A Plan to Recruit Teachers to an Urban School District in Brazil

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Foreword

Disclaimer

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not those of the World Bank or the Salvador Municipal Secretary of Education.

Dedication

A project of this scope takes a village. My village includes too many to name, but I want to highlight a few key members. I want to thank Professors Dan Player and Annie Rorem for their support, encouragement, and guidance thorough this project. Ildo Lauthare Junior, Gio Pavlovic Quintão, and Lousiee Cruz at the World Bank for their knowledge, time, and kindness. Rafael Salles Moniz Freire and others at the Salvador Municipal Secretary of Education for their patience with my less-than-perfect Portuguese and frequent lack of contextual knowledge. To my dear housemate Lucas Martínez, thank you for feeding me, keeping me sane, and reminding me to be nice to myself throughout this process. Finally, to my family and friends, who invariably support and love me—I owe you everything.

Key Terms

GYO — Grow Your Own

FUNDEB — Basic Education Maintenance and Development Fund

LMIC — Low- and Middle-Income Country

MEB — Bahia Ministry of Education

MEC — Brazil Ministry of Education

OECD — Organisation for Economic Cooperation and Development

PST — Pre-service Teacher

RCA — Root Cause Analysis

STR — Student-Teacher Ratio

SAEB — National Basic Education Assessment System

SMED — Salvador Municipal Secretary of Education

SME — São Paulo Municipal Secretary of Education

Executive Summary

Problem

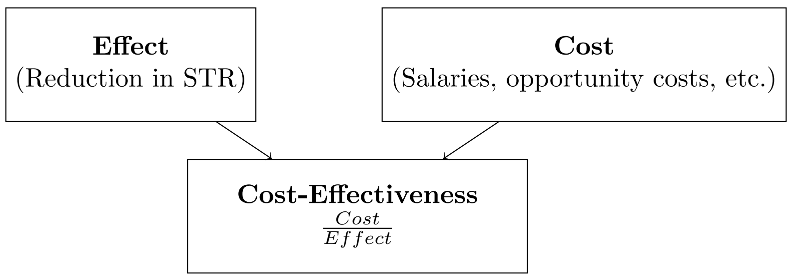
The Municipal Secretary of Education (SMED) in the city of Salvador, Brazil finds it difficult to attract high-quality teaching candidates. As a result, SMED schools have relatively high student-teacher ratios (see: Figure 1) and students in SMED schools have significantly worse academic outcomes than the country average (see: Figure 2).

Policy Alternatives

1. Hiring Bonuses
   - \$500 hiring bonuses for 478 new teachers over two years ($\sim$ 10% of a novice teacher's salary)
2. Grow Your Own (GYO) Program
   - A teacher preparation program in Salvador High Schools to increase interest in teaching
3. Marketing Campaign
   - A marketing campaign at teacher education programs to increase interest in SMED schools and promote in-person teacher education programs

Criteria

To chose a policy alternative, I evaluate program effects, costs, and cost-effectiveness over eight years after implementation



Recommendation

To provide the best reduction of STR over an eight year period at a reasonable cost, I recommend that the SMED adopt a Grow Your Own (GYO) program. The table below shows my preferred estimates of how each policy would affect each of the three criteria:

Policy Alternative Matrix: Preferred Estimates

Policy Alternative	Total Effect	Cost	Cost Effectiveness
Hiring Bonuses	4.532	\$6,340,699	\$1,398,945
Grow Your Own	1.015	\$282,394	\$278,328
Marketing Campaign	0.795	\$675,560	\$849,384

Implementation

- Work with the World Bank and Federal Ministry of Education (MEC) to secure consistent funding for a GYO program via FUNDEB (i.e., the primary source of school financing in Brazil)
- Partner with Bahia Ministry of Education (MEB), who runs secondary schools in Salvador, to implement program in high schools

1 Introduction

1.1 Problem Statement

The Municipal Secretary of Education (SMED) in the city of Salvador, Brazil finds it difficult to attract high-quality teaching candidates. As a result, SMED schools have relatively high student-teacher ratios (see: Figure 1) and students in SMED schools have significantly worse academic outcomes than the country average (see: Figure 2).

1.2 Client Overview

This project is a collaborative effort between the author, the World Bank, and the SMED. The SMED manages municipal primary schools in the city of Salvador, Brazil[1]. The goal of the World Bank is to "end extreme poverty and promote shared prosperity in a sustainable way." The World Bank partners with the SMED on several research and policy initiatives. The proposals in this report aim to provide policy solutions to the problem above. Some of these policy solutions cannot be implemented unilaterally by the SMED and will require coordination with external agencies.

1.3 Purpose

The purpose of this report is to provide context for this problem, evaluate policy alternatives that may attract a sufficient number of high-quality teachers and reduce the student-teacher ratio (STR) in SMED schools, and make a policy recommendation to address this problem. The findings of this report will be communicated with employees of the World Bank who conduct research on education in Brazil and members of the SMED Human Resources team. The section that follows provides the reader with the contextual information required to understand this project.

2 Background

This section provides necessary background for this report. The first subsection discusses the context in Salvador, Brazil: its schools, the socioeconomic situation in Salvador relative to other parts of Brazil, and important background on the city's history. The next subsection describes the root causes of the problem. Finally, this section concludes with information on school governance and finance in Brazil.

2.1 Context

Primary school students in Salvador public schools perform far worse on standardized exams than the country average. Using data from the fifth grade 2021 SAEB Exam[2], Figure 2 shows that students in Salvador public schools performed 0.18 standard deviations worse in Math and 0.08 standard deviations

[1] The municipality also operates in some secondary (i.e., middle) schools, but shares this responsibility with the state government. This is discussed in further detail in the Background section.

[2] SAEB is a series of exams and surveys administered to a nationally representative sample of students and teachers in Brazil every other year. It is not tied to any school accountability program, but instead is used to provide policymakers, stakeholders, and researchers insight into Brazil's education system.

worse in Portuguese than the average in the rest of Brazil. For context, this is 33% of Black-white achievement gap on the fifth grade SAEB exam in Math. Interviews with employees of the Salvador Secretary of Education highlight that improving student achievement on these exams is a primary goal of the SMED.

Relatively low student achievement in Salvador is driven, in part, by poor economic opportunity. Salvador is located in the northeastern state of Bahia, which is the fourth largest by population, with over 14 million people. Despite its size, the state is relatively poor, raking 18th out of 27 in terms of GDP per capita in 2020. Research shows that family income explains much of the variation in student achievement (Guimarães and Sampaio, 2013). Although improving the economic conditions of Salvador is outside the scope of this report, understanding the relative disadvantage of the state of Bahia and city of Salvador is crucial to the problem at hand.

Salvador and Bahia are deeply connected to Brazil's history of slavery, which continues to influence the racial composition and culture of the city. During the Atlantic Slave Trade, more enslaved people were brought to Brazil than any other country Bergad (2001). As a major port city, many of these enslaved individuals were brought to Salvador. The influence of slavery is evident in the demographics of the city today; in 2010, 79.5% of residents in Salvador were Black or mixed race, compared to just 50.7% in Brazil. Additionally, Salvador is considered the center of Afro-Brazilian culture, which permeates through music, food, language, and religion.

2.2 Root Cause Analysis (RCA)

Figure 3 provides a Root Cause Analysis (RCA) of the problem. The primary objective of the SMED is to improve student achievement in Salvador municipal schools. To this end, the focal point of the RCA and main short-run outcome of this project is student achievement. Student achievement (i.e., test scores) is generally accepted as a good predictor of later in life outcomes. For example, Goldhaber and Özek (2019) highlight that improvements in test scores are causally linked to positive intermediate outcomes like high school graduation, college-going, and income. In addition, improved educational outcomes may also lead to positive externalities, such as increased civic engagement, which are included as long-run outcomes in the RCA.

The Primary Root Causes in this RCA are inputs to an education production function (Hanushek, 2020). An education production function is a way of relating education inputs (e.g., parental investment, class size, etc.) to student achievement. For example, an education production function might be used to estimate how much decreasing a class size would affect student achievement. Typical inputs to these functions include student ability, school quality, class size, teacher quality, and parental investments.

In this report, I focus on improving one input to the education production function: class size. Class size is measured as the ratio of students to teacher in a school, or a school's student-teacher ratio (STR). Lower student STRs indicate more teachers per student at a school. I focus on reducing class size in this report for three reasons. First, high-quality empirical evidence shows that reducing class size improves student achievement in the short- and long-run (Krueger and Whitmore, 2001). Second, reducing class size in SMED schools is relatively feasible compared to improving the economic conditions of families in the district. Finally, the SMED finds it difficult to recruiting teachers. Improving the teacher pipeline can solve two related problems for the district: difficulty hiring teachers and low student achievement.

This report focuses on improving the teacher training pipeline, as opposed to improving the quality of the existing teacher workforce. Although research shows policies such as teacher evaluation can improve the quality of the existing teacher workforce (e.g., Dee and Wyckoff, 2015), these programs often require sophisticated data and evaluation systems that provide feedback to teachers. Less sophisticated systems often result in all teachers receiving high evaluation ratings, which makes it difficult for teachers to know where they can improve and for administrators to differentiate between more and less effective teachers (Weisberg et al., 2009). The SMED has relatively little proprietary data to set up these systems. Additionally, the district is relatively resource-constrained can probably cannot conduct high-quality teacher evaluations. Given these constraints, I focus on solutions that aim to recruit addition teachers to the district.

Improving teacher hiring may increase the quality of teachers and help students. There is a large body of research shows that teacher quality has an outsized impact on student learning, relative to other inputs (Jackson et al., 2014; Kane and Staiger, 2008; Rivkin et al., 2005). For example, students who have more effective teachers are more likely to attend college, earn more, and less likely to have a teenage pregnancy (Chetty et al., 2014). Increasing the supply of teachers allows districts to hire more selectively. Additionally, unfilled teaching positions often lead districts to fill classrooms with underqualified teachers. For example, school districts with an insufficient number of teachers may turn to hiring individuals with provisional licenses, which may contribute to poor student achievement.

2.3 Educator Supply in Salvador

The SMED cannot hire an adequate number of teachers. Although the district does not collect data on teacher vacancies, interviews with district staff have made it clear that they find it difficult to fill teaching vacancies and currently face a teacher shortage. To better understand the teacher pipeline in Salvador, I analyze data from Brazil's Census of Higher Education. These data are collected annually and contain information on enrollment and graduation for all degrees offered by postsecondary education institutions in Brazil. In addition, the census contains descriptive information about programs. For example, whether programs are completed in-person or online.

Staffing difficulties are likely related to declining enrollment and graduation rates from teacher training programs. Figure 4 shows a line graph with the enrollment rate in teacher training programs in Salvador and the Rest of Brazil, relative to 2015. Since 2015, enrollment in primary school teacher training programs in Brazil rose by 26.4%. Over the same period, enrollment in primary school teacher training programs in Salvador decreased by 5.3%. At the same time, the graduation rate from these programs has decreased. Figure 5 shows the five year graduation rates for students enrolled in primary school teacher training programs in Salvador. In 2017, the five year graduation rate was over 25% (i.e., 25% of students who started a primary school teacher training program in 2012 completed that degree by 2017). In 2022, this number dropped by over 50% to 12.3%. To improve enrollment in teacher training programs, policymakers may wish to consider options that increase interest in these programs.

The rise of online teacher training programs make it difficult to attract teachers to SMED schools. Online teacher training programs are increasingly popular in Salvador. Figure 6 shows that online teacher training programs in Salvador now enroll more students than in-person programs. Interviews with members of the SMED Human Resources Team made it clear that they find it difficult to attract pre-service teachers (PSTs) attending online teacher training programs to internships. These internships are akin to clinical teaching experiences in the United States and are a key hiring mechanism used by the district to attract PSTs to enter SMED schools after graduating. Beyond this, PSTs who attend teacher training programs online are significantly less likely to complete their teaching degrees than their peers who study in-person. Figure Figure 7 shows that graduation rates of online teacher training programs are generally around 25%, compared to around 75% for in-person programs. The rise of online teacher training programs in Salvador may also have implications for teacher quality. Recent evidence from the United States suggests that teachers who complete their training programs entirely online are less effective than those who have at least some in-person training (Kirksey and Gottlieb, 2023). Policies aimed at alleviating teacher shortages in Salvador may consider nudging candidates towards in-person programs.

Low teacher pay and occupational status may contribute to school staffing shortages in Salvador. Surveys conducted by the Organisation for Economic Co-operation and Development (OECD) show that teacher salaries in Brazil are relatively low and teachers feel undervalued (OECD, 2021). According to these surveys, only 20% of Brazilian teachers consider their salary adequate. Low salaries may explain why the most academically gifted individuals are less likely to go into teaching (i.e., those with many outside options) (Bank, 2016). Finally, just 10% of teachers in Brazil believe the teaching profession is socially valued, compared to 26% in other OECD countries (OECD, 2020). Policies that seek to expand the teacher training pipeline should consider increasing teacher pay.

2.4 School Governance and Finance in Brazil

Figure 8 provides a governance map of the public school system in Brazil. The Salvador Secretary of Education runs municipal schools in Salvador (i.e., those governed by local municipalities—the blue box in Figure 8). These are distinct from state run schools. Primary I schools (i.e., grades 1 to 5) are run exclusively by municipalities. Primary II schools (i.e., grades 6 to 9) are managed by either municipalities or states. The allocation of state and municipal primary II schools between varies across Brazil, but is split evenly in Salvador. States exclusively run secondary schools (i.e., grades 10 to 12).

The supply of teachers varies by school level. In primary II grades, municipal schools compete with state schools for teachers. It is unclear if teachers have a preference for one of these types of schools. Additionally, the required teacher certification varies by school level. Like the United States, students in primary I schools (grades 1 to 5) have just one teacher for the entire day. Students in primary II and secondary schools are taught by different teachers for each subject. To become a certified teacher primary I teacher, individuals need to receive a Bachelor's degree in Pedagogy from a university in Brazil. In primary II and secondary schools, teachers become qualified by receiving a licensure in subject area. For example, in order to teach Math in 7th grade, an individual needs to get a Math licensure from a Brazilian university. Receiving any of these degrees takes either four or five years, depending on the program and university.

Schools in Brazil are generally financed by their governing body (i.e., municipality, state, or federal government). The Brazilian constitution requires that municipalities and states use at least 25% of their tax revenues and transfers from the federal government to the "maintenance and development of education" (OECD, 2019). Although the federal government provides financial resources to states unable to raise a minimum level of per-student funding, there are vast differences in education spending across states in Brazil. For example, some municipalities in the richer, southern states in Brazil spend nearly 20,000 Brazilian reais per student annually In Bahia, the wealthiest municipalities spend just $R 8,000.

The Basic Education Maintenance and Development Fund (FUNDEB) is a key source of financing for K-12 education in Brazil. FUNDEB is administered through Brazil's federal Ministry of Education (MEC) and is composed of a variety of state and municipal tax dollars, in addition to transfers from the federal government. The purpose of FUNDEB is to make per-pupil spending more equitable across states and municipalities in Brazil. Some estimates indicate that without FUNDEB per-student expenditure across municipalities would be as high as 10,000% (pela Educação, 2018). FUNDEB is a key financing mechanism that could potentially be leveraged to finance some of the policy alternatives proposed in this report.

3 Consequences

Prior research shows a clear connection between student-teacher ratios and test scores (Krueger and Whitmore, 2001), but the consequences of low-student achievement extend far beyond the classroom. For example, research shows that students who perform poorly on standardized exams are less likely to engage in risky behavior and more likely to attend college (Goldhaber and Özek, 2019). If left unaddressed, high student-teacher ratios may well contribute to poor long-term outcomes for students in SMED schools[3].

Low student achievement in Salvador contributes to inequity in Brazil. Brazil is one of the world's most racially unequal countries (Lima and Prates, 2019). Despite numerous large-scale social policies, Black people in Brazil often occupy the lowest place in social hierarchies. Figure 9 shows the racial composition of SMED schools, compared to schools in the rest of Bahia and the rest of Brazil. Black

[3]The "business as usual" subsection of the "Outcomes" section below shows that the STR in Salvador is unlikely to change in the future, given trends over the past several years.

students make up 25% of all students in Salvador, compared to just 11% in the rest of Bahia and 4% in the rest of Brazil. Given Salvador's racial composition—and historical ties to slavery—outcomes for students in SMED schools are directly tied to racial inequality in Brazil. Moreover, since Bahia is a historically Black city, the performance of students in its capital may be pivotal in igniting social change.

Attracting teachers to SMED schools may improve short- and long-run outcomes for students in Salvador. Since Salvador is a historically Black city, improvements to SMED schools may result in lowered inequality, which has been a persistent issue in Brazil. The following section describes three policy alternatives that may help the SMED attract additional teachers to the district.

4 Policy Alternatives

This section describes alternative options that may solve SMED's teacher recruitment problem. The three alternatives are: teacher hiring bonuses, Grow Your Own (GYO) programs, and a marketing campaign. For each alternative, I define the intervention broadly, explain why it is suitable for this problem, and describe—in detail—how a policy would work in this context.

4.1 Bonuses

Hiring bonuses are one-time pecuniary incentives provided to new teachers in a school district. These bonuses provide clear incentives to attract new teachers to a district. Economic theory and empirical evidence show that hiring bonuses are very effective at attracting teachers to schools (e.g., Falch, 2011; Glazerman et al., 2013). In this context, hiring bonuses are paid to new teachers upon entry in SMED schools. Hiring bonuses may be an effective solution to improve notably low teacher salaries in Brazil (OECD, 2019) and attract individuals to the teaching profession.

This policy alternative includes 478 hiring bonuses of $500 for two years. As shown in Table 1, SMED employed 4,879 educators to teach 107,125 students in 2022, implying a STR of 22.0. Assuming a constant number of students, hiring an additional 478 educators would bring the STR below 20, a 9.1% decrease. Research shows that the size of hiring bonuses is an important determinant of their effectiveness Rosa (2019). Specifically, Rosa (2019) finds that 5% hiring bonuses were insufficient to draw teachers to hard-to-staff schools in São Paulo. A $500 bonus is the equivalent of 9.3% of a novice teacher's salary in SMED schools. SMED staff may consider increasing the amount of these bonuses and lowering number of bonuses given if trying to draw teachers to especially hard-to-staff schools in the district.

4.2 Grow Your Own Program

Grow Your Own (GYO) programs cover a range initiatives that aim to recruit and support individuals from local communities to join as teachers. These programs have the potential to improve interest in the teaching profession and expand the teacher pipeline. Moreover, a GYO program may address waning interest in teacher education programs (see: Figure 4) in Salvador.

In this context, a GYO program would operate in secondary schools in Salvador with goal of increasing the number of students who enter teacher training programs at local universities. There are 112 public secondary schools in Salvador. An ambitious GYO program could operate in each of these schools and would be offered as an elective where students can learn pedagogical skills. The program would also include an advertising campaign for its launch.

4.3 Marketing Campaign

The final alternative is a marketing campaign, targeted at postsecondary institutions that offer teacher education programs in Salvador. The purpose of this campaign is to encourage students to pursue a major in education—a requirement to teach in SMED schools. Additionally, this program could encourage , which may solve declining enrollment in in-person teacher education programs (see: Figure 6), that have better graduation rates than online programs (see: Figure 7. Finally, this campaign could encourage students already enrolled in teacher education programs to apply for jobs and complete internships in SMED schools.

There are 84 postsecondary institutions that offer education majors in Salvador. A marketing campaign would include fliers, informational pamphlets, information sessions, and interviews with exemplary SMED teachers. SMED would likely need to hire a marketing manager for this role. The marketing manager would arrange for twice-annual campus visits from members of the SMED to each program.

5 Evidence Review

This section provides a review of relevant empirical evidence for each of the three policy alternatives. To improve applicability in this context, evidence from other low- and middle-income countries in Latin America is preferenced over evidence from high-income countries. Highly relevant evidence from different contexts is included when there is a dearth of evidence from more comparable settings, but these results should be interpreted with care.

5.1 Teacher hiring bonuses

Evidence from low- and middle-income countries (LMICs) demonstrates that hiring bonuses are an effective way to attract teachers to the profession. Evans and Mendez Acosta (2023) provide a systematic review of evidence on policies aimed at recruiting teachers in hard-to-staff schools in LMICs. They find that "most financial incentive programs have positive impacts on teacher outcomes". For example, Bobba et al. (2021) analyze the impact of a policy change in Peru that offered salary increases to teachers in rural schools. Using a regression discontinuity (RD), the authors compare schools just below the eligibility cutoff (i.e., ineligible for the salary increase)[4] to those just above the cutoff (i.e., eligible for the salary

[4]The cutoff was based on population and distance from the nearest city. The key identifying assumption of this study is that schools just below the cutoff are comparable to those just above the cutoff.

increase). They find that schools just eligible for the salary increase attracted new teachers that were 0.45 standard deviations more effective than those just ineligible for the salary increase.

Despite the demonstrated success of these programs, prior evidence shows that the size of hiring bonuses is an important determinant in their effectiveness. Most relevant to this project, Rosa (2019) explores the effect of a program that increased teacher pay by 5% to teach in schools in São Paulo, Brazil that were located in hard-to-staff neighborhoods. Using an geographic RD design, Rosa (2019) compares schools eligible for the pay increase to proximal schools that were ineligible for the pay increase. He finds that the bonuses were not sufficiently high to change the number of new teachers that these schools attracted. These results highlight the importance of teacher preferences and that the size of bonuses is of the upmost importance in designing teacher bonus programs.

Since bonuses must be sufficiently high to attract teachers, policymakers may want to target them towards the most effective teachers. The Dallas Independent School District (ISD) Accelerating Campus Excellence (ACE) program offered bonuses up to $10,000 to teachers identified as effective that moved to schools identified as low-performing[5]. Morgan et al. (2023) employ a difference-in-differences (DID) strategy to evaluate the effect of the ACE program on student learning in elementary schools. In this study, they compare the change in academic performance in ACE schools to other low-performing schools that were not eligible for the ACE bonus[6]. The authors find that the program had large, positive effects on student achievement in both math and reading. To put the results in context, these increases brought the achievement of students in previously low-performing elementary schools up to the district average. Other districts in the United States have implemented similar teacher incentive programs and also find positive impacts on teacher quality (Dee and Wyckoff, 2015) and student achievement (James and Wyckoff, 2020).

Hiring incentives work to reduce vacancies in hard-to-staff subject areas and schools. Like many states, Hawai'i has a shortage of Special Education teachers (SETs) (Meinecke, 2023). In 2020, the Hawai'i State Board of Education (HBOE) increased the pay of SETs by $10,000 in an attempt to alleviate shortages in this subject. The policy also offered an an additional bonus to SETs in schools that were historically difficult to staff that was worth up to $8,000. In a recent working paper, Theobald et al. (2023) evaluate the impact of this policy on SET vacancies. Using a difference-in-differences (DiD) design, Theobald et al. (2023) compare the vacancy rates before and after the policy change between SET and non-SET vacancies. The key identifying assumption of the DiD design in this context is that the trends in vacancy rates for non-SET positions is what would have occurred for SET positions if the policy was not implemented. This assumption is not directly testable, but the authors provide evidence for this by showing that the pre-policy trends were parallel. The authors estimate that this program decreased the proportion of vacant SET positions and those filled by unlicensed teachers by 32% and

[5]For context, Dallas ISD launched ACE one year after the start of a new teacher evaluation scheme—the Teacher Excellence Initiative (TEI). This evaluation scheme differentiated teacher pay based on performance metrics relative to other teachers in the district. Hanushek et al. (2023) provide an evaluation of TEI on student outcomes and find that the program improved student learning.

[6]The key identifying assumption of the DID design in this context is that the trend in student learning in control schools is what would have occurred in the ACE schools in absence of the program.

35% respectively (Theobald et al., 2023). Finally, they find that the policy had the largest impact on vacancy reduction in hardest-to-staff schools, where bonuses were $18,000.

5.2 Grow Your Own Program

Initial evidence on GYO programs indicates that they can increase the supply of teachers. In an unpublished manuscript, Lagos et al. (2023) evaluate the Teacher Academy of Maryland (TAM). TAM is a GYO program implemented in Maryland high schools. The program gives high school students the opportunity to take courses in teaching, which translate to college credits. Using a DID strategy, they exploit the staggered roll out of TAM to compare students who attended schools with TAM to those without access to the program. The authors find that on average, students exposed to TAM are about 0.7 percentage points more likely to go into teaching (a 70% increase). Although this research is preliminary—and from a drastically different context—it suggests that GYO programs may indeed increase the supply of teachers.

Although evidence on the effects of GYO programs is sparse, these programs are grounded in a solid Theory of Change. The theory underlying GYO programs is based in prior research that suggests that teachers who were once students in their own districts are less likely to exit the district Redding (2022). Additionally, GYO programs may lead to teachers who have similar backgrounds to their students. A growing body of research demonstrates that students tend to preform better with teachers who share their racial/ethnic identities (Dee, 2004; Gershenson et al., 2022), which suggests that teachers with backgrounds similar to their students may be more effective. Although there is a dearth of evidence on GYO initiatives, these programs are both popular and promising.

5.3 Marketing Campaign

Research from other Latin American countries demonstrates that behavioral interventions can affect where teachers decide to work. In a recent working paper, Ajzenman et al. (2021) use a randomized controlled trial (RCT) in Peru to evaluate the impact of two behavioral interventions on PSTs' decisions to work in hard-to-staff schools. The teacher labor market in Peru is centralized through the federal government; all individuals apply to teaching positions on a single platform after passing a qualifying exam. The RCT randomly assigned individuals who entered the platform into three conditions: (1) a business as usual control group; (2) an altruism arm, that asked individuals to write a five minute reflection on why they became a teacher and received pop-ups and texts to prime them for prosocial behavior (e.g., "Thank you for being an agent of social change"); or (3) an extrinsic arm, that provided information to individuals on financial bonuses offered to teach in hard-to-staff schools. The authors find that individuals assigned to groups (2) and (3) were 2.2% (1.8 ppts) and 2.6% (2.0 ppts) more likely list a hard-to-teach school in their preferences than those assigned to the business-as-usual group, respectively. Although just one study, these results highlight the potential for behavioral interventions to affect decisions to enter schools with high needs.

6 Criteria

This section describes criteria used to evaluate each policy alternative. These criteria are: Effectiveness, Cost, Cost-Effectiveness.

6.1 Effectiveness

The effectiveness of each policy alternative is measured as its total improvement (i.e., reduction) in the STR over a five-year period. This measure of effectiveness allows me to compare the three policy alternatives, which likely impact STR differentially over time. For example, hiring bonuses can have an immediate impact on STR, whereas GYO programs may take several year to impact the number of teachers in SMED schools. An eight year window allows me to compare the effectiveness of these policies in a reasonably short time frame.

To make this measure of effectiveness more concrete, consider the following example. Imagine a policy that is expected to reduce the STR from 22.0 to 20.0 in year one and two after implementation. Then, imagine that the policy expires and the STR ratio goes back to 22.0 in years three, four, and five. The effect of this policy in the first two years is two (22.0-20.0) and the 0 in years three to five (22.0-22.0). The total effect of this policy is the sum of these numbers: 4.0 (2+2+0+0+0).

To account for the uncertainty of each policy, I calculate a preferred, lower bound, and upper bound estimates of the effect of each policy alternative. For policies alternatives that are well-supported by prior evidence, I provide narrower ranges of uncertainty relative to policies with a smaller evidence base. In these bounds, I also build in temporal uncertainty, where more proximal effects are more certain than those that will occur years in the future. When making a policy recommendation, I will put equal consideration to each of these estimates: preferred, lower bound, and upper bound.

6.2 Cost

The total cost of a policy is as its the sum of accounting and opportunity costs. Accounting costs are tangible expenditures. In the case of hiring bonuses, the amount spent on bonuses is a clear accounting cost. In addition to accounting costs, this figure also includes opportunity costs. For example, in the context of GYO programs and marketing campaigns, I calculate a cost to students who are drawn into the teaching profession away from higher paying fields. I identify key accounting and opportunity costs associated with each policy alternative costs. Then, I sum these costs to create a total cost number for each policy alternative.

When calculating costs incurred in the future, I discount to account for the future value of money. For example, $100 received today is likely valued more than $100 received several years in the future. I do this using the net present value formula below:

$$\text{Net Present Value} = \frac{R_t}{(1.18)^t} \tag{1}$$

where the net present value of a cost incurred in year t is equal to the ratio of the nominal cost (R_t) divided by 1.18 raised to the power of t. This formula assumes a discount rate of 18%. I take this figure from the discount rate for Brazil, provided by the Federal Reserve Bank of St. Louis. Using this formula, if a teacher would be paid \$6,000 in three years time ($t = 3$), the NPV of this cost would be: $\frac{\$6{,}000}{1.18^3} = \$3,651.79$.

6.3 Cost-Effectiveness

Cost-effectiveness is the ratio between the effectiveness and costs. Cost-effectiveness is helpful in determining the effectiveness of a policy alternative per dollar spent. Generally, lower cost-effectiveness numbers indicate a more cost-effective policy alternative. In this context, cost-effectiveness for each alternative is calculated using this formula:

$$\frac{\text{Cost}}{\text{Effect}} = \frac{\text{Total Cost}}{\text{Improvement in STR}} \tag{2}$$

This number can be interpreted as a dollars spent on a 1 point change in STR for an alternative. Using this metric, lower numbers are interpreted as more cost-effective policies.

7 Outcomes

7.1 Business as usual predictions

Before analyzing the impact of policy alternatives on STR, it is important to understand how the STR may under business as usual practices (i.e., in the absence of an intervention). To estimate business as usual trends in STR without an intervention, I predict the linear trend in STR in Brazilian primary schools. Using data from Brazil's annual school census (Ministry of Education, 2024), I estimate the following equation via OLS:

$$STR_{td} = \alpha + \beta_1 Year_t + \beta_2 COVID_t + \gamma_d + \varepsilon_t \tag{3}$$

In this model, student-teacher ratio in year t (STR_t) is a function of $Year_t$ ($Year_t \in [2017 : 2022]$), a binary variable, $COVID_t$, which takes on the value of 1 if $Year_t \geq 2020$ and 0 otherwise, and school administration fixed effects (γ_d)[7].

Figure 10 shows the results from this prediction. Solid lines show the observed trend in STR from 2017 to 2022. Dashed lines show estimated trends in STR from 2023 to 2027 (i.e., $\widehat{STR}_{td}$ from Equation 3). The different line colors distinguish school types. The model estimates that business as usual practices would result in a reduction in STR in SMED schools. Despite the estimated reduction in STR under current practices, SMED schools will have a STR that is much higher than other primary schools in Bahia and in the rest of Brazil. This result provides some suggestive evidence that the SMED

[7] γ_d controls for if school's type: SMED, non-SMED school in Bahia, or a school in the rest of Brazil.

must change their current practices to reduce the student-teacher ratio in the district.

7.2 Bonuses

Offering 478 bonuses worth nearly 10% a teacher's annual salary for two years would likely result in 478 new teachers in SMED schools. In a review of studies evaluating the effects of policies that aim to attract teachers to hard-to-staff schools in LMICs, Evans and Mendez Acosta (2023) show that hiring bonuses are a highly effective tool. Unfortunately, teachers who are recruited to schools because of hiring bonuses are not likely to stay after these bonuses end Glazerman et al. (2013). Although the SMED could potentially offer hiring bonuses in perpetuity, it is more likely that a program like this would be temporary.

The red bars in Figure 11 show the preferred estimated effect of bonuses on improving STR each year after implementation. The first and second red bar show a 2 point improvement in STR (i.e., hiring 478 new teachers in each year). After year two—when the hiring bonus program ends—the bar drops to 0.31, which assumes that 70 of the 478 (15%) teachers hired in years one and two remain in the district. This number is halved in years four and five. Overall, the total effect of this alternative—the sum of the bars in each year—is 4.5.

The gray error bars surrounding the red preferred estimates in Figure 11 upper and lower bound effects for this policy. Since there is a large body of causal evidence which demonstrates the impact of pecuniary hiring bonuses (e.g., Evans and Mendez Acosta, 2023; Morgan et al., 2023; Glazerman et al., 2013), these bars are very narrow. More specifically, I assume a potential error of 0.01 around the my preferred estimates. To account for future uncertainty, I allow this error to grow by 0.01 each additional year. Given these assumptions, my upper bound estimate for the bonuses is 4.972 and my lower bound estimate is 4.264.

The costs of this program are primarily salaries and bonus payments paid to new teachers. These costs are discounted in future years using the formula in Equation 1. Assuming a \$500 bonus and that each new teacher is paid the average teacher salary in Brazil (e.g., \$6,000), the cost each of these components is given by the following formulas:

$$\text{Cost of Bonuses} = \sum_{t=0}^{7} \frac{478 \times \$500}{(1.18)^t} \tag{4}$$

$$\text{Cost of Salaries} = \sum_{t=0}^{7} \frac{TeachersHired_t + (TeachersHired_{t-1} * 0.7)) \times \$6,000}{1.18^t} \tag{5}$$

Applying these formulas to the estimated number of teachers hired above, my estimated costs for this program sum to \$6,340,699. I consider this a lower bound estimate for the cost of this program, as there may be other unforeseen costs associated with this policy alternative.

7.3 GYO Program

In 2022, there were 30,223 students enrolled in secondary schools in Salvador. Assuming one quarter of these students are in each grade implies that 7,556 graduating students would be exposed to a GYO program each year. Lagos et al. (2023) show that exposure to a GYO in Maryland increased the probability that students became educators by 70% (0.7 percentage points). Since this evidence is preliminary (i.e., not peer-reviewed) and from a drastically different context, I assume a much smaller effect size to be conservative.

Assume that, in absence of a policy change, 100/7,556 (1.3%) students in Salvador public schools would become teachers in SMED schools [8]. To be conservative, I assume that a GYO program implemented in high schools in Salvador would yield an additional 10 teachers four years after implementation (a 10% effect size), 20 teachers five years after implementation (a 20% effect size), and 30 teachers each year afterwards (a 30% effect size). Additionally, I assume that there is a 70% retention rate for these teachers, which is not uncommon for novice teachers in large, urban districts in Brazil (Carrasqueira and Koslinski, 2021).

The green bars in Figure 11 show the preferred estimated effect of a GYO program on improving STR each year after implementation. During the first three years of the program, there is no effect on STR. In year four, assuming an increase in 10 teachers, the program improves the STR by 0.04. In year five, assuming an increase in 20 teachers and a 70% retention rate for teachers from year four, the program improves the STR by 0.12. In all following year, the GYO program results in 30 additional teachers entering the district, who would not have in absence of the GYO program. Overall, the total effect of this alternative—the sum of the bars in each year—is 1.015.

The gray error bars surrounding green the preferred estimates in Figure 11 upper and lower bound effects of the GYO program. There is very little causal evidence on the effective of GYO programs. Moreover, these programs have never been evaluated outside of the United States. Since there is so little evidence on these programs, these bars are very wide. Specifically, I assume a potential error of 0.15 around the my preferred estimates. Again, I allow this error to grow by 0.01 each additional year to allow for increase uncertainty over time. Finally, I limit my lower bound estimates to 0, assuming that this policy will do no harm to teacher recruitment. Given these assumptions, my upper bound estimate for the GYO policy is 2.051 and my lower bound estimate is 0.175.

The key costs for a GYO program include $6,000 salaries for each teacher hired because of this program, $500 payments to 28 teachers who would instruct the GYO classes, $10,000 in materials for the GYO program (including translation of existing materials in English), and $200 in opportunity cost for half of the teachers recruited in to the GYO program[9]. These costs are discounted in future years using the formula in Equation 1. In sum, my estimated costs for this program are $282,394.

[8]This is aligned with Rucinski (2023), who finds that 1.9% of student enrolled in Massachusetts high schools between 2002-03 and 2019-20 became teachers.

[9]This assumes that half of the teachers in the GYO program would be induced into the teaching profession away from hiring-paying career alternatives.

7.4 Marketing Campaign

Prior research finds that marketing campaigns and hiring drives can have small impacts on teacher recruitment in low- and middle-income countries. For exampling Chin (2005) find that a hiring drive aiming to recruit new teachers to schools across a state in India drew small numbers of new teachers into the profession. Assume that a marketing campaign at teacher education programs (TEPs) in Salvador manages to attract an additional five teachers to SMED schools in its first year and ten teachers each year afterwards. Now, assume that 30% of these teachers leave each year after their first year (i.e., a 70% retention rate). The blue bars in Figure 11 show the estimated effect of a marketing campaign under such assumptions on improving STR each year after implementation. The overall effectiveness of this program—the sum of the blue bars—is 0.795.

The gray error bars surrounding the blue preferred estimates in Figure 11 upper and lower bound effects of a marketing campaign. Although these campaigns are simple and fairly well studied, their effects are heterogeneous across contexts. Since the evidence backing these programs is fairly strong, these bars are narrower than those around the GYO program, but not as narrow as those around the hiring bonuses. Specifically, I assume a potential error of 0.05 around the my preferred estimates. Again, I allow this error to grow by 0.01 each additional year to allow for increase uncertainty over time. Given these assumptions, my upper bound estimate for the hiring bonus policy is 1.555 and my lower bound estimate is 0.082.

Below I outline the key costs of the marketing campaign alternative. The key accounting costs include $6,000 salaries for each teacher hired because of this program, $200 worth of marketing materials at each of the 84 TEPs in Salvador each year, an annual $6,000 salary for a marketing manager, and compensating SMED teachers $20 for twice annual visits to 84 teacher training programs in Salvador. These costs are discounted in future years using the formula in Equation 1. In sum, my estimated costs for this program are $675,560.

8 Recommendation

To make a policy recommendation, I review the three criteria across each policy alternative. Table 2 provides a matrix that allows for this comparison. In this matrix, I provide estimates of each criteria under my preferred, lower bound, and upper bound model specifications as outlined in the section above. The background color of each cell represents the relative strength of a policy alternative, within criteria and model specification. Cells that are green are the best option (e.g., most effective, least costly, or most cost effective). Cells that are red are the worst option (e.g., least effective, most costly, or least cost effective). Blue cells are somewhere in the middle.

The effectiveness column shows that hiring bonuses are far and away the most effective policy under all model specifications. In my preferred estimates, I find that hiring bonuses would have an effect of 4.532, followed by the GYO program (1.015) and the marketing campaign (0.795). If the SMED wants to quickly reduce student-teacher ratios—and cares less about cost—they should strongly consider hiring bonuses. Notably, under pessimistic lower bound estimates, the GYO policy hardly results in a meager reduction in STR (0.175), whereas the hiring bonus policy still has a total effect greater than four. In this scenario, hiring bonuses also become the most cost effective policy. This result highlights the precision of the hiring bonus policy under all scenarios, which reflects how well-studied this option is relative to the other alternatives.

Although hiring bonuses are the most effective policy alternative, they are also the most costly. Under my preferred estimates, hiring bonuses cost nearly 10 times as much as the marketing campaign and 22 times as much as a GYO program. Notably, much of this cost is in the $6,000 provided to each new teacher[10]. Insofar as the SMED wishes to contract additional teachers, programs that bring in lots of new teachers will be very costly.

To this end, I also consider a variant of the hiring bonus alternative in which the SMED would offer just 100 bonuses for two years. This policy dramatically reduces the cost of the hiring bonus program by decreasing the number of teachers brought into the district. Under this plan, I assume that 30 teachers remain after year three, when bonuses expire. All of the assumptions of the bonus alternative remain the same (e.g., 50% retention after year three). The effect of this policy alternative are graphed in Figure A1 and the criteria shown in Table A1. Despite the dramatic reduction in the cost of the hiring bonus program, GYO programs remain the most cost effective in my preferred estimates. This is due to heavily discounted costs (see: Equation 1). Since inflation and the discount rate are so high in Brazil, discounting substantially reduces costs occurred in the future. These results again highlight the temporal factors affecting this analysis. Again, it is worth noting that policies that draw teachers to SMED schools in the near future will necessarily be more expensive than those that do so several years from now.

In terms of cost effectiveness, the GYO outperforms hiring bonuses and the marketing campaign in both preferred and upper bound model specifications. Although the GYO program is not the most effective, its low cost—in part due to discounting—allow it to outperform the other policy alternatives in terms of cost effectiveness. Notably, the program is considerably less cost effective than hiring bonuses in the lower bound model specification. This occurs because the wide range of uncertainty of the effects of this programs, due to a slim body of evidence around these policies.

To provide the best reduction of STR over a eight year period at a reasonable cost, I recommend that the SMED adopt a Grow Your Own (GYO) program. Although hiring bonuses would have the largest effect on reducing STR, their high cost makes this policy alternative prohibitively expensive. The marketing campaign is a clear loser in this situation.

Besides being the most cost effective policy, GYO programs have the potential to alleviate systemic issues in teacher hiring by increasing interest in the profession. Whereas hiring bonuses likely serve as a temporary solution to a teacher shortages in SMED schools. Still, as mentioned previously, hiring

[10]Using Equation 5, I calculate cost of teacher salaries under this program to be $5,899,156.

bonuses may be a good option to quickly lower the STR in SMEDS schools. If financially feasible, I would recommend that the district use hiring bonuses to bring in additional teachers during the next two years, while simultaneously implementing a GYO program.

9 Implementation

This section describes a plan for implementing a GYO program in schools in Salvador. It includes a discussion of how to equitably distribute new teachers across schools, a strategy for to engage other required stakeholders, and how to finance the policy. I also detail potential challenges that may hinder the sustainability of the program.

9.1 Plan

There is large variation in STR across SMED schools. Figure 12 shows the distribution of STR in SMEDS schools. 10% of SMED schools have a student-teacher ratio greater than 30. Unfortunately, it is impossible to link these schools to academic outcomes (i.e. SAEB exam scores), but it is likely that schools with high STRs are also the lowest performing. To promote equity—in any of the policy alternatives—the SMED should aim to first reduce STRs in schools with the greatest need.

Implementing a GYO program in Salvador requires multiple stakeholders. Since this program would be run out of secondary schools, implementing it would require that the SMED partner with the Bahia Ministry of Education (MEB), who runs secondary schools in Salvador. This requires non-trivial coordination with a large state agency and may not occur quickly. Successful implementation likely requires that the MEB has capacity and interest in the GYO program. To improve the likelihood of inacting a GYO program, the SMED should leverage its existing connections with the World Bank to promote the project to the MEB.

Although less costly than other alternatives, a GYO program would require fundraising. Municipal and State education agencies in Brazil share a common source of funding—the Basic Education Maintenance and Development Fund (Fundo de Manutenção e Desenvolvimento da Educação Básica, FUNDEB). FUNDEB is a fund administered by the federal government in an attempt to equalize school per-pupil spending in Brazil. Both the SMED and State Department of Education of Bahia receive money from this fund. Since the SMED and State Department of Education of Bahia share this source of funding, it can likely be used to fund a GYO program.

A GYO program needs to recruit students and teachers to participate. To expand the teacher training pipeline, students enrolled in the GYO program must include students beyond those who would enroll in teacher education programs in absence of the program. The SMED needs to consider how high school students in Salvador choose their coursework and how they might encourage students to enroll in the GYO program. The program also requires 28 teachers to lead the GYO classes. To the best of their abilities, the district should ensure that these are highly effective teachers. Prior research shows that teachers tend to be more effective when their are paired with effective mentor teachers during their clinical teaching experience (Goldhaber et al., 2020). Although somewhat speculative, it is likely that having a more effective teacher leading a GYO class would result in more effective teachers.

9.2 Potential Challenges

Research shows that even effective policies are often repealed or see their effect deteriorate over time due to political challenges (Patashnik and Weaver, 2021). A GYO program in Salvador public schools would face several of such challenges. These include designing context-appropriate programming, getting teachers and students interested in the program, and loss of funding or support due to politics. The SMED should consider ways to prepare for and address these challenges before implementation.

GYO programs have never been implemented in Brazil, so course materials and curriculum need to be translated from English into Brazilian Portuguese. If the program is not appropriately designed for the context, it is unlikely to be sustained over a long period of time or have its intended effect. Moreover, simply getting the individuals together with enough expertise in GYO programs, contextual knowledge of teacher education in Salvador and Brazil, and English to Portuguese translation may be difficult and costly.

Identifying highly effective teachers to staff the GYO program will be challenging, as the district does not have any data on teacher performance that can be linked across schools. Although the district can ask principals for teachers ratings or recommendations, prior research from the United States shows that principals often provide biased reviews of their teachers (Kraft and Gilmour, 2017) and that teacher observations rarely provide sufficient variation to distinguish between high and low performers (Weisberg et al., 2009). Given these constraints, it is unlikely that SMED will be able to identify its most effective teachers for this job, which may reduce the effects of the GYO program.

To improve the SMED's capacity to evaluate teacher performance and improve the quality of the existent teacher workforce, I suggest that the district start collecting longitudinal dataset on teachers and students in their schools. Other municipalities in Brazil already collect such data and may be able to help set up these systems. For example, the São Paulo Municipal Secretary of Education (SME) who runs primary schools in Brazil's largest city administered annual exams that allow students to be linked longitudinally, which supplement federal data systems like SAEB. Longitudinal data would enable the SMED district to more accurately measure student and teacher performance, identify effective teachers to lead GYO, and target retention policies towards their most effective staff.

Finally, the programs funding through FUNDEB maybe be at risk if there are substantial shifts in federal education spending. Given the tumultuous situation of federal politics in Brazil, this may be an undermine a GYO program. Patashnik and Weaver (2021) highlight an example of a federal environmental policy that was recently attacked by former Brazilian President Jair Bolsonaro. If Bolsonaro, or another staunchly conservative candidate, were elected as president, FUNDEB, which allocates federal dollars in an attempt to equalize per pupil spending across Brazil, may be at risk. If SMED decides to implement a GYO program, they should consider sources of funding that would could keep the program afloat if federal education funding were decreased.

10 Conclusion

This report analyzed the challenge of attracting too few high-quality teaching candidates to Municipal Secretary of Education (SMED) schools in Salvador, Brazil. This problem leads to suboptimal student-teacher ratios and poorer academic outcomes compared to national standards. To mitigate the effects of these challenges, I evaluate three policy alternatives: hiring bonuses, a Grow Your Own (GYO) Program, and a marketing campaign. Each of these alternatives are assessed based on their effectiveness, cost, and cost-effectiveness over an eight-year period after implementation. This assessment incorporates a detailed review of empirical evidence, potential impacts on the student-teacher ratio (STR), and the associated costs each policy.

After evaluating each policy alternative, I recommend implementing the GYO program as the most viable strategy to solve this problem. The GYO program is the most cost-effective alternative and provides the best reduction of STR over a eight year period at a reasonable cost. Furthermore, this recommendation underscores the GYO program's potential to sustainably enhance the teacher pipeline by fostering interest in teaching careers among local students, thereby addressing the root causes of teacher shortages. Bringing in additional teachers also has the potential to indirectly improve educational quality and student performance in SMED schools.

Implementing and sustaining a GYO program in Salvador will be a collaborative effort involving strategic partnerships, particularly with the Bahia Ministry of Education (MEB). This approach aims to overcome potential challenges, including funding, program design, and recruitment, thereby ensuring the theorized impact on the educational landscape of Salvador, enhancing teacher quality, and fostering improved academic outcomes for students.

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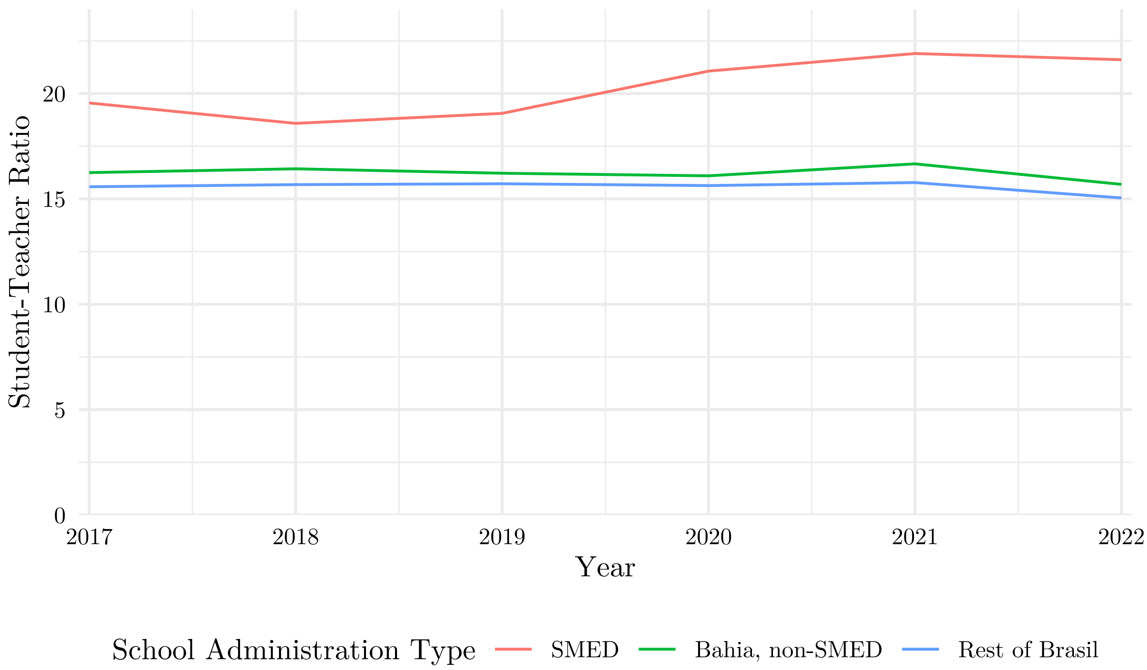
Figures and Tables

Figure 1: Student-Teacher Ratio (STR) in SMED schools, compared to Bahia and Brazil



Notes: Data from Censo Escolar.
Data are limited to public primary schools.

Figure 2: SAEB Exam performance in SMED schools, compared to Brazil

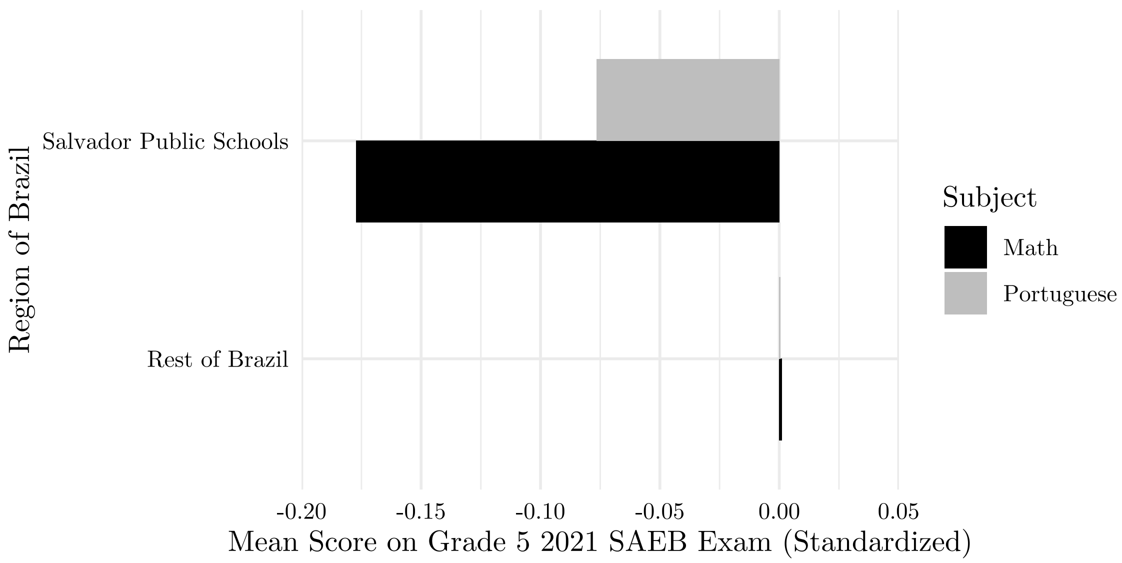


Figure 3: Root Cause Analysis diagram

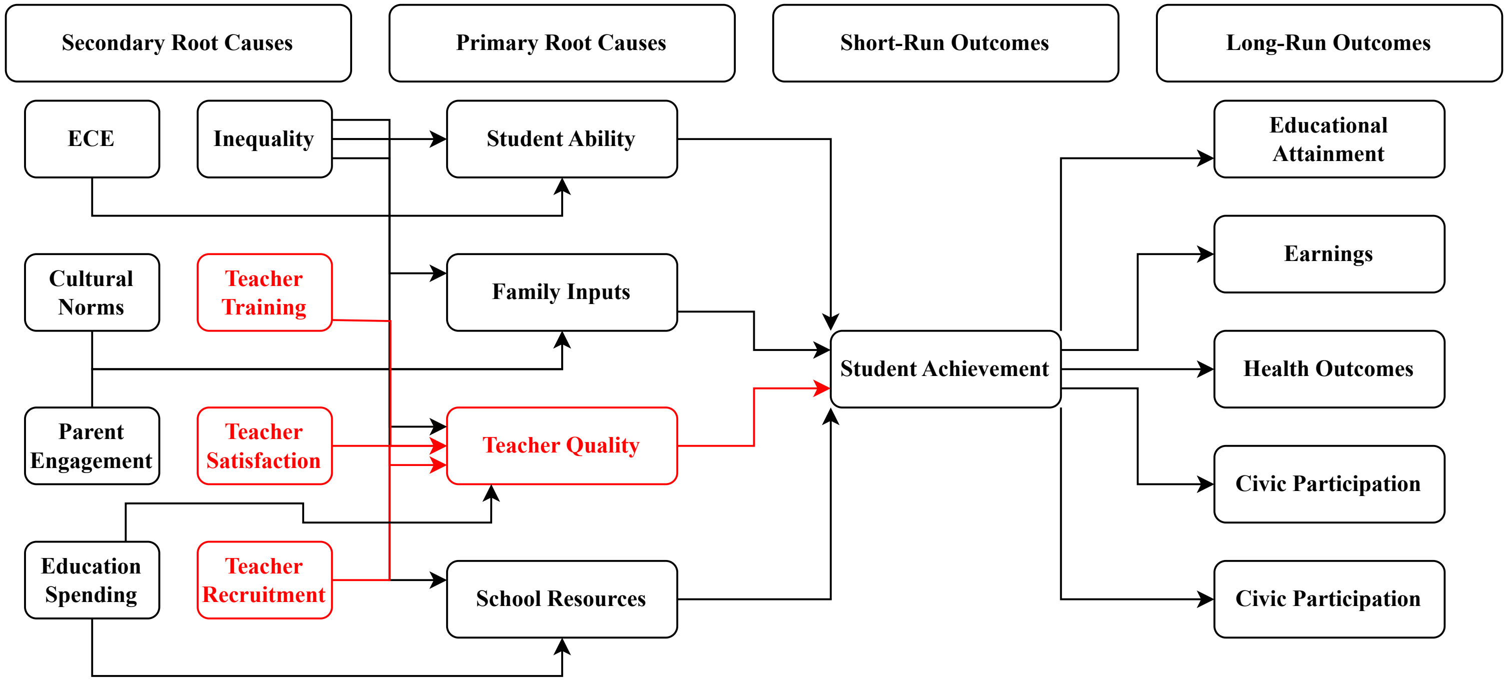
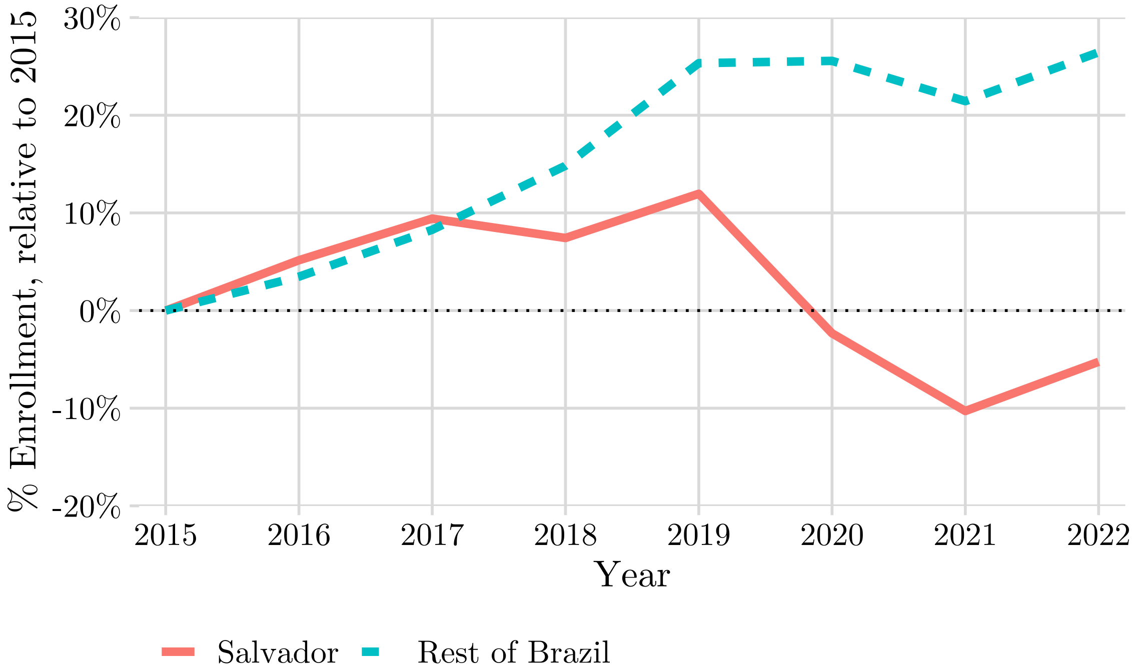
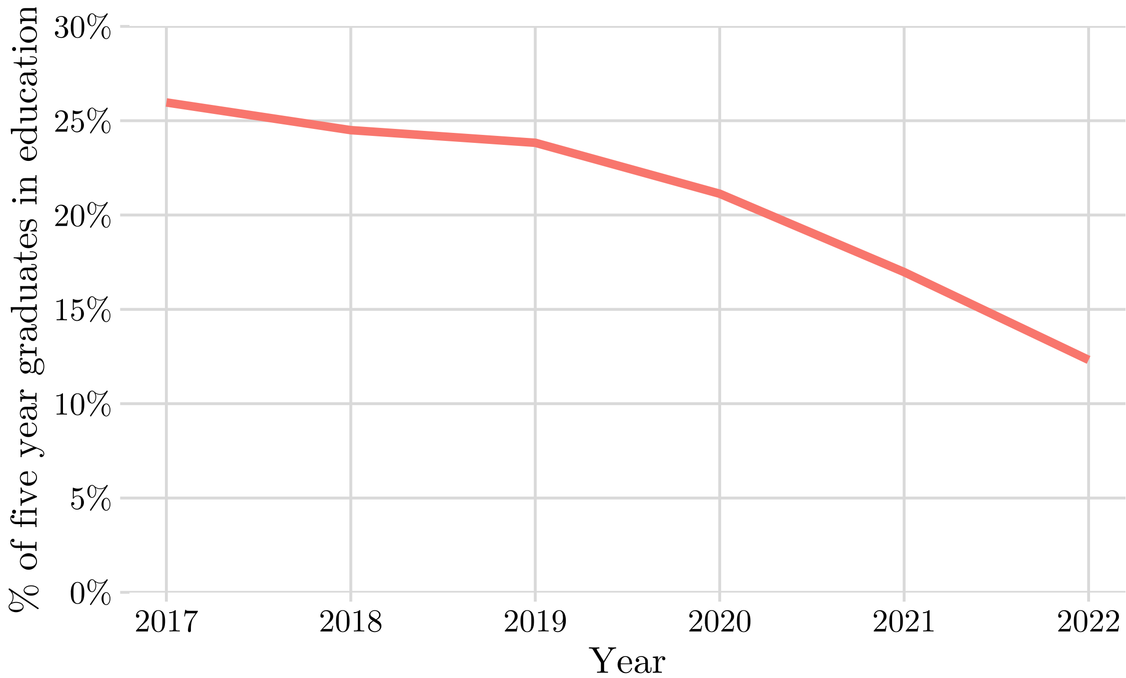


Figure 4: Enrollment in teacher training programs in Salvador and Brazil



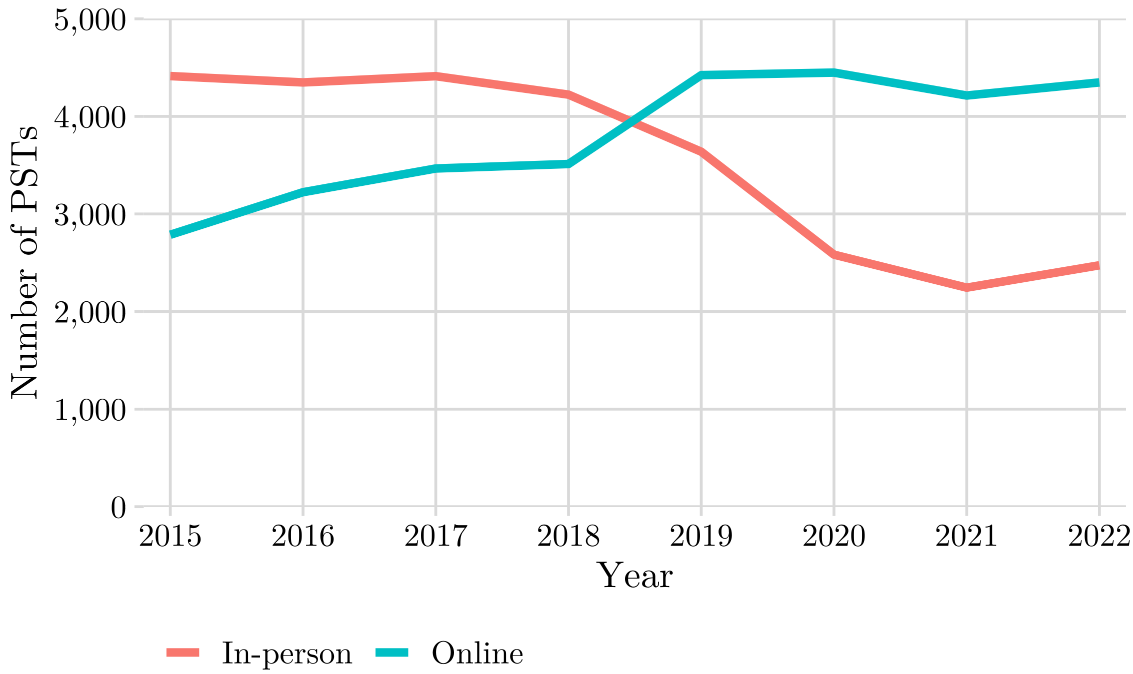
Notes: Data from Censo da Educação Superior.
Data are limited to courses with the CINE code 0113P01 (Pedagogia).

Figure 5: Proportion of students graduating from education degree programs in Salvador



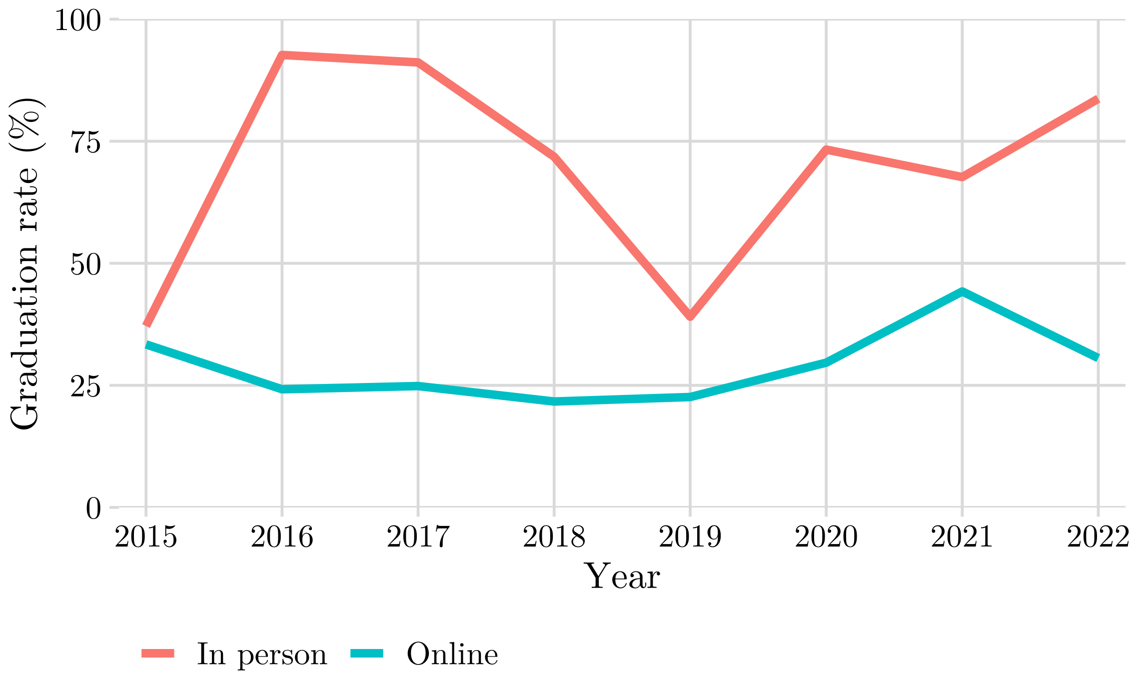
Notes: Data are from Indicadores de Fluxo da Educação Superior.
Data are limited to colleges in Salvador and degrees classified as neducation.

Figure 6: Teacher training program enrollment, by learning modality



Notes: Data from Censo da Educação Superior.
Data are limited to courses in Salvador with the CINE code 0113P01.

Figure 7: Graduation rates from teacher training programs, by learning modality



Notes: Data from Censo da Educação Superior.
Data are limited to courses in Salvador with the CINE code 0113P01 (Pedagogia).

Figure 8: Brazil's public school system and the teacher training pipeline

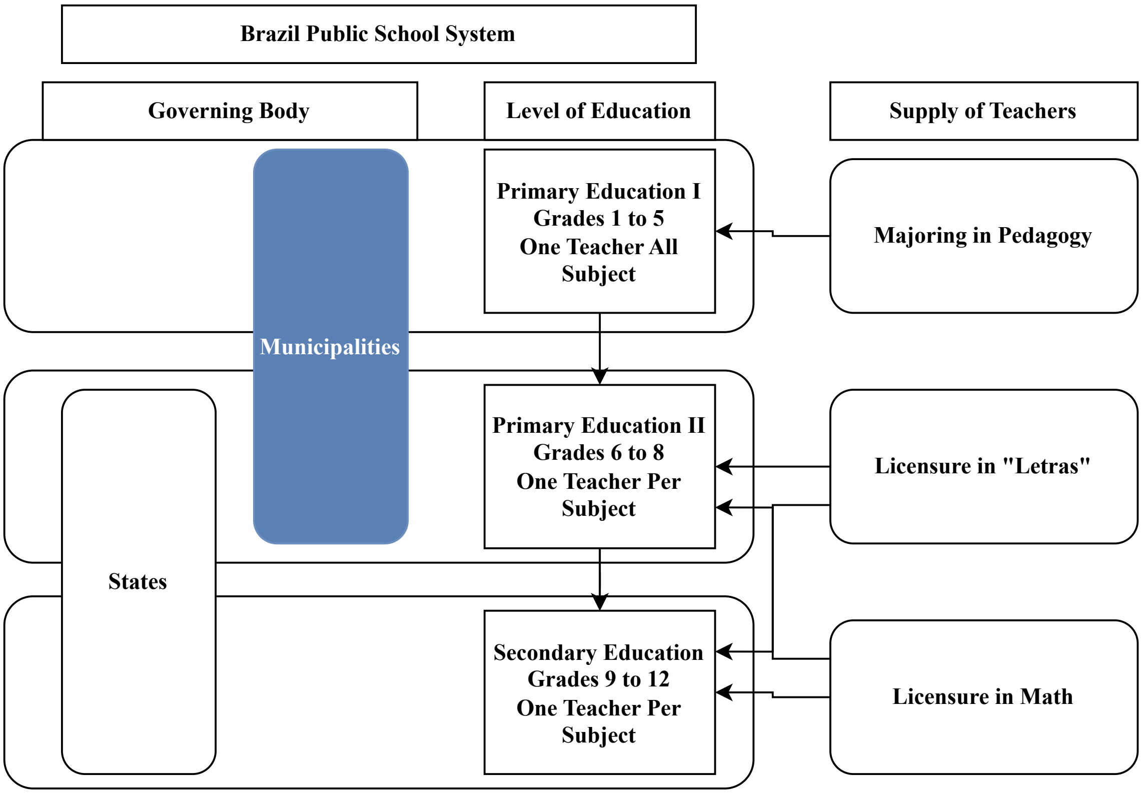


Figure 9: Racial composition of SMED schools, compared to Bahia and Brazil

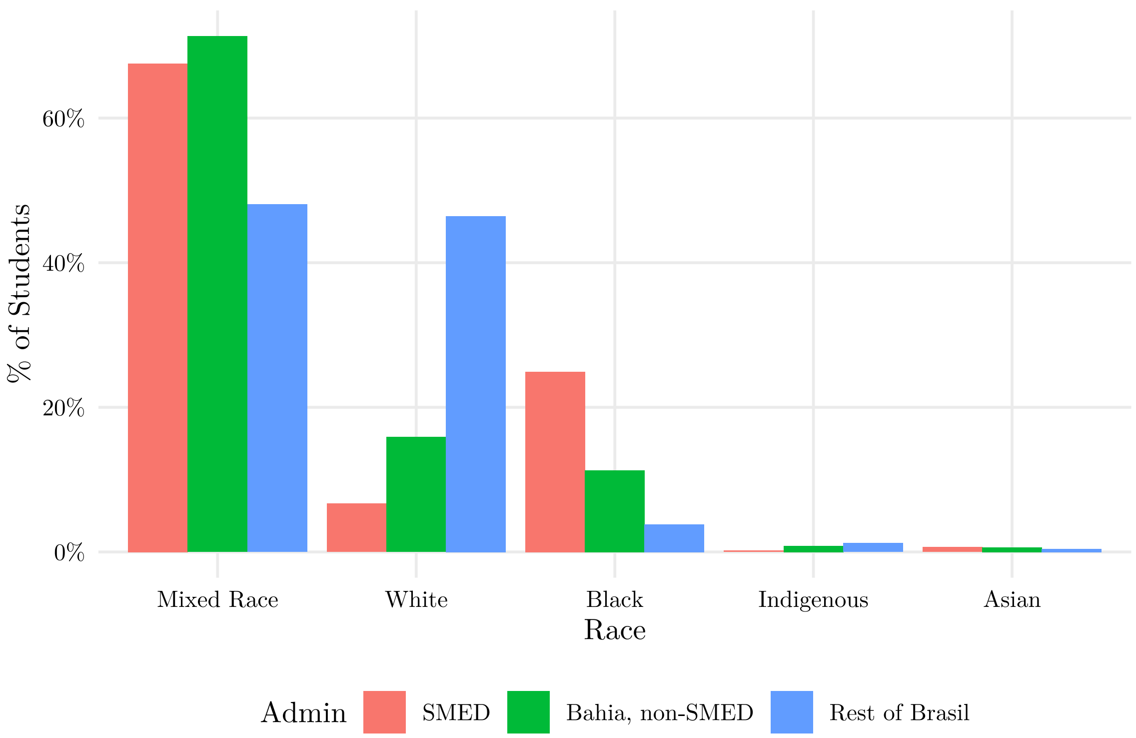
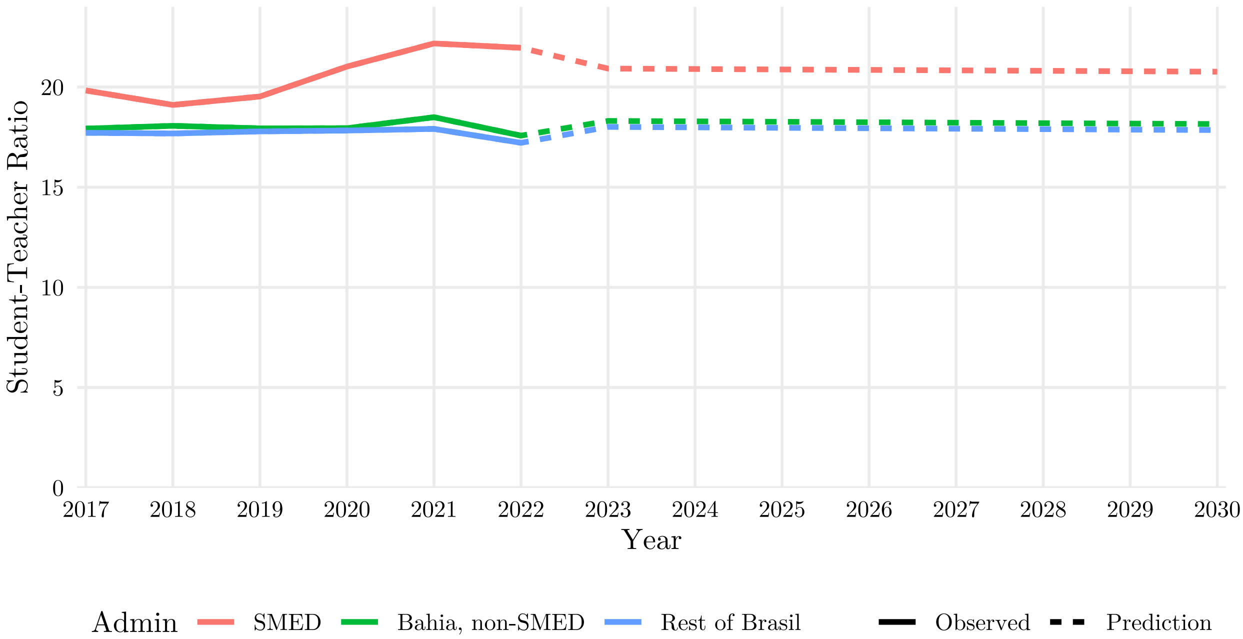
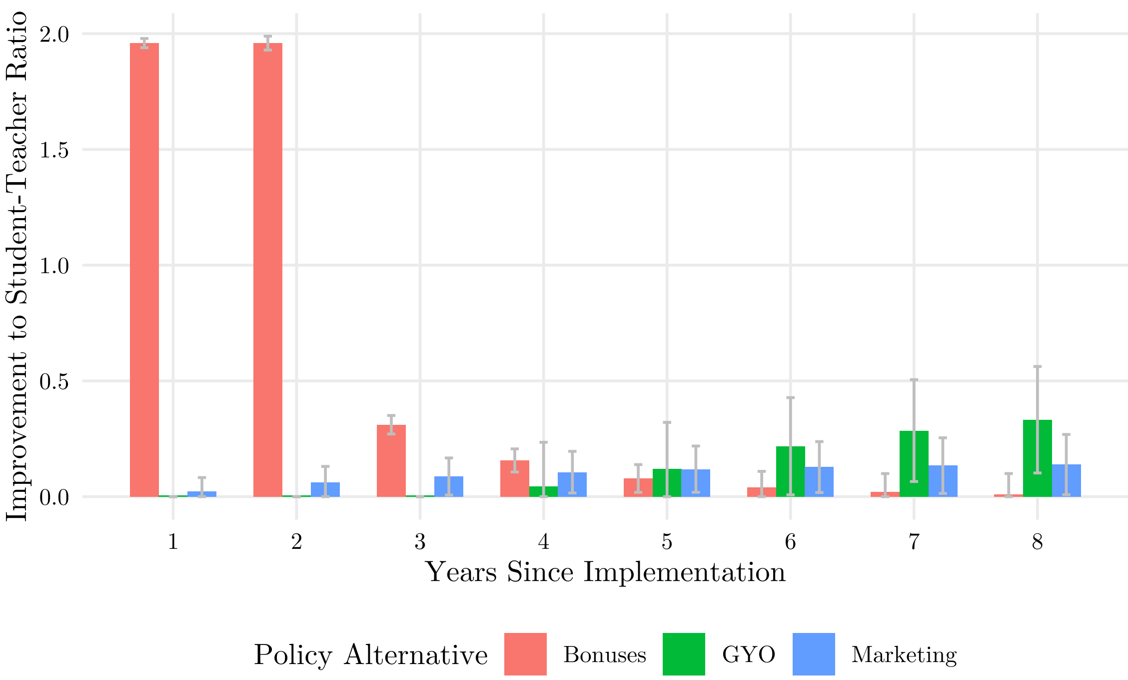


Figure 10: Predicted student-teacher ratio in SMED schools, compared to Bahia and Brazil



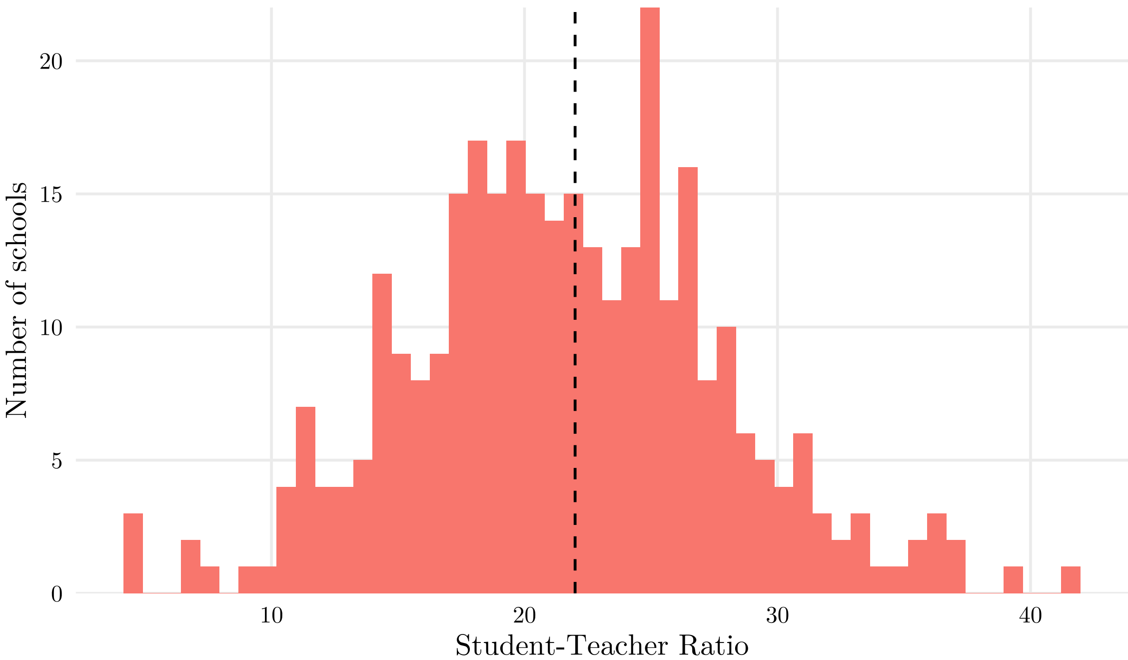
Notes: Data from Censo Escolar.
Data are limited to public primary schools.
Predicted lines estimated with a linear regression controlling for year, COVID, and school administration.

Figure 11: Effects of alternatives, by years of implementation



Note: Improvement to student-teacher ratio is a reduction in the student teacher ratio.
Grey error bars represent potential variance in treatment effect.

Figure 12: Distribution of student-teacher ratio (STR) in SMED schools



Notes: Data from Censo Escolar.
Data are limited to public primary schools in Salvador.
Black dashed line shows the mean student-teacher ratio in SMED schools.

Table 1: Student and Teacher Information, SMED vs. Other Administrations

Year	Students	Teachers	Student-Teacher Ratio
SMED			
2017	98,822	4,984	19.8
2018	97,246	5,090	19.1
2019	97,177	4,977	19.5
2020	98,997	4,710	21.0
2021	107,319	4,840	22.2
2022	107,125	4,879	22.0
Bahia, non-SMED			
2017	1,462,244	81,582	17.9
2018	1,431,968	79,279	18.1
2019	1,408,048	78,508	17.9
2020	1,381,957	77,019	17.9
2021	1,421,108	76,853	18.5
2022	1,379,409	78,498	17.6
Rest of Brazil			
2017	13,993,967	789,975	17.7
2018	13,897,992	786,079	17.7
2019	13,756,440	773,524	17.8
2020	13,729,259	770,144	17.8
2021	13,944,060	778,607	17.9
2022	13,887,007	806,754	17.2

Notes: Data from Brazil's School Census

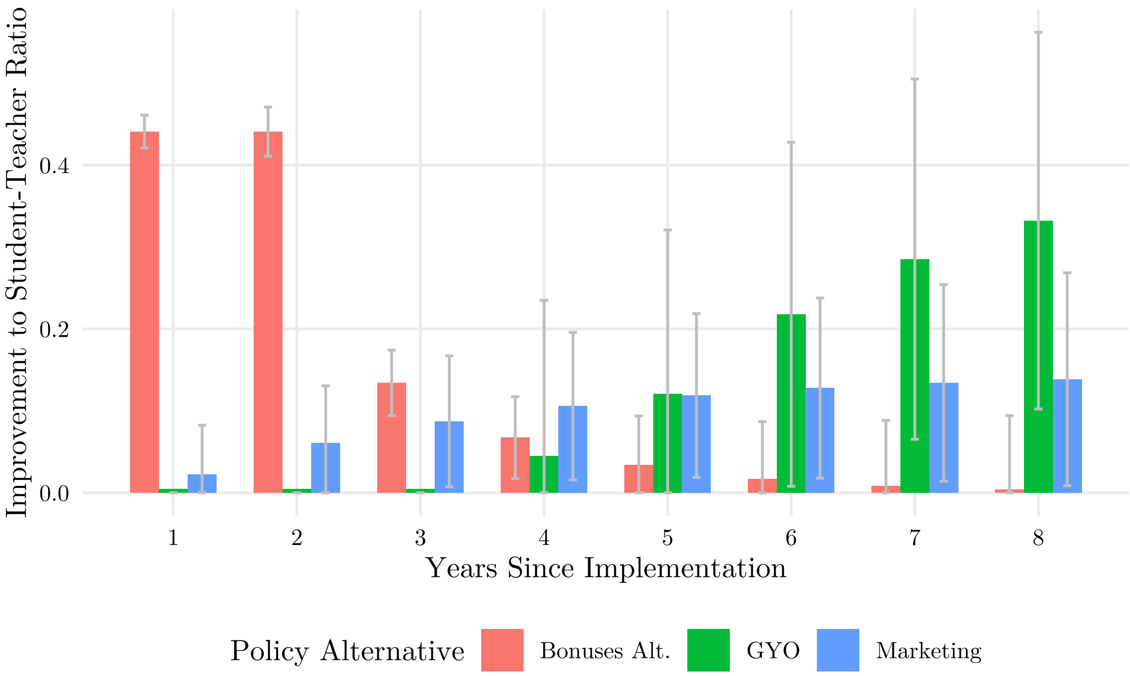
Table 2: Policy Alternative Matrix

Policy Alternative	Total Effect	Cost	Cost Effectiveness
Preferred Estimate			
Hiring Bonuses	4.532	$6,340,699	$1,398,945
Grow Your Own	1.015	$282,394	$278,328
Marketing Campaign	0.795	$675,560	$849,384
Lower Bound			
Hiring Bonuses	4.264	$6,340,699	$1,487,142
Grow Your Own	0.175	$282,394	$1,610,115
Marketing Campaign	0.082	$675,560	$8,208,771
Upper Bound			
Hiring Bonuses	4.972	$6,340,699	$1,275,156
Grow Your Own	2.051	$282,394	$137,679
Marketing Campaign	1.555	$675,560	$434,346

Notes: Total effect column provides the estimated total reduction in student-teacher ratio of the policy alternative across five years of implementation. Cell background color represent relative strength of policy alternative, within criteria.

Appendix

Figure A1: Effects of alternatives, by years of implementation, alternative specification



Note: Improvement to student-teacher ratio is a reduction in the student teacher ratio.
Grey error bars represent potential variance in treatment effect.

Table A1: Policy Alternative Matrix, alt.

Policy Alternative	Total Effect	Cost	Cost Effectiveness
Preferred Estimate			
Bonuses Alt.	1.147	$1,458,268	$1,271,796
GYO	1.015	$282,394	$278,328
Marketing	0.795	$675,560	$849,384
Lower Bound			
Bonuses Alt.	0.943	$1,458,268	$1,545,726
GYO	0.175	$282,394	$1,610,115
Marketing	0.082	$675,560	$8,208,771
Upper Bound			
Bonuses Alt.	1.587	$1,458,268	$919,104
GYO	2.051	$282,394	$137,679
Marketing	1.555	$675,560	$434,346

Notes: Total effect column provides the estimated total reduction in student-teacher ratio of the policy alternative across five years of implementation. Cell background color represent relative strength of policy alternative, within criteria.