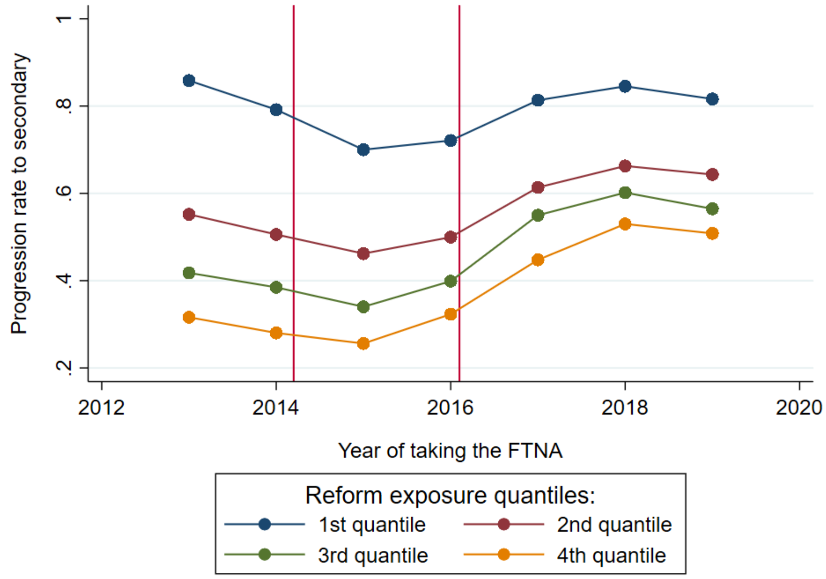

Figure 4: *District-level progression rate over time for different quantiles of reform exposure*

Notes: The y-axis refers to the number of FTNA students in year t (not repeating Form 2) divided by the number of PSLE students two years before. The first quantile contains the districts least exposed to the reform. Red lines represent the time of reform announcement and implementation.

Source: National Examination Council of Tanzania, and authors' calculations.

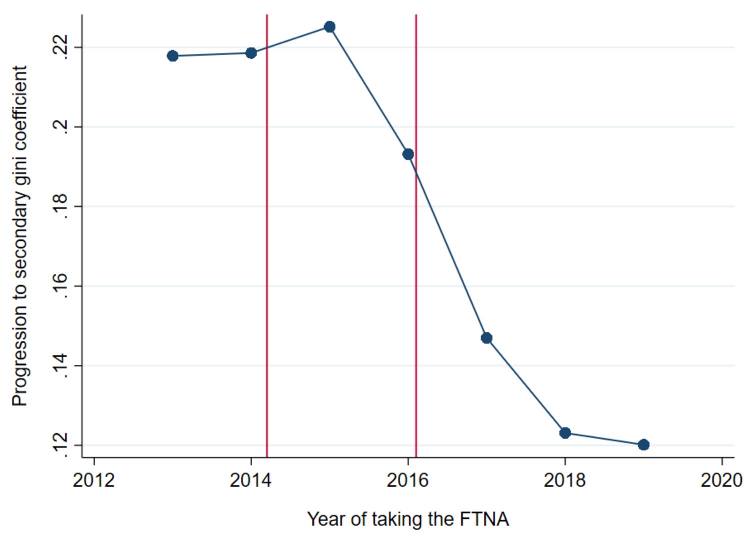

Figure 5: *Gini coefficients for primary to secondary school enrolment*

Notes: The Gini coefficient is the sum of distances between cumulative district percentages of PSLE students and cumulative district percentages of FTNA students divided by the sum of cumulative district percentages of PSLE students. Red lines represent the time of reform announcement and implementation.

Source: National Examination Council of Tanzania, and authors' calculations.

progression rates, the overall impact on educational inequality is clearer in Figure 5. Figure 5 illustrates the yearly Gini coefficients in regard to the number of secondary school students in a district relative to the number of primary school students two years before. Right after the announcement of the reform, the coefficient slightly increased. The reason for this is that there is a general drop in the progression rate between 2014 and 2015. While the drop is less significant in terms of percentage points for highly exposed districts, less-exposed districts take up a larger share of secondary school students in 2015 due to the relative drop being marginally larger in highly exposed districts. After the implementation of the reform in 2016, the Gini coefficient drops substantially and it lowers off four years after the implementation (five years after announcement).

Row five, six, and seven of Table 2 present the means for the share of FTNA students failing, number of secondary schools, and night-time radiance, respectively. The average share of FTNA students failing has remained constant at around 10 percent. While exam difficulty may have changed, it is an interesting observation that there is no sudden increase after the implementation of the fee-free reform. The number of secondary schools and night-time radiance are potentially affecting both pre-reform levels and post-reform enrolment development. We notice that the average number of schools per district has increased by two schools between 2014 and 2019, and the average night-time radiance has doubled. The doubling of night-time radiance happens from 2016 to 2017 and appears to be driven by a general measurement change in the raw satellite data. Supporting this hypothesis is that average radiance increased by 0.23 in 2017 independent of lagged radiance level. In the empirical analyses, cohort fixed effects capture such general measurement changes.

The last two rows report the sample means of the individual GPAs at the PSLE and the FTNA. While PSLE scores of FTNA takers are only available for the cohorts that took the FTNA exams in 2015 and onwards, the development is positive between the 2015 cohort and the 2019 cohort.

On the other hand, FTNA scores have worsened over the sample period. In the empirical analysis, exam scores are standardized to have mean zero and standard deviation one within each year.

IV. Identification strategy

We present two different analyses of the fee-free secondary school reform. The first analysis examines the impact on progression from primary to secondary education at the district level. This includes both the overall impact on progression, and divided by public and private education. The second analysis examines learning, where the outcome variables are secondary school exam scores at the individual level and the number of students failing the FTNA exams at the district level.

Impact on enrolment

The identification strategy follows a difference-in-differences approach, relying on district and cohort variation in exposure to the reform.[21] District variation stems from different pre-reform progression rates. Districts with an initially high progression rate have less potential to benefit from the reform. Cohort variation stems from the timing of the reform, as students who took the FTNA exams in 2013 and 2014 were unaware of impending reform plans. The 2015 FTNA cohort received an 'information treatment' at the beginning of the second year of secondary education, as the policy plans were announced in February 2015. The 2016 FTNA cohort received the same information in the first year of secondary education and further experienced fee-free secondary education in the second year of secondary education. Lastly, the 2017, 2018, and 2019 FTNA cohorts received

[21] Choosing a unit of observation that is too small, migration between areas and spillover effects becomes an identification problem. Choosing a unit that is too high, exposure within the unit of observation might vary substantially and harm precision (Jepsen 2002). Adhering to related literature, we choose the district as the unit of observation.

full fee-free secondary education and they could also take this into account when they applied for secondary education.

We observe each district-cohort group only once. The empirical specification for evaluating the enrolment effect is:

$$\Delta y_{d,t} = \beta_0 + \sum_{t=2014}^{2019} \beta_{t-2013}(E_d * \delta_t) + \delta_t + \alpha X_{d,t} + \varepsilon_{d,t}, \tag{3}$$

where $\Delta y_{d,t}$ is the yearly change in the progression rate from primary to secondary school for district d and FTNA cohort t, δ_t represents cohort fixed effects, E_d is the degree of exposure to the reform for district d, and $X_{d,t}$ includes first differences of the log of secondary schools, contemporary and lagged night-time radiance, and district-specific pre-trends. The beta coefficients measure the impact on enrolment from reform exposure for the different cohorts. The β_1 measures the impact on enrolment for the 2014 FTNA cohort, which is included to test if highly and less-exposed districts were on a similar path prior to the reform. The rest of the beta coefficients are included to analyse the dynamics of the enrolment effect. The analysis on public-private market structure follows the same empirical strategy, except substituting the outcome variable to be changes in the share of students progressing to public secondary schools and the share of students progressing to private secondary schools.

Impact on learning

We change the unit of observation to the individual level when studying the impact of the fee-free reform on exam scores. Standard errors are clustered at the district level, as this is the level of reform exposure. The analysis contains three different models explaining different dimensions of learning.

First, we assume new students that progress due to the reform are similar to the students that would progress without the reform. Hence, the first empirical specification for evaluating learning effects is given by Equation 4:

$$y_{i,d,t} = \beta_0 + \sum_{t=2015}^{2019} \beta_{t-2014}(E_d * \delta_t) + \delta_t + \gamma_d + \alpha X_{d,t} + \varepsilon_{i,d,t}, \tag{4}$$

where $y_{i,d,t}$ represents FTNA exam scores for student i in district d and cohort t, and γ_d represents district fixed effects. We standardize exam scores to have a mean of zero and a standard deviation of one within each year.

Second, we move to a value-added model identical to Equation 4, but further controlling for PSLE scores, as the composition of students might change and thereby violate the assumption of similar students. Before estimating the value-added model, we examine whether highly exposed districts experienced a different development in lagged exam scores (PSLE scores) of their secondary school students after the reform compared to less-exposed districts. One can imagine that the reform induced academically weaker students to progress if their return to secondary education was low and the drop in costs made it profitable to progress. On the other hand, some individuals might have been constrained by, for example, credit or social norms, thereby blocking progression to secondary education. As emphasized in Section II, the impact of a public school price reduction on innate ability of individuals in school is ambiguous.

Third, the unit of observation reverts to the district level and we examine the share of students failing the FTNA exams. We use the coefficient estimates from this model to predict the number of students failing due to the reform for each district. This estimated number of students failing due to the reform is compared to the estimated number of individuals enrolling due to the reform. In the extreme case where all new students are not learning at all, the estimated number of students failing due to the reform is similar to the estimated number of new students. At the other extreme, where new students learn the same as others and the entrance of new students do not affect others, around 10 percent of new students fail. As difficulty of exams might vary over time, the explanatory variables of interest are year dummies interacted with reform exposure. The empirical specification for evaluating failing effects is given by Equation 5:

$$y_{d,t} = \beta_0 + \sum_{t=2015}^{2019} \beta_{t-2014}(E_d * \delta_t) + \delta_t + \gamma_d + \alpha X_{d,t} + \varepsilon_{d,t}, \tag{5}$$

where $y_{d,t}$ is the share of students failing the FTNA exams in district d and cohort t.

The difference-in-differences approach assumes that without any reform exposure, post-reform trends would be the same as pre-reform trends. We examine the sensitivity of the results to this assumption in a robustness analysis, where post-trends are allowed to deviate from pre-trends dependent on reform exposure. The issue is further mitigated by controlling for two likely determinants of differences in pre-reform levels of the outcome variable.

V. Results

Impact on enrolment

Table 3 presents the coefficient estimates from estimating Equation 3 from Section IV. Three different progression rates act as the dependent variable: 1) the overall progression rate for all schools; 2) the public school progression rate; and 3) the private school progression rate. As the public-private school distinction is only available from 2014 and onwards, columns (2) and (3)

Table 3: *Impact of the fee-free reform on yearly changes in district-level progression rates*

	Δ Progression rate (all schools)	Δ Progression rate (to public schools)	Δ Progression rate (to private schools)
Reform exposure × *Cohort*2014	0.048		
	(0.041)		
Reform exposure × *Cohort*2015	0.096***	0.095***	0.008
	(0.023)	(0.019)	(0.011)
Reform exposure × *Cohort*2016	0.075***	0.080***	0.004
	(0.024)	(0.019)	(0.011)
Reform exposure × *Cohort*2017	0.074**	0.059**	0.017**
	(0.029)	(0.026)	(0.008)
Reform exposure × *Cohort*2018	0.026	0.014	0.032**
	(0.036)	(0.031)	(0.016)
Reform exposure × *Cohort*2019	0.013	−0.051*	0.070***
	(0.031)	(0.030)	(0.010)
Cohort FE	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
N	780	650	650
R^2	0.525	0.532	0.266

Notes: Heteroscedasticity-consistent standard errors are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. Additional controls include district-specific pre-trends, first differences of the log of secondary schools, first differences of the log of contemporary night-time radiance, and first differences of the log of one and two year lagged night-time radiance. Appendix Table A2 reports all coefficient estimates. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

do not include a coefficient estimate on the interaction between cohort 2014 and reform exposure. A full table of all coefficient estimates is reported in Appendix Table A2. Appendix Figures A2 and A3 further illustrate the coefficient estimates associated with reform exposure times cohort interaction terms from the first difference model and a district fixed effects model, respectively.

We notice that the impact of reform exposure depends heavily on the cohort. As expected since the 2013 and 2014 cohorts were unaware of impending reform plans, the coefficient estimate associated with reform exposure for the 2014 cohort is insignificant (p-value = 0.24). The 2015 cohort received an 'information treatment', as they were told, with almost one year until the exams, that the government planned to make four years of secondary education fee-free. For this cohort, highly exposed districts experienced an increase in the progression rate relative to less-exposed districts.[22] This result is entirely driven by an increase in the progression rate to public schools. The 2016 cohort received fee-free education in the second year. As expected, highly exposed districts increased the overall progression rate even more in 2016 relative to less-exposed districts. Again, this effect is entirely driven by the progression rate to public schools.

The 2017, 2018, and 2019 cohorts were all fully exposed to the reform, as students were able to take into account the elimination of fees when they applied for secondary education. The overall progression rate increased more in highly exposed districts than in less-exposed districts between the 2016 and 2017 cohorts. While impacts in the first two years with partial exposure were driven entirely by public schools, highly exposed districts in 2017 also experienced an increase in the progression rate to private schools relative to less-exposed districts. As described in the theoretical framework in Section II, this result could be driven by declining quality of public schools. For the 2018 and 2019 cohorts, highly exposed districts did not experience statistically significant changes in the overall progression rate relative to less-exposed districts. In 2019, however, this null effect

[22] Instead of interpreting the coefficient as a zero to one change, one may reasonably scale down the coefficient to an effect of being in the district at the 80th percentile, in terms of reform exposure, relative to being in the district at the 20th percentile. The values of reform exposure for the 80th and 20th percentile districts are 0.67 and 0.30, respectively. Hence, the 80th percentile district is expected to have a $9.6 \times (0.67 - 0.30) = 3.6$ percentage points higher increase in the progression rate compared to the 20th percentile district between the 2014 and 2015 cohorts.

masks two diverse effects on progression rates to public and private schools. The progression rate to public schools declined for highly exposed districts relative to less-exposed districts between the 2018 and 2019 cohorts. At the same time, however, highly exposed districts saw a relative increase in the progression rate to private schools.

In economic terms, these results are substantial. Appendix Figure A3 illustrates the coefficient estimates on the interactions between reform exposure and year of taking the FTNA in a district fixed effects model. The district at the 80th percentile, in terms of reform exposure, is expected to have a 12 percentage points higher increase in the progression rate compared to the 20th percentile district between 2014 and 2019.[23] As pre-reform progression rates for the 20th and 80th percentile districts are 0.70 and 0.33, respectively, a 12 percentage points narrowing of the gap is a considerable change.

The additional controls demonstrate that an increase in the number of secondary schools is positively correlated with an increase in the overall progression rate. This relationship is entirely driven by the progression rate to private schools, suggesting the newly established schools are predominantly privately operated. Only changes in two-year lagged radiance are significantly correlated with changes in the progression rate. This is in line with expectations, as students decide whether to enter secondary education two years before the FTNA. The relationship is negative, suggesting more economic activity at the time of deciding whether to progress to secondary education is negatively correlated with progression. In the theoretical framework, this corresponds to an improvement in the outside option of working in both time periods.

The underlying assumption for the difference-in-differences approach is that post-trends follow

[23] This result is derived by taking the gap in reform exposure between the 80th and 20th percentile districts (0.67 – 0.30) and multiplying it with the difference between the 2019 and 2014 impact of reform exposure (0.38 – 0.06).

pre-trends. We investigate the sensitivity to this assumption by allowing post-trends to deviate from pre-trends dependent on reform exposure. Specifically, we define district-specific post-trends as:

$$\textit{Post-trend}_{d,t} = \textit{Pre-trend}_{d,t} + \theta \times E_d \times (t - 2014), \tag{6}$$

where E_d is the district-specific reform exposure, and θ is a measure of how much larger the post-trends in highly exposed districts should be relative to less-exposed districts. We let $\theta = 0.1$, which corresponds to a considerable increase in the post-trend for highly exposed districts relative to less-exposed districts. Prior to the reform announcement, progression rate pre-trends for districts below and above the median of reform exposure were, on average, -7.1 and -5.3 percentage points per year, respectively. Setting $\theta = 0.1$, however, post-trends for districts below and above the median of reform exposure change to -3.7 and 1.4 percentage points per year, respectively. That is, we allow the expected development in progression rates to be larger for highly exposed districts. Appendix Figure A4 compares the baseline coefficient estimates to coefficient estimates when $\theta = 0.1$. The coefficient estimates remain significantly different from zero at the 5 percent significance level when setting $\theta = 0.1$.[24]

Impact on learning

The previous subsection demonstrated a substantial impact of the fee-free secondary school reform on progression rates between primary and secondary education. In the present subsection, we investigate whether this improvement came at the cost of learning. We study both FTNA exam scores at the individual level and the share of students who failed the FTNA at the district level. The

[24] Setting $\theta = 0.37$ makes all interaction terms insignificant at the 5 percent significance level. This level of θ, however, seems highly unrealistic, and we believe setting $\theta = 0$ is most reasonable.

latter is used to predict the number of students who failed due to the reform and compare this to the expected number of students induced by the reform to progress to secondary education.

FTNA exam scores

Table 4 presents the results from estimating Equation 4 from Section IV. This is done both with and without controlling for PSLE scores, as including this variable excludes the 2014 FTNA cohort and a fraction of students where PSLE records could not be matched. Columns (1), (2), and (3) present the full sample model without controlling for PSLE scores, the partial sample model without controlling for PSLE scores, and the partial sample model controlling for PSLE scores, respectively. In order to compare coefficient estimates between models, the base cohort is 2015 for all models. The table further shows the association between reform exposure and PSLE scores of FTNA students in column (4). A full table of all coefficient estimates is reported in Appendix Table A3.

Columns (1) and (2) demonstrate that highly exposed districts experienced a drop in FTNA exam performance after the implementation of the fee-free reform. Reform exposure did not have a significant correlation with FTNA scores in 2014 relative to 2015. This is in spite of the results in Table 3 showing that the reform had an impact on progression rates already for the 2015 cohort. Between the 2015 and 2016 cohorts, students in highly exposed districts experienced a significant drop in performance relative to their counterparts in less-exposed districts. This effect worsened even more between 2016 and 2018. The magnitudes are slightly smaller when moving to a sample of students where FTNA students are matched with their PSLE records. These students all completed the first two years of secondary education on time and their names were reported in the exact same way at the PSLE and the FTNA. This means the types of students in columns (1) and (2) may deviate and create slightly different results.

Table 4: *Impact of the fee-free reform on individual exam scores*

	FTNA GPA	FTNA GPA	FTNA GPA	PSLE GPA
Reform exposure $\times$ *Cohort*2014	0.081			
	(0.079)			
Reform exposure $\times$ *Cohort*2016	-0.142^{***}	-0.135^{***}	-0.245^{***}	0.191^{***}
	(0.049)	(0.049)	(0.061)	(0.057)
Reform exposure $\times$ *Cohort*2017	-0.291^{***}	-0.249^{***}	-0.442^{***}	0.335^{***}
	(0.064)	(0.060)	(0.087)	(0.083)
Reform exposure $\times$ *Cohort*2018	-0.364^{***}	-0.300^{***}	-0.403^{***}	0.179^{*}
	(0.063)	(0.066)	(0.109)	(0.107)
Reform exposure $\times$ *Cohort*2019	-0.386^{***}	-0.272^{***}	-0.389^{***}	0.203^{*}
	(0.064)	(0.059)	(0.099)	(0.104)
PSLE GPA			0.575^{***}	
			(0.016)	
District and cohort FE	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
N	2,745,748	1,537,231	1,537,231	1,537,231
R^2	0.042	0.048	0.367	0.051

Notes: Standard errors clustered at the district level are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. The base cohort is 2015 in all models. FTNA and PSLE GPAs are standardized within each cohort. Additional controls include log of secondary schools, log of contemporary night-time radiance, and log of one and two year lagged night-time radiance. Appendix Table A3 reports all coefficient estimates. Significance levels: * p<0.1, ** p<0.05, *** p<0.01. Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

While columns (1) and (2) show a negative development in exam scores for students in highly exposed districts, column (3) further demonstrates that this negative effect is not driven by changes in the composition of students in regard to academic abilities. Including the PSLE GPA as a control variable in column (3), the aggravating impacts of the reform magnify. As seen in column (4), this is caused by secondary school students in highly exposed districts improving their average

PSLE performance relative to students in less-exposed districts. These findings are in line with the theoretical framework suggesting that individuals constrained by, for example, credit or social norms could be academically stronger than other students. The magnitude of the results are both statistically and economically significant. The model predicts that students in the district at the 80th percentile, in terms of reform exposure, experienced a 0.10 to 0.15 standard deviation drop in FTNA exam scores between 2015 and 2019 relative to students in the district at the 20th percentile.[25] The lower bound is the impact when we do not account for academic ability of students.

The negative overall effects on FTNA exam scores were driven entirely by public schools, whereas private school exam scores were unharmed (see Appendix Table A4). Between 2015 and 2019, the performance of public school students in highly exposed districts deteriorated progressively compared to public school students in less-exposed districts. Without accounting for PSLE scores, there was no effect of the reform on the FTNA performance of private school students. Accounting for PSLE scores, there was a positive and significant effect on FTNA exam scores in 2018 and 2019 for private school students in highly exposed districts. This suggests that the new students who enrolled in private school due to the reform performed slightly worse in primary school relative to other private school students.

One potential confounding factor in the analysis of exam score performance is the "Big Results Now in Education" program. The program introduced the publication of government school rankings both at the primary and secondary school level. Cilliers, Mbiti, and Zeitlin (2020) show that primary schools at the bottom of their within-district ranking were induced by the reform to improve their average PSLE performance. Our findings could be impacted by this, assuming the result holds for

[25]This is calculated by taking the difference in reform exposure between the 80 percentile and 20th percentile district multiplied by the interaction terms for cohort 2019 in columns (2) and (3) of Table 4.

secondary schools and for national rankings as well. The direction of the bias depends on whether highly exposed districts have academically weaker or stronger students. If students are academically weaker, the publication of school rankings should improve average exam performance, meaning that the negative results in Table 4 are biased upward. The pre-reform correlation between average FTNA performance and reform exposure is significantly negative (p-value = 0.03), suggesting the results in Table 4 are biased upward given the results from Cilliers, Mbiti, and Zeitlin (2020) hold for secondary schools and national rankings.[26] The authors do, however, suggest that their results are driven by within-district rankings and not national rankings.

Share of students failing

Table 5 investigates whether the negative effect on exam scores was large enough to make more students fail the FTNA exams. Specifically, Table 5 presents the results from estimating Equation 5 from Section IV. Columns (1), (2), and (3) examine the impact on the share of students failing for all students, public school students only, and private school students only, respectively. A full table of all coefficient estimates is reported in Appendix Table A5. Highly exposed districts experienced an increased share of students failing already in 2015 relative to less-exposed districts. This effect worsened until 2017, but declined in 2018 and 2019. In line with the results on exam scores, the negative impact on students failing was entirely driven by public schools.

We use the coefficient estimate associated with reform exposure in 2019 from the first column of Table 5 to predict the number of students who failed due to the reform.[27] A similar exercise is

[26] Results are available upon request.

[27] We predict the number of students failing due to the reform by multiplying the coefficient estimate on *Reform exposure* $\times$ *Cohort2019* with the actual reform exposure and number of FTNA students.

Table 5: *Impact of the fee-free reform on students failing*

	Share failing (all schools)	Share failing (public schools)	Share failing (private schools)
Reform exposure × *Cohort*2015	0.117***	0.130***	0.018
	(0.033)	(0.039)	(0.018)
Reform exposure × *Cohort*2016	0.151***	0.174***	0.003
	(0.035)	(0.041)	(0.016)
Reform exposure × *Cohort*2017	0.182***	0.204***	0.008
	(0.036)	(0.043)	(0.018)
Reform exposure × *Cohort*2018	0.150***	0.175***	0.013
	(0.035)	(0.041)	(0.018)
Reform exposure × *Cohort*2019	0.141***	0.174***	0.008
	(0.034)	(0.040)	(0.016)
District and cohort FE	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
N	780	780	718
R^2	0.548	0.526	0.473

Notes: Heteroscedasticity-consistent standard errors are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. The base cohort is 2014 in all models. Additional controls include log of secondary schools, log of contemporary night-time radiance, and log of one and two year lagged night-time radiance. Districts without a private school are excluded in column (3). Appendix Table A5 reports all coefficient estimates. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

performed for student enrolment.[28] Figure 6 plots, for each district, the predicted change in students who failed due to the reform (y-axis) against the predicted change in students who progressed due to the reform (x-axis). These are predicted changes between the 2014 and 2019 cohorts. An expected increase in enrolment is associated with an expected increase in students failing. While

[28]While Table 3 uses first differences, the model used for predicting the number of students enrolling in secondary education due to the reform is based on a district fixed effects model (see Appendix Figure A3).

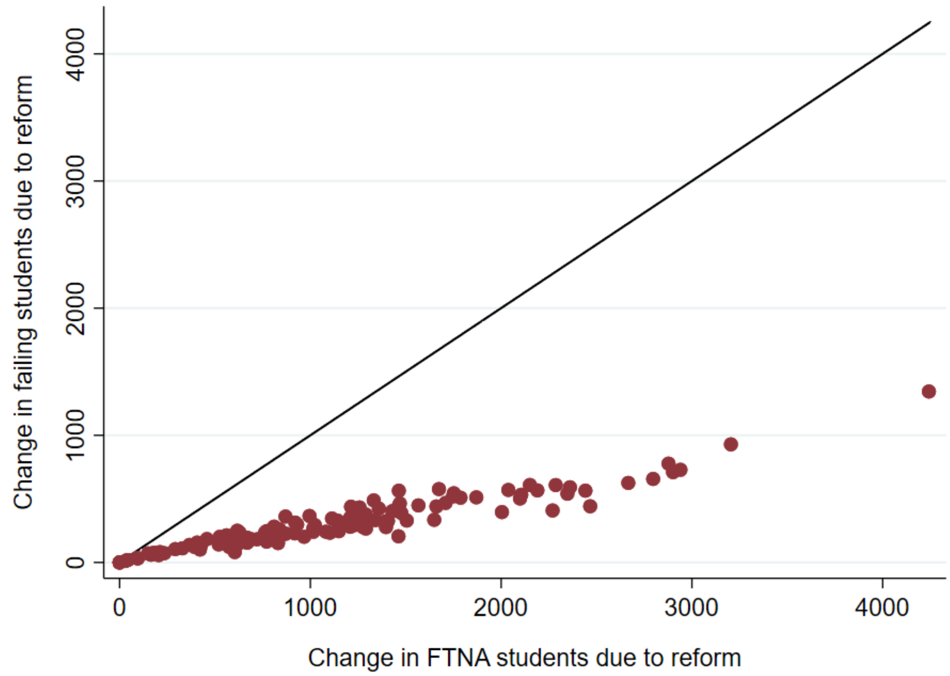

Figure 6: *Predicted changes in enrolment and students failing due to the reform*

Notes: The changes in number of students failing and progressing are based on estimated impacts of the reform between 2014 and 2019. The black line represents the 45 degree line.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

pre-reform failing rates were around 10 percent, the gradient of the scatter plot in Figure 6 is 0.25. This suggests either a larger proportion of the new students failed relative to students who would progress without the reform, or declining quality of public education leading students who would progress without the reform to fail. On the other hand, the figure also reveals that the majority of new students arguably learned something during the two years as the gradient is considerably smaller than one.

VI. Discussion

Secondary school fees remain a substantial barrier to education even when costs are relatively low. Prior to the fee-free secondary school reform, the standard fee for enrolment was 20,000 shillings per year, corresponding to approximately 2 percent of median household consumption per adult. Despite eliminating this relatively small fee, the progression rate to secondary education increased by almost 15 percentage points over a five-year period. During the same period, PSLE scores for secondary school students improved in highly exposed districts relative to less-exposed districts, suggesting academic ability is not driving the decision to progress to secondary education for students at the margin prior to the reform. These developments demonstrate a high price sensitivity for households, potentially magnified by enrolment constraints related to, for example, credit or social norms. Drawing on the theoretical framework, the results are best resembled by the scenario where individuals face enrolment constraints independently of academic ability.

While enrolment surges, the quality of education is at risk. The first sign of worsening quality of public education is the increase in private school enrolment in highly exposed districts relative to less-exposed districts in spite of a wider price gap. Evaluating directly the impact on exam scores, it is clear that highly exposed districts experience a drop in performance relative to less-exposed districts, which is unrelated to students' academic abilities. Two potential explanations for the decline in quality are erosion of the value of the compensation fee received by the school and lack of teachers and classrooms. The compensation fee is fixed at 20,000 shillings per year, implying that inflation gradually erodes its value.[29] Moreover, a large intake of new students challenges schools

[29]The compensation fee is paid directly to schools, rather than indirectly through local governments, to avoid local capture or reallocation of funds (Reinikka and Svensson 2004).

in terms of providing enough classroom space and hiring of new teachers. Despite the number of secondary school teachers rising by a larger magnitude than total enrolment, the allocation of new teachers do not favour highly exposed districts. As the enrolment effect varies significantly between districts, in contrast to hiring of new teachers, a mismatch between supply and demand arises.

The results from Tanzania cannot be used for predicting expected outcomes in other countries without caveats. It is important to keep in mind that Tanzania already had a large proportion of children finishing primary school without progressing to secondary education. The mixture of a high primary school completion rate and a low rate of progression to secondary school served as the basis for a large and immediate enrolment response. The negative impacts on learning are related to the enrolment effect. When enrolment immediately surges, it is challenging for schools to adapt with new classrooms and more teachers, and it puts pressure on the authorities to train new teachers as quickly as possible. The substantial funds allocated to the sector take time to materialize. In the Tanzanian case, new teachers were not allocated disproportionally such that highly exposed districts received relatively more teachers. This could play a significant role in explaining the widening gap in exam score achievement between less-exposed and highly exposed districts.

VII. CONCLUSION

In January 2016, Tanzania implemented a secondary school reform eliminating public school fees. This led to an immediate and substantial enrolment effect, in particular for districts with a low pre-reform progression rate between primary and secondary education (high exposure to the reform). While this effect was driven predominantly by public schools, private schools in highly exposed districts also experienced increased enrolment relative to private schools in less-exposed districts two years after the implementation of the reform. The magnitude of the results suggests that the district at the 80th percentile, in terms of reform exposure, experienced a 12 percentage points increase in the overall progression rate between 2014 and 2019 relative to the district at the 20th percentile. The substantial enrolment effect came at the cost of learning. Between 2015 and 2019, FTNA exam scores dropped by an estimated 0.10 to 0.15 standard deviation for students in the district at the 80th percentile, in terms of reform exposure, relative to students in the district at the 20th percentile. This finding cannot be attributed to the academic abilities of new students. Highly exposed districts further experienced a significant increase in the share of students failing relative to less-exposed districts.

The Tanzanian case of eliminating secondary school fees provides valuable lessons for other countries planning similar reforms. First, even a small price change can have profound implications on secondary school enrolment, in particular when initial progression rates are low. Second, a sudden spike in enrolment challenges the education system. Consequently, policy makers should consider a gradual implementation of eliminating fees to make time for adaptation. This adaptation involves building classrooms where needed and training teachers. Importantly, since areas are affected differently, the allocation of additional resources should also vary.

Looking ahead, the pressure on the public secondary school system is expected to grow in the years to come. The government plans to phase out the PSLE and automatically promote students to lower secondary education in 2021. This policy is projected to increase enrolment in the first four years of secondary education by approximately 370,000 students in 2025 relative to continuing only with fee-free secondary education and no automatic progression (Asim, Chugunov, and Gera 2019). While free secondary education for all children is within reach, the quality component of SDG 4.1 is challenged by the surge in enrolment and geographically disproportional needs for investment.

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APPENDIX A: ADDITIONAL FIGURES AND TABLES

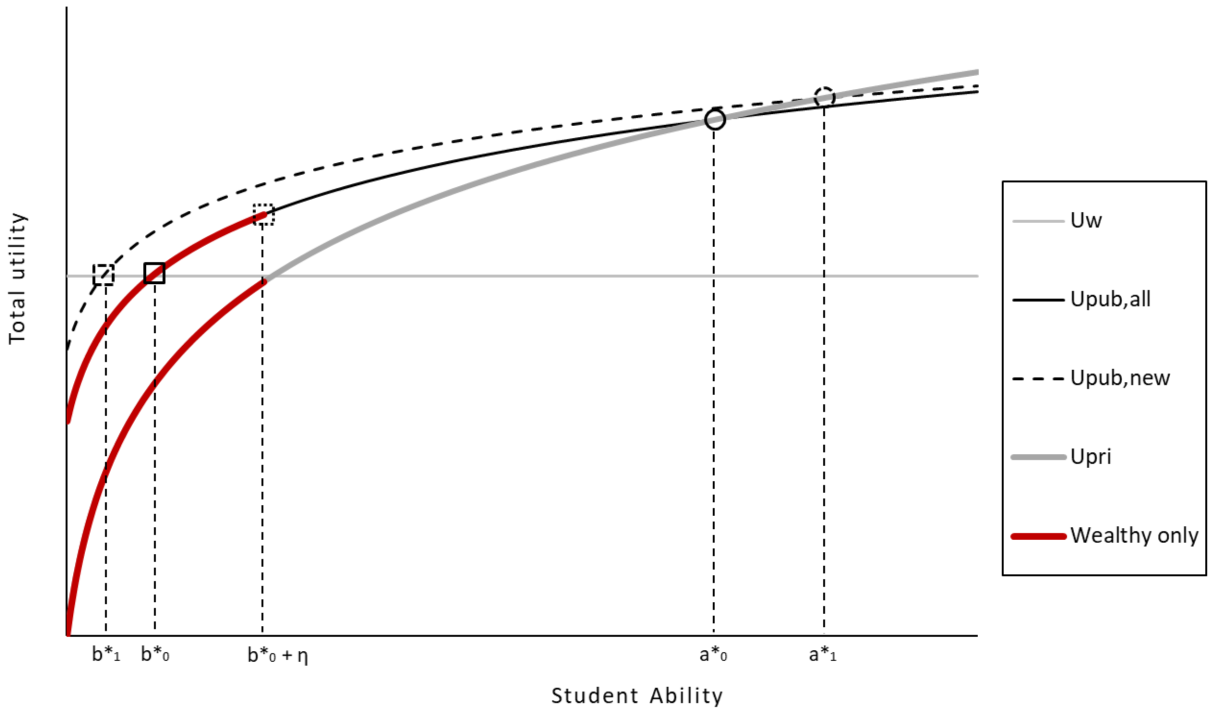

Figure A1: *Enrolment constraints and small public education quality effects*

Notes: The model assumes low-ability individuals can be either non-constrained ("wealthy") or constrained ("poor"), whereas high-ability individuals cannot be constrained, and there *are* quality effects caused by higher enrolment in public schools. *Uw* represents utility from working in both time periods. *Upub,all* and *Upub,new* represent utility from enrolling in public school before and after a public education price reduction, respectively. *Upri* represents utility from enrolling in private school. *Wealthy only* represents utility from enrolling in public or private school for non-constrained individuals only. The solid square and circle represent the ability cut-off points, where individuals are indifferent between working or public education and public education or private education, respectively, before reducing the price on public education. The dashed square and circle represent equivalent ability cut-off points after reducing the price on public education. The dotted square represents the ability cut-off point between working and public education for constrained individuals prior to a public school price reduction.

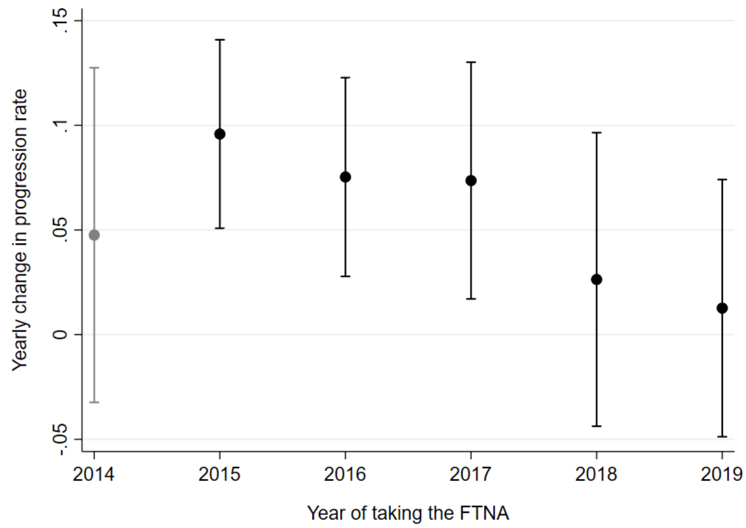

Figure A2: *Impact of the fee-free reform on yearly changes in district-level progression rates*

Notes: The yearly estimates are the interaction terms from Table 3. The confidence intervals are with a significance level of 5 percent. The 2014 cohort was not exposed to the reform.
Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

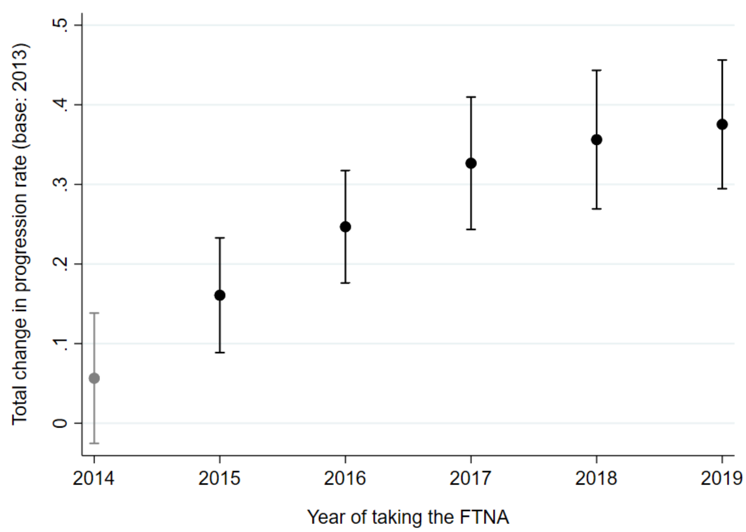

Figure A3: *Impact of the fee-free reform on district-level progression rates since 2013*

The yearly estimates are the interaction terms from estimating Equation 3 with absolute values instead of first differences and further controlling for district fixed effects. The confidence intervals are with a significance level of 5 percent. The 2014 cohort was not exposed to the reform.
Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

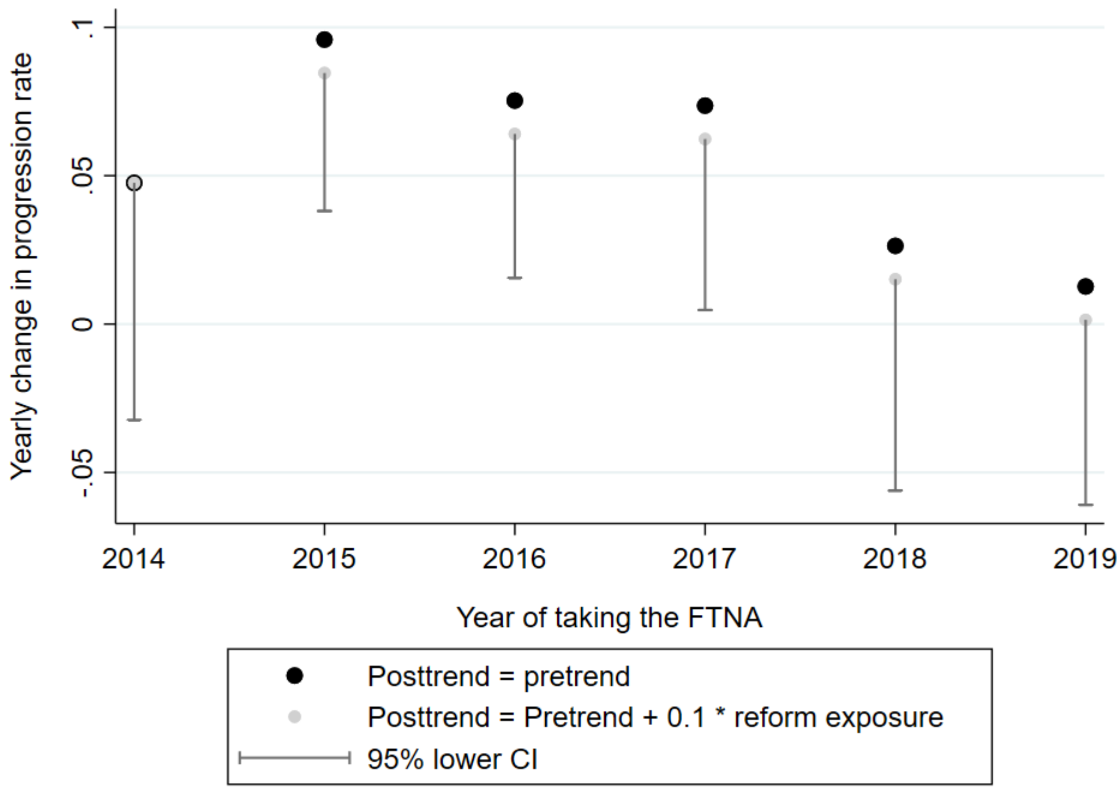

Figure A4: *Yearly impact of the fee-free reform with higher post-trends for highly exposed districts*

Notes: The yearly estimates are the interaction terms from estimating Equation 3, but letting highly exposed districts have a higher post-reform trend than less-exposed districts. Specifically, the post-trend is defined as $Post\text{-}trend_{d,t} = Pre\text{-}trend_{d,t} + 0.1 \times E_d \times (t - 2014)$. The confidence intervals are with a significance level of 5 percent. The 2014 cohort was not exposed to the reform.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

Table A1: *Districts merged together for the empirical analysis (page 1 of 5)*

District number	District name 1	District name 2	District name 3	District name 4
1	Arusha Rural			
2	Arusha Urban			
3	Babati Urban			
4	Babati Rural			
5	Bagamoyo	Chalinze		
6	Bahi			
7	Bariadi	Itilima		
8	Biharamulo			
9	Bukoba Urban			
10	Bukoba Rural			
11	Bukombe	Mbogwe		
12	Bunda			
13	Chamwino			
14	Chato			
15	Chunya	Songwe		
16	Dodoma			
17	Geita	Nyang'hwale		
18	Hai			
19	Hanang			
20	Handeni Urban	Handeni Rural		
21	Igunga			
22	Ilala			
23	Ileje			
24	Iramba	Mkalama		
25	Iringa Urban			
26	Iringa Rural			
27	Kahama TC	Msalala	Ushetu	
28	Karagwe	Kyerwa		

Districts merged together for the empirical analysis (page 2 of 5)

District number	District name 1	District name 2	District name 3	District name 4
29	Karatu			
30	Kasulu Urban	Kasulu Rural	Buhigwe	
31	Kibaha Rural			
32	Kibaha Urban			
33	Kibondo	Kakonko		
34	Kigoma Urban			
35	Kigoma Rural	Uvinza		
36	Kilindi			
37	Kilolo			
38	Kilombero	Ifakara		
39	Kilosa	Gairo		
40	Kilwa			
41	Kinondoni	Ubungo		
42	Kisarawe			
43	Kishapu			
44	Kiteto			
45	Kondoa	Chemba		
46	Kongwa			
47	Korogwe Rural			
48	Korogwe Urban			
49	Kwimba			
50	Kyela			
51	Lindi Urban			
52	Lindi Rural			
53	Liwale			
54	Longido			
55	Ludewa			
56	Lushoto	Bumbuli		

Districts merged together for the empirical analysis (page 3 of 5)

District number	District name 1	District name 2	District name 3	District name 4
57	Mafia			
58	Magu	Busega		
59	Makete			
60	Manyoni	Itigi		
61	Masasi Urban	Masasi Rural		
62	Maswa			
63	Mbarali			
64	Mbeya Urban			
65	Mbeya Rural			
66	Mbinga	Nyasa		
67	Mbozi	Momba	Tunduma	
68	Mbulu			
69	Meatu			
70	Meru			
71	Missenyi			
72	Misungwi			
73	Mpanda Urban			
74	Mkinga			
75	Mkuranga			
76	Monduli			
77	Morogoro Urban			
78	Morogoro Rural			
79	Moshi Urban			
80	Moshi Rural			
81	Mpanda Rural	Mlele	Nsimbo	Mpimbwe
82	Mpwapwa			
83	Mtwara Urban	Mtwara Rural	Nanyamba	
84	Mufindi	Mafinga		

Districts merged together for the empirical analysis (page 4 of 5)

District number	District name 1	District name 2	District name 3	District name 4
85	Muheza			
86	Muleba			
87	Musoma Urban			
88	Musoma Rural	Butiama		
89	Mvomero			
90	Mwanga			
91	Nyamagana	Ilemela	Mwanza	
92	Nachingwea			
93	Namtumbo			
94	Nanyumbu			
95	Newala			
96	Ngara			
97	Ngorongoro			
98	Njombe Rural	Makambako	Wanging'ombe	
99	Njombe Urban			
100	Nkasi			
101	Nzega			
102	Pangani			
103	Rombo			
104	Rorya			
105	Ruangwa			
106	Rufiji	Kibiti		
107	Rungwe	Busokelo		
108	Same			
109	Sengerema	Buchosa		
110	Serengeti			
111	Shinyanga Urban			
112	Shinyanga Rural			

Districts merged together for the empirical analysis (page 5 of 5)

District number	District name 1	District name 2	District name 3	District name 4
113	Siha			
114	Sikonge			
115	Simanjiro			
116	Singida Urban			
117	Singida Rural	Ikungi		
118	Songea Urban			
119	Songea Rural	Madaba		
120	Sumbawanga Urban			
121	Sumbawanga Rural	Kalambo		
122	Tabora	Uyui		
123	Tandahimba			
124	Tanga			
125	Tarime			
126	Temeke	Kigamboni		
127	Tunduru			
128	Ukerewe			
129	Ulanga	Malinyi		
130	Urambo	Kaliua		

Table A2: *Impact of the fee-free reform on yearly changes in district-level progression rates*

	Δ Progression rate (all schools)	Δ Progression rate (to public schools)	Δ Progression rate (to private schools)
Reform exposure × *Cohort*2014	0.048		
	(0.041)		
Reform exposure × *Cohort*2015	0.096***	0.095***	0.008
	(0.023)	(0.019)	(0.011)
Reform exposure × *Cohort*2016	0.075***	0.080***	0.004
	(0.024)	(0.019)	(0.011)
Reform exposure × *Cohort*2017	0.074**	0.059**	0.017**
	(0.029)	(0.026)	(0.008)
Reform exposure × *Cohort*2018	0.026	0.014	0.032**
	(0.036)	(0.031)	(0.016)
Reform exposure × *Cohort*2019	0.013	−0.051*	0.070***
	(0.031)	(0.030)	(0.010)
Cohort2015	0.006		
	(0.027)		
Cohort2016	0.096***	0.089***	0.005
	(0.026)	(0.013)	(0.010)
Cohort2017	0.193***	0.202***	−0.017**
	(0.028)	(0.016)	(0.008)
Cohort2018	0.115***	0.147***	−0.025**
	(0.028)	(0.020)	(0.011)
Cohort2019	0.101***	0.127***	−0.035***
	(0.030)	(0.018)	(0.009)
Δ*District pre-trend*	0.113***	−0.053*	−0.008
	(0.035)	(0.029)	(0.009)
Δ*Secondary schools (log)*	0.144*	−0.027	0.134***
	(0.075)	(0.091)	(0.042)
Δ*Radiance (contemporary, log)*	−0.056	−0.112	0.065*
	(0.082)	(0.079)	(0.036)
Δ*Radiance (1-year lag, log)*	−0.001	−0.089	−0.001
	(0.104)	(0.100)	(0.040)
Δ*Radiance (2-year lag, log)*	−0.258***	−0.151*	−0.079**
	(0.094)	(0.079)	(0.039)
Constant	−0.085***	−0.091***	−0.004
	(0.024)	(0.012)	(0.007)
N	780	650	650
R^2	0.525	0.532	0.266

Notes: Heteroscedasticity-consistent standard errors are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

Table A3: *Impact of the fee-free reform on individual exam scores*

	FTNA GPA	FTNA GPA	FTNA GPA	PSLE GPA
Reform exposure × *Cohort*2014	0.081			
	(0.079)			
Reform exposure × *Cohort*2016	−0.142***	−0.135***	−0.245***	0.191***
	(0.049)	(0.049)	(0.061)	(0.057)
Reform exposure × *Cohort*2017	−0.291***	−0.249***	−0.442***	0.335***
	(0.064)	(0.060)	(0.087)	(0.083)
Reform exposure × *Cohort*2018	−0.364***	−0.300***	−0.403***	0.179*
	(0.063)	(0.066)	(0.109)	(0.107)
Reform exposure × *Cohort*2019	−0.386***	−0.272***	−0.389***	0.203*
	(0.064)	(0.059)	(0.099)	(0.104)
PSLE GPA			0.575***	
			(0.016)	
Cohort2014	−0.044			
	(0.041)			
Cohort2016	0.049**	0.066**	0.119***	−0.091***
	(0.024)	(0.026)	(0.027)	(0.024)
Cohort2017	0.183***	0.200***	0.288***	−0.152***
	(0.034)	(0.028)	(0.042)	(0.043)
Cohort2018	0.185***	0.139***	0.202***	−0.110*
	(0.044)	(0.036)	(0.054)	(0.059)
Cohort2019	0.240***	0.210***	0.277***	−0.116
	(0.045)	(0.042)	(0.065)	(0.072)
Secondary schools (log)	0.908***	0.159	−0.053	0.370
	(0.236)	(0.205)	(0.363)	(0.372)
Radiance (contemporary, log)	−0.329**	−0.281***	−0.281*	0.000
	(0.140)	(0.104)	(0.149)	(0.152)
Radiance (1-year lag, log)	0.082	0.403**	0.300	0.179
	(0.156)	(0.189)	(0.274)	(0.239)
Radiance (2-year lag, log)	−0.345*	−0.508***	−0.474*	−0.059
	(0.184)	(0.163)	(0.245)	(0.191)
Constant	−3.242***	−0.518	0.301	−1.423
	(0.880)	(0.761)	(1.350)	(1.384)
District FE	Yes	Yes	Yes	Yes
N	2,745,748	1,537,231	1,537,231	1,537,231
R^2	0.042	0.048	0.367	0.051

Notes: Standard errors clustered at the district level are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. The base cohort is 2015 in all models. FTNA and PSLE GPAs are standardized within each cohort. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

Table A4: *Impact of the fee-free reform on individual exam scores (public-private distinction)*

	FTNA GPA	FTNA GPA	FTNA GPA	FTNA GPA
Reform exposure $\times$ *Cohort*2014	0.135		−0.032	
	(0.087)		(0.114)	
Reform exposure $\times$ *Cohort*2016	−0.153***	−0.229***	0.052	0.037
	(0.044)	(0.057)	(0.064)	(0.074)
Reform exposure $\times$ *Cohort*2017	−0.320***	−0.427***	0.029	0.014
	(0.062)	(0.082)	(0.063)	(0.078)
Reform exposure $\times$ *Cohort*2018	−0.417***	−0.430***	0.057	0.157**
	(0.063)	(0.111)	(0.077)	(0.079)
Reform exposure $\times$ *Cohort*2019	−0.453***	−0.407***	0.015	0.146**
	(0.063)	(0.100)	(0.086)	(0.065)
PSLE GPA		0.496***		0.557***
		(0.017)		(0.015)
Cohort2014	−0.074		0.132***	
	(0.046)		(0.047)	
Cohort2016	0.068***	0.104***	0.003	0.116***
	(0.022)	(0.026)	(0.024)	(0.026)
Cohort2017	0.243***	0.288***	0.137***	0.237***
	(0.031)	(0.038)	(0.038)	(0.035)
Cohort2018	0.277***	0.216***	0.170***	0.079*
	(0.044)	(0.055)	(0.056)	(0.041)
Cohort2019	0.358***	0.272***	0.381***	0.227***
	(0.047)	(0.066)	(0.066)	(0.051)
Secondary schools (log)	0.583***	−0.218	0.872**	0.428
	(0.218)	(0.368)	(0.371)	(0.325)
Radiance (contemporary, log)	−0.404**	−0.314**	0.102	−0.076
	(0.160)	(0.149)	(0.214)	(0.146)
Radiance (1-year lag, log)	0.090	0.373	0.034	0.059
	(0.155)	(0.280)	(0.213)	(0.185)
Radiance (2-year lag, log)	−0.364*	−0.415	−0.381	−0.327
	(0.196)	(0.269)	(0.275)	(0.203)
Constant	−2.212***	0.785	−2.455*	−0.789
	(0.807)	(1.357)	(1.440)	(1.282)
District FE	Yes	Yes	Yes	Yes
Sample (public/private school students)	Public	Public	Private	Private
N	2,304,422	1,388,767	440,985	148,354
R^2	0.0391	0.300	0.109	0.538

Notes: Standard errors clustered at the district level are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. The base cohort is 2015 in all models. FTNA and PSLE GPAs are standardized within each cohort. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

Table A5: *Impact of the fee-free reform on students failing*

	Share failing (all schools)	Share failing (public schools)	Share failing (private schools)
Reform exposure $\times$ *Cohort*2015	0.117***	0.130***	0.018
	(0.033)	(0.039)	(0.018)
Reform exposure $\times$ *Cohort*2016	0.151***	0.174***	0.003
	(0.035)	(0.041)	(0.016)
Reform exposure $\times$ *Cohort*2017	0.182***	0.204***	0.008
	(0.036)	(0.043)	(0.018)
Reform exposure $\times$ *Cohort*2018	0.150***	0.175***	0.013
	(0.035)	(0.041)	(0.018)
Reform exposure $\times$ *Cohort*2019	0.141***	0.174***	0.008
	(0.034)	(0.040)	(0.016)
Cohort2015	−0.054***	−0.064***	−0.001
	(0.018)	(0.023)	(0.008)
Cohort2016	−0.073***	−0.088***	0.000
	(0.019)	(0.024)	(0.007)
Cohort2017	−0.093***	−0.115***	−0.010
	(0.021)	(0.026)	(0.008)
Cohort2018	−0.082***	−0.109***	−0.002
	(0.024)	(0.030)	(0.010)
Cohort2019	−0.088***	−0.116***	−0.015
	(0.026)	(0.032)	(0.010)
Secondary schools (log)	−0.217***	−0.212***	−0.006
	(0.063)	(0.069)	(0.036)
Radiance (contemporary, log)	0.132*	0.178**	0.004
	(0.069)	(0.081)	(0.028)
Radiance (1-year lag, log)	−0.039	−0.043	−0.032
	(0.094)	(0.107)	(0.045)
Radiance (2-year lag, log)	0.062	0.045	0.049
	(0.081)	(0.094)	(0.044)
Constant	0.820***	0.817***	0.034
	(0.212)	(0.235)	(0.123)
District FE	Yes	Yes	Yes
N	780	780	718
R^2	0.548	0.526	0.473

Notes: Heteroscedasticity-consistent standard errors are in parentheses. Cohorts 2014 to 2019 refer to the cohorts that took the FTNA exams in 2014 to 2019, respectively. The base cohort is 2014 in all models. Districts without a private school are excluded in Column (3). Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: National Examination Council of Tanzania, Earth Observation Group, NOAA (2020), and authors' calculations.

Appendix B: Constrained individuals independent of ability

Section II assumes low-ability poor individuals face enrolment constraints, whereas high-ability poor individuals do not. In this robustness section, we assume instead that poor individuals are randomly constrained. It is further assumed that there are no effects on quality of public education when reducing the price. Changing the assumption on quality effects has the same implications as in the baseline case where only low-ability poor individuals are constrained.

Total enrolment and enrolment in public education increase following a price reduction on public education. As net return to public education increases, some individuals change preference from private to public education. Consequently, enrolment in private education decreases. While the effect on average ability in public education is still ambiguous, the relative intake of new low- and high-ability individuals changes. That is, more of the new public school students are high-ability individuals compared to the second model in Section II. Some of the new public school students even prefer private education, but only the constraint on public education is alleviated and these high-ability individuals therefore enrol in public education.

Figure B1 is similar to Figure 2 with the exception that poor individuals are randomly constrained. This can be seen as the thick red lines (*Wealthy only*) only represent wealthy individuals. Hence, even poor individuals with a high ability level can face enrolment constraints. For instance, at four different ability levels above a_0^*, poor students are constrained. They prefer to attend private education, but they have to work in both periods due to enrolment constraints. When reducing the price on public education, constraints on public education are mitigated. The high-ability students enrol in public schools because the enrolment constraints on private education remain.

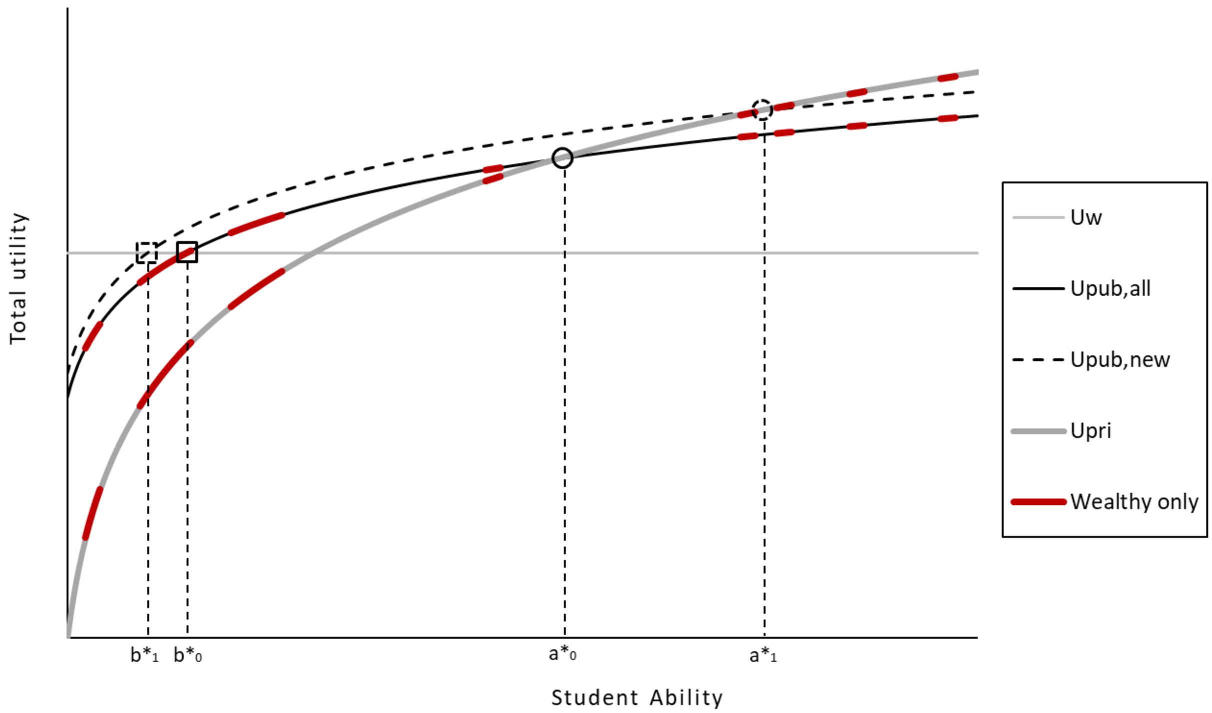

Figure B1: *Enrolment constraints randomly distributed among poor individuals*

Notes: The model assumes individuals are randomly constrained and there are no quality effects caused by higher enrolment in public schools. *Uw* represents utility from working in both time periods. *Upub,all* and *Upub,new* represent utility from enrolling in public school before and after a public education price reduction, respectively. *Upri* represents utility from enrolling in private school. *Wealthy only* represents utility from enrolling in public or private school for non-constrained individuals only. The solid square and circle represent the ability cut-off points, where individuals are indifferent between working or public education and public education or private education, respectively, before reducing the price on public education. The dashed square and circle represent equivalent ability cut-off points after reducing the price on public education.