Secondary school access raises primary school achievement

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Abstract

I study how the introduction of Free Secondary Education (FSE) affected primary students in Tanzania. I first confirm FSE increased secondary access: secondary enrollments rose, household spending on secondary school fees plummeted, and elites' transition premium disappeared. Then, using variation in treatment exposure from fee payment microdata, I show that FSE increased primary exam pass rates by 6% and secondary transition rates by 23%. This was not due to supply inputs: there was no effect on school entry, and class sizes rose. Instead it appears to be driven by demand-side investments: primary students selected into better schools, attended more, and worked less.

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1 Introduction

Can large-scale expansions of school access crowd in human capital investments by individuals? Complementarities between supply-side educational inputs have been shown to be important (Mbiti et al., 2019; Kerwin & Thornton, 2021). But the scholarly debates over supply- vs. demand-side constraints on education in the developing world have largely overlooked how these might interact (Glewwe & Muralidharan, 2016; Banerjee & Duflo, 2012).[1] Free school access is among the most fundamental supply-side inputs governments can provide, and understanding the demand response to it is a first-order question with important implications for the policy debate over free secondary education in poor countries (Crawfurd & Ali, 2022; Garlick, 2019).

Measuring these complementarities is challenging for a number of reasons. At-scale expansions in school access are rare, and by definition affect everyone, making it difficult to identify a counterfactual. RCT studies of the effect of scholarships provide evidence that access can raise individual student achievement (Kremer et al., 2009). However, general equilibrium and implementation concerns make the scalability of such effects an open question (Crawfurd & Ali, 2022; Bold et al., 2018). Furthermore, decomposing any aggregate effect into supply- and demand-side channels is complicated by the fact that student outcomes combine the effect of the intervention with demand-side adaptation (Das et al., 2013).

This paper overcomes these obstacles by studying how Tanzania's introduction of Free Secondary Education (FSE) affected the human capital investments and achievement of primary school students. By focusing on the anticipatory response among primary school students, I am able to isolate the demand-side investment responses to an expansion of (future) access — as distinct from the direct supply-side effect FSE may have had on secondary-age students. Tanzania abolished fees for public lower secondary school in 2016 (public primary schooling has been free since 2002). Transition into secondary school, however, still requires that students pass the Primary School Leaving Examination (PSLE). Both of these policy decisions make Tanzania typical in the context of global expansions in school access: about half of sub-Saharan African countries have made lower secondary free, but two-thirds of African countries still have an exam requirement (Gruijters et al., 2024; Bashir et al., 2018).

The analysis uses the universe of administrative data on high-stakes exams from mainland Tanzania for primary and secondary school. The Primary School Leaving Examination (PSLE) is taken in Grade 7; passing it is a requirement for enrolling in a public secondary school (both before and after the reform). This is my main measure of primary student achievement. The Form Two National Assessment (FTNA),

[1] An important exception is Eble & Escueta (2023), who study complementarities between school quality and parents' aspirations.

taken in Grade 9, is the first standardized test of secondary school; sitting this exam provides a proxy for secondary enrollment. A pass is necessary to advance to grade 10. In the pre-reform period, Grade 9 exam results could be withheld (and grade progression halted) for failure to pay fees. I also use household survey data from the Tanzania National Panel Survey to measure household educational investments.

I first show that the FSE policy succeeded in increasing access to secondary school. This is not trivial: Tanzania's government, like many in the region, has made various commitments to universalize primary and secondary education which ultimately failed (Opalo, 2022; Crawfurd & Ali, 2022). I present three pieces of evidence that the 2016 policy succeeded. Figure 2 shows that household spending on secondary students' school fees fell sharply after the reform. Figure 3 shows that secondary enrollments began to rise after the policy's implementation, especially in places where school fees were binding for more families *ex-ante*. Figure 4 shows that elites' advantage in secondary transition disappeared after school fees were abolished (where elites are those who share a last name with a local political candidate).

To measure the causal effect of FSE on primary school attainment, I compare outcomes before vs. after the reform for primary school students from families who were more vs. less constrained by school fees *ex ante*. This strategy shares an intuition with prior studies of universal schooling, which typically exploit broad geographic variation in "treatment exposure" as proxied by regional dropout rates (Lucas & Mbiti, 2012; Brudevold-Newman, 2021). My measure of treatment exposure is more granular and more directly indicative of fee constraints, coming from student-level microdata on secondary school fee payments prior to FSE's implementation. Families with a pre-FSE secondary student who stopped paying school fees are defined as fee-constrained — i.e., "treated" by the FSE policy. The comparison group consists of families with a pre-FSE secondary school student who did not stop paying fees. Before FSE, treated families' primary students were 6 percentage points less likely to transition to secondary school (conditional on test scores), a gap which did not vary significantly in the years prior to the reform. I compare how the difference in performance between treated and non-treated primary students changed after the reform.

My main result is that secondary school access raised the pass rate for the Grade 7 primary school leaving examination, as well as the transition rate to secondary school. After the reform, primary students from fee-constrained families began to catch up to comparison students in both outcome measures. By the third year of the reform, the pass rate gap had almost completely disappeared (Figure 6). The reform raised pass rates for treated students by 6% (a 3.3 percentage point increase from a base of 56%). It also increased the transition rate by 23% (a 4.0 percentage point increase from a base of 17%). These findings are robust to changing the set of fixed effects, the procedure for identifying families, and the definition of treatment (using older sibling's dropout as an alternative measure) — see Section B for more details.

Turning to mechanisms, I show evidence that these effects are the result of increased demand-side investments rather than supply-side inputs. Administrative exam data show that the reform reduced absence rates and increased selection into better schools, two direct measures of demand-side investment. FSE also altered the distribution of Grade 7 test scores in a way that indicates a reallocation of student effort to maximize the probability of passing: effects were concentrated around the passing threshold, and the likelihood of getting high scores in easy subjects fell as the likelihood of getting passing scores in difficult subjects increased. Data from household surveys shows that the policy increased primary students' school attendance and reduced their participation in child labor.

I rule out the possibility that effects were driven by supply-side inputs or the manipulation of test scores. Because my estimates rely on within-school family-level variation in fee constraints, I can discount explanations involving inputs at the school level. Using variation in the prevalence of fee constraints across wards to study supply-side investments at a less granular level, I confirm the family-level results on test scores but find no evidence that the policy led to school entry or reduced class sizes (to the contrary, primary enrollments rose sharply). FSE also appears to have raised scores on the low-stakes Grade 4 exam, suggesting that learning effects were not the result merely of exam score manipulation.

This paper's main contribution is to the literature on the interaction between supply- and demand-side educational investments. Many studies find that households treat supply-side inputs as substitutes for their own investments (Houtenville & Conway, 2008; Pop-Eleches & Urquiola, 2013; Greaves et al., 2023; Fredriksson et al., 2016; Das et al., 2013). However, these studies consider only contexts where school access is taken as a given, mostly in the developed world: none examine an input as fundamental as access to school.[2] Andrabi et al. (2024) show that investments in public school quality spill over into the private sector due to competitive pressure, implying a supply-demand complementarity. The RCT literature on NGO-provided scholarships in the developing world is germane, as scholarships can considered individual-level fee abolition. Yi et al. (2015) finds no effect on test scores of unconditional junior-high scholarships in China. Duflo et al. (2021) show that secondary-school scholarships raised secondary educational attainment in Ghana, where secondary entry is subject to an exam requirement. Kremer et al. (2009) randomize the provision of merit scholarships to secondary school among 127 primary schools, showing that the scholarships raised test scores. This study is most relevant to mine, as it examines the primary-to-secondary transition in a context where access is conditional on performance. My study builds

[2] In Tanzania, Burke & Beegle (2004) document a negative correlation between primary enrollment and distance to a secondary school, consistent with supply-demand complementarities.

on this literature by showing evidence of these complementarities for a national-scale expansion of public school access.

I also contribute to the literature on anticipatory human capital investments. Dynamic considerations are central in human capital theory (Becker, 1964; Ben-Porath, 1967). One strand of the empirical literature on these dynamics measures anticipatory demand-side responses to environmental changes, such as reduced maternal mortality or increased labor market returns to education (Jayachandran & Lleras-Muney, 2009; Khanna, 2020; Jensen, 2012; Oster & Steinberg, 2013; Jensen, 2010; Moeeni & Tanaka, 2023). When considering changes to future school access in particular, there are many reasons investments might respond, including option value (Stange, 2012), continuation value (Heckman et al., 2018), dynamic complementarities (Foster & Gehrke, 2017), and cumulative returns (Fabregas & Navarro-Sola, 2024). Anticipatory effects of college access have been studied among secondary students, yielding positive estimates in the US and Colombia (Akhtari et al., 2024; Cortes & Zhang, 2011; Golightly, 2019; Laajaj et al., 2022) but null or negative effects in Brazil and Chile (Estevan et al., 2019; Tincani et al., 2023). My study shows that positive anticipatory effects can exist even for primary age children.[3]

Finally, this paper informs the active policy debate over the provision of free secondary schooling in developing countries. Free primary education is nearly universal, but 32% of African children live in countries which require fees for attending public secondary school (vs. 5% in the rest of the world).[4] FSE is expensive, and opponents sometimes argue that it constitutes a regressive transfer to the relatively wealthy who are more likely to send their children to secondary school (Doe-Glah, 2017; O'Malley, 2015).[5] Another worry is that overcrowding could reduce quality (Bold et al., 2015; Garlick, 2019). This concern is not unfounded in Tanzania: where Free Primary Education (FPE) increased pupil-teacher ratios, reduced teacher quality, and reduced test scores in urban areas (Valente, 2019).[6] In general, the FPE expansions of recent decades have not yielded large learning gains.[7] As such, some argue that raising primary quality (or pre-primary access) should precede secondary access (Glewwe & Kremer, 2006; Pritchett & Beatty, 2015; Attanasio et al., 2020; Heckman, 2006). However, existing studies of FSE expansions find evidence of increased enrollment (Borkum, 2012), test scores (Blimpo et al., 2019), labor market outcomes (Brudevold-

[3] A related literature shows that construction of higher education institutions affects primary enrollment and attendance in India, though part of the effect comes through crowding in supply of primary schools (Mukhopadhyay & Sahoo, 2016; Jagnani & Khanna, 2020).

[4] WORLD Policy Analysis Center (2024); World Bank (2022); figures based on population under 20. This number refers to *de jure* free secondary education; in practice, even many countries with nominally free secondary education still charge fees.

[5] Some commentators make the argument that FSE will reduce long-run GDP per capita through children's foregone wages (Fujimoto et al., 2023).

[6] Brandt & Mkenda (2020) argue that FSE in Tanzania also reduced test scores.

[7] See e.g. Kremer et al. (2013); Bold et al. (2017); Pritchett (2013); Kadzamira & Rose (2003); Al-Samarrai & Zaman (2007); Deininger (2003); Lucas & Mbiti (2012).

Newman, 2021), and even educational attainment in the next generation (Agüero & Ramachandran, 2020). Supporters of FSE argue that expanding secondary access should be a priority, in part because it is politically feasible and has been shown to be technically implementable at scale (Crawfurd, 2024). My paper shows that cost-benefit analyses of these programs must also consider the crowding-in of demand-side investments which raise performance among primary students (complementing Ferreira & Sandholtz (2024)'s evidence that FSE can help equalize investments across children within households).

Section 2 and 3 of this paper present the background and data for the study. Section 4 presents evidence that FSE increased secondary school access. Section 5 outlines the strategy for identifying the effect of FSE on primary student outcomes and presents results. Section 6 explores mechanisms, and Section 7 concludes.

2 Context

The context of Tanzania's Free Secondary Education (FSE) reform is one in which primary enrollment is high, but secondary enrollment lags behind significantly. Primary net enrollment in Tanzania was 81% as of 2018 (World Bank, 2021). This is partly due to the fact that public primary schools have been fee-free since 2001 (Valente, 2019). Public schools are overwhelmingly dominant, accounting for 97% of primary enrollment.[8] Primary schooling in Tanzania begins officially at age seven, and consists of seven years (Standards 1-7). Most students start primary school on time: in the (pre-reform) 2014-15 wave of the nationally representative National Panel Survey, 76% of students said they had started school at or before age 7 (see Figure A.1a). At the end of Standard 7 — around age 13 for students who remain on-track — students sit the Primary School Leaving Examination (PSLE). This is a national standardized test, and passing it is a requirement for being admitted to a public secondary school (private secondary schools are not bound to require a passing grade on the PSLE, but many do so, especially the most selective). Nearly all students who make it through primary school sit the PSLE: in the 2014-15 NPS, 97% of respondents who finished standard 7 also sat the exam.

Participation in secondary school is much less common: as of 2018, secondary net enrollment stood at 26% (World Bank, 2021). Lower secondary school consists of 4 years (Forms 1-4), with upper secondary constituting an additional two years (Forms 5-6). Tanzania's 2016 FSE policy made public schooling fee free only through Form 4, the end of lower secondary. The private sector is more important at the

[8] As proxied by the number of grade 7 students sitting the PSLE in public vs. private schools.

secondary level than in primary, though still small, accounting for 13% of enrollment.[9] The first national exam of secondary school comes at the end of Form 2 (grade 9), when students sit the Form Two National Assessment (FTNA). This exam is high-stakes: it must be passed in order to progress to Form 3 (grade 10). The academic year for both primary and lower secondary schools begins in January, with exams administered at the end of the school year: the PSLE in September, the FTNA in November.

Prior to the FSE reform, official school fees for government secondary schools were about 20,000 Tanzanian shillings (TZS) per pupil per year (about $25 USD PPP).[10] But other compulsory contributions — for services such as building maintenance and security, and supplies such as desks and exams — could rise to the order 300,000 TZS ($372 USD PPP) – over 15% of GDP per capita in 2015 ($2294 USD PPP) (Taylor, 2016; World Bank, 2021).[11] For many households, this would have been a significant expenditure, especially in light of research on the difficulty of saving and the importance of household financial constraints on educational investments in Tanzania (Sandholtz, Carroll, et al., 2024; Burchardi et al., 2024). These fees likely played a role in the wide disparity between net enrollments rates in primary and secondary school.

However, returns to secondary education in Tanzania appear to be high. As of 2015, those who had finished secondary school were 32 percentage points more likely to report having been an employee for most of the last year, and 12 percentage points more likely to report earning a wage. Among wage earners, median wages for those who had barely finished secondary school (11 years of schooling) were $65 USD PPP, compared to an average of $11 USD PPP for those who had not finished secondary school (see Figure A.1b).[12] Montenegro & Patrinos (2014) estimate the Mincer returns to each year of secondary education in Tanzania at 15%, as of 2011. Perhaps unsurprisingly then, universal primary education in Tanzania has been said to have increased demand for secondary education (Opalo, 2022).

2.1 The policy: Free Secondary Education (FSE)

In December of 2015 – after that year's final exams, and one month before the start of the 2016 school year – newly-elected president John Magufuli announced that all basic education through the fourth year of secondary school would be free, effective immediately. Notably, the announcement stipulated that all fees, official and unofficial, were to be covered, and school attendance was intended to be truly fee-free at the point of sale. As officially articulated in government Circular No. 5, the program forbade

[9] As proxied by the number of grade 9 students sitting the FTNA in public vs. private schools.

[10] Using World Bank's LCU per international $ PPP conversion factor of 806.45 for Tanzania in 2015 – World Bank (2022).

[11] See Habyarimana et al. (2020) on how Tanzania's government paid for public goods including education by requiring contributions from local resident users.

[12] Figures from the nationally representative Tanzania National Panel Survey 2014-2015; $N = 2498$.

schools from soliciting fees or contributions from students or parents, declaring that "provision of free education means pupils or students will not pay any fee or other contributions that were being provided by parents or guardians before the release of new circular" (United Republic of Tanzania, 2015). In his speech announcing the policy, Magufuli emphasized the comprehensive nature of the fee abolition, underscoring his commitment with a note of menace toward would-be fraudsters:

> When I say free education, I indeed mean free . . . The funds for providing free education are being set aside, already we have TSh 131bn. We have planned to transfer these funds directly to all the relevant schools, with copies sent to the Regional and District Commissioners, and to the council Director. This is why we say they will study for free. All the money for capitation grants, money for chalk, money for examinations, money for everything, we are sending it. We will send it each month starting this December. Money for food. I am certain that those being sent the money will use it well, I warn them not to use it badly. (Taylor, 2016)

To help pay for the policy, the education budget was increased by 22%, from 3.9 trillion to 4.77 trillion TZS – an increase of 870 billion TZS ($\approx$ \$1.1 billion USD PPP) (Twaweza East Africa, 2016b). Some of these funds appear to have been used to increase the disbursement of capitation grants — officially set at 10,000 TZS for primary students and 25,000 TZS for secondary students — which had been required by law since 2004 but rarely fully delivered in practice (Shukia, 2020; James, 2023; Ministry of Education, Science and Technology, Tanzania, 2004).

Despite the rhetoric, it was not obvious that the program would increase school access: Crawfurd & Ali (2022) find that declarations of fee-free education, while common, have little impact unless accompanied by money to replace the foregone revenue. Even if the policy did raise access, a subsequent worry was that the program would lead to overcrowding in schools. Indeed, various studies find evidence that the government's investments did not keep up with the large influx in students (Brandt & Mkenda, 2020; Lazaro & Matiku, 2022). At the same time FSE was increasing demand for secondary schools, the government decided to expel foreigners working without proper permits, including thousands of teachers from neighboring Kenya, further exacerbating worries of a supply crunch (The Economist, 2016).

But the available evidence is that the program was seen favorably by ordinary Tanzanians. In a nationally representative phone survey conducted by the NGO Twaweza from December 2015 to January 2016, 88% of the 1,894 respondents said it was "likely" that the promise of free education would be implemented on the announced date; 76% reported that they expected fee-free education to improve quality by improving the teaching environment (Twaweza East Africa, 2016a). A few months later, in August 2016, 50%

of 1,806 respondents reported that the quality of education had "become better" since becoming fee-free, with 35% saying it had stayed the same and only 15% saying it had become worse (Twaweza East Africa, 2016b).

3 Data

My primary analyses draw on administrative test score data from the National Examinations Council of Tanzania (NECTA). I also use these data to construct measures of secondary school transition, family relationships, and sensitivity to school fees. For supplementary analyses I use data on household education expenditures from the Tanzania National Panel Survey; aggregate enrollments from the President's Office, Regional Administration and Local Government Tanzania (PO-RALG); and local election results from the national gazette.

3.1 Exam data

I rely on the universe of high-stakes exam scores from mainland Tanzania. The agency responsible for administering these examinations is the National Examinations Council of Tanzania (NECTA).[13] None of these exams are graded by students' own teachers. Instead, all exam papers nationwide are gathered to a central location to be graded, rendering remote the possibility of systematic manipulation in grading.[14]

I focus primarily on two of these exams: the Primary School Leaving Examination (PSLE), the last exam of primary school (grade 7); and the Form Two National Assessment (FTNA), the first exam of secondary school (grade 9).

Grade 7: Primary school leaving examination (PSLE)

NECTA's website describes the PSLE as "a selection test which enables the government to select form one entrants for its schools," and specifies that any pupil who has completed Standard 7, whether in a government or a private school, may sit the exam.

The PSLE consists of five sections: Mathematics, Science, English, Kiswahili, and Social Studies.[15] Each section has a maximum score of 50 marks, with letter grades corresponding to A, B, C, D, and E

[13] Zanzibar's examinations data are administered separately.
[14] Decisions about individual investments in primary schooling may be taken by some combination of students and their parents or guardians. For the purposes of this paper, I abstract away from the question of who is responsible for demand-side investments.
[15] Figure D.1 shows some example questions from the English and Math portions of the PSLE.

corresponding to minimum marks of 40, 30, 20, 10, and 0 respectively. The overall PSLE score is the sum of marks earned on each of the five sections, yielding a maximum overall score is 250. The passing threshold is 100 marks overall (40%).

NECTA reports students' letter grade on each subject of the exam, as well as the letter grade corresponding to their overall marks. This provides a precise measure of which students passed the exam: those who achieved at least a "C" as their overall grade. However, it provides only a noisy measure of scores, both overall and for each subject. To convert these coarse categories into estimated scores, I let each grade correspond to the midpoint of its range. I.e., as students are assigned "As" for scores between 80% and 100%, I code an "A" as 90%, and a "C" as 50%, etc. I then create a continuous measure of students' "combined score" by adding together these proxy scores for each of their five subjects scores, then divide by five to express the score as a percentage. Section C provides evidence that this yields a good proxy for true overall scores: among a subset of students for whom precise overall scores are available, the correlation is 0.98. In the period from 2013-2019, between 867,000 and 958,000 pupils sat the PSLE each year.

Families

I group primary students into "families" – unique combinations of last name $\times$ ward.[16] Naming conventions in Tanzania make this a reasonable way to identify likely family members: children carry their father's last name, so siblings tend to share a last name. Wards (Swahili: *kata*) are small: they are the third administrative unit of Tanzania, there are over 3600 of them, and the median ward has around 200 PSLE takers per year in the period I study. These family groupings of primary students have an average size of 2.72. In contemporaneous, nationally representative data from the Tanzania National Panel Survey, the average household contains 2.5 children. Tanzania's Total Fertility Rate in 2000-2006 — the years in which 13-year-old takers of the 2013-2019 PSLE would have been born — hovered around 5.6, so large families should not be considered especially surprising (World Bank, 2021). As a robustness analysis testing the sensitivity of the main analysis to the possible presence of false positive family matches, Table B.2 limits attention to grade 7 students whose last name is unique within their ward $\times$ cohort, and yields similar results to the main analysis.

[16]See Cruz et al. (2017) for another example of family grouping based on names.

Grade 9: Form two national assessment (FTNA)

The Form Two National Assessment (FTNA) is the first major test students take in secondary school. It is taken at the end of a student's second year of lower secondary school (grade 9). It is also high-stakes: a pass is required to continue on to the third year of secondary school. Students typically sit the exam for 9 subjects, though some sit more. As with the PSLE, NECTA data provides only letter grades for each subject, but the overall aggregate score in points is available, as well as a precise measure of passing. The number of students sitting the FTNA varied between 448,000 (2014) and 652,000 (2021).

Transition to secondary school

A key quantity of interest is the transition rate – the fraction of students who make the transition from primary school to secondary school. NECTA does not report direct measures of secondary transition at the individual level, so I use a student's participation in the FTNA exam as a proxy. In the period I study, NECTA did not assign unique student identifiers which allowed linking students across tests, so instead I link students using their names. Of the 6 million primary school pupils who sat the PSLE from 2013 to 2019, 98% have a name (typically "first middle last") which uniquely identifies them within their cohort nationwide. 98% of FTNA takers also have unique names. I match the names of PSLE students in a given cohort to the names of FTNA takers from two years later (the same cohort of students, assuming normal grade progression). This measure likely undercounts the true number of transitioners for at least three reasons: 1) it misses pupils who skip ahead or fall behind the normal grade progression schedule; 2) it misses pupils who transition to secondary school but drop out sometime in the first two years before taking the FTNA; and 3) it misses pupils whose name is recorded differently between PSLE and FTNA, including misspellings. Section C provides more details on the construction of this measure, and suggests that dropouts and misspellings account for a greater source of measurement error than delayed grade progression. 70% of (uniquely-named) FTNA takers in this period have a name which matches precisely to the name of a PSLE taker from 2 years earlier.[17]

Payment of secondary school fees

For the cohort of FTNA takers from 2014, available data show which students had their results withheld for failing to pay exam fees. Because exam payments and school fee payments are typically made at the

[17] See also Blackmon (2017) and Sandholtz, Gibson, & Crawfurd (2024), which use a similar same string matching procedure in order to measure school value-added, and Ferreira & Sandholtz (2024), who do so to measure intra-household allocations of human capital investments.

same time, a failure to pay exam fees implies a likely failure to pay school fees as well. These exam results were later made available for most students, implying that they paid their fees eventually. But the initial failure to pay functions as a measure of sensitivity to school fees which is useful in identifying the families most directly affected by FSE's fee abolition. This measure does not capture all the ways in which families could be financially constrained by school fees. Many families would have struggled to pay but nevertheless scraped together the funds on time; many other families would likely have never been able to pay to send a student to secondary school in the first place. However, this measure does identify families for whom secondary school fees are a *binding* constraint: they had overcome all the other obstacles to enrolling a child in secondary school, but their ability to keep up with the fees was marginal.

Grade 9 students who fail to pay school fees do not appear to be worse students than their on-time-paying peers. In fact, their pass rates for the 2014 FTNA were about 4pp higher than those who paid the fee on time (whether or not ward fixed effects are included). This suggests that fee non-payment is not driven by parents strategically cutting their investments in unpromising students, but rather by financial constraints *per se*.

Descriptive patterns of primary school performance suggest that this measure of fee constraints identifies families where primary school investments tend to be lower. In the two years prior to FSE, primary students from fee-constrained families scored .18 standard deviations lower on the PSLE, and were 8.4 percentage points less likely to pass. They were also 9.8 percentage points less likely to transition to secondary school.

Linking primary students to the family-level measure of fee constraints

As my interest is in primary student outcomes, it is necessary to link them to this family-level measure of fee constraints. I define "families" among 2014 grade 9 students in the same way I did for grade students: unique combinations of last name $\times$ ward. I limit attention to families with a clear treatment definition – that is, families in which *all* grade 9 students either did or did not pay their exam fees. This describes 92% of the students, 63% of whom have a unique last name in their ward$\times$cohort. I then match up these grade 9 families with their grade 7 counterparts. Although 2013 is the earliest year for which grade 7 data are available, I focus on the years from 2014 onward to avoid potential endogeneity between primary student outcomes in 2013 and the fee constraint measure defined using secondary student data from 2014. The result of this exercise is a set of 2014-2019 grade 7 students who share a last name with a 2014 grade 9 exam taker in the same ward, and therefore can be defined as belonging to a fee-constrained family or not.

This set of over a million grade 7 students makes up 21% of all grade 7 students, and constitutes the main analysis sample for identifying the causal effect of secondary access on primary outcomes (see Section 5).

Grade 11: Certificate of Secondary Education Examination (CSEE)

At the end of Form 4 (grade 11) — the last year of lower secondary education — students sit the Certificate of Secondary Education Examination (CSEE), similar to the "O-level" in the traditional British system. This determines eligibility for upper secondary school. Students who continue through the sixth year of secondary school (i.e., the second year of upper secondary) take the Advanced Certificate of Secondary Education Examination (ACSEE) — similar to the "A-level" — which determines eligibility for college. Unlike the PSLE and FTNA exams, NECTA's CSEE and ACSEE data do not report student names, making it impossible to link them to earlier exams. I use CSEE data only to proxy for 11th grade enrollments in an analysis aggregated to the ward level.

Elites

Finally, I create a measure of which grade 7 students are more likely to be relatives of local political candidates. I label these "elites:" as they are likelier than average citizens to wield local political power, as well as to be relatively wealthy given the costs required by running for office (Babeiya, 2011). I draw on ward-level election results for local council members (*diwani*) from the 2015 election, published in the national gazette (*Gazeti la Serikali la Tanzania*, 2016). I match the last names of Grade 7 exam takers to the last names of candidates in the same ward; those students which share a last name with a candidate in their ward I designate as "elites." Of the 2,987 wards with mappable electoral results, 1,906 (64%) contain at least one PSLE taker with the same last name as at least one ward council election candidate.

Summary statistics

Table 1 displays summary statistics on NECTA data for primary students. Column 1 summarizes variables for the full universe of grade 7 PSLE takers 2014-2019. Column 2 summarizes variables for the main analysis sample: grade 7 PSLE takers in years 2014-2019, whose school can be located in a ward, and who share a last name with a 2014 grade 9 FTNA taker in the same ward.

Although the family fee constraints treatment variable is not defined for *all* grade 7 students, those who are classifiable look very similar to the overall. PSLE pass rates are around 70% on average, with transition rates close to 50%. There is significant variation in exam performance by subject: students tend to score lower on English and Math, while scoring significantly higher on Science and especially Swahili.

3.2 Geography

Many of the measures in the foregoing section rely on locating students within wards. I accomplish this by matching school identifiers in the NECTA data to coordinates of school locations provided by the President's Office, Regional Administration and Local Government Tanzania (PO-RALG). I then locate these school coordinates within wards using GIS shapefiles available from the United Nations Office for the Coordination of Humanitarian Affairs (United Nations Office for the Coordination of Humanitarian Affairs, 2018). 98.8% of grade 7 students and 99.8% of grade 9 students are able to mapped to a ward in this way; the small fraction of other students, whose school identifiers did not match any school in the PO-RALG list, were dropped from the analysis.

Figure 1 presents a map of these wards. Orange-shaded wards contained at least one grade 9 exam taker who failed to pay fees on time in 2014; in green-shaded wards all students paid their fees on time. Gray-shaded wards contained no secondary schools in 2014 on which to base this measure. While my main analyses rely on variation in fee constraints at the individual level, some supplementary analyses will employ this ward-based measure of the prevalence of fee constraints.

3.3 Household survey data

I supplement the administrative data above with household survey data from the Tanzania National Panel Survey / Living Standards Measurement Survey (World Bank, 2014–2020). This survey is nationally representative, and includes (at the time of writing) five waves stretching from 2008 to 2021. The first three waves were a panel; waves 4 and 5 were a panel from a new "refreshed" nationally representative sample. I use the survey as a repeated cross-section. To match as closely as possible the period for which I have administrative data, I focus on Waves 3, 4, and 5, which were conducted in 2012-13, 2014-15, and 2020-21, respectively. There are 11,420 respondents in primary school in the dataset across these three waves. Of these, about 20% live in thatched-roof houses, a common proxy for household poverty.

The NPS includes a number of questions relevant for assessing households' investments in primary education. These include measures of the child's enrollment, attendance, attainment, and labor market participation; test taking and score received; time spent studying; and money spent on education.

Table 1: Summary stats: Grade 7 exam takers

	All	Analysis Sample
School cohort size	83.708	83.985
	(69.952)	(71.034)
Female	0.529	0.534
	(0.499)	(0.499)
Public school	0.966	0.969
	(0.182)	(0.173)
Elite (shares last name with local political candidate)	0.006	0.012
	(0.078)	(0.111)
Pass exam	0.708	0.723
	(0.455)	(0.447)
Sec. transition (sat Grade 9 exam 2 yrs later)	0.483	0.510
	(0.500)	(0.500)
Overall exam score (%)	47.835	48.049
	(17.118)	(16.467)
English subject score (%)	41.070	41.262
	(20.648)	(20.088)
Math subject score (%)	44.105	43.981
	(22.249)	(21.647)
Social studies subject score (%)	47.601	47.828
	(18.393)	(17.866)
Science subject score (%)	49.654	50.023
	(18.864)	(18.270)
Swahili subject score (%)	56.744	57.150
	(20.982)	(20.390)
Full name unique in nationwide cohort	0.979	0.957
	(0.144)	(0.202)
Family fee payment status available	0.208	1.000
	(0.406)	(0.000)
Family failed to pay sec. school fees ('treated')		0.105
		(0.307)
N	5,200,947	1,046,083

An observation is an individual primary school student. The full universe includes all PSLE takers from mainland Tanzania 2014-2019. The analysis sample is restricted to PSLE takers in these years whose school can be located in a ward, and who can be clearly matched to a treatment status through a 2014 FTNA taker in the same ward. 'Sec. transition' defined only for students whose full name is unique within their nationwide cohort.

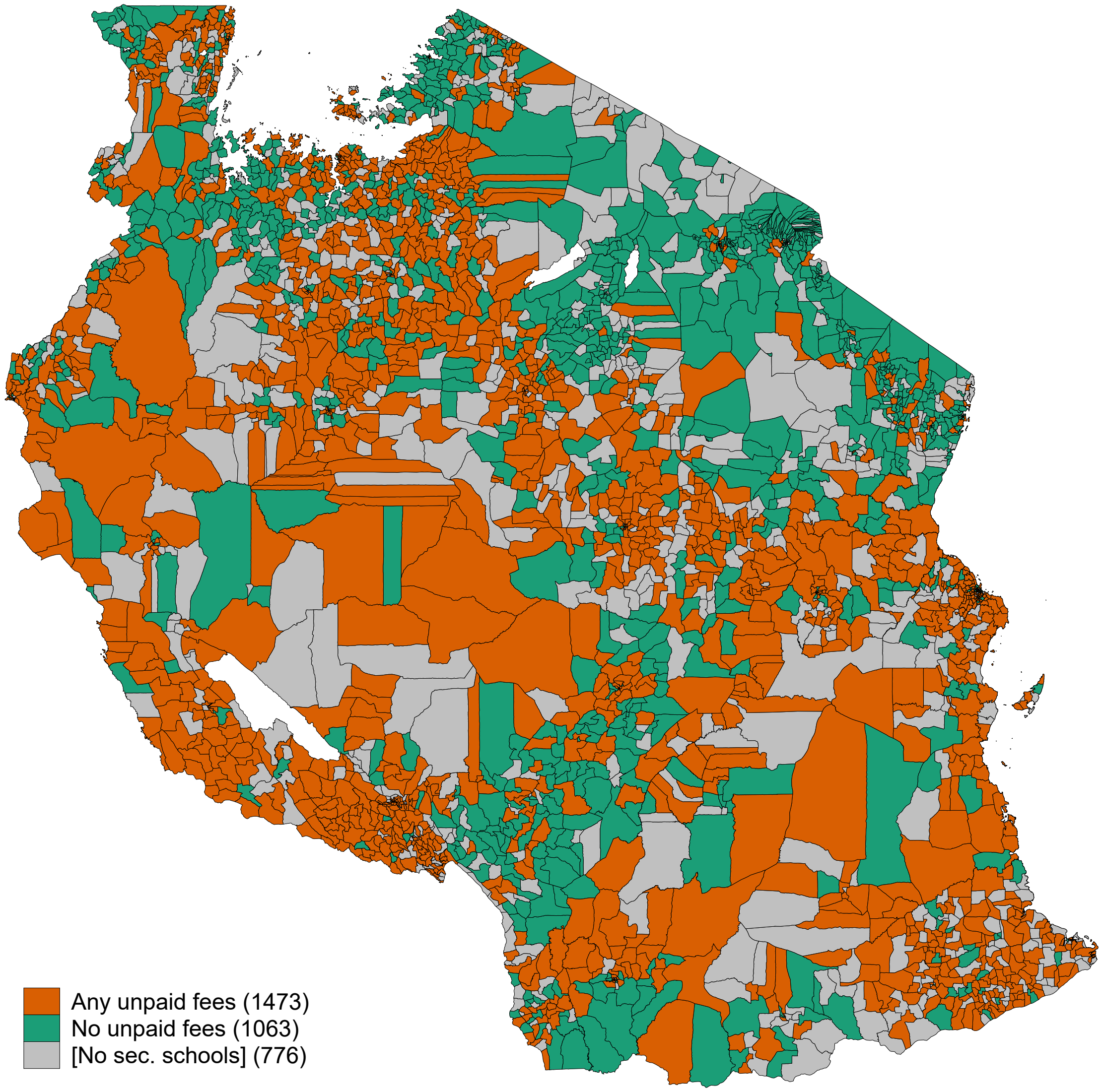


Figure 1: Ex ante payment of secondary school fees, by ward
Wards classified by binary measure of whether any 2014 Grade 9 (FTNA) exam taker had exam scores initially withheld for failure to pay fees. Map shows only wards in mainland Tanzania; the autonomous region of Zanzibar is excluded.

4 FSE increased secondary school access

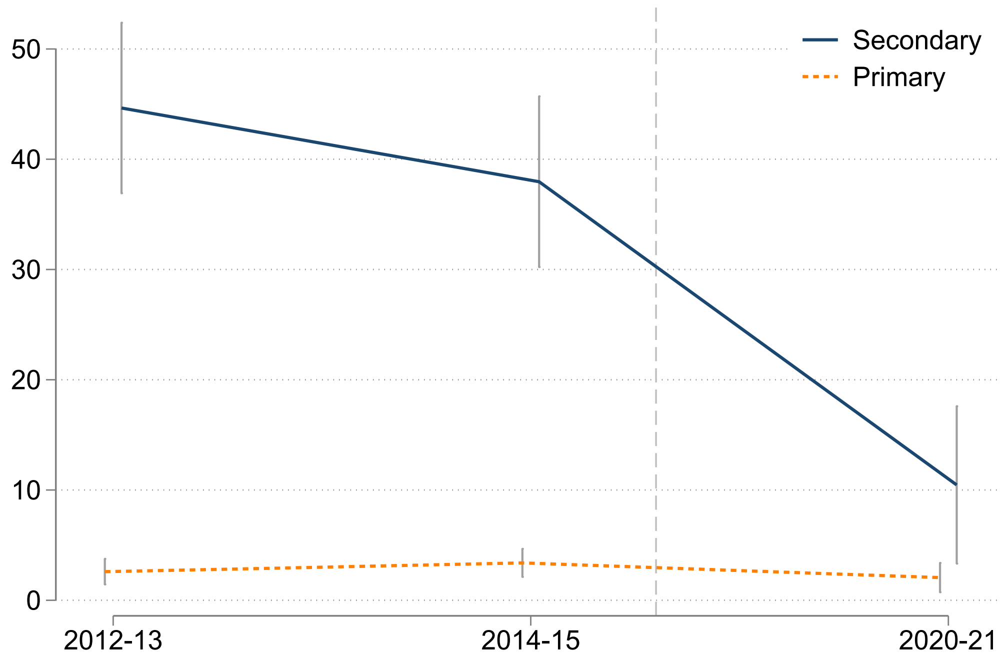
I first demonstrate that the FSE policy did indeed increase access to public secondary schooling. Although this was FSE's stated goal, success was not a foregone conclusion. Prior to the reform, Tanzania had a history of education policies which didn't live up to expectations. Through the Free Primary Education program, the government had promised schools capitation grant transfers which faced perennial complaints for failing to materialize on time or in full (Twaweza East Africa, 2013; Manara & Mwombela, 2012). In the decades leading up to 2016, Tanzania's government had made various commitments to free education, at both the primary and secondary level, not all of which were met (Opalo, 2022). Other countries in the region have struggled to make promises of free secondary education into reality, and *de jure* free secondary is much more common than *de facto* access (Crawfurd & Ali, 2022). Case studies of the implementation of FSE in various parts of the country found the capitation grants provided to be unreliable and/or insufficient to meet the needs of the large influx of students (Lazaro & Matiku, 2022; Majumba, 2019; James, 2023; Munisi et al., 2018). That said, there is also evidence of optimism among ordinary Tanzanians about FSE after its announcement. A contemporaneous household survey carried out by a Tanzanian NGO found that people widely believed that the government would make good on its promise to abolish fees (Twaweza East Africa, 2016a). A qualitative report stated that, despite causing confusion among key implementers, "there is no doubt that the implementation of the fee-free education policy has significantly promoted access to basic education for children from various socio-economic backgrounds" (Shukia, 2020).

To demonstrate that FSE succeeded in increasing access to secondary school, I present three analyses. First I show using household survey data that public secondary school fee expenditures fell sharply after the policy's implementation. Next I show using administrative data that the policy coincided with a sudden rise in secondary enrollments, concentrated in places where secondary school fees were binding ex ante. Finally I show that the policy abruptly eliminated the advantage in primary-to-secondary transition rates previously enjoyed by local elites.

4.1 School fee expenditure fell for students in public secondary schools

I draw on National Panel Survey data to show that in the wake of FSE's implementation, household spending on school fees fell markedly for students in public secondary schools. Figure 2 shows raw average annual expenditures on school fees over time, separately for students in public primary and secondary schools. Primary students' expenditures on fees was constant and low throughout the period, hovering between 2 and 3.5 USD PPP, with no significant changes across waves. This is consistent with reasonably faithful implementation of the existing Free Primary Education policy. Secondary students' expenditure on school fees, meanwhile, was 44 USD PPP in 2012-13, did not change significantly in 2014-15, then plummeted in the first wave after the FSE by over 70% to 10 USD PPP. This suggests that FSE did indeed succeed in dramatically reducing the school fees students had to pay to attend government secondary schools.

Figure 2: Average yearly school fee spending for public school students, real USD



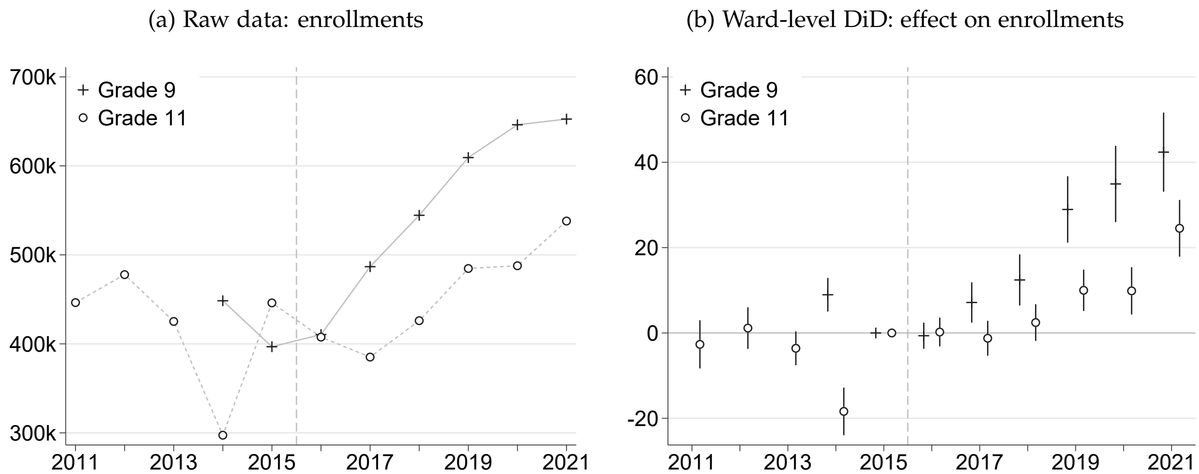
Average expenditure per student on school fees among public school students in primary and secondary school. Data from Tanzania National Panel Survey, Waves 3-5. N = 14463. Vertical line represents implentation of FSE. Real values obtained by applying PPP conversion figures from WDI to original nominal values in TSH (World Bank, 2022).

4.2 Secondary enrollments grew, especially where school fees were binding ex-ante

Another piece of initial supporting evidence that FSE increased access to secondary education is that it preceded large increases in secondary enrollment. While I do not have access to official enrollment data at a granular level, I proxy for enrollments using the number of exam takers in secondary school. Figure A.2 relates aggregate measures of enrollment and test takers to suggest this is a good proxy.

Figure 3a shows that raw enrollments began increasing after FSE, after years of stagnation. Grade 9 enrollments (for which data are only available starting in 2014) declined from 2014 to 2015, increased slightly in 2016, then saw a dramatic uptick beginning in 2017, one year after FSE was implemented. This is consistent with the timing of FSE's implementation: the first cohort allowed to enter secondary school fee-free would have begun grade 8 (Form 1) in 2016, then continued in grade 9 (Form 2) in 2017 – precisely when the number of Form 2 enrollees dramatically increases. A similar dynamic is visible in the data for students in Grade 11, the final year of lower secondary school. Enrollments stayed roughly constant in the 5 years prior to FSE (aside from an anomalous dip in 2014), and continue stagnant for a few years thereafter as cohorts who entered secondary school under the fee regime age upward. An increase in enrollments above the levels of the previous years becomes visible starting in 2019, which corresponds to the fourth year of secondary school for the first cohort to enter secondary school after the fee abolition. This provides suggestive evidence that FSE increased secondary school access.

Figure 3: Secondary enrollments rose, especially where secondary school fees were binding



Panel (a) shows raw number enrolled in Grade 9 and Grade 11 nationwide, as proxied by the number of exam takers. Panel (b) shows coefficients and 95% confidence intervals for interaction terms in Equation 1 with Grade 9 and Grade 11 enrollments as outcomes.

I next examine whether these enrollment increases were concentrated in places with more fee-constrained families. I aggregate my family-level fee constraints measure up to the the ward level, classifying a ward as "treated" if any grade 9 students in it had exam results withheld for failure to pay fees in 2014. Of the wards which had secondary schools in 2014, 1473 (58%) were treated by this measure, while the other 1063 saw no non-payment of fees. Figure 1 maps the geographic variation in this measure.

I use a difference-in-differences framework to compare the number of Grade 9 and Grade 11 students in treated vs. non-treated wards before vs. after the implementation of FSE.

$$Y_{wt} = \alpha + \delta \, treat_w \times post_t + \lambda_t + \eta_w + \varepsilon_{wt} \tag{1}$$

In Equation 1, Y_{wt} designates the outcome (Grade 9 or Grade 11 enrollments) for ward w in year t. The variable $treat_w$ indicates that ward w had non-zero Grade 9 fee nonpayment in 2014. The indicator $post_t$ signifies the implementation period (post-2015). The variables λ_t and η_w indicate year and ward fixed effects, respectively.

Figure 3b shows the results. Prior to FSE, the gap in enrollments between treated and untreated wards was more or less constant (although as with the raw enrollments data, the year 2014 is anomalous). Thereafter, treated wards see significantly more relative growth in enrollments. As in Figure 3a, the patterns match up with what one would expect given the grade progression of affected cohorts. The positive effect on Grade 9 enrollments starts in 2017, the year in which the first fee-free cohort reached Grade 9. The positive effect on Grade 11 enrollments starts in 2019, the year in which the first fee-free cohort reached Grade 11. These patterns are highly consistent with FSE expanding access to secondary school by alleviating school fees as a binding constraint.

This dramatic increase in enrollments is especially striking given that Tanzania's secondary fee abolition was not accompanied by a removal of test barriers to secondary education. This suggests that prior to FSE, a large number of students met the academic requirements necessary for secondary entry and were only held back by their inability to pay school fees.

4.3 The elite premium in secondary transition disappeared

Another index of school access is how regular people fare in the system relative to elites (Lucas & Mbiti, 2014). As outlined in Section 3, my measure of "elite" students is those who share a last name with a local council electoral candidate in their ward. Prior to FSE, elite Grade 7 exam takers were 2.8 percentage points likelier to transition to secondary school than non-elites in the same ward who earned the same PSLE score (the non-elite mean in 2015 was 27%).

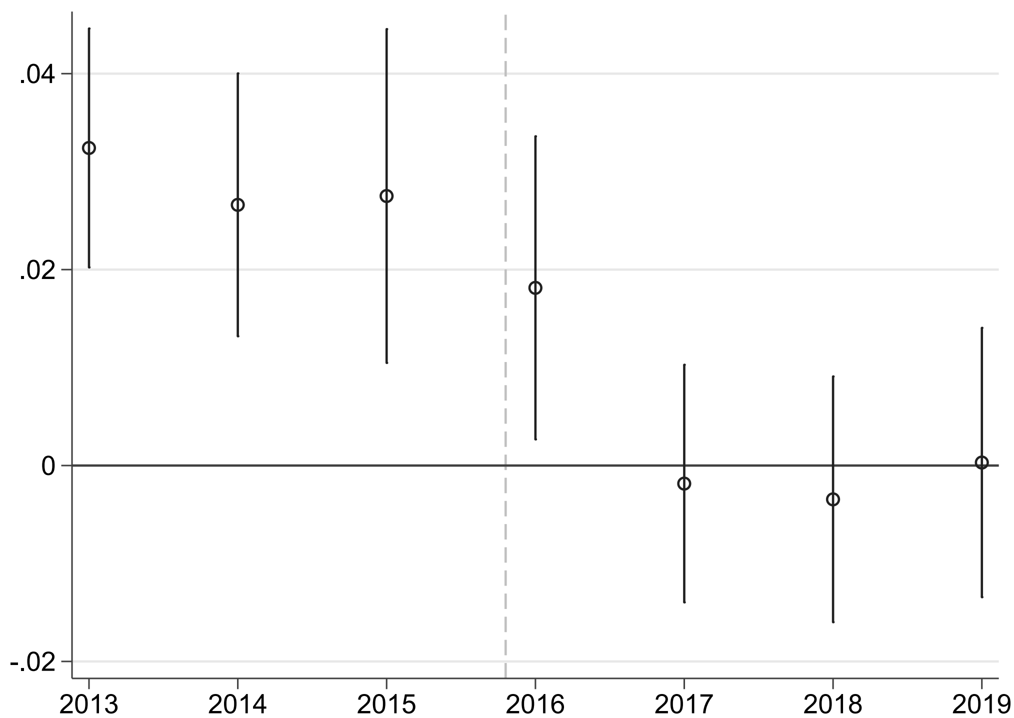
To measure how the elite premium changed over time, I use Equation 2:

$$Y_{ifswt} = \alpha + \phi_{sw} + \lambda_t + \delta\, elite_f + \sum_{t=2013}^{2019} \beta_t\, elite_f \times \lambda_t + \varepsilon_{ifswt} \tag{2}$$

Y_{ifgwt} is a dummy for the secondary transition status of student i from family f who earned overall PSLE score s in ward w in year t. ϕ_{sw} are PSLE score $\times$ ward fixed effects. λ_t is a year fixed effect. $elite_f$ indicates that the student comes from an elite family; i.e., shares a last name with a 2015 local council election candidate in their ward. The β_t coefficients measure the difference in secondary transition between elites and non-elites by year — *conditional on Grade 7 exam scores* — relative to the base year of 2015. To illustrate how the absolute difference between the two groups changed over time, I plot the linear combination of $\delta + \beta_t$ (for the omitted year 2015, I plot only δ). Standard errors are clustered at the ward level.

Figure 4 shows that after the introduction of FSE, elite premium in secondary transition fell to zero. This is consistent with FSE reducing financial barriers to secondary school and increasing access.

Figure 4: Elite transition premium over time



Point estimates and 95% confidence intervals represent linear combination of main effect + interaction effect from Equation 2's regression of secondary transition on the interaction of "elite" dummy with year indicators, including year and PSLE-score-by-ward fixed effects. As 2015 is the omitted year for the interaction, point estimate for 2015 represents the main effect of "elite." Coefficient on "elite" is 0.028 . Standard errors clustered at the ward level.

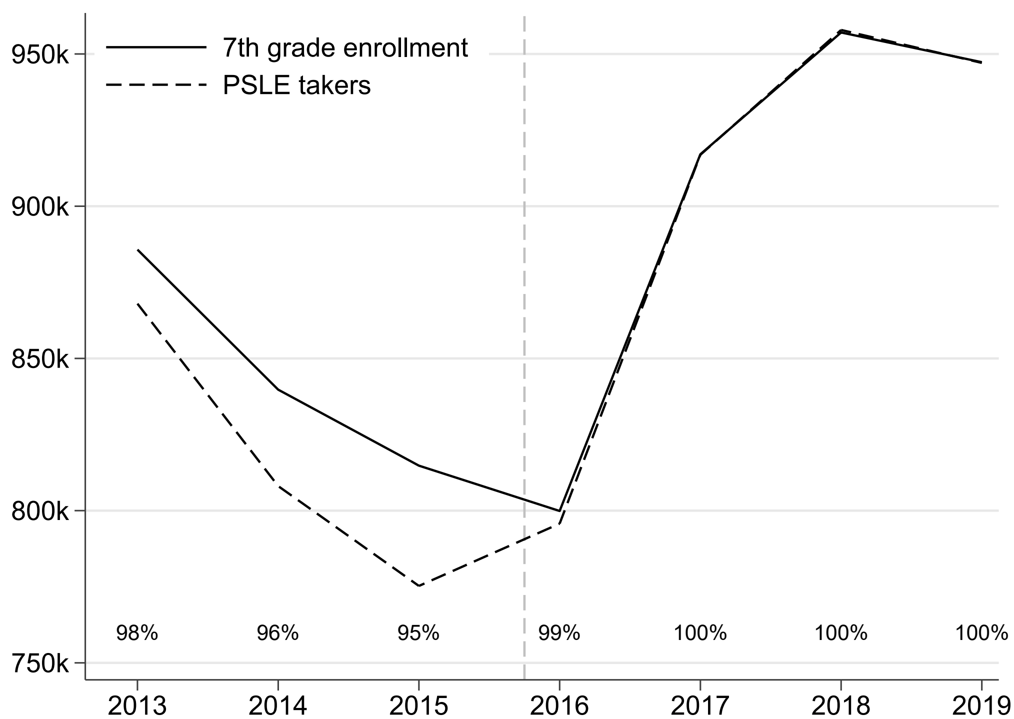
5 FSE raised primary students' investments and achievement

Having established in Section 4 that FSE increased access to secondary school, I turn to its effect on primary students. I first provide descriptive motivating evidence on student investments from aggregate data, then I outline my empirical strategy for demonstrating the causal effect of FSE on primary student investments and achievement and present the results.

5.1 Descriptive motivating evidence on student investments

One piece of *prima facie* evidence of FSE's impact on primary students was that it directly preceded dramatic increases in both primary enrollments and the fraction of enrolled Grade 7 students who sat the PSLE. Figure 5 plots two aggregate nationwide data series: the number of students enrolled in Grade 7 (from PO-RALG data) and the number of PSLE examinees (from NECTA data). Even before FSE, these two measures tracked each other closely, with well over 90% of enrolled students choosing to sit the PSLE. After FSE's implementation, the share sitting the PSLE rose to 100% (even as the number enrolled rose significantly).

Figure 5: Enrollment and test takers: Grade 7



Aggregate nationwide trends in Grade 7 enrollment and PSLE test takers. Ratio of test takers to enrollments expressed as a percentage at the bottom of the graph for each year. Vertical line represents implementation of FSE.

These two data series represent two different and important margins of primary school investment, both of which increased sharply after the introduction of FSE. As discussed in Section 2, primary enrollment in Tanzania is high but not universal. Enrollment in primary school is one of the most fundamental possible human capital investments, and even in the absence of official school fees, there are costs associated with sending a child to school — both directly (see Figure 2) and in terms of opportunity cost (as will be explored further in Section 6.4). This may be particularly relevant for students, like those measured here, who are in the last year of primary school and for whom the labor market returns are likely highest.

Sitting the PSLE represents another dimension of human capital investment. While it also entails an opportunity cost, perhaps more important is the option value of future education it unlocks. Passing the PSLE is a requirement for entering public secondary school. Observing an increase in the fraction of students who sit the exam is consistent with the idea that FSE moved some households on the margin to make forward-looking investments in primary education.[18]

5.2 Empirical strategy

The aggregate patterns shown above are consistent with FSE affecting primary student investments, but not dispositive. Identifying the causal effect of Tanzania's FSE policy is challenging because it came into effect for the entire country simultaneously. There was no staggered rollout nor randomized trial. Who can be considered "treated" by the policy, and who should be considered as a valid comparison group?

I argue that the policy's most direct effect was on those who were constrained by secondary school fees *ex ante*. That is, students from families who had tried and failed to pay secondary school fees can be considered the reform's direct beneficiaries, while students from families in similar circumstances who succeeded in paying secondary school fees were less directly affected, and therefore constitute a comparison group. Section 3 demonstrated that it is possible to identify primary school students from families for whom secondary school fees were binding prior to the reform, using data on Grade 9 exam fee payments in 2014. While these certainly weren't the only students who faced any kind of financial constraints, they are those for whom we have evidence that financial constraints imposed by fees were binding in the absence of the reform. Primary students from families who failed to pay fees on time performed signficantly worse *ex ante* than those from fee-paying families: on average their PSLE scores are 0.18 standard deviations lower, they are 8.4 percentage points less likely to pass, and 9.8 percentage points less likely to transition to secondary school.

To measure the policy's causal effect on primary students, I use a difference-in-differences design which measures how the gap between students from fee-constrained vs non-constrained families changed

[18] Cilliers et al. (2020) provides evidence that "Big Results Now," a previous government education initiative to share low-stakes performance information among district education officers beginning in 2013 and abandoned by 2015, caused schools to strategically exclude students from the last year of primary school. This may partly explain the falling trend in the years prior to the introduction of FSE. In Table B.1 I examine and reject the hypothesis that changes to the composition of who sat the PSLE are responsible for my main results.

after FSE. Equation 3 articulates a dynamic difference-in-differences framework which measures these differences year-by-year. Equation 4 shows a standard difference-in-differences estimation comparing the before- and after-FSE periods:

$$Y_{itf} = \alpha + \eta_f + \lambda_t + \sum_{t=2014}^{2019} \beta_t \, Treat_f \times \lambda_t + \varepsilon_{itf} \tag{3}$$

$$Y_{itf} = \alpha + \eta_f + \lambda_t + \beta \, Treat_f \times Post_t + \varepsilon_{itf} \tag{4}$$

Y_{itf} is the outcome for PSLE-taker i in year t, from family f, whose sibling took the FTNA in 2014.[19] λ_t are year fixed effects. η_f are family (last name $\times$ ward) fixed effects, which absorb all variation at the family level or higher, such that the estimate is identified off of within-family differences over time. $Treat_f$ is an indicator for whether the student's 2014 sibling failed to pay the FTNA fee. This indicator is then interacted with indicators for the years 2014-2019 in Equation 3, and with a dummy for whether the year is 2016 or later in the Equation 4.[20] The β coefficients on the interaction terms are the coefficients of interest.

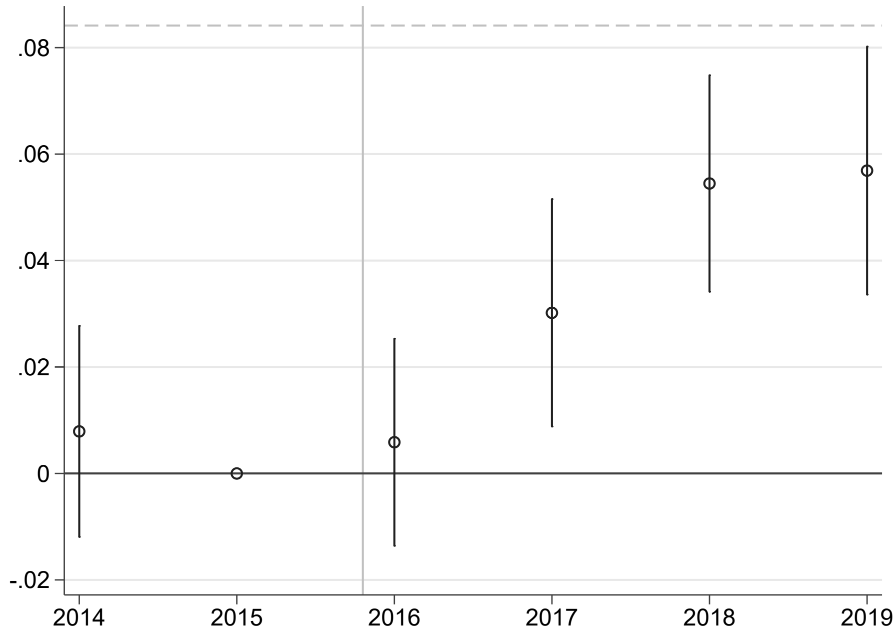
5.3 Results

Free Secondary Education raised pass rates on the Primary School Leaving Examination. Figure 6 depicts this result, plotting the interactions between the family-level fee constraints dummy and the year dummies from Equation 3. There was no significant change in the difference in pass rates between students from more vs. less financially constrained families prior to the reform. After secondary school fees were abolished for public schools, students from poorer families became relatively more likely to pass the exam.

[19] I replace missing values with zero and include a dummy for missingness in the regression.

[20] Although PSLE scores are available for 2013, I exclude this year to avoid potential endogeneity between outcome variables measured in 2013 and the "treatment" variable measured in 2014.

Figure 6: Effect of FSE on Grade 7 exam pass rates



This figure shows interaction coefficients from Equation 3. The specification shows how the difference in outcomes between Grade 7 exam takers from fee-constrained vs. non-constrained families changed over time. The figure plots the coefficients and 95% confidence intervals on the interaction between the $Treat_f$ *dummy and each year dummy (where the omitted year is 2015, the last year before the policy began). For reference, the dotted line at 0.084 shows the average raw pre-reform difference in pass rates between pupils from fee-constrained vs. non-constrained families.*

This change dramatically attenuated the raw gap in pass rates between students from more vs. less financially constrained families. Figure 6 includes a horizontal line for reference denoting the average pre-reform difference in pass rates of 8.4 percentage points. By 2019, this gap had narrowed considerably, to 2 percentage points.

Table 2 shows the diff-in-diff results from Equation 4. The reform increased pass rates by 3.3 percentage points – a 6% increase from a base of 56% among fee-constrained families. There was no statistically significant effect on overall test scores however (this fact will be explored in further Section 6.1). The policy did affect various other indices of individual investment in primary schooling. It caused an appreciable drop in the share of students who registered for the Grade 7 exam but failed to show up on the day of the test ("Absent"). Few students are absent — 2 percent of fee-constrained students in the pre-reform period — but FSE reduced absenteeism significantly with an effect of -29% (-0.3 percentage points).

FSE also caused students to select into better schools. I proxy for school quality with the Grade 7 exam pass rate of the school at which the student sat the exam (with pass rate measured in 2013, prior to any students in the analysis taking the exam, to avoid endogeneity). The pre-reform pass rate of the primary school at which treated students sat the exam increased by 5% (2.4 percentage points from a base of 48%). Because I constrain the definition of "families" to consist of students with the same last name at schools within the same ward, this may be an underestimate of the true effect on school selection: it does not capture selection into primary schools in different wards. This finding is consistent with evidence from other contexts showing that households respond to public investments in schooling by selecting into better schools (Andrabi et al., 2024).

Perhaps the most direct effect FSE had on primary school students was to raise their likelihood of making the transition to secondary school. The transition rate — 17% for the treated group prior to the reform — increased by 23% (4.0 percentage points). There is also suggestive evidence that the policy may have affected these students' investments beyond the transition to secondary school: conditional on making the transition, FSE made students slightly more likely to pass the Grade 9 high-stakes FTNA exam (though these results should be interpreted cautiously given the policy's effects on transition).

How large are these effects? Evans & Yuan (2022) compile a distribution of reported effect sizes of educational interventions studied with RCTs in the developing world, measured in standard deviations. My estimate on secondary transition corresponds to an effect size of 0.11 σ, placing it at the 70th percentile of the distribution of effects on enrollment. The effect I estimate on overall test scores was not statistically significant in my preferred specification (though it was in the alternate specification shown in Table B.3). However, the point estimate of 0.028 σ would place it at the 30th percentile of effect sizes on reading and math assessments.

My within-family design makes it unlikely that these results could be driven by changes to supply-side inputs such as school construction or teacher hiring which might affect class sizes. Indeed, Figure A.3 shows that FSE was followed by large *increases* in aggregate pupil:teacher ratios and a slowdown in the pace of public primary school construction. Consistent with these aggregate trends, my estimates show no significant effect on the size of the cohort in which students sat the Grade 7 exam.

These effects also do not appear to be driven by changes to the composition of students sitting the Grade 7 exam. I test this by comparing paying vs. non-paying 2014 FTNA takers' likelihood of matching by last name $\times$ ward to any PSLE taker before vs. after the reform. The reform had no effect on the likelihood of students appearing in the PSLE data (see Table B.1 in Section B).

Table 2: Effects of FSE on primary student investment and achievement

	Pri achievement		Pri investment			Sec achievement	
	Pass PSLE	PSLE score (σ)	Absent PSLE	Pri. school pass rate (pre-reform)	Pri. school cohort size	Transition	Pass yr9 exam | transition
Treat × Post	0.033***	0.028	-0.006***	0.024***	-0.906	0.040***	0.019**
	(0.008)	(0.019)	(0.001)	(0.005)	(1.132)	(0.011)	(0.008)
N	1,046,083	1,046,083	1,046,083	1,046,083	1,046,083	1,046,083	491,630
Mean (treated, pre)	0.561	-0.141	0.022	0.476	86.613	0.172	0.871

All regressions include family FE. Standard errors clustered by ward. Transition only measured for students whose full name is unique across the country within their cohort. * p<0.10, ** p<0.05, *** p<0.01

In Section B, I test the robustness of these findings to alternative treatment definitions and estimation strategies. I consider a stricter matching method for creating family groups; an estimation which eschews family fixed effects for older sibling's school × Grade 9 score fixed effects; and defining treatment based on older siblings' dropout rather than fee non-payment. All results support those presented in this section.

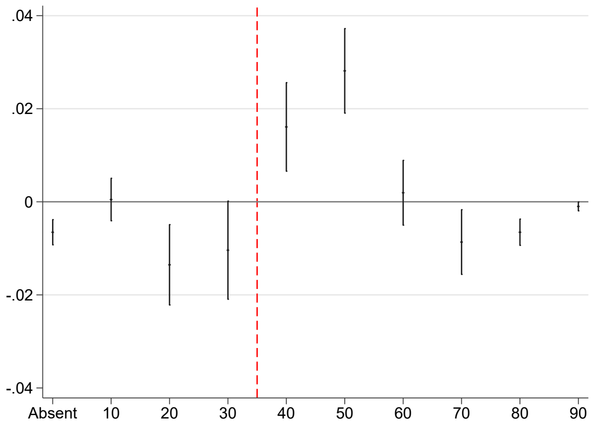
6 Mechanisms

In this Section I show four pieces of evidence to support the hypothesis that the main effects shown in Section 5 are driven by demand-side investments. I first investigate patterns in effects on the distribution of test scores which are consistent with reallocated effort to maximize the probability of passing the Grade 7 exam. I then show suggestive evidence that the effects on improved exam performance are present for low-stakes Grade 4 exams, which increases confidence that results are not driven by manipulation of exam results. I then use variation in the prevalence of fee constraints at the ward level to show evidence that supply-side inputs are not likely to explain the results. Finally, I analyze nationally representative household survey data in a difference-in-differences framework to show evidence that FSE increased households' investments in education — especially by reducing school absences and child labor.

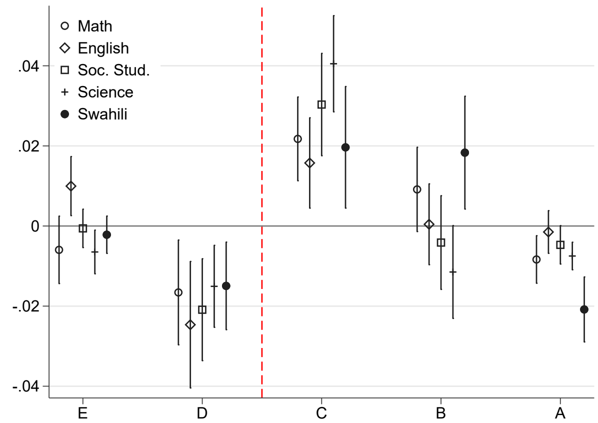
6.1 Effects on the distribution of test scores

Table 2 showed that the reform raised exam pass rates even though it had no impact on overall test scores. In Figure 7, I show that this is consistent with the reform causing students to reallocate effort, by examining the effect of the policy on the distribution of test scores.

Figure 7: Effects on grade 7 test score distributions



(a) Overall score



(b) By subject

Panel 7a shows the diff-in-diff estimates on students' likelihood of receiving an overall score in each of ten bins. Panel 7b shows the diff-in-diff estimates on students' likelihood of receiving a score of each of five grades (A-E) in each of the PSLE's five subjects. Fraction of pupils receiving a grade of C (40%) or greater in each subject prior to 2016: Math (38%); English (41%); Social studies (57%); Science (58%); Swahili (72%)

Figure 7a shows that FSE did not move the entire distribution – instead, it caused students to be less likely to get a just-failing score and more likely to barely clear the threshold to pass the exam – an overall score of 40%. This suggests that results are not driven by mean reversion (Ashenfelter, 1978). If the effects on average pass rates merely reflected students recovering from a bad shock which resulted in a temporary inability to pay school fees, this would be expected to shift their entire distribution of scores to the right. (This also would imply an increase in overall PSLE scores, which I do not in fact observe.) Instead I observe large effects around the passing threshold, indicative of an allocation of effort to maximize the likelihood of passing the PSLE to qualify for secondary school. I also observe a slight reduction in the likelihood of getting very high grades, which is also consistent with students shifting effort away from strong subjects toward weak ones.

Figure 7b shows how FSE affected students' performance on the five individual subjects in the exam: Math, English, Social studies, Science, and Swahili. Prior to FSE, Swahili was by far the subject with the highest scores: 72% of pupils scored a "C" or better. Science was the next "easiest" subject, with 58% of students scoring a "C" or better. By comparison, only 38% of students got at least a "C" in Math, the most-failed subject. FSE caused large shifts from "D" to "C" for all subjects. But it also reduced scores for the easiest subjects. It caused a large shift from "A" to "B" in Swahili, and from "B" to "C" in science. This is consistent with students reallocating study effort away from easier subjects and toward more difficult subjects in pursuit of a passing grade overall.

6.2 Grade 4 low-stakes exam outcomes

The PSLE is a high-stakes exam determining entry to secondary school, which implies that after secondary fees were removed, passing the exam would have been the binding constraint on secondary entry for many more students. Could the average effects I measure be driven by the manipulation or corruption of grading practices to help students get over this barrier? PSLE tests are graded centrally, not marked by students' own teachers or administrators, which makes this possibility remote. In the one region and cohort for which precise PSLE scores are available — Mwanza in 2016 (after the introduction of FSE) — there is no evidence for excess mass to the right of the passing threshold (see Figure C.2).

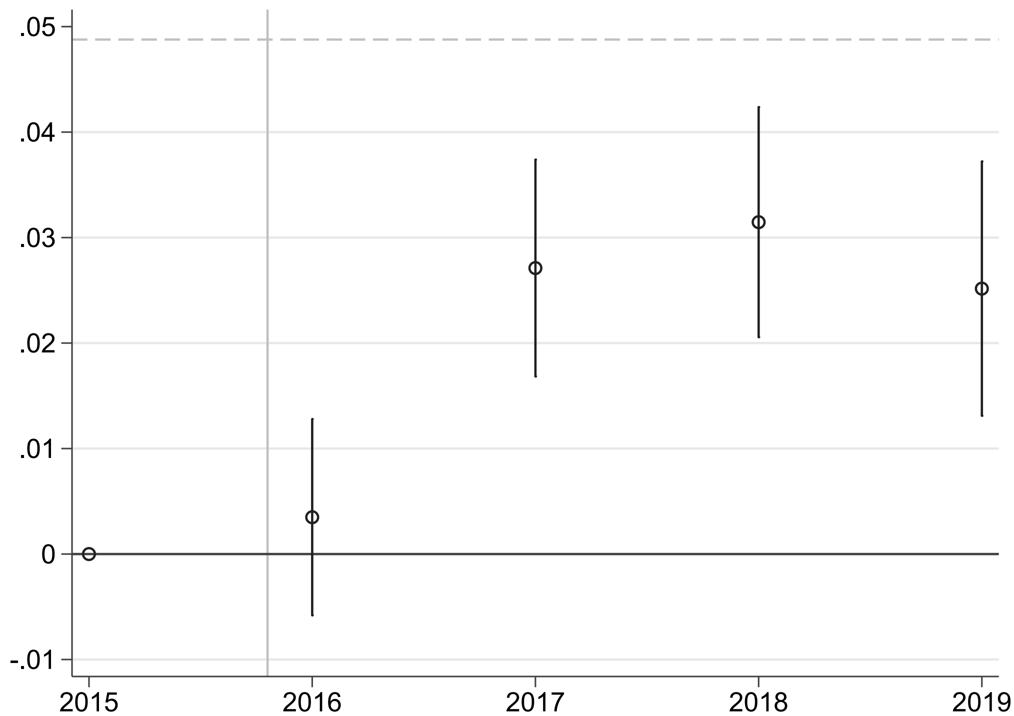
To further interrogate this hypothesis, I look at Grade 4 low-stakes exam results. In Grade 4, students sit the first national standardized test of primary school, the Standard Four National Assessment. Like the PSLE, it entails five subjects on which all students are tested: English, Math, Science, Social Studies, and Swahili, with NECTA providing data on letter grades for each subject as well as on the overall score (A, B, C, D, and E). For the SFNA, a D is considered a passing grade. However, failing the SFNA does not prevent students from continuing on to Grade 5; in this sense the test is low-stakes. Manipulation around the passing threshold may therefore be considered less likely than on the PSLE given that failing has no consequences for students' ability to continue their schooling.

To study how FSE might have affected Grade 4 students' performance on the low-stakes SFNA, I follow the same strategy I did with Grade 7 exam outcomes. I assign treatment status by identifying students who share a last name with at least one 2014 Grade 9 test taker in the same ward ("family members"); treated students are those whose 2014 Grade 9 family members failed to pay school fees on time, and control students are those whose 2014 Grade 9 family members succeeded in paying school fees on time. Equation 5 presents the estimating equation:

$$Y_{itf} = \alpha + \eta_f + \lambda_t + \sum_{t=2015}^{2019} \beta_t \, Treat_f \times \lambda_t + \varepsilon_{itf} \tag{5}$$

Unfortunately, Grade 4 exam results are only available in digitized format starting in 2015, one year before the FSE reform was implemented. This means that while it is possible to measure the difference in outcomes between these two groups in the year prior to treatment, testing for parallel pre-treatment trends is impossible (although the fact that parallel trends were established on Grade 7 outcomes using the same family-level treatment variation may diminish concerns somewhat). I interpret these estimates with caution.

Figure 8: Differences in Grade 4 exam pass rates



This figure shows interaction coefficients from Equation 5. The specification shows how the difference in outcomes between Grade 4 exam takers from fee-constrained vs. non-constrained families changed over time. The figure plots the coefficients and 95% confidence intervals on the interaction between the $Treat_f$ dummy and each year dummy (where the omitted year is 2015, the last year before the policy began). For reference, the dotted line at 0.049 shows the average raw pre-reform difference in pass rates between pupils from fee-constrained vs. non-constrained families.

Figure 8 plots the β coefficients from Equation 5. The broad patterns of differences for Grade 4 students look very similar to those for Grade 7 students. Prior to the reform, failure rates were 66% higher in the treatment group (13.4% compared to 8.9%). This difference narrowed dramatically after the reform took place. That performance on low-stakes Grade 4 exams among students from fee-constrained families converged toward that of students from non-constrained families after FSE's implementation is consistent with FSE causing greater primary student investment. Summary statistics for this sample and a regression table for this analysis can be found in Section A.

6.3 Ward-level analysis

I use ward-level variation in fee constraints to provide further evidence that the main results are not driven by supply-side investments. Equation 4's use of family-level (within-ward) variation in fee constraints rules out simple ward-level supply-side channels as potential explanations of the effects. However, it does not preclude the possibility that fee-constrained families responded differentially to potential ward-level supply-side investments — such as school construction and class sizes. Aggregate trends in supply-side investments make this look unlikely: as mentioned in Section 5, FSE was followed by a slowdown in primary school construction and an increase in PTR. But if these putative supply-side investments were targeted at wards with more affected families, it is possible they could help explain the increases in primary student achievement.

To test this possibility, I return to the specification outlined in Equation 1 which relies on ward-level variation in fee constraints. This permits the measurement of outcomes at a larger level of aggregation – including some outcomes which can only be measured in a more aggregated way, such as school entry and overall enrollments. It also provides outcomes which, although aggregated to the ward level, are based on a wider sample of students (because it is not limited to students for whom the family-level fee constraint measure can be defined).

Table 3: Ward-level results

	Pri achievement		Pri (demand) investment		Pri (supply) investment	Sec achievement
	Pass rate PSLE	PSLE avg score (σ)	Absent rate	Num students	Num schools	Transition rate
Post × Treat	0.021***	0.030**	-0.002**	10.259**	0.053	0.020***
	(0.006)	(0.014)	(0.001)	(5.089)	(0.058)	(0.006)
N	13,624	13,624	13,624	13,624	13,624	13,624
Mean (treated, pre)	0.598	-0.031	0.017	322.168	6.063	0.220

Year and ward FE. Sample consists of ward-level aggregates of student-level PSLE data from 2014-2019. Standard errors clustered by ward. * p<0.10, ** p<0.05, *** p<0.01

Table 3 shows evidence that supply-side investments are unlikely to explain the student achievement effects. The results are consistent with those from the student-level estimation: FSE increased pass rates in treatment areas by 2.1 percentage points relative to control areas, and raised overall PSLE score levels by about 0.03 standard deviations. It also reduced absent rates by 0.2 percentage points (from a base of 1.4%) and increased enrollments by about 10 students. However, this increased enrollment was not accompanied by a greater number of schools per ward, implying more crowded schools. Despite this, the effect on transition rates was a positive and significant 2.0 percentage points.

6.4 Diff-in-diff: Household survey data on primary student investments

The results from administrative data presented in Table 2 — higher pass rates, lower absence rates, selection into better schools — are consistent with the narrative that expanding secondary access increased educational investments for primary students. The distributional results in Figure 7 further suggest that the reform changed students' allocation of effort. But administrative data are limited in their capacity to speak directly to students' investments in education.

To illuminate how the secondary school fee reform affected primary students' investments, I turn to nationally representative household survey data. The Tanzanian National Panel Survey (NPS) asks households about various measures of investment in each individual child's education, including enrollment, attendance, attainment, time spent studying, test taking, and education expenditures.[21] I employed this data in Section 4 to supply evidence that FSE reduced public secondary school fees. As in that analysis — and to match as closely as possible the timeframe of the main analysis using administrative data — I use Waves 3, 4, and 5 of the NPS, which were conducted in 2012-13, 2014-15, and 2020-21, respectively. Descriptively, most of these measures of human capital investments in primary-age students increased in the first post-FSE survey wave, often after staying constant in the two prior waves. These descriptive trends are displayed in Section A. These patterns are consistent with FSE raising primary student investments, but cannot be interpreted causally.

To test whether these descriptive trends represent the causal effect of FSE, I employ a diff-in-diff framework which tests whether educational investments rose more for families most likely to have been affected by FSE. To match as closely as possible the sample from the main analysis on administrative data, I focus on primary schoolchildren in households who have at least one child in secondary school at the time of the interview.

As before, it is necessary to identify which households were more "treated" by the FSE policy which eliminated the requirement of school fee payment for entry into public secondary schools. The household survey data, unlike the administrative data, does not include information on which students paid school fees. However, it does include direct measures of family financial constraints. I assume that more

[21] Education expenditures include expenditures on school fees, transportation, meals, uniforms, books, private tutoring, and "other" expenses.

financially-constrained families would have been more treated by the abolition of school fees, and proxy for a family's financial constraints using an indicator for whether the family lives in a house which has a thatched roof. This is a common and simple means test for poverty (Egger et al., 2022).

$$Y_{it} \quad = \quad \alpha + \lambda_t + \beta_1 \, Treat_i + \beta_2 \, Treat_i \times Post_t + \varepsilon_{it} \tag{6}$$

Equation 6 mimics the structure of Equation 4, substituting in the financial constraints measure from the household survey data. Y_{it} is the outcome for primary school student i in survey wave t, in a household with at least one student in secondary school.[22] λ_t are survey wave fixed effects. $Treat_i$ is an indicator for whether the student lives in a thatched-roof house. Unlike Equation 4, this regression does not include family fixed effects because it is based on a repeated cross section, so the family-level $Treat_i$ variable is included individually. This indicator is then interacted with a dummy for whether the year is 2016 or later, with the β_2 from this interaction as the coefficient of interest.

Table 4: Diff-in-diff: family financial constraints measured by thatched roof homes, comparable sample (primary school students from households with a secondary school student)

	Enrolled primary school	At grade level	Absent last 2 weeks	Took PSLE	Worked last 7 days	Hours studied last wk	Total ed. spending (USD, yr)
Treat	0.007	-0.123***	0.058***	-0.005	0.112***	-1.096***	-104.137***
	(0.014)	(0.020)	(0.022)	(0.031)	(0.019)	(0.209)	(24.451)
Treat × Post	0.032	0.017	-0.121***	0.084	-0.108***	0.069	19.771
	(0.029)	(0.041)	(0.045)	(0.063)	(0.039)	(0.431)	(50.498)
N	5,213	5,368	5,368	646	5,368	5,368	5,368
Mean (treated), Pre (2014-15)	0.941	0.638	0.400	0.065	0.311	1.386	31.011

All regressions limited to households with at least one child in secondary school. Column 1 includes primary-age children (7-13); other columns include children in primary school. Waves 3 (2012-13), 4 (2014-15), and 5(2020-21). 'Post' corresponds to wave 5. 'Treat' indicates children living in thatched roof homes. Means displayed for poor students in wave 4 at the bottom of the table. 'Enrolled Primary School' defined as a dummy for all children age 7-13. 'Took PSLE' defined as a dummy for all primary students age 14 and over. Missing outcome values replaces with zero; dummies for missing included in all regressions. * p<0.10, ** p<0.05, *** p<0.01

The results can be seen in Table 4. Among households with secondary school children, FSE reduced absence rates for poorer households by 12 percentage points relative to less-poor households (where absence is measured as an indicator for whether the child was absent from school at all in the last two

[22] As in Figure A.4, the regression using the outcome of whether a child is enrolled in primary school at all considers all primary-age students from households with at least one child in secondary school, and the regression for whether the child took the PSLE considers only primary school children age 14 and over.

weeks). This is consistent with the negative effects of FSE on exam absenteeism found in the administrative data (Table 2). These students were also made 11 percentage points less likely to have worked in the last seven days. This is consistent with research showing that resource shocks affect households' allocation of child time into schooling vs. labor (Edmonds, 2006; Tang et al., 2020; Akresh et al., 2012), and with prior work suggesting that household income shocks affect child labor in Tanzania specifically (Beegle et al., 2006; Human Rights Watch, 2013). (Coefficients are positive but not significant for primary enrollment, being enrolled at grade level, taking the PSLE, hours spent studying, and household education spending on the child.) Overall, these results imply that that students' attendance at school (and absence from work) was an important dimension on which FSE affected investments in primary students' human capital.

7 Conclusion

Free Secondary Education (FSE) has expanded rapidly in the developing world in recent decades, and is likely to continue to do so. One reason is that FSE programs appear to bring large benefits to the target demographic of secondary school students (Crawfurd, 2024; Crawfurd & Ali, 2022; Duflo et al., 2017; Brudevold-Newman, 2021; Blimpo et al., 2019; Agüero & Ramachandran, 2020). This helps make these reforms politically popular, and politically popular education reforms are something of a rarity (Sandholtz, 2023, 2024; Biasi & Sandholtz, 2024; Dias & Ferraz, 2019; Cox et al., 2024; Bursztyn, 2016).

Because human capital acquisition is dynamic, understanding the full effects of FSE requires that we also understand how it affects *primary* students' responses. This paper examines primary student responses to Tanzania's FSE reform, using the universe of high-stakes national standardized exams. Comparing students from *ex-ante* fee-constrained families with their less-constrained counterparts, I show that the reform increased primary school exam pass rates and transition rates to secondary school. This appears to have operated through demand-side channels: the policy changed patterns of effort on the exams, reduced absences and child labor, and increased positive school selection.

I find little evidence of a supply-side response, at least in the short term. However, the continued success of the policy likely hinges on that changing (Garlick, 2019; Bold et al., 2015). Other countries, faced with supply crunches and substandard quality, have turned to the private sector, with mixed results (Romero et al., 2020; Barrera-Osorio et al., 2020, 2022). While many promising education reforms are technically or politically complicated to scale up, expanding access is expensive but relatively straightforward (Bold et al., 2018). This makes it a potentially attractive target for aid from other countries or multilateral institutions (Crawfurd & Ali, 2022). Knowing that the benefits of FSE extend to the (much larger) group of children still in primary school implies a higher cost-effectiveness than previously understood.

Like much research on education in developing countries, this paper offers a glimpse of the world's vast reservoir of untapped ability. Households' and students' decisions about educational investments are dependent on the menu of investments available to them, both present and future. This implies that measures of student ability depend on the context in which they are taken. Many students rationally disinvest in education when faced with future obstacles, yet have the ability to succeed when opportunities are available.

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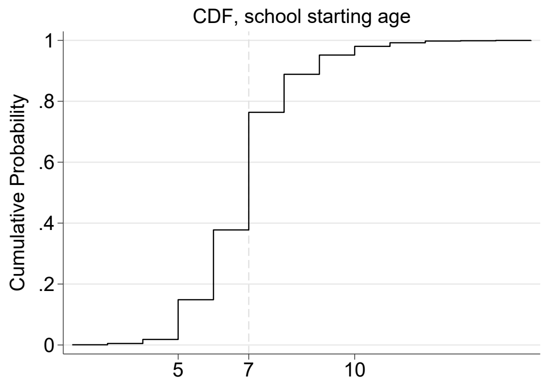
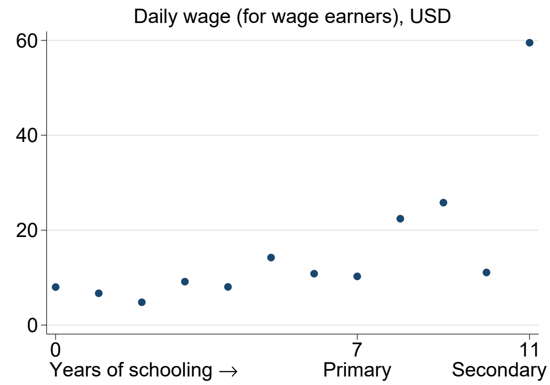
A Descriptive data

A.1 Descriptive: Primary school starting age and mincer returns

Figure A.1: Schooling in Tanzania



(a) Age of school starting



(b) Mincer wage returns

Panel (a): TZ National Panel Survey, Wave 4 2014-15. Includes students currently in school. N = 4064. Panel (b): Binscatter using Tanzania National Panel Survey, Wave 4 2014-15. Includes wage earners with $\leq$ 11 yrs education. N = 2498. Real USD values obtained by applying PPP conversion figures from WDI to original nominal values in TSH (World Bank, 2022).

Figure A.1a shows that the vast majority of Tanzanian students start primary school by the mandated age of 7. Figure A.1b shows that the descriptive returns to finishing secondary school are large.

A.2 Descriptive: Grade 9 enrollment and exam takers

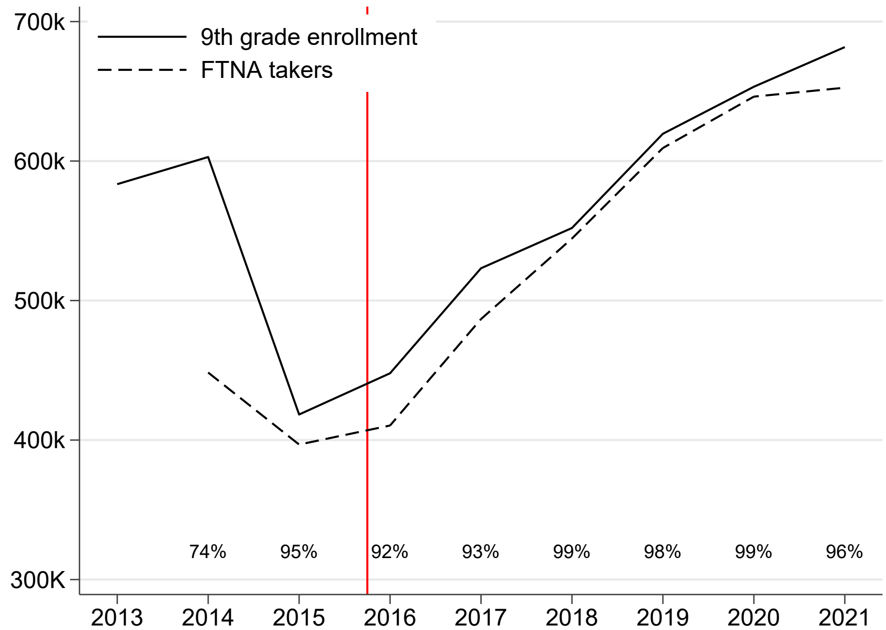
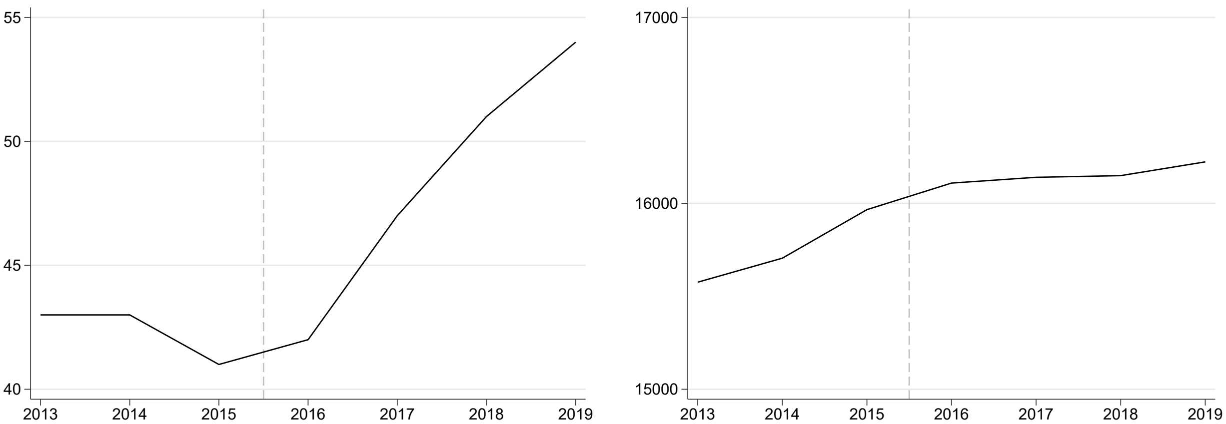


Figure A.2: Grade 9 enrollment and test takers

Figure A.2 shows that the number of students sitting the FTNA Grade 9 exam (from NECTA data) is a good proxy for the number of students enrolled in Grade 9 (from PO-RALG data).

A.3 Descriptive: Primary PTR and school

Figure A.3: Aggregate primary school resources



(a) Pupil:teacher ratio in primary schools

(b) Number of government primary schools

Pupil:teacher ratios at the primary level increased sharply following the policy, while government school construction flattened out.

A.4 Low-stakes Grade 4 exams

Table A.1 displays summary statistics for Grade 4 (low-stakes) exam takers, for the overall sample and the analysis sample of students for whom the fee constraints variable can be defined.

Table A.1: Summary stats: Grade 4 exam takers

	All	Analysis Sample
School cohort size	142.394	136.276
	(129.667)	(130.668)
Female	0.505	0.509
	(0.500)	(0.500)
Public school	0.966	0.965
	(0.182)	(0.183)
Elite (shares name with local political candidate)	0.005	0.012
	(0.072)	(0.109)
Pass Grade 4 exam	0.860	0.881
	(0.347)	(0.324)
Overall exam score (%)	47.461	48.517
	(19.405)	(18.931)
English subject score (%)	37.155	38.140
	(22.519)	(22.378)
Math subject score (%)	40.254	40.955
	(24.319)	(23.973)
Social studies subject score (%)	51.434	52.216
	(22.105)	(21.717)
Science subject score (%)	49.761	50.818
	(22.278)	(21.939)
Swahili subject score (%)	58.702	60.455
	(25.366)	(24.770)
Full name unique in nationwide cohort	1.000	1.000
	(0.000)	(0.000)
Family fee payment status available	0.177	1.000
	(0.381)	(0.000)
Family failed to bay sec. school fees('treated')		0.099
		(0.299)
N	9,657,718	1,672,847

An observation is an individual student. The full universe includes all SFNA takers from mainland Tanzania 2015-2019. The analysis sample is restricted to SFNA takers in these years whose school can be located in a ward, and who can be clearly matched to a treatment status through a 2014 FTNA taker in the same ward.

Table A.2 shows regression results for estimating Equation 5 on various outcomes: passing the SFNA

Grade 4 exam; score on the Grade 4 exam; being absent for the Grade 4 exam; and the size of the cohort in which the student sat the Grade 4 exam.

Table A.2: Grade 4 exam takers

	Pri achievement		Pri investment	
	Pass Grade 4 exam	Grade 4 exam score (σ)	Absent Grade 4 exam	Pri. school cohort size
Treat × Post	0.028***	0.083***	-0.003	-6.537**
	(0.005)	(0.018)	(0.003)	(2.858)
N	1,672,847	1,672,847	1,672,847	1,672,847
Mean (treated, pre)	0.864	-0.192	0.053	107.499

All regressions include family FE. Standard errors clustered by ward. Transition only measured for students whose full name is unique across the country within their cohort. * p<0.10, ** p<0.05, *** p<0.01

A.5 Descriptive: household survey data on primary investments over time

Table A.3 uses the full sample of primary school students from Waves 3-5 of NPS household survey data to show that among primary school students, enrollment, attainment, attendance, and test-taking were all higher after the reform (Section 6, by contrast, limits attention to households with a secondary school student). Child labor and school absenteeism were lower. Household expenditure on education was much higher.

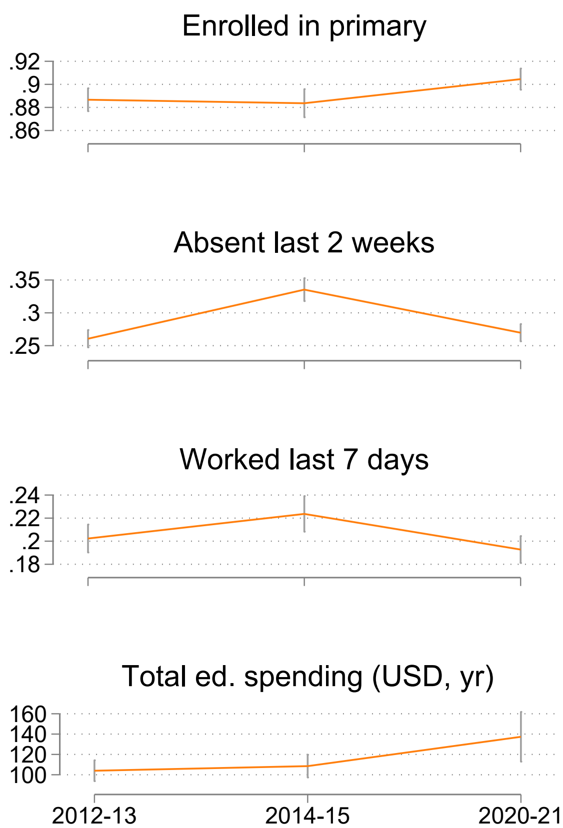
Table A.3: Descriptive: primary investment over time, all primary school children

	Enrolled primary school	At grade level	Absent last 2 weeks	Took PSLE	Worked last 7 days	Hours studied last wk	Total ed. spending (USD, yr)
post	0.019***	0.066***	-0.021**	0.067***	-0.018**	0.021	31.573***
	(0.006)	(0.008)	(0.009)	(0.005)	(0.008)	(0.081)	(9.996)
N	10,514	11,387	11,417	7,520	11,414	11,409	9,839
Mean, Wave 4: Pre (2014-15) (omitted)	0.884	0.712	0.335	0.005	0.224	1.944	108.518

Column 1 includes all children age 7-13; other columns include all respondents in primary school. Omitted category is wave 4 (2014-15). Wave 3 corresponds to 2012-13, Wave 5 corresponds to 2020-21. * p<0.10, ** p<0.05, *** p<0.01

Descriptive analysis of this household survey data is consistent with a general increase in educational investments in primary school students after the introduction of FSE. Figure A.4 displays descriptive data on these 7 measures of educational investment from the waves of the NPS bracketing FSE's implementation (two before and one after). The sample consists of all children in primary school ($N = 11,420$). (The exceptions are "Enrolled in primary," which consists of all children of primary age (7-13) ($N = 12,016$); and "Took PSLE", which was only asked of children enrolled in primary who are 14 or over ($N = 1394$).)

Figure A.4: Descriptive: measures of individual primary ed. investment over time



Data from Tanzania National Panel Survey, Waves 3-5.

Figure A.4 shows that many (though not all) of these indices stayed more or less constant across the two survey waves prior to the reform, then saw a significant change after the reform. After the implementation of FSE, the primary enrollment rate (for primary-age students) rose. Primary school students were more likely to be at grade level and to have sat the PSLE, and less likely to have been absent in the past 2 weeks or to have worked in the past 7 days. Total household spending on primary school children rose significantly (even as spending on secondary school fees for public school students fell precipitously as shown in Figure 2). There was, however, no change in the number of reported hours children studied.

B Robustness

In this section I test the robustness of the main findings to various alternative treatment definitions, estimation strategies, and channels. I examine and reject the potential for effects to be driven by changes in the composition of Grade 7 exam takers or by false positives in the family matching procedure. I then show that the results are robust to replacing family fixed effects with older sibling's school $\times$ by Grade 7 exam score fixed effects, and to using older siblings' dropout as a measure of "treatedness" by FSE rather than fee constraints.

B.1 No effect on number of younger siblings taking PSLE

One potential margin could be students' likelihood of sitting the grade 7 exam at all. Previous work from Tanzania has found evidence of school administrators manipulating which children are allowed to sit the exam in order to engineer higher pass rates (Cilliers et al., 2020). To test this, I match grade 7 exam takers by last name within ward to the list of 2014 grade 9 takers ("older siblings"), and collapse to the level of the older sibling $\times$ grade 7 year to measure how many younger siblings each older sibling had in each cohort of grade 7 test takers. I test whether the number of grade 7 takers matched to each older sibling changed after Free Secondary Education was introduced, clustering standard errors by year and older sibling.

Table B.1: Diff-in-diff: effect on number of younger siblings taking PSLE

	Any sibling took PSLE		Num. siblings took PSLE	
Treat $\times$ Post	0.002	0.000	0.002	-0.007
	(0.001)	(0.001)	(0.001)	(0.004)
Mean	0.089	0.147	0.089	0.293
N	1,977,675	1,977,675	1,977,675	1,977,675
Year FE	✓	✓	✓	✓
Family FE	✓	✓	✓	✓
Match criterion	Strict	Less strict	Strict	Less strict

An observation is a 2014 FTNA taker $\times$ year. Standard errors clustered by 2014 FTNA taker and year. Odd columns limit sibling definition to PSLE takers with unique last names within their ward $\times$ cohort to reduce the incidence of false positives. Even columns omit this restriction. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table B.1 shows that grade 9 test takers from more vs. less financially constrained families are no more or less likely to have younger siblings sitting the grade 7 exam in the aftermath of the policy. This is consistent with Figure 5, which shows that even the baseline rates of exam sitting for grade 7 students are very high.

B.2 Stricter family matching

My main analysis sample consists of all grade 7 test takers whose last name matches that of a 2014 grade 9 test-taker with a unique last name within the ward. That incorporates the largest possible sample, but it may be more likely to introduce false positives. In this section, I limit the analysis sample to grade 7 test takers *whose last name is unique within their ward × cohort*, and whose last name matches that of a 2014 grade 9 test-taker with a unique last name within the ward.

Table B.2: Diff-in-diff: family financial constraints measured by exam fee non-payment
Unique last names within ward × cohort

	Pri achievement		Pri investment			Sec achievement	
	Pass PSLE	PSLE score (σ)	Absent PSLE	Pri. school pass rate (pre-reform)	Pri. school cohort size	Transition	Pass yr9 exam | transition
Treat × Post	0.031***	0.031	-0.003	0.008**	0.330	0.043***	0.017
	(0.010)	(0.023)	(0.002)	(0.004)	(1.234)	(0.012)	(0.015)
N	108,740	108,740	108,740	108,740	108,740	108,740	38,487
Mean (treated, pre)	0.627	0.016	0.016	0.525	91.284	0.218	0.903

All regressions include family FE. Standard errors clustered by ward. Transition only measured for students whose full name is unique across the country within their cohort. * p<0.10, ** p<0.05, *** p<0.01

The results, shown in Table B.2, are very similar to those in Table 2, showing evidence that FSE raised Grade 7 exam pass rates, slightly increased selection into higher-pass-rate schools, and increased transition rates to secondary school. This specification finds slightly noisier but qualitatively similar results on reduced absences.

B.3 School × FTNA score fixed effects

An alternative specification omits family fixed effects, but includes fixed effects for the 2014 grade 9 sibling's school × FTNA score:

$$Y_{itsg} = \alpha + \delta\, Treat_i + \sum_{t=2014}^{2019} \beta_t\, Treat_i \times \lambda_t + \lambda_t + \eta_s \times \zeta_g + \varepsilon_{itsg} \quad (7)$$

In Equation 3, Y_{itsg} is the outcome for PSLE-taker i in year t, whose sibling took the FTNA in school s and received grade g. $Treat_i$ is an indicator for whether the student's sibling failed to pay the FTNA fee in 2014. This indicator is then interacted with indicators for the years 2014-2019[23]. λ_t are year dummies, η_s are dummies for the secondary school in which the older sibling sat the FTNA, and ζ_g are dummies for the overall grade the older sibling received on the FTNA. The β_t coefficients on the interaction terms are the coefficients of interest.

Table B.3: Diff-in-diff: family financial constraints measured by exam fee non-payment
School × score fixed effects

	Pass PSLE	PSLE score (σ)	Absent PSLE	Pri. school pass rate (pre-reform)	Pri. school cohort size	Transition	Pass yr9 exam | transition
Treat	-0.026***	-0.036**	0.003**	-0.010***	0.992	-0.038***	-0.010
	(0.007)	(0.017)	(0.002)	(0.004)	(0.951)	(0.009)	(0.009)
Treat × Post	0.034***	0.035**	-0.005***	0.017***	-1.366	0.037***	0.017*
	(0.008)	(0.018)	(0.001)	(0.004)	(0.971)	(0.011)	(0.009)
N	477,302	477,302	477,302	477,302	477,302	477,302	227,237
Mean (treated, pre)	0.577	-0.096	0.019	0.492	86.851	0.187	0.879

All regressions include older sibling's school × FTNA score FE. Standard errors clustered by ward. Transition only measured for students whose full name is unique across the country within their cohort. * p<0.10, ** p<0.05, *** p<0.01

The results, in Table B.3, are very similar to those in Table 2. FSE raised Grade 7 exam pass rates (and scores), significantly reduced absences from an already low base, increased selection into better schools, and increased transition rates to secondary school.

B.4 Older sibling dropout as treatment measure

Another measure of which families might be "treated" by the abolition of secondary school fees is whether children in the pre-reform period who passed the PSLE but nevertheless dropped out before sitting the FTNA — perhaps partly due to an inability to pay secondary school fees. This population may be con-

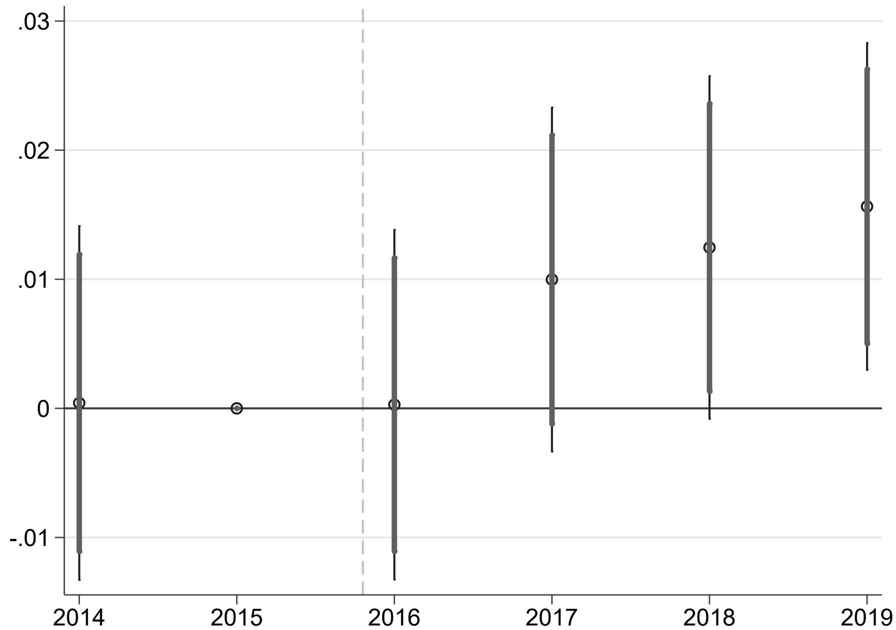
[23]Although PSLE scores are available for 2013, I exclude this year to avoid potential endogeneity of 2014 FTNA payments to siblings' 2013 PSLE performance.

sidered less "marginal" than the main sample in terms of its ability to pay secondary school fees: these families may or may not have sent any pupils to secondary school in the pre-reform period, whereas all families in the main analysis sample sent at least one. (Among families for whom both measures of treatment can be defined – 42,801 of the 2,221,612 total families – the correlation between $Dropout_f$ and $NonPayment_f$ at the family level is just .0253.)

$$Y_{itf} = \alpha + \eta_f + \lambda_t + \sum_{t=2014}^{2019} \beta_t \, Dropout_f \times \lambda_t + \varepsilon_{itf} \tag{8}$$

In Equation 8, Y_{itf} is the outcome for PSLE-taker i in year t, from family f, whose sibling took the PSLE in 2013. λ_t are year fixed effects; η_f are family (last name $\times$ ward) fixed effects. The sample is limited to 2014-2019 PSLE takers who shared a last name with exactly one 2013 PSLE taker in their ward who obtained a passing score ("older family member"). $Dropout_f$ is an indicator for whether the student's older family member failed to make the transition to secondary school (as proxied by sitting the FTNA exam 2 years later in 2015). This indicator is then interacted with indicators for the years 2014-2019. The β_t coefficients on the interaction terms are the coefficients of interest.

Figure B.1: Difference in pass rates for younger siblings of PSLE-passing dropouts vs. non-dropouts



This figure shows interaction coefficients from Equation 8. The specification shows how the difference in outcomes between grade 7 exam takers whose older siblings passed the PSLE in 2013 but did vs. did not drop out changed over time. The figure plots the coefficients and 90% and 95% confidence intervals on the interaction between the $Dropout_f$ dummy and each year dummy (where the omitted year is 2015, the last year before the policy began).The average raw pre-reform difference in pass rates between these two groups was 13.9 percentage points.

Figure B.1 shows that, while effects are a bit noisier and smaller, the general pattern evident from the main analysis is present here as well. After the introduction of FSE, families more likely to have been constrained by school fees (here proxied by previous dropout within the family) saw disproportionate increases in primary school test scores.

This analysis can be repeated for various outcomes in a difference-in-differences framework:

$$Y_{itf} = \alpha + \eta_f + \lambda_t + \beta \, Dropout_f \times post_t + \varepsilon_{itf} \quad (9)$$

Table B.4 shows coefficients from Equation 9, with results broadly similar with those in Table 2. PSLE takers from treated families (defined here as those where an older family member failed to transition to secondary school despite passing the exam) became more likely after the reform to pass the PSLE and

Table B.4: Diff-in-diff: family financial constraints measured by prior dropout

	Pri achievement		Pri investment			Sec achievement	
	Pass PSLE	PSLE score (σ)	Absent PSLE	Pri. school pass rate (pre-reform)	Pri. school cohort size	Transition	Pass yr9 exam | transition
Treat × Post	0.010**	0.001	-0.000	0.001	-0.727	0.054***	0.001
	(0.005)	(0.011)	(0.001)	(0.002)	(0.522)	(0.006)	(0.006)
N	310,271	310,271	310,271	310,271	310,271	310,271	144,553
Mean (treated, pre)	0.677	0.146	0.014	0.600	84.193	0.235	0.905

All regressions include family and year FE. Sample limited to students whose older sibling passed the PSLE. Standard errors clustered by ward. Transition only measured for students whose full name is unique across the country within their cohort. * p<0.10, ** p<0.05, *** p<0.01

to transition to secondary school (though this analysis shows no evidence of reduced absence rates or selection into better schools).

C Data details

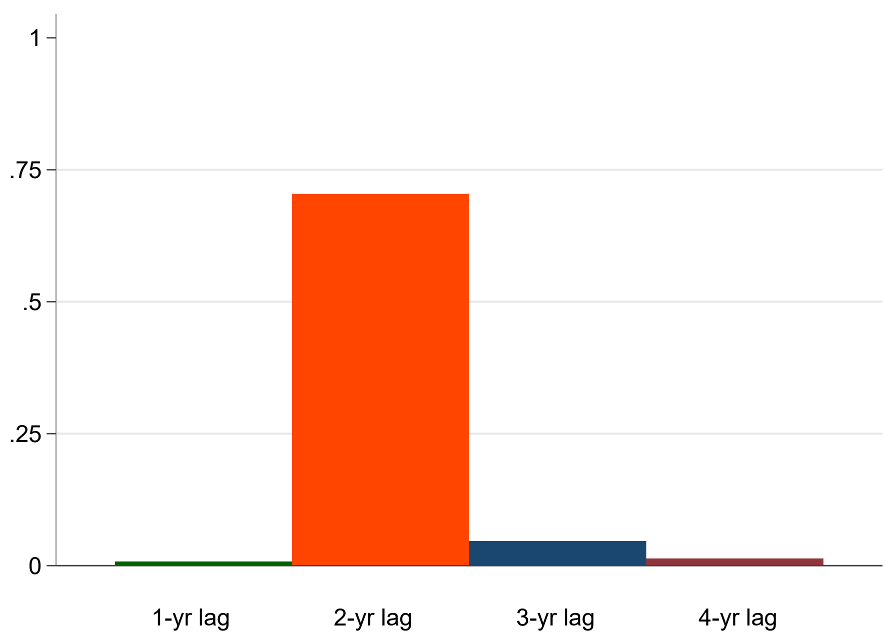
This section provides more detail on variable construction using NECTA data.

C.1 Transition to secondary school

Because the measure of secondary transition relies on matching student names across exams, assessing the fidelity of this match is important. One measure of data quality is whether student names include a middle name or only a middle initial. This would affect the probability of matching on multiple dimensions: students with a middle name in one test but a middle initial in the other will not be matched, and students with only a middle initial are less likely to be uniquely identified in general. Within ward×cohorts, names from treated families are no more or less likely than those from control families to have only a middle initial, in either the grade 7 PSLE exam or the grade 9 FTNA exam.

Testing how many FTNA (grade 9) test takers match to a PSLE (grade 7) test taker from two years prior is another way to assess the quality of this measure of transition. Figure C.1 shows what fraction of Grade 9 FTNA takers match to the name of a PSLE taker from prior years.

Figure C.1: Match rate of FTNA takers to PSLE takers in prior cohorts



This figure shows the fraction of uniquely-named FTNA takers whose name matches a uniquely-named PSLE taker from one, two, three, or four years earlier. A two-year lag represents normal grade progression.

Most FTNA takers with unique names — 70% — match to the unique name of someone who took the PSLE two years earlier, representing normal grade progression. Less than 1% match to the name of a PSLE taker from one year earlier. These matches could be "false positives" – spurious name-sharers who don't in fact represent the same student – or precocious students who skipped ahead one grade. About 5% and 1% match to the PSLE cohorts from three and four years prior, respectively. Many of these matches likely represent students who failed the PSLE the first time around, or who were delayed for a year or two in their studies for other reasons, but ultimately made it to the end of the second year of secondary school (though some are likely also spurious name-sharers).

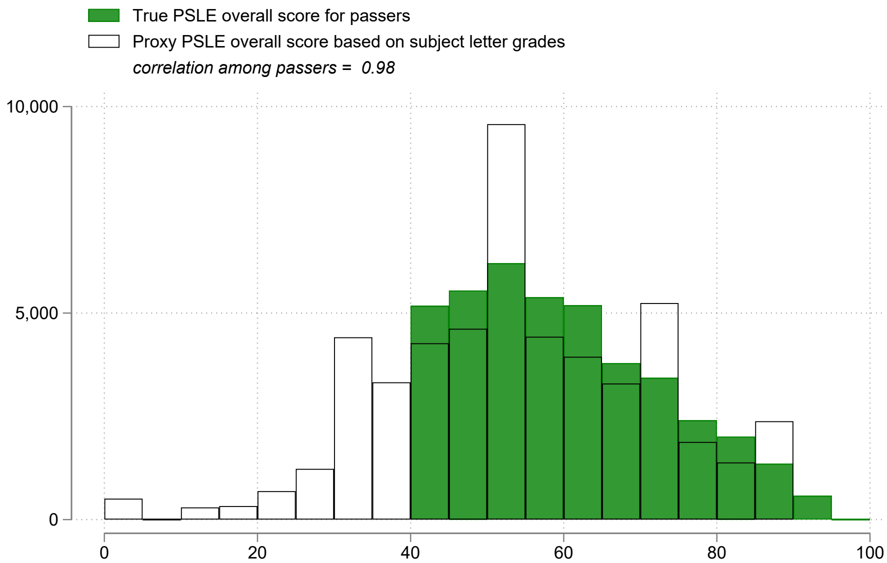
C.2 Proxy PSLE overall score

NECTA provides coarse measures of students' overall PSLE score, while providing a sharp measure of whether they passed. My proxy measure of overall PSLE score is the sum of subject scores – where each subject score is interpolated to be the midpoint of the range of scores that correspond to the letter grade reported – normalized to a 100-point scale.

It is possible to partially validate this measure, at least for one cohort in one region. For the 2016 PSLE cohort from Mwanza (the second-most populous region in Tanzania), the list of precise overall PSLE scores is available, but only for students who cleared the passing threshold (i.e. scored over 40%). Comparing this distribution with the proxy overall PSLE scores devised from the NECTA data for matchable students yields a correlation of .98. This suggests that the proxy measure of PSLE overall scores is a reasonably good one.

This exercise also shows no evidence of excess mass to the right of the passing threshold, increasing confidence that test scores are not being manipulated.

Figure C.2: Histogram: comparison of proxy overall PSLE score with true overall PSLE score



This histogram shows the distribution of proxy PSLE overall scores — calculated by assigning each of the five subject letter grades the midpoint of its score range and summing each student's five subject scores — on top of the distribution of true overall PSLE scores for those who passed the exam. Both distributions show test takers from Mwanza region in 2016, the only group for which precise overall PSLE scores were available.

D PSLE questions

Question 2: Juayote __________ reading a book now.

A. have
B. is
C. were
D. had
E. was

Response pattern

Option	A	B*	C	D	E	Omitted	Others
No. of candidates	148757	437924	104199	49250	100943	1361	2282
% of candidates	17.61	51.84	12.34	5.83	11.95	0.16	0.27

Question 15: This book is yours but the blue one is __________.

A. mine
B. your
C. my
D. me
E. their

Response pattern

Option	A*	B	C	D	E	Omitted	Others
No. of candidates	331523	186011	112602	114238	94206	2839	3297
% of candidates	39.25	22.02	13.33	13.52	11.15	0.34	0.39

Swali la 1: $6.894 - 5.759 =$

A. 1.085
B. 1.045
C. 1.135
D. 1.145
E. 1.125

Majibu ya watahiniwa

Chaguo	A	B	C*	D	E	Wasiojibu	Mengine
Idadi ya watahiniwa	35,671	36,059	672,201	77,955	19,757	890	2,176
Asilimia ya watahiniwa	4.22	4.27	79.58	9.23	2.34	0.11	0.26

Swali la 4: $472 \times 8,934 =$

A. 4,216,884
B. 4,126,848
C. 4,216,848
D. 4,126,748
E. 4,206,848.

Majibu ya watahiniwa

Chaguo	A	B	C*	D	E	Wasiojibu	Mengine
Idadi ya watahiniwa	87,192	132,281	427,855	91,799	93,863	8,697	3,022
Asilimia ya watahiniwa	10.32	15.66	50.65	10.87	11.11	1.03	0.36

Figure D.1: Example questions from the PSLE