Inequalities in High School Outcomes in Brazil: Determinants and Interventions

Sandra Valeria Araujo Macedo

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Abstract

This thesis examines the complex demographic and socioeconomic inequalities in the performance of Brazilian high-school performance. Using microdata from the nationwide Brazilian high-stakes university exams (N≈8 million), this study unveils the multifaceted nature of educational inequalities in Brazil across four self-contained chapters.

The first chapter focuses on a major national affirmative action (AA) policy, the Law of Quotas, designed to enhance access to elite public universities for public school students. Through isolating the effects of this policy from prior AA initiatives on different quota subgroups, this paper tests the hypothesis that a widely advertised AA programme can boost students' motivation to invest in education. Results reveal improved performance of most quota subgroups after the law, with larger effects for non-white and high-income students.

Chapter 2 disentangles economic status into an absolute and a relative component, showing that they independently relate to exam results. Alongside the importance of material resources, this stresses the relevance of relative socioeconomic standing in triggering psychosocial mechanisms involving self-esteem, aspirations and identity.

Chapter 3 uses an intersectionality framework to study how absolute and relative standards of living interplay with gender and race, unfolding different interactive patterns. In a context marked by unequal opportunities and multifaceted discrimination, educational performance in Brazil emerges as directly linked to students' backgrounds.

The fourth chapter tests the "Mulatto Escape Hatch" hypothesis, a term coined in the 1970s in the realm of a comparison between racial relations in Brazil and the United States. Significant differences between the performance of blacks and *'pardos'* (mixed race) are observed, lending support to the hypothesis. Achievement gaps between blacks and *pardos*, however, are much smaller in magnitude compared those between whites and non-whites.

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1. Introduction

1.1 Background and motivation

Over the past decades, Brazil has made substantial progress in expanding school enrolments, achieving universal access to primary education, and significantly decreasing high-school dropout rates. Similarly, there has also been a surge in participation of young people in higher education, a trend attributed to several educational policies implemented since the early 1990s (Marteleto, Marschner, and Carvalhaes 2016). This progress has been further reinforced by the establishment of national cash transfer program "Bolsa Familia" (Chitolina, Foguel, and Menezes-Filho 2016). All these efforts resulted in significant improvements in educational attainment of the population which evolved from 9.8 years in 2012, to 11.8, in 2020 for the 18-29 age bracket (Todos pela Educação 2022). These changes have partially contributed to a decline in income inequality in the country in recent years (Menezes Filho and Kirschbaum 2018; Neri 2020; Ferreira, Firpo, and Messina 2021; Jaume 2021).

However, Brazil still faces important challenges to achieve equity in educational outcomes, with persistent achievement gaps across race, gender, region, and socioeconomic background. The association between demographics and social origins with educational outcomes is stronger in Brazil compared to many countries and has become stronger after the COVID-19 pandemics (OECD 2021). Moreover, the quality of education in Brazil remains far from the levels of countries with similar income level (OECD 2021). The recent results for Brazilian students in PISA 2022 have shown a stable trajectory since 2009 in all three subjects (OECD 2023), where the country occupied the lowest rankings over a sample of 81 countries. Results were particularly poor in math, where 73% of students did not reach Level 2, the minimum level of proficiency, and only 1% were top performers, in contrast with the average share of OECD countries (9%). This is a concern since achievement gaps between rich and poor students tend to increase with income inequality (Patel and Sandefur 2020).

The low quality of education provided by public schools at basic education level has been a major barrier for disadvantaged students to access good-quality higher education, as admission is based solely on the scores from university entrance tests; private schools are instead, with exceptions, of very high level and prepare students well for university entrance tests. The opposite occurs in higher education. Public universities, particularly federal ones, enjoy superior educational resources, while private institutions, with few exceptions, often lag in delivering quality education. In addition to being highly rated for the quality of education, public institutions are tuition-free. As a consequence, admission process is highly competitive and is based on the scores obtained in the National High School Examinations (*Exame Nacional de Ensino Médio*, ENEM), the national large-scale standardized test, in some cases combined with institutions' own admission tests ("vestibular").

In this context, ENEM often ends up functioning as a "funnel", enhancing educational inequalities. This is because students coming from low-quality public schools and disadvantaged backgrounds in general do not achieve the minimum score requirements for admission to public universities (Mendes Junior, Souza, and Waltenberg 2016). By contrast, students from higher socioeconomic backgrounds and families with more educated parents are more likely to obtain higher scores as they invest more in quality education (Cavalcanti, Guimaraes, and Sampaio 2010; Senkevics and Carvalho 2020; Senkevics, Carvalhaes, and Ribeiro 2022; Valente 2017). Consequently, white, and wealthier students have been historically overrepresented in higher education.

When it comes to race, mechanisms of racial inequality in Brazil are widespread and pervasive. Beyond socioeconomic status, also structural, institutional, and political factors shape racial relations in Brazil (Hasenbalg 1979; Guimarães 2004; Lima and Prates 2019; Senkevics, Carvalhaes, and Ribeiro 2022), where black students often grapple with additional challenges that translate into lower performance in university entrance exams

(Osorio, 2008, 2009; Paixão et al., 2009; Marteleto et al., 2016; Marteleto and Dondero, 2016; Valente, 2017). Inequalities can be produced and reproduced by structural racism (Bonilla-Silva 2015; Reskin 2012), which creates identities of lower self-perception and feelings of unworthiness that decrease aspirations and expectations about future opportunities, leading black students to engage less with schooling (Caldwell Jr. 2008; Lavecchia, Liu, and Oreopoulos 2016; Loury 2002; Merolla and Jackson 2019). As argued by Hasenbalg (1979), this process triggers a cycle of "cumulative disadvantages" that contributes to the persistence of achievement gaps where race, gender, region of birth and socioeconomic factors intertwine, hindering the chances of disadvantaged students (Hasenbalg 1979; Valente 2017).

Acknowledging these disparities, the Brazilian government has, since the late 1990s, implemented various reforms and educational policies targeting public school students. The goal was to improve individual opportunities and foster social mobility for disadvantaged groups through access to higher education. Among these initiatives, affirmative action (AA) policies have played a crucial role in reshaping the portrayal of higher education in Brazil, especially the government-mandated national Law of Quotas introduced in 2013. By reserving 50% of the admissions to all undergraduate courses in federal universities for public-school students, with explicit targets for low-income and non-white students, the Brazilian government aimed to mitigate socioeconomic and race-based disadvantages. Nevertheless, educational achievement gaps remain significantly high, with important implications on future wages and income inequality.

The purpose of this thesis is to provide empirical evidence of the complexities of demographic and socioeconomic inequalities in Brazilian high-school outcomes. By examining these factors with the use of ENEM microdata from different years, this research aims to enhance our understanding of the multifaceted nature of educational inequalities in the country. The idea of this project is not a recent one. Since I started higher education as a mature student, around 25 years ago, I felt drawn about the deep

impact of inequalities in Brazil. Later, my attention shifted towards the striking educational disparities in the country. While constructing this project, navigating into the fabric of my own life and that of certain family members was inevitable.

I consider myself fortunate to have had parents who valued and invested in my education, while some from my extended family did not have the same opportunities. In Brazil, the lottery of life's circumstances can be detrimental for most people. Not surprisingly, Brazil is one of the countries with lowest social mobility (Britto et al. 2022). For years, I have witnessed negative and positive transformations in the lives of relatives, stemming from their educational choices. I have also witnessed the struggles many of them faced in persevering through higher education, while others simply chose to give it all up.

On top of the plethora of benefits of education to a range of social outcomes, I have consistently maintained that education should be valued also as an intrinsic goal. Beyond being a tool for promoting personal growth and self-improvement, most importantly, education has a huge potential to transform the way people think, what they believe in and who they are – as was the case for me. Having an Economics degree allowed me to land a steady job in a large public company in Brazil, but once again, the dream of pos-graduation and the goal to "change the world" had to be delayed due to the responsibilities of work and raising my daughters as a single mother.

Given the many interruptions in my academic path, this journey towards a PhD unfolded much later than I intended. There were moments when I questioned why I should not give up. The impostor syndrome closely accompanied me throughout these four years, and hurdles were significant. From enduring full isolation due to Covid-19 pandemics in a foreign country to the sad loss of my mother during my fieldwork in Brazil, that triggered my father's depression and dementia, alongside with the struggle to find the right

balance between work, study, and motherhood, letting alone the challenges of a long Covid affecting my physical and mental well-being.

Undoubtedly, this journey has proven to be the most arduous chapter of my life, demanding unwavering patience, mental resilience, and physical endurance. Fueled by my strong interest and encouraged by the unconditional support of my primary supervisor and my family, I found the strength to overcome these obstacles and follow my dream. This was never about the 'Doctor' title, but about love. I was deeply committed to my life project and, more importantly, by the motivation to apply the knowledge gained in my PhD to support educational systems in helping students pursue their dreams and contribute to narrowing the gaps. I hope the empirical evidence that I provide in this thesis contributes to help policymakers to design better solutions to improve the quality of education in Brazil.

My fieldwork, conducted from the end of 2020 to the end of 2021, was extremely enriching, but at the same time extremely challenging due to the ongoing pandemic. The original plan was ambitious as I prepared to conduct semi-structured interviews and focus groups with teachers as well as students from public and private schools in different states in Brazil. The goal was to explore student motivation for higher education within the context of the Law of Quotas. The data collected would be used in Chapter One, initially conceived as a mixed-method study, and for an additional fully qualitative chapter. Unfortunately, the pandemic led to school closures and the adoption of social distancing measures which jeopardised the possibility to carry out my fieldwork; on top of this, restrictions established by the UEA Ethics guidelines, made it impossible to conduct presential interviews, which made me defer the interviews with students. For several months, while uncertain about the direction of my fieldwork, I continued with the original plan and pursued all the steps needed to formally carry out primary data collection in Brazil, including the request of formal authorizations. I also kept trying to connect virtually with teachers, although setting up meetings was very challenging given

the level of confusion and the stressful organizational demands they faced during the pandemic. Despite these difficulties, I was able to reach out to state departments of education, regional coordinators, and schools, securing the authorization to collect data and finding schools willing to collaborate via virtual meetings. By December 2021, I successfully conducted 20 interviews and 6 focus groups with high-school teachers, for a total of 63 participants from 16 public schools, from the states of Ceara, Pernambuco, Goias, Minas Gerais and Rio Grande do Sul.

Processing the qualitative data during 2022 proved much more time consuming than expected. At the same time, I kept refining the interview schedules for my data collection with students. This unfortunately never happened, because in-person visits remained restricted and my attempt to carry out virtual focus group discussions with students proved unsuccessful. Given the lack of students' views, as well as the large amount of material needed analysing, while the submission clock started ticking, I decided with my supervisors to leave aside the qualitative data I collected and not use it for this thesis. To maintain the idea behind my original mixed-methods research proposal, I used the qualitative data collected by my primary Supervisor, Lucio Esposito, with 30 high-school teachers in Rio de Janeiro. This data, focused on socioeconomic, racial and gender inequalities, fitted well the intersectionality setting of Chapter Three. The analysis of the Law of Quotas in Chapter One was instead carried out only quantitatively. This chapter evolved into a comprehensive quantitative study, in line with my objective to produce a causal inference article.

The data gathered from teachers, nevertheless, revealed some intriguing insights. It became clear that, while the Quota Law was very well-known, high-school students and their families, including teachers themselves, lacked access to crucial information about the precise criteria of the Quota Law to which students could be entitled. This emerged very strongly in schools attended by disadvantaged students but was evident also in some high-performing state schools. These findings require further investigation with

students themselves, as it remains unclear how they are generally informed about the Quota Law and about further education, and how such (lack of) knowledge may impact their decision-making and motivation to pursue higher education. I hope I can carry out the original fieldwork project, using the data collected as a pilot and as preliminary evidence to request funding. It is worth highlighting, however, that efforts to enhance motivation through incentive-based policies may only have a limited effect. The substantial achievement gaps between advantaged and disadvantaged students are rooted in structural issues and cannot be solely attributed to a lack of motivation, and therefore may require additional policies (Cotton et al. 2020).

Improving the quality of education in Brazil for all children, irrespective of their origins is particularly urgent in light of the UN Sustainable Development Goals (SDG), notably Goal 4, which establishes that countries should ensure inclusive and equitable quality education, as well as Goal 10, which demands the reduction in inequalities within and between countries up to 2030. As one the most unequal countries in the world (Hoffmann 2018), high inequalities in Brazil are a bottleneck for sustainable growth and increased productivity. Although education may not be the only factor in determining income inequalities (Medeiros, Barbosa, and Carvalhaes 2020), quality of education has the highest predictive power for intergenerational mobility (Britto et al. 2022).

1.2 Brief synopsis of the four empirical chapters

The thesis is structed into four self-contained chapters. Chapter One assesses the impact of the Law of Quotas on the performance of eligible and non-eligible students in ENEM (N≈7 million, period 2010-2015). Through isolating the effects of this policy from prior AA initiatives on different quota subgroups, this paper tests the hypothesis that a widely advertised AA programme can boost students' motivation to invest in education. Results reveal improved performance of eligible and non-eligible students in states that adopted proportional quotas when the Quota Law was introduced, with distinct mechanisms

involved. This was also the case for most eligible subgroups, with significant effects on treated states in math and science subjects, and larger effects for non-white and high-income students compared to their low-income (white and non-white) counterparts.

Chapter Two disentangles measures of standards of living into an absolute and a relative component, showing that they are independently related to ENEM results (N≈8million, period 2012 to 2018). The paper fills a gap in the literature where absolute and relative measures of economic status are jointly employed as explanatory variables to explain educational performance outcomes (i.e. test scores rather than census-based enrolment status). This evidence highlights the importance of relative socioeconomic standing, also known as "*relative deprivation*". Alongside the role played by absolute standards of living through material pathways to education (e.g. affordability of education and material hardship), relative economic status matters through psychosocial pathways related to self-esteem, aspirations, motivation and identity. The strength of the relative deprivation increases at higher levels of absolute income.

Chapter Three is a mixed-methods study built upon the intersectionality and multiple jeopardy frameworks. The aim of the chapter is to understand the way the two demographic characteristics most widely used in the intersectionality and multiple jeopardy literature (gender and race) interact with economic status. By conceptualising the latter as comprising an absolute and a relative component (in line with Chapter 2), we show that the interaction effects for gender and race have the same sign in the case of absolute income but have opposite sign in the case of relative deprivation. By enriching our econometric evidence (N≈8million) with qualitative data collected via semi-structured interviews and focus group discussions with 30 secondary school teachers, we provide a rich discussion of our quantitative findings.

Lastly, Chapter Four tests for the existence of the so-called "Mulatto Escape Hatch" (MEH) phenomenon, a term coined in the 1970s in the realm of a comparison between racial relations in Brazil and the United States. By systematically comparing educational achievements of black and '*pardo'* (mixed-race) students using ENEM data (N≈9.5 million), results support the MEH hypothesis: statistically significant advantages for `pardos' are observed, including in trends over time. However, these effects are rather small in magnitude when compared to the advantage of whites over non-whites.

I hope the findings presented in the upcoming chapters can not only contribute meaningfully to the academic literature on educational inequalities, but also inspire concrete and impactful solutions for a more inclusive educational scenario in Brazil.

Contribution Statement

Chapter One. Sole author with guidance on causal estimation provided by Dr Sunil Kumar (who was de facto my secondary PhD supervisor).
Chapter Two. I benefited from the following contributions: Dr Lucio Esposito (my primary PhD supervisor) provided extensive editing and his expertise on relative deprivation. Dr Adrian Villasenor provided the computation for the indices of relative deprivation.
Chapter Three. I benefited from the following contributions: Dr Lucio Esposito provided extensive editing, fieldwork data and his expertise on relative deprivation. Dr Adrian Villasenor provided the computation for the indices of relative deprivation (the same as in the previous chapter). The framing of the paper within the intersectionality literature was suggested by Dr Sunil Kumar.
Chapter Four. Sole author, with guidance on conceptualisation and analysis provided by Dr Lucio Esposito.

Chapter 1 : Effects of the Brazilian national affirmative action programme on high-stakes exams

Abstract

This study assesses the impact of a national affirmative action (AA) policy in Brazil, the Law of Quotas, on students' scores on high-stakes university entrance exams. The policy reserves at least 50% of seats in federal universities to public school students, with additional class- and race-based sub-quotas. Our evaluation design sought to isolate the effects of this policy from prior AA initiatives and test the hypothesis that this widely advertised AA programme could improve investment in education for eligible and non-eligible high-school students. Findings indicate that both eligible and non-eligible groups and their race/income subgroups increased their performance in average test scores, with significant effects in math and science, and larger effects for non-white students from higher income households. The results however do not show improvements with regards to the achievement gap between eligible and non-eligible students, which suggests that educational inequalities persist.

1.1. Introduction

Affirmative action (AA) for higher education has been increasingly widespread in the world, with over 190 countries implementing some type of AA scheme with a variety of formats (Jenkins and Moses 2014; Paguyo and Wei 2014). By granting admission preferences to historically marginalised and disadvantaged minorities into selective undergraduate programmes, these policies aim to level out unequal playing fields and repair historical injustices that hinder the chances of these groups to achieve better prospects in life.

The primary justifications for AA are grounded on their significant role in improving equity and promoting social mobility for disadvantaged minority groups, while also addressing past discrimination (Jenkins and Moses 2014), which make these policies particularly important in countries with high level of inequalities and high returns to education. Research has shown that AA can increase diversity in campus and future wages of beneficiaries (Bowen and Bok 1998; Holzer and Neumark 2000; Bertrand, Hanna, and Mullainathan 2010; Paguyo and Wei 2014; Long and Bateman 2020; Chetty 2021).

However, as AA involves the redistribution of scarce and prestigious resources in favour of less privileged students by displacing more qualified counterparts, they face contentious debates and political opposition (Arcidiacono, Lovenheim, and Zhu 2015; Arcidiacono and Lovenheim 2016). Much of the recent debate concentrates on efficiency issues. Critics argue that despite the good intentions of these programmes, AA can affect the way individuals react, leading to distortions and unintended consequences that can potentially harm those these policies are designed to help (Sowell 2004; 1990).

Specifically, there is a concern that AA may cut incentives for additional investments in education for both targeted and non-targeted groups (Sowell 1990). This could mean that students would be even less prepared to follow course programmes after admission – a phenomenon known as "mismatch", which could increase dropout rates and reinforce in-campus discrimination (Loury and Garman 1993; Moro and Norman 2003; Sander 2004; Arcidiacono et al. 2011; Sander and Taylor 2012; Arcidiacono et al. 2014; Arcidiacono and Lovenheim 2016). Supporters, on the other hand, believe that AA can improve efficiency by motivating disadvantaged and minority students to improve academic performance as their prospects to access higher education become more realistic (Harry Holzer and Neumark 2000; Loury 2002; Fryer and Loury 2005). Furthermore, non-eligible students may also be affected, and two potential outcomes may arise: i) they may either respond negatively, feeling resentful and discouraged as their merits may not be considered for admission (Sowell 1990), or ii) they may intensify their educational investments to face enhanced competition resulting from the reduced number of available seats reserved for them (Loury 1992; Su 2005).

Understanding to what extent AA policies affect the way students invest in education prior to college application is an important empirical question. There is a large body of research evidence associating high-school academic performance with educational attainment and future earnings (Dale and Krueger 2002; French et al. 2015; De Hoyos, Estrada, and Vargas 2018; Chetty, Friedman, et al. 2020). Moreover, performance on

standardised tests has also been related to long-term outcomes, such as growth and development outcomes (Hanushek and Kimko 2000; Hanushek and Woessmann 2007). Therefore, a policy that creates incentives for poor students to invest in education may have important individual and social long-term economic implications.

While there is a new strand of theoretical and empirical studies examining how AA affects individual decisions on pre-college investment in education (Antonovics and Backes 2014; Assuncao and Ferman 2015; Bodoh-Creed and Hickman 2017; Khanna 2020; Cotton, Hickman, and Price 2022; Leal and Choi 2023; Akhtari, Bau, and Laliberté 2024), the direction of the change is contingent and ambiguous.

We add new empirical evidence on the extent to which such policies affect the academic performance of high-school students in Brazil, a developing country context, other than the traditional Indian and US experiences where most AA evaluation literature concentrates. Additionally, the Brazilian AA framework allows us to examine the effects of both racial- and class-based AA policies ('class' will be used to refer to standards of living, in particular defined by per capita family income). Specifically for Brazil, results from existing studies are also ambiguous (Saeme 2014; Assuncao and Ferman 2015; Estevan, Gall, and Morin 2019b; Leal and Choi 2023)[1].

This paper evaluates the impact of the implementation of a large-scale government-mandated affirmative action (AA) program in Brazil, known as the "Quota Law" (hereinafter referred to as the "National Quota Law" to distinguish it from other quota initiatives) - on the performance of high-school students in high-stakes national standardised university entrance tests. The National Quota Law (NQL) is an important policy in Brazil, where blatant social and racial inequalities are heavily associated with educational disparities, particularly with higher education attainment (Barros and Lam

[1] We present the literature in the next section.

1993; Menezes-Filho 2007; Menezes Filho and Kirschbaum 2018; Menezes-Filho 2007; Medeiros, Barbosa, and Carvalhaes 2020). The law establishes that 50% of seats in all undergraduate programs at federal institutions, considered the most selective, be reserved for students who completed the three years of high-school education level at public schools. The rationale behind targeting students from public schools is rooted in their concentration of the most socioeconomically disadvantaged, as well as their consistently lower performance on standardized university entrance tests compared to students from private schools. By additionally combining household per-capita income and race/ethnicity criteria[2], the Brazilian AA regulation aims to address class and race inequalities to promote access to selective institutions for students who face social and economic disadvantages.

However, the AA experience was not new to Brazil. Since early 2000's, many higher education institutions gradually implemented their own institutional quota programmes, with different formats and schemes. According to Vieira and Kuenning (2019), with respect to federal universities, by the time the NQL was enacted, there were 34 federal universities adopting quotas programmes, with most of these programmes targeting public-schools, race, or a combination of the two. The law established a minimum share of 12.5% on its first year, gradually incrementing 12.5 p.p. each year between 2012 and 2016, to reach 50% by 2016. However, in the first year, some universities already had the minimum share of quota required by NQL. We take advantage of the lagged implementation of higher education quotas across states to isolate the effects from the federal law on the performance of eligible and non-eligible students using a difference-in-differences (DID) approach. Our empirical strategy compares the effects of the federal AA policy on the performance of (non) eligible students from states that had none or lower share of previous quotas than the minimum mandated, with other eligible students from states whose share of quota was equal or above the minimum. By carrying out comparisons between similar groups, we avoid making inferences regarding effects on

[2] Quotas for disabled students are not considered in our analyses, as they were only introduced after 2016.

achievement gaps between eligible (mostly disadvantaged) and non-eligible (mostly advantaged) students, which depend less on motivation and incentives and more on structural factors, as improving academic efficiency can be too costly for racial minorities and the poor and should be addressed by additional policies (Cotton et al. 2020).

To account for the different characteristics of each of the subgroups targeted by the law, as defined by the race and income additional criteria, we further conduct separate analyses to explore for potential heterogeneous effects. This step is necessary because since the composition of eligible students is very broad (around 75% of all graduating students are eligible), we anticipate that the substantial differences across subgroups can influence the way each one responds to the policy. In addition to examining effects on the performance of students targeted by the law, we also investigate whether the policy had a negative effect on the performance of non-eligible students, who may have felt discouraged by the policy. Finally, we conduct further subgroup analyses to assess additional heterogeneous effects due to other students' characteristics, not just the ones determined by the law, such as, total and per-capita household income level, age, race, or gender, among others; this will provide us with a more comprehensive understanding of the how performance is affected, as often these analyses are missed in AA evaluations (Chetty, Friedman, et al. 2020; Cotton, Hickman, and Price 2020).

Our main hypothesis is that the implementation of the quota law can potentially enhance the hopes and motivation of students in states that had no previous quotas, encouraging them to invest more in education than those in states which started earlier. The widespread media coverage during the passing of the bill, approved by the Congress in 2012, generated accessible public information about the role of higher education and messages about how the NQL would improve opportunities for non-white and poor students. This factor could have affected more strongly the students from states that had no previous quotas compared to those with previous quotas. Research has shown the role of information on students' decisions, shaping expectations, and creating incentives

for the poor, particularly for high-achieving students (Hoxby and Avery 2013; Hoxby and Turner 2015; Karlson 2019). Our analytical strategy is feasible because of the mobility of students in Brazil is low, as they tend to apply for universities in their place of residence[3] (Mello 2023).

Brazil makes an interesting scenario for this investigation, because candidates are selected based solely on their individual rankings on high-stakes entrance exams. As opposed to the US, which contains some sort of subjective admission criteria and college preferences are "complex and multidimensional" (Holzer and Neumark, 2006, p. 28), the probability of being admitted into a selective university in Brazil relies on a unique information that can more directly reflect student incentives and effort for increasing investment in education and test preparation (Jacob 2002; Gneezy et al. 2019). Another important feature of Brazilian college admission system is that it is a centralised, transparent process which enables applicants to be previously informed[4] of their admission chances and the minimum requirements (cut-off) for their degree programme/institution of interest to make their choices accordingly[5], allowing students to prepare in advance for the annual entrance exams and decide the effort to be employed.

Our data consists of pooled cross-sections of six editions (N=6.9 million) of the national university entrance exams (*Exame Nacional do Ensino Medio*- ENEM), where there is a new cohort of participants in each edition. We restrict our data to the population of fresh

[3] In this paper, we use the location of school in place of student state of residence. This approach remains consistent in our analysis, as the share of students from other states in the sample is less than 0.7%, and results remains unaffected.

[4] This may not necessarily be true as it may be the case that students do not master the use of application platform. That also applies to information about quota category that applies to them. This point needs further investigation.

[5] See Aygun and Bo (2021) and Mello (2022a) for more information of how this process occurs. Important to note that the cut-off scores vary by degree, shift, campuses, and universities.

high-school graduates[6], where 75% belong to the targeted group and 25% are not eligible students from private schools. We disaggregate the data into these two samples: i) a group including only eligible students, and ii) a group including only non-eligible students. The period of analysis ranges from 2010 to 2015. To gather information about previous quotas, we use an original dataset prepared by Mello (2022) with information of vacancies and number reservations for each higher education institution, which we complemented and adjusted to cover our period of analysis and research question. As we are studying the NQL, we only include the information for federal institutions, since other public universities are not covered by the law.

Our findings document that the NQL led to an overall increase of .04 standard deviation (SD) on the average test score[7] for eligible and .03 SDs for non-eligible students in treated states. Furthermore, these effects follow an increasing trend over time, as the intensity of NQL grows. Nevertheless, effects are heterogeneous across subjects and specific subgroups, with higher-income groups, especially non-white higher-income groups, experiencing significant larger impacts than the ones observed on lower-income groups. This result indicates that family income is an important determinant of the NQL impact. We also found that effects were higher in science and math subjects, with little or no significant effects found in languages and humanities. However, it is important to highlight that these results do not indicate any significant improvements in the achievement gap between eligible and non-eligible students. This suggests that the policy on average has not been able to actively reduce the persistent educational inequalities between students from public and private schools within treated states. To test the robustness of our findings, we used alternative strategies, which yielded similar results. Additional findings may also suggest that implementing AA at a later stage could have

[6] We only consider students who are graduating on the same year of the ENEM editions, as this group is more likely to invest in test preparation, while still in school. Brazilian system allows a high-school student to take the university entrance tests as many times as possible, irrespectively of when they graduated.
[7] Does not consider the essay scores.

encouraged educational systems to prepare students better for the new academic opportunities brought by the NQL, although mechanisms are still unclear.

Overall, we contribute to the literature of pre-college effects of AA policies in developing countries by reporting the causal effects of this important Brazilian AA policy at a national level. We also provide detailed analyses for each of the four subgroups covered by the policy, including non-eligible applicants. So far, up to our knowledge, this is the first study to examine the effects of this policy on the performance of each specific targeted subgroup, as well as the first attempting to isolate the effects of the National Quota Law from previous AA experiences.

Including this introduction, this paper is structured in seven sections. Section 2 reviews the previous literature on pre-college effects of AA programmes. Section 3 discusses the Brazilian context of higher education and AA policies, including the underlying details of the AA regulation in the country. Section 4 presents the data while Section 5 explains the empirical strategy. Section 6 presents the results and main discussions and Section 7, the final conclusions.

1.2. Previous literature on the effects of AA on pre-college outcomes

While there is a plethora of studies approaching the effects of AA programmes on different aspects during application process and after entrance in university[8], research on

[8] These studies approach issues such as college and major decisions, (mis)matching and student performance after going to college (Arcidiacono, Aucejo, and Hotz 2016; Arcidiacono, Lovenheim, and Zhu 2015; Badge, Epple, and Taylor 2020; Fischer and Massey 2007; Holzer and Neumark 2000; Holzer and Neumark 2006; Howell 2010; Kane 1998), graduation and labour market wages (Arcidiacono, Lovenheim, and Zhu 2015; Marianne Bertrand, Hanna, and Mullainathan 2010; Rothstein and Yoon 2008) peers and information effects (C. Hoxby and Avery 2013). Other studies explore the effects of policy bans and race-neutral policies (Blume and Long 2014; Card and Krueger 2005; Darity, Deshpande, and Weisskopf 2011; Ellison and Pathak 2021; Hinrichs 2012; Kane 1998; M. C. Long and Bateman 2020), diversity at campus and other externalities (Allen and Solorzano 2000; Gurin et al. 2004). For more compound revision of empirical evidence on the effects of affirmative action in higher education see Arcidiacono et al. (2015), Holzer and

the potential incentive effects of AA on students' pre-college outcomes is still lacking.

Drawing on economic theory, Fryer and Loury (2005) deem that AA policies could dampen students' incentives and reduce effort if they are at the margin of being selected and admission is perceived as "easier", but it is also possible that eligible students may respond with increased effort and greater test preparation if their prospects to access higher education are enhanced through a decline of relative competition in their favour, increasing their motivation and reducing discouragement effects, i.e. if chances for admission are minimal, disadvantaged students may feel discouraged to pursue a place at university. They agree that effects of AA policies are ambiguous and contingent, as a "subtle and context-dependent empirical question", relying on the specifics of AA schemes and implementation context.

As anticipated by Fryer and Loury (2005), recent theoretical and empirical research has shown that AA policies have the potential to affect incentives for pre-college human capital investment but effects are mixed (Franke 2012; Antonovics and Backes 2014; Assuncao and Ferman 2015; Bodoh-Creed and Hickman 2017; Khanna 2020; Cotton, Hickman, and Price 2020; 2022; Mello 2022; Leal and Choi 2023; Akhtari, Bau, and Laliberté 2024). These studies argue that students' decision to invest in education is not just a given function of students' own ability and background, but they are endogenous to AA schemes.

Based on auction literature, Bodoh-Creed and Hickman (2018; 2017) built a structural model for college admission and different AA designs for the US higher-education context. They used counterfactual analyses to evaluate the effects of different AA admission rules (proportional quota and colour-blind admissions) and compared with the

Neumark (2006) and Long (2007). Sowell (2004) also summarises empirical evidence of these policies in countries other than the US.

US status-quo rule. With respect to investment in education, the authors found that AA affects students' incentives in different ways, depending on their demographic group, learning costs, and expected returns. Effects occur through the interaction of two channels of returns: i) "productive channel" (direct incentives), depending on students' own achievement that enables them to access good-quality colleges; and ii) "competitive channel" (indirect incentives), where students respond strategically to competition and establish their positions. They found that the competitive channel was surprisingly strong. Amongst AA schemes, proportional quota is more likely to incentivise low-performing minorities to increase effort, while colour-blind policies impact negatively this group, driving them to low-quality institutions that begets lower wages in the future. Their findings show that proportional quotas are more efficient than other AA schemes to improve academic achievement. Results from Cotton, Hickman, and Price (2020; 2022) indicate that, on average, AA increases effort of targeted students while affecting negatively higher ability students. The authors conclude that a well-designed AA can narrow the overall achievement gap through changes in expected returns and competition, but AA may not be enough to incentivize the high-performing students, and additional interventions may be necessary.

These questions have been tested empirically with AA bans in the US context, often regarded as natural experiments which allow identification of causal relationships (Antonovics and Backes 2014). Antonovics and Backes (2014) and Card and Krueger (2005) examined the effects of AA ban in California and Texas and found little or no change on SAT/GPA grades or application behaviour for minorities affected by the ban, particularly on high-achieving beneficiaries, contradicting the argument that AA reduces incentives. Studying the re-establishment of AA policies in three US states, Akhtari, Bau and Laliberte (2024) document that AA increases pre-college grades, while reducing racial gaps in SAT scores, with higher effects concentrated on the top of score distribution. Bleemer (2022) found that AA ban in California reduced applications from qualified minorities in UC campus. On the other hand, Caldwell (2010) report negative effects on effort intensity and grades from minority children affected by AA bans,

concluding that AA has a significant role in improving students' expected returns from education.

Positive effects of AA on pre-college outcomes have also been documented in other countries. Khanna (2020) found AA for civil-service employment in India improved high-school attendance and completion rate for minority groups, although their findings indicate that if proportional quotas are too aggressive impact on outcomes may be negative. The author concludes that minority students respond accordingly when their expectations increase. In Chile, Grau (2018) found increased effects of SES-quota policies on academic achievement and university admissions of disadvantaged students.

In Brazil, results from prior evaluations of AA policies on pre-college outcomes are also mixed. Most of these studies involve institutional AA programmes implemented before the federal law restricted to specific states and universities. Using a DID approach and ENEM data, Saeme (2014) studied the effects of AA programme in Federal University of São Carlos (UFSCar) in São Paulo and found that targeted students scored slightly higher in ENEM scores, respectively, compared students in states without the policy. With a similar strategy, Assuncao and Ferman (2015) compared AA schemes on state universities from Rio de Janeiro (UERJ) and Bahia (UEBA) and found that in Rio, who introduced a more aggressive quota scheme, the performance of targeted black students from public schools fell, while other targeted students with low-intensity quota scheme were not affected, supporting the view that aggressive quotas may deteriorate achievement gaps. However, Francis and Tanuri-Pianto (2012b) found no negative effect on ENEM scores of non-white students following a race-based AA policy at the University of Brasilia (UNB). Looking into another elite university (Unicamp), Estevan, Gall and Morin (2019b) also identified no change in effort of targeted students after AA programme was implemented.

Several studies have documented the positive effects of the AA policies in Brazil, addressing both equity and efficiency issues after students go to college or during application process, but most of them consider the period before the introduction of NQL (Cardoso 2008; Childs and Stromquist 2015; Valente and Berry 2017; Vilela et al. 2017; Francis-Tan and Tannuri-Pianto 2018; Melo 2019; Estevan, Gall, and Morin 2019a). Research specifically approaching the quota law shows that the policy substantially changed application behaviour and composition on competitive degrees at elite universities increasing representation of low-SES and non-white students (Mendes Junior, Souza, and Waltenberg 2016; Mello and Senkevics 2018; Vidigal 2017; Vieira and Kuenning 2019; Mello 2022), albeit evidence of increased strategic behaviour have also been found with over-qualified applicants claiming eligibility to quotas during application process (Aygun and Bó 2021). Other studies analyse AA long-term effects on income and inequality (Ribeiro and Estevan 2021; Otero, Barahona, and Dobbin 2021; Brotherhood, Herskovic, and Ramos 2023); enhanced *negro* identity (Daflon, Feres Júnior, and Campos 2013; Francis-Tan and Tannuri-Pianto 2018) and improved retention rates (Francis-Tan and Tannuri-Pianto 2018).

However, there are not many studies documenting nationwide effects of the NQL on pre-college outcomes in Brazil. Mello (2023) reports unintended (behavioural) effects on school choice during transition from elementary to high school, where students who attended private elementary schools rationally moved from private to public high schools to gather benefits from the policy, particularly in the regions more exposed to the policy (i.e., close to university campuses). These movements were more intense for non-white and lower income groups who attended low-quality schools, showing the policy had little or no effect on movements from higher-SES students.

Our paper relates more closely to a new study conducted by Leal and Choi (2023), which, to the best of our knowledge, is the first to examine the effects of the quota law on student performance in ENEM at a national level in Brazil. The authors document small

positive average effects for the “school component”, i.e., by comparing eligible white students (students from public school) with all non-eligible students (students from private schools) and for the “racial component”, i.e., comparing eligible non-white students with eligible white students. They also found higher effects on science and math subjects. However, this evidence does not consider NQL’s specific targeted populations and income criteria. Moreover, they did not isolate effects from prior AA programmes.

This paper also relates closely to Mello (2022), who studied the effects of the NQL on application behaviour and entrance rate for different subgroups covered by the quota, although the income threshold considered by Mello (2022) is different than the one stablished by the policy, but importantly covers effects on outcomes of students from very low-income households (up to one minimum wage).

Adding to these results, we show that the quota Law improved student investment in education for eligible students in treated states, as well as for each specific subgroup.

1.3. Brazilian social and educational context, background of AA initiatives and the Quota Law

1.3.1 Brazilian educational context and access to higher education

Education in Brazil is highly stratified and marked with persistent achievement gaps, strongly rooted on structural problems and high socioeconomic, racial, and geographic disparities, among other factors, which create barriers for disadvantaged students to access quality higher education (Senkevics and Carvalho 2020). After the expansion of basic education in the last decades, progress has been made, where almost 100% of all children under 14 years of age are enrolled in primary and middle school (Todos pela Educação 2022; Barbosa et al. 2023). However, completing high school remains a

significant challenge for disadvantaged youth. As of 2020, among 19-year-olds, only 69.4% successfully finished high school. Within this share, 61.4% were non-white individuals, contrasting with 79.1% among their white counterparts (Todos pela Educação 2022). Over 40% of 19-year-old individuals from the lowest income level had not completed high school by 2020 (Todos pela Educação 2022). These disparities coupled with high dropout and repetition rates in Brazil, make even harder for disadvantaged students to access higher education. In this sense, high school functions as a filter for higher education with the poorest quintiles having less opportunities (Senkevics and Carvalho 2020).

A paradox underlying the stratified Brazilian educational system is that while, on one hand, public schools at basic-education level deliver free low-quality education and are often underfunded, which hinders opportunities for the poor to improve learning; on the other hand, private schools provide better resources so that students are well-prepared for university entrance tests. However, the quality of services delivered varies widely within systems. There are high-performance public high schools, such as federal schools, often attended by middle-class students; and low-quality private schools, who serve disadvantaged neighbourhoods. When it comes to higher-education level, the situation inverts. Public universities, particularly federal institutions, are tuition free and have the best faculty and educational resources, thus admission is highly competitive. There is at least one federal university in each of the 27 states, including the federal district, Brasilia. Public universities administered by states and municipalities are also available and well rated, though not as highly as federal institutions. On the other hand (with exceptions), private universities offer bad-quality degrees and tend to enrol low-income students with few admission requirements.

Entrance to public universities is generally based on ENEM scores alone or combined with institutions' own exams ("vestibular"), whose tests are implemented in the same location as the institutions. Even before ENEM became compulsory, test-score rankings have

always been the only criteria for accessing public institutions, either through *vestibular* or using ENEM scores as a complimentary part of admission processes. It is important to note that the belief in meritocracy is very strong in the country, as common in very unequal societies (Mijs 2021), therefore the use of test scores, exclusively, as a proxy of student ability has seldomly been questioned. In Brazilian culture, test performance of all different nature determines not just admission to university, but also studentships and access to high quality jobs, especially on the civil service. In this sense, opportunities are mainly determined by individual schooling trajectory.

The challenge with the underlying meritocratic belief stems from the strong correlation between test scores and students' origins, encompassing factors such as race, income, parental education, and geographic region, particularly evident in the Brazilian context (Paes de Barros and Mendonça 2000; Menezes-Filho 2007; Francis and Tannuri-Pianto 2012; Alves, Soares, and Xavier 2016; Marteleto, Marschner, and Carvalhaes 2016; Menezes Filho and Kirschbaum 2018). Students from disadvantaged backgrounds, who attend public schools, tend to perform worse on admission tests, making it difficult for them to achieve the minimum scores to enter selective public universities. In contrast, their advantaged counterparts from private schools, benefit from early exposure to high-quality educational resources, better health care and supportive parenting, which prepare them to achieve the top scores on entrance exams. Before the introduction of AA, disadvantaged students willing to improve their chances in the job market typically would sort into less competitive degree programmes or enrol in low-quality private universities that yield lower returns; while affluent white students have always had higher chances to secure seats in top-rated degree programmes that are highly valued by employers. For long, this mechanism reproduced and reinforced a vicious cycle of inequalities by favouring high-income students from elite schools while marginalising disadvantaged students from public schools who faced structural deficits in education and innumerable hardships that impeded them to improve their academic performance

and achieve further education (Valente 2017; 2016).

With increasingly more students graduating from high-school over the last decades, the demand for higher education surged in Brazil; but, for a great majority of students, accessing selective higher education institutions is still an impossible dream, where the quality of high-school education has always been a major barrier for further education attainment (Cavalcanti, Guimaraes, and Sampaio 2010; Oliveira, Belluzzo, and Pazello 2013; Valente 2016; Dias Lopes 2017; Valente and Berry 2017; Senkevics and Carvalho 2020). Despite some progress, Brazil still has the worst higher-education attainment among 25-64-year-old population compared to other countries in South America or in the OECD (OECD, 2023).

When it comes to race, non-white students[9] tend to underperform whites, as apart from being more represented in low-income families, they are subject to racism and discrimination since very early in life, which hampers their self-esteem, aspirations, and overall achievements in education (Marteleto, Marschner, and Carvalhaes 2016; Valente 2017; Becker and Arends-Kuenning 2020). It is worth noting that gaps in educational attainment have been gradually decreasing over the years but still remain high (Marteleto 2012). According to the 2000 population census, only 14% of over 25-year-old population with a university degree were non-white, in contrast with 85% of white. With the introduction of educational policies, among those with higher education for the same age bracket raised to 36% for non-white by 2022[10], with more people self-classifying themselves as non-white (56%)[11]. Despite improvements in educational attainment, income disparities between white and non-white workers still persist. In 2019, the average hourly wage of white workers with higher education was 44% higher than that of

[9] Black and *pardos* (mixed-coloured*)*, according to the race classification by IBGE (National Geography & Statistics Institute)

[10] PNAD Continua 2022/IBGE [Brazilian Institute of Geography and Statistics]. The 2022 Census information regarding education had not yet been released by the time I wrote this thesis.

[11] 2022 Population Census (IBGE 2023)

non-white workers with the same level of education (IBGE, 2020). These disparities may reflect discrimination in the job market, but also the high dominance of low-quality degrees, mostly from private universities, which increased dramatically since early 2000s to absorb the expansion of schooling (Carvalhaes, Senkevics, and Ribeiro 2022; Firpo, França, and Portella 2021). Private universities tend to target disadvantaged working students who pay a small fee or use public vouchers/loans to attend underrated programmes that promote little mobility. The country has the largest private sector in tertiary education (Carvalhaes, Senkevics, and Ribeiro 2022).

Table 1-1 presents an overall landscape of Brazilian higher-educational system, including the changes in number of institutions, courses and vacancies offered and number of participants in the admission processes for the years 2000, 2009 and 2016. Between 2000 and 2009, there was a huge expansion of higher education, mostly led by private institutions that increased number of institutions (106%), number of vacancies (185%) and number of degrees (199%). Public institutions also tried to cope with the increasing demand for higher education, with much of the increase occurring in federal institutions, thanks to the expansion of interiorization programmes and implementation of new technological centres that offered technical higher education degrees[12]. Although the number of applicants raised by over two million in the period, this extra demand was absorbed by private institutions (95%) with a small increase in applications for federal (15%) and state institutions (23%). This led to an overall decrease in competition, i.e., the number of participants per vacancy, particularly in public institutions. After 2009, the demand for a place in federal institutions surged by 357% and competition escalated for federal institutions with some change in applications for other public (state and municipal) universities but remained almost unchanged for private institutions. Competition soared from 6 to 19 candidates for a place, but competition is usually higher for more selective programmes. Between 2009 and 2016, federal institutions raised total vacancies by 50% and presential degrees (36%), whereas 3,000 new degrees were offered by private institutions. Private sector was responsible for 87% of all vacancies in

[12] These are shorter degrees, usually taking 3 years, lower than usual bachelor's degrees that last 4 to 5 years.

higher education with over 2,100 institutions, compared to almost 300 public institutions, among which, 107 are federal.

TABLE 1-1: CHANGES IN HIGHER EDUCATION IN BRAZIL - 2000, 2009 AND 2016

	2000	2009	2016	Variation 2009-2000(%)	Variation 2016-2009(%)
Part 1:					
New vacancies (1,000) (A)	**1,216**	**3,165**	**3,937**	**160**	**24**
Federal	120	210	316	75	50
Other public	125	184	214	47	16
Private	971	2,771	3,408	185	23
Applicants (1,000) (B)	**4,040**	**6,223**	**13,635**	**54**	**119**
Federal	1,156	1,330	6,073	15	357
Other public	1,023	1,259	1,831	23	45
Private	1,861	3,634	5,731	95	58
Competition (B/A)	**3.3**	**2**	**3.5**	**-39**	**78**
Federal	9.6	6.3	19.2	-34	205
Other public	8.2	6.9	8.6	-16	25
Private	1.9	1.3	1.7	-32	31
Part 2:					
No. presential degrees	**10,585**	**27,827**	**32,704**	**163**	**18**
Federal	1,996	4,368	5,938	119	36
Other public	3751	3,860	4,155	3	8
Private	6,564	19,599	22,611	199	15
No. institutions	**1,180**	**2,314**	**2,364**	**96**	**2**
Federal	61	94	107	54	14
Other public	115	151	189	31	25
Private	1,004	2,069	2,111	106	2

Source: Census of Higher Education/MEC/INEP/DEED (2009/2016)

Note: This table presents statistics and major changes between years 2009 and 2016 in Brazilian higher education system per administrative instance, including federal, other public (state and municipal) and private institutions. Part 1 highlights the competition changes in the period for the new vacancies: (A) the number of vacancies offered by selective processes; (B) the number of participants in selective process (ENEM, vestibular or others); the competition rate for the new vacancies (A/B). Part 2 shows the changes in the number of presential undergraduate courses and number of institutions. All higher-education institutions are considered.

As demand for quality higher education grew and competition intensified after 2000, the more difficult it became for disadvantaged students to attain further education, thus creating a scenario for the introduction of higher education AA policies.

1.3.2 Background of AA initiatives

The call for AA quotas starts as racial inequalities in education became more conspicuous, particularly harming black students in achieving better jobs. Black movements intensify as education is seen as key for social transformation and with the growing awareness that a major source of inequality was the uneven allocation of public resources into higher education, that primarily favoured privileged groups (Htun 2004; Bailey, Fialho, and Peria 2018).

Despite having the biggest Afro-descendent population outside of Africa[13], a history of slavery and long-standing oppression to Afro-descendant populations, race had never been recognised as a determinant of inequality in Brazil, what refrained policymakers from adopting race-based policies (Francis-Tan and Tannuri-Pianto, 2018). Brazil had the largest enslaved black population in the world, with nearly five million African slaves being traded (Bucciferro 2017) and was the last country in the west to abolish slavery[14] (Heringer and Johnson 2015), but the fact that race apartheid was never legally enforced in the country and that race miscegenation was strongly incentivised led Brazilians to think that races coexisted harmonically in the country. For long, the concept of "racial democracy" had hardly been challenged, while racial disparities were masked by the interplay of class and income inequalities. The myth of the racial democracy prevented for long black people to organise into a "black" identity and genuinely fight for their rights (Htun, 2004; Sales and Moses, 2014; Bailey et al., 2018). Within this context, deep racial inequalities and systemic discrimination persisted generating a cycle of "cumulative disadvantages" and segregation on which education systems played a significant role in feeding it (Hasenbalg, 1979).

[13] According to the 2022 Population Census, 55.5 % of the population declared themselves as *pretos* or *pardos*, from which 45.3% are *pardos* and 10.2% are blacks. Together, the non-white population for a group of 112.7 million inhabitants in the country.

[14] Abolishment of slavery occurred in March 1888.

This situation became more evident in the last decades when technological development brought structural changes to the labour market and black people saw their opportunities shrink and acknowledged that having a high-school diploma was not enough to be employed (Barbosa-Filho and Pessoa 2009; Menezes-Filho 2001).

Considering education as a fundamental human right after democratization of Brazil, the 1988 Constitution established that education should be compulsory for all children aged 4 to 17 (BRASIL 1988). This ruling led to a surge in enrolments; however, the emphasis was primarily on access, with minimal attention to the quality of the educational services provided.

The new Constitution provided legal framework to enforce human rights and combat racism and racial discrimination, after two decades of authoritarianism, but the overt lack of opportunities for black population in education triggered the growth of Black movements and their advocates to organise themselves under a non-white ("*negro*") identity to claim for race-based policies to improve university access and promote inclusion. The binary racial classification aimed to solve the complexity of racial classification in Brazil based in a colour continuum by unifying dark-skinned black with mixed-coloured (*pardos*), who are also thought to share the same type of disadvantages and discriminations, thus increasing support for their cause. For this reason, all race-based policies considered this binary colour division. This group wanted compensation for past racial injustices, a halt to structural discrimination and racism and a drop in the dramatic racial inequalities. These movements grew strongly in communities and "favelas", initially by providing additional preparation courses for university admission exams for disadvantaged black students (Guimarães 2003; Francis-Tan and Tannuri-Pianto 2018) Later, these initiatives led to mobilisations for AA policies in higher education.

A bill was put forward in 1999, originally targeting only at public-school students to address the structural divides in Brazilian educational system. While in Congress, the bill was soon sponsored by the new democratic government, who put race at the centre of the programme, but the legal process until the enactment of the law was long and hotly debated [15]. This was the first time a race-based policy became part of the national agenda (Bailey, Fialho, and Peria 2018; Bailey, Fialho, and Loveman 2018; Francis-Tan and Tannuri-Pianto 2018). While a national consensus over racial-based AA was not yet established, in the early 2000s, some states and universities[16] started to introduce AA programmes and soon were followed by federal institutions. Every year, a growing number of universities embraced some type of quota system on their admission processes mostly focused on race or students from public schools (Sales and Moses, 2014; Marteleto et al., 2016). The variety of AA policies across federal institutions required a national regulation.

In the meantime, to improve access of disadvantaged students into higher education, the federal government implemented new race-blind educational policies, such as PROUNI (2004), a scholarship programme for private institutions; FIES (1999), a subsidised-loan scheme – also focused on the private sector, as well as REUNI (2007), the expansion and interiorisation programme of federal institutions and PNAES (2007), which offered financial support for low-income students enrolled in federal institutions.

Although the rationale for AA policies became more generally accepted, the debate over race-based policies lost strength, as society showed a clear preference for class-based policies (Schwartzman and da Silva 2012) which led to changes on the scope of the bill while in Congress. Besides also targeting on race, the new law should additionally include income criteria, not addressed in the previous proposal. Despite all controversies, the

[15] See Silva (2017) for a good documental study about the process of approval of the Quota Law.
[16] UERJ and UEBA were the first universities to implement in 2002, followed by UNB, first federal university to adhere, in 2004 (Vieira and Kuenning, 2019).

NQL was approved by the Congress in August 2012 (BRASIL 2012)[17], after judged constitutional by the High Court, to be mandated in 2013, with the declared mission to mitigate social and racial inequalities.

1.3.3 ENEM and SISU

The National High-School Exam (ENEM) is the most important university entrance exams in Brazil and has become increasingly competitive over the last decade after centralization of university admission process. ENEM is considered the second largest university entrance exam in the world after China's Gaokao, with 8.7 million registrations in 2014, when the number of applicants reached its peak**.** Created in 1998, ENEM was initially a low-stake test used as a tool to evaluate high-school educational systems, but as more and more institutions increasingly required ENEM scores as part of their admission processes, the Ministry of Education determined that from 2009 onwards, that ENEM should be mandatory for admission in all undergraduate courses in federal institutions and for quota applicants, either alone or combined with institutions' own entrance exams ("vestibular"). Many state, municipal and private universities also adopt ENEM.

To comply with its new function, the structure of the test totally changed in 2009. The "new" ENEM became more focused on high-school curriculum, covering four specific subjects (Math, Languages, Natural Sciences and Humanities), with 45 questions each, and an essay on a given topic. The scores of all five subjects are used to compose the final application score[18]. An innovation was the adoption of the Item Response Theory (IRT)

[17] Besides quotas for higher education, in 2014, the Government of Brazil also sanctioned a quota regulation for work in civil service, reserving 20% vacancies to candidates who declare themselves *pretos* or *pardos* on the registration for admission exams. Admission is based on score rankings of specific civil service exams and educational attainment levels (BRASIL, 2014).

[18] The weights for each individual subject vary according to institutions and courses, e.g. Engineering applies higher weights to Math and Science scores, while Law courses might put more weight on Languages, Humanities, or essay.

model in place of the classical grading system based on simple averages (INEP and Ministerio da Educacao 2018). This grading methodology aims to improve scoring accuracy and has been applied in many standardized tests, such as the as the Scholastic Aptitude Test (SAT), the Graduate Record Examination (GRE), or American College Test (ACT) in the US. It scales each question according to the difficulty level, which depends not just on "how many" questions are marked right, but "which" questions are marked right. This means that if most students mark a question correctly, it is considered "easy", and grading will be low; if the opposite happens, the question is considered more difficult, and scores will be higher. Therefore, grading depends on individual performance, as well as the performance of all students in each specific question. In theory, scores range from 0-1000 for each subject, but because of IRT methodology, a top grade is hardly reached, except for the essay, which is corrected by two human evaluators. The more "difficult" the test, the higher the scores. The test runs once a year during two days on the weekends, usually before the end of the academic year (October-December). The scores are used for applications in the online platform called SISU - Unified Selection System[19] - at the start of the following year. Senior high-school students, nearing graduation, and graduate students from previous years can take and retake the test for as many editions as they wish, which explains why the number of participants is much higher than the number of recent graduates. Students from first and second year of high school can also take the test as a training exercise but cannot apply for a university spot. Although most of the applications are centralized on SISU, some universities may adopt alternative selection mechanisms outside SISU, by combining ENEM scores with scores from their own "vestibular" exams. Others may offer part of the vacancies via SISU, and part though their own entrance tests. Using the SISU platform, students make their choices according to their chances[20] and quota eligibility; and at the

[19] *Sistema de Selecao Unificada*

[20] This process is very dynamic, as the cut-off score changes constantly during the application window as it is calculated according to the scores of all applicants. The ENEM scores are used to make choices of degree and institutions based on their odds, taking into consideration the scores of other applicants. The platform provides full information to applicants and allows for changes in choices during the application window. For more information about how SISU operates, read Mello (2022); Aygun and Bó (2021); Otero, Barahona, and Dobbin (2021).

end of the application window, the top-performing candidates are selected within each group (quota or general competition).

With the introduction of SISU[21], students are able to apply to any university in the country based on their ENEM scores, without having to move to a specific state to take the "vestibular" exam. This policy reduced the costs for disadvantaged students but also increased competition in their state of residency (see Mello 2022). With SISU and ENEM, applications became a centralised and transparent process, where applicants receive previous information of minimum admission scores (cut-off scores) from previous years for the course of interest according to each quota group, as well as for general competition (i.e., not eligible to quotas). In the year of application, students use the platform to monitor their own performance in comparison to other applicants and the cut-off scores, which are dynamically updated during the application window, that usually lasts one week. This information allows applicants to change their options according to their own scores and those of their competitors and choose the degree/university they have greater chances to be admitted at[22], depending on the quota group they qualify for. Applicants can choose up to two programmes and admission relies on their score rankings. They may also refuse to apply for quotas if their scores are high enough to match those from general competition (see Aygun and Bó 2021). After application window is closed, the applicant cannot change the course or quota group she applied for, unless the slots are not totally filled (in case there are not enough applicants in a specific quota group reaching the minimum cut-off score), which follows an admission rule from the most to the least disadvantaged quota groups.

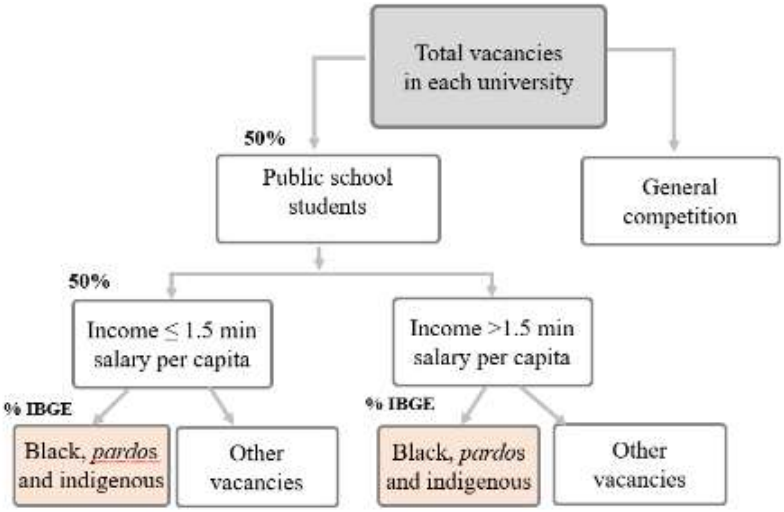
[21] Although not all federal institutions adopt SISU, its use has increased substantially in the last years. While few institutions still apply their own admission tests, including ENEM scores as an additional criterion, others may split the vacancies into SISU and their own *vestibular*.

[22] See Aygun and Bo (2021) and Mello (2022a) for more information of how this process occurs.

1.3.4 The National Quota Law

The National Quota Law determined that 50% of available spots in all undergraduate programmes in federal institutions[23] should be reserved to students from public schools. To be eligible, the applicant must have completed all three years of high school in a public school (BRASIL, 2012). The reserved spots are split into two groups based on an income criterion, then each of these groups are further divided into subgroups based on race/ethnicity[24] to address different social disadvantages. A diagram explaining the division into subgroups is depicted in Figure 1-1 below:

FIGURE 1-1: THE NATIONAL LAW OF QUOTAS



Notes: Elaborated by the author based on the Law 12.711/2012. From 2016, 50% of all vacancies offered for a particular programme in a federal institution, should be reserved for students who completed all high-school education in public schools. Half of the reservations (25%) should go to students from low-income households (1.5 minimum-wage per capita) and the other half has no income criteria. These two halves are further divided to comply black, *pardo* and indigenous students according to their share of population on each state informed by the latest National Census.

[23] The law also ensured spots at high school level in vocational (technical) schools.
[24] In December 2016, the policy was revised to include disability as one of the eligible conditions for the 2017 application session. This category is not analysed in this paper, as our data does not cover this period.

As shown in the diagramme above, half of the reserved spots benefits students from low-income families (households with up to 1.5 minimum wage per capita) and the other half requires no income criteria. Within each of the two groups of reservations, a percentage should be assigned for non-white ethnic groups (black, *pardo* and indigenous) corresponding to their share of the population on the states where the institution is located[25]. The introduction of quotas was gradual, starting with a minimum of 12.5% in 2013, increasing 12.5 p.p. each year until reaching a minimum of 50% by 2016.

Therefore, the policy targets four major groups: i) *public school (PS*): white or Asian students from households with income above the minimum threshold (1.5 minimum wage per capita); ii) *low income (LI)*: white or Asian students from household income equal or below the minimum threshold; iii) *non-white (NW):* black and *pardo* students coming from households without any income restriction and, iv) *non-white and low income (NWLI)*: black and *pardo* students with household income equal or below the minimum threshold. Race is self-declared during application process, while evidence for per-capita household income must be presented for enrolment if the students claim for class-based quotas.

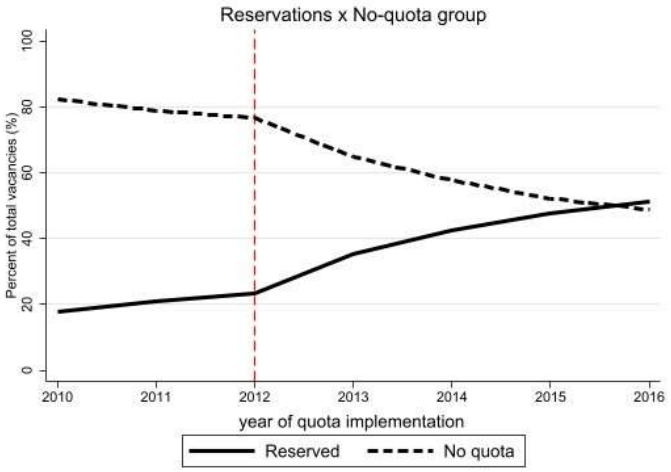
The NQL did not promote significant changes to the general admission processes, where vacancies are filled according to the highest ranking, achieved on either ENEM or other admission tests. This means that applicants need to compete for the vacancies in their own group, or quota subgroups, for each undergraduate programme of interest, whose scores must be higher than the cut-off scores, that vary by degree, shift, campus location and institution. Since cut-off scores for each targeted group tend to be lower compared to their counterparts not covered by the policy, the relative competition is shifted in benefit of the former to increase their admission opportunities. However, it is worth mentioning that it is not always true that eligible students have a lower score than their

[25] The share of black, mixed-coloured and indigenous is informed by the latest IBGE Population Census, which for the period considered in this study corresponds to 2010.

non-eligible counterparts, as observed by Aygun and Bó (2021) who found that on some occasions, for highly competitive programmes, some eligible students can outperform non-targeted competitors but instead of choosing the general competition vacancies, which would also assure their admission, they strategically take advantage of the quotas to increase their admission probability, while reducing the chances of other eligible students.

The policy promoted a huge expansion on the number of reservations, as depicted in Figure 1-2 below:

FIGURE 1-2: EVOLUTION OF QUOTA RESERVATIONS BEFORE AND AFTER THE NATIONAL QUOTA LAW



Notes: Figure presents the share of quota vacancies and the share of vacancies for non-eligible students with respect to total vacancies. Source: Mello (2022). Adjusted by the authors.

Previous quotas at federal universities corresponded to 20% of total vacancies until 2012 and were more concentrated on non-white and public-school groups, there was little consideration for income. After the NQL, reservations increased expressively until the final implementation.

1.4. Data

1.4.1 Data sources

The data used in this paper has two major sources. Our primary dataset uses ENEM microdata which was made available on the website of the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP), an institution linked to the Ministry of Education. This dataset (N=7MM) consists of pooled cross-sections of six editions of the test for the period 2010 to 2015, with a new cohort of participants on each edition. Besides containing information of individual test scores for each specific subject, ENEM dataset includes demographic and socioeconomic data from an extended-survey made with all candidates before the test, such as type of high-school and primary school previously attended, age, gender, race, income category, parental education, among others.

To gather information about reservations before and after NQL, we use a unique dataset constructed by Mello (2022) from official documents for selection processes on institutions' websites or obtained directly from each institution via citizen's information systems[26]. This dataset contains information of the number of vacancies by quota types for each higher education institution from 2010 to 2015 admission processes, including the vacancies for general competition. The different types of quotas were re-classified to match the NQL criteria, and those not comparable were put into a general category. We adjusted the information where applicable after revising Mello (2022)'s original data against data we had gathered from SISU system from the Ministry of Education, also via citizen information system, and data from the Higher Education Census produced by INEP[27]. We added data for 2016, which were missing from Mello (2022), following the

[26] The procedure Mello (2022) used to construct this dataset is described in her paper's Appendix.

[27] Sinopses Estatísticas da Educação Superior [Statistics Synopsis of Higher Education], available on Brazilian Government website https://www.gov.br/inep/pt-br/acesso-a-informacao/dados-abertos/sinopses-estatisticas/educacao-superior-graduacao

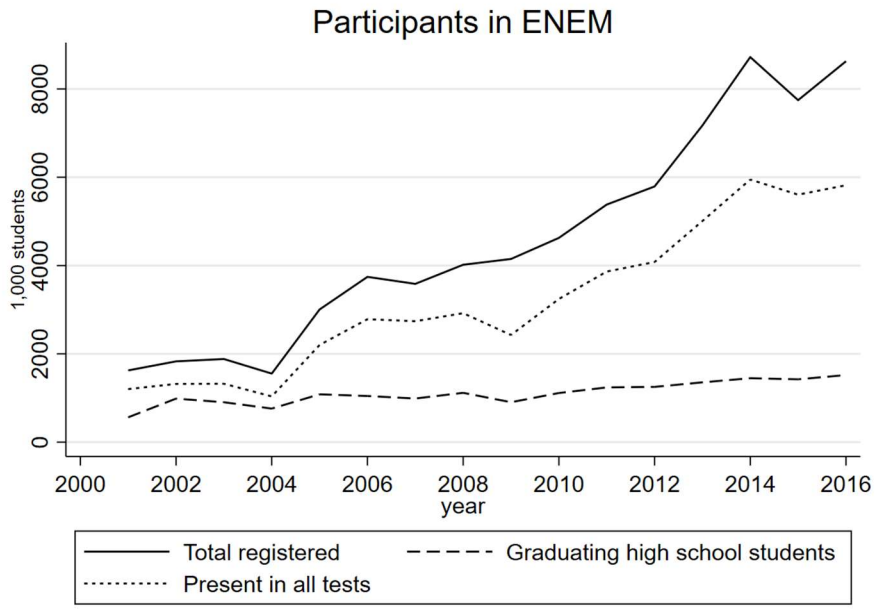
same procedure used by her. As this study examines the effects of the federal law, we dropped the observations from universities from state and municipality administrations. This dataset comprises all 107 higher-education institutions, including the institutions that offer technological degrees at higher education level (i.e., technological institutes).

1.4.2 Sample and variables

The total number of applicants who registered for ENEM in our period of analysis (2010-2015) was 39.4 million. From this population, 27.7 million (70%) effectively sat for the test and, among these candidates, only 7.8 million (20%) graduated on the same year of ENEM, on average 1.3 million per year. After data cleaning, our final sample contains 6.88 million observations, which corresponds to nearly 88% of the population of fresh graduating students who sat for the test.

Figure 1-3 illustrates the evolution of the number of participants in ENEM, which has rocketed after 2009, when ENEM became mandatory. There were 4 million applicants, and this number more than doubled in 2014 and 2016. On average, 70% of registered students sat for the test. There was a significant increase (68%) in the participation of graduating students who took the test, although at a much slower rate than the changes in number of participants.

FIGURE 1-3: EVOLUTION IN THE NUMBER OF PARTICIPANTS IN ENEM (2000-2016)



Source: INEP/MEC (ENEM 2000-2016). Elaborated by the author.

We restrict our sample to the population of fresh-graduating students, i.e., students who graduated in the same year of the test, to capture the effects of the policy on academic effort of high school graduates as they are more likely to invest in education while they are still attending school, not easily identified for those who graduated in previous years. We kept observations of 15- to 30-year-old participants, who detain a valid score, that is, students who sat for the five tests and whose essay score is not equal to zero[28]. We also discarded missing observations from important variables (e.g., school code, type of high school attended, age, race, mother education, income category, etc.). As the purpose of this study is to investigate effects of the policy for white and nonwhite groups, we also do not include Indigenous students, although they are also eligible[29].

[28] A zero score in essay means student is eliminated from the application process.

[29] This is a very small group whose eligibility criteria for application to quotas differs substantially from non-white group, as it does not rely on self-declaration. It requires confirmation by an indigenous authority or a statement from the National Indigenous Foundation – FUNAI.

Our sample has two million observations for the pre-treatment cohorts (2010-2011) and 4.9 million for the post-treatment cohorts (2012-2015). It is important to clarify that the results of ENEM are used for admission/application in the following year, therefore each ENEM cohort is always one year behind ($t_{ENEM} = t_{APPLICATION} - 1$). Our time variable *year* refers to the ENEM cohorts, not the application year. As the NQL was publicized in August 2012 to start in 2013, effects were likely to be felt from 2012 cohorts onwards. The NQL initially introduced 12.5% reservations in 2013, gradually increasing 12.5 p.p. by year and reaching full implementation (50%) by 2016. Our period of analysis involves the time spanning the implementation of the NQL corresponding to the ENEM cohorts from 2012 to 2015, and two pre-intervention periods (2010-2011). Having an extra pre-treatment period allows us to have at least two years before the intervention for testing identifying assumptions. The 2009 cohort was not considered because two important policies happened in that year: i) the change in methodology of ENEM and the fact that it became mandatory for federal university admissions; ii) the implementation of SISU which allowed students to apply for institutions beyond their own state of residency (see Vilela et al. 2017; Mello 2022). These policies most certainly would also have affected student incentives, and changed the composition of participants, hence, by starting our analyses from the 2010 cohorts, these effects would have already been there.

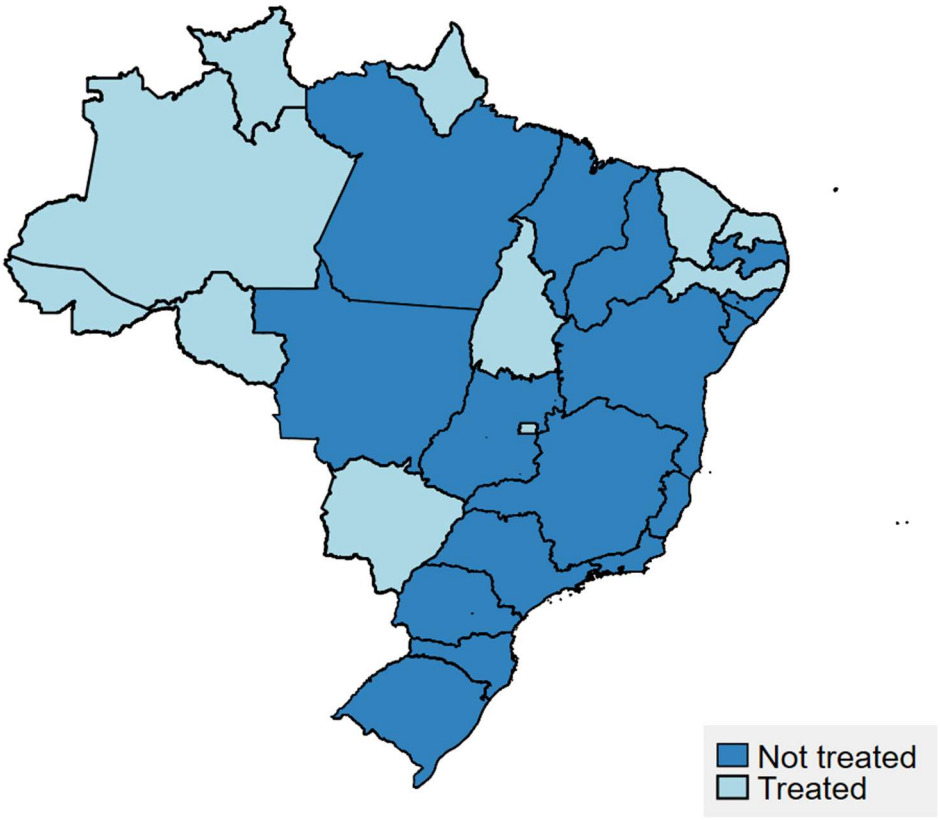
The main outcome of interest is the simple average scores from the four multiple-choice tests (i.e., excluding essay). Students use this score, together with the essay score, to apply for vacancies, however the weight of each subject depends on programme of interest. In this study, we adopted the simple average, assuming all subjects have the same weight. Besides the average individual test scores, we study the effects of the policy on the scores of each individual test. All scores are standardised by year with mean zero and standard deviation equal to one. Normalisation is necessary to make results more comparable, since the ITR methodology varies according to the test difficulty and the overall student performance, i.e., if more students find the questions easier, test scores will be lower, and the opposite occurs if test is harder, therefore we cannot tell

whether scores improved (decreased) over time or whether the test had a higher (lower) difficulty level (Valente 2017).

The treatment variable is determined by the intensity of quotas due to the NQL at state level, therefore states with previous quotas from other programmes would be entitled to lower shares of quotas established by the law. To define the treatment variable, we first collapsed the data from institution level to state level for each year to obtain the share of reservations with respect to the total number of vacancies offered in 2012, the first year before the NQL. If a state had less than 12.5% reserved spots in 2012, it is assigned to the high-intensity treatment group, else, to a low-intensity treatment group, which becomes our comparison group. This share of quotas of 12.5% was the minimum established by the policy on the first year of implementation. This procedure aims to isolate the effect of the quota law from other quota schemes that existed prior to the law. For this analysis, only the quota types that matched the criteria established by the policy were considered, excluding general quotas or quotas for people with disabilities, not covered by the quota law[30]. Following this procedure, we were left with 11 states who implemented quotas only when the NQL was introduced, which are Acre, Amazonas, Amapa, Ceara, Mato Grosso do Sul, Pernambuco, Rio Grande do Norte, Roraima, Rondonia, Tocantins and Distrito Federal (Brasilia), and the remaining 16 states belonging to the low-intensity (comparison) group. Note that after the quota law, all states were mandated to implement the minimum share of reservations by year. To define the states, we used the state where the last school is located, as students who study outside their state of residence represent less than 0.7% of the entire sample. Our results remain unaffected. The map in Figure 1-4 shows the geographical locations of high-intensity quota states (treated) and low-intensity quota states (comparison) before implementation of NQL.

[30] We tested with a sample that included all types of quotas and results do not change. Worth noticing that quotas for disabled students were only considered by the federal law from 2017.

FIGURE 1-4: STATES WITH HIGH-INTENSITY TREATMENT (TREATED) AND STATES WITH LOW-INTENSITY TREATMENT (NOT TREATED)

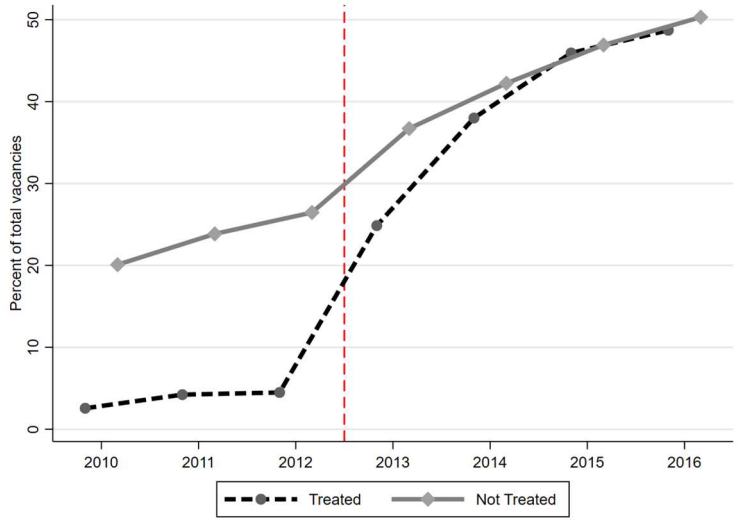


Source: Mello(2022)'s dataset, adjusted by the author to include 2016 data collected individually from federal universities public contests..

It is important to highlight that the richest states in the Southeast introduced AA policies before the NQL which could imply different effects of the law. We provide sensitivity analyses excluding these states and our findings are still robust.

The plot in Figure 1-5 depicts the share of reservations with respect to total vacancies for treated and non-treated states. While non-treated states had over 25% of quotas in 2012, treated states had less than 5%. After the quota law, all states have the same share of quotas, but the treatment group experienced the more prominent changes.

FIGURE 1-5: SHARE OF QUOTAS BY TREATMENT STATUS



Note: Treatment and comparison group had up to 12.5% share of quotas in 2011 (before the policy was introduced).

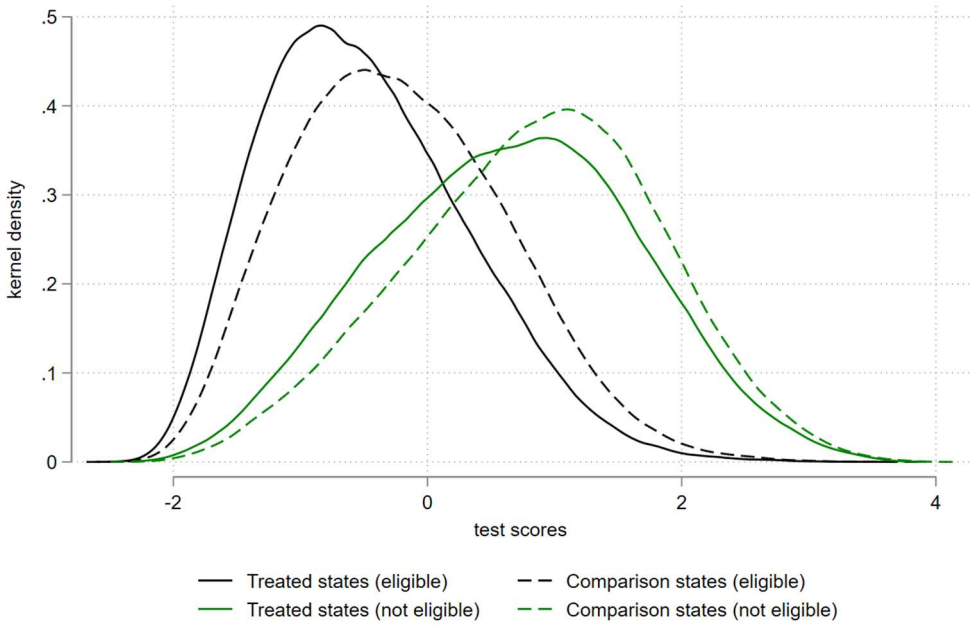
The *eligible* variable was constructed from the ENEM survey questionnaire, where students indicate whether they studied all grades of high school in a public school or otherwise. We checked consistency of the answers with the information of the previous high school attended and information from the school census to attest whether the previous school was public or private, and dropped where data was inconsistent[31]. The overall group of eligible students represents 75% of the sample, and 25% are non-eligible students who studied at least one year of high school at a private school. These percentages are the same for the periods before or after intervention. Our analyses address the effects on the outcomes of eligible and non-eligible students separately. Only eligible students from the 2012-2015 cohorts were able to apply for their programmes of interest thru NQL. Older

[31] In 2014, some information of what type of school attended during the three years of high school students attend were missing or inconsistent, due to fake school codes. Where missing we considered previous school information (for instance, if previous school was private, then student was not eligible, we also double checked with variable that indicates type of school (TP_ESCOLA). In case of inconsistencies not possible to double check (such as when fake school codes were used), information was dropped (37,234 observations).

cohorts were not eligible to the quota law, although they may have been eligible to other AA programmes in some institutions.

Figure 1-6 shows that kernel density estimates of distribution of test scores by eligibility status within treated and comparison states at baseline (2011), as expected, non-eligible students outperform eligible students, and students from comparison states outperform students from treated states.

FIGURE 1-6: KERNEL DENSITY ESTIMATION OF DISTRIBUTION OF TEST SCORES BY ELIGIBILITY AND TREATMENT STATUS AT BASELINE (2011)



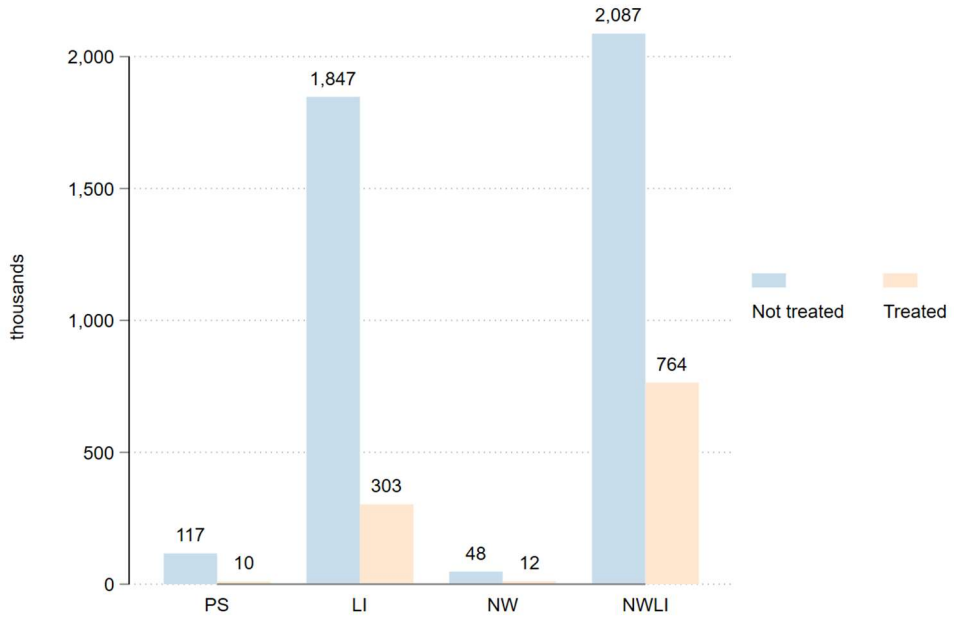
Note: Kernel density estimation of test scores
Source: Research data from INEP/MEC (ENEM 2010-2015). Elaborated by the author.

To define each specific quota subgroup and their corresponding non-eligible subgroups, we use the policy's additional race and per-capita income criteria. Race is obtained directly from the dataset. We consider a binary variable *nonwhite*, which is equal to one for students self-classified as "black" and "*pardos*" (mixed race), who are eligible for the race component, and equal to zero if the students are white or Asian ("yellow"), who cannot claim for the racial component. Including Asian students to the white group is justified as they share similar performance and background. With respect to eligibility

based on the income component, it was necessary to build a subgroup of students from households whose per capita income is equal or below 1.5 minimum wage (mw). As this information was not readily available in the survey, we calculated the total household income in terms of minimum wages, as well as the number of people in the household, both available in the survey data. The family income categories were fully informed for the 2011-2015 cohorts, however, for the 2010 cohort, the information did not match the same categories. We took the midpoint average of the range of income categories to define a continuous variable of individual total household income and did the same exercise for the average number of people in the household. The per-capita income in minimum wages was obtained by the ratio of the total family income and the number of people in the household. Where missing values were generated, we used an OLS regression to predict per capita income based in individual characteristics. Per capita income shares for 2010 were consistent with neighbouring years. We then created a dummy variable indicating whether the student is within the income threshold (=1) or otherwise (=0), that allowed us to generate the four eligible subgroups: i) PS - white students from public school and household per-capita income >1.5 mw; ii) NW – non-white students from public school and household per-capita income>1.5 mw; iii) LI - white from public school and household per-capita income<=1.5 mw and iv) NWLI - non-white from public schools and household per-capita income <=1.5 mw. The respective non-eligible groups have the same characteristics but comprise only students who attended at least one year of high school in private schools. For instance, a non-eligible version of the PS subgroup comprises white students from private schools with household per-capita income >1.5 mw. We followed the same reasoning to build the other subgroups.

In Figure 1-7, it can be observed that the number of students for higher income subgroups NW and PS is much smaller than the groups from households with lower per capita income, even though they share together the same number of quotas as low-income groups (25%). On the other hand, the great majority (96%) of graduating students eligible to quotas come from households below the income threshold.

FIGURE 1-7: PARTICIPANTS BY SUBGROUP (ELIGIBLE STUDENTS)



Note: Number participants in ENEM in our sample by subgroups according to NQL's race and income criteria Source: Research data from from INEP/MEC (ENEM 2010-2015). Elaborated by the authors.

Table 1-2 describes the covariates used for our main conditional models or for subgroup analysis.

TABLE 1-2: COVARIATES AND DESCRIPTIONS

Variable	Description
Overage	Equal to 1 if the student is over 19 years old
Mother education	1. No education, 2. Primary education 3. Middle school 4. High school 5. University level 6. Post-graduation
Mother high education	Equal to 1 if mother education is above high-school level
Non-white	Equal to 1 if student is black or *pardo*
Girl	Equal to 1 if the student's gender is female
Total household income <=6	Equal to 1 if total household income is lower or equal to 6 minimum wages
Public middle-school	Equal to 1 if students attended middle-school education entirely at a public school (not available in 2014)

And Table 1-3 presents descriptive statistics for outcome variables and characteristics of students in treated and comparison states in the baseline period (2011) for eligible and non-eligible groups. Data were split into these two groups, as in our analyses we compare eligible on treated states and eligible on untreated states. Similarly, we compare non-eligible on treated states versus non-eligible on non-treated states.

TABLE 1-3: SAMPLE MEANS OF COVARIATES FOR TREATMENT AND COMPARISON GROUPS AT BASELINE (PRE-TREATMENT PERIOD) AT BASELINE (2011)

	All eligible students (public schools)					All non-eligible (private schools)				
	Treated states		Untreated states		Difference	Treated States		Untreated states		Difference
	Mean	Sd	Mean	Sd	(A-B)	Mean	Sd	Mean	Sd	(A-B)
Dependent Variables										
Test scores	-.477	.808	-.210	.849	-0.267**	.638	1.021	.840	.993	-0.202**
Math scores	-.444	.795	-.191	.864	-0.253**	.559	1.058	.778	1.035	-0.219**
Humanities scores	-.408	.894	-.186	.899	-0.222**	.584	.980	.730	.945	-0.146**
Language scores	-.401	.933	-.163	.927	-0.239**	.517	.943	.671	.912	-0.153**
Science scores	-.416	.842	-.194	.861	-0.222**	.587	1.061	.761	1.031	-0.174**
Covariates										
Overage (>19)	.148	.355	.102	.303	0.045**	.037	.188	.028	.166	0.009**
Non-white (Black/P*ardo*)	.683	.465	.498	.500	0.184**	.432	.495	.287	.452	0.145**
Girl	.614	.487	.616	.486	-0.002	.554	.497	.553	.497	0.000
Mother education										
No education	.052	.222	.031	.174	0.021**	.007	.081	.004	.060	0.003**
Primary education	.273	.446	.255	.436	0.018**	.044	.205	.041	.198	0.003
Middle school	.235	.424	.238	.426	-0.002	.094	.292	.081	.273	0.013**
High School	.352	.478	.382	.486	-0.030**	.438	.496	.429	.495	0.010
University	.058	.233	.065	.247	-0.003	.247	.431	.286	.452	-0.039**
Postgraduation	.030	.171	.029	.168	0.001	.170	.376	.161	.367	0.009
Household income < =6 MW	.981	.136	.970	.171	0.011**	.681	.466	.632	.482	0.049**
Per capita household income < 1.5 MW	.980	.14	.964	.186	0.016**	.664	.472	.596	.491	0.068**
Nobs (t=2011)	163,432	-	645,564	-	-	49,601	-	216,087	-	-

Note: This table presents the means and standard deviations (in brackets) of covariates and dependent variable by treatment group and eligibility to quotas. Data information not available in 2014. Source: research data. Legend: * p<0.05; ** p<0.01.

Based on the provided statistics in Table 1-3, we note that eligible groups from treated states are not too similar to their counterparts in non-treated states. However, the most important differences emerge by comparing eligible and non-eligible groups. Students from treated states have lower scores than students from non-treated states, no matter whether eligible or not. This reflects the overarching regional educational disparities in Brazil, where students from the South or Southeast tend to outperform students from other regions. Eligible non-white and overaged students (i.e. students over 19 years-old, deemed the right age for conclude the high-school cycle) are more represented on treated states compared to eligible non-treated states (68% vs 50% and 15% vs 10%, respectively). This aligns with expectations, especially in the North and Northeast regions, who tend to have higher repetition and dropout rates. However, differences in mother education, income (up to six minimum wages), per-capita income, school location across treated and untreated states are minimal and not germane.

Amongst non-eligible students, it is notable that average scores are considerably higher in both treated and untreated states. This trend is a result to these students attending private schools and coming from more advantaged backgrounds. Analogously to the eligible sample, scores are lower in treated states. However, the variations in characteristics between treated and untreated states seem to be smaller than in the eligible sample. Non-eligible students typically complete high school at the 'right' age, have mothers with higher education attainment, have a higher proportion of white participants and have higher income levels compared to eligible students. By splitting the sample into two groups, we aim to compare more similar individuals, mitigating the issues of selection bias.

1.5. Empirical strategy

We employ a difference-in-difference (DID) strategy to identify the average and dynamic effects of a large-scale government-mandated AA policy in Brazil on student outcomes in university entrance exams (ENEM). The outcomes of interest are the simple average score

from multiple-tests and the scores of each individual subject[32], which include languages, math, science, and human sciences. All scores are based on a 0-1000 scale and standardised by year, with mean zero and standard deviation equal to one[33]. DID is a popular tool to address selection bias which has recent growing interest and novel approaches[34]. It can be applied to repeated cross-sections and fits well our data structure. The basic model requires two groups and two periods, a treatment group is treated only in the second period and a control group that is not treated in any of the two periods.

In this paper, none of the groups are untreated in the second period, but treatment rate is more intensive for one group than for the other. We exploit the variation in treatment intensity across units and time to build the required time and group dimensions which are crucial for DID. A similar DID design has been used by (Duflo 2001; Havnes and Mogstad 2011; 2015) and has been recently addressed by de Chaisemartin and D'Haultfœuille (2017, 2020). As the treatment group does not change over time, and groups remain stable and there are no shifters, we adopt the sharp design aiming for the Average Treatment Effect (ATT).

To construct the treatment and control groups, we account for existing AA schemes at higher education institutions before the federal law was implemented, which varies across institutions. Reservations were lower in institutions (and states) with previous quota schemes because they had already reached the minimum thresholds established for the first year. As we aggregated these reservations from institutional to state level, treatment should also vary across states. Thus, exposure to the quota law depended on the calendar time when the test was taken (ENEM cohort) and the state the student lived in. Since the policy was publicised in August 2012, it should affect candidates who

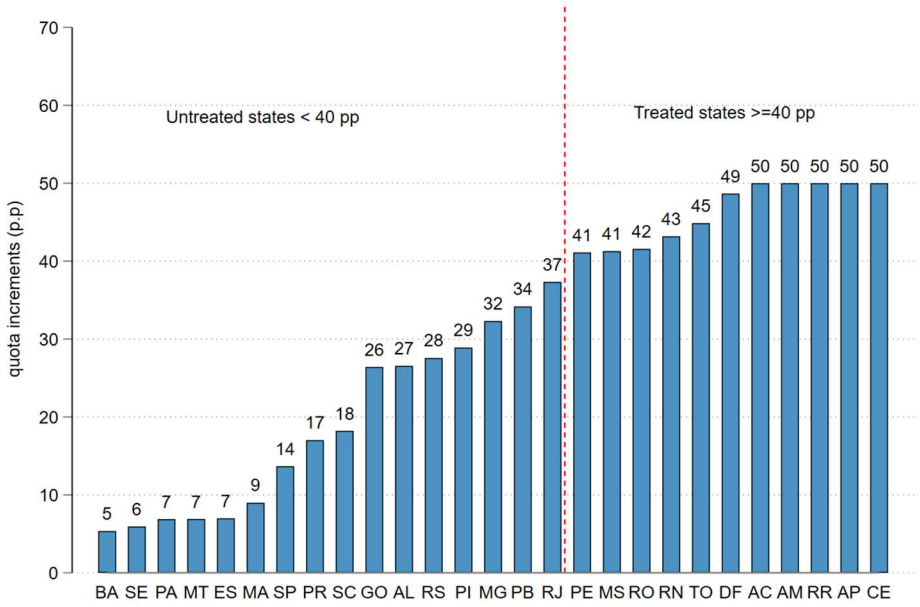
[32] In spite that scores of high-stakes exams can be a noisy measure of human capital investment (Ebenstein, Lavy, and Roth 2016), and effort is not directly observed in our data, changes in test scores have been used as proxies for changes in effort, as also seen in many studies (Assuncao and Ferman 2015; Estevan, Gall, and Morin 2019b; Leal and Choi 2023).

[33] See section 1.3.3 for more details about ENEM and grading methodology.

[34] See Roth et al. (2023) for a review on recent updates.

took ENEM in 2012 or after, whose scores can be only used for college applications on the following year, while applicants in periods 2010-2011 should not be affected. Responses to these changes should occur within students' states of residency because students generally attend universities close to their homes in Brazil, as shown by Mello (2023), even though SISU reduced application costs in different states. A possible explanation could be that scholarships for living expenses are scarcely available and family ties are strong, although these factors may have lower influence on students who can afford to move away from home. States with no previous quotas or whose quota share was lower than 12.5%, the minimum threshold established by the law for the first year (2011), or either, those which needed more additional quotas to achieve 50% in 2015, were considered high-intensity implementers and, thus, were assigned to the treatment group. On the other hand, states that required less or no additional share to achieve 50% by 2015, or with existing quotas above the first-year minimum threshold were considered low-intensity implementers and were assigned to the comparison group. Fig. 1-8 depicts the additional share of quotas required by treated and untreated states to achieve the minimum threshold by 2015, which is the simple difference in percentage points (pp) from the share of quotas in 2011 (the baseline). States with at least 40 pp increase were assigned to the treatment group (high intensity quotas).

FIGURE 1-8: QUOTA INCREMENTS IN PERCENTAGE POINTS BY STATE FROM BASELINE (2011) TO MAXIMUM ESTABLISHED BY THE NATIONAL LAW (50%)



Note: Expected increments in percentage points by state to existing federal quotas in 2011 to the maximum established by the quota law in 2015 (50%)

Nevertheless, claims for federal quotas depends on eligibility. The primary condition states that students are eligible to quotas if they finish the entire high-school education in public schools. Therefore, if a student attended at least one year of high school in a private school she cannot claim for quotas, independently of her race or income. It is important to highlight that eligibility for quotas does not necessarily imply that students will eventually claim for quotas, but we assume they are compliers, as we had no access to individual application data. We disaggregated the data to conduct separate evaluations for eligible and non-eligible subpopulations, as we expect each group to be affected in different ways due to changes on patterns of competition brought by AA in the "market" for higher education (Bodoh-Creed and Hickman 2017; 2018; Cotton, Hickman, and Price 2020).

Our DID strategy compares the variation in test scores between (non) eligible students in treated states before and after the implementation of the law, while simultaneously considering the differences in test scores of (non) eligible students in comparison group. Under certain conditions, this procedure would recover the effects of the quota law for the

(non) eligible subpopulation of students from treated states separately. However, we cannot estimate the effects of the quota law for the population, which would require further assumptions. However, it is important to be aware that only a fraction of high-school students takes ENEM which is already an indication of self-selectivity.

Given the diverse demographic and socioeconomic characteristics of the eligible population, which represents approximately 75% of all graduating students who take ENEM annually, effects across characteristics are likely to differ. Therefore, we expand our analyses to examine the effects of the quota law on treated states considering separately the samples of each of the four (non) eligible subgroups based on the racial and income criteria, as outlined in 4.2. We compare eligible subgroups (e.g., PS) from treated states with its respective eligible subgroups from untreated states. Similarly, we compare non-eligible subgroup from treated states with its respective non-eligible subgroup from untreated states. Moreover, we conduct further subgroup analyses to assess how treatment effects correlate with observable school or individual characteristics, other than those determining eligibility, such as age group, mother education, total household income, per-capita income, and type of primary school, to shed light on the underlying mechanisms of change. Subgroup analyses are important to characterise treatment effect heterogeneities as students with certain characteristics may respond differently to the intervention (Heckman, Smith, and Clements 1997).

An advantage of DID is that it allows for treatment and comparison groups to start at different levels, while it controls for unobserved time-invariant confounding factors that may be associated with treatment status and the outcome variable (Angrist and Pischke 2009). This means that groups do not need to be similar as required for cross-sectional studies, but if characteristics are too different, it may be necessary to rebalance the sample using matching approaches (Abadie 2005).

A key identifying assumption for consistent causal estimates of the effects of the Quota law is that in the absence of treatment (i.e., the counterfactual state), the average scores for treatment states and comparison states would follow the same paths over time – the "parallel trends" assumption (PTA). This means that if the treatment had not occurred, changes in test scores of the treatment group should be the same as changes in test scores of the comparison group over time. Within the DID framework, the score trends of the comparison group are used as a proxy to simulate the score trends of the treatment group in the counterfactual state. If the score trends of the eligible group have been varying more strongly than in the comparison group, PTA fails and our parameters are biased and cannot be attributed to the policy alone, as there could be other factors affecting these changes, such as pre-existing differences across groups or shocks affecting groups differently. We address this issue by adjusting for potential confounders that may affect trends and rebalance the sample using inverse probability weighting (IPW) technique, as developed by Abadie (2005).

Next, we present two different models to estimate the treatment effects: i) the *static* (average) model with only two periods (before-after), and ii) the *dynamic* model, which considers each period or ENEM cohort relative to the introduction of policy. Both models are also used for estimating the aggregate and dynamic effects for each of the four quota subgroups targeted by the AA regulation. Later, we provide robustness checks of these models using a novel DID estimator developed by Callaway and Sant'Anna (2021).

1.5.1 Average model

We start estimating the following OLS simple equation that is known as the two-way fixed effects (TWFE) estimator:

$$Y_{ist} = c + \alpha_s + \delta_t + \beta^{twfe} \times (treated_s \times post_{i)} + \varepsilon_{ist} \quad (1\text{-}1)$$

where $\mathrm{Y_{ist}}$ is the standardised test scores for student *i,* who lives in state *s* and took ENEM at time *t* and *treated* indicates whether the student *i* lives in a high-intensity quota state. $Post_i$ refers to the ENEM cohorts who should be affected by the quota law after its implementation (2012-2015), while the reference (baselevel) considers the first year before the treatment (**t=2011**). The interaction term $treated_s \times post_i$ refers to the individuals who receive the treatment in higher-intensity states after the treatment, which can also be denoted by $\mathrm{D_{it}}$, while ε_{ist} is the stochastic error. As required in TWFE models, we include group fixed effects α_s and time fixed effects β_t to control for time-invariant differences between groups and time. Errors are clustered at school level to account for any serial-correlation between students from the same school. The coefficient of the interaction term β^{twfe} is the parameter of interest, that should reflect the changes in scores in terms of standard deviations due to the policy. We apply this equation on the samples of eligible students and non-eligible students, and on each respective subgroup. This basic model includes no covariates, which are added through matching and reweighting procedures.

1.5.1.1 Including covariates.

Following Abadie (2005), we add covariates using an inverse probability weighting (IPW) two-step procedure. The weights **ωi** are obtained from the inverse of the estimated propensity scores, i.e., the individual probability of belonging to a treated state. These scores are the predicted estimates obtained after conducting a logit regression on a set of individual characteristics that are likely to affect trends of potential outcomes but should not be affected by the treatment (Abadie 2005). We include dummies indicating if the student is above the minimum age, if the mother has higher education and if total household income is below or above 6 minimum wages. We then use these weights to rebalance our sample on the OLS equation (1). DID requires that the values of these covariates overlap across treatment and comparisons groups (common support assumption). This condition is fulfilled as seen in Table 1-3, which demonstrates that covariates are present on each group, therefore, all have common support. The IPW

procedure aims to eliminate differences across groups, making them more similar so that PTA can be feasible when conditioned on these confounders. PTA is usually assumed if pre-trends coefficients (placebo tests) are close or equal to zero. Unfortunately, due to the lack of data, we only have one additional pre-treatment period in our model (2010-2011). All results of the placebo tests are presented in Table A1 of the Appendix.

Nevertheless, even if PTA holds, the TWFE coefficient may be different than the causal parameter, as shown by recent research (Goodman-Bacon 2018; de Chaisemartin and D'Haultfœuille 2020; Borusyak, Jaravel, and Spiess 2021; Sun and Abraham 2021). The main issue is that TWFE may not perform well in settings where effects are not constant across units and time, thus TWFE may not be robust to heterogeneous effects, particularly on specifications involving multiple timing or staggered treatment. Some of the reported problems with TWFE are negative weighting and use of treated individuals as control groups in multiple timing settings (see Baker et al. 2022; de Chaisemartin and D'Haultfoeuille 2023 and Roth et al. 2023 for a synthesis of the discussions). De Chaisemartin and D'Haultfœuille (2020) recommend the use of the *twowayfeweights* package as a diagnosis tool to check for negative weightings. Our tests show that all ATTs have positive weights; however, for robustness checks, we use a newly DID estimator developed by Callaway and Sant'Anna (2021)[35].

On the next subsections, we initially present the dynamic models, based on the TWFE model.

1.5.2 Dynamic model

A way to address heterogeneities across time is by investigating the dynamic effects of the policy with an event-study strategy from initial to full implementation of the quota law. As the policy was implemented gradually, increasing from 25% in 2013 (12.5% of vacancies),

[35] We used the *csdid* Stata module by Rios-Avila, Sant'Anna, and Callaway (2022)

to 100% in 2016 (50% of vacancies), these changes must also be considered in our research design, as it may affect individual responses on each period.

For the dynamic effects, we present a TWFE specification that is similar to the one presented above, where we regress the ENEM scores on group and time fixed effects, but instead of having only two periods (*before-after*), we include several dummies d_{ik} that represents number of years *k* relative to the introduction of the policy, as shown in Equation (1-2).

$$Y_{ist} = c + \alpha_s + \beta_t + \sum_{\substack{k=-2 \\ k\neq -1}}^{k} \delta_k^{twfe} * (treated_s * d_{ik}) + \varepsilon_{isk} \quad (1\text{-}2)$$

This basic model allows us to estimate the effects of the policy on the average scores for each ENEM cohort. When ***k*** is negative it shows the relative time in number of years until the treatment (leads) and when ***k*** is positive, it represents the relative time after the policy (lags) for student ***i*** from state ***s***. The reference at baselevel is k = -1, which represents the 2011 ENEM cohort, the last one assumed to be unaffected by the quota law as the one before its introduction. Estimates are consistent if effects on years before the policy are zero or very close to zero, suggesting that PTA may hold, which is not testable (Kahn-Lang and Lang 2020), also indicating "no anticipation", which means that the policy did not elicit behavioural changes on individuals before the policy was introduced, another required assumption. $\mathrm{Y_{ist}}$ are the individual test scores for student ***i*** , as in the previous model, at time **t**. Similarly, *treated* indicates whether the student ***i*** lives in a high-intensity quota state. This model has no covariates. As in the static model, covariates enter the model exclusively via inverse probability weights $\boldsymbol{\omega_i}$, which were calculated in the same manner explained above and used to adjust the control groups to resemble the treated counterparts and then applied to equation (2). The coefficients δ_k^{twfe} of the interaction terms are the expected dynamic effects at each period. This strategy also provides estimates of the average aggregate parameters, while additionally providing evidence in support of underlying identification assumptions, as PTA is not testable (Kahn-Lang and Lang 2020).

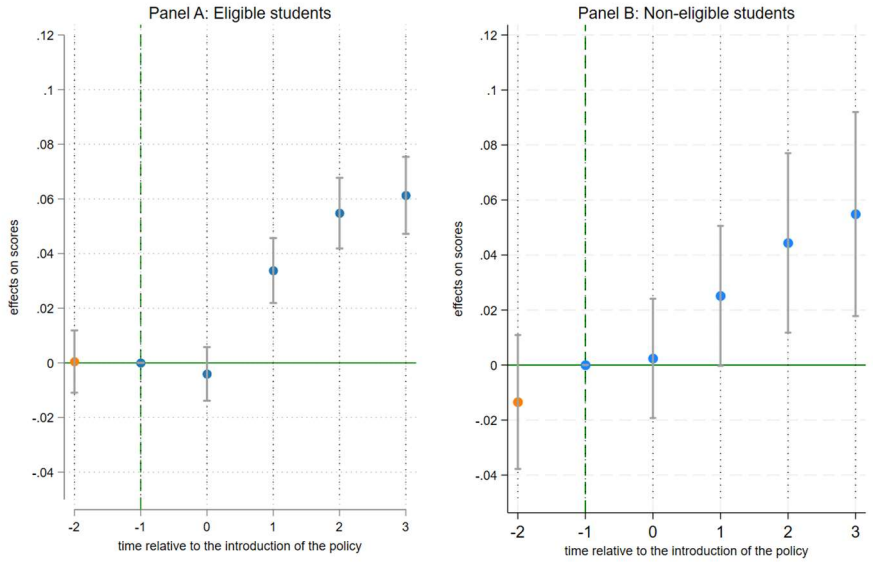
1.6. Effects of the quota law

Our results derive from the dynamic models from equation (1-2), but subsequently we also provide tables with results for the static models from equation (1-1). We initially report the OLS estimates of the dynamic effects of the policy on the average scores for the multiple-choice tests for eligible and non-eligible students from treated states. The results are presented by event-study graphs with different specifications; initially with the simple model with no covariates and then including covariates. We then present the results for each subject, separately and then by subgroups. For sensitivity analyses, we compare these results with those from the DID estimator developed by Callaway and Sant'Anna (2021)'s DID estimator.

*1.*6.1 Dynamic effects on overall test scores

The event-study plots in Fig. 1-9 present the OLS estimates of the basic model from equation (1) for eligible and for non-eligible students, where panel A presents the results for the former and panel B for the latter. There is an increasing trend on treated states after the quota law was introduced for both eligible and non-eligible groups, but policy seems to be more effective after the second year of implementation. This could be due to the short notice for students to improve preparation for ENEM, as the law was passed in August 2012, whereas the test was in November 2012. Larger effects of the regulation can be observed for the 2014 and 2015 ENEM cohorts, with 0.05 and 0.06 standard deviation, respectively, for eligible and 0.04 and 0.05, for non-eligible students. Apart from having more time to prepare for the test considering the new scenario, these cohorts may also have been affected by the full implementation of the law, which gradually increased until reaching the maximum of 50% share. Both eligible and non-eligible groups responded positively to the policy, which contradicts the argument that non-eligible groups could lose incentives due to AA. On the other hand, this also suggests that the achievement gap between eligible and non-eligible may have remained unchanged after the policy.

FIGURE 1-9: EFFECTS OF THE QUOTA LAW ON AVERAGE TEST SCORES OF ELIGIBLE AND NON -ELIGIBLE STUDENTS



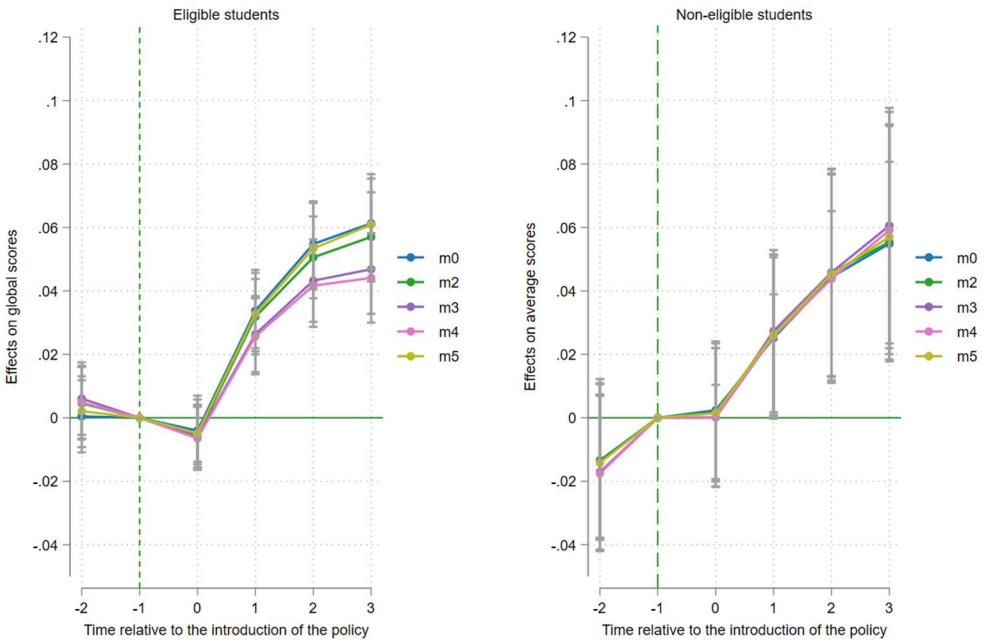
Note: Event study results from OLS regressions on the average ENEM test scores with simple specification (no covariates) for eligible students (from public schools) and non-eligible students (from private schools). Errors clustered at school level and 95% confidence interval.

Effects for pre-trends on the eligible sample are not significant, suggesting PTA may be met and causal identification is possible.

We plot the coefficients of conditional models as shown in Fig. 1-10 to compare results with the results of the simple model, and the overall pattern does not change too significantly, neither do results for the sample of non-eligible students. We control for covariates using inverse probability weight (IPW) procedure with different specifications for estimating the propensity scores, and results do not vary much from the simple specification. The variables include dummies or categorial variables at individual level of demographic and socioeconomic background to avoid issues related to the curse of dimensionality (see Abadie, 2005). These variables are recognised as direct predictors of outcomes (Menezes-Filho 2007; Ricardo Paes de Barros and Mendonça 2000; Ricardo Paes de Barros et al. 2001; Haveman and Wolfe 1995; Duncan and Murnane 2016; Anazawa et al. 2016). Although models m3 and m4 diverge slightly from the other models for the

eligible sample, they are still very close to the main result, which may indicate that results are fairly robust to adding covariates.

FIGURE 1-10: EFFECTS OF QUOTA LAW ON AVERAGE TEST SCORES (CONDITIONAL MODELS)



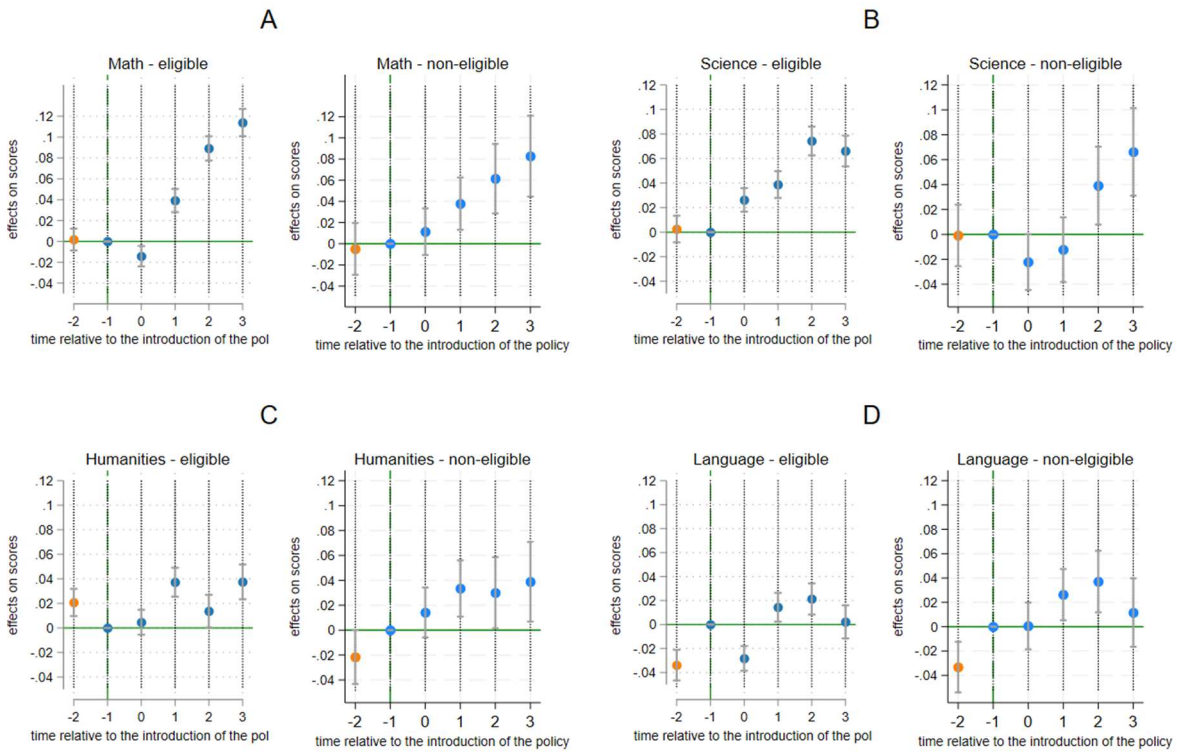
Note: Event study results from OLS regressions with IPW including different specifications, where model **m0** is the simple model, **m2** controls for dummies indicating if mother education is up to high school and if student is above the expected age to finish high school (>19 years-old); **m3** additionally controls for a dummy indicating whether household income is up to six minimum wages and if students is non-white; **m4** controls for overage, mother education (categorical) and if student is non white, and **m5** controls for a dummy indicating if the student comes from a household with total income above six minimum wages and another dummy indicating if the mother has at least a university degree. Errors clustered at school level and 95% confidence interval.

Next, we investigate the effects of the intervention on each subject to identify which subjects may be contributing to these results.

1.6.2 Dynamic effects by subjects

We applied the same model in equation (1-2) to the scores of each subject. The results for the simple model (no covariates) are presented in Fig. 1-11.

FIGURE 1-11: DYNAMIC EFFECTS BY SUBJECT SCORES FOR ELIGIBLE AND NON -ELIGIBLE STUDENTS



Note: Effects on scores of student scores by subjects for eligible and non-eligible students. Plot A presents the effects on math scores. Plot B presents the effects on science scores. Plot C presents effects of human-science scores. Plot D presents the effects on language scores. Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

Results suggest that there were positive and increasing effects of the policy on math and science scores for eligible and non-eligible, but no relevant effects on human sciences and language, therefore major effects on average scores are deriving from the former subjects. Effects on math scores were higher for eligible students, reaching .11 SD in 2015, while non-eligible achieved almost .08 SD. This shows that, at least in math, the achievement gap between eligible and non-eligible students may have narrowed. Eligible students increased their science scores by approximately .07 SD in 2014 and in 2015, with respect to the comparison group; non-eligible students experience negative effects in the initial years after the introduction of the law, but later achieved 0.07 SD by 2015. Pre-intervention effects on math and science scores are not significant, suggesting causal interpretation. Effects on scores of human sciences of eligible students shifted between zero to 0.04 SD, while effects for non-eligible students stood close to 0.04 SD on the last

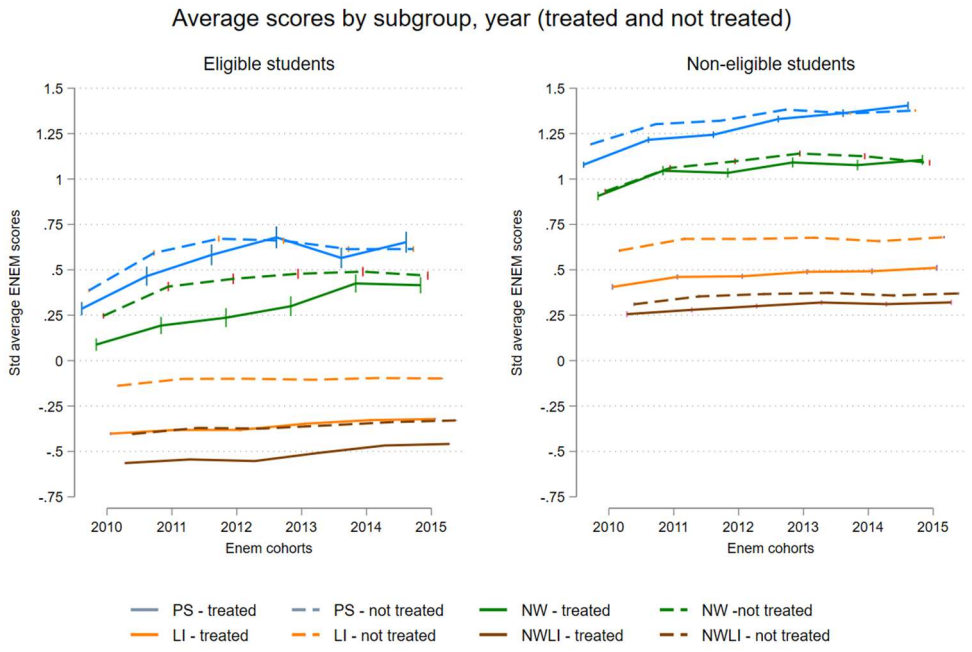
two years of implementation. Changes on language scores were very close to zero for eligible groups with some significant effects for non-eligible in 2013 and 2014, however, as pre-intervention coefficients are significant, we cannot infer causality for both language and humanities results.

The higher effects on math and science indicate increased student effort to achieve more competitive programmes, such as engineering, computer science or medical sciences, which put more emphasis on these subjects.

1.6.3 Dynamic effects by subgroup

We start our analysis by disaggregating the sample into subgroups so that we study each one separately. We compare students with the same characteristics based on the income and race criteria of the quota law from public schools (eligible) and their respective counterparts with the same characteristics from private schools (non-eligible). Subgroup PS considers white students from households with income above 1.5 minimum wage per capita (high income); subgroup NW includes non-white students from households with income above 1.5 minimum wage per capita ("high income"); subgroup LI includes white students from households with income up to 1.5 minimum wage ("low income"), and subgroup NWLI includes non-white students from households with income up to 1.5 minimum wage per capita ("low income"). Fig. 1-12 illustrates the mean scores in standard deviations of each subgroup from treated and untreated states by year. There are striking differences between scores of eligible and non-eligible students, reflecting the high educational inequalities based on type of school, race and income in Brazil, which justified the choice for this public policy.

FIGURE 1-12: AVERAGE SCORES BY SUBGROUP, ELIGIBILITY STATUS AND YEAR (TREATED AND NOT TREATED SUBGROUPS)



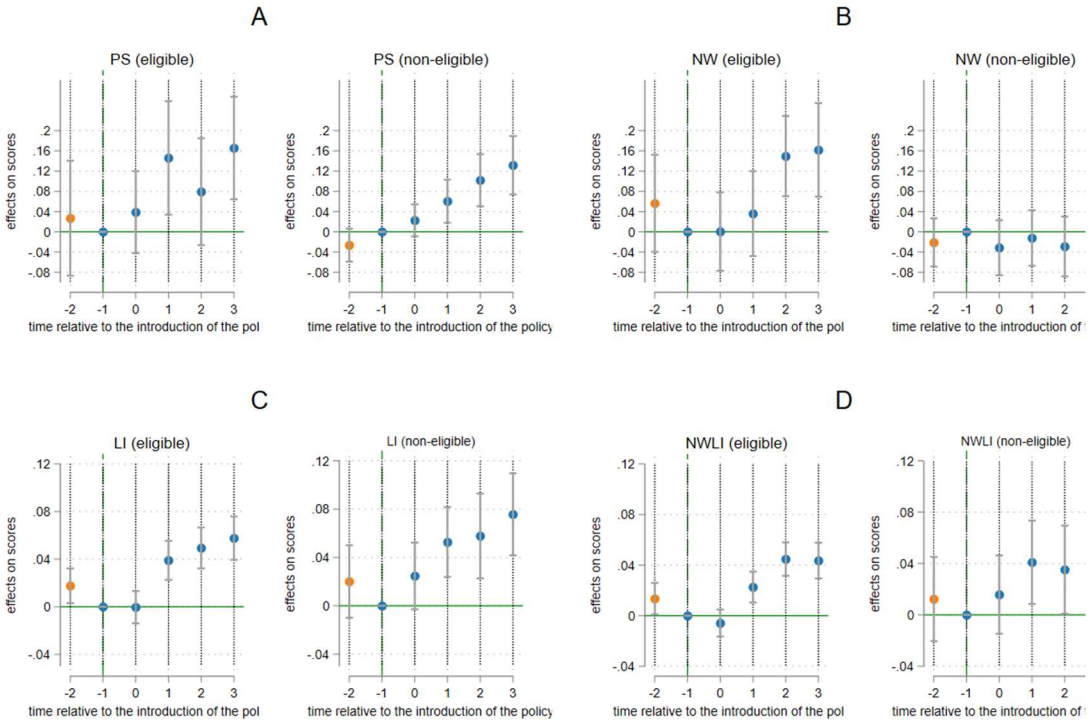
Note: Test scores of students in treated and untreated states by subgroups and eligibility status over time.

For both eligible and non-eligible groups, we can visualise that high-income groups surpass the scores of low-income groups by around 1 to .25 SDs, while non-white groups tend to stand below their white counterparts, either in low-income or high-income groups, albeit the gap between white-and non-white high-income groups has improved overtime for eligible students in both treated and untreated states, but it has likely to have widened amongst non-eligible students. White, and high-income students tend to perform better either in eligible or non-eligible samples. Comparing the scores of each subgroup between treated and untreated states, we can see certain convergence amongst high-income groups, however, low- income groups tend to average below the mean and differences in scores do not seem to change after the policy.

We present below in Fig.1-13 the effects of the quota law for eligible and non-eligible subgroups, which shows that there are positive effects for white students from high-

income households (PS), and for non-white (NW) on the eligible sample, but zero effects for non-white students from private schools (non-eligible). The effects the PS and NW reached .16 SD on the eligible sample, and .12 to .02 for the non-eligible sample. These results indicate that high-income groups responded more effectively to the policy than low-income ones, except for non-eligible non-white students. This is interesting finding. While white non-eligible students from high-income households seemed to have employed more effort to face increasing competition, their non-white counterparts showed no reaction.

FIGURE 1-13: DYNAMIC EFFECTS ON TEST SCORES BY SUBGROUPS (ELIGIBLE AND NON-ELIGIBLE SUBGROUPS)



Note: Effects on scores of student scores by subgroups who are eligible (public schools) and not eligible to quotas (private schools). Plot A presents the effects for PS subgroup (white & high income); plot B presents for NW subgroup (non-white & high income); plot C presents the effects for LI students (white & low income), and plot D presents the effects for NWLI (non-white & low income). Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

A possible explanation could be related to the hardships experienced by these groups to improve human capital investment, which involve socioeconomic factors and the quality of

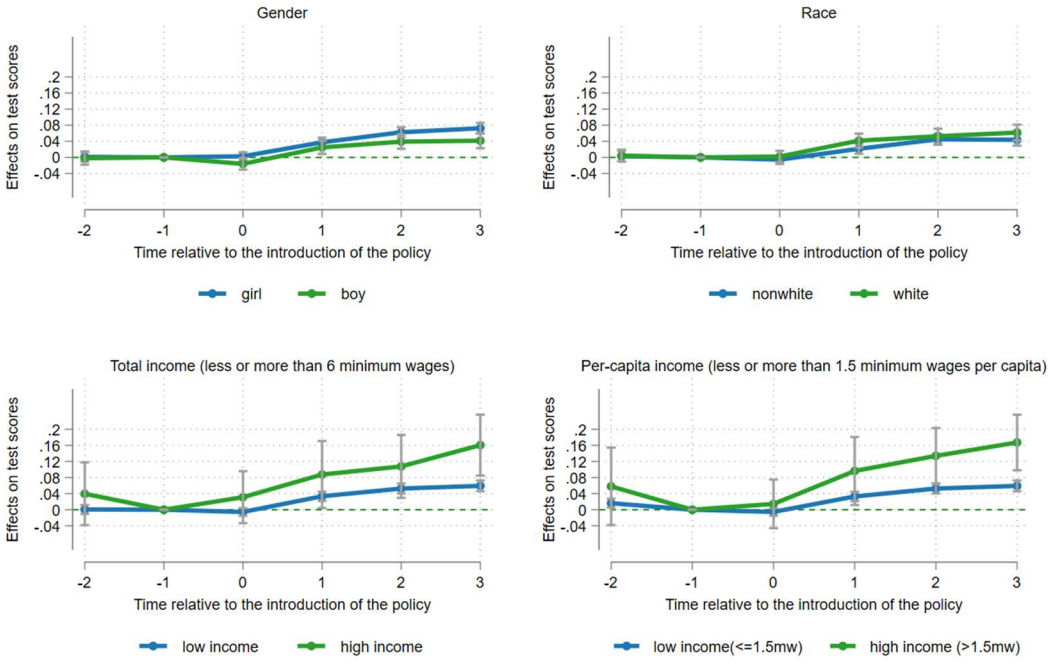
schools which serve them. This could mean that additional policies may be required than simply improving motivation. Yet, the effects were positive for both LI and NWLI, although at a lower intensity, indicating they do respond to motivation too. Another possibility can be related to discouragement effects since the low-income groups are too broad and include better-off or middle-class students.

Next, we conduct subgroup analyses by student characteristics, to understand the extent to which income and other characteristics affects results.

1.6.4 Subgroup analyses by student characteristics

Now, instead of separating the subgroups considering NQL's criteria, we estimate the effects by subgroups based on demographic and social characteristics, such as gender, race, and income (total and per-capita). For this analysis, we split the sample of eligible students into further subgroups (e.g., girl and boys, white and non-white, low income, and high income). The results are depicted on Fig. 1-14, showing that race and gender play little part on the effects, which derive more intensively from the high-income groups whose impact exceed by almost three times those of low-income groups, which reinforce our previous conclusions, that low-income groups had less incentives to improve human capital investment.

FIGURE 1-14: EFFECTS ON ELIGIBLE STUDENTS FROM TREATED STATES BASED ON STUDENT CHARACTERISTICS



Note: Effects by subgroups based on individual characteristics (gender, race, total income, and per capita income), considering only the eligible groups. Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

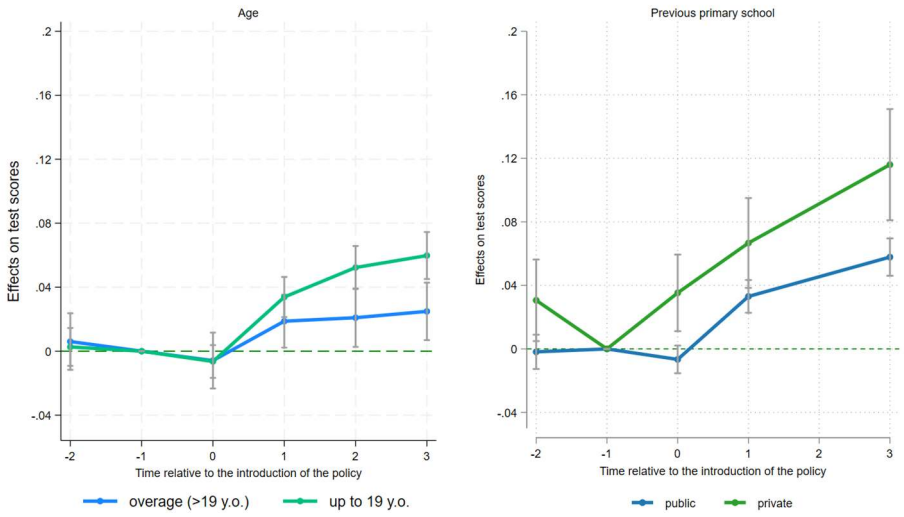
This may be due to the socioeconomic hardships faced by poor students that may inhibit their motivation and involve many factors, such as lack of quality of school, scarce information about quotas and higher education, lack of role models and parental support, lower teacher expectations, among others, that must be fully investigated.

This is expected, as in Brazil, where income inequality is so high and there is a strong relationship between income and academic performance (see Marteleto 2012; Mendes Junior, Souza, and Waltenberg 2016; Carvalhaes, Senkevics, and Ribeiro 2022), reason why the policy had an income-based content. However, as the threshold is too broad, including basically the entire population of applicants, the AA regulation might have not been enough to increase incentives for the poorest amongst the low-income groups. In fact, as these more affluent segments tend to perform better, opportunities for the poorest tend to be lower, even with quotas. This indicates that the income content needs to be revised

to improve opportunities for the poor, possibly combined with additional educational policies to improve the performance of low-income students.

We also provide results from analyses examining changes by age and the type of primary school in Figure 1-15. Positive effects were observed in treated states; however, these effects were more pronounced for students who attended private schools and those who completed high school at the "right" age (i.e., up to 19 years-old). These findings align with the impact on higher-income students who typically attend private primary schools, exhibit lower dropout and repetition rates, and graduate earlier from high school.

FIGURE 1-15: EFFECTS ON ELIGIBLE STUDENTS FROM TREATED STATES BASED ON STUDENT AGE AND TYPE OF PRIMARY SCHOOL.



Note: Effects by subgroups based on individual characteristics (age and type of primary school), also only eligible groups. %. Results for type of primary school do not include 2014 (which we had no data). Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

However, we need caution interpreting estimates for the effects on scores of non-eligible students, as the PTA does not hold in this context. Additionally, there may be reservations regarding students who completed primary education in private schools given recent findings by Mello (2023), who found behavioural changes among students from private primary schools. It is important to highlight that our tests for changes in composition in the eligible sample indicate no significant increment of these characteristics. This suggest that

the movement between school types were similar across states and not related to treated states specifically. Results for composition tests are presented in Table A1 in Appendix 1.A.

1.6.5 Sensitivity analyses

We have already shown on 6.1 that the effects of quota law change little across different specifications, which reassures our confidence on these results. Now, we compare our OLS results with those obtained with recent estimator developed by Callaway and Sant'Anna (2021)[36] – CS, to evaluate if they are robust given the potential biases reported with the TWFE estimator. CS can be applied to investigate with models with multiple timings and with staggered treatment, while allowing for PTA conditional on covariates using a doubly robust (DR) procedure, which resembles the IPW procedure used in our weighted OLS models. The doubly robust estimator was proposed by Sant'Anna and Zhao (2020), combining IPWs based on estimated propensity scores (Abadie 2005) with the outcome regression (OR) from Heckman, Ichimura, and Todd (1997) (see Roth et al. 2023 for additional details). CS estimates the average treatment effects (ATTs) of every 2x2 year combination in multiple periods taken separately relative to the base year (i.e., the base year is 2011, year *t-1* before the treatment where *t* is the first year of treatment) and applies the DR adjustment when covariates are included. CS can also provide the total effect over the entire period of analyses for all treated groups, by aggregating each yearly effects into a weighted average. The CS approach avoids treated units being used as comparison groups and it accounts for heterogeneous effects over units, which are not assumed by TWFE (Roth et al. 2023).

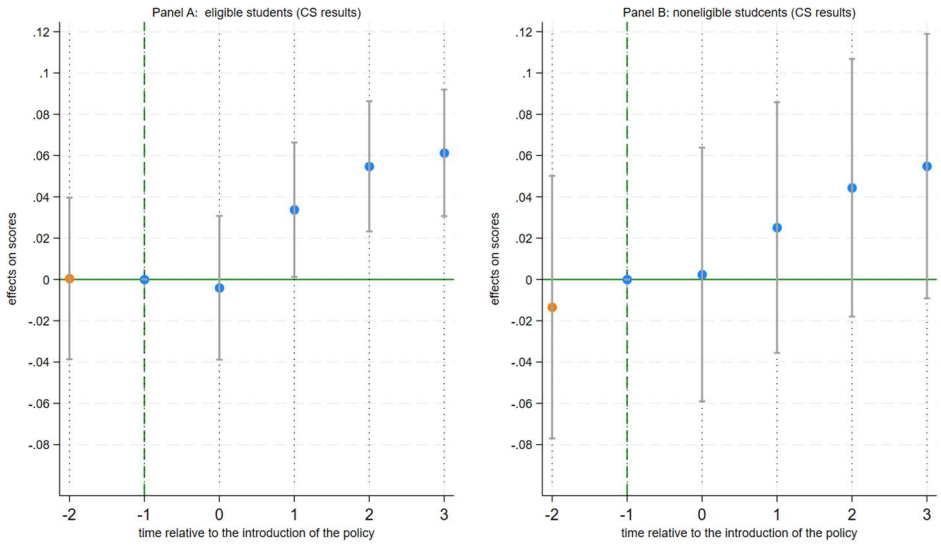
We hope this additional evidence will increase credibility to our results. One limitation, however, is that we did not apply a "fuzzy" design, as we believe the sharp DID is more adequate to our data. Another limitation is that the comparison group is assumed as a

[36] We used the *csdid* package available in Stata (Rios-Avila, Sant'Anna, and Naqvi 2022; Rios-Avila, Sant'Anna, and Callaway 2022)

"never treated" group, but it is worth mentioning that we have used equivalent estimator developed by de Chaisemartin and D'Haultfœuille (2020), more flexible to differential treatment intensity across treated and comparison groups, and effects seem consistent with CS.

Looking at Fig. 1-16, we note that results show little variation from the ones estimated with OLS, however the confidence intervals at 95% are larger, particularly for the non-eligible group, and are not statistically significant, while they remain significant for the eligible group.

FIGURE 1-16: EFFECTS OF QUOTA LAW ON TEST SCORES BY ELIGIBILITY – ESTIMATED WITH CS (NO COVARIATES)

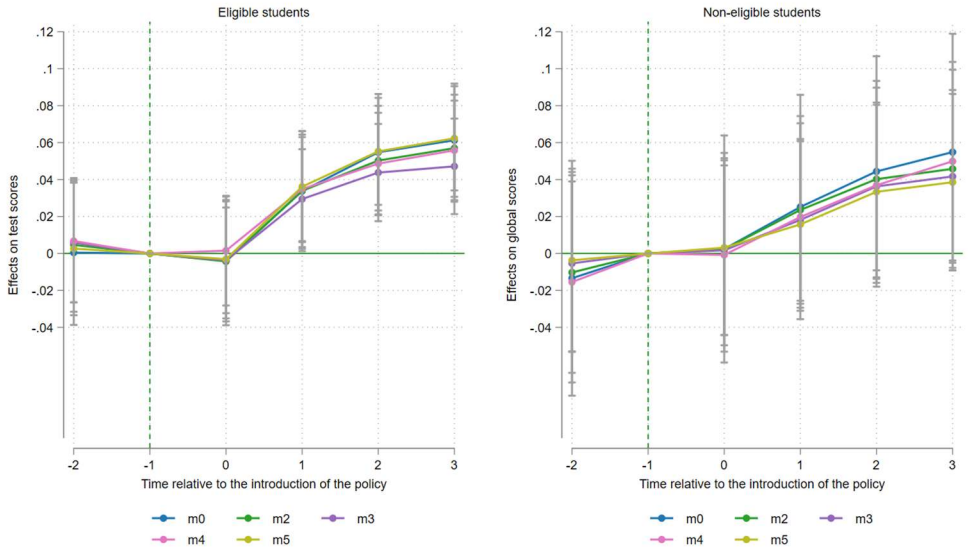


Note: Event study results estimated with Callaway and Sant'Anna (2021)'s estimator on test scores with no covariates for eligible students (from public schools) and non-eligible students (from private schools). Errors clustered at school level and 95% confidence interval.

Further analyses in Fig. 1-17 show that results of conditional models are slightly different from our initial models, but similar patterns of outcome evolution are observed. Effects become smaller and less steep for the non-eligible group, while they become more stable for the eligible group, thus improving confidence on our estimates. These small differences derive from the way the parameters are estimated by CS, which consider the treatment

effect at period t versus period t2011 with a 2x2 design, while the TWFE combines all periods together in the regression and weights are calculated over the entire period.

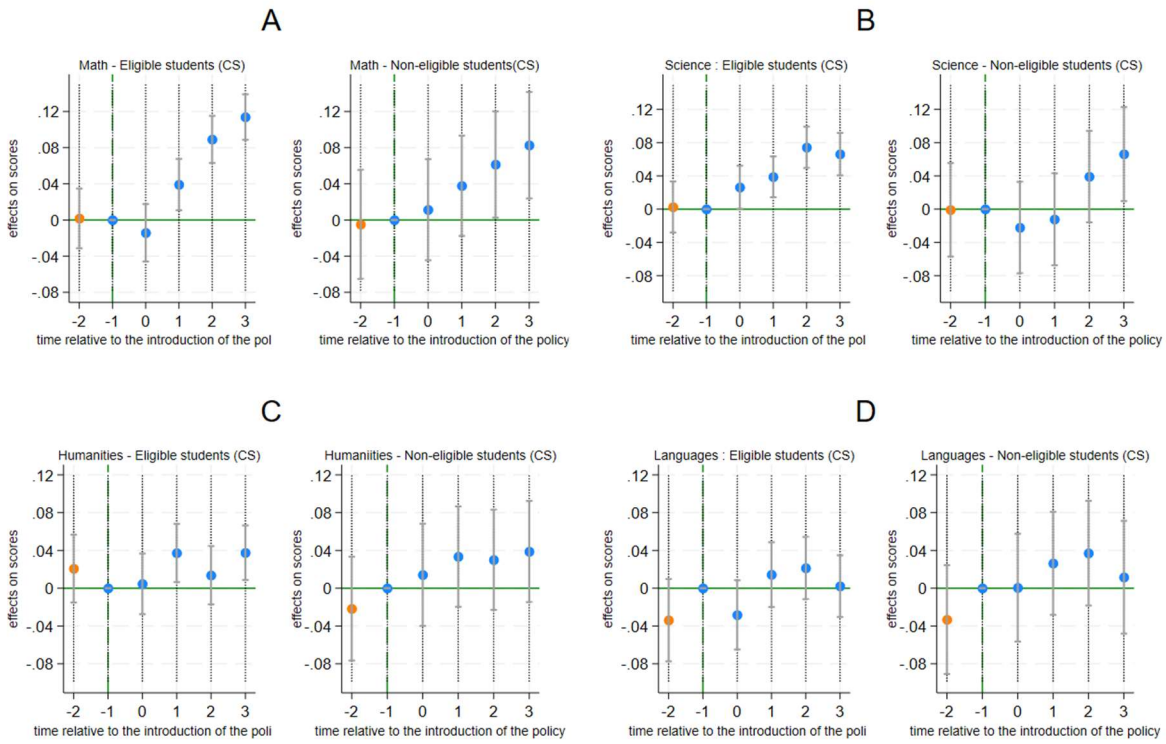
FIGURE 1-17: EFFECTS OF QUOTA LAW ON TEST SCORES BY ELIGIBILITY ESTIMATED WITH CS (CONDITIONAL MODELS)



Note: Event study results from OLS regressions with IPW including different specifications, where model **m0** is the simple model, **m2** controls for dummies indicating if mother education is up to high school and if student is above the expected age to finish high school (>19 years-old); **m3** additionally controls for a dummy indicating whether household income is up to six minimum wages and if students is non-white; **m4** controls for overage, mother education (categorical) and if student is non white, and **m5** controls for a dummy indicating if the student comes from a household with total income above six minimum wages and another dummy indicating if the mother has at least a university degree. Errors clustered at school level and 95% confidence interval.

We applied the same tests to each subject, and results were consistent with OLS, as presented in Fig.1-18. However, we observed slightly larger confidence intervals for the non-eligible groups, which may indicate a less pronounced effect on these students. The consistency of these results provides confidence in the validity of our conclusions that effects were positive on STEM subjects (math and science) and small or not significant on humanities and languages.

FIGURE 1-18: EFFECTS OF QUOTA LAW ON THE SCORES OF EACH SUBJECT BY ELIGIBILITY STATUS WITH CS

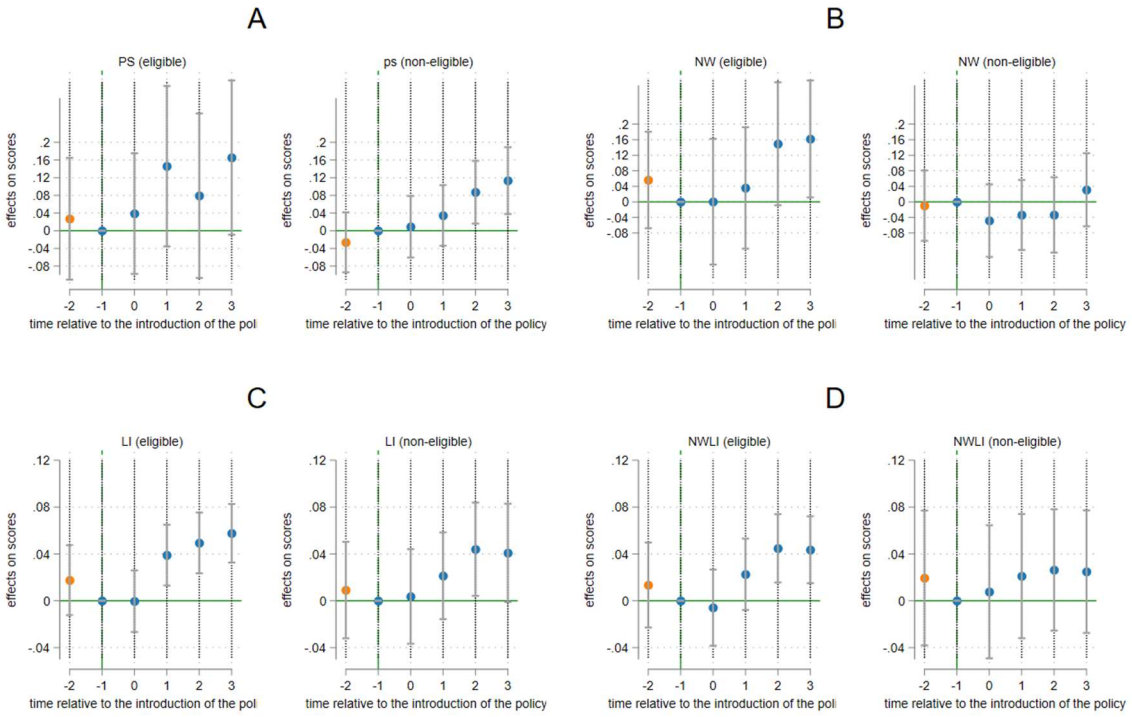


Note: Effects on scores of student scores by subjects for eligible and non-eligible students with Callaway and Sant'Anna (2021) DID estimator. Plot A presents the effects on math scores. Plot B presents the effects on science scores. Plot C presents effects of human-science scores. Plot D presents the effects on language scores. Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

Again, these findings suggest that the policy increased student aspirations for higher education programmes that require STEM scores among eligible students. Non-eligible students also appeared to be more motivated to secure their spots, as competition odds were against them, but further investigation is needed to understand the dynamics of non-eligible students' behaviour.

Moreover, we investigated the effects of this policy using CS on subgroups and found in Fig. 1-19 that they follow the same general pattern as OLS, but effects on scores of non-eligible low-income students decreased by almost half. Again, larger standard errors were observed for eligible PS and NW groups might be related to the size of the sample, as this group is underrepresented within the eligible sample, as shown in Fig. 1-7 in 1.4.1.

FIGURE 1-19: EFFECTS ON SUBGROUPS (ELIGIBLE AND NON-ELIGIBLE STUDENTS) USING CS ESTIMATOR



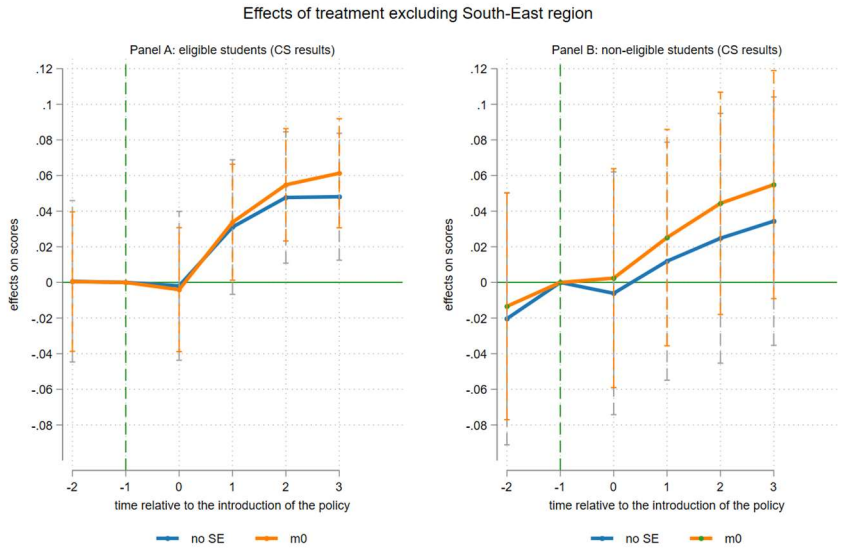
Note: Effects on scores of student scores by subgroups who are eligible (public schools) and not eligible to quotas (private schools) using CS estimator. Plot A presents the effects for PS subgroup (white & high income); plot B presents for NW subgroup (non-white & high income); plot C presents the effects for LI students (white & low income), and plot D presents the effects for NWLI (non-white & low income). Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

1.6.5.1 Excluding Southeast

We have seen that, generally, treated states have poorer performance compared to untreated from Southeast, a more developed region compared to the rest of the country, thus they could have more "room" to increase their outcomes than their counterparts. One may also think that students from the Southeast could behave differently, due to improved expectations regarding higher prospects in the labour market. As we mentioned before, all states in the Southeast belong to the comparison group (not treated), therefore we estimate the effects without considering the Southeast in the comparison group, to investigate how results change relative to a model that includes this region. As seen in Fig. 1-20, if we exclude this region from the comparison group, results are still positive, albeit slightly lower for eligible students on treated states, and about 0.02 SDs lower for non-

eligible students. This indicates that eligible students from the Southeast may feel less motivated after implementation of quota programmes in their states, than those on treated states who started quotas with the introduction of the federal law.

FIGURE 1-20: EFFECTS OF NQL ON TEST SCORES OF ELIGIBLE AND NON-ELIGIBLE STUDENTS, EXCLUDING STUDENTS FROM THE SOUTHEAST FROM COMPARISON GROUP



Note: Effects on scores of eligible and non-eligible students using the CS estimator, considering the full model (m0) and the model without Southeast region (no SE). Panel A presents the effects on eligible students and Panel B, on non-eligible students. Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

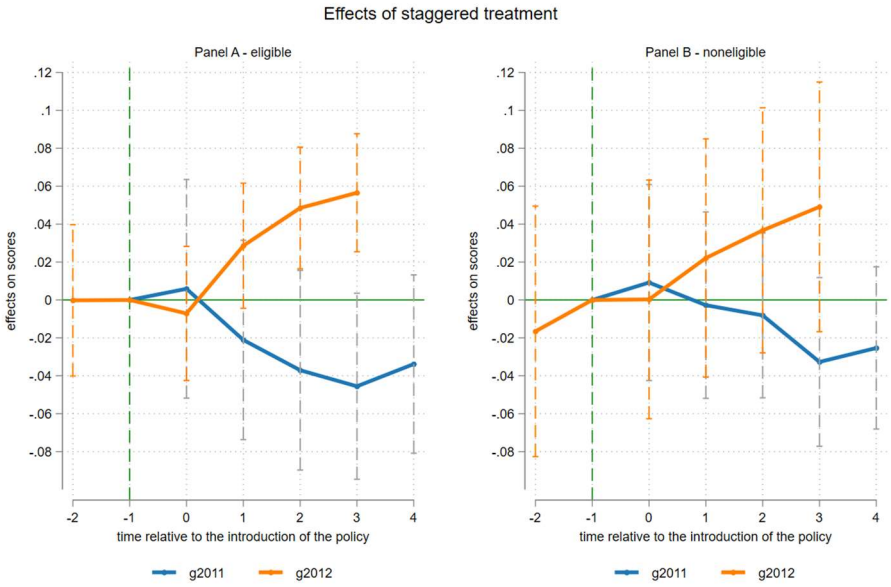
It is worth mentioning that a positive effect of the policy in treated states means that effects were null or negative in the comparison states, which implies that earlier quota programmes might have been ineffective, compared to the federal programme. Next, we investigate this further, by assuming treatment in two timings.

1.6.5.2 Assuming a staggered treatment.

This time we consider two treatment groups. The first treatment group comprises states with less than 12.5% of quotas in 2011, initiating the treatment one year earlier than the second group that started quotas following the enactment of the federal law in 2013. The

states in the 2011 group, namely Paraiba, Rio de Janeiro and Goias, had their federal universities implementing quota programmes in 2012, potentially affecting the 2011 ENEM cohorts in their respective states. As illustrated in Figure 1-21, the group that started quota programmes before the NQL exhibited negative effects, while the 2012 cohort, which implemented quotas when the federal law was introduced presented positive effects for both eligible and non-eligible groups.

FIGURE 1-21: EFFECTS BY GROUP, ASSUMING TWO DIFFERENT TIMINGS OF THE POLICY



Note: Effects on scores of eligible and non-eligible students using the CS estimator, assuming staggered treatment with two timings, 2011 and 2012. Panel A presents the effects on eligible students and Panel B, on non-eligible students. Models do not include covariates. Errors clustered at school level and confidence intervals at 95%.

Our findings confirm that previous quota programmes did not seem to create incentives for low-income groups (the large majority of students) in treated groups in 2011. We conclude that these changes relate specifically to the federal law and not just due to any quotas, even though, we still do not understand the mechanisms that led to these results. One potential explanation could be that states who started quotas later, prepared their educational systems to incentivize students to the new context, while, on the other hand, systems from states that started earlier did not change their academic processes to improve educational outcomes for the poor. This implies that not just individuals may have

reacted to the policy but educational systems too. The aggressive media coverage when the policy was introduced could have played an important role in creating incentives on these states but the question why it did not seem relevant on the comparison groups is still to be investigated. Another possible reason may be related to the type of quotas implemented that mostly complied public school students and race, probably not considering class-based quotas. This investigation was not subject of this study.

1.6.5.3 Results for the average model

We now report the average effects of the national quota law on test scores for eligible and non-eligible samples separately. Based on equation (1-1), we used t=2011 as the reference year to obtain the average estimates of the post-treatment period (2012-2015) and compare results obtained with OLS with CS estimators, as displayed in Table 1-4, where (A) presents results for eligible students and (B) the results for non-eligible students.

TABLE 1-4: OLS AND CS ESTIMATES OF ATTS OF THE NATIONAL QUOTA LAW ON TEST SCORES FOR ELIGIBLE AND NON-ELIGIBLE STUDENTS (2011-2015)

	(A) Eligible students					(B) Non-eligible students				
	m0	m2	m3	m4	m5	m0	m2	m3	m4	m5
ATT (OLS)	0.038**	0.035***	0.029***	0.028***	0.037***	0.031*	0.032*	0.033**	0.032*	0.032**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
ATT (CS)	0.037**	0.035**	0.030**	0.036**	0.039**	0.031	0.028	0.024	0.026	0.023
	(0.014)	(0.013)	(0.012)	(0.012)	(0.013)	(0.028)	(0.023)	(0.020)	(0.023)	(0.021)
Obs:	4,473,236					1,459,307				

Note: Average treatment effects on the treated estimated with weighted OLS regressions (**with IPW**) and with CS2011 method using different specifications. Model **m0** is the simple model, **m2** controls for dummies indicating if mother education is up to high school and if student is above the expected age to finish high school (>19 years-old); **m3** additionally controls for a dummy indicating whether household income is up to six minimum wages and if students is non-white; **m4** controls for overage, mother education (categorical) and if student is non-white, and **m5** controls for a dummy indicating if the student comes from a household with total income above six minimum wages and another dummy indicating if the mother has at least a university degree. Errors clustered at school level and 95% confidence interval. Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

Initially, we compare eligible students from treated and comparison states, finding an overall effect on test scores approximately of .04 standard deviations with OLS or CS

methods. This translates to a change of about 3 to 4points of the actual test score. Adding covariates does not significantly change the estimates, ranging from .03 to 0.04 standard deviation for both OLS and CS, with minor variations between models, particularly in models 4 and 5, which include more covariates. All estimates are statistically significant and identifying condition holds across all models. However, the overall effects on scores of non-eligible students from treated stated shown in (B) are slightly smaller, ranging from 0.03 and 0.02 standard deviations. Notably, the CS estimates are not significant in this case. This suggests that the overall scores in treated states improved compared to counterfactual, the effects were predominantly significant for eligible students.

We follow the same exercise for the subjects on Table 1-5. The average estimates show larger effects on math and science scores, but effects on human science and language were very small and significant with CS. For the non-eligible sample effects were only positve for math, but only significant with OLS. The CS estimates were not significant.

TABLE 1-5: OLS AND CS ESTIMATES OF ATTS OF THE NATIONAL QUOTA LAW ON ELIGIBLE AND NON-ELIGIBLE STUDENTS BY SUBJECTS (2011-2015)

	(A) Eligible				(B) Non-eligible			
	Math	Science	Humanities	Languages	Math	Science	Humanities	Languages
treated	-0.253***	-0.222***	-0.222***	-0.239***	-0.219***	-0.174***	-0.146***	-0.153***
	(0.012)	(0.011)	(0.012)	(0.012)	(0.033)	(0.032)	(0.029)	(0.025)
post	0.003	-0.008***	0.016***	0.009***	-0.043***	-0.001	-0.058***	-0.019***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.005)	(0.004)
ATT	0.061***	0.053***	0.024***	0.003	0.048***	0.017	0.030**	0.019
(OLS)	(0.005)	(0.005)	(0.006)	(0.005)	(0.012)	(0.012)	(0.011)	(0.010)
ATT (CS)	0.059***	0.052***	0.024	0.003	0.048	0.017	0.029	0.019
	(0.012)	(0.011)	(0.013)	(0.014)	(0.025)	(0.025)	(0.024)	(0.025)
N	4,473,236	4,473,236	4,473,236	4,473,236	1,459,307	1,459,307	1,459,307	1,459,307

Note: ATT estimates with OLS and CS methods on subject scores. Models do not include covariates. Errors clustered at school level and 95% confidence interval. Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

Table 1-6 displays the ATTs across various subgroups with consistent effects observed between CS and OLS methods. OLS estimates reveal an average effect of 0.11 SDs for the eligible Public School (PS) group and 0.10 SD for the Non-White (NW) group both higher income cohorts. Conversely, the effects are notably lower at 0.04 and 0.03 SD for the two low-income groups. Among the non-eligible, white students (mirroring the PS groups)

experienced a 0.06 SD effect, while the non-white higher income group had a a slight, non-significant negative effect of -.02 SD. The effects on the Low-Income (LI) group was close to .03 SD and for the Non-White Low-Income (NWLI) group, it was approximately 0.02 -LIl both not statistically significant. While CS estimates closely align with OLS, the standard errors become larger, and, with the exception of eligible LI and eligible NWLI, most results are not statistically significant. This may be a result of the sample size among eligible higher-income groups. On the other hand, all estimates for non-eligible students were not found to be statistically significant.

TABLE 1-6: OLS AND CS ESTIMATES OF ATTS OF THE NATIONAL QUOTA LAW ON ELIGIBLE AND NON-ELIGIBLE STUDENTS BY SUBGROUPS (2011-2015)

	(A) Eligible				(B) Not eligible			
	PS	NW	LI	NWLI	PS	NW	LI	NWLI
Treated	-0.128	-0.215**	-0.281***	-0.173***	-0.086*	-0.015	-0.209***	-0.074**
	(0.114)	(0.081)	(0.013)	(0.011)	(0.041)	(0.043)	(0.024)	(0.026)
Post	0.045***	0.065***	0.001	0.023***	0.059***	0.051***	0.001	0.013
	(0.012)	(0.016)	(0.003)	(0.003)	(0.008)	(0.013)	(0.005)	(0.007)
ATT (OLS)	0.109*	0.098**	0.036***	0.028***	0.059**	-0.019	0.026*	0.020
	(0.044)	(0.033)	(0.007)	(0.006)	(0.020)	(0.024)	(0.012)	(0.013)
ATT (CS)	0.108	0.093	0.036***	0.027*	0.060	-0.020	0.027	0.020
	(0.072)	(0.070)	(0.011)	(0.013)	(0.031)	(0.040)	(0.016)	(0.023)
N	86,103	40,951	1,847,319	2,498,863	407,458	107,085	558,634	386,130

Note: Estimates of ATTs using OLS and CS methods by subgroups. Models do not include covariates. Errors clustered at school level and 95% confidence interval. Standard errors in parentheses * p < 0.05, ** p < 0.01, *** p < 0.001

1.7. Conclusion

In this paper, we investigated the pre-college effects of the Brazilian national Affirmative Action (AA) regulation on high-stakes test scores, examining both eligible and non- eligible groups who might have been affected by the policy. Our main strategy was to try to isolate the effects of the National Quota Law (NQL) from prior AA initiatives implemented through state or institutional legislations. To achieve this, we classified states into high-intensity (treatment groups) and low-intensity (comparison group) quota implementation. The

treatment group consisted of states that had implemented less than 12.5% of quotas, the minimum stipulated by the law on its first year, before the law was introduced.

In our empirical strategy, we employed a difference-in-difference (DID) design, opting to compare students who share common characteristics (all from public schools or all from private schools) rather than making comparisons between private and public-school students.

Overall, the results reveal positive effects of the NQL when compared to the counterfactual, indicating the policy enhanced high-school students' scores in states that newly implemented the quota law, i.e., those with minimal or no previous quota schemes. Effects were more pronounced in math and science subjects, suggesting that applicants were aspiring to pursue more competitive degrees that heavily rely on these subjects. Moreover, positive effects were also found among non-eligible students, which may indicate increased effort in response to the limited availability of vacancies.

While the observed effects were positive, we found they were more pronounced for advantaged students, specifically for eligible non-white high-income (NW) students, although the mechanisms involved are not clear. These effects might be attributed to the broader influence of media information, encompassing encouragement from school and communities that enhanced motivation and increased engagement among students. However, it is noteworthy that a sizable portion of disadvantaged students did not respond with the same level of enthusiasm. Further research is needed to understand why.

In addition to potential factors, such as receiving less information about the NQL and returns from higher education; along with fewer teacher incentives and motivation, low-income groups may have felt more discouraged in increasing effort due to the income threshold being relatively high. This broad definition of the low-income group, including

segments of the middle-class could have led to an added feeling of discouragement. Jensen (2010) argues that perceived returns to education matter more than measured ones for changing student behavioural responses to AA. This is often overlooked by policymakers that disadvantaged students tend to have lower or inaccurate perceptions about their real chances, especially in low and middle-income countries, where AA may not be inducive of changes, what he calls as a "development trap". In this situation, information-based interventions could lead to greater changes, while stimulating the demand for schooling as well. It is worth mentioning that the race-based benefits of the quota law were more widely advertised, while the class content may not have been as well spread in high schools that serve the poor, which could trigger information issues. This may explain why many quota students sort into less competitive degree programmes, thus reproducing inequality (Dias Lopes 2017). This mechanism relates to the way they perceive college returns to education. Further qualitative studies are needed to understand whether perceived returns from AA were worse for low-income groups in the Brazilian context. Motivation and incentives are not the only factor affecting students' effort, where structural differences play a role with increased costs for disadvantaged students to improve academic performance, in which case, AA programmes should be complemented by additional policies (Cotton et al. 2020).

Moreover, although our findings suggest some convergence of the achievement gaps between high-income treated and comparison groups, the high private-public achievement gap has hardly changed, particularly for low-income students. Researchers have widely reported the direct relationship of income (and consequently type of school) and educational performance, and the hardships experienced by poor students that may make it difficult for them to increase investment in education. Their low performance seems persistent. Policymakers need to improve the quality of education in public schools that serve disadvantaged students, so that they can compete on equal terms with their private counterparts in case the AA policy is not sustainable in the future. Countries like Brazil, with deep divides, may require more time for AA policies in order to evaluate long term effects but could suffer disruptions. It is important to emphasize that AA is not a

silver bullet to solve structural problems and that pre-college responses do not rely uniquely on behavioural incentives. This means not just improving the quality of teaching, but also providing more preparation of these groups for competitive contests. It is important to give aspirations and correct their perceptions about ENEM exams and higher education (Hoxby and Avery 2013). Further qualitative studies may be necessary to investigate these mechanisms, as such factors may also be related to the decreased performance of students in comparison states, who started AA programmes before the NQL.

However, while this trade-off between equity and effectiveness may exist in the short-term, the long-term effects can promote structural changes which would not be achieved if the policy is banned. For now, the policy is still extremely necessary to increase mobility, as seen in recent research (Brotherhood, Herskovic, and Ramos 2023; Otero, Barahona, and Dobbin 2021). Without the policy, disadvantaged students (non-white and low-income) would not likely be admitted, particularly into elite courses (Mendes Junior, Mello Souza and Waltenberg 2016). With respect to race, Vieira and Kunning (2019) found that race-blind AA policies alone had little effect in increasing admissions of non-white students. Despite increased representation of eligible groups in higher education, it is not difficult to assume that eligible middle-class students would more likely be admitted in detriment of most disadvantaged, which means the welfare and equity goals of the policy may not be entirely achieved.

It is important to note that the students eligible for quotas in treated and untreated states represent 80% of all high-school students. Further, those who qualify for the low-income category make up for 97% of the eligible high-school graduates in our sample. Therefore, it is reasonable to think that the policy leaves little opportunities for disadvantaged students to access university even with quotas. While public-school students with per-capita income higher than 1.5 minimum wage represent are entitled to 25% of all reserved spots, the huge low-income group face fierce ccompetition for the same share of reservations.

Chetty at all (2020) argues that policymakers often overlook this relationship when defining targeted groups for AA interventions in higher education. In settings where family income is a strong predictor of admission student's scores, a careful definition of who should be eligible and who should not be is essential to improve equity. Bertrand, Hanna and Mullainathan (2010) are also concerned on who AA policies target. They alert that some AA programmes could be regressive if admitted eligible students from advantaged households crow-out marginal disadvantaged students who are not in the eligible group.

This may change in the future, as recently, the Brazilian Congress revised the per-capita income threshold down to one minimum-wage (Araujo 2023), that can increase motivation of poorer students and be fairer to this group.

It is important to highlight that the focus of AA programmes should be on the long-term effects and policymakers should choose the most effective design for the programmes' goals. In this sense, further studies to understand why pre-college achievement gaps did not evolve is important as a preparation for a context without the quotas in the future. While AA policies should last for as long as achievement gaps persist, a caveat is that their sustainability in time is highly dependent on the political context. The US case is a classic example. The more controversial AA programmes are the more difficult to build consensus and the more they are subject to political "threats".

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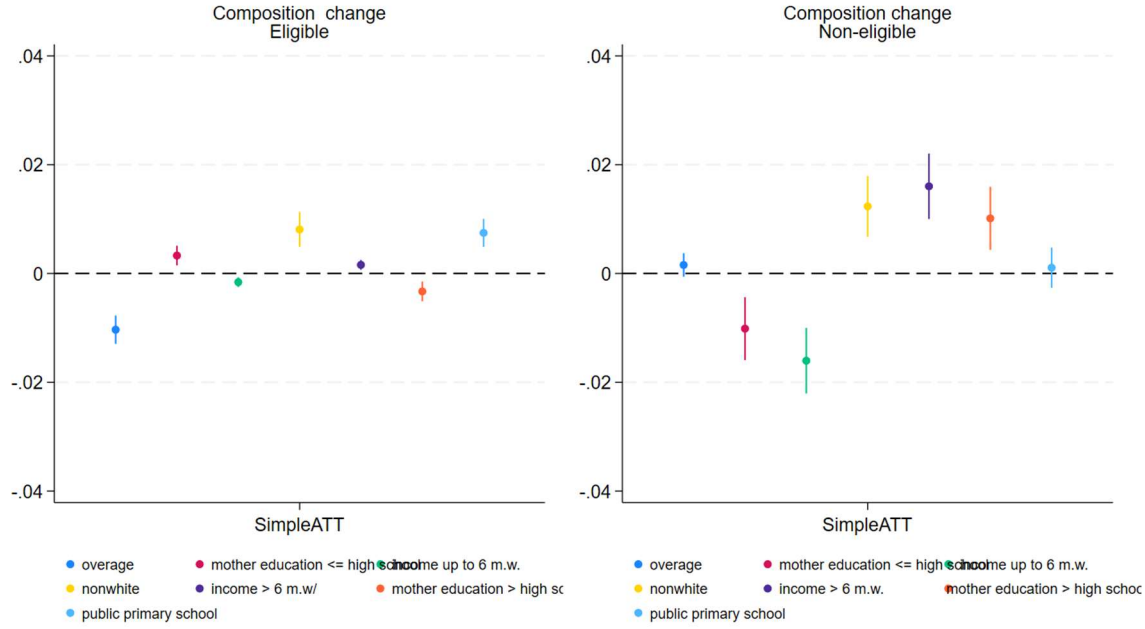
Appendix 1.A

TABLE A1: OLS AND CS ESTIMATES OF THE ATTs OF THE NATIONAL QUOTA LAW BEFORE INTERVENTION (2010-2011)

	(A) Eligible students					(B) Non-eligible students				
	m0	m2	m3	m4	m5	m0	m2	m3	m4	m5
ATT (OLS)	-0.000 (0.006)	-0.005 (0.006)	-0.006 (0.006)	-0.005 (0.006)	-0.002 (0.006)	0.013 (0.012)	0.014 (0.012)	0.017 (0.012)	0.018 (0.012)	0.014 (0.012)
ATT (CS)	0.000 (0.020)	0.005 (0.018)	0.006 (0.017)	0.007 (0.017)	0.003 (0.018)	-0.013 (0.032)	-0.010 (0.028)	-0.005 (0.024)	-0.015 (0.028)	-0.004 (0.025)
Obs:	1,523,524					509,500				

Notes: Estimates of ATTs using OLS and CS methods in pre-intervention period. The coefficients simulate the effects between 2010 and 2011. Models do not include covariates. Errors clustered at school level and 95% confidence interval. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

FIGURE A1: COMPOSITION CHANGES BETWEEN TREATED AND UNTREATED STATES



Note: Coefficients of changes of individual characteristics between pre and post intervention periods for eligible and non-eligible groups. Tests conducted using with CS method, with errors clustered at school level and 95% confidence interval.

Chapter 2 : The absolute and relative facets of the economic gradient in educational attainment: large-scale evidence from Brazil

Abstract

The positive relationship between household economic status and pupils' educational achievement is well established across a large body of research. However, there is barely any evidence able to disentangle the absolute and relative nature of the advantage afforded by higher economic status. Using data from seven waves of Brazilian high-stake secondary education exams (N=≈8million), the paper fills this gap by estimating econometric models where absolute and relative measures of economic status are jointly employed as explanatory variables. Findings indicate that the nature of the economic gradient in educational achievement is two-faceted. Alongside the role played by absolute standards of living through material pathways to education (e.g. affordability of education and material hardship), relative economic status matters through psychosocial pathways related to self-esteem, aspirations, motivation and identity. The strength of relativists concerns appears to be greater at higher levels of absolute income.

2.1. Introduction

Education is a key domain of human development. It holds a prominent place in major global initiatives such as the Sustainable Development Goals and it features as a key dimension in the most widely-used development and deprivation indicators such as the Human Development Index and Multidimensional Poverty Index (Anand and Sen 1997; Alkire et al 2015; UN 2015; UNESCO 2020). Education can be conceived as both an inherent component and a goal of human development, as well as an enabling factor which contributes to the flourishing of individual and societal potentials across multiple domains. In this way, education has been argued to yield intrinsic as well as instrumental benefits ranging from economic growth to civic attitudes, tolerance, and environmental awareness (Reid 1998; Robeyns 2006; Selby and Kagawa 2010). Despite the progress made globally in recent decades in ensuring access to education, serious challenges remain in particular for post-primary education and for children from disadvantaged groups (UN 2020).

The importance of education has prompted international development scholars to produce a wealth of research describing and explaining multiple determinants of educational inequalities. Unequal educational attainment originates from a number of

sources, including parents' education (Basant and Sen 2014; Contreras and Puentes 2017), discrimination across socio-demographic lines such as gender, race or caste (Borooah 2012; Masterson 2012; Taş, Reimão and Orlando 2014; Lee, Rhee and Rudolf 2019) and education supply (Haddad, Freguglia and Gomes 2017; Cunningham et al 2019). An important source of educational disadvantage is economic status. Studies on economic sources of educational disadvantage have illustrated at length how material hardship and financial constraints limit the inputs parents can afford to provide their child with (food, transportation, educational materials and opportunities) and increase the need for children to engage in labour to contribute to the household's livelihood (Chamarbagwala 2008; Salazar and Glasinovich 2018; Sánchez and Singh 2018).

In this paper, we advance the literature on the economic sources of educational inequalities by investigating the possible roles of both the *absolute* and the *relative* facets of economic status as determinants of educational attainment. The absolute facet of economic status refers to the concrete standard of living we can enjoy, while the relative facet refers to how much we have relative to others in our society. Two individuals living in different socioeconomic contexts may have very similar absolute standards of living but can differ considerably in the relative deprivation they experience if they are situated at different steps of the economic ladder. A growing body of cross-disciplinary research argues for the importance of the absolute and relative facets of economic status for a number of social outcomes, stressing how their *joint* analysis enables the identification of specific pathways through which economic disparities may affect social outcomes – see the reviews of Adjaye-Gbewonyo and Kawachi (2012), Smith et al (2012), Clark and D'Ambrosio (2015), Esposito (2018), Verme (2018) and Power, Madsen and Morton (2020).

However, the joint analysis of the two facets of economic studies has been largely neglected in the study of educational inequalities. Research has mainly focused on the absolute facet of economic status and on sociomaterial pathways to educational inequalities – whereby absolute deprivation jeopardises the concrete affordability of education due to lower provision of physical and pedagogical inputs, the increased need

for child labour and the effects of credit constraints (Basu and Van 1998). Far less attention has been given to the *additional* role played by the relative facet of economic status, which regards households' economic status vis-à-vis others in society. Beyond issues related to material hardship and the concrete affordability of education, relative deprivation has been argued to lead to psychosocial pathways whereby lower relative standing along the economic ladder affects schooling outcomes by shaping aspirations and carving social identities (Mayer 2001; Destin and Oyserman 2009 and 2010). The failure to disentangle the roles of these two facets of economic status limits our understanding of the different mechanisms that link economic inequalities to educational inequalities, and, as a consequence, jeopardises the ability to design effective educational policies aimed at countering economic disadvantage.

We estimate models which simultaneously account for the absolute and relative facets of economic status using secondary data from seven waves of the Brazilian high-stake secondary education exams (Exame Nacional do Ensino Médio, ENEM, years 2012 - 2018 X, N=8.6 million). Our results highlight independent and significant roles of absolute and relative economic status as explanatory variables for educational achievements, supporting the notion of coexistence of a material and a psychosocial pathway through which economic disadvantage leads to educational inequalities. While the former relates to material hardship and inability to afford an education, the latter stresses how lower position in the socioeconomic hierarchy depresses self-confidence, curbs aspirations, and fosters the creation of rigid/crystallised identities of pupils and parents alike who are unable to see social mobility as a concrete possibility.

The paper develops as follows. In section 2 we review the concepts of absolute and relative economic status and discuss their relationship with educational outcomes. Section 3 describes our data and our empirical approach. Section 4 presents our results and section 5 concludes.

2.2. Literature review

The idea that our lives are affected not only by the absolute amount of goods and services we can afford but also by how we fare relative to others has long been discussed in the social sciences – e.g. sociology (Stouffer et al. 1949), economics (Duesenberry 1949), psychology (Bradburn 1969), political science (Gurr 1970) and anthropology (Foster 1972). The second half of the twentieth century was ripe with contributions expounding the conceptual nuances of the relative facet of economic status, and exploring how, independent of the absolute one, this had specific affective and behavioral consequences for humans (Davis 1959; Crosby 1976; Mark and Folger 1984; Kosaka 1986). Theoretical models were developed to explain possible effects of the two components of economic status on a number of social phenomena, including revolts (Davies 1962), fertility (Leibenstein 1975), economic growth (Cole et al. 1992), unemployment (Akerlof and Yellen 1990), educational subsidies (Lommerud 1989) and consumer behaviour (Frank 1985). Beyond the social sciences, Wilkinson (1997) argued how the economic gradient in health should be seen as the result of material and psychosocial pathways, resulting, respectively, from the absolute and relative facets of economic status.

This body of literature created the theoretical basis for the empirical estimation of models comprising absolute and relative specifications of economic status, which aimed to disentangle the specific relationship of each with the social outcome of interest. One branch of the empirical literature followed the early work of Stark and Taylor (1991) and Clark and Oswald (1996) with the analysis of secondary survey data via the simultaneous inclusion of explanatory variables accounting for the two facets of economic status in multivariate regressions, so that the independent effect of each could be isolated. The increasing variety of available surveys has enabled researchers to study an array of social outcomes – inter alia, see the recent work on health (Gero, Miyawaki and Kawachi 2020), migration (Kafle, Benfica and Winters 2020), crime (Burraston et al 2019), happiness (Wang, Cheng and Smyth 2019), risk attitudes (Elgar et al 2018), quit behaviour (Dube, Giuliano and Leonard 2019)) and suicide (Pak and Choung 2020). Other researchers

implemented experimental designs following the Fehr and Schmidt's (1999) framework of self-centered inequality aversion, where variation in one facet of economic status while holding the other constant was achieved through randomised allocation to treatments (see Clark and D'Ambrosio 2015 for a detailed review). The outcomes of interest in the experimental strand of this literature have been mostly restricted to wellbeing (e.g. Lavergne and Strobel 2004; Müller and Tan 2013), although more recent papers are branching out to alternative outcomes as well – e.g. obesogenic behaviour (Sim et al 2018) and hostility (Greitemeyer and Sagioglou 2019).

Evidence able to disentangle the specific roles of the absolute and the relative facets of economic status on educational outcomes is lacking. A vast amount of research across the social sciences has documented the positive effects of economic status on academic achievement and cognitive development, in both high- and low-income countries – *inter alia*, see Duncan, Brooks-Gunn and Klebanov (1994), McLoyd (1998), Bradley and Corwyn (2002), Engle et al (2011), Fernald et al (2011), Walker et al (2011), Sánchez and Singh (2018). Recent work in neuroscience has also improved our understanding of the physiology behind the positive economic gradient in education, with socioeconomic status being associated with a range of factors influencing cognitive ability, including prefrontal cortex function (Kishiyama 2009), structural and functional brain development (Hackman and Farah 2009, Noble et al 2012 and Tomalski et al 2013), epigenetic responses (Essex et al 2013), systemic inflammation-related damage to brain networks (Gianaros et al 2013) and working memory performance (Hackman et al 2014).

However, the current evidence fails to offer insights into the nature of the widely observed economic gradient in educational attainment: to what extent is this economic gradient due to children being poor, or to them being poorer than others? There is barely any empirical evidence that can provide a precise answer to this question, despite clear arguments have been developed in the literature for why the absolute and relative facets of economic status may create educational inequalities through different pathways. With regard to the absolute facet of economic status, educational outcomes are affected via sociomaterial

pathways. In the influential child labour model of Basu and Van (1998), education is a seen as a 'luxury' for households living in material hardship. Scarcity of resources makes other more pressing needs a priority, so that households cannot afford the costs directly related to education – school materials, fees, transportation, uniform, etc. Lack of resources also deprives children of an array of inputs which, directly or indirectly, support educational attainment (Brown and Park 2002; Knight, Shi and Quheng 2009). For example, lack of appropriate nutrition strongly hinders cognitive development and educational attainment (Grantham-McGregor et al 1991; Glewwe, Jacoby and King 2001; Engle et al. 2007; Jackson 2015). Material hardship often dictates the need for children to engage in work in order to contribute to the economy of the household, with negative implications for school outcomes (Chamarbagwala 2008; Salazar and Glasinovich 2018).

The relative facet of economic status affects educational outcomes via psychosocial pathways arising from the detrimental effects of occupying an inferior position in the socioeconomic hierarchy. According to Mayer's (2001) sociological work, "If children feel relatively deprived, they may be less inclined to study or stay in school. Relative deprivation can also make parents feel stressed and alienated, lowering their expectations for their children" (p. 4). This view tallies with the theory of identity-based motivation, according to which people tend to pursue long- and short-term goals tailored to the identities they have developed through their life experiences and social milieus (Destin and Oyserman 2009, 2010; Oyserman and Destin 2009). Students from lower socioeconomic backgrounds would develop identities conforming to low-skilled professions and social roles, which deflate motivation towards the pursuit of academic goals and investment in human capital. According to Hackman, Farah and Meaney (2010), the fact that children and parents from disadvantaged households "experience increased stress related to social rank" (p. 654) triggers cognitive, physiological, and ecological mechanisms responsible for lower neurological development and academic achievements. Indeed, Destin et al. (2012) show that adolescents' low position in the socioeconomic hierarchy hinders school engagement and ability to study through an increase of depressive symptoms and emotional distress. In addition, relative deprivation has been found to increase adolescents' likelihood of

attitudes which are prejudicial to academic achievement, among which normless and antisocial behaviours, alcohol consumption and active and passive bullying at school –see Bernburg, Thorlindsson and Sigfusdottir (2009), Balsa, French and Regan (2014), Napoletano et al. (2016), Odgers et al. (2015) and Vogel and South (2016).

To the best of our knowledge, the only work carrying out a joint analysis of absolute and relative economic status as explanatory variables for educational outcomes is Esposito and Villaseñor (2019). Using the 2010 Mexican census, they find that the two facets of economic status are independently and significantly associated with school enrolment. The gap in the literature has therefore several dimensions. Not only is the evidence with regard to educational outcomes very limited, but it is confined to one educational outcome: the binary status of enrolled/not enrolled, derived from a demographic survey rather than from more nuanced data on educational attainment such as exam scores.

2.3 Methods

2.3.1 *D*ata

In this study, we use data from the Brazilian National High School Examination (Exame Nacional do Ensino Médio, ENEM) from the years 2012 to 2018. ENEM is a standardized test administered to high school students in Brazil and is considered a comprehensive assessment of their knowledge and skills in various subjects. The data were obtained from the National Institute of Educational Studies and Research-INEP (*Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira)*, an agency linked to the Brazilian Ministry of Education (Ministério da Educação), who is responsible for carrying out the ENEM. INEP also publicizes different educational indicators by school, municipality, state, region, and national levels on an annual basis, such as average class size and daily school journey. Additionally, we include municipality population size as a control variable using information from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de*

Geografia e Estatística). All data were cleaned and processed to ensure their quality and consistency before being analysed.

ENEM is the most important standardised entrance exams in Brazil, and it has become increasingly competitive over the last decade. Created in 1998 as a low-stake test to evaluate high-school educational systems, ENEM changed its methodology in 2009 and became mandatory for applications to undergraduate programmes at federal universities, either alone or combined with institutions' own entrance exams ("vestibular"). Competition is fierce for degrees on federal universities who are the highest rated in the country, are free of change and detain the best quality tuition. followed by other public universities, which are also seen as good quality. With few exceptions, competition is low on private institutions where the majority of students enrol, as their degrees are less appreciated by the labour market. Gradually over time, many state, municipal and private universities have included ENEM scores as part of their entrance credentials.

Besides containing the individual test scores for each specific subject comprising the test, ENEM microdata include demographic and socioeconomic information from an extended survey made with all candidates before the test, which generally runs in two days, close to the end of the academic year (October or November). The test can be taken multiple times, after graduating from high school (to try and improve one's score) or before graduating in order to rehearse. We restrict our sample to the population of fresh-graduating students with a valid score and who were present in all exam sessions. We kept only observations from participants within 16-30 age bracket and discarded indigenous participants – who are a very small minority. After cleaning and adjusting the data, our final sample consists of 8.6 million, nearly 88% of the population of fresh graduating students who sat for the test and had a valid score.

2.3.2 Dependent Variable

Our dependent variable is the average test scores of the students who took the ENEM. The average scores represent the total score according to the type of question and correct answers given by each student in all subjects (mathematics, natural sciences, human sciences, languages, and a written essay on a given topic). Each test consists of 45 multiple-choice questions, except for the written essay, which is manually evaluated by two different examiners. Similar to other examinations such as the Scholastic Assessment Test, the Graduate Record Examination and the Program for International Student Assessment (widely known by their acronyms SAT, GRE and PISA, respectively), the ENEM grading system uses item response theory to weigh questions according to their level of difficulty based on student performance – with questions receiving weights which are inversely related to the percentage of students getting them right. The grading scale ranges from 0 to 1000.

2.3.3 Independent Variables

The main independent variables in our study are student absolute and relative standards of living. Absolute standards of living are measured using data on pupils' monthly household income, available in the dataset as an ordinal variable with 17 income-brackets categories – which we employ in different models as continuous or as categorical. For our relative deprivation measure, we first calculate an asset index following widely used methodologies (Filmer and Pritchett, 2001; Filmer and Scott, 2012; Kolenikov and Angeles, 2009) exploiting information on ownership of various assets, including but not limited to real estate, durable goods, and financial assets. The procedure for constructing this index assigs values to different types of assets through principal components analysis and sums the weights multiplied by the household characteristics (often expressed as binary indicators) to obtain a continuous variable representing the total wealth score for each student. Once we have calculated the asset index, we measure the relative standard of living of the household using the Yitzhaki (1979) index defined as:

$$RD_i = \frac{1}{N}\sum(y_j - y_i) \ \forall \ y_j < y_i, \textit{ 0 otherwise} \qquad (2\text{-}1)$$

Where the relative deprivation of individual *i* is defined as the sum of the distances between her income and the income of those richer than her – normalised by the size of the reference group. In line with Balsa, French & Regan (2014), we define the reference group as the students in the same school given that the school is the most immediate milieu where social comparisons take place. The Yitzhaki index has been widely used in academic research to measure relative deprivation and its relationships with various social outcomes. For example, previous studies have used the Yitzhaki index to examine the relationship between relative deprivation and educational outcomes (Esposito & Villaseñor, 2019) as well as health outcomes (Eibner & Evans, 2005; Esposito et al., 2022; Mishra & Carleton, 2015). The use of the Yitzhaki index in our study provides a widely accepted measure of relative deprivation that allows us to examine different facets of the relationship between socio-economic status and educational achievement. We also relax the linearity assumption in the Yitzhaki index by performing robustness checks with a nonlinear relative deprivation index, namely the Esposito (2010) index, which allows for different degrees of sensitivity to the sense of relative deprivation arising from lagging behind others. In addition, we stress-test our results by computing relative deprivation indices based on alternative reference groups. Results are robust to those alternative estimations.

It is worthwhile to notice that employing a measure of relative deprivation built on assets for our analysis has a twofold advantage. First, basing the quantification of relativists concerns on assets rather than income has been encouraged given that wealth is more visible and therefore more able than income to capture the psychosocial mechanisms triggered by economic inequality (Heffetz 2011; Sweet 2011; Hicks and Hicks 2014). The relevance of the visibility aspect of wealth for the effects of inequality to occur has also been experimentally shown by Nishi et al (2015). Second, from an operational point of view, it should be noted that we build the measure of relative deprivation upon an asset

index while the measure of absolute economic status upon household income. This reduces the correlation between the variables used to estimate the absolute and the relative aspects of economic status, hence helping us to untangle their independent associations with ENEM scores and decrease potential multicollinearity problems.

2.3.4 *E*mpirical Approach

In this study, we use multilevel models to investigate the relationship between ENEM test scores and both absolute and relative standards of living. Multilevel models are specifically designed to handle data that is nested within higher-level units, such as schools. In our models, the fixed part of the model (first level) is made of the pupils who took the ENEM test, while the schools in which the pupils are enrolled represent the random effects' part (second level). This allows us to account for the fact that pupils who attend the same school are likely to share similar experiences and characteristics, such as school resources and the quality of teaching –multilevel models enable researchers to explicitly model the variation of unobservable variables among schools. By using a multilevel model, we can control for both the individual-level and the school-level factors that contribute to the relationship between deprivation and educational achievement. Formally, the model that we estimate is:

$$ENEM_{is} = \alpha + \beta_1 Income_{is} + \beta_2 RD_{is} + \gamma Control_{is} + \xi_s + \epsilon_{is} \qquad (2\text{-}2)$$

Where $ENEM_{is}$ and $Income_{is}$ are, respectively, the ENEM score and the income of student *i* from school *s.* RD_{is} is the relative deprivation experienced by individual *i* within school *s* and $Control_{is}$ is a rich set of controls which include i) student's demographics: age, sex, race, whether they have a disability and they are single; ii) household characteristics: whether at least one of their parents has had a university education; and iii) school characteristics: whether the school is under federal, state, municipal, or private administration, the average school ENEM score, average class size, and average student

school hours. Finally, we include the size of the municipality as well as region and year fixed effects. ξ_s is the estimated school level random effects which allows us to control for unobserved school variables. Our estimated coefficients of interest are β_1 and β_2, while ϵ_{is} is the estimated error.

We investigate whether the main results are driven by specific student's characteristics first by estimating stepwise regression models along the full income distribution (Table 2 below). We next split the sample by income quartiles and run regressions models for each of them, as well as a separate model where relative deprivation is interacted with income quartiles (Table 3 below). This will allow us not only to confirm our results, but also to shed some light on how the relationship between relative deprivation and ENEM scores may be heterogeneous across the income domain.

2.4 Results

Table 2-1 presents descriptive statistics of the variables used in our estimations. The average ENEM score is 514. On average individuals in our sample are 17 years old, 58% are females and 0.13% declared a physical or mental disability. The near totality of students is single and around a quarter come from households in which at least one parent has university education. Most of the individuals in our sample are either white (44.16%) or mixed race (42.83%), 10.77% are black and 2.23% Asian. Looking at school-level variables, most schools are urban (97.4%) with a class size close to an average of 33 pupils. The school-year average ENEM score is 515. Most schools (84.95%) have between of 4 and 8 daily hours of schooling. With regards to school administration, and 75% are managed by the State and only 0.72% by the municipality; federal schools are 2.65% of our sample and private schools around one fifth.

TABLE 2-1: ESTIMATION SAMPLE DESCRIPTIVE STATISTICS

	Mean / Percentage	Min	Max
ENEM Score	514.00	358.92	725.5
Income		1	17
Yitzhaki School	0.636	0	8.01
Yitzhaki State	0.836	0	5.81
Esposito School	0.116	0	1
Esposito State	0.143	0	1
Age	17.707	16	30
Female	58.7%	0	1
Physical or Mental Disability	0.13%	0	1
Single	98.7%	0	1
Parent Education University	25.5%	0	1
Class Size	32.87	1	261.3
Urban school	97.4%	0	1
School average score	515.19	317.13	767.76
Black	10.77%		
Mixed	42.83%		
White	44.16%		
Asian decent	2.24%		
School hours 0 to 4 hours	9.43%		
School hours 4 to 8 hours	84.95%		
School hours More than 8 hours	5.62%		
School Federal	2.65%		
School State	75.12%		
School Municipal	0.72%		
School Private	21.51%		
Midwest	8.34%		
Northeast	27.22%		
North	8.86%		
Southeast	41.87%		
South	13.71%		
Small Municipality	39.61%		
Medium Municipality	27.66%		
Large Municipality	32.73%		
Total Number of Observations	8,023,580		

Table 2-2 presents the results from our multilevel mixed effects models. In all our models, the dependent variable is the average ENEM score. Models 1 – 3 use the Yitzhaki index as a measure of relative deprivation with school as the reference group. Model 1 only includes income and relative deprivation, model 2 controls for individual, household, and school characteristics as well as year and region dummies, and model 3 uses income as a categorical variable. Model 4 to 6 follow the same pattern but use the Esposito index as

our measure of relative deprivation to show that our results do not depend on the functional form of the relative deprivation index.

As observed in Table 2-2, income is always positive and statistically significant. Looking at model (2), an increase of one unit (one category) in income is associated with an increase in the ENEM score of around 1.5 points. Our measures of relative deprivation are always statistically significant and negative. According to model 2 an increase of one point in the Yitzhaki index is independently associated with a decrease in the ENEM total score of about 5 points. Figure 2-1, based on model (2), shows these relationships graphically. The dotted line plots the estimated relationship between income and ENEM scores whilst the solid line does so for relative deprivation. It shows that the difference between a student with the lowest level of income and one with the highest level of income is about 20 ENEM points (the two extremes of the curve). With regards to the relative deprivation curve, the difference between a student at the bottom of the relative deprivation index (at the top of the wealth distribution within their reference group) and one with the highest level of relative deprivation is over 40 points. These relationships have similar patters across all our models.

The estimated coefficients from our control variables shed light on interesting socio demographic relationships in Brazil too. Compared to black students, mixed race, Asian, and white students score on average higher scores (increasingly in this order), while female students score, on average, 5 points less than male students. The demographic characteristic with the highest predicted coefficient is whether the student has a physical or mental disability which is correlated to a lower ENEM score of about minus 20 points. Consistent with the literature, students with at least one parent with university education have on average higher scores. Our measures of school administration are also consistent with the literature and stylised facts in Brazil: compared to students in federal schools, students in state, municipal, and private schools perform worse. Class size is negatively associated with test scores and there seems to be an inverse U-shape relationship

between the average time students spend in school hours test scores, although these coefficients are not always statistically significant.

TABLE 2-2: MULTILEVEL MIXED EFFECTS RESULTS

	Yitzhaki School			Esposito School		
	(1)	(2)	(3)	(4)	(5)	(6)
ABS	2.550***	1.549***		2.609***	1.606***	
	(0.009)	(0.009)		(0.009)	(0.009)	
RD	-6.203***	-5.291***	-3.886***	-32.568***	-27.689***	-19.914***
	(0.035)	(0.035)	(0.037)	(0.172)	(0.174)	(0.187)
Age		-6.605***	-6.507***		-6.574***	-6.500***
		(0.015)	(0.015)		(0.015)	(0.015)
Race (Black: omitted)						
Mixed Race		1.879***	1.796***		1.873***	1.801***
		(0.065)	(0.065)		(0.065)	(0.065)
White		6.470***	6.320***		6.457***	6.332***
		(0.068)	(0.068)		(0.068)	(0.068)
Asian		4.291***	4.167***		4.262***	4.162***
		(0.140)	(0.140)		(0.140)	(0.140)
Female		-5.251***	-5.017***		-5.209***	-5.007***
		(0.039)	(0.039)		(0.039)	(0.039)
Disability		-20.011***	-19.929***		-20.103***	-19.979***
		(0.536)	(0.535)		(0.536)	(0.535)
Single		-9.247***	-9.217***		-9.314***	-9.249***
		(0.191)	(0.191)		(0.191)	(0.191)
Uni Parent		7.512***	7.310***		7.464***	7.278***
		(0.053)	(0.053)		(0.053)	(0.053)
School Type (Federal: omitted)						
State		-7.275***	-5.850***		-7.092***	-5.769***
		(0.228)	(0.232)		(0.233)	(0.238)
Municipal		-6.675***	-5.746***		-6.579***	-5.719***
		(0.416)	(0.423)		(0.424)	(0.431)
Private		-12.759***	-12.118***		-13.113***	-12.469***
		(0.220)	(0.224)		(0.225)	(0.229)
Urban		1.069***	0.063		0.781***	-0.109
		(0.157)	(0.159)		(0.159)	(0.160)
School Average Score		0.840***	0.840***		0.835***	0.836***
		(0.001)	(0.001)		(0.001)	(0.001)
Class size		-0.026***	-0.025***		-0.027***	-0.026***
		(0.004)	(0.004)		(0.004)	(0.004)
Day journey (0 to 4 hours: omitted)						
4 to 8 hours		0.038	-0.030		0.025	-0.040
		(0.086)	(0.086)		(0.087)	(0.087)
More than 8 hours		-0.172	-0.215		-0.193	-0.229
		(0.147)	(0.149)		(0.149)	(0.150)
Municipality size (Small: omitted)						
Medium		0.895***	0.292***		0.622***	0.133
		(0.076)	(0.077)		(0.077)	(0.079)
Large		1.188***	0.717***		0.845***	0.507***
		(0.078)	(0.079)		(0.080)	(0.081)
Region (South: omitted)						
Midwest		3.226***	3.980***		3.501***	4.163***
		(0.136)	(0.139)		(0.139)	(0.142)

Northeast		7.321***	10.016***		8.272***	10.595***
		(0.107)	(0.110)		(0.109)	(0.112)
North		6.694***	8.739***		7.443***	9.198***
		(0.141)	(0.144)		(0.144)	(0.147)
Southeast		3.151***	3.745***		3.346***	3.875***
		(0.094)	(0.096)		(0.096)	(0.097)
ABS Income level (Lowest: omitted)						
2. ABS			1.896***			0.906***
			(0.136)			(0.137)
3.ABS			7.647***			6.395***
			(0.141)			(0.144)
4.ABS			11.699***			10.475***
			(0.148)			(0.151)
5.ABS			13.659***			12.535***
			(0.155)			(0.158)
6.ABS			15.688***			14.623***
			(0.160)			(0.163)
7.ABS			18.500***			17.492***
			(0.161)			(0.164)
8.ABS			19.536***			18.606***
			(0.170)			(0.173)
9.ABS			20.223***			19.439***
			(0.181)			(0.184)
10.ABS			20.870***			20.163***
			(0.197)			(0.199)
11.ABS			21.491***			20.847***
			(0.217)			(0.219)
12.ABS			22.325***			21.736***
			(0.235)			(0.236)
13.ABS			21.839***			21.306***
			(0.247)			(0.248)
14.ABS			22.194***			21.822***
			(0.231)			(0.232)
15.ABS			22.119***			21.837***
			(0.244)			(0.245)
16.ABS			22.481***			22.293***
			(0.260)			(0.261)
Highest Income			21.202***			21.161***
			(0.242)			(0.242)
Constant	496.668***	205.996***	198.744***			201.563***
	(0.235)	(0.691)	(0.712)			(0.719)
Observations	8,608,077	8,023,580	8,023,580	8,608,077	8,023,580	8,023,580
Year Fixed Effects	NO	YES	YES	YES	YES	YES

Notes: *** p<0.001, ** p<0.001, * p<0.05. Clustered standard errors at the school level. Second level is the school.

FIGURE 2-1: PREDICTED MARGINS OF INCOME AND RELATIVE DEPRIVATION ON ENEM SCORES

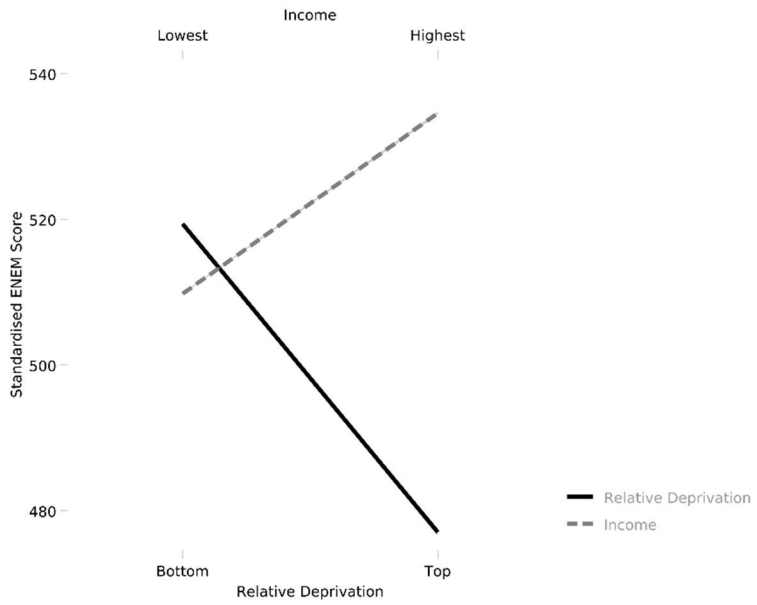


Table 2-3 presents the results from the sub-group analysis to investigate patterns in the relationship between RD and ENEM scores at different levels of income. We estimate our models described by equation (1) but we first split our sample by income quartiles (models 7 – 10) and finally by interacting an income quartile variable with RD (model 11). Absolute and relative deprivation display the expected signs across all models, suggesting that these relationships are consistent across the income distribution. Our interactions model suggests that while being in a higher income quartile is associated with better ENEM scores compared to pupils in the bottom quartile, the possible effect of relative deprivation is worse the richer students are. Indeed, Figure 2-3 shows that the higher the income quartile, the steeper the slope in the predicted ENEM scores across the RD domain is. Whilst students in the top income quartile score around 20 points more than those in the bottom quartile when relative deprivation is low, the difference almost vanishes at the highest levels of RD. This result is in keeping with Maslow's (1943) notion of a hierarchy of needs, whereby relativist concerns would be considered as 'luxury goods' more prevalent at higher standards of living – and is in line with the empirical findings of Didier (1995) and Ravallion and Lokshin (2010) who found relative deprivation to be stronger at higher incomes.

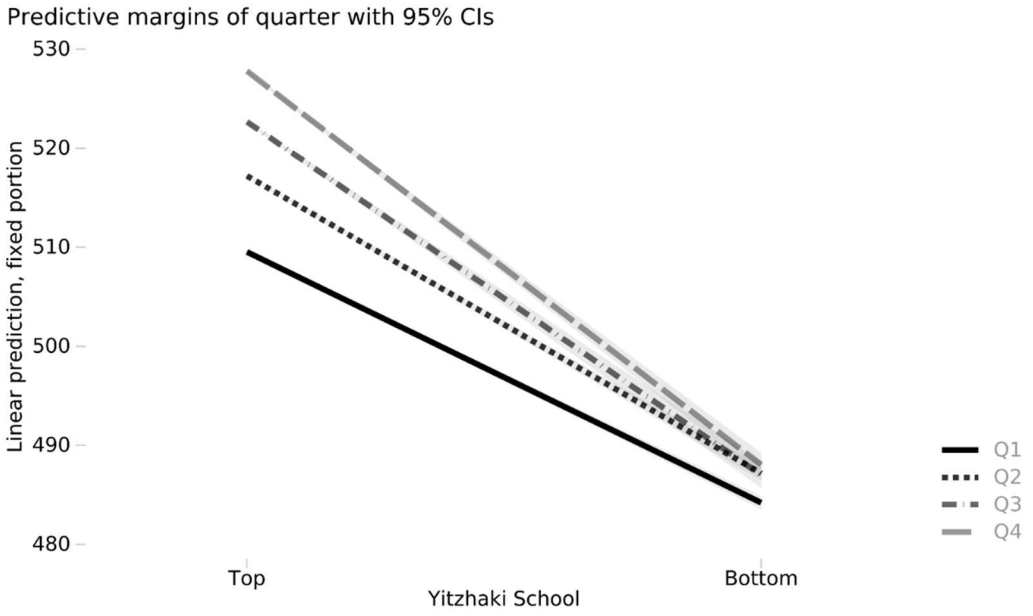
TABLE 2-3: SUBGROUP ANALYSES

	Poorest Quartile (7)	Second Quartile (8)	Third Quartile (9)	Richest Quartile (10)	Quartiles Interaction (11)
ABS	1.897***	3.977***	2.033***	0.494***	
	(0.129)	(0.071)	(0.102)	(0.017)	
RD	-4.116***	-4.200***	-5.062***	-4.156***	-3.615***
	(0.056)	(0.061)	(0.113)	(0.101)	(0.055)
Quartile (Bottom: omitted)					
2nd Quartile					7.693***
					(0.085)
3rd Quartile					13.146***
					(0.101)
4th Quartile					18.269***
					(0.098)
*Quartile (Bottom Q*RD: omitted)*					
2ndQ*RD					-0.675***
					(0.076)
3rdQ*RD					-1.478***
					(0.114)
4thQ*RD					-2.063***
					(0.103)
Age	-5.047***	-6.303***	-7.901***	-11.389***	-6.504***
	(0.021)	(0.025)	(0.048)	(0.050)	(0.015)
Race (Black: omitted)					
Mixed Race	0.970***	1.506***	2.090***	3.752***	1.828***
	(0.104)	(0.107)	(0.184)	(0.175)	(0.065)
White	5.838***	6.148***	6.312***	7.275***	6.383***
	(0.118)	(0.112)	(0.183)	(0.170)	(0.068)
Asian	3.436***	3.201***	4.623***	6.733***	4.184***
	(0.240)	(0.239)	(0.386)	(0.313)	(0.140)
Female	-6.245***	-5.894***	-4.785***	-3.399***	-5.079***
	(0.073)	(0.068)	(0.102)	(0.078)	(0.039)
Disability	-11.987***	-17.822***	-20.981***	-31.807***	-19.946***
	(0.943)	(0.904)	(1.432)	(1.184)	(0.535)
Single	-6.964***	-10.389***	-11.929***	-2.813***	-9.227***
	(0.261)	(0.316)	(0.643)	(0.748)	(0.191)
Uni Parent	6.784***	5.701***	5.501***	8.569***	7.607***
	(0.153)	(0.100)	(0.121)	(0.088)	(0.053)
School type (Federal: omitted)					
State	-3.987***	-4.291***	-5.141***	-9.333***	-5.726***
	(0.365)	(0.341)	(0.450)	(0.413)	(0.227)
Municipal	-3.544***	-4.477***	-5.759***	-9.491***	-5.607***
	(0.660)	(0.614)	(0.813)	(0.833)	(0.415)
Private	-3.730***	-9.105***	-12.253***	-18.598***	-11.479***
	(0.379)	(0.333)	(0.428)	(0.391)	(0.219)
Urban	-0.559**	1.302***	1.986***	1.876***	0.066
	(0.197)	(0.250)	(0.435)	(0.477)	(0.157)
School Score	0.823***	0.858***	0.867***	0.847***	0.846***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Class size	-0.067***	-0.046***	-0.016*	-0.004	-0.023***
	(0.007)	(0.006)	(0.008)	(0.006)	(0.004)
Day journey (0 to 4 hours: omitted)					
4 to 8 hours	-0.735***	0.203	1.233***	1.728***	-0.063
	(0.120)	(0.136)	(0.216)	(0.231)	(0.086)
More than 8 hours	-0.728***	0.957***	1.006**	0.693*	-0.317*
	(0.205)	(0.232)	(0.361)	(0.350)	(0.147)
Municipality size (Small: omitted)					
Medium	1.096***	0.431***	-0.205	-0.554***	0.341***
	(0.116)	(0.113)	(0.158)	(0.155)	(0.076)

Large	1.680***	1.020***	0.572***	-0.145	0.779***
	(0.118)	(0.116)	(0.163)	(0.157)	(0.078)
Region (South: omitted)					
Midwest	3.220***	4.767***	4.968***	3.494***	3.908***
	(0.238)	(0.200)	(0.268)	(0.258)	(0.136)
Northeast	7.426***	11.773***	12.938***	9.390***	9.697***
	(0.190)	(0.166)	(0.237)	(0.228)	(0.108)
North	7.215***	9.109***	9.031***	7.066***	8.533***
	(0.219)	(0.211)	(0.309)	(0.301)	(0.141)
Southeast	3.681***	4.440***	4.459***	3.372***	3.635***
	(0.184)	(0.143)	(0.182)	(0.172)	(0.094)
Constant	180.954***	180.945***	212.007***	288.108***	197.773***
Obs	2,119,633	2,595,188	1,213,294	2,095,465	8,023,580
Year Fixed Effects	YES	YES	YES	YES	YES

Notes: *** p<0.001, ** p<0.001, * p<0.05. Clustered standard errors at the school level. Second level is the school

FIGURE 2-2: PREDICTED MARGINS OF INCOME AND RELATIVE DEPRIVATION ON ENEM SCORES BY QUARTILES OF INCOME



2.5. Conclusion

This paper has contributed to the literature of educational inequalities by refining the study of the economic gradient in education. By disentangling the roles of the absolute and relative facets of economic status, our findings based on Brazilian high-stake exams indicate that absolute and relative standards of living are related to educational achievements independently of one another. This suggests that, beyond well-studied material pathways related to material hardship and affordability of education, economic status may determine educational achievements through psychosocial pathways related to self-esteem, aspirations, motivation, stress, and identity. Both facets of economic status should therefore be considered as possible sources of educational inequalities.

Importantly, while the only comparable previous analysis looked at school enrolment using demographic data, this paper employs more nuanced data from a large scale high-stakes exam which is key for university admission. The richness of our data also enabled a nuanced reading of the way absolute and relative standards of living are related to educational results, with evidence of this relationship being stronger at higher standards of living. The acknowledgment of the two sides of the economic gradient in education urges scholars, policymakers and educators to place a greater emphasis on the role of socioeconomic inequalities.

Further research is needed to explore the distinct roles of absolute and relative standards of living as sources of educational inequalities in other geographical contexts, as well as for other age groups and educational outcomes. While we used data from a very important exam taken by millions of students in Brazil every year, and participation has expanded considerably over time, participation is lower among the poorest: by missing the bottom of the distribution, our evidence may therefore underestimate the educational effects of economic status.

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Chapter 3 : Gender, race and their interplay with economic status: intersectionality and asymmetric jeopardies in ENEM results

Abstract

A large body of research has illustrated how inequalities in educational achievements are rooted in a range of demographic and socioeconomic characteristics. However, sources of educational disadvantages are too often considered in isolation, without addressing the way they interplay with one another. Building upon the intersectionality and multiple jeopardy frameworks, in this paper we analyse the role played by economic status, gender and race in shaping education attainment in Brazilian high-stake secondary education exams – focusing on the way economic status interplay with gender and race. Importantly, we conceptualise economic status as comprising an absolute and a relative facet and observe that the two economic status components interplay symmetrically with gender but asymmetrically with race. We follow a mixed methods approach, where we first produce quantitative evidence via the econometric analysis of large-scale data (N≈8million), and then shed light on it using primary data collected via semi-structured interviews and focus group discussions with 30 secondary school teachers. Our work improves our understanding of the multifaceted disadvantage experienced by students from underprivileged households in Brazil, highlighting how economic inequality and discrimination hinder educational attainment and jeopardise social mobility.

3.1 Introduction

Inequalities of outcomes and opportunities across the economic status, gender and racial axes have long existed and been of interest to several academic disciplines. Despite significant progress has been achieved in the past decades, females' discrimination persists in economic opportunities, education, health, and empowerment (UN 2023; WEF 2023). The recent World Inequality Report devotes a chapter to gender disparities, illustrating how gender parity in economic resources and employment is far to be achieved, in particular in Latin America (Chancel et al, 2022). In the Latin American continent, women are on average poorer than men and females' disadvantage continues in a range of domains (Bando, 2019; Liu, Amarante, Colacce and Scalese 2022; Castro Torres and Batyra 2023), with detriment for economic development (Koengkan et al 2022). In a similar fashion, there is a growing literature illustrating the pervasive character of racial inequalities, including in Latin America (Telles 2012; Wrigley-Field 2020; Darity, Mullen and Slaughter 2022; Derenoncourt et al 2022; Igreja, Santos and Agudelo 2022). Hummer (2023) forcefully maintains that despite large evidence of striking racial inequalities, societies have been unable to tackle and fully account for existing racial injustices and structural racism.

While discrimination across multiple socioeconomic or demographic axes can be studied in isolation, an increasingly adopted approach in academic research consists in studying how sources of disadvantage interplay in determining social outcomes. In other words, while sources of disadvantage such as economic deprivation, gender and race exert their own roles in shaping people's life, additional effects would arise from the simultaneous combination of these factors – for example, being deprived and at the same time belonging to a certain gender or race. The intersectionality (Crenshaw 1989; Collins 2015) and multiple jeopardies (Beale 1970; Ransford 1980; King 1988) frameworks stress that when multiple sources of disadvantage are present/occur at the same time, failure to acknowledge their interplay beyond their individual effects would prevent researchers from fully understanding the realities experienced by individuals and groups. Such an approach has been applied to multiple contexts and is increasingly common in quantitative research (Reingold, Haynie and Widner 2020; Bauer et al 2021; Fisher and Rouse 2022; Merz et al 2023).

In this paper, we adopt an intersectionality framework to study the determinants of educational inequalities in Brazil. We focus on the economic dimension as a source of disadvantage, which, for the first time in intersectionality research, we disentangle in an absolute and a relative facet. Keeping the economic dimension as the fulcrum of our study, we analyse the intersection between each of the two facets of economic status with gender and race – which are the demographic axes most widely taken into examination in intersectionality studies and well fit the investigation of educational inequalities in Brazil. We provide both quantitative and qualitative evidence through a mixed-methods approach, comprising the econometric analysis of a large dataset coupled with qualitative primary data. The quantitative analysis is based on secondary data from 7 waves of the Brazilian high-stake secondary education exams (ENEM, Exame Nacional do Ensino Médio, N≈8million). Our fieldwork data was collected during February-March 2019 through semi-structured interviews and focus group discussions with 30 secondary school teachers in Rio de Janeiro. We follow a sequential design, where the qualitative fieldwork data is used to shed light on the relationships previously identified through the quantitative analysis.

From our analysis, economic status, gender and race emerge as important sources of educational inequalities – taken individually as well as considered in their interplays with one another. Our quantitative results highlight significant interactions between each facet of economic status and both gender and race. However, such interactions suggest diverse patterns for gender and race. In the case of gender, the disadvantaged category (females) is increasingly disadvantaged compared to males both i) the lower the absolute income and ii) the lower the relative standing in the economic ladder (i.e. the higher the relative deprivation). A stark asymmetry arises in the case of race, where the disadvantaged category (black/mixed) is increasingly disadvantaged compared to whites the lower the absolute income (as in the case for females) but is less disadvantaged the lower the relative standing in the economic ladder (i.e. higher relative deprivation is more detrimental to whites– the otherwise advantaged category). The decreasing relevance of gender and race at higher levels of absolute income is interpreted as due to the lower intrahousehold and societal mechanisms leading to discriminations for females and blacks/mixed in presence of economic affluence. With regards to relative deprivation, its stronger role for females can be made sense of in light of females' greater sensitivity economic inequality and relative standing; the greater role of relative deprivation played for whites is ascribed to societal mechanisms rooted in prejudice, adaptation, and resilience.

The remainder of the paper develops as follows. Section 2 presents the conceptual framework, which is based upon the intersectionality and multiple jeopardies frameworks. A methods section follows, with subsections 3.1, 3.2 and 3.3 introducing, respectively, our overall mixed methods approach, and the quantitative and qualitative phases of our empirical strategy. Section 4 offers our quantitative results, and section 5 discusses them in light of the views offered by our teachers. Section 6 concludes.

3.2. Conceptual framework

The adoption of an intersectionality framework is increasingly fostered in diverse settings and disciplines, ranging from economics (Bogan and Wolfolds 2022; Alonso-Villar and del Río 2023) to international development (Marslev, Staritz and Raj-Reichert 2022), sociology

(Masquelier 2022), psychology (Lei and Rhodes 2021), public health (Merz et al 2023) and the formulation of local and national policies (Garcia and Zajicek 2022; Qureshi et al 2022; Harpur, Szucs and Willox 2023; La Barbera, Espinosa-Fajardo and Caravantes 2023; Williams et al 2023). The popularity gained by this approach is catalysing continuous theoretical research endeavours to achieve stronger conceptualizations of intersectional social categories, constructs and sociodemographic axes (Bauer 2023; Lei, Foster-Hanson and Goh 2023), as well as methodological reflections on how to implement an intersectional framework empirically (Harari and Lee 2021; Misra, Curington and Green 2021; Bauer et al 2022).

The intersectionality framework is both a conceptual stance as well as an approach to carry our empirical research (Hancock 2007). It maintains that systems of oppression such as sexism, racism, classism, ableism, etc. are strictly interwoven. Crenshaw (1989; 1991) used the term 'intersectionality' as an analogy of being at a road junction, where not only can one be said to be on each of the two roads, but they are also at a special position in these two roads – indeed, their intersection. This analogy was used to describe the social position of being at the intersection of two of more axes – in her case, gender and race. Being simultaneously female and black conferred a unique status, burdened with unique forms of discrimination, which could not be accounted for by simply being female or simply being black. Crenshaw exemplifies this by referring to a legal case where the court failed to acknowledge intersectionality: General Motors was found not guilty for discriminating black women simply because they were hiring enough blacks (despite these being mostly males) and enough women (despite these being mostly white) (DeGraffenreid v. GENERAL MOTORS ASSEMBLY DIV., 1976).

The intersectional framework has significant commonalities with the "*multiple jeopardy-advantag*e" framework (MJA). According to MJA, in social spaces displaying multiple stratifications along sociodemographic axes, each individual is identified by a "unique social space" (Ransford, 1980, p. 277) characterized by its positions in each domain. In order to explain differences in social outcomes across individuals or groups, it is necessary to consider where they are positioned across the domains of interest. MJA has long been used in studies looking at the implications of concurrent demographic axes as sources of

disadvantage, such as gender and race (Beale 1969; French 1978), gender and age (Chappell and Havens 1980), race and age (Dowd and Bengtson 1978), while a focus on the concurrence of demographic and socioeconomic axes is more recent (e.g. Mendelson et al 2008).

In order to introduce the ways in which the intersectionality and MAJ frameworks may be applied, it is useful to report the words of King (1988: 47). She finds the early applications of MAJ "overly simplistic", in that "merely additive… [as] the mathematical equation racism plus sexism plus classism equals triple jeopardy… [where] each discrimination has a single, direct, and independent effect on status… An interactive model, which I have termed multiple jeopardy, better captures those processes. The modifier 'multiple' refers not only to several, simultaneous oppressions but to the multiplicative relationships among them as well. In other words, the equivalent formulation is racism multiplied by sexism multiplied by classism".

Discussions around additive vs multiplicative approaches to the conceptualization as well as the operationalization of intersectionality feature in a number of influential contributions (McCall 2005; Hancock 2007; Bowleg 2008, 2012; Weldon 2008; Choo and Ferree 2010; Bauer 2012; Bowleg and Bauer 2016; Else-Quest and Hyde 2016; 2020). Following the taxonomy proposed by Choo and Ferree (2010), the ways in which manifold sources of disadvantage affect human experience can be categorised in 3 main types: group-centered, process-centered, and system-centered. A *group-centered* approach to understanding and implementing intersectionality is based on the idea that each axis has a separate effect on social outcomes, which cumulates with the effects of other axes but is independent of them. A *process-centered* approach does not deny the existence of 'main effects' of each axis, but also stresses the need to consider how axes interplay – in line with core intersectionality tenets, only by considering the ways axes interact would researchers really unveil intersectional states. For example, gender and race would have their individual effects, which apply to all individuals of a certain gender or race, but each gender-race intersection would yield further specific effects. A *system-centered* approach, instead, sees

intersectionality as a complex system where axes meld into one another giving rise to shades and nuances where every state is the result of an intersection; 'main effects' are not of interest and only interactions count – Weldon (2008) calls this as an 'intersection only' approach. Here, gender and race would be embedded into one another, with the identities of interest being not, say, 'female', 'male', 'black' and 'white', but rather 'black female', 'black male', 'white female' and 'white male'.

With reference to the above taxonomy, we adopt a process-centered approach where the economic dimensions (absolute and relative economic status) and the demographic dimensions (gender and race) are included in the analysis alongside their interactions. We operationalise this in regression analysis where the economic and the demographic variables are interacted. The empirical operationalization of intersectionality via interaction terms in regression analysis is widely used in the relevant literature across disciplines (Berdahl and Moore 2006; Spierings 2012; Hinze, Lin and Andersson 2012; Elu and Loubert 2013; Jackson, Williams and VanderWeele 2016; Hancock 2019; Bauer et al 2021). At the same time, it is important to highlight the limitations of quantitative analysis. This cannot fully account for the complexity of intersectional mechanisms occurring in society as a result of multiple forms of oppression and discrimination, given the epistemological limitations of positivist paradigms, the precariousness of using data collected via instruments not designed for unveiling intersectionality mechanisms (for example, because axes such as gender are considered homogeneous), and the constraining assumptions embedded in statistical and econometric analyses (e.g. linearity, absence of multicollinearity and endogeneity, etc.) – see Weldon (2008), Bauer (2014) and Bowleg (2017).

The adoption of mixed methods approaches is a way of partially addressing these limitations. Mixed methods have been argued to be well suited to the application of an intersectionality framework, given their ability to identify large scale patterns and also offer insights into the social dynamics occurring beyond them (Hankock 2007; Choo and Ferree 2010; Spierings 2012; Dubrow 2013; Fehrenbacher and Patel 2020). The use of qualitative methods alongside quantitative ones also responds to a crucial need of intersectionality,

namely carrying out contextualised analysis situating investigations in a certain social and cultural milieu (Bowleg 2008). The way axes interplay in society and affect human experiences are situated in the reality of a specific social environment and are often idiosyncratic to local practices and customs; interactions occur within specific social arrangements and structures of power, ranging from laws and policies to religious institutions and cultural traits, leading to diverse pathways to advantage and disadvantage (Hankivsky et al 2017). This also implies that a specific location on an a certain axis (e.g. being female or black) should not be seen as necessarily detrimental in every social outcomes, as intersectionality posits that a certain social states can afford penalties in some domains and advantages in others (Purdie-Vaughns and Eibach 2008; Larson et al 2016) – examples of this are the lower degree of weight discrimination suffered by blacks (Reece 2019) and lower health burdens suffered by ethnic minorities at low levels of standards of living (Brannon, Higginbotham and Henderson 2017). In the words of Hancock (2019: 266-267) "One's membership on some single axis of disadvantage (for example, being a member of racial minority group) does not prevent one from having privilege on another axis of disadvantage". In this sense, Bauer et al (2021: 2) argue that "intersectionality structures the question, rather than hypothesizing the answer". Needless to say, these last remarks do not deny that a certain group may overwhelmingly suffer from discrimination.

In the following section, we lay out our mixed methods approach – presenting first the rationale for our overall sequential strategy, and next the details for the quantitative and qualitative research phases.

3.3 Methods

3.3.1 ENEM and our mixed methods approach

ENEM is an annual large-scale high-stakes exam introduced in 1998 by the Brazilian Ministry of Education and managed by the National Institute of Educational Research (INEP) to test the academic competence of high school leavers. The test covers five subjects (writing, maths, humanities, natural sciences and foreign language), is administered over two days

and takes place simultaneously across Brazil (Schwartzman and Knobel 2016). From 2009, ENEM scores became the main determinant for admission to public and private universities, making ENEM a crucial vehicle for access to higher education and social mobility. Beyond access to university, ENEM is also an opportunity for participants to obtain an accreditation of their knowledge, which could also be used in the job market. While the exam is taken on a voluntary basis, it has grown in popularity, with over five million participants a year taking the exam in the past decade (INEP 2018). Our aim is to offer a fuller picture of how economic status relates to this important exam, including both the absolute and the relative facets of standards of living and disentangling the specific role each facet has. Since we want to both unveil systematic patterns and statistical relationships as well as shed light on the nuances and mechanisms behind them, we combine quantitative and qualitative methods in a mixed methods study.

We frame our approach within the widely used taxonomy for mixed methods research developed by Onwuegbuzie and Collins (2007), which is based upon three main dimensions: time orientation, purpose and relationship. With regard to time orientation, we use a *sequential* approach wherein the qualitative and the quantitative components are not concurrent but take place in different phases – in our case, with the quantitative preceding the qualitative. This choice is linked to the purpose of our research, which fits Onwuegbuzie and Collins's *expansion* category. The main goal of our qualitative phase is not to triangulate, compare or validate results from the quantitative phase, but to elicit perspectives as to the possible social dynamics and processes which may explain the reasons why such patterns were observed. Since it would be difficult to identify nuanced explanations from quantitative secondary data, not least because of the inevitably limited number of available variables, qualitative data are used to shed light on the quantitative results and provide a richer contextualised understanding. Finally, for Onwuegbuzie and Collins the relationship dimension refers to the mixed methods implementation in terms of sampling design. We follow what they term a *multilevel* design, since our samples are extracted from different levels of study rather than from the same population – as with the example the authors provide in their paper, our quantitative sample consists of students while the qualitative one

consists of teachers (for a detailed discussion and an in-depth analysis of the conceptual aspects of multilevel mixed-methods, see Headley and Plano Clark 2020).

3.3.2 Quantitative phase

We use national data from seven ENEM waves viz. 2012-2018. ENEM scores for each participant are calculated by INEP on the basis of item response theory (each question in the exam is weighted according to its difficulty), and each of the 5 subjects is given a score on a 0-1000 scale. Our dependent variable is the simple average of the 5 scores standardized to N(0,1) to support cross-year comparability. The simple average of the 5 scores is a relevant metric, since it is used by most university programs as admission criterion – weighted averages are employed for specific programs, e.g. for engineering degrees a larger weight is given to the maths score (Cordeiro 2014).

Our independent variables of interest are measures of absolute and relative economic status. We derive our absolute economic status variable using the information on family income. In the data this is provided in 17 ordered-categories (1=no income, 2=up to R$90,000, 3=R$90,000-R$130,000 etc.), which we transform into a continuous variable by setting income at the midpoint of each category (and scale to million Reals). We choose this simpler approach for clarity and simplicity over alternative approaches such as Monte Carlo simulations or imputation by fitting to a distribution (e.g. Banerjee and Piketty 2005). For our measure of relative economic status, we employ measures of relative deprivation which quantify one's disadvantage compared to other members of a reference group (Esposito 2018). These relative deprivation measures are computed on the basis of a continuous wealth index developed using polychoric principal component analysis on the basis of information on household assets (Filmer and Pritchett 2001; Kolenikov and Angeles 2009).

We develop multiple versions of relative deprivation measures, using linear and nonlinear functional forms (Yitzhaki, 1979; Esposito 2010) as well as different reference groups defined on different combinations based on location (the entire student population or students from the same school), gender and/or race – this enables us to confirm that results

do not depend on the specific characteristic of the measure used. The results reported in the paper are based on a relative deprivation measure based on pupil's own schools as a reference group, whose correlation with income is -0.28.

Given that the students are naturally clustered into schools, we employ hierarchical linear models and adjust for pupil and school characteristics. Hierarchical models are a generalisation of linear regression which explicitly account for the grouped or hierarchical structure of data, in our case pupils (level 1) clustered within schools (level 2). In their simplest form, they allow for a school-specific shift of the regression line, and more generally they can accommodate greater flexibility in functional form. They are appropriate for settings such as ours also because grouped data frequently violate the assumption of independence across observations – in our case, because we would expect exam scores to be clustered by school. Hierarchical models explicitly account for such clustering, and as a result are popular in educational settings (Paterson and Goldstein 1991, Schagen and Schagen 2005, Leckie and Goldstein 2015).

Formally, our general model can be written as:

$$y_{ij} = \beta_0 + \sum_{k=1}^{K} \beta_k x_{kij} + \sum_{p=1}^{P} \gamma_p z_{pj} + \mu_j + \epsilon_{ij}, \qquad (3\text{-}1)$$

where y_{ij} is the achievement score for child *i* in school *j*, β_0 is the constant term, β_k (k=1,…,K) are the K regression coefficients corresponding to K level-1 regressors; x_{kij} is the value of x_k for child i in school j. γ_p (p=1,...,P) are the P regression coefficients corresponding to level-2 regressors where z_{pj} is the value of z_p for school j. Finally, μ_j is the school-level random effect for school j where $\boldsymbol{\mu} \sim N(0, \sigma^2)$ and the parameter σ^2 is estimated as part of the model, while ϵ_{ij} is the individual-level error.

For each model we report robust standard errors that are clustered at school level. Robust standard errors are called for because our data are not from a random sample, and we

cannot a priori assume that error terms are independent and identically distributed. Therefore, beyond school-specific random effect using hierarchical models, we additionally cluster errors by school because exam scores are likely to be correlated within schools. We also include control variables at the individual level (age and disabiilty status, maternal and paternal education, household size) as well as at school level (rural location and whether the school administration is municipal, state, federal or private). Descriptive statistics for our variables are shown in Table 3-1 below.

TABLE 3-1: SUMMARY STATISTICS

Variable	Mean	SD	Min	Max
Gender				
Male	0.420			
Female	0.580			
Race				
Black	0.107			
Mixed	0.433			
White	0.460			
Disabled	0.001			
Type of school				
Federal	0.027			
State	0.731			
Municipal	0.010			
Private	0.233			
Household location				
Urban	0.974			
Rural	0.026			
Household Income (million BRL)	0.265	(0.349)	0	2.068
Household relative deprivation	0.121	(0.131)	0	0.999
Mother's education				
No education	0.021			
Primary School	0.230			
Middle School	0.171			
High School	0.377			
University	0.120			
Postgrad	0.081			
Father's education				
No education	0.037			
Primary School	0.306			
Middle School	0.172			
High School	0.338			
University	0.097			
Postgrad	0.049			
Household size	4.066	(1.107)	1	6
N		7,715,598		

3.3.3 Qualitative phase

The data collection took place during February and March 2019 in Rio de Janeiro, so that quantitative and qualitative results concern the same context. The importance of aligning qualitative and quantitative sampling in mixed methods research primarily concerns concurrent rather than sequential designs like ours (Sykes, Verma and Hancock 2018), and the phenomena we are interested in are unlikely to be unique to a certain geographical area. Yet, given the large sociodemographic heterogeneity of the Brazilian subcontinent, we wanted our quantitative and qualitative data to refer to largely the same context and our qualitative insights to be offered by teachers from the area the quantitative data refers to. We purposively selected 7 high schools, of which 5 were standard high schools and 2 were technological high schools – where the curriculum places a greater emphasis on applied subjects. For both categories, we selected high- and low-performing schools in terms of ENEM average results in previous years. While we only visited federal, state and municipal schools, some of our respondents were also employed in private schools – having multiple teaching assignments across schools is common in Rio de Janeiro (Elacqua and Marotta 2020). Principals facilitated our access to teachers, who were selected across ages and genders to have a range of perspectives and teaching experience. Of the 30 teachers participating in our research, 23 were females and 7 were males, with an age range between 29 and 69. We carried out 13 semi-structured interviews and 3 Focus Group Discussions (FGDs, with 4, 5 and 8 teachers). FGDs and most interviews were arranged in advance based on teachers' schedules, and in some cases, we were able to interview teachers who were available during the days we visited the schools. All sessions took place in the school premises and only one case a teacher we approached declined to be interviewed. In each interview we presented participants with our quantitative evidence (an overview of basic descriptive statistics and an explanation of our econometric results) and invited them to comment on possible explanations for our results. Interviews were fully transcribed, and the quotes reported in this paper are our translations.

We let the concept of saturation define the limit of our qualitative data collection. Locating our strategy in Saunders et al's (2018) discussion of typologies and aims of saturation, we primarily followed their notion of *data saturation* rather than theoretical saturation. In other

words, we collected data until reaching information repetition and redundancy, with only marginal reference to theory. Saunders et al's (2018) point out that often multiple notions of saturation coexist in qualitative research, the consequence being that in practice hybrid notions of saturation guide qualitative data collection. According to this perspective, our strategy can be seen as also having elements of what they call a priori thematic saturation. While we approached interviews and FGDs from the perspective of no prior knowledge (in order to let teachers express their views as unconditionally as possible), we clearly did have a background awareness of potential explanations provided by the existing literature. To a lesser degree, this prior knowledge has also influenced the decision of 'when to stop'. With regard to Hennink et al's (2017) distinction between 'code saturation' and 'meaning saturation', our approach sits within the former because our aim consists in identifying pathways and potential mechanisms behind our quantitative evidence, rather than inductively developing theoretical meanings around these pathways. Finally, following gender insights provided by our teachers we perform some additional quantitative analysis – but since this analysis is peripheral to the aims of our paper, we would not define our mixed methods approach as iterative.

3.4 Quantitative results

Our quantitative results are presented in Table 3-2 which displays coefficients from multiple hierarchical regression models. Each model has two levels, viz. pupil and school, and all models include year fixed effects. Across all models, income and relative deprivation are highly significant (p<0.001) with a positive sign for the former and a negative sign for the latter. Their statistical significance when they are jointly employed in our regressions suggests the relevance of both the material and psychosocial dimensions of socioeconomic pathways to educational attainment. Likelihood-ratio tests support the use of hierarchical models over customary linear regressions (p<0.001 for all specifications).[37]

[37] We note that this since this test cannot be run on specifications employing robust clustered standard errors, we have carried it out on specifications using regular standard errors.

Models 1-4 focus on the roles of race, gender, income, and relative deprivation without considering interaction effects. Model 1 includes only race, gender, income, and relative deprivation besides year fixed effects. Coefficients for all four are significant and have the expected sign: ENEM scores for females are lower than for males, White students have the highest scores followed by Mixed and Black, and scores rise with income and fall with relative deprivation. Model 2 adds other pupil characteristics (age and disability status), while model 3 adds multiple household characteristics (household size, father, and mother's education). Model 4 additionally adjusts for school type and location (rural or urban). The coefficients for school type are specified to have a fixed as well as (school-level) random component. Through models 1-4, the signs and significance of race, gender, income, and relative deprivation coefficients remain unchanged, while their magnitude generally reduces as control variables are added.[38] This reduction is not surprising given the strong correlation in Brazil between economic status and sociodemographic characteristics such as parent education, household size, and the type of school attended.

The estimated standard deviations of the random-effects (RE) components are also statistically significant. In the case of school effects, this term captures the effects of school-level unobservables as (e.g. teacher quality). We would therefore expect these RE terms to have substantive variation, and indeed the standard deviation is of comparable magnitude to the coefficients of income and relative deprivation. The standard deviation for the residuals captures remaining unobserved heterogeneity, and indicates that, as expected, there are important factors determining the variation in ENEM scores beyond our explanatory variables. The standard deviation of the random component for school-type coefficient (models 4 and 8) is of similar magnitude. This indicates that, as expected, even though average ENEM scores vary according to school type, there remains substantial variation in scores across schools of the same type.

[38] For simplicity, we do not display the coefficients of the various control variables, and these results are available on request. All control variables display expected signs. Pupils with a disability have lower ENEM scores on average; ENEM scores fall with rising pupils' age and household size, while they rise with maternal and paternal education. Federal schools (the base category) have the highest average scores, followed by private, and then state and municipal schools.

Models 5-8 introduce interaction effects between race and economic status (both income and relative deprivation) and likewise between gender and economic status. Model 5 includes only these interaction effects in addition to race, gender, income and relative deprivation. Models 6-8 additionally adjust for pupil characteristics, household characteristics, school type and rural location, respectively. Across all four specifications, interaction terms are statistically significant, and their signs are stable, while the coefficients for race, gender, income, and relative deprivation themselves are qualitatively unchanged from those in models 1-4.

Examining the coefficients of the interaction terms in models 5-8, we see that race and gender are asymmetric in how they interact with income and relative deprivation. Female#income has a positive coefficient while female#relative deprivation has a negative coefficient. These are the same signs as those of income and relative deprivation themselves. Bearing in mind that the coefficient for female is negative, both interaction terms show that the disadvantage faced by female students is attenuated by higher income as well as lower relative deprivation. That is, the male-female gap reduces with higher income and lower relative deprivation.

However, these effects are asymmetric in the case of race. Both interaction effects, viz. race and income as well as race and relative deprivation, are positive. In so doing, the interaction with relative deprivation (positive) is the opposite sign to that of relative deprivation itself (negative). Bearing in mind that the signs of the two race coefficients (Black and Mixed) are themselves negative, these interaction terms suggest that while the ENEM score-gap between White and Black (respectively, Mixed-race) pupils narrows with rising income, it instead *widens* with falling relative deprivation. Why might this be? We examine this question in greater depth in the next section and suggest a potential explanation based on our qualitative data in the form of interviews with teachers.

TABLE 3-2: REGRESSION RESULTS

Coefficient	Model specifications							
	1	2	3	4	5	6	7	8
Black	-0.123*** (0.001)	-0.112*** (0.001)	-0.095*** (0.001)	-0.095*** (0.001)	-0.162*** (0.002)	-0.149*** (0.002)	-0.125*** (0.002)	-0.126*** (0.002)
Mixed	-0.083*** (0.001)	-0.080*** (0.001)	-0.066*** (0.001)	-0.066*** (0.001)	-0.124*** (0.001)	-0.119*** (0.001)	-0.100*** (0.001)	-0.101*** (0.001)
Female	-0.057*** (0.001)	-0.074*** (0.001)	-0.062*** (0.001)	-0.062*** (0.001)	-0.064*** (0.001)	-0.077*** (0.001)	-0.066*** (0.001)	-0.066*** (0.001)
Income (million BRL)	0.255*** (0.005)	0.255*** (0.005)	0.194*** (0.004)	0.190*** (0.004)	0.201*** (0.005)	0.197*** (0.005)	0.152*** (0.004)	0.148*** (0.004)
RD School	-0.498*** (0.003)	-0.381*** (0.003)	-0.320*** (0.003)	-0.324*** (0.003)	-0.516*** (0.005)	-0.420*** (0.005)	-0.345*** (0.005)	-0.349*** (0.005)
Black # Relative deprivation					0.095*** (0.007)	0.113*** (0.007)	0.113*** (0.007)	0.114*** (0.007)
Mixed # Relative deprivation					0.065*** (0.005)	0.082*** (0.005)	0.083*** (0.005)	0.083*** (0.005)
Black # Income (million BRL)					0.108*** (0.005)	0.091*** (0.005)	0.057*** (0.005)	0.058*** (0.005)
Mixed # Income (million BRL)					0.137*** (0.003)	0.126*** (0.003)	0.103*** (0.003)	0.105*** (0.003)
Female # Relative deprivation					-0.021*** (0.005)	-0.032*** (0.005)	-0.039*** (0.004)	-0.038*** (0.004)
Female # Income (million BRL)					0.038*** (0.003)	0.040*** (0.003)	0.031*** (0.002)	0.031*** (0.002)
SD of RE parameters								
School random effects	0.582*** (0.003)	0.548*** (0.003)	0.507*** (0.003)	0.102*** (0.001)	0.579*** (0.003)	0.546*** (0.003)	0.506*** (0.003)	0.102*** (0.001)
School residual	0.733*** (0.001)	0.720*** (0.001)	0.719*** (0.001)	0.719*** (0.001)	0.733*** (0.001)	0.723*** (0.001)	0.719*** (0.001)	0.719*** (0.001)
Random effect for school type				0.194*** (0.004)				0.192*** (0.004)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pupil covariates	-	Yes	Yes	Yes	-	Yes	Yes	Yes
Household covariates	-	-	Yes	Yes	-	-	Yes	Yes
School type	-	-	-	Yes	-	-	-	Yes
Observations	7715598							

Notes: Robust standard errors clustered at school level in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All models are 2-level mixed models, with school random effects. The dependent variable for all models is the year-wise standardized average

ENEM score (across all five components). The data spans 2012-2018. Additional pupil covariates include age and disability status. Additional household covariates include education of father, education of mother (for both: primary/middle/higher/univ/postgrad), household size, rural or urban location.

As robustness checks, we estimate several versions of model 8 (which uses all covariates and includes interaction terms), results of which are provided in appendix A. The signs of race, gender, income and relative deprivation, and their respective interaction terms remain unchanged across all models and statistical significance maintains, which reassures us with regard to the stability of our results. While the estimates shown in the main text pool observations across 2012-2018, we examine whether our findings vary significantly by year by re-estimating for year-wise subsamples. These results show that coefficients vary quite little, and their signs and significance remain all but unchanged across the various years. Second, we estimate a 3-level hierarchical model with municipalities as the third level; the municipality-level random effect is statistically significant, evidencing variation in scores at this level, but with a standard deviation roughly half that of the school random effect, this variation is comparatively smaller. Third, instead of hierarchical models we use OLS with school fixed effects.

3.5. Qualitative insights and discussion

Teachers' views on the quantitative results produced valuable insights on the role played by economic status, gender, and race as well as on the interplay among these variables. The discussion on gender led to a wealth of interesting perspectives. Initially, we were surprised by our negative regression coefficient for females, since recent patterns of educational attainment across Latin America show an advantage for girls (Marteleto et al, 2012; World Bank, 2012; UNESCO, 2018). Teachers, however, were not surprised by our findings, and argued that girls' ENEM underperformance compared to boys is due to the stark asymmetry in gender norms and expectations in Brazilian society – which is strongly dominated by males. Terms such as 'machismo' and 'patriarchy' were repeatedly used by teachers to characterise a culture where females are often deemed inferior and have fewer opportunities to fulfil their potential.

The mechanisms through which this context leads to a disadvantage for female students in ENEM outcomes are complex and multi-layered. One of the mechanisms often indicated by our teachers as a source of disadvantage for girls is girls' far greater burden of obligations within the household, referred to by some teachers as the 'double shift'. In addition, machismo was argued to negatively affect girls' confidence in their academic abilities and future prospect – through objectifying women, undervaluing their intellectual abilities and failing to recognise that their roles in society go beyond motherhood and wifehood:

> *"When a girl gets back home, she can't sit and study. She has to cook, clean, do the washing and only when housework is done can she study."* (FGD 3, Teacher 4)
>
> *"Machismo always portrays females as incapable. As a consequence, often some girls interiorise this inability… there are even teachers telling girls that they are not cut for scientific disciplines"* (FGD 2, Teacher 3)

Pregnancy was also often mentioned by teachers as another reason behind girls' disadvantage. Managing the pregnancy and a newborn, often with little psychological and material support, leads to missed schooldays and detracts from the energy needed to study. Interestingly, teachers observed that the way teenage pregnancy enters the picture of a gender gap in educational achievement goes beyond the simple story of detrimental consequences of an undesired pregnancy. Teachers explained that in some cases even quite young girls deliberately choose to become pregnant. The difference in the roles society assigns to females and males generates an asymmetry in the motives for teenage pregnancy as well as in its consequences:

> *"In a context where females have lower social visibility… when some girls get pregnant, their social status rises. From being an ordinary girl, 'Now I am pregnant, now I am a mother.'"* (Teacher 1)
>
> *"It is not uncommon that girls get pregnant consciously. I heard various say 'As I am already raising my younger siblings, why can't I raise my own child?*' (Teacher 7)

> *"Girls have limited ambitions… But since boys know they will have to be the breadwinners, this is a stimulus, an incentive, to get higher scores: 'Teacher, I've had a child, now I have to study as I need to be able to land a better job'… They know they will have to fly higher."* (Teacher 1)

A final remark about gender concerns the different composition of the female and male sample. A teacher said that the average male score may be higher than the female one also as a result of the greater dropout of males – more likely to leave high school in order to work or join gangs. As a consequence, a selection would be in play whereby the male population represents fewer children from socioeconomically disadvantaged backgrounds.

> *"Dropout is greater for males… So they are more selected, those who remain are those who really want to study, who have an aim"* (Teacher 10)

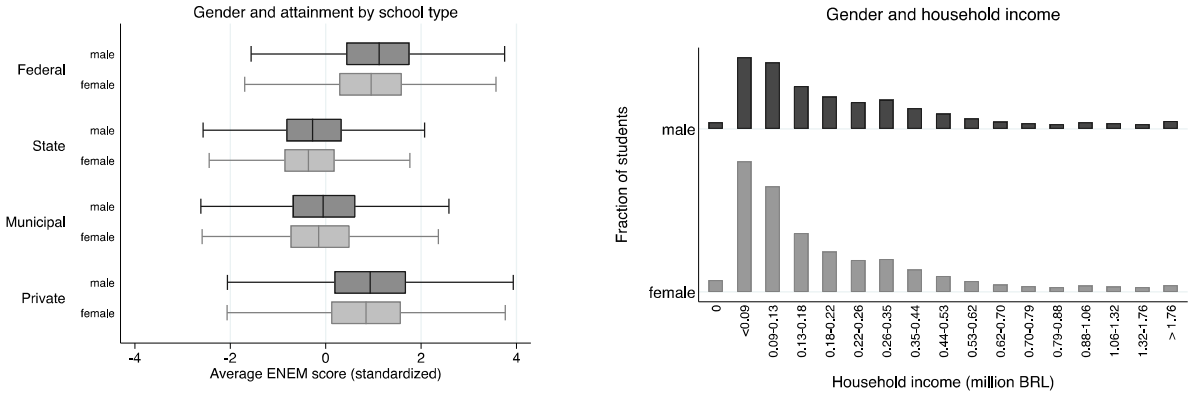
We examined this hypothesis further and found that indeed males taking ENEM come from significantly wealthier households, that higher scores for males can be seen across all four types of schools, and that the selection issue boosting males' average score is only part of the story. Figure 1(a) summarises the distribution of ENEM scores by gender and school type using box plots, and we can see that boys score higher than girls irrespective of the type of school they attend.[39] Females are also less likely to achieve the very top scores. Girls make up just under 50% of those who score in the 95th percentile or above on the ENEM, but this noticeably less than the percentage of girls in the data as a whole – at 58.14%.[40] Girls are also more likely to achieve bottom scores – 60% of those attaining the 15th percentile or less are female. These findings are similar to those obtained by for sixth graders in Latin America by Liu, Alvarado-Urbina and Hannum (2020), who express a strong concern for girls' vulnerability to being bottom achievers.

[39] The same pattern holds for average scores as well, with $p<0.001$ for t-tests by gender, both in subsamples by school type as well as for the overall sample.

[40] This figure varies little across years, ranging from 59.1% in 2012 to 57.3% in 2018.

Figure 3-1(b) presents the distribution of household income by gender and shows that girls are also more likely to belong to lower-income households; in particular to the two categories <0.09 and 0.09-0.13 million BRL per year. This confirms the notion that boys who end up taking the ENEM represent a more prosperous, selective sample – those who did not drop out of school – whereas girls belong to a wider variety of income backgrounds that more closely mirrors the distribution of income in the general population.

FIGURE 3-1: GENDER, ATTAINMENT AND HOUSEHOLD INCOME



***(a)* ATTAINMENT SCORES** **(B) HOUSEHOLD INCOME**

Another result teachers provided valuable insights upon is the higher performance of white students relative to other racial groups. Since we are including several control variables in our regressions, our evidence suggests that a racial pattern in favour of whites remains even once heterogeneities in socioeconomic background are (at least to a large extent) taken into account – a finding echoed also by Marteleto and Dondero (2016) and Valente (2017). An explanation for this provided by teachers revolved around the unfavourable effects of the phenotype-based explicit or implicit forms of discrimination faced by non-white populations, in particular blacks and those of mixed-race, within social institutions – family, schools, communities, markets, etc., see Telles (2014). Another explanation focused on the specific content of the ENEM exam, which would disproportionally advantage whites. The knowledge which is deemed relevant, and which students need to possess to do well, largely contains elements of and is influenced by white/European culture. As a consequence, it favours students from this cultural background who have been exposed to a more

international set of knowledge – not only at school but also at home, through family connections, extra-curricular experiences, etc.

> *"'Teacher, you are not black, you don't know what being black is, you don't feel in your skin what this means' – a student from a favela told me. You always need to be well dressed up to be respected, minimally a bit more respected."* (Teacher 11)
>
> *"The knowledge which is tested in ENEM is that of the white middle class…of a niche which is not only economic but also cultural. It is unfair…I happened to be from this niche and for me ENEM was easy – not because I am clever or I have a 'high' culture, just because I am white.* (Teacher 4)

Teachers maintained that while the pervasive character of machismo and racial discrimination in Brazilian society meant that most girls and mixed/black students were to some extent affected, the intensity of the above gender and race mechanisms are greater for students from poorer households. With regard to gender, the explanations for this pattern revolved around the higher prevalence of gender discrimination within households at lower levels of income and education. The teachers stressed that in these households not only are there stronger patriarchal attitudes and lower awareness of the importance and value of gender equality, but there are also more objective reasons leading to gender discrimination such as scarcity and pressure on limited resources – for example, girls from affluent backgrounds are not asked to do housework because, in the words of one of our interviewees, in these households 'nobody washes a glass'. This view aligns with our interaction results between gender and absolute income. We also run regressions for economic quintiles subsets and found that gender and racial differences, whilst remaining highly significant throughout, do decrease in magnitude for wealthier quintiles (results for these subsets are available upon request).

In a similar fashion, teachers argued that black students in affluent households would be to some extent shielded by the racial discrimination suffered by poorer ones – along the 'money whitens' phenomenon widely discussed in the literature, whereby a rich person tends not to be seen as 'black' despite possessing typical black phenotypes (Harris, 1964; Telles and Lim, 1998). In this case, not only would income enable richer black students to

overcome the economic barriers to education, but also, intersected with race, it would also lessen for them those obstacles stemming from a system of structural racial disadvantage. For gender and race, therefore, the interplay with absolute income tallies with the double jeopardy view of cumulative disadvantages, with two jeopardies such as economic scarcity and membership to the disadvantaged demographic groups (being female and being mixed/black) not only representing individual and independent sources of disadvantage but leading to additional detriment.

While our quantitative results show that while the gender/race interaction terms with income display the same sign, those with relative deprivation display opposite signs. The jeopardy of being relatively deprived adds detriment to the jeopardy of being female, yet in the case of race it is worse for the advantaged category (whites). As mentioned in Section 2 when presenting the intersectionality literature, a number of scholars (e.g. Purdie-Vaughns and Eibach 2008) argue that due to the contextualized nature of social identities and power structures, intersections between sources of disadvantage do not necessarily lead to additional detriment in every situation. In our analysis, we indeed observe that in the case of gender the intersection with relative deprivation leads to an instance of cumulative disadvantage, but this is not the case for race.

The negative sign of the female#relative deprivation interaction did not come as a surprise given the large evidence pointing to females being more inequality averse and sensitive to relative deprivation and interpersonal comparisons (Croson and Gneezy 2009; Corazzini, Esposito and Majorano, 2012). An interesting perspective emerging in a focus group discussion was how in Brazilian society female adolescents need to pay more attention to fashion and clothing patterns to be able to fit in compared to their male counterparts – so that for girls being poorer than their peers would be more visible and hurt them more. The positive sign of the race#relative deprivation interaction was more difficult to interpret for us, and the views of our teachers were particularly helpful in searching for possible explanations of why relative deprivation might indeed be worse for the advantaged category.

> *"Whites have internalised that they have more power than the others; when they see that they don't have the power they should have they feel worse… 'I am white, why am I disadvantaged?'"* (Teacher 2, FGD 1)

> *~[Blacks] "are more used to it [being low in the socioeconomic hierarchy]" (Teacher 2); "This is the reality, they are more used to deal with it" (Teacher 5); "Like 'I am not doing well, but as a black person, I was not expected to do well'" (Teacher 1); "Given the reality they live, blacks have more resilience to this" (Teacher 5); "This is the right word, resilience" (Teacher 3)~* (exchange among teachers, FGD 3)

According to the above quotes, the observed heterogeneity in the role of relative deprivation for whites and blacks/mixed could be explained by psychological mechanisms such as resilience/adaptation and the mismatch between expectations and objective reality. These explanations appear interesting given the psychosocial nature of the ways in which relative deprivation affects humans. Relative deprivation would be felt more strongly by whites given the discrepancy between the lower position occupied in the socioeconomic ladder and the higher standing generally enjoyed by whites in Brazilian society – which they also ought to enjoy. Ridgeway and Kricheli-Katz (2013) describes the situation of deprived whites such as that of "off diagonal" people: given that in a system of racial discrimination they have de facto had more opportunities, "poor whites may be held fully accountable for a personal "failure" to achieve" (p. 311). Mixed and blacks would instead be more resilient to the lower socioeconomic standing jeopardy, due to adaptation mechanisms and lower self and social expectations of being better off than others.

Interestingly, using adolescent data from the United States, Kuo et al. (2020) find that socioeconomic status and race interact in explaining social and emotional skills: at low socioeconomic status these were found to be higher for blacks than for whites, and a possible interpretation provided was that being poor may be less damaging for blacks due to cultural reasons or to the fact that deprivation is a more common predicament among this group. More generally, the role played by adaptation mechanisms in lessening the psychological burden of human predicaments has been widely discussed in the economics and international development literature and is one of the critiques made by Amartya Sen

to money-based welfare economic theory (e.g. Sen 1982). The psychological literature has also investigated ways in which deprived individuals may successfully adopt resilience and adaptation strategies (Chen and Miller, 2012; Gallo et al., 2009). In particular, it seems worth mentioning the growing interest in a so-called 'black-white mental health paradox' consisting in better mental health enjoyed by blacks in spite of lower standards of living, typically explained in terms of resilience to stressors (Keyes 2009; Louie et al 2022; Mushonga and Henneberger 2023).

Finally, the teachers felt that our quantitative results with regard the other explanatory variables were familiar as well – in particular the positive role of parental education and the negative roles of disability and household size. With regard to school type, they commented on how federal and private schools are typically better funded and provide higher-quality education compared to state and municipal schools. Federal schools also have very strict academic entry requirements, which raise average student ability, and top private schools provide intense ENEM-specific training in the form of tailored lessons and regular mock exams. Teachers explained that the negative coefficient for age likely stems from the lower performance amongst students who repeated grades or entered school late (due to child labour, lack of school places in Rio de Janeiro and/or low abilities) and from families particularly keen on education often sending their children to school before the statutory age.

3.6. Conclusion

In this paper we advanced the literature on intersectionality in education by studying how the two demographic characteristics most widely used in intersectionality studies, gender and race, interact with a multifaceted notion of economic status – comprising its absolute as well as its relative components. The explicit conceptual and empirical acknowledgement of the two facets of economic status is, to the best of our knowledge, novel in intersectionality studies and has enabled us to provided novel insights on educational inequalities in Brazil. The interplay between sources of disadvantage has been investigated via implementing a mixed methods design where quantitative and qualitative evidence are used sequentially –

where qualitative teacher interviews were employed to shed light on econometric evidence obtained analysing large-scale data from the ENEM high stake exams.

Our results indicate that demographic characteristics such as being female and black/mixed are sources of educational disadvantage – as are lack of economic resources and low standing in the economic hierarchy. The interaction between absolute economic status (income) and our demographic variables of interest is associated to worse educational outcomes, supporting a cumulative/multiplicative view of multiple jeopardies – the lower a student's income, the greater the loss in ENEM scores for the already disadvantaged categories of females and blacks/mixed. This is the case also when relative economic status (relative deprivation) is interacted with gender, while in the case of race the interaction acts in the opposite manner – i.e. relative deprivation being more detrimental to the advantaged category. This picture fits a framework of intersectionality where the outcome of the interplay between sources of disadvantage is not predetermined but depends on a range of context-specific factors.

Future research would benefit from the application of the intersectionality framework to the study of how the interplay between economic status and other variables may matter for social outcomes in Brazil – including outcomes other than education, such as health, migration, violence, etc. The range of sources of disadvantage should also be expanded, to include age, sexual minority, migration status, etc. In addition, while theory and our qualitative evidence suggest that the identified quantitative patterns may be causal, our quantitative models alone are only able to demonstrate significant associations. Further research should aim to identify causality also within quantitative models, for example using panel data. Lastly, the use of qualitative data to understand and expand upon robust quantitative evidence proved extremely valuable, and this approach should find greater use in future research.

Overall, our findings have clear implications for policymakers. Brazil did implement a series of progressive policies in the first two decades of the twenty-first century, ranging from

means-tested benefits to affirmative action measures. However, a pervasive inequality of outcomes and of opportunities in the country remains, which, in particular for the youth, was heightened by the economic recession occurred during the mid-2010s (Mont'Alvao and Costa Ribeiro 2020). Our evidence shows that success in the exam determining admission to university, and hence to a large extent membership of the future Brazilian political, economic, and cultural elite, largely depends on characteristics assigned at birth. Through intricate dynamics of economic disadvantage, top-down legitimisation of knowledge, and discrimination across gender and racial axes, education can lead to the reproduction of socioeconomic inequalities, fostering the intergenerational accumulation of privilege and hindering social mobility:

> *"These students have better results because those who rule knowledge are from the same group as them… it's a cycle, you see?"* (Teacher 4)

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Appendix 3.A

The table below presents additional results as described in the main text. The first seven columns estimate the same specification as model 8 in table 2 in the main text within year-

wise subsamples (this specification includes interaction terms between race, gender and income, relative deprivation) and therefore omit year fixed effects. Column 8 presents results from a 3-level hierarchical model with municipalities as the third level, while column 9 uses OLS with school fixed effects.

TABLE 3.A-1: MODELS

	Year-wise subsamples								
Coefficient	2012	2013	2014	2015	2016	2017	2018	3-level	OLS FE
Black	-0.140***	-0.128***	-0.134***	-0.133***	-0.125***	-0.140***	-0.152***	-0.126***	-0.123***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)
Mixed	-0.114***	-0.109***	-0.113***	-0.105***	-0.111***	-0.118***	-0.125***	-0.101***	-0.097***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)
Female	-0.110***	-0.055***	-0.053***	-0.045***	-0.071***	-0.058***	-0.076***	-0.066***	-0.066***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
Income (million BRL)	0.162***	0.173***	0.215***	0.178***	0.171***	0.147***	0.127***	0.148***	0.142***
	(0.005)	(0.005)	(0.016)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.001)
Relative deprivation	-0.211***	-0.234***	-0.287***	-0.403***	-0.424***	-0.415***	-0.339***	-0.349***	-0.354***
	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)	(0.012)	(0.013)	(0.005)	(0.004)
Black # Relative deprivation	0.106***	0.063***	0.100***	0.122***	0.144***	0.146***	0.154***	0.114***	0.112***
	(0.020)	(0.018)	(0.021)	(0.016)	(0.015)	(0.017)	(0.019)	(0.007)	(0.007)
Mixed # Relative deprivation	0.047***	0.058***	0.075***	0.100***	0.105***	0.111***	0.094***	0.083***	0.082***
	(0.013)	(0.012)	(0.013)	(0.011)	(0.011)	(0.012)	(0.013)	(0.005)	(0.005)
Black # Income (million BRL)	0.075***	0.055***	0.063***	0.055***	0.046***	0.080***	0.090***	0.058***	0.056***
	(0.013)	(0.013)	(0.012)	(0.011)	(0.012)	(0.012)	(0.013)	(0.005)	(0.004)
Mixed # Income (million BRL)	0.108***	0.114***	0.112***	0.097***	0.121***	0.121***	0.114***	0.105***	0.101***
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.003)	(0.002)
Female # Relative deprivation	-0.060***	-0.080***	-0.041***	-0.008	-0.008	-0.052***	-0.051***	-0.038***	-0.037***
	(0.012)	(0.012)	(0.011)	(0.011)	(0.010)	(0.011)	(0.012)	(0.004)	(0.004)
Female # Income (million BRL)	0.044***	0.047***	0.008	0.011*	0.023***	0.048***	0.064***	0.031***	0.030***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)
Constant	2.407***	2.331***	2.356***	2.436***	2.360***	2.429***	2.440***	2.271***	1.495***
	(0.038)	(0.036)	(0.046)	(0.033)	(0.031)	(0.029)	(0.028)	(0.026)	(0.033)

SD of RE parameters									
School random effects	0.098***	0.104***	0.104***	0.111***	0.111***	0.106***	0.106***	0.102***	
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
School residual	0.213***	0.196***	0.197***	0.185***	0.186***	0.202***	0.210***	0.186***	
	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	
Random effect for school type	0.717***	0.714***	0.719***	0.709***	0.712***	0.715***	0.707***	0.719***	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
Municipality random effects								0.048***	
								(0.011)	
Adjusted R^2									0.493
Year fixed effects	-	-	-	-	-	-	-	Yes	Yes
Pupil covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1016815	1112559	1155147	1166131	1233304	1096422	935220	7715598	7715598

Chapter 4 : Racial Disadvantage in Brazilian Education: 2011-2018 ENEM exams

Abstract

This paper investigates racial achievement gaps in the performance of large-scale university entrance exams in Brazil, with a specific focus on testing the existence of the so-called "mulatto-escape-hatch" (MEH) phenomenon. The term was coined in the 1970s to compare racial relations in Brazil and the United States and refers to the idea that *mulattos* (mixed-race or "*pardos*") occupy an intermediate position in the racial hierarchy. Their lighter skin tone would grant them certain social advantages compared to blacks, who are positioned at the bottom – while whites are at the top. The ambiguity of racial identities in Brazil, based on a skin-colour continuum, physical phenotypes, and social standing, led many scholars to question a three-category (blacks, *pardos* and white) classification in favour of a simpler binary white vs non-white taxonomy, that combines blacks and *pardos* together. Using data from ENEM exams, our results support the MEH hypothesis, revealing statistically significant differences in outcomes between blacks and mixed-race students, even after controlling for a range of variables. Moreover, these disparities increase at higher levels of socioeconomic standing and in regions with lower non-white population, and do not seem to decline over time. Although the black-*pardo* achievement gaps are much smaller than the black-white gaps, our results suggest that adopting of a ternary system may offer a more nuanced understanding of racial inequalities.

4.1 Introduction

Brazil has the largest Afro-descendant population outside Africa, accounting for 55.9%[41] of the national population (IBGE 2022). It is estimated that almost 5 million African slaves landed in the country over three centuries of slave trade, seven times the number of enslaved Africans as North America, (Telles 2004; Bucciferro 2013; 2017). By the 1850s, slaves accounted for half of the population (Hasenbalg and Huntington 1982). Despite the country's unique racial composition, pervasive and persistent racial inequalities with low social mobility of non-white population have been widely documented (Hasenbalg and Silva 1990; Hasenbalg and Silva 1988; Pastore and Valle Silva 2000; Osorio 2004; 2008; Ribeiro 2006; Nogueira 1998; Cardoso and Ianni 1960). For long, racial disparities remained masked or neglected by the academic community; not that they were invisible, but those differences were blamed on class stratification, because of their interplay with socioeconomic factors,

[41] According to the 2022 National Household Survey (PNADC), includes individuals self-declared as *pretos* (black) or *pardos* (brown or mixed colour).

thus overlooking the crucial role of race in shaping them (Osorio 2008; Valente 2017; Telles 2004).

The absence of a legal framework that explicitly discriminated against black people, in the fashion that other racially diverse countries like the United States and South Africa, fuelled the belief that Brazil was a "*racial democracy*", a term popularised by Gilberto Freyre (1933), and characterised by a "paradisiac innocence, with respect to differences of race" (Park 1942, p. xix). For over half a century, when claims of racial superiority, racial segregation and apartheid regimes seemed to be the norm across continents, the myth that races in Brazil coexisted harmonically was well spread worldwide (Telles 2004). Freyre's idea of racial democracy is that the "harmonious" miscegenation of Indigenous, African and "race-tolerant" Portuguese formed a unique multicultural breed, a human "*hybrid vigour*" fit for the tropics, that became distinctive of the Brazilian identity and nationalism (Hasenbalg and Huntington 1982). Freyre's work was the first to address race, and while it formed a body of writing standing against the scientific racism spread in the 19th century (Skidmore 2002), it fostered a romanticised view that Brazil had no racial issue. Race dynamics were however far from innocent, with skin colour patterning a range of socioeconomic inequalities in Brazilian society (Twine 1998; Telles 2004) and challenging the long-standing perception of Brazil as a symbol of social justice with respect to race (Hasenbalg 1979; Bastide and Fernandes 1959; Fernandes 1964).

Apart from the nonexistence of legal segregation, the myth of racial democracy in Brazil is heavily tied to the country's diverse range of race categories. In stark contrast with the US, where legal and social structures rigidly defined two clear-cut racial lines through the *one-drop-rule*: *black* and *white*, the Brazilian system considers skin colour on a rich continuum of tones spanning from white on one end and black on the other end, including physical and cultural traits, giving rise to a complex array of classifications that may vary over time and across several dimensions, such as level of education, socioeconomic status, social interactions and region of residence (Telles and Paschel 2014; Telles 2004).

The official Brazilian census classification comprises three major race/colour categories: *branco* (white), *preto* (black) and *pardo* (mixed-race/brown or mulatto), along with *amarelo* (Asian) and *indígena* (indigenous). The *pardo* category is the product of extensive miscegenation (*mestiçagem*), a practise forbidden in the US but socially accepted, and even encouraged, amongst white colonisers in Brazil. This practice arose from the gender imbalance among white men, a scarcity of European women and the abundance of slaves (Degler 1971; Hasenbalg and Huntington 1982; Skidmore 1993; Telles 2004) – leading to unions which often were far from consensual (Do Nascimento 1978; Skidmore 1993;Telles 2004). It is important to highlight that the *pardo* classification involves any mixture of races, including white and indigenous. High miscegenation led to a sizable population of mixed-race individuals, many of them slaves (Hasenbalg and Huntington 1982). Miscegenation has been argued to have been crucial in supporting the ideology of racial democracy, in this way obstructing efforts to address racial inequalities (Daniel 2006).

According to Carl Degler (1971)'s influential work, *mulattos* were the key to understand the comparative differences between US and Brazil. He used the expression "*mulatto escape hatch*" to describe the privileges held by mixed-race in Brazilian society compared to blacks, whilst they remained disadvantaged compared to whites. The historical advantage of mixed-race people led to the belief that they were to some extent "immune" to race, as they could "escape" the stigmatization of "blackness" and access opportunities to ascend socially (Degler 1971). Since the colonial era, after whites, *mulattos* were favoured over blacks as the preferred labour force for intermediate positions (Hasenbalg and Huntington 1982; Skidmore 1993; Daniel 2006); they also were the majority among freed slaves (Do Nascimento 1978; Skidmore 1993). The fluidity of racial classification allowed non-white groups, including blacks in some cases, to be categorized as whites, depending on their social hierarchy, although it was much easier for mixed-race individuals, who would often be offended if compared to blacks (Bastide and Fernandes 1959; Telles 2004). These prospects could be achieved through marriage or concubinage with white or light-skinned partners or via integration into the new economic opportunities from an emerging capitalist society, a process known as "whitening" (Bastide and Fernandes 1959; Hasenbalg and Huntington 1982; Telles 2004).

Whitening was part of a white supremacist ideology that viewed blacks as inferior, lazy and degenerate (Hasenbalg and Huntington 1982), and considered the growing population of mulattos a "threat" to Brazil's future development (Telles 2004). This belief was internalised by non-white people who aspired to assimilate into white culture (Cardoso and Ianni 1960; Nogueira 1998; Schwartzman 2007; Telles and Bailey 2013;). The entire process unfolded under the control of white domination, where those eligible to enter the white universe were often light-skinned mulattos or individuals with high social standing (Hasenbalg and Huntington 1982), giving rise to the idea that "money whitens" (Cardoso and Ianni 1960; Telles 2004; Lovell 2006). Whitening was intensified after 1888, when slavery was abolished, and Brazil imported a large contingent of European immigrants to substitute enslaved labour force that occupied many of the established positions of *mulattos* (Skidmore 1993; Hasenbalg and Huntington 1982; Telles 2004). In the emerging competitive society, blacks were rapidly discharged, as deemed unwilling or unable to integrate (Fernandes 2004; Bastide and Fernandes 1959). By contrast, mixed-race workers would still trade their African ancestry for social status and avoid the segregation suffered by their darker skinned counterparts (Skidmore 1993; Hasenbalg and Huntington 1982; Telles 2004; Winant 1992). Non-white women faced worse discrimination given the low rate of marriage between white men and mulatto/black women, a trend that persisted over the decades, albeit casual relationships are common (Telles 2004). As opposed to the US, where a unified "black" identity emerged to fight against racism and discrimination, Brazilian elite faced no opposition, as mixed-race individuals were put against blacks (Winant 1992; Telles 2004) and their culture coopted by whites (Hasenbalg and Huntington 1982; Nogueira 1998).

In the late 80s and the 90s, the idea of a '*mulatto escape hatch'* was heavily criticised, when black consciousness movements became salient and whitening behaviour seemed to be declining. Black movements and activists argue that the focus on the flexibility and ambiguity of racial classification disguises the truth about racial inequalities; they also advocate for collapsing blacks and *pardos* together into a *negro* category, as a strategy to deconstruct racial stigmas, build a *black* identity, and develop collective actions against racism (Do Nascimento 1978; Winant 1992). Scholars have shown that the most significant racial divide is between whites and the non-whites, not between blacks and *pardos*,

maintaining that these two groups face the same discriminations and exclusions (Silva 1980; Hasenbalg and Silva 1988; Hasenbalg and Silva 1990; Ribeiro 2006; Osorio 2008; Marteleto 2012). Using census data and quantitative analyses, sociologists Carlos Hasenbalg and Nelson do Valle Silva found that the two non-white groups were equally exposed to the so-called "*cycle of cumulative disadvantage*" since slavery, following similar patterns with respect to income, social mobility, and educational attainment (Hasenbalg 1979; Hasenbalg and Silva 1988; 1990; Silva 1985; 2000). These authors agree that although some individuals had managed to "*escape*" blackness, this was not the case systematically for the mixed-race group as a whole. For this reason, they maintain the binary classification, but instead of calling them *negros*, they used the term *non-white* which relates to the same "*negro*" category proposed by black movements, resembling the US system (Bailey and Telles 2006; Marteleto 2012; Bailey, Loveman, and Muniz 2013). Many academics in Brazil have used this binary system to analyse racial inequalities, particularly in light of the inconsistencies and complexities of race boundaries (de Carvalho, Wood, and Andrade 2004). This system was also the basis for race-targeted public policies (Bailey 2008).

There is a long debate on whether the binary approach is the best alternative to represent racial inequalities in Brazil (Skidmore 2003; Bailey and Telles 2006; Marteleto 2012; Loveman, Muniz, and Bailey 2012; Bailey, Loveman, and Muniz 2013; Francis and Tannuri-Pianto 2013; Monk 2016). Indeed, some studies have shown that there are important differences between blacks and *pardos,* such a*s* distinct historical backgrounds (Telles and Lim 1998; Arias, Yamada, and Tejerina 2004; Arcand and D'Hombres 2004; Daniel 2006) and that mixed-race people do not identify themselves with the *negro* category (Francis and Tannuri-Pianto 2013; Bailey and Telles 2006; Bailey 2008; Harris et al. 1993). Others have also argued that the official three categories do not consistently reflect popular identities (Telles 2004; Bailey and Telles 2006; Bailey 2008; Francis and Tannuri-Pianto 2012; Francis-Tan and Tannuri-Pianto 2015), and that skin colour continuum is a better predictor of inequalities than clear-cut categories, particularly when classification is conducted by interviewers instead of self-classification (Telles and Lim 1998; Telles 2004; Bailey and Telles 2006; Monk 2016; Ribeiro 2018). As a result of the existence of multiple approaches,

estimates of inequality levels may vary depending on the racial metrics used (Bailey, Loveman, and Muniz 2013).

In Brazil the meaning of race is not an immutable and fixed construct; rather, it is a multidimension social construct, which may change over time and context, particularly with socioeconomic status (Schwartzman 2007; Senkevics 2022). Recent research has found that *pardos* have become more conscious of their blackness and are more likely to self-identify as *negros* in recent years (Micheli 2021), particularly more educated individuals, showing a "darkening" trend – a reverse of the historical "whitening" trend (Bailey and Telles 2006; Francis and Tannuri-Pianto 2013; Bailey, Fialho, and Loveman 2018; Micheli 2021; Senkevics 2022). This indicates that educated blacks may have developed increased awareness of their African ancestry, largely considered a result of the political efforts of black movements. This factor has also led to the rise in *pardo* self-identification in most recent censuses (Francis and Tannuri-Pianto 2013; Micheli 2021). As a result, blacks now seem to connect more to their racial identities, leading to more consistent classifications compared to the past (Guimaraes 1999; Bailey 2008; Francis-Tan and Tannuri-Pianto 2013; 2015). Another influential factor contributing to the phenomenon of "darkening" was the implementation of racial quotas for higher education targeting non-whites (Francis and Tannuri-Pianto 2013). Since affirmative action (AA) programmes adopt a binary black-white colour line, where black and mixed-race are both eligible, they act as incentives to revert the historical whitening process. Additionally, it is worth mentioning that AA programmes have also incentivized more students from disadvantaged backgrounds to take ENEM and pursue higher education (Mello 2022). Bailey, Loveman, and Muniz (2013) suggest that using a ternary lens is important to identify possible nuances of racial dynamics.

In this paper, we examine racial disparities in the performance of high-school student in high-stakes exams in Brazil, with a specific focus on testing the "mulatto escape hatch" hypothesis among non-white students, that is, whether there is a significant difference in outcomes between *blacks* and *pardos*, including whether there is a trend over time. Using nationwide data from ENEM (Exame Nacional do Ensino Médio – National High School Exam) exams,

covering the period from 2011 to 2018 (N>9 million), we employ fixed effect regressions models to estimate the coefficients of each race group with respect to blacks (used as baseline). Race information in ENEM is self-declared and uses the same categories as the census. To ensure a more consistent race classification, we focus on graduating students who finished high school in the same year as the ENEM wave and took the test for the first time. Despite potential risks of inconsistencies, we believe there is no incentive for *pardo* or black students to self-classify as white due to improvements in black consciousness and to the requirements of affirmative action policies for higher education. Additionally, the increase in the number of blacks and *pardos* participating in ENEM reflects that more non-whites are completing high school and taking their chances in the test. This could be due to the expansion of education and changes in educational policies, which led to a decrease in repetition and dropout rates (Senkevics 2022). However, white students may also self-identify as mixed-race to benefit from these policies, and although such cases have happened, we assume they are not particularly relevant.

Beyond its size and coverage, this data is of particular significance because of ENEM's critical role as the main criterion for admission into an elite university in Brazil, mostly public federal institutions. The exam is highly competitive and the second largest university entrance exams in the world (Schwartzman and Knobel 2016; Arias, Yamada, and Tejerina 2004). Evidence on the returns to higher education is vast (Patrinos 2016; Chetty et al. 2017; Card and Krueger 1992) particularly in Brazil (Menezes Filho and Kirschbaum 2018; Curi and Menezes-Filho 2013; Arias, Yamada, and Tejerina 2004). The new ENEM (i.e. since its 2009 reform) aims to increase democratic access to higher education by allowing students to apply to any university in the country, by reducing application costs (Schwartzman and Knobel 2016; Mello 2022).

This study closely relates to Marteleto (2012), who used data from national household surveys (PNAD) from 1982 to 2007 to explore whether the education attainment of non-whites complied with a binary or a ternary pattern. She found no significant differences between black and *pardos* in 2007, although they existed in 1982. Regarding racial gaps

between whites and non-whites, she found gaps were declining albeit still persistent. Another important finding was the phenomenon of "darkening with education" by which college educated parents label their children as black for the new cohorts, which represents a significant change to whitening process. In contrast to her work, we do not focus on the white-non-white gap, which has been widely studied. Our emphasis lies in differences within the non-white category, although we also present results of how relative advantages of white students differ between blacks to *pardos.* Another important difference is that our dependent variable are test scores, a more realistic measure associated with wellbeing and professional outcomes compared to education attainment (Hanushek 2013; Pritchett 2006).

Additionally, this study contributes to research on high-stakes university entrance exams, which carry large implications in determining young's people life success, such as access to higher education and better labour market prospects (Schwartzman 2013; Lavy, Ebenstein, and Roth 2014; Valente 2017), and contribute to exacerbate inequalities in Brazil. It also adds to the literature on the effects of colourism[42] in school contexts. Understanding the patterns of educational disparities across colour subgroups can be of interest of policymakers, particularly in a context of where race-targeted policies have been applied.

First, our data shows that ENEM outcomes are markedly lower for both black and mixed-race groups compared to white students. Although a substantial portion of racial disparities can be attributed to socioeconomic status, racial inequalities still persist after controlling for socioeconomic variables, demographics, and contextual variables. With regards to our specific research question, we find support for the so-called 'mulatto escape hatch' hypothesis (REF), as there are statistically significant differences between black and mixed-race students. These differences are overall small in magnitude, becoming more evident in higher socioeconomic strata as well as in Southeastern and Southern regions, where mixed-race students seem to have larger advantage over blacks.

[42] Discrimination or inequalities based on skin colour, where darker-skinned individuals tend to suffer more discrimination than lighter-skinned counterparts.

The paper develops as follows. Section 2 discusses race and education in the Brazilian context. Sections 3 and 4 present, respectively the data source and empirical methodology, respectively. Section 5 presents the results, followed by the conclusion.

4.2 Racial inequality and education in Brazil

Despite recent improvements, Brazil is still one of the most unequal countries in the world, struggling with inequality in various dimensions. Among these, racial inequalities have been blatant and persistent for a wide array of social indicators, including health (de Oliveira and Luiz 2019; Baqui et al. 2020; Bruce et al. 2020; Chor 2013; Nyarko et al. 2013); income and employment opportunities (Arcand and D'Hombres 2004; Lovell 2006; Osorio 2008; Reis 2017; Firpo, França, and Portella 2021); violence and criminality (Schwartzman 2020; Décary-Secours 2021; Santos et al. 2023); education (Becker and Arends-Kuenning 2020; Marteleto, Marschner, and Carvalhaes 2016b; Marteleto and Dondero 2016; Valente 2017; Menezes Filho and Kirschbaum 2019; Carvalhaes, Senkevics, and Ribeiro 2022;); political participation (Firpo et al. 2022a; 2022b), among others.

The main causes of long-term inequalities in Brazil and many countries in Latin America have been accounted to the extensive use of slave labour and past colonial experiences (Engerman and Sokoloff 2005; Nunn 2008; Soares, Assunção, and Goulart 2012; Bertocchi and Dimico 2014; Eslava and Caicedo 2023). The underlying mechanisms at play can be traced to a high concentration of land, which led to the disproportionate accumulation of wealth of European elites, whose unequal political power shaped institutions to keep the established order, while hindering the provision and access to public goods and services to masses of disadvantaged groups, particularly affecting the accumulation of human capital by these groups (Camps and Engerman 2016). Bertocchi and Dimico (2014) studied the effects of slavery in US counties showing how the use of slave labour correlates positively with inequality, where counties with higher enslaved population tended to have lower per-capita investments in education, and descendants from slaveholders' elites influenced their provision (or lack of). The authors conclude that racial inequalities in education is a key determinant of income inequality in many parts of the world. Additionally, persistent

discriminatory practices, such as bias, prejudice and stereotyping, against racial groups tend to amplify these effects and are endogenous to the way institutions, identities, and the entire social tissue develops across time (Bonilla-Silva 1994; Feagin 1991; Reskin 2012).

Prior to the abolishment of slavery, non-white labour, including labour for freed slaves, was replaced by state-sponsored and more educated European immigrants (Rocha, Ferraz, and Soares 2017). As a result, blacks and *pardos* were marginalised in the labour market, deemed unfit or unreliable, and were also being denied land possession, education and other services restricted to the elites and the incoming immigrants (o Theodoro 2008; Komatsu, Menezes Filho, and Oliveira 2017). In response to this, without alternatives of livelihood, non-white population, migrated to the poor northern or northeastern regions, and into major urban centres, living in "*favelas*" and under challenging conditions, where work and education opportunities were limited (Theodoro 2008; Hasenbalg 1979). By contrast, state-sponsored Europeans settled in more economically dynamic regions, mainly in the South or Southeast, where they were granted land and investments in education were more generous. This was a crucial factor that helped them to seamlessly integrate into the emerging industrial society (Rocha, Ferraz, and Soares 2017). This process engendered the high inequalities in the early 20thcentury in Brazil that persists until present.

The role of unequal access to education shaping income inequalities in Brazil has been widely documented (Barros and Lam 1993; Psacharopoulos and Patrinos 2018; Menezes Filho and Kirschbaum 2019). In Brazil, race, socioeconomic background and region of residence, are strong predictors of children's educational achievement and future earnings (Fishlow 1972; Langoni 1973; Barros and Mendonça 2000; Barros et al. 2001; Menezes-Filho 2001; 2007; Soares 2006; Anazawa et al. 2016). Research has shown that achievement gaps are shaped very early in life and widen as children grow older (Fryer and Levitt 2004; Heckman and Carneiro 2003; Card and Rothstein 2007; Cunha and Heckman 2007; Magnuson and Duncan 2016; Gibbs and Downey 2020 ;). Children belonging to minority groups, low-income families and less educated parents tend to fall behind their counterparts, becoming less qualified to access higher education and better employment

opportunities (Mayer 2002; Duncan and Murnane 2011; Bourguignon 2015; Magnuson and Duncan 2016; Chetty, Hendren, et al. 2020).

In Brazil, students from low-income background predominantly attend public schools that provide lower quality education than their private counterparts at all levels of basic education, from pre-school to high-school level. Given that non-white children are overrepresented in these low-income strata, their academic performance tend to lag behind white students. However, in higher education, public universities, particularly those under federal administration, detain the best educational resources and are highly rated by the labour market. Additionally, they are tuition free, so competition is fierce. Historically, admission to these institutions relies on achieving competitive scores on entrance tests, ENEM or ”vestibular”, which act as a barrier for disadvantaged students to achieve higher education level and social mobility, since white students from high-income households tend have better grades, as they have more parental attention and can afford attending private schools, more health care, more access to information, more time dedicated for test preparation, and are less exposed to violence (Marteleto, Marschner, and Carvalhaes 2016; Carvalhaes, Senkevics, and Ribeiro 2022; Cavalcanti, Guimaraes, and Sampaio 2010).

Following the democratization of Brazil in the late 1980s, the Brazilian educational system went through a rapid expansion. The new Constitution mandated free public basic education for all children from ages 4 to 17, but little attention was paid to the quality of services delivered. To improve opportunities for non-white and low-income students, the Brazilian government, including sub-national governments, implemented various educational reforms and policies targeted at public school students, such as affirmative action policies, educational loans and social scholarships, which have contributed to reduce gaps in educational attainment of disadvantaged students (Marteleto, Marschner, and Carvalhaes 2016; Bruns 2012) but achievement gaps in basic education still persist. It is worth mentioning that the national Law of Quotas improved diversity in campus (Childs and Stromquist 2015; Vieira and Kuenning 2019; Senkevics 2021; Mello 2022;) with the potential to improve mobility.

Despite recent progress, educational inequalities persist. The annual report elaborated by Todos pela Educacao (2022), using data from national household survey (PNADCA/IBGE) and the Ministry of Education, reveals significant differences in educational attainment among black, *pardo* and white students. The figures indicate that black students generally have lower outcomes compared to white counterparts. For instance, in 2021, the completion rates for middle school among 16-year-old black students was 77.5%, while for *pardos* was 79.6% and 87.5% for white students. The situation is more striking for students aged 15 to 17 enrolled in high school education level, with only 70.8% of blacks, 71.8 % of *pardos* and 81.4% of white students. Regarding 19-year-old students who graduated from high school, blacks account for 61.4%, *pardos* for 63.9% and whites for 79.1%. This also reflects the high repetition rate, where many youngsters are still studying in lower levels of education, either primary or middle school. However, circa of 482k (5.6%) students were not studying nor working. Additionally, the proficiency levels in math and language also demonstrate substantial gaps, with white students having higher proficiency levels compared to black and pardo students. In the last year of high school, only 4.6% and 28.2% of black students have adequate proficiency levels in math and language, respectively. Pardo students account for 6.9% in math and 31.6% in language, while white students 18.1% in math and 50.8% in language.

Racial differences persist into the labour market. Reis (2017) found that the earnings gap between non-white and white workers is still large, even if they have the same academic qualifications. He emphasizes that non-white tend to select low-prestigious fields of study that beget lower returns. The choice of academic field however, partially explained (33%) the earnings gap in 2010, while the unexplained part was over 50%. This also suggests that some kind of discrimination could be operating in the labour market. Nunes et al. (2023) studied the evolution of racial inequalities for all sort of income, including rents, cash transfers, among others, that after accounting for several characteristics, non-white workers earn 14.5% less than white counterparts.

Structural discrimination may permeate other dimensions of social life, impacting families and schools. Rangel (2015) investigated how parents from mixed-race families with different skin-colour children decided to invest in the education of their children. He found that parents differentiate children by skin colour, where light-skinned children tended to receive more formal education compared to dark-skinned counterparts. Marteleto and Dondero (2016) conducted a similar study focusing on adolescent twins categorised indifferent race groups to examine racial inequalities. Despite accounting for family fixed effects, her findings indicates that non-white adolescents, particularly boys, had lower levels of educational attainment than their white siblings. These studies highlight that parents' decisions may also contribute to aggravate racial disparities, emphasizing the need for strategies to address such biases.

Racial inequalities tend to be more pervasive than income inequality, as they are commonly followed by race prejudice and racism. Embedded in society, racism triggers social mechanisms that produce and reproduce racial inequalities (Reskin 2012; Bonilla-Silva 2015) creating identities of lower self-perception, feelings of unworthiness and low self-esteem that reduce students' self-expectations about future opportunities, and lead to poor engagement with schooling (Loury 2002; Harris-Britt et al. 2007; Caldwell Jr. 2008; Lavecchia, Liu, and Oreopoulos 2016; Bertrand and Duflo 2017; Merolla and Jackson 2019). Research has shown that social identities rooted on racial stigmatisation and stereotypes can highly undermine black children's development (Akerlof and Kranton 2002; Loury 2002; Benjamin, Choi, and Strickland 2010; Bertrand and Duflo 2017). School systems may become part of this process by delivering low-quality education to black students or either allowing or reinforcing discriminatory behaviour (Haslanger 2014; Merolla and Jackson 2019). In this sense, racial discrimination can contribute significantly to inequalities in education (Hanna and Linden 2009; Fryer 2011a; Curran and Kellogg 2016; Gibbs and Downey 2020; Morris et al. 2020).

The black-white achievement gap is a widely investigated phenomenon (Fryer and Levitt 2004; Card and Rothstein 2007; Fryer 2011a; 2011b; Chetty, Hendren, et al. 2020) and a

matter of concern if they put barriers that prevent minority children from accessing quality education that would allow them social mobility (Cavalcanti, Guimaraes, and Sampaio 2010; Chetty et al. 2017; Chetty et al 2020; Salata 2020). However, much less is studied about skin-colour bias (i.e. colourism) which has emerged as a growing phenomenon in the United States and may affect students' performance (Thompson and McDonald 2016). Colourism relates to the idea of the "mulatto escape hatch", generally it stands within racial groups and affects many life dimensions (Saperstein and Gullickson 2013; Hunter 2016). This does not mean that light-skinned individuals are not subject to racism and discrimination, but they are more tolerated than darker-skinned counterparts (Hunter 2016). Hunter (2016) uses theories of social interactions and social structures to study the mechanisms by which colour-based discrimination affects school contexts and how they reflect in lower outcomes for darker-skinned students. The biases are subtle and often unconscious and affects many types of social interactions in schools (Burton et al. 2010).

Examining the factors associated with university entrance test scores using a ternary colour system provides a nuanced and deeper analysis of educational outcomes within distinct racial groups, that are more consistent with students' identities compared to the binary system. This approach is especially valuable in understanding differences among black and mixed-race students, shedding light on subtle nuances within racial dynamics. This study gains particular relevance given the finding of the 2022 Census, which disclosed that the mixed-race share of population now exceeds that of white counterparts, with 45.3% of the population, while the proportion of whites is 43.5%. When combined with the black population, the non-white Brazilians now represent 55,5% of the overall population[43] (IBGE 2023).

[43] Indigenous and Asians together represent 1.2% of the population.

4.3. Data

This paper uses administrative data from the Brazilian high-stakes standardised admission tests – ENEM ("Exame Nacional do Ensino Médio"), elaborated and made publicly available by the National Institute of Studies and Educational Research Anisio Teixeira – INEP (*Instituto Nacional de Estudo e Pesquisas Educacionais Anisio Teixeira*), an institution linked to the Ministry of Education. ENEM is the most important national standardized test administered to high-school graduates who intend to access public higher education. The test has been conducted annually since 1998. Initially designed as low-stakes high school evaluation test, it was reformulated in 2009 to become mandatory for accessing public higher education, particularly for federal institutions, either on its own or in combination with institutions' own admission tests (known as "vestibular"). ENEM scores are also accepted by many private universities, as well as by some international institutions. Our analyses consider the ENEM cohorts for the period 2011-2018 (N= 9.5 MM), with each cohort accounting for a new set of participants each year. The test comprises four multiple-choice tests on specific subjects: math, natural sciences, human sciences, and languages, each containing 45 questions, and a written essay on a given topic. In addition to providing the individual-level scores of each of the four tests and the essay, the data includes information on key demographic and socioeconomic variables of the participants, such as race, gender, type of high school, age, gender, household income, parental education, ownership of household assets, among others. The assessment occurs towards the end of the academic year (generally October or November) and covers the standard curricula required at high-school level in Brazil. Students apply for their specific programmes in institutions of interest using their scores obtained from the average of the five tests, although the weight may vary according to the specific programme. For instance, engineering and economics programmes generally give a higher weight to maths, whereas law to language and essay. It is important to highlight that in Brazil, competition relies exclusively on ENEM-score rankings, independently of whether they are eligible for affirmative action policies or not – with competition occurring within each eligible group.

Despite the large number of participants in each ENEM cohort, we restrict our sample to the subpopulation of fresh-graduating students who hold a valid score for all test sessions and whose essay score was different from zero. Graduating students represent almost 20% of the total candidates. After cleaning and adjusting the data for quality and consistency, our final sample contains 9.5 million observations, which consists of 88% of the population of fresh graduating students who sat for the test and had a valid score. We kept only observations from participants within 15- and 30-years age bracket and discarded all missing observations of important variables, such as school code, type of high school attended, age, gender, race, mother education and income.

4.3.2 Dependent variable

Our main dependent variable is the simple average score across the five tests. Each tests receives a score on a 0-1000 scale. Apart from the essay, which is evaluated by two independent human examiners, all tests are graded following the Item Response Theory (IRT). The IRT methodology gives each question weights which are inversely related to the percentage of correct answers, based on the idea that questions which only a few students get right are harder. In order to maintain comparability across time, we standardised the scores with mean equal to zero and standard deviation equal to one.

4.3.3 Independent variable and controls

Our independent variable of interest is students' race. This variable, along with other control variables, are directly available from the ENEM socioeconomic survey. Race is self-reported into five categories: *amarelo* (Asian), *branco* (white), *indigena* (indigenous), *pardo* (mixed-coloured, mulatto) and *preto* (black), following the standard race classification from IBGE [Instituto Brasileiro de Geografia e Estatistica]. As our goal is to test the "mulatto escape hatch" hypothesis, we focus on the two non-white categories (black and mixed), examining the differences both between these two groups and how they compare to white participants. To simplify our analysis, we i) aggregated white and Asian (2% of the sample) into a "wide-

white" classification, since they tend to share similarities in academic performance. and ii) dropped the observations with indigenous students, which represent a very small share in our sample – such decisions do not lead to qualitative changes to the findings of this paper. Results are presented considering a two-race variable, *race2*, using mixed and black participants only, and a three-race variable, *race3*, using all participants.

As controls, we add individual and school characteristics, also available in our dataset from the socioeconomic survey, such as age, type of school attended, if the school is urban or rural, parent education and a measure of household wealth, which we constructed a continuous asset index based on information of family ownership of durable goods. To construct the index, we used 10 items: number of cars; number of computers; number of refrigerators; number of mobile phones; number of DVD players, number of TV sets; and washing machines, plus the existence of internet; TV cable, and a telephone line, following methodologies that use polychoric principal component analysis (PCA) – see Filmer and Pritchett 2001; Filmer and Scott 2012, and Kolenikov and Angeles 2009. In this chapter where we are not using measures of relative deprivation, we opted for using the asset index instead of income, because asset index is a continuous variable, - while household income is ordinal. For this study, we need only one proxy of economic status. However, both income and asset index used as a measure of standards of living give similar results.

4.3.4 Descriptive statistics

Table 4-1 displays the descriptive statistics for the race groups, both for the entire sample and for the top ten percent sample. On average, black and mixed-race students exhibit similar characteristics in terms of age, parental education, asset index, and type of school. Whites, on the other hand, are slightly younger, with more than double the measure of the asset index, a higher proportion of professional parents (33%), and larger share attending private schools. The majority of black and mixed-race students attended state and municipal public schools, while white students were more likely to attend private schools, with twice the share of blacks and *pardos*. All races had similar participation in federal

schools. Within the top ten deciles, white students still have a higher asset index compared to blacks and mixed-race students. Additionally, over 70% of white students have a graduate parent, in contrast with only 47% and 53% of blacks and pardos, respectively. Over 80% of white students attended private and federal schools, while 68% of black and 72% of pardos, and 70% of white students attended schools in the southern and southeastern regions, but only 48% black and 43% of pardos. Rural schools were rare for ENEM participants.

TABLE 4-1: DESCRIPTIVE STATISTICS

	All sample				Top 10% ENEM scores			
	Black	Mixed	White	Total	Black	Mixed	White	Total
N	1,014,324 (10.6%)	4,035,937 (42.3%)	4,485,402 (47.0%)	9,535,663 (100.0%)	46,913 (4.9%)	242,717 (25.5%)	663,936 (69.6%)	953,566 (100.0%)
Global scores	-0.242	-0.213	0.247	-0.000	1.861	1.930	2.004	1.978
Age	18.080	17.953	17.621	17.810	17.420	17.327	17.279	17.298
Girl	0.560	0.599	0.580	0.586	0.480	0.505	0.517	0.512
Parent education								
No education	0.019	0.018	0.006	0.012	0.002	0.002	0.000	0.001
Primary	0.142	0.149	0.084	0.118	0.029	0.024	0.011	0.015
Middle school	0.248	0.248	0.178	0.215	0.091	0.079	0.041	0.053
High school	0.431	0.410	0.401	0.408	0.408	0.363	0.244	0.282
University	0.101	0.107	0.191	0.146	0.250	0.272	0.345	0.322
Postgrad	0.059	0.068	0.141	0.101	0.220	0.261	0.359	0.327
Asset index	-0.385	-0.413	0.581	0.058	0.770	0.964	1.728	1.487
Urban								
No	0.027	0.031	0.021	0.026	0.016	0.014	0.007	0.009
Yes	0.973	0.969	0.979	0.974	0.984	0.986	0.993	0.991
School type								
Federal	0.029	0.026	0.024	0.025	0.165	0.129	0.068	0.088
State	0.834	0.819	0.652	0.742	0.313	0.272	0.169	0.203
Municipal	0.011	0.009	0.010	0.010	0.009	0.006	0.005	0.006
Private	0.126	0.145	0.314	0.223	0.513	0.592	0.758	0.703
Region								
Midwest	0.088	0.095	0.073	0.084	0.090	0.101	0.073	0.081
Norwest	0.349	0.376	0.161	0.272	0.336	0.368	0.147	0.213
North	0.083	0.144	0.042	0.090	0.062	0.092	0.026	0.044
Southeast	0.426	0.334	0.490	0.417	0.483	0.403	0.579	0.529
South	0.054	0.051	0.233	0.137	0.030	0.035	0.175	0.132

4.4. Empirical strategy

4.4.1 Basic model

To analyse if ENEM test scores differ between black and mixed-race students, we use ordinary least square (OLS) regressions with fixed effects, as presented in the following equation:

$$\boldsymbol{Y_{is} = \alpha + \beta_1 RACE_{is} + \gamma X_{is} + \delta_s + \lambda_s + \epsilon_{is}} \quad (4\text{-}1)$$

where $\boldsymbol{Y_{is}}$ is the average score of participant ***i*** from school ***s*** in ENEM. $\boldsymbol{RACE_{is}}$ is a categorical variable for the race of participant ***i*** and school ***s*** is, with black participants are used at the baseline. $\boldsymbol{X_{is}}$ is a set of controls, which include age, highest parental education (with six categories), asset index, and school variables, such as type of administration (private, federal, state, and municipal) and a dummy indicating whether school is urban. One limitation is that our dataset consists of repeated cross-sections where the students are not the same at each wave, therefore, we cannot control for individual-level unobservable characteristics. We add school fixed effects $\boldsymbol{\lambda_s}$ and 26 state dummies, $\boldsymbol{\delta_s}$, to absorb time-invariant differences between school and states, that may correlate with scores. Robust standard errors are clustered at school level in order to capture similarities within groups of students who attended the same school, and $\boldsymbol{\epsilon_{is}}$ is the estimated error. We highlight that these results must not be interpreted as causal, as this would require meeting further assumptions about the unobservable term.

Further analyses are conducted by subgroups based on participants' characteristics, such as quintiles of asset index, or categories of parent education, as well as by type of school. Additionally, these tests were applied on a sub-sample of the top 10% scores of each year.

4.4.2 Trends in achievement and gaps

We use the following regression to investigate the trajectory in outcomes by race, which is simply adjusting the model in (4-1) by adding an interaction with time, as presented below:

$$\boldsymbol{Y_{is} = \alpha + \beta_1 RACE_{is} + \ \rho_t TIME \times \ RACE_{is} + \ \gamma X_{is} + \delta_s + \lambda_s + \epsilon_{is}} \qquad (4\text{-}2)$$

where $\rho_t TIME \times \ RACE_{is}$ provides the interactions between race dummies and a continuous time variable *t* ranging from 2011 to 2018. This allows us to investigate linear patterns of the predicted values of each race group across time.

Moreover, to estimate trends in achievement gaps between groups, we took the difference of the average estimated scores of one group with respect to the other group by year and plot them on a chart, so that we can visualise any particular changes across them over time. Robustness checks with different specifications were conducted, leading to similar results, and can be provided upon request.

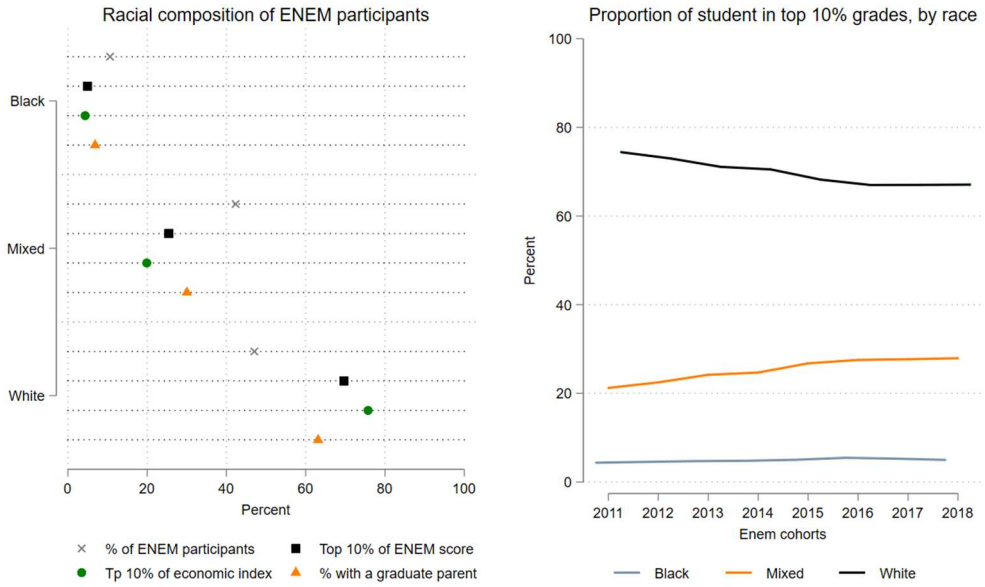
4.5. Results

4.5.1 Key variables: shares across race.

Before starting into the regression analyses, we provide a comparative overview of the distribution of participants across key indicators, disaggregated by race. Figure 4-1below illustrates the shares of participants who: i) took the ENEM test; ii) had a graduate parent; iii) belonged to the top 10% of distribution of the asset index; and iv) scored within the top 10% ENEM scores. This analysis depicts a visual outline of the demographic differences among the three race groups (black, mixed-coloured, and white) in our sample, which is crucial for understanding racial inequalities in the Brazilian educational landscape. Socioeconomic disparities are evident: white students comprised 47% of participants, yet account for 63% of students having a parent with a university degree and for 75.7% of the top decile of the asset index. With regard to the 10% highest performers, white students

accounted for 69.6%, while black and mixed students accounted for 4.9% and 24.5%, respectively, although they accounted for 10.6% and 42.2% of the total sample. With regards to having a graduate parent, mixed-race students accounted for half the share of white students with a difference of 33 percentage points (p.p.) and black students for only 6.8%. These shares seem even more striking among the top 10% of asset index, where black and mixed accounted for only 4.4% and 19.9, respectively.

FIGURE 4-1: PROPORTION OF PARTICIPANTS ACROSS KEY INDICATORS AND WITHIN TOP 10% SCORES OVER TIME



Note: Panel left presents the proportion of participants on the test and other key indicators by race. Panel left presents the proportion of each race in the sample of top 10% performers by year.

The right panel shows the trends in race participation among the top-10% performers over time. The share of white students who achieved top-10% scores is over the double of that of black and mixed students together. This is concern for mobility since the top 10% scores are more likely to attend quality higher education. Mixed students were the only students for whom this figure increased, while for white students it decreased and for black students there have been no changes. These panel indicates that there are important and persistent differences between the three groups that need to be investigated.

4.5.2 Role of race from conditional and unconditional models

To address our research question, we initially use conditional and unconditional models as in equation (4-1). The "mulatto escape hatch" in our analysis can be seen as the difference in ENEM scores between mixed and black students – in some regressions we include whites to enable an appreciation of also the gaps with white students. All results are measured in terms of standard deviations (SD) for each year. Table 4-2 displays the results for the full sample, which includes white subjects, as well as the results for a subsample consisting only of mixed and black students. Similarly, we present for each of these two groups the results obtained from using all observations in the sample and from using only the observations within the top score decile (Top 10%). Race coefficients are always highly significant (p<0.001). The first four columns show the results for the unconditional model (m0), where the mixed-coloured students perform slightly better than black, with an advantage of 0.044 to 0.045 SD; however, this advantage increases on the top 10% of the score distribution to 0.067 - 0.068 SD. Differences with respect to white students are greater, who perform 0.143 SD higher than blacks, and around 0.10 SD higher than mixed-coloured. Since the average test SD is around 79 score points, the difference with respect to blacks is around 11 points and almost 8 points relative to mixed-coloured. As we add covariates (m1), the coefficients fall moderately for white and mixed-coloured, and they fall further when we control for household asset index (m2), showing that part of unequal achievement can be explained by these variables. For the full model (m2), coefficients for mixed-coloured vs black are around 0.03SD in the entire sample, to 0.04 on the top-score-decile sample, while the black-white difference falls from 14% to around 10% of a standard deviation when we consider the entire sample, and from 18% to 8% of a standard deviation considering the top scores' sample. These findings indicate that 29% of the differences between black and mixed are accounted for by socioeconomic background. Even with controls, the black-white gap is still significant, and is slightly larger in the top score decile. Age has a negative relationship with scores but becomes less relevant among top performing students. Girls tend to score less than boys, even when considering the top 10% scores. Among other explanatory variables, the most important role is played by the type of school, with federal schools having the highest correlation with scores, followed by parent education, with graduated parents having the highest coefficients. These coefficients decline on the top ten percent sample,

since the groups tend to be more similar. It is important to note that difference between federal and private schools becomes very small amongst students within the top 10% scores. This result is in line with the large dispersion in quality across private schools, while high quality private schools tend to perform similarly to federal schools.

TABLE 4-2: REGRESSIONS

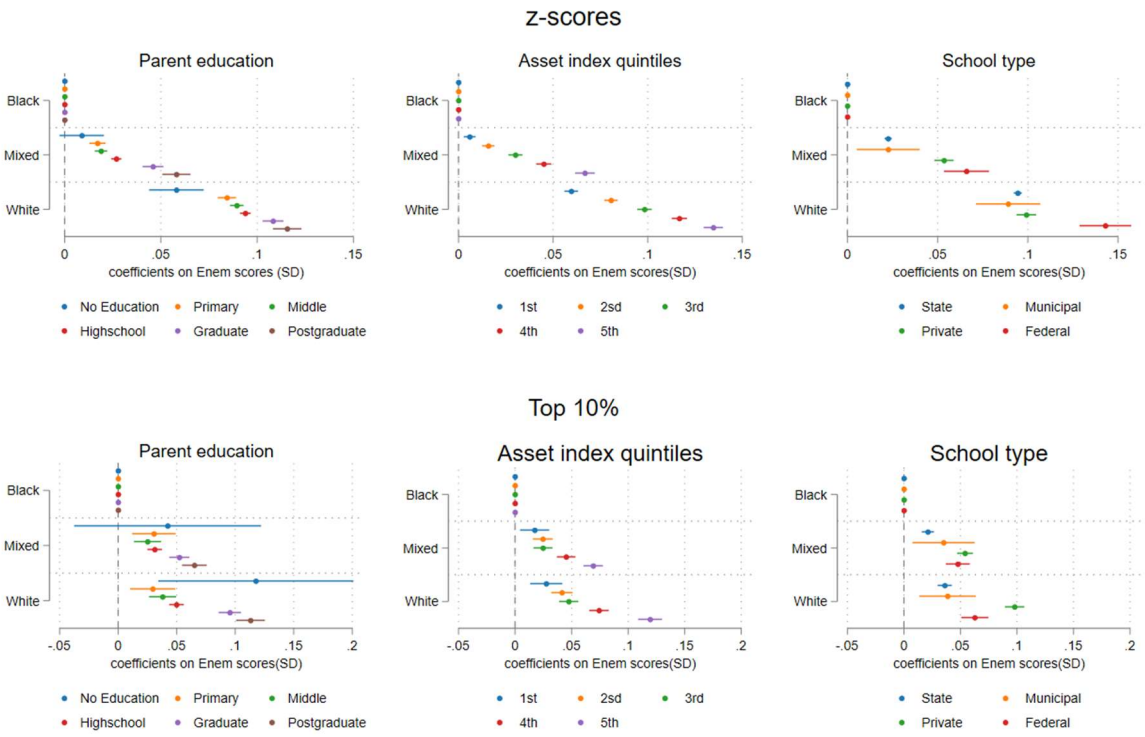
	m(0)				m(1)				m(2)			
	M&B&W		M&B		Full sample		M&B		Full sample		M&B	
	All	Top 10%	All	Top 10%	All	Top 10%	All	Top 10%	All	Top 10%	All	Top 10%
Mixed	0.045***	0.068***	0.044***	0.067***	0.037***	0.049***	0.036***	0.050***	0.032***	0.043***	0.032***	0.044***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
White	0.143***	0.178***	0.000	0.000	0.113***	0.101***	0.000	0.000	0.102***	0.083***	0.000	0.000
	(0.001)	(0.006)	(.)	(.)	(0.001)	(0.004)	(.)	(.)	(0.001)	(0.003)	(.)	(.)
Controls												
Age					-0.081***	-0.016***	-0.076***	-0.016***	-0.079***	-0.017***	-0.073***	-0.016***
					(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Female					-0.079***	-0.053***	-0.079***	-0.049***	-0.070***	-0.048***	-0.070***	-0.045***
					(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Parent education												
Primary					0.049***	0.004	0.050***	0.026	0.038***	-0.018	0.039***	0.004
					(0.002)	(0.016)	(0.002)	(0.020)	(0.002)	(0.018)	(0.003)	(0.023)
Middle					0.091***	0.006	0.094***	0.026	0.066***	-0.036*	0.069***	-0.015
					(0.002)	(0.016)	(0.003)	(0.019)	(0.002)	(0.018)	(0.003)	(0.023)
High school					0.208***	0.033*	0.212***	0.056**	0.170***	-0.026	0.174***	-0.001
					(0.002)	(0.016)	(0.003)	(0.019)	(0.002)	(0.018)	(0.003)	(0.023)
Graduate					0.323***	0.129***	0.326***	0.136***	0.270***	0.048**	0.273***	0.059*
					(0.003)	(0.016)	(0.003)	(0.020)	(0.002)	(0.018)	(0.003)	(0.023)
Postgraduate					0.386***	0.199***	0.387***	0.200***	0.322***	0.105***	0.320***	0.110***
					(0.003)	(0.016)	(0.003)	(0.020)	(0.003)	(0.018)	(0.003)	(0.023)
School type												
State					-1.122***	-0.222***	-1.107***	-0.225***	-1.095***	-0.207***	-1.079***	-0.209***
					(0.020)	(0.015)	(0.021)	(0.015)	(0.020)	(0.014)	(0.020)	(0.014)
Municipal					-1.168***	-0.212***	-1.152***	-0.204***	-1.131***	-0.209***	-1.115***	-0.200***
					(0.021)	(0.019)	(0.022)	(0.018)	(0.021)	(0.018)	(0.021)	(0.018)
Private					-0.344***	-0.006	-0.312***	-0.012	-0.361***	-0.026	-0.331***	-0.030*
					(0.021)	(0.015)	(0.021)	(0.016)	(0.020)	(0.015)	(0.021)	(0.015)
Urban					0.087***	0.135***	0.098***	0.140***	0.078***	0.114***	0.087***	0.118***
					(0.007)	(0.015)	(0.007)	(0.016)	(0.006)	(0.014)	(0.007)	(0.015)
Asset index									0.047***	0.043***	0.048***	0.040***
									(0.000)	(0.001)	(0.000)	(0.002)
Constant	-0.505***	1.651***	-0.506***	1.700***	1.837***	1.836***	1.707***	1.854***	1.840***	1.915***	1.714***	1.923***
	(0.026)	(0.036)	(0.026)	(0.032)	(0.027)	(0.052)	(0.027)	(0.051)	(0.026)	(0.049)	(0.027)	(0.050)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations					9535663	953566	5050261	289630	9503382	952770	5027592	289328

Notes: OLS estimates of race and other controls on ENEM individual scores (average global). These estimates include full sample (includes white) and a subsample which includes only black and mixed students. We use three specifications, where m(0) corresponds to the simple model (no covariates) and m(1) includes covariates, but does not include asset index, and m(2), includes asset index. Includes r state FE. All models were estimated with school fixed effects and standard errors clustered by school. Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.5.3 Role of race on subsamples of key variables

The relationship of scores and socioeconomic factors can be better visualised in Figure 4-2, which illustrates the coefficients derived from regressions conducted across socioeconomic and school type subsamples. In the regression models presented in Table 4-2, black is the baseline category, allowing the coefficients to represent the achievement gaps relative to black students. The figure reveals the existence of statistically significant disadvantages for black students even when regressions are based on subsamples, with these gaps widening as socioeconomic status grows, i.e., as parent education and asset index rise. As previously mentioned, type of school also plays an important role in promoting inequalities. Even with controls, the advantages of white students relative to black and mixed students are particularly large. Mixed students' highest level of parent education and top quintile of asset index produce similar coefficients as the lowest level of parent education and bottom quintile of asset index for white students. Similarly, White participants from federal schools score .15 SD and .07 higher than black and mixed students, respectively. This suggests that educational disparities become more evident at higher socioeconomic levels, corroborating with previous research in this field (Bailey, Loveman, and Muniz 2013). Gaps between races in the top 10% of score distribution are displayed in the inferior panel in Figure 4-2. At this level of performance, differences between black and mixed are still relevant. The coefficients are smaller at this level of performance, particularly between mixed and white, with a slight advantage of white, but black are still in disadvantage relative to the two races with the same characteristics. Racial differences persist, although with less intensity, despite having the same socioeconomic background and type of school.

FIGURE 4-2: RACE COEFFICIENTS FROM SUBSAMPLE REGRESSIONS (BLACK=BASELINE)

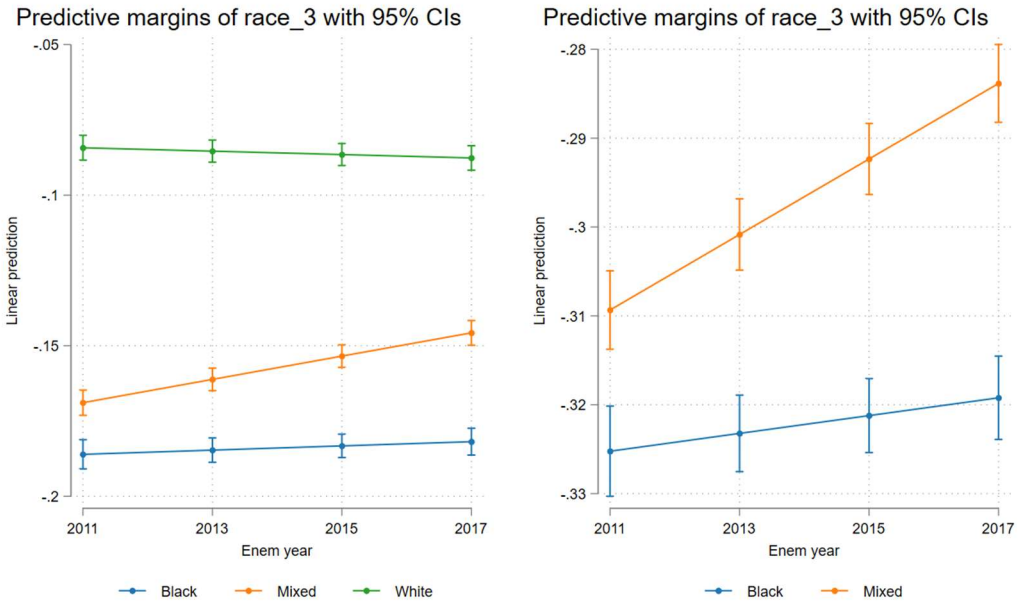


Note: This figure displays the coefficients of each race group by subsamples of parent education, quintiles of asset index and type of school. The top panel considers the entire sample, and the bottom panel considers the sample of top 10% performers in ENEM. All models include the same covariates in model 2 (see Table 2) except for their respective subsamples on the analysed variable.

4.5.4 Racial gaps over time

To examine whether racial gaps decrease over time, we run regressions of our full model in equation (4-2) with an interaction of race with year, assuming year as a continuous variable. This procedure aims to provide linear predictions. Our results are displayed in Figure 4-3, showing that the trajectory of black students in ENEM has been practically the same in the eight years of analysis. However, we can visualise that the scores for mixed-coloured students follow an ascending trend, although moderate – while a descending trend for white students. While this indicates that mixed and white students are converging, disparities seem to be increasing for blacks.

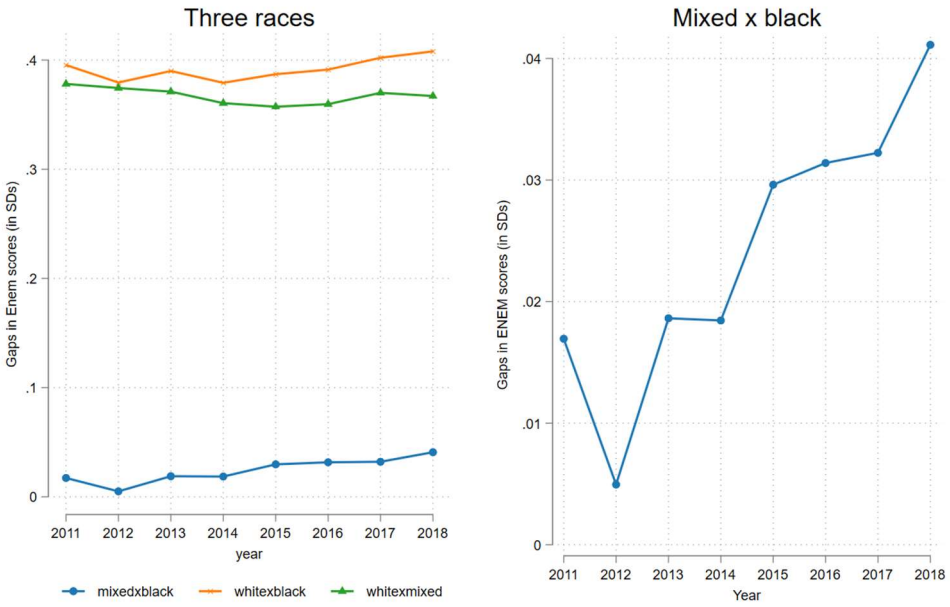
FIGURE 4-3: RACE TRENDS IN SCORES OVER TIME (2011-2018)



Note: This figure displays predicted scores for each race group by year estimated with regressions using the full model adding the interaction term of race and year. On the left side, we use the full sample, on the right side, the mixed and black sample.

For better visualisation of the size of gaps over time, we calculated the estimated average gaps between races by year and plotted then in Figure 4-4 to provide a graphic comparison. The gaps are merely the difference between the averages of predicted scores for race A and predicted scores for race B.

FIGURE 4-4: ACHIEVEMENT GAPS ACROSS RACES OVER TIME (2011-2018)

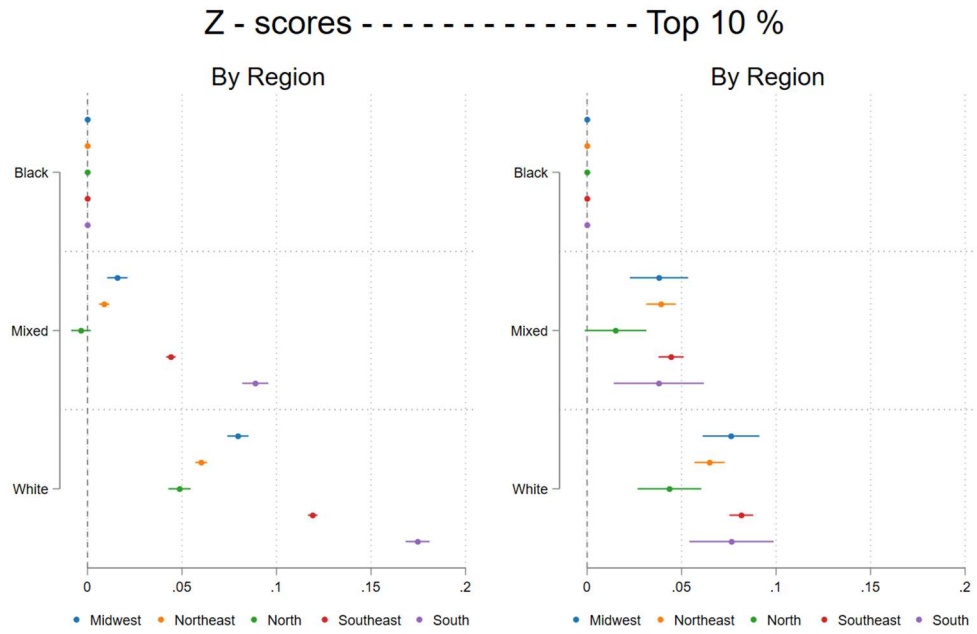


Note: This figure displays estimated gaps in ENEM scores for each race group by year estimated with regressions using the full model with an interaction term of race and year. On the left side, we use the full sample, on the right side, the mixed and black sample.

4.5.5 Gaps by region

Lastly, but not least, regional differences are important to understand Brazilian society (Telles 2004). Brazil is a continental country, with sharp regional differences regarding race composition and historical legacies. This explains the important role geographic regions play as determinants of educational disparities in Brazil. We estimated the race coefficients from regressions of the full conditional model on subsamples for each region the country. Results are presented in Picture 4.5 in two panels: i) left-hand panel, which considers the full sample, and ii) right-hand panel, which considers only the sample with top 10% scores. In the first panel, we note striking differences in the coefficients of mixed and white students in South and Southeast regions relative to blacks, while mixed and black students from North and Northeast tend to have similar performances. Differences are much smaller in the top 10% scores, as the dispersion between scores are smaller.

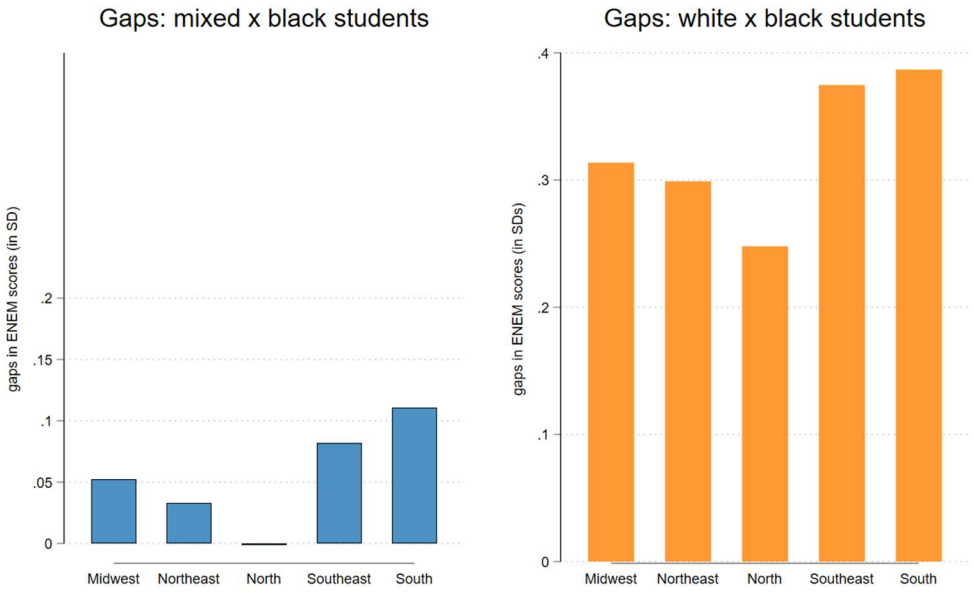
FIGURE 4-5: COEFFICIENTS OF RACE BY REGION SUBSAMPLES



Note: This figure illustrates the coefficients of each race group within regional subsamples. The left panel encompasses the entire sample, and the right panel focuses on the top 10% performers in ENEM. All models, as in Table 4-2, consider the covariates outlined in model **m2**.

Next, we calculated the estimated gaps of the full model for better visualisation of the differences between races, more specifically differences from average estimated white and mixed scores with respect to black students, which are presented in Figure 4.6. As we had anticipated in Figure 4-5, the larger gaps between mixed and black are faced in South and Southeast regions. Students from the North show no differences between mixed and black. However, the black and white gap overcomes the black-mixed gap in all the regions, but they are particularly large in the South and Southeast. The differences are explained by the fact that these regions experienced different historical, political and social contexts. Besides being less developed, the Northern regions have smaller white population, in contrast with rich more industrialized Southern regions that received a large number of European immigrants and where the majority of population is white.

FIGURE 4-6: GAPS IN ENEM SCORES RELATIVE TO BLACK STUDENTS



4.6. Conclusion

This paper examined and compared the performance of black and mixed-coloured high school students in Brazilian high-stakes university entrance exams. Our aim was to test for the potential existence of a phenomenon known as the "mulatto escape hatch" in an educational setting. The expression refers to the hypothesis that mixed-coloured individuals hold an intermediate social standing relative to black and white individuals, due to having a lighter skin tone which through complex social dynamics lessens the discrimination they suffer compared to individuals with darker skin tones. Our findings indicate that on average there is a statistically significant advantage in the performance of mixed-coloured students in ENEM scores compared to black students, although the magnitude of this difference is very small. Estimated gaps are larger in richer regions, where the non-white population is less represented, such as in the southern and southeastern regions. Another important finding from this article is that achievement gaps between mixed-coloured and blacks do not seem to be decreasing over time – on the contrary, blacks are lagging behind.

Overall, these findings suggests that on average, racial inequalities are still evident as mixed-race and black students have markedly lower outcomes than whites – even when important factors such as socioeconomic status, parent education, state of residence and type of school are controlled for. In addition, while the differences between mixed-race and white students seem to be narrowing, they are still very large. Further research is necessary, as, despite having similar patterns of performance, black and *pardos* may differ on many important dimensions – which requires careful analyses before combining the two categories together. This is particularly important as results from the 2022 Census were recently announced, where the *pardo* share of the population alone become the major racial group in Brazil, with 45.3%, surpassing the 43.5% share of whites. This implies that future research needs to improve the understanding of the categorisation of 'mixed-race group' as a particular group.

Based on our findings, it is evident that education systems must critically examine the impact of school dynamics on perpetuating the disadvantages faced by non-white students within basic education. This requires further research to fully understand the intricate relationships involved. To mitigate the negative impacts of racial discrimination and structural racism in schools, it is essential to implement targeted measures aimed at enhancing the academic outcomes of darker-skinned students while reducing their repetition and dropout rates. A key strategy involves ensuring equitable provision of early childhood education to non-white and poor children, coupled with school commitment to eliminate practices that reproduce racial patterns at all levels of schooling. Moreover, race-based policies should be designed to specifically address the needs of dark-skinned individuals, recognising them as the most disadvantaged groups in educational settings. Although not presented in this study, it is well known that gender gaps in test performance are also prominent in Brazil, with black girls being in the most unfavourable position, which also need to be further investigated and tackled by educational policies. Addressing achievement gaps requires a comprehensive approach by policymakers by ensuring the delivery of quality education in schools that serve poor non-white population; disseminating college information and returns to education; confronting discriminatory practices, and providing more equitable opportunities, especially during high school years.

These policies should be designed to comply with a nuanced understanding of the intersections involving class, race and gender to open significant life-change opportunities for disadvantaged Brazilian youth, including their transition to prestige higher education courses. It is important to note that this paper does not claim to centralise the issue of inequalities exclusively within the realm of education. Rather, it recognises that colour discrimination and inequalities are embedded in many dimensions of Brazilian society.

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2. Conclusion of the thesis

This thesis explored various facets of educational inequalities for Brazilian high-school students, recognizing high-school education as a critical stage for employment opportunities and for higher education pursuits, becoming extremely relevant for youth prospects. The objective of this study is to provide empirical evidence of the persistent achievement gaps across demographic and socioeconomic groups in Brazil's university entrance exams. By using microdata from ENEM, the second largest entrance exams in the world, this study aims to contribute to a nuanced understanding of educational inequalities in Brazil, including an investigation of how achievement gaps evolved over the past years, particularly in a context of affirmative action policies ("the Quota Law") that target income and race disadvantages. Existing research has shown that cognitive skills, as gauged by standardized-test performance, serve as a more significant predictor than years of education for individual and societal progress (Hanushek and Kimko 2000; Hanushek and Woessmann 2007; Hanushek 2013). This is a big concern for Brazilian economic and human development, which have slowed in recent years (OECD 2023). The low quality of Brazilian public schools, where over 80% students are enrolled (Todos pela Educação 2022), hinders the chances of disadvantaged students to access prestigious universities that would enable them to ascend the social ladder. Despite the rapid expansion of education over the last decades, the country grapples with the challenge of assuring equitable access to quality of education at all levels of education. While the implementation of AA policies and additional educational initiatives have increased participation of disadvantaged students in higher education, including in federal institutions, achievement gaps in basic education are large. Disadvantaged groups are still overrepresented in less prestigious higher education programmes, which yield lower returns in the labour market and reproduce inequality (Dias Lopes 2017; Reis 2017; Bertolin and McCowan 2022). Moreover, systemic, and institutional factors, such as discrimination practices, exacerbate this vicious cycle. This research highlights the persistence of achievement gaps across various social groups in ENEM scores, with specific focus on race, income (absolute and relative), and its intersections with race and gender. Addressing these disparities is imperative for fostering more democratic opportunities, including interventions that span from early childhood to high school education.

The four self-contained chapters of this thesis explored distinct dimensions of these disparities in academic performance of high school students in ENEM, with each chapter contributing with unique insights into the nuances of the achievement gaps among these groups. Next, I will summarise the findings, contributions, and implications for future research of each chapter, to offer a comprehensive understanding of the multifaceted challenges to foster a more equitable and inclusive educational landscape in Brazil.

2.1 Findings

In Chapter One we assessed the impact of the National Law of Quotas (NQL) on ENEM scores, examining both eligible and non-eligible groups that could be affected by the policy. By attempting to isolate the effects of the NQL from prior AA initiatives, I tested for the hypothesis that a widely advertised large-scale AA programme can boost the motivation of high-school students, by raising their probability of reaching higher education (Bodoh-Creed and Hickman 2018; Cotton, Hickman, and Price 2020; Cotton et al. 2020). The findings indicate that the policy raised the performance of both eligible and non-eligible students in states that newly implemented the NQL, i.e., those with less than 12.5% of quotas or no previous quota schemes before the law was introduced. Effects were more pronounced in math and in science, suggesting that eligible applicants were aiming for degrees that most heavily rely on these subjects and yield higher returns. High-income groups, particularly the non-white subgroup, experienced larger impacts than their low-income counterparts, indicating that income is an important driver of AA impacts. While these findings suggest a convergence in achievement gaps between high-income students from treated and comparison states, the high and persistent achievement gap between private and public students remains evident. We conclude that while without the NQL the majority of low-income students would have minimal chances of gaining admission to public universities, the law is not the silver bullet that will narrow achievement gaps for the majority of them. For more effective results on this specific goal, policymakers must design comprehensive strategies that both address incentive mechanisms and enhance the overall quality of basic education in public schools that serve disadvantaged students.

Chapter Two delves more closely into the effects of socioeconomic standing to examine how it relates to educational performance. By disentangling economic status into an absolute and a relative component, the chapter shows that they are independently related to ENEM results. The strength of relative deprivation increases at higher levels of absolute income. Alongside the role played by absolute standards of living through material pathways to education (e.g. affordability of education and material hardship), relative economic status may influence educational achievements through psychosocial pathways related to self-esteem, aspirations, motivation, and identity. Both facets of economic status should therefore be considered as possible sources of educational inequalities.

Chapter Three employs an intersectionality and multiple jeopardy framework to study how the two demographic characteristics most widely used in intersectionality studies (gender and race) interact with a multifaceted notion of economic status – comprising its absolute as well as its relative components. Carrying out a mixed-methods study, we show that the interaction effects for gender and race have the same sign in the case of absolute income but have opposite signs in the case of relative deprivation. The explicit conceptual and empirical acknowledgement of the two facets of economic status is, to the best of our knowledge, novel in intersectionality studies and has enabled us to provided novel insights on educational inequalities in Brazil. By complementing the econometric analyses of the ENEM datasets with qualitative insights from data collected via semi-structured interviews and focus group discussions with 30 secondary school teachers in Rio, this study sheds fresh light on the complex picture of disadvantage in education in Brazil.

Lastly, Chapter Four tests for the existence of the so-called “Mulatto Escape Hatch” (MEH) phenomenon, a term coined in the 1970s in the realm of a comparison between racial relations in Brazil and the United States. The expression refers to the hypothesis that mixed-coloured individuals hold an intermediate social standing relative to black and white individuals; this would be due to having a lighter skin tone, which through complex social dynamics lessens the discrimination they suffer compared to individuals with darker skin

tones. By using ENEM data, we systematically compare educational achievements of blacks and 'pardos' (mixed race). Results support the MEH hypothesis: statistically significant advantages for `pardos' are observed, including in trends over time. However, these effects are rather small in magnitude when compared to the advantage of whites over non-whites. Furthermore, estimated gaps are larger in richer regions, where the non-white population is less represented, such as in the southern and southeastern regions. Importantly, achievement gaps between mixed-coloured and blacks do not seem to be decreasing over time – on the contrary, blacks are lagging behind. These findings indicate that, despite similarities, the two non-white racial categories may face different challenges.

This is particularly important as recently announced results from the 2022 Population Census, reveals that the *pardo* share of the population alone became the major racial group in Brazil, with 45.3%, surpassing the 43.5% share of whites. This implies that future research needs to improve the understanding of the categorisation of 'mixed-race group' as a particular group.

2.2 Research and policy implications

Chapter One contributes to the literature on the pre-college impacts of AA policies in developing countries. Furthermore, it advances the existing research by extending our analyses beyond the entire sample of eligible students to examine each of the four subgroups covered by the policy, including their non-eligible counterparts. To the best of our knowledge, this is the first study to examine the effects of this policy on the performance of each specific targeted subgroup. It is also the first attempting to isolate the effects of the National Quota Law from previous AA experiences.

It is important to highlight that while the evaluation of AA policies should be focused on the long-term effects on beneficiaries and the programmes' goals, which has been evidenced by prior research, policymakers need to account and fully understand for the effects on the way high-school students decide to invest in education and the mechanisms

involved. This requires deeper investigation, including qualitative data collection with students and teachers. This is particularly important for low-income students, since, regardless of their race, they seem to have a similar pattern. The recent modification in the Law of Quotas (BRASIL 2023; Araujo 2023) which reduces the per-capita income threshold down to one minimum-wage may change students' expectations by reducing discouragement effects for the low-income students and enhance their motivation. This presents an interesting avenue for future research to investigate how the revision of the law affected the performance of low-income students.

Moreover, further policies are urgently needed to address the persistent achievement gaps while students are still in high school, as preparation for a possible context without quotas in the future. While AA policies should last for as long as achievement gaps persist, a caveat is that their sustainability in time depends on the political context. The US case is a classic example. The more controversial AA programmes are, the more difficult is the creation of political consensus.

Chapter Two contributes to the literature of educational inequalities by refining the study of the economic gradient in education. It fills a gap in the literature where absolute and relative measures of economic standing are jointly employed as explanatory variables to explain educational performance outcomes (i.e. test scores rather than census-based enrolment status). Importantly, while the only comparable previous analysis looked at school enrolment using demographic data, this paper employs more nuanced data from a large scale high-stakes exam which is key for university admission. The richness of the ENEM data also enabled a nuanced reading of the way absolute and relative standards of living are related to educational results. The acknowledgment of the two sides of the economic gradient in education urges scholars, policymakers, and educators to place a greater emphasis on the role of socioeconomic inequalities.

Further research is needed to explore the distinct roles of absolute and relative standards of living as sources of educational inequalities in other geographical contexts, as well as for other age groups and educational outcomes. While we used data from a very important exam taken by millions of students in Brazil every year, and participation has expanded considerably over time, participation is lower among the poorest: by missing the bottom of the distribution, our evidence may therefore underestimate the educational effects of economic status.

Chapter Three contributes to the intersectionality literature via a mixed-methods design (where quantitative and qualitative evidence are used sequentially), where qualitative data from teacher interviews and focus group discussions were employed to shed light on large-scale econometric evidence. This study highlights how patterns of inequality in Brazil can cross socioeconomic and demographic axes in ways which are far from intuitive. Future research would benefit from the application of the intersectionality framework to the study of how the interplay between economic status and other variables may matter for other social outcomes in Brazil – including outcomes other than education, such as health, migration, violence, etc. The range of sources of disadvantage should also be expanded, to include age, sexual minority, migration status, etc.

It is worth noting that while theory and our qualitative evidence suggest that the identified quantitative patterns may be causal, the quantitative models used in Chapter Two and Three alone are only able to demonstrate significant associations. Further research should aim to quantitatively identify causality, for example using panel data. Lastly, the use of qualitative data to understand and expand upon robust quantitative evidence proved extremely valuable, and this approach should find greater use in future research.

Our evidence shows that success in the university admission exam, a crucial determinant of social mobility, largely depends on characteristics assigned at birth. This process involves intricate dynamics of economic disadvantage, top-down legitimisation of knowledge, and discrimination across gender and racial axes. This illustrates how educational systems can

reproduce socioeconomic inequalities, contributing to the intergenerational accumulation of privilege and hindering social mobility. The acknowledgment of the two sides of the economic gradient in education urges scholars, policymakers and educators to place a greater emphasis on the role of socioeconomic inequalities.

Chapter Four contributes to the literature of racial inequalities and racial relations in Brazil, particularly focusing on the distinctions between black and mixed-race individuals, which are often analysed as a single entity. However, future research should aim to study these two categories separately, as, despite having similar patterns of performance, blacks and *pardos* may differ along important dimensions. Thus, careful analysis is needed before aggregating these two categories together.

Policymakers willing to mitigate the negative effects of racial discrimination and structural racism in schools should consider the desirability of targeted measures aimed at enhancing the academic outcomes of darker-skinned students. A key strategy involves ensuring equitable provision of early childhood education to all children, coupled with school commitment to eliminate practices that reproduce racial patterns at all levels of schooling. Moreover, race-based policies should be designed to specifically address the needs of dark-skinned individuals, recognising them as the most disadvantaged groups in educational settings.

Addressing achievement gaps requires a comprehensive approach by policymakers that ensures the provision of quality education in schools that serve poor non-white population; disseminating college information and returns to education; confronting discriminatory practices, and providing more equitable opportunities, especially during high school years. These policies should be designed to comply with a nuanced understanding of the intersections involving class, race and gender to open significant life-change opportunities for disadvantaged Brazilian youth, including their transition to prestige higher education courses.

"Mais da metade do país é negra e se esquece
Que tem acesso apenas ao resto que ele oferece
Tão pouco para tanta gente
Tanta gente na mão de tão pouco"
Racionais MC

"More than half of the country is black and forgets
That they only have access to the rest it offers.
So little for so many people
So many people in the hands of so little"

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