Gender gap competition: Evidence from a high-stakes exam

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Abstract

The gender performance difference in competitive environments represents a relevant behavioral explanation for the observed gender gap persistence. We evaluate this explanation by investigating whether competitive pressure impacts the gender gap in a real-world setting from a highly competitive entrance exam. We exploit a change in competitiveness caused by the adoption of a non-gender-focused affirmative action (AA) policy aimed at increasing the enrollment of applicants from disadvantaged backgrounds. We show that policy makes the competition less fierce for eligible students. As a result, we find that eligible female applicants score about 0.1σ higher and are admitted with a higher probability relative to their male counterparts. Still, the net effect of competitiveness in performance does not change the prospects for admission. These results suggest that competitive pressure is a relevant explanation for female underperformance in settings with contest incentives. However, our findings cast doubt on whether gender differences in competition can explain the gender gap in the long-run.

Keywords: gender gap in competition, affirmative action policy, post-secondary education
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1 Introduction

Despite female educational attainment growth in recent years, the gender gap in labor market outcomes persists (Blau and Kahn (2016)). This contradictory pattern attracted attention to behavioral explanations, such as the impact of socio-emotional skills. An emerging body of experimental studies establishes that competition is a relevant factor that impacts gender differences in labor market outcomes. Controlled laboratory experiments that aim to understand the effect of competition on the gender gap suggest that women are less effective than men in competitive environments.[1]

In this paper, we use data from the admission exam of one of the most selective universities in Brazil, namely *Universidade Estadual de Campinas* (UNICAMP), to address whether changes in the competitive environment impact women's performance under a not gender-focused affirmative action policy. To measure the effect of competition in the entrance exam, we exploit the change in competitiveness caused by introducing an affirmative policy at UNICAMP.

Affirmative action programs that promote the higher participation of underrepresented groups can affect women's and men's performance differently. That is because such policies change the success rate of eligible applicants: the policy makes the competition less fierce for eligible students. Following previous studies, we measure competition as the change in enrollment rate (Jurajda and Münich, 2011; Ors et al., 2013). We verify that the enrollment rate among eligible students has increased after the policy's adoption.

College admission processes are mostly configured as a competitive environment since that setting has many competitors and few positions to fill. This setting provides an opportunity to analyze the competition's effects on performance by gender. The UNICAMP entrance exam is an appropriate framework to study these effects since it is highly competitive: there is an average of 16 applicants per seat in the UNICAMP majors. In addition, UNICAMP's affirmative action policy aimed to increase the enrollment of applicants from disadvantaged backgrounds, specifically students from public high schools and minority racial groups, by adding points to the final score of eligible applicants. Unlike other affirmative action policies, UNICAMP does not reserve a spot for a particular group. Therefore, there is no restriction on competition in our setting since all applicants compete for the same spots.

[1] Niederle and Vesterlund (2007) show that men select the tournament scheme more than women. Gneezy et al. (2003) and Price (2008) present experimental evidence that women are less efficient than men in competitive environments. Niederle and Vesterlund (2010) and Ors et al. (2013) show how women's educational performance in non-competitive environments is more satisfactory compared to competitive environments.

We first show that the adoption of the policy does not substantially change the composition of the applicants' pool. Then, we observe that, after the adoption, the eligible female applicants do better than their male counterparts. Eligible females score 7.237 points higher than males, about 0.1 standard deviations from the normalized final exam score. Therefore, we have evidence that less competitive pressure associated with bonuses makes women perform better. Although this result is significant, it is not enough to change eligible females' admission prospects. In addition, we show that the affirmative action policy affects the less able female students and those far below the cutoff score. Finally, we show that the effect is caused by the increase in the eligible female applicant's performance and not by the decrease in the non-eligible female applicant's performance.

Economic theory suggests underlying theoretical explanations for different behavioral reactions to competitiveness, such as preferences for competition (Croson and Gneezy, 2009), overconfidence (Comeig et al., 2016; Niederle and Vesterlund, 2007) and differences in ability (Cotton et al., 2015). To further understand the mechanism behind gender disparities in reactions to competition, we employ a straightforward contest model inspired by the theoretical framework presented in Estevan et al. (2019a), which itself draws upon established contest literature (Baik, 1994; Tullock, 2001; Stein, 2002). Our model suggests that the gender difference widens between eligible and gets smaller among non-eligible applicants. The performance response to the bonus occurs through the change in the admission probability of public school students and through the effort return increase. This is because eligible applicants have a larger return on their effort due to the incentive and improved probability of admission. Meanwhile, non-eligible applicants have a lower chance of getting admitted. This change impacts the performance of female applicants, who are more responsive to the bonus.

Our study closely relates to the stream of the literature examining gender-specific behavioral responses in competitive environments within laboratory settings. Gneezy and Rustichini (2004) conducts experiments to measure the speed at which children reach tasks in a competitive environment and shows that boys do better when competition increases. With a similar objective, Gneezy et al. (2003) compares the resolution time of maze games between men and women under competitive pressure. They find an improvement in men's performance in the competitive environment, while this effect did not occur for women.

A growing body of literature suggests that differences in attitudes towards competition between men and women remain outside the laboratory. Buser et al. (2014) use a laboratory experimental measure to predict the real-world choice of a secondary school career track using data from the Netherlands. They conclude that boys are more competitive and choose more prestigious academic tracks than girls. Also, using real-life high-stakes settings, studies find that men outperform women in university entrance examinations when they face a competitive environment (Jurajda and Münich, 2011; Ors et al., 2013). Prior studies also find that increasing exam stakes negatively affects women's performance by analyzing multiple-choice tests (Azmat et al., 2016; Cai et al., 2019; Montolio and Taberner, 2021; Arenas et al., 2021). Iriberri and Rey-Biel (2019) show the competitive pressure increases from stage 1 to stage 2 in a two-stage elimination math contest by showing that stage 2 has 1) a higher performance level and 2) a lower proportion of winning spots. They also administered a questionnaire asking the applicants if they agreed with the statement 'While doing the test, I felt more pressure during Stage 2 than in Stage 1'. Most participants agree with this statement, confirming that participants felt more pressure in the second stage. Using data from graduate students in Economics, Rocha et al. (2022) find evidence that women outperform men in undergraduate disciplines but underperform on the graduate admission exam. Changes in admission rate and the number of winners also harm female performance (Morin, 2015; Balafoutas and Sutter, 2019).

Lastly, our paper relates to previous literature that evaluates the reaction to task rewards within a competitive setting by gender. Using the UNICAMP data, Borges et al. (2023) examines how performance and admission are affected by shifting rewards (weights) across different subjects, with a disproportionate negative influence on women. The analysis further reveals that while priority subjects' scores positively correlate with future wages, the gender performance gap related to weight variation contributes little to explain the gender disparities in the labor market. In alignment with these findings, our study also identifies a notable effect of changes in competitive dynamics on the gender performance gap. However, when we look at how competition influences admissions (a possible pathway that influences labor market outcomes), we find no effect. Our main finding cannot be affected by the priority subjects' weights because we control for major choice (we explain how the UNICAMP final scores are computed in Section 2).

Our contribution enhances the understanding of competition and gender dynamics by evidencing the disproportionately positive impact of lowering competitive pressure on women relative to male counterparts in real-world settings. Additionally, we contribute by showing that the magnitude of change solely attributable to alterations in competitive dynamics is not substantial enough to shift long-term outcomes significantly. This insight is particularly relevant to labor market outcomes, where the admission rate is the primary mechanism through which university entrance exams influence future labor market success. Further, to the best of our knowledge, we provide the first direct causal estimation of the bonus addition and non-gender-focused affirmative action policy on gender gaps under competitive pressure.

The organization of the research project is as follows: Section 2 describes the institutional background and the affirmative action adoption. Section 3 represents the theoretical framework. Section 4 describes the data, Section 5 presents the main research questions and empirical strategy, and Section 6 presents our main results. Section 7 concludes.

2 Institutional Background

2.1 UNICAMP's Admission Process

UNICAMP is a research-intensive public university located in Campinas, Brazil. Like other Brazilian public universities, UNICAMP does not charge students tuition fees. However, students must write a university-specific, highly competitive admission exam (*vestibular*) to attend UNICAMP. Annually, 50,000 applicants apply to the UNICAMP's admission exam to fill the nearly 3,000 major vacancies. The exam offers a chance to attend one of Brazil's most prestigious universities, being highly valued by applicants.

Students register for the admission exam about five months before the beginning of the academic year. During the registration, they can choose up to three major options and rank them. There is a registration fee, but low-income applicants can request a fee exemption. Also, when signing up to participate in the examination, applicants have a good idea of the competitiveness of each major. Indeed, UNICAMP sets out the major-specific information from the previous year, such as the number of slots, the number of applicants, the ratio of applicants to slots, and the normalized final score cutoff.

The entrance process consists of a two-stage exam, Phase 1 (henceforth P_1) and Phase 2 (henceforth P_2). To be able to attend the second phase, applicants need to pass the first phase. The baseline first phase cutoff is 50% of the maximum P_1 score, i.e., 30 out of 60 points. Still, UNICAMP adjusts the major's specific cutoff score to guarantee that the number of applicants in the second phase remains between three and eight per seat. If the major is less competitive, the cutoff score may be below 50%, following the requirement to guarantee at least three applicants per slot. If the major is competitive, the major cutoff is adjusted upward. As a result, about

70% of the applicants are eliminated in the first phase.

In both phases, applicants need to answer questions about high school subjects. Applicants usually write P_1 in November and P_2 in January. Specifically, UNICAMP's 2004 P_1 examination took place on 23 November 2003, and UNICAMP's 2005 took place on 21 November 2004. UNICAMP's 2004 and 2005 P_2 took place in mid-January.

P_1 consists of 12 general open questions and an essay. P_1 score is defined by the maximum between (i) the sum of questions and essay scores and (ii) an average that grants weight 80% to the sum of questions and essay scores and 20% the *Exame Nacional do Ensino Medio* (ENEM) score.[2] The ENEM exam took place on 29 August 2004, while COMVEST published the manual of UNICAMP's 2005 admission exam on 27 August 2004.[3]

After the first phase, UNICAMP administers the P_2 examination over four days. Again, the questions are the same for all students. But, while in the P_1 all subjects are weighted equally, in P_2, the weights depend on the major chosen. This is because each major assigns higher weights at least for one priority subject in the P_2 score.

Finally, the admission is computed using the normalized final examination score, or the *nota padronizada de opçao* (NPO). The NPO is calculated using the standardized weighted average of P_1 and P_2 score, weighted according to the priority and non-priority subjects. P_1 score and each of the P_2 priority subject scores has a weight of two, and each P_2 non-priority subject score has a weight of one. Finally, UNICAMP computes the admission by ranking applicants' final exam scores in decreasing order and filling the seats subsequently.

2.2 UNICAMP's Affirmative Action Policy

UNICAMP implemented the affirmative action (AA) program in 2004, affecting the 2005 admission. Once the policy was implemented in 2005, it has been in effect every year since then. As mentioned, UNICAMP's AA policy is not gender-focused and aims to increase the share of public high school graduates among UNICAMP students. Under the AA policy, applicants from public high schools could request a granting of 30 points in the normalized final score (NPO). That bonus represents 30% of a standard deviation, added to the NPO. Note that the bonus does not help the possible eligible students to be approved in the first phase, as the bonus only applies

[2]The ENEM consists of a national end-of-high-school test that several public universities use as their admission exam.

[3]Comissão Permanente para os Vestibulares (COMVEST) is UNICAMP's admission office (https://www.comvest.unicamp.br/).

to the NPO after the second phase. In addition, students from public schools and minority groups can request an additional 10 points.[4] We included the latter group in the analysis as public school students.[5]

The motivation for adding the 30 points is to equalize the chances of admission of applicants from public schools and applicants from private schools. Estevan et al. (2019b) shows that adding 30 points shifts the distribution of the NPO score to the right so that the peaks of public and private school applicant distributions align in 2005.

In September 2004, the applicants filled out an online form during the registration and chose the major they were applying for. During registration, applicants also found out about the AA policy characteristics. So, applicants were aware of the policy criteria two months before the exam's first phase. Importantly, they had time to prepare for the UNICAMP exam in both stages in reaction to the policy announcement: applicants had about 3 and 4.5 months to adapt their preparation effort. Furthermore, it is reasonable to assume that the applicants know *ex-ante* the exam that the policy changes the probability of admission.

2.3 Competition effects

This section shows that UNICAMP's affirmative action policy is a source of competitive pressure variation since the policy changes the enrollment probability.

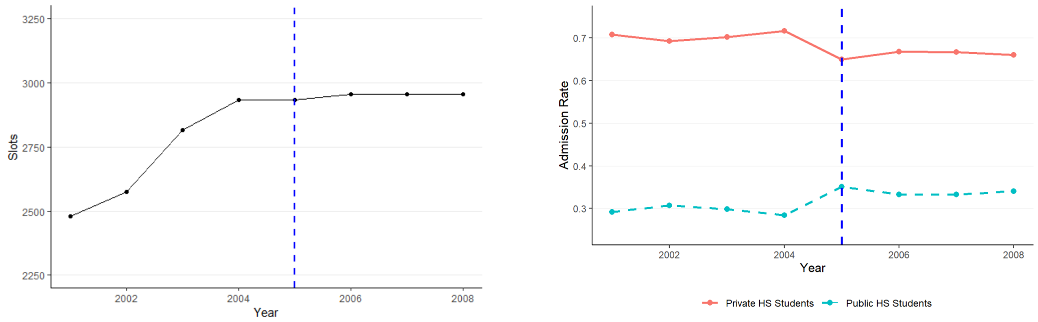
Figure 1a presents the number of slots through all majors by year. It increased slightly between 2001 and 2003 (an increase of 13.5%), but between 2004 and 2008, it was nearly unchanged. Importantly, there were 2,934 spots available in both 2004 and 2005.[6] Figure 1b shows the ratio of students enrolled in UNICAMP from different types of high schools by year. In other words, it shows the proportion of public (private) high school students among all students enrolled in UNICAMP. It suggests that the competitive pressure decreased between 2004 and 2005 for public school students (and increased for students from private high schools) since the enrolled ratio increased (decreased). The rate of public high school students enrolled went from about 24.5p.p. to 30.4p.p., representing an increase of 24.1%. Thus, there is evidence that public

[4]UNICAMP considered applicants belonging to minority groups who declare themselves black, mulatto, or native.

[5]They represent only 5.6% of the sample. Furthermore, as the applicant's belonging to the minority group is self-reported, the policy may have induced students to declare this option. In this case, the minority group indicator would be endogenous, which would bias our results. Nevertheless, we do an extra exercise using the heterogeneity of bonus to identify the effect on the 40-point addition group and report the results in Appendix A. We did not find a significant heterogeneous effect on NPO.

[6]The applicants' manual detailed the number of available slots for each major, ensuring that candidates were informed about the slot allocations for each major during the registration for the UNICAMP entrance exam.

high school applicants faced less competition after the policy.[7] The magnitude of change was less significant (9.7%) for students from private schools, given their initially higher enrollment rate, which shifted from 72p.p. to 65p.p. To sum up, the proportion of winning spots of applicants from public (private) schools is higher (lower) after the policy, making winning easier (harder).



(a) Total slots offered

(b) Enrollment rate

Figure 1: Slots and Enrollment Rate Change

3 Theoretical Framework

In this section, we build on the theoretical model from Estevan et al. (2019a) to sketch a simple model and predict gender responses to competitive environments. This model is drawn from well-known results from the contest literature (see, e.g., Baik (1994), Tullock (2001) and Stein (2002)). The male performance advantage under competition observed previously in the literature may be driven by factors such as real or perceived differences in confidence, ability, or preference for competition. However, the literature has little consensus on how those factors underlie behavioral responses. Thus, theoretical literature modeling contests and tournaments can provide insight into the mechanisms affecting gender differences. Our analysis uses this contest model to assess the expected performance variation among female public school applicants.

Four relevant groups can be defined for the UNICAMP exam: females and males from private schools and females and males from public schools. We want to determine the changes in the performance of females compared to males, so the differentiation between genders is important to understand the response of these groups to competition. In addition, the differentiation between public and private schools is relevant to distinguish the groups eligible for the bonus.

[7] Another way to measure exogenous variations in the competition is to use year-to-year fluctuations in the admission rate. Since the number of slots at UNICAMP was relatively stable and the number of applicants changed yearly, there was a non-expected admission rate variation between 2001 and 2004. However, this variation was very small: the average change in the ratio of applicants per offered slot from one year to the next was 1.74 between 2002 and 2004. Using the sample from 2002 to 2004, we test if females perform differently depending on the admission rate within the major in the previous year. We do not find any significant results.

Let four groups of players populate a contest. There are 1) females from private schools (PF), 2) females from public schools (BF), 3) males from private schools (PM), and 4) females from public schools (BM). Players from group g simultaneously and independently choose a level of effort, $e_g \geq 0$. The player's utility equals $u_g = W_g - \tau_g e_g$, where $W_g \geq 0$ indicates the winning prize and τ_g captures the cost of effort for group g. We assume that $W_g = W$ is equal among four groups and, in our framework, $W = 0$ means that the applicant is not admitted.

Define the exam performance as $y_g = e_g a_g$, where $a_g > 0$ is group g's players ability. It represents the rate at which the effort e_g is converted into effective performance. Since our empirical results control for observed ability (i.e., ENEM scores), the a_g in the model represents agents' ability under competitive pressure, excluding observed ability. Player costs, valuations, and ability parameters are common knowledge.

Drawing on the model built by Estevan et al. (2019a), we assume that success at the admission exam increases in own effort spent on exam preparation and decreases in the other players' effort choices. We define the group g probability of winning the contest as

$$p_g = \frac{a_g e_g}{\sum_{j=1}^{4} a_j e_j}.$$

Therefore, the expected utility is given as follows:

$$\mathrm{Eu}_g = W p_g - \tau_g e_g.$$

While ability is not directly observed, we can infer it using pre-policy UNICAMP exam scores since it is reasonable to think this ability is positively related to the observed ability. So, we assume that $a_{PM} > a_{PF} > a_{BM} > a_{BF}$. Such ability ranking is consistent with what we observe from the UNICAMP score before the affirmative action policy. The average normalized final score (NPO) of males from private schools is 520.92, 517.19 for females from private schools, 476.63 for males from public schools, and 460.89 for females from public schools (see Section 2 for the definition of NPO). To isolate the effect of ability differences, we assume that the players do not differ in the cost of effort, i.e., $\tau = \tau_{PF} = \tau_{PM} = \tau_{BF} = \tau_{BM}$.

We solve for the Nash equilibrium of this simultaneous move game. In equilibrium, neither player can be incentivized to deviate from their effort choice, given the effort choice of the other players. Following Cotton et al. (2015), we assume two hypotheses to ensure an interior solution.

The first is:

$$\frac{3W}{a_g} < \sum_{j=1}^{4} \frac{1}{a_j}. \tag{1}$$

In that case, all students choose to participate. This captures the participation condition in stage P_2. We conclude from (1) that if the other player's ability is much higher than the ability of player i, then that player i may not have much of an incentive to participate, as the probability of winning would be low. This condition is easily satisfied for students with higher abilities (students from private schools). We assume that is true for all students who take the second phase of the entrance exam. The second hypothesis is:

$$\frac{a_g e_g}{\sum_{j=1}^{4} a_j e_j} < \frac{1}{2}. \tag{2}$$

Here, we are stating that the likelihood of group g winning the competition cannot be greater than 50%. If a group has a more than 50% chance of winning the tournament, the other groups start to lose interest in competing.

We derive the equilibrium solution when solving the system of first-order conditions for $\{e_{PM}, e_{PF}, e_{BM}, e_{BF}\}$, following Cotton et al. (2015). We find the equilibrium effort as follows:

$$e_g^* = \frac{1}{\tau}\left(\frac{3Wa_g\left(\sum_{j=1}^{4}\frac{1}{a_j}\right) - 9W^2}{a_g^2\left(\sum_{j=1}^{4}\frac{1}{a_j}\right)^2}\right).$$

Consequently, we can determine the equilibrium performance by $y_g^* = a_g e_g^*$.

Affirmative action policy: Following Estevan et al. (2019a), we assume that the bonus represents an increase in the effort return. We model the ability of applicants that receive a bonus after the policy as $a'_g = a_g + \delta$, with $\delta > 0$. Because of policy timing, we expect the bonus to primarily affect examination preparation, i.e., the effort e_g.

Note that eligible applicants receive a bonus only in P_2. Therefore, we expect that the equilibrium effort and performance will not change in the first phase, given that there is no bonus addition. We also assume that the value of being accepted W remains unaffected by the policy in all groups.

We are interested in measuring how the AA policy impacts differently the gender gap among students from public and private schools. In addition, for our econometric approach, it is useful to determine the changes in the performance difference between genders among applicants from public schools compared to applicants from private schools. Therefore, we measure the affirmative policy's effect on the gender gap by the triple interaction coefficient β_6 in equation (4). Denoting the post-intervention parameters by primes, we define that performance variation of interest as:

$$\Delta y^* = [(y^{*\prime}_{BF} - y^*_{BF}) - (y^{*\prime}_{PF} - y^*_{PF})] - \\ [(y^{*\prime}_{BM} - y^*_{BM}) - (y^{*\prime}_{PM} - y^*_{PM})].$$

If this variation is positive, female applicants from public schools, which receive the bonus, perform better when facing less competition. We use the effort and performance in the equilibrium to simplify the final score variation of female applicants from public schools. We present the mathematical derivations in Section B. The result is as follows:

$$\Delta y^* = \frac{9W^2\left(\frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}} - \frac{1}{a_{BF}+\delta} - \frac{1}{a_{BM}}\right)}{\tau\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)^2}. \tag{3}$$

It is straightforward to conclude that $\Delta y^* > 0$, since $a_{BF} < a_{BM}$. Therefore, as expected, the variation in the performance of females from public schools under the policy is positive.

4 Data and Descriptive Statistics

Our primary dataset contains administrative individual-level data from the UNICAMP admission exam (*vestibular*) provided by COMVEST. We have information on all applicants who registered for UNICAMP's entrance examination. We also observe the applicants' scores in the first and second stages, their admission and enrollment status at UNICAMP, background information, and family characteristics.

The dataset is available for 2001-2008, but we limit our analysis to 2004 and 2005. We do so because UNICAMP implemented its affirmative action policy in 2005. Therefore, to avoid significant changes in the pool of applicants caused by the policy, we use the sample ending in 2005 in the main specification. We also limit our analysis to the sample starting in 2004 because, as we show in Figure 1 in Section 2, the effect of policy on the enrollment rate change was greater between 2004 and 2005. We observe that the admission rate increased for public school students and decreased for private school students in this period. However, we also perform robustness tests using the 2001-2005 sample (see Appendix A).

Our data contains the ENEM scores of those applicants who provided their information to UNICAMP from the Ministry of Education. Our main analysis uses the ENEM score to control for the applicant's academic ability. Since the ENEM score only increases the UNICAMP score, the applicant is incentivized to provide that information. The sample of students that provided the ENEM information represents 90% of the applicants. Although the formulation of the ENEM exam has not changed between 2003 and 2008, the scores over the years are not comparable. So, we normalized the ENEM score by year using all UNICAMP students. The P_1 score is normalized among the students who passed the first phase, and the P_2 score is normalized for each year.

We have the admission and enrollment information. Additionally, with the aim of measuring the net effect of the policy on performance without accounting for the mechanical effect of performance improvement due to the bonus, we construct a 'predicted admission' for each individual who applied in 2004 or 2005. To do this, for each of these years, we calculate the filled slots in each major, which essentially involves counting how many students enrolled in each major per year. Afterward, we rank the students according to their normalized final score (NPO) net of the bonus within each year. In this ranking, if the student's placement is lower than the number of slots filled in the major and year, they would be admitted without considering the bonus addition. Then, we create a binary indicator that is assigned a value of one if the student is admitted to their chosen major without taking into account the bonus points and zero otherwise.

In addition, we limit our analysis to P_1 survivors (see discussion below). Our initial sample contains 99,653 applicants who applied to UNICAMP for admission in 2004 and 2005. We keep only 98,779 observations due to missing gender information (0.88% of the sample). Upon excluding students eliminated in the first phase, our dataset comprises 26,745 observations. We remove 1.68% of the sample due to missing high school information. We also limited our final sample to applicants who had information on score and admission, as well as additional information on the students' controls in our main regression, such as age, occupation, and parental education levels. We drop 16.13% of the sample with those restrictions. After dropping eliminated students in the first phase, our final sample contains 22,275 observations of students eligible to attend the second exam phase.

As the bonus is not applied to the first phase score and the admission for the second phase maintains the same rule as before the policy, the policy effect on the applicants' pool is likely less evident in the P_1 survivors sample. Tables 1 and 2 compare the applicant pools pre and post-intervention between genders considering respectively all students and only P_1 survivors. In both tables, we report the difference between 2004 and 2005 for males in column (3) and females in column (6). We can see that, in general, males and females differ in educational performance. Female applicants have, on average, lower ENEM scores.

We report the applicant pool differences by gender between 2004 and 2005 in column (7). That coefficient represents the difference between female and male applicant pools before and after the intervention. We can see that more females from public schools choose to take the exam one year after the policy change. Female applicants have a higher chance of having a job, lower mothers' education, manual-occupated parents, and lower normalized ENEM scores after the policy adoption. That result shows a change in the pool of students who took the first phase between 2004 and 2005. Niederle and Vesterlund (2007) claims women tend to participate more in less competitive environments. Following this statement, we would expect a higher number of female students from public high schools to register for the entrance exam in comparison to their male counterparts from the same educational background if public school students perceive higher admission prospects after the policy. Thus, this outcome aligns with the perception of increased admission chances among public school students and that eligible women are more likely to enter the competition after the policy. However, we will not discuss the causal effect of the policy on competition entry as it falls outside the scope of this project.

Table 1: Descriptive Statistics 2004-2005 by Gender - All students

	Male			Female			
	2004	2005	Difference	2004	2005	Difference	Gender Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eligible Groups							
Public high school (%)	32.1	34.4	2.335***	34.1	38.7	4.512***	0.874***
Visible minority (%)	15.2	20.7	5.456***	14	20	6.011***	0.184
Work information							
Financed by family (%)	86.7	87	0.229	91.2	90.7	-0.488*	-0.921***
Financially help familly (%)	8.8	9.2	0.342	6.1	6.9	0.777***	0.678***
Work 32+	13.3	13.1	-0.277	9.2	9.2	0.056	0.868***
Parents information							
Mother with manual occ. (%)	7.4	7	-0.388	8	8.8	0.832***	0.66***
Mother with 'mid-top occ.' (%)	29.2	26.6	-2.594***	30.1	26.6	-3.466***	-1.316***
Mother with 'top occ.' (%)	27.4	29.2	1.754***	25.1	26.6	1.465***	-0.378
Father with manual occ. (%)	12.7	13.4	0.669**	14.5	16.4	1.848***	0.406*
Father with 'mid-top occ.' (%)	32.9	30	-2.861***	34	30.4	-3.665***	-1.751***
Father with 'top occ.' (%)	47.7	46.9	-0.743	43.8	41.8	-2.044***	0.484
Mother without HS degree (%)	26.1	26.1	0.027	28.8	29.9	1.136***	-0.054
Mother with HS degree (%)	31.6	31.1	-0.56	31.9	31.6	-0.302	1.007***
Mother with university degree (%)	42.3	42.8	0.533	39.3	38.5	-0.834*	-0.952***
Father without HS degree (%)	25.3	25.4	0.162	28.7	29.7	1.007**	0.043
Father with HS degree (%)	27.5	27	-0.529	28.7	29	0.337	0.302
Father with university degree (%)	47.2	47.6	0.368	42.6	41.2	-1.344***	-0.345
City of residence							
Sao Paulo state	84.6	82.5	-2.145***	86.5	84.8	-1.663***	-0.014
Other state southeast	6.6	7.3	0.749***	6	6.6	0.592***	-0.021*
Northeast (%)	2.6	3.6	0.969***	2.3	3	0.743***	0.008
South (%)	2.3	2.4	0.061	2	2.2	0.187	-0.003
Centre West (%)	2.2	2.6	0.339**	1.9	2	0.062	-0.005
North (%)	0.7	0.7	0.038	0.6	0.5	-0.039	-0.003
ENEM information							
Missing ENEM score (%)	13.4	15.4	2.048***	9.3	12	2.717***	0.804***
ENEM Score	91.52 (17.218)	92.213 (17.188)	0.692***	85.343 (18.635)	84.569 (18.883)	-0.774***	0.029
Normalised ENEM Score	1.492 (0.801)	1.737 (0.796)	0.245***	1.204 (0.867)	1.383 (0.874)	0.179***	-0.018***
Others							
Age	20.004 (3.846)	20.08 (3.919)	0.076**	19.69 (3.401)	19.838 (3.553)	0.148***	0.008
Observations	23,520	25,173		23,917	26,169		

Notes: This table shows the means of various applicants' characteristics by gender. Columns (3) and (6) represent the difference in gender over the years. Gender difference in column (7) and corresponding significance are computed based on a regression that interacted with the female indicator with the year of policy adoption dummy and controls for gender, major choice, and municipality fixed effect. Public high school is a binary variable equal to one if the applicant was enrolled in a Brazilian public school and zero otherwise. Visible minority represents applicants who declare themselves black, mulatto, or native. The Normalized ENEM score is normalized yearly using all applicants' averages and standard deviations. Standard errors are reported in parentheses. Also, we use a cluster-robust municipality and major choice to calculate the significance. *Significant at 10%; **significant at 5%; ***significant at 1%.

The pool change is less pronounced when we restrict the sample to P_1 survivors, as shown in Table 2. The share of females from public high schools among P_1 survivors has not increased compared to males. We observe that there is an over-representation of female applicants who have a job and an under-representation of females with parents occupied in 'mid-top' positions among stage P_1 survivors.

The changes in the pool of applicants have led to a higher proportion of female candidates from less advantaged backgrounds. Therefore, we can hardly attribute an improvement in the performance of public school female students after the intervention to a change in the applicant pool. Note that the changes are small in magnitude, representing less than a 2% change in the applicant's proportion gap. Furthermore, we use family background information and labor market indicators as controls in our main regressions to deal with that change.

Table 2: Descriptive Statistics 2004-2005 by Gender - P_1 Survivors

	Male			Female			
	2004	2005	Difference	2004	2005	Difference	Gender Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eligible Groups							
Public high school (%)	25.1	24.6	-0.536	25.7	26.9	1.119	1.378
Visible minority (%)	11.5	15.3	3.764***	9.9	13.1	3.178***	-0.605
Work information							
Financed by family (%)	93	93.4	0.43	95.2	95.3	0.027	-0.151
Financially help familly (%)	4.3	4.5	0.263	3.2	3.1	-0.092	-0.556
Work 32+	8	7.4	-0.688	5.8	5.6	-0.201	0.134
Parents information							
Mother with manual occ. (%)	5.4	5.3	-0.061	5.6	5.3	-0.339	-0.302
Mother with 'mid-top occ.' (%)	30.4	27.9	-2.476***	31.9	28.8	-3.184***	-0.753
Mother with 'top occ.' (%)	29.7	31.8	2.05**	27.8	30	2.234**	0.771
Father with manual occ. (%)	9.4	9.4	0.03	10.3	10.1	-0.282	-0.259
Father with 'mid-top occ.' (%)	33.1	29.6	-3.472***	35	31.8	-3.17***	-0.233
Father with 'top occ.' (%)	53.2	53.8	0.548	49.2	49.5	0.343	0.367
Mother without HS degree (%)	19	18.6	-0.369	21.2	20.6	-0.555	-0.623
Mother with HS degree (%)	32.4	31.4	-0.961	30.9	32.8	1.905**	3.033**
Mother with university degree (%)	48.6	49.9	1.331	47.9	46.6	-1.35	-2.41*
Father without HS degree (%)	18.4	18	-0.48	20.7	20	-0.682	-0.599
Father with HS degree (%)	27.7	26	-1.703**	28.6	29.4	0.734	2.577**
Father with university degree (%)	53.9	56.1	2.182**	50.7	50.6	-0.052	-1.978
City of residence							
Sao Paulo state	86.1	84	-2.099***	88	87.3	-0.691	-0.052
Other state southeast	6.6	7.3	0.654	5.6	6.4	0.828*	-0.015
Northeast (%)	2	2.8	0.77***	1.7	1.9	0.23	0.01
South (%)	1.8	1.8	-0.01	1.8	1.8	-0.08	0.047
Centre West (%)	2.3	3	0.695**	1.8	1.8	0.066	-0.017
North (%)	0.5	0.6	0.148	0.6	0.4	-0.188	0.041
ENEM information							
Missing ENEM score (%)	0	0		0	0		
ENEM Score	101.117 (10.807)	102.352 (10.694)	1.236***	97.495 (11.915)	97.645 (12.218)	0.15	-0.869***
Normalised ENEM Score	1.938 (0.503)	2.206 (0.495)	0.268***	1.769 (0.554)	1.988 (0.565)	0.218***	-0.039***
Others							
Age	19.303 (2.478)	19.351 (2.411)	0.049	19.263 (2.207)	19.376 (2.166)	0.113**	0.026
Observations	6,935	5,773		5,315	4,252		

Notes: This table shows the means of various applicants' characteristics by gender. Columns (3) and (6) represent the difference in gender over the years. Gender difference in column (7) and corresponding significance are computed based on a regression that interacted with the female indicator with the year of policy adoption dummy and controls for gender, major choice, and municipality fixed effect. Public high school is a binary variable equal to one if the applicant was enrolled in a Brazilian public school and zero otherwise. Visible minority represents applicants who declare themselves black, mulatto, or native. The Normalized ENEM score is normalized yearly using all applicants' averages and standard deviations. Standard errors are reported in parentheses. We use a cluster-robust municipality and major choice to calculate the significance. *Significant at 10%; **significant at 5%; ***significant at 1%.

Overall, there has not been a significant change in the applicants' characteristics regarding educational background, home city, and ENEM score by gender (see Table 2 column (7)). Thus, we cannot exclude that the policy altered the pool of UNICAMP applicants by gender, although the changes are small when considering the P_1 survivors.

5 Empirical strategy

Our main analysis aims to measure whether the competitive pressure induced by the affirmative policy has affected the gender performance gap in the UNICAMP exam. Formally, the specification takes the following form:

$$\begin{aligned} S_{i,c,m,t} = \alpha &+ \beta_0 Female_i + \beta_1 AA_t + \beta_2 Public_i + \beta_3 (Female_i \times AA_t) \\ &+ \beta_4 (Female_i \times Public_i) + \beta_5 (AA_t \times Public_i) + \beta_6 (Female_i \times Public_i \times AA_t) \\ &+ \gamma ENEM_i + \psi_c + \eta_m + X_i \Gamma + u_{i,c,m,t} \end{aligned} \tag{4}$$

where $S_{i,c,m,t}$ represents one of our performance measures, as described below, for applicant i observed in year t, who applied to major c and lives in the municipality m. $Female_i$ is a dummy variable that indicates if the student i is female; AA_t is equal to one if the student application took place after the implementation of the affirmative action policy; $Public_i$ is equal to one if the student studied in a public high school; $ENEM_i$ is the normalized score obtained by student i on the ENEM exam; and X_i is a vector of controls for other applicant's characteristics, as a quartic function of age, parental educational attainment, and parental occupation. ψ_c and η_m are the fixed effects of major choice and municipality, respectively. We control for parental characteristics, as there is a slight change by gender in our sample post-policy, as shown by Table 2 in Section 4. Moreover, it is well documented in the literature that the education and occupation of parents are strongly correlated with the development of their children's cognitive skills (Lundborg et al., 2014). Additionally, we control for major fixed effects due to the fact that the major choice might change following the policy for some individuals, and these choices affect the final score and admission probability. We include municipality-fixed effects to control for potential geographical-level differences. Finally, $u_{i,c,m,t}$ is a purely random performance shock. Our standard errors are clustered at the major choice and municipality levels in our regressions. We cluster at major choice and municipal levels to handle shocks in prior education for applicants with similar major choices and from the same geographical region, following Estevan et al. (2019a).

We include normalized ENEM score as a control since it measures student ability with little influence from UNICAMP's affirmative policy. Given the timing of the policy, applicants did not have time to adjust their effort for the ENEM examination. Still, they had enough time to adjust their effort for both stages of the UNICAMP exam. We also assume that the link between the ENEM score and the applicant's ability did not change differently after the AA implementation between genders.

We look at four particular outcomes: 1) normalized final score (NPO) without the bonus, 2) normalized first phase score, 3) the probability of being admitted to the UNICAMP exam, and

4) the simulated probability of being admitted.

One might argue that measuring the effect of policy on admission would capture both the effect of the bonus addition to the score and the response to the competition. To account for this, we try to isolate the effect of the competition on scores, excluding the effect of the bonus. Recalling, we compute the filled positions in each major for the years 2004 and 2005. Next, we assign a ranking to each student based on their NPO after deducting the bonus. If the student's placement in this ranking is less than the total number of spots filled in the major and year, we consider that he is admitted without taking the bonus addition into account. The goal is to measure whether the effect of competition on the final score is enough to change the admission, excluding the effect of adding the bonus. We explain how we compute this measure in Section 4.

Our parameter of interest is β_6 which measures the effect of implementing the affirmative policy on females from public schools. Under standard OLS assumptions and the hypothesis $E[u_{i,c,m,t} \mid Female, Public, AA] = 0$, we draw on the formal triple interaction definition.[8] We use the framework from Olden and Møen (2022) to guide our empirical work. Starting at the top of the equation (4), we can define the triple interaction as

$$\begin{aligned}\beta_6 =& [(E[S \mid Public = 1, Female = 1, \text{ Post } = 1] - E[S \mid Public = 1, Female = 1, \text{ Post } = 0]) \\ & - (E[S \mid Public = 0, Female = 1, \text{ Post } = 1] - E[S \mid Public = 0, Female = 1, \text{ Post } = 0])] \\ & - [(E[S \mid Public = 1, Female = 0, \text{ Post } = 1] - E[S \mid Public = 1, Female = 0, \text{ Post } = 0]) \\ & - (E[S \mid Public = 0, Female = 0, \text{ Post } = 1] - E[S \mid Public = 0, Female = 0, \text{ Post } = 0])],\end{aligned} \tag{5}$$

where S is our outcome (applicant's performance). Note that, when we consider the normalized final score as the outcome, the triple interaction coefficient represents the variation Δy^* formulated in equation (3) in Section 3.See Appendix B for details.

Another key coefficient for our analysis is β_3, which emerges from the interaction between $Female_i$ and AA_t, and is defined as:

$$\begin{aligned}\beta_3 =& E[S \mid Public = 0, Female = 1, \text{ Post } = 1] - E[S \mid Public = 0, Female = 1, \text{ Post } = 0] \\ & - (E[S \mid Public = 0, Female = 0, \text{ Post } = 1] - E[S \mid Public = 0, Female = 0, \text{ Post } = 0]).\end{aligned} \tag{6}$$

It can be clearly demonstrated that the sum of $\beta_3 + \beta_6$ captures the gender difference before

[8]Since we are controlling for a vector Z of variables in equation (4), the exact hypothesis is $E[u_{i,c,m,t} \mid Female, Public, AA, Z] = 0$. For clarity in notation, we will omit Z from subsequent references.

and after the policy implementation among public school applicants. We define this sum as:

$$\beta_3 + \beta_6 = E[S \mid Public = 1, Female = 1,\ \text{Post} \ = 1] - E[S \mid Public = 1, Female = 0,\ \text{Post} \ = 1]$$
$$- (E[S \mid Public = 1, Female = 1,\ \text{Post} \ = 0] - E[S \mid Public = 1, Female = 0,\ \text{Post} \ = 0])$$

Note that this sum represents the effect of the policy on eligible females compared with their male counterparts.

Identification Strategy: As discussed in Section 2, competition increased for private school students and decreased for public school students after the AA policy adoption. Since the change in competitiveness is exogenous, given the quasi-random assignment nature of UNICAMP's affirmative action policy, we claim that the triple differences model estimates the competitive pressure effects on performance. More specifically, if competitive pressure is a significant factor in determining students' exam performance, we expect female public school students to do better after the AA policy adoption than male public school students.

Using the potential outcome framework, we can define $E[S_{1,i,c,m,t}]$ as the expected performance of an applicant i from municipality m, in major c and year t if treated, while $E[S_{0,i,c,t}]$ is the expected performance of the applicant if not treated. We derive the parallel trend assumption that identifies the average treatment effect on the treated (ATT) as:

$$(E\left[S_0 \mid Public = 1, Female = 1,\ \text{Post} \ = 1\right] - E\left[S_0 \mid Public = 1, Female = 1,\ \text{Post} \ = 0\right])$$
$$- (E\left[S_0 \mid Public = 1, Female = 0,\ \text{Post} \ = 1\right] - E\left[S_0 \mid Public = 1, Female = 0,\ \text{Post} \ = 0\right])$$
$$=$$
$$(E\left[S_0 \mid Public = 0, Female = 1,\ \text{Post} \ = 1\right] - E\left[S_0 \mid Public = 0, Female = 1,\ \text{Post} \ = 0\right])$$
$$- (E\left[S_0 \mid Public = 0, Female = 0,\ \text{Post} \ = 1\right] - E\left[S_0 \mid Public = 0, Female = 0,\ \text{Post} \ = 0\right]).$$

Thus, we need the differential in the outcomes of females and males from private schools to trend similarly to those of females and males from public schools in the absence of treatment. In other words, the gender gap before and after the policy, if not treated, must be the same among applicants from public and private schools. To check the validity of this assumption, we use data from 2001 to 2004. We show the pre-affirmative action trends (2001-2004) in Table 3 in admission rate and normalized final score as outcomes (columns (1) and (2), respectively). We conclude that the trends in the female-male gaps were stable before affirmative action for both outcomes of interest.

Table 3: Pre-Affirmative Action Trends (2001-2004) - P_1 Survivors

	(1)	(2)
Enem Score	0.015***	2.851***
	(0.000)	(0.098)
Female× Public HS × 2002	0.010	−0.982
	(0.027)	(3.054)
Female × Public HS ×2003	0.007	2.015
	(0.026)	(3.215)
Female × Public HS × 2004	−0.013	−3.534
	(0.031)	(2.776)
Dep. Variable mean	0.31	458.417
Year Fixed Effects	Yes	Yes
Personal Characteristics	Yes	Yes
Parental Education	Yes	Yes
Parental Occupation	Yes	Yes
Major Fixed Effects	Yes	Yes
Municipality Fixed Effects	Yes	Yes
Observations	46,979	43,959

Notes: Personal characteristics consist of a function of age, gender, while the parental education and occupation controls each consists of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Although we control for 'Public High School', 'Female' and the interactions of 'Public High School' and 'Female' with years 2002-2004 in all specifications, we do not present these coefficient estimates. Two-way cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

A possible concern is the applicant's pool selection caused by the policy. For example, suppose the policy causes an over-representation of public school students and attracts applicants with different non-observable characteristics. In that case, it may change the gender gap in the potential outcome of public school applicants differently than private school applicants. To account for this, our final sample contains only P_1 survivors. In this case, we control for the heterogeneity in unobservables related to academic ability since there is less unobserved variation among applicants admitted to P_2. Additionally, in Section 4, we show that the difference in applicant pool before and after the policy implementation remained relatively unchanged by gender among P_1 survivors.

Another concern is that some students may change their major application choices. Applicants from public schools may choose more competitive majors, given a higher chance of being approved under the new policy. Furthermore, within a major choice, there may be a shift in the applicant pool. That change in the major choice may affect the preparation effort applicants apply for the exam. Literature suggests that women try to avoid greater competition than men. Niederle and Vesterlund (2007) and Datta Gupta et al. (2013), for example, show through laboratory experiments that women tend to choose less competitive environments. Also, Flory et al. (2014) shows that the choice of occupation may differ between men and women given the occupation's competitiveness level. With the implementation of the AA policy and the consequent change in competition, female applicants may change their application major.

Estevan et al. (2019b) finds that UNICAMP's major choices changed for public high school applicants relative to their private school counterparts only from 2006 onwards when students already knew in advance of the policy's existence. However, Estevan et al. (2019b) just discusses public vs. private change after AA policy, but the important question here is whether eligible male and female applicants choose different careers post-policy. Then, we estimate the equation (4) to test if the AA policy implementation affects more female applicants from public schools relative to their male counterparts. Following Estevan et al. (2019a), we investigate the impact of the policy on major choices using three outcomes. First, we use a dummy equal to 1 if the applicant chose one of the top 5 more competitive majors in UNICAMP. Second, we use the probability that applicants apply to medicine, one of the more prestigious and competitive UNICAMP majors. Finally, we use the previous year's P_2 cutoff of the major chosen. As mentioned in Section 2, applicants can see the P_2 cutoff for each major of the previous year when registering for the admission exam. The previous P_2 cutoff corresponds to the specific major final score of the last admitted student in the last year. During the 2004 registration, applicants can see the 2003 major specific P_2 cutoff, and in the 2005 registration, the 2004 P_2 cutoff. So, looking at those outcomes, we can investigate if the applicants choose a more competitive major under the new policy.

Table 4 depicts the coefficient estimation using the three dependent variables suggested above (columns (1) to (3)). When considering competitive majors application, we see that the likelihood of female applicants choosing top-five majors became higher after the policy adoption relative to their male counterparts (Female $\times$ AA year estimator is marginally significant in column (1)). We also observe that females from public schools choose majors with a lower P_2 cutoff score in the previous year. However, female applicants from public schools that experience lower competition do not change their major choice to a more prestigious major relative to their male counterparts and controlling for private school applicants trend (see Female $\times$ AA year $\times$ Public

HS estimator in columns (1), (2), and (3)).

Regarding selective attrition between UNICAMP's first and second phases, we test whether females from public schools have a different likelihood of showing up to the second phase examination. The estimation results in Table 4 (column (4)) show that considering only applicants eligible for P_2, females from public schools do not voluntarily drop out of the examination more than applicants from other groups. In summary, our findings indicate that there are no significant gender-based disparities in major choices and examination attendance.

Table 4: Affirmative Action and UNICAMP Major Choice - P_1 Survivors

	Top 5	Medicine	Previous P_2 Cutoff	P_2 Drop Out
	(1)	(2)	(3)	(4)
Female	−0.010	0.095**	7.884	−0.002
	(0.082)	(0.045)	(8.947)	(0.002)
AA year	−0.057***	−0.030	−44.095***	0.003
	(0.021)	(0.019)	(9.336)	(0.002)
Public HS	−0.060**	−0.050*	−6.980	0.001
	(0.025)	(0.028)	(6.616)	(0.001)
Normalized ENEM Score	0.233***	0.161*	55.735***	−0.020***
	(0.080)	(0.088)	(9.096)	(0.007)
Female × AA year	0.025*	−0.001	6.518	−0.002
	(0.014)	(0.005)	(7.880)	(0.003)
Female × Public HS	−0.023	−0.038	−11.988*	0.020***
	(0.037)	(0.024)	(6.480)	(0.006)
AA year × Public HS	−0.004	0.002	0.695	0.002
	(0.010)	(0.007)	(6.703)	(0.004)
Female × AA year × Public HS	−0.005	−0.004	−0.965	−0.018*
	(0.020)	(0.013)	(6.961)	(0.009)
Dep. Variable mean (Female from public HS 2004)	0.071	0.045	453.042	0.037
Year Fixed Effects	Yes	Yes	Yes	Yes
Personal Characteristics	Yes	Yes	Yes	Yes
Parental Education	Yes	Yes	Yes	Yes
Parental Occupation	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes
Observations	22,275	22,275	21,334	22,275

Notes. The dependent variable in columns (1)-(2) is a dummy that indicates if the applicant applied to a top-five more competitive majors and a medicine major, respectively; in column (3), the dependent variable is the second phase cutoff of the previous year; and the dependent variable in column (4), P_2 Drop Out, takes the value of 1 if the participant was selected to participate in phase 2 but does not show up, and 0 otherwise. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

6 Main Results

6.1 UNICAMP Normalized Final Score

We start by analyzing whether the affirmative action (AA) policy affects the applicant's UNICAMP normalized final exam score (NPO) net of the bonus. We interpret the response to the policy in the group of applicants from public schools that experienced an increase in the admission rate and as a decrease in competitive pressure. Furthermore, as mentioned in Section 4, our sample consists only of applicants who passed the first phase.

Table 5 presents the results of estimating equation (4) for the years 2004 and 2005. We vary the set of controls in columns (1)-(5) to ensure the robustness of our findings. In column (2), we add the applicant's characteristics and parental education as controls, while column (3) repeats the same exercise and controls for the ENEM Score. The last two columns sequentially add fixed effects for major choices and municipalities where applicants live. The results suggest that female applicants score better than male applicants among private school applicants when we control for ability. While in columns (1) and (2), we do not estimate a significant female performance advantage (see Female estimator), column (3) shows that females had better scores. Even after controlling for major choice fixed effects in column (4), the higher scores of female applicants remain. Using our full set of controls in column (5), our results suggest that females score 7.400 more than their male counterparts controlled for the private school applicants trend.

Turning to the potential effect caused by the competition on the gender gap, we look to the Female $\times$ AA year $\times$ Public HS estimator. Although it is insignificant when we do not control for ENEM score, females from public schools generally seem to have an advantage under the AA policy. Focusing on column (5), female public school applicants score better relative to their male counterparts when we control for ability and major and municipality fixed effect. They score 7.237 higher (see Female $\times$ AA year $\times$ Public HS estimator in column (5)). That effect represents 0.1σ of the baseline sample's standard deviation of the NPO.

Table 5: Affirmative Action and Normalized Final Score - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female	-4.631	-4.097	10.278^{**}	7.252^{***}	7.400^{***}
	(7.131)	(6.884)	(4.236)	(1.707)	(1.689)
AA year	2.688	2.238	-22.908^{***}	-13.278^{***}	-13.487^{***}
	(2.499)	(2.417)	(2.350)	(1.625)	(1.806)
Public HS	-39.604^{***}	-23.686^{***}	-16.432^{***}	-6.129^{***}	-6.273^{***}
	(9.854)	(8.472)	(3.671)	(1.962)	(2.107)
Normalized ENEM Score			93.242^{***}	57.057^{***}	57.499^{***}
			(7.427)	(2.405)	(2.308)
Female × AA year	-3.673^{*}	-3.397	-0.122	-0.707	-0.617
	(2.195)	(2.273)	(1.762)	(1.561)	(1.710)
Female × Public HS	-14.734^{*}	-13.414^{*}	-10.141^{***}	-5.527^{**}	-5.357^{**}
	(8.935)	(7.913)	(3.610)	(2.615)	(2.517)
AA year × Public HS	-5.416	-4.871	-3.143	-3.553^{*}	-2.796
	(4.244)	(4.255)	(2.786)	(1.805)	(1.778)
Female × AA year × Public HS	5.625	5.549	8.888^{***}	8.113^{***}	7.237^{***}
	(4.419)	(4.491)	(3.050)	(2.045)	(1.943)
Dep. Variable mean	464.116	464.116	464.116	464.116	464.116
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	22,275	22,275	22,275	22,275	22,275

Notes. The dependent variable is the Normalized Final Score without the bonus. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Our findings also suggest that the ENEM score is highly correlated with UNICAMP's final score: one standard deviation difference in the ENEM score is associated with a 57.499-point difference in the NPO. These results suggest that the ENEM score captures some dimension of ability that is relevant to the UNICAMP exam.

The main result captures changes in the performance of private and public high school applicants relative to their male counterparts. To examine a possible additional effect in the group that is granted 40 points, we re-estimate the results, including the visible minority dummy. We show the results in Table 14 in Appendix A. First, the Female × AA year × Public HS changes since some public school applicants are now classified as minorities (see column (5)). Second, the Female × AA year × Public HS × Minority is positive, although insignificant. That means that an additional effect makes females from minority groups perform even better, but the difference of 10 points is not huge enough to impact the result significantly.

To sum up, we show that females who face less competition perform better relative to their male counterparts controlled for the private school applicants trend. However, that result does not necessarily imply that the score increase is enough to change admission patterns. Therefore, we perform a similar exercise using admission as an outcome to investigate the potential effect on this variable. This approach allows us to shed light on whether the affirmative action score effects are enough to increase the admission of females from public schools.

6.2 Admission Probability

We now examine the possible policy impact on the exam admission probability. Table 6 compares the change in the likelihood of admission for female applicants from public schools following the introduction of the affirmative action policy relative to their male counterparts. As expected, the policy increased the admission probability for students from public schools. In addition, the AA year × Public HS coefficient estimation suggests that implementing affirmative action policy correlates to increasing public school student admission among males. Considering our full set of controls, the private-public high school difference is ten percentage points among males (see column (5)).

Turning to possible gender responses, we focus on the difference in the female-male admission gap among students from public schools relative to their male counterparts. Table 6 suggests that affirmative action increased the admission likelihood of female public high school applicants in UNICAMP relative to their male counterparts. While in columns (1) and (2), we do not estimate a significant advantage in the admission of females from public school after the policy (see Female × AA year × Public HS estimator), column (3) shows that females from public school had better admission prospects. Even after controlling for major choice and municipality fixed effects in columns (4) and (5), the higher admission of female applicants from public schools remains. After the policy implementation, the advantage would be 5.5 p.p. relative to their male counterparts (without considering private school applicant's change, we estimate a variation of $\beta_3 + \beta_6 = 5.498$ with a p-value of 0.07758 with $H_0 : \beta_3 + \beta_6 = 0$). The effect represents about 16.45% of the mean admission of females from public schools for the 2004 sample.

To sum up, our preferred specification, which includes all control variables, demonstrates that the policy led to a substantial increase in the admission probability for applicants from public schools and a higher increase for female applicants from these schools compared to their male counterparts.

Table 6: Affirmative Action and UNICAMP Admission - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female	0.017	0.018	0.042**	0.049***	0.049***
	(0.016)	(0.016)	(0.019)	(0.008)	(0.009)
AA year	0.046***	0.046***	0.002	−0.042***	−0.044***
	(0.015)	(0.015)	(0.012)	(0.013)	(0.014)
Public HS	−0.013	0.015	0.028	−0.008	−0.013
	(0.021)	(0.021)	(0.022)	(0.019)	(0.017)
Normalized ENEM Score			0.160***	0.317***	0.324***
			(0.023)	(0.012)	(0.012)
Female × AA year	−0.012	−0.011	−0.005	−0.003	−0.002
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Female × Public HS	−0.017	−0.019	−0.014	−0.042*	−0.048**
	(0.023)	(0.022)	(0.022)	(0.022)	(0.022)
AA year × Public HS	0.097***	0.096***	0.099***	0.096***	0.102***
	(0.028)	(0.028)	(0.029)	(0.032)	(0.034)
Female × AA year × Public HS	0.045*	0.045*	0.051**	0.058*	0.055*
	(0.024)	(0.024)	(0.025)	(0.030)	(0.032)
Dep. Variable mean	0.322	0.322	0.322	0.322	0.322
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	22,275	22,275	22,275	22,275	22,275

Notes. The dependent variable is a binary variable equal to one if the applicant was accepted to UNICAMP and zero otherwise. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

6.3 Simulated Admission Probability

Our main finding suggests that competition reduction encourages female public high school applicants to perform better than their male counterparts. As a result, the net bonus final score has a significant behavioral effect. However, the previous admission analysis cannot distinguish the effect of the bonus from the effect of competition change. In this subsection, we test if the behavioral change would be enough to change the admission of female public school applicants relative to their male counterparts.

As explained in Section 5, we employ a strategy to isolate the effect of competition in admission from the mechanical effect of the bonus points. To estimate the effect caused by the decrease in competition, we re-estimate the main regression using a simulated admission in which we do not consider the bonus addition to calculate the admission probability. To this end, we ranked students according to their final score without the bonus. The result is in Table 7. The Female × AA year × Public HS estimator becomes insignificant and smaller (without considering private school applicant's change, we estimate a variation of $\beta_3 + \beta_6 = -0.015$ with a p-value of 0.10117 with $H_0 : \beta_3 + \beta_6 = 0$).

Overall, we do not find significant results for the admission probability induced by competition reduction. The competition effect is not enough to change the female applicant's admission without the bonus points of the AA policy.

6.4 First Phase Score

The framework presented in Section 3 suggests that the policy does not affect first-phase performance since the bonus is not added to that score. However, we cannot exclude that applicants reacted already in P_1, given the policy adoption timing. Focusing on the P_1 Survivors sample, we analyze whether UNICAMP's affirmative action (AA) policy affects the applicant's normalized first phase exam score. Table 8 presents the results. As in our main specification, we vary the set of controls in columns (1)-(5) to ensure the robustness of our findings.

Importantly, introducing the affirmative action policy is not associated with an increase in the first-phase performance of females from public schools. Generally, the Female × AA year × Public HS estimator is insignificant. When we control for the ENEM Score, the estimated coefficient is positive but insignificant (see column (3)). Only when we control for major fixed effects the estimator becomes marginally significant. The significance of the effect disappears when we consider municipality-fixed effects.

We re-estimate the regression using all students and report the results in Table 15 in Appendix A. We see that females from public schools perform better under the policy. Considering all the controls set, eligible females score 2.751 higher, which represents 5.68% of the P_1 score average. However, one would expect that this effect is partially explained by applicants' pool change caused by the policy in the P_1.

Table 7: Affirmative Action and Simulated Admission - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female	−0.008	−0.008	−0.014	−0.012	−0.013
	(0.013)	(0.013)	(0.014)	(0.007)	(0.008)
AA year	0.067***	0.068***	0.080***	0.068***	0.069***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
Public HS	0.007	0.006	0.003	−0.007	0.000
	(0.013)	(0.014)	(0.014)	(0.013)	(0.011)
Normalized ENEM Score			−0.044***	0.001	0.001
			(0.014)	(0.009)	(0.010)
Female × AA year	−0.007	−0.008	−0.009	−0.010	−0.013
	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Female × Public HS	0.046**	0.043**	0.042**	0.024	0.019
	(0.018)	(0.018)	(0.017)	(0.017)	(0.016)
AA year × Public HS	−0.002	−0.004	−0.004	−0.010	−0.013
	(0.021)	(0.021)	(0.022)	(0.021)	(0.020)
Female × AA year × Public HS	−0.014	−0.013	−0.014	−0.011	−0.002
	(0.028)	(0.028)	(0.028)	(0.029)	(0.029)
Dep. Variable mean	0.353	0.353	0.353	0.353	0.353
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	22,275	22,275	22,275	22,275	22,275

Notes. The dependent variable is a binary variable equal to one if the applicant would be accepted to UNICAMP without considering the bonus, zero otherwise. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 8: Affirmative Action and Normalized P_1 Score - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female	−5.896	−5.314	13.123**	7.244***	7.200***
	(9.302)	(9.015)	(5.461)	(1.938)	(2.046)
AA year	4.920	4.506	−27.747***	−15.739***	−16.297***
	(4.000)	(4.019)	(4.624)	(3.598)	(3.784)
Public HS	−41.683***	−25.487**	−16.184***	−4.952**	−5.396**
	(12.102)	(10.289)	(4.674)	(2.139)	(2.237)
Normalized ENEM Score			119.589***	73.322***	73.999***
			(8.849)	(2.571)	(2.447)
Female × AA year	−6.611*	−6.480*	−2.280	−2.668	−2.245
	(3.910)	(3.825)	(3.326)	(3.291)	(3.436)
Female × Public HS	−21.246**	−19.384**	−15.187***	−6.305***	−5.352***
	(10.315)	(9.165)	(4.041)	(2.087)	(1.932)
AA year × Public HS	−5.674	−5.056	−2.840	−3.783	−2.351
	(6.168)	(6.204)	(4.196)	(3.426)	(3.371)
Female × AA year × Public HS	1.181	1.186	5.469	5.377**	3.820
	(5.802)	(5.737)	(4.495)	(2.675)	(2.640)
Dep. Variable mean	452.917	452.917	452.917	452.917	452.917
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	22,275	22,275	22,275	22,275	22,275

Notes. The dependent variable is the Normalized first-phase score. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

We see that the policy causes a very small and insignificant effect on the first phase score, as expected, given the predictions of the theoretical framework. As both phases are about high school subjects, the marginally positive effect may be due to the applicant's anticipation of the second phase effect, which affects their preparation effort.

6.5 Heterogeneity: Enem Quartile

We split our main result into four quartiles based on their ENEM scores to examine the possible heterogeneity across student abilities. To do that, we re-estimate equation (4) among the ENEM score quartiles (where Q1 is the bottom quartile and Q4 is the top). Finally, we use the UNICAMP normalized final score as the outcome and present the results in Table 9.

As mentioned in Section 2, for the cohort applying in 2005, the ENEM exam took place before the official announcement of the affirmative action policy at UNICAMP. Columns (1)–(2) suggest that female applicants from public schools score less than males in UNICAMP in the bottom quartiles since the Female × Public HS estimator is negative and significant. The results also show that the affirmative action policy seems to affect more female students from public HS who scored less in ENEM, i.e., applicants in Q1 and Q2 (See Female × AA year × Public HS in columns (1) and (2)). Therefore, the effect on the lowest-ability applicants drives our results. The results show that females from public high schools reacted differently from their male counterparts, depending on their ability level. This finding is consistent with the lack of effects on admission, as the effect primarily comes from the group of applicants with lower admission prospects.

Table 9: Affirmative Action and Normalized Final Score: by ENEM Quartile - P_1 Survivors

	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Female	2.336	8.816***	9.254***	9.717***
	(1.685)	(2.562)	(2.202)	(2.554)
AA year	−4.476	−0.249	−0.560	−1.354
	(2.915)	(2.483)	(1.841)	(2.048)
Public HS	−4.687	−3.261	−7.357**	−11.416***
	(2.945)	(4.260)	(3.072)	(2.560)
ENEM Score	1.006***	3.030***	3.376***	4.394***
	(0.159)	(0.232)	(0.307)	(0.340)
Female × AA year	0.821	−2.725	2.305	2.839
	(2.419)	(3.076)	(2.186)	(3.030)
Female × Public HS	−7.404**	−8.631**	−5.074	−1.241
	(3.021)	(3.422)	(5.369)	(4.298)
AA year × Public HS	−3.066	−2.018	1.377	−1.858
	(3.147)	(3.863)	(2.866)	(3.627)
Female × AA year × Public HS	9.980**	6.672*	5.193	1.563
	(4.066)	(3.597)	(5.602)	(5.180)
Dep. Variable mean (Female from public HS 2004)	433.102	450.865	475.532	504.045
Year Fixed Effects	Yes	Yes	Yes	Yes
Personal Characteristics	Yes	Yes	Yes	Yes
Parental Education	Yes	Yes	Yes	Yes
Parental Occupation	Yes	Yes	Yes	Yes
Major Fixed Effects	Yes	Yes	Yes	Yes
Municipality Fixed Effects	Yes	Yes	Yes	Yes
Observations	5,614	5,588	5,551	5,522

Notes. The dependent variable is the Normalized Final Score net before the bonus addition. Applicants were separated into four quartiles (Q1, Q2, Q3, and Q4) based on their Normalized ENEM score. Q1 (Q4) comprises the 25% of the 2004 and 2005 applicants with the lowest (highest) ENEM scores. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

6.6 Alternative Explanations: Distance to Cutoff and Groups' Effect

We have shown that girls from public schools outperform boys following the implementation of the AA policy, especially when we look at lower ability levels. We claim that this identifies a positive reaction of female applicants as a response to decreased competition. Therefore, we rule out alternative explanations based on major choice and the applicants' pool change after the policy.

One may argue that competition has increased for the policy-eligible applicants since, after the policy, those far from and below the cutoff may be closer to the cutoff after the bonus addition. Specifically, females from public schools could be closer to cutoffs under the new policy, representing an increase in competitive pressure. In this case, we could not interpret the post-policy change among female applicants as a response to decreased competitive pressure.

To elucidate this alternative policy effect according to applicants' distance to the cutoff, we need to verify if the students perform differently given that. Given the major applied, we re-estimate the equation (4) by distance to the previous year's cutoff. The idea is that the policy does not affect the 2004 cutoffs and that the applicants should know how close they are to last year's cutoff.

Table 10 shows the estimation results for regressions, with the dependent variable being the NPO without the bonus. We first restrict our sample to applicants with a final score distance between $(-100, 100)$. We do this because it is in this sample where the bonus can be decisive for approval. Then, we split our regression into six ranges of distances. If the cutoff distance is negative, the applicant is below the cutoff and above otherwise. The estimation results, shown in Table 10, rule out the closeness to cutoff as an explanation. Female $\times$ AA year $\times$ Public HS is significant only for applicants between 60 and 30 points below the previous year's cutoff, i.e., those whose additional points are insufficient to change admission.

Table 10: Affirmative Action and Normalized Final Score: by Distance to Previous Year's Cutoff - P_1 Survivors

	(-100,-60) (1)	(-60,-30) (2)	(-30,0) (3)	(0,30) (4)	(30,60) (5)	(60,100) (6)
Female	−1.938	−0.769	−0.418	0.707	0.715	1.799
	(1.557)	(1.373)	(1.876)	(2.982)	(3.851)	(3.745)
AA year	−44.254***	−29.827***	−27.321***	−23.104***	−19.489**	−17.516**
	(5.454)	(5.622)	(7.324)	(7.296)	(7.407)	(7.036)
Public HS	0.821	−0.585	−2.853**	0.956	−4.001**	−0.401
	(1.307)	(1.035)	(1.330)	(2.465)	(1.695)	(1.792)
Normalized ENEM Score	2.694	4.088***	7.387***	9.299***	10.223***	14.098***
	(1.694)	(0.945)	(1.609)	(1.742)	(1.717)	(2.243)
Female × AA year	20.120***	6.891	7.887	3.408	1.409	1.067
	(5.896)	(4.162)	(6.060)	(5.807)	(6.829)	(6.068)
Female × Public HS	−4.801*	1.082	1.629	−2.945	−1.121	−1.778
	(2.578)	(1.217)	(1.200)	(2.044)	(1.704)	(2.369)
AA year × Public HS	−9.320	−7.236*	2.534	1.194	3.966	1.755
	(5.707)	(3.827)	(3.930)	(4.168)	(3.918)	(2.838)
Female × AA year × Public HS	7.462	5.759*	−2.232	−0.627	−2.236	0.022
	(7.653)	(3.382)	(3.566)	(3.826)	(3.562)	(3.492)
Dep. Variable mean	439.035	451.698	468.664	487.929	509.666	534.88
Observations	789	1,610	2,804	3,878	4,205	4,273

Notes. The dependent variable is the Normalized Final Score without the bonus. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

To shed some light on the heterogeneous effect concerning schools, we run the main results separately for applicants from private and public schools. We show the results in Tables 11 and 12. As shown in Section 2, competition decreases for public school applicants and increases for private school applicants.

Now, our coefficient of interest is Female × AA year. Controlling for all controls set, we see that the effect is positive and significant only for applicants from public schools, i.e., females who are awarded the bonus outperform male applicants from public schools. The estimated coefficient for private school applicants is negative, but it is not significant. Given that competition increased among private school applicants, we would expect that they would react in the opposite direction of public school applicants. One plausible reason for the absence of a significant negative effect could be that applicants from private schools did not foresee the impact of the policy on their chances of admission. Being outside the policy's target, they likely had limited information about its specifics and implications. Additionally, as illustrated in Figure 1, the policy's effect on the admission rates of private individuals was comparatively modest: an impact of 9.7% for private school applicants compared to a 24.1% effect for public school applicants.

Table 11: Affirmative Action and UNICAMP Final Score: Only Public School

	(1)	(2)	(3)	(4)	(5)
Female	−19.365***	−17.799***	−1.693	−0.198	0.643
	(7.168)	(6.406)	(3.740)	(2.109)	(2.080)
AA year	−2.728	−2.464	−23.509***	−14.428***	−13.213***
	(4.061)	(4.105)	(2.218)	(1.494)	(1.385)
Normalized ENEM Score			83.713***	47.797***	48.112***
			(5.145)	(2.108)	(1.970)
Female × AA year	1.951	2.361	8.138***	6.667***	5.444***
	(4.000)	(4.028)	(2.048)	(1.839)	(1.922)
Dep. Variable mean	464.116	464.116	464.116	464.116	464.116
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	5,673	5,673	5,673	5,673	5,673

Notes. The dependent variable is the Normalized Final Score without the bonus. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 12: Affirmative Action and UNICAMP Final Score: Only Private School

	(1)	(2)	(3)	(4)	(5)
Female	−4.631	−4.213	10.908***	7.921***	7.857***
	(7.131)	(6.831)	(4.174)	(1.685)	(1.702)
AA year	2.688	2.207	−24.128***	−14.412***	−14.777***
	(2.499)	(2.402)	(2.697)	(1.655)	(1.837)
Normalized ENEM Score			97.798***	61.056***	61.384***
			(8.506)	(2.398)	(2.212)
Female × AA year	−3.673*	−3.518	−0.051	−0.567	−0.144
	(2.195)	(2.307)	(1.780)	(1.582)	(1.732)
Dep. Variable mean	518.454	518.454	518.454	518.454	518.454
(Female from private HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	16,602	16,602	16,602	16,602	16,602

Notes. The dependent variable is the Normalized Final Score. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005 and zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

7 Conclusion

In this paper, we use college admission process data to test if female applicants do better than their male counterparts under competition. To do that, we use data from UNICAMP's 2005 affirmative action policy. Our results show that the adoption of a non-gender-focused affirmative action policy causes an increase in eligible female applicants' performance relative to their male counterparts. We argue that this result is a piece of evidence that less competitive pressure makes women perform better. We also verified that the effect is greater for less able applicants and that the result is explained by the increase in performance of female applicants who receive the bonus and not by the drop in performance of female applicants who do not receive the bonus relative to their male counterparts. We also rule out alternative explanations based on the distance to cutoff and selection.

Our theoretical framework suggests this occurs because of the difference in men's and women's competition ability levels. One possible explanation for our findings might be that the bonus addition and higher admission rate raise the effort return of eligible female applicants relative to their male counterparts.

Our analysis further suggests that the affirmative action policy helps increase female performance in competition, even though affirmative action is not gender-focused. A consequence is that the policymakers may need to consider that side effect when implementing such policies since they may be influencing more than they intend to. Since our setting resembles many of the features of the labor market, we uncover a possible mechanism through which the gender gap in labor market outcomes persists (Blau and Kahn (2016)).

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A Appendix

Table 13: Affirmative Action and Normalized Final Score: 2001-2005 - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female	-16.302^{**}	-15.385^{**}	1.880	4.995^{***}	5.064^{***}
	(7.112)	(6.814)	(4.017)	(1.227)	(1.209)
AA year	1.552	0.791	-23.997^{***}	-13.001^{***}	-13.210^{***}
	(3.920)	(3.764)	(2.879)	(3.121)	(2.982)
Public HS	-35.533^{***}	-18.450^{***}	-10.285^{***}	-3.681^{**}	-3.449^{**}
	(8.231)	(6.364)	(2.889)	(1.534)	(1.541)
ENEM Score			3.734^{***}	2.421^{***}	2.426^{***}
			(0.240)	(0.077)	(0.071)
Female × AA year	7.998^{***}	8.089^{***}	6.033^{***}	5.415^{***}	5.569^{***}
	(2.373)	(2.282)	(1.636)	(1.613)	(1.680)
Female × Public HS	-13.968^{**}	-13.188^{**}	-6.942^{**}	-4.105^{**}	-4.189^{**}
	(6.532)	(5.628)	(2.959)	(1.846)	(1.868)
AA year × Public HS	-9.487^{**}	-7.909^{**}	-9.755^{***}	-8.506^{***}	-8.184^{***}
	(3.816)	(3.800)	(3.120)	(2.529)	(2.407)
Female × AA year × Public HS	4.859^{**}	4.814^{**}	4.349^{*}	5.099^{**}	4.801^{**}
	(2.035)	(2.384)	(2.613)	(2.186)	(2.146)
Dep. Variable mean	458.417	458.417	458.417	458.417	458.417
(Female from public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	53,984	53,984	53,984	53,984	53,984

Notes. The dependent variable is the Normalized Final Score without the bonus. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005, zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2001 to 2005. Two-way cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 14: Affirmative Action and Normalized Final Score: Minority Group - P_1 Survivors

	(1)	(2)	(3)	(4)	(5)
Female × AA year × Public HS	5.302	5.823	9.557***	7.978***	7.196**
	(6.090)	(5.938)	(3.227)	(2.624)	(2.801)
Female × AA year × Minority × Public HS	−9.164	−9.586	−2.164	2.016	1.732
	(8.296)	(7.482)	(6.988)	(6.798)	(7.261)
Dep. Variable mean	449.696	449.852	452.107	452.107	452.107
(Female from minority group and public HS 2004)					
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	24,062	23,305	22,216	22,216	22,216

Notes: The dependent variable is the Normalized Final Score without the bonus. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005, zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. Minority is a binary variable equal to one if the applicant was from a minority group and was granted 40 points, zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Two-way cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 15: Affirmative Action and P_1 Score - All students

	(1)	(2)	(3)	(4)	(5)
Female	−1.780***	−1.528**	1.888***	2.397***	2.434***
	(0.635)	(0.609)	(0.284)	(0.439)	(0.437)
AA year	−21.460***	−21.621***	−22.407***	−22.521***	−22.576***
	(1.696)	(1.713)	(1.759)	(1.768)	(1.742)
Public HS	−9.127***	−6.859***	−3.105***	−3.779***	−3.649***
	(0.973)	(1.183)	(0.574)	(0.698)	(0.676)
ENEM Score			0.749***	0.778***	0.775***
			(0.020)	(0.019)	(0.023)
Female × AA year	−4.168***	−4.107***	−3.457***	−3.409***	−3.421***
	(1.035)	(1.064)	(1.070)	(1.066)	(1.065)
Female × Public HS	−3.253***	−2.731***	−0.768***	−1.065***	−1.080***
	(0.902)	(0.849)	(0.257)	(0.331)	(0.350)
AA year × Public HS	−0.855	−0.568	−0.144	−0.015	0.039
	(1.468)	(1.479)	(1.398)	(1.395)	(1.358)
Female × AA year × Public HS	2.234**	2.316**	2.659***	2.840***	2.759***
	(0.983)	(0.997)	(0.945)	(0.944)	(0.929)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Personal Characteristics	No	Yes	Yes	Yes	Yes
Parental Education	No	Yes	Yes	Yes	Yes
Parental Occupation	No	Yes	Yes	Yes	Yes
Major Fixed Effects	No	No	No	Yes	Yes
Municipality Fixed Effects	No	No	No	No	Yes
Observations	79,018	79,018	79,018	79,018	79,018

Notes. The dependent variable is the P_1 Score. Female is a binary variable equal to one if the applicant is female and zero otherwise. AA year is a binary variable equal to one if the year is 2005, zero otherwise. Public HS is a binary variable equal to one if the applicant was enrolled in a Brazilian public high school and zero otherwise. The Normalized ENEM score is normalized yearly using all student's averages and standard deviations. Personal characteristics consist of a quartic function of age, while parental education and occupation control each consist of 8 dummy variables (4 per parent). Municipalities are the ones of the applicant's residence. Our final sample contains information from 2004 to 2005. Two-way cluster-robust standard errors at the municipality and major choice are shown in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

B Theoretical Framework - Details

In this section, we present the mathematical derivations of the theoretical framework developed in Section 3. Cotton et al. (2015) develops a contest model similar to ours and find that the equilibrium effort is

$$e_i^* = \frac{1}{a_i}\frac{N-1}{\sum_{j=1}^{N}(\tau_j/a_j)} - \frac{\tau_i}{a_i^2}\left(\frac{N-1}{\sum_{j=1}^{N}(\tau_j/a_j)}\right)^2.$$

We adjust this result for our four groups: 1) females from private schools (PF), 2) females from public schools (BF), 3) males from private schools (PM), and 4) females from public schools (BM). Then, for each group g, the equilibrium effort is:

$$\begin{aligned} e_g^* = & \frac{1}{\tau}\left(\frac{3}{a_g\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}\right)} - \frac{1}{a_g^2}\left(\frac{3}{\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}}\right)^2\right) \\ = & \frac{1}{\tau}\left(\frac{3a_g\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}\right)-9}{a_g^2\cdot\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}\right)^2}\right). \end{aligned}$$

Consequently, equilibrium performance is defined as:

$$y_g^* = e_g^* a_g = \frac{1}{\tau}\left(\frac{3a_g\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}\right)-9}{a_g\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}}+\frac{1}{a_{BF}}\right)^2}\right).$$

The AA policy modifies the effort returns. This is represented in the model as an increase in the ability a_g, which is the effort multiplier that contributes to performance. Consequently, after the policy, the ability of eligible applicants is $a_g' = a_g + \delta$, where $\delta > 0$ (we denote the post-intervention parameters by primes). We define the post-intervention equilibrium efforts by the four groups:

$$e_{PM}^{*\prime} = \frac{1}{\tau}\left(\frac{3a_{PM}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{a_{PM}^2\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^2}\right),$$

$$e_{PF}^{*\prime} = \frac{1}{\tau}\left(\frac{3a_{PF}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{a_{PF}^2\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^2}\right),$$

$$e_{BM}^{*\prime} = \frac{1}{\tau}\left(\frac{3\left(a_{BM}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{\left(a_{BM}+\delta\right)^{2}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right),$$
$$e_{BF}^{*\prime} = \frac{1}{\tau}\left(\frac{3\left(a_{BF}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{\left(a_{BF}+\delta\right)^{2}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right).$$

Consequently, post-intervention performance is defined as:

$$y_{PM}^{*\prime} = e_{PM}^{*\prime}a_{PM} = \frac{1}{\tau}\left(\frac{3a_{PM}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{a_{PM}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right),$$
$$y_{PF}^{*\prime} = e_{PF}^{*\prime}a_{PF} = \frac{1}{\tau}\left(\frac{3a_{PF}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{a_{PF}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right),$$

$$y_{BM}^{*\prime} = e_{BM}^{*\prime}\left(a_{BM}+\delta\right) = \frac{1}{\tau}\left(\frac{3\left(a_{BM}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{\left(a_{BM}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right),$$
$$y_{BF}^{*\prime} = e_{BF}^{*\prime}\left(a_{BF}+\delta\right) = \frac{1}{\tau}\left(\frac{3\left(a_{BF}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)-9}{\left(a_{BF}+\delta\right)\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{2}}\right).$$

Now, let's assess the impact of the bonus on the performance of each group. This is evaluated by the partial derivative of the new equilibrium performance ($y_g^{*\prime}$) with respect to the bonus δ. Let's start with the response of private school students. Among these students, the performance response to the bonus occurs only through the change in the admission probability of public school students. The partial derivative of $y_g^{*\prime}$ when $g = PM$ or $g = PF$ is given by

$$\frac{\partial y_{PM}^{\prime *}}{\partial \delta} = \frac{\partial e_{PM}^{\prime *}}{\partial \delta}a_{PM} = \frac{1}{\tau}\left(\frac{3\left[\frac{1}{(a_{BM}+\delta)^{2}}+\frac{1}{(a_{BF}+\delta)^{2}}\right]\left(\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)a_{PM}-6\right)}{a_{PM}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{3}}\right)$$
$$\frac{\partial y_{PF}^{\prime *}}{\partial \delta} = \frac{\partial e_{PF}^{\prime *}}{\partial \delta}a_{PF} = \frac{1}{\tau}\left(\frac{3\left[\frac{1}{(a_{BM}+\delta)^{2}}+\frac{1}{(a_{BF}+\delta)^{2}}\right]\left(\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)a_{PF}-6\right)}{a_{PF}\left(\frac{1}{a_{PM}}+\frac{1}{a_{PF}}+\frac{1}{a_{BM}+\delta}+\frac{1}{a_{BF}+\delta}\right)^{3}}\right)$$

Claim 1. Considering that we have an interior solution, we claim that $\frac{\partial y_{PM}^{\prime *}}{\partial \delta} < 0$ and $\frac{\partial y_{PF}^{\prime *}}{\partial \delta} < 0$.

Proof. Using the second interior solution hypothesis defined in Section 3 by equation (2), we have that $\dfrac{a_{PM}e'^*_{PM}}{\sum_{j=1}^4 a'_j e'^*_j} < \dfrac{1}{2}$. Substituting e'^*_g and a'_g for each group g, we have:

$$a_{PM}\frac{1}{\tau}\left(\frac{3a_{PM}\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-9}{a_{PM}^2\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)^2}\right) < a_{PF}\frac{1}{\tau}\left(\frac{3a_{PF}\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-9}{a_{PF}^2\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)^2}\right) + (a_{BM}+\delta)\frac{1}{\tau}\left(\frac{3(a_{BM}+\delta)\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-9}{(a_{BM}+\delta)^2\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)^2}\right) +$$
$$(a_{BF}+\delta)\frac{1}{\tau}\left(\frac{3(a_{BF}+\delta)\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-9}{(a_{BF}+\delta)^2\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)^2}\right)$$

$$\begin{aligned}
\frac{a_{PM}\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-3}{a_{PM}} &< \frac{a_{PF}\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-3}{a_{PF}} + \frac{(a_{BM}+\delta)\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-3}{(a_{BM}+\delta)} + \frac{(a_{BF}+\delta)\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)-3}{(a_{BF}+\delta)}\\
-\frac{3}{a_{PM}} &< -\frac{3}{a_{PF}} - \frac{3}{a_{BM}+\delta} - \frac{3}{a_{BF}+\delta} + 2\left(\sum_{j=1}^4 \frac{1}{a'_j}\right)\\
\frac{3}{a_{PM}} &> \frac{3}{a_{PF}} + \frac{3}{a_{BM}+\delta} + \frac{3}{a_{BF}+\delta} - 2\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)\\
\frac{5}{a_{PM}} &> \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\\
\frac{6}{a_{PM}} &> \frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}
\end{aligned}$$

Using this last relation, we manipulate to get:

$$\begin{aligned}
&\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta} < \frac{6}{a_{PM}}\\
&\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)a_{PM} - 6 < 0\\
&3\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\left(\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)a_{PM} - 6\right) < 0\\
&\frac{1}{\tau}\left(\frac{3\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\left(\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)a_{PM} - 6\right)}{a_{PM}\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)^3}\right) < 0\\
\implies &\frac{\partial y'^*_{PM}}{\partial \delta} < 0
\end{aligned}$$

We can do a similar demonstration to prove that $\frac{\partial y'^*_{PF}}{\partial \delta} < 0$. □

Then $\frac{\partial y'^*_{PM}}{\partial \delta} < 0$ and $\frac{\partial y'^*_{PF}}{\partial \delta} < 0$. Using words, the model predicts that the response of private school students (both females and males) to the AA policy is a decrease in performance. This is because the return on effort is lower, given that the probability of this group being admitted is lower than before the policy.

Claim 2. Since $a_{PM} > a_{PF}$, we claim that $\frac{\partial y'^{*}_{PF}}{\partial \delta} < \frac{\partial y'^{*}_{PM}}{\partial \delta}$.

Proof.

$$a_{PM} > a_{PF}$$
$$-\frac{6}{a_{PF}} < -\frac{6}{a_{PM}}$$
$$\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta} - \frac{6}{a_{PF}} < \frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta} - \frac{6}{a_{PM}}$$
$$\frac{\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right) a_{PF} - 6}{a_{PF}} < \frac{\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right) a_{PM} - 6}{a_{PM}}$$

$$\frac{1}{\tau}\left(\frac{3\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\left(\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right) a_{PF} - 6\right)}{a_{PF}\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)^3}\right) <$$
$$\frac{1}{\tau}\left(\frac{3\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\left(\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right) a_{PM} - 6\right)}{a_{PM}\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)^3}\right)$$

□

Prediction 1. Using **Claim 1** and **Claim 2**, we conclude that the performance of female applicants from private schools decreases more relative to their male counterparts following the AA policy $\left(\frac{\partial y'^{*}_{PF}}{\partial \delta} < \frac{\partial y'^{*}_{PM}}{\partial \delta} \text{ and } \frac{\partial y'^{*}_{PF}}{\partial \delta}, \frac{\partial y'^{*}_{PM}}{\partial \delta} < 0\right)$.

We now analyze the response of public school students. Among these students, the performance response to the bonus occurs through the change in the admission probability of public school students and through the effort's return. The partial derivative of $y^{*\prime}_{g}$ when $g = BM$ or $g = BF$ is given by:

$$\frac{\partial y^{*\prime}_{BM}}{\partial \delta} = \frac{\partial e^{*\prime}_{BM}}{\partial \delta}(a_{BM}+\delta) + e^{*\prime}_{BM}$$
$$\frac{\partial y^{*\prime}_{BF}}{\partial \delta} = \frac{\partial e^{*\prime}_{BM}}{\partial \delta}(a_{BF}+\delta) + e^{*\prime}_{BF}.$$

Calculating $\frac{\partial e^{*\prime}_{BM}}{\partial \delta}$ and $\frac{\partial e^{*\prime}_{BF}}{\partial \delta}$, we obtain:

$$\frac{\partial e^{*\prime}_{BM}}{\partial \delta} = \frac{\left[\left(\sum_{j=1}^{4}\frac{1}{a'_j}\right) - (a_{BM}+\delta)\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\right]\left(18 - 3(a_{BM}+\delta)\left(\sum_{j=1}^{4}\frac{1}{a'_j}\right)\right)}{\tau (a_{BM}+\delta)^3 \left(\sum_{j=1}^{4}\frac{1}{a'_j}\right)^3}$$

$$\frac{\partial e^{*\prime}_{BF}}{\partial \delta} = \frac{\left[\left(\sum_{j=1}^{4}\frac{1}{a'_j}\right) - (a_{BF}+\delta)\left[\frac{1}{(a_{BM}+\delta)^2} + \frac{1}{(a_{BF}+\delta)^2}\right]\right]\left(18 - 3(a_{BF}+\delta)\left(\sum_{j=1}^{4}\frac{1}{a'_j}\right)\right)}{\tau (a_{BF}+\delta)^3 \left(\sum_{j=1}^{4}\frac{1}{a'_j}\right)^3}$$

Claim 3. Since $a_{BM} > a_{BF}$, we claim that $\frac{\partial y^{*\prime}_{BM}}{\partial \delta} < \frac{\partial y^{*\prime}_{BF}}{\partial \delta}$.

Proof. We can prove this by substituting definitions of $e^{*\prime}_{BM}$, $\frac{\partial e^{*\prime}_{BM}}{\partial \delta}$ in $\frac{\partial y^{*\prime}_{BM}}{\partial \delta} = \frac{\partial e^{*\prime}_{BM}}{\partial \delta}(a_{BM}+\delta) + e^{*\prime}_{BM}$. We also have to substitute $e^{*\prime}_{BF}$, $\frac{\partial e^{*\prime}_{BF}}{\partial \delta}$ in $\frac{\partial y^{*\prime}_{BF}}{\partial \delta} = \frac{\partial e^{*\prime}_{BM}}{\partial \delta}(a_{BF}+\delta) + e^{*\prime}_{BF}$. □

Prediction 2. Using **Claim 3**, we conclude that the performance of female applicants from private schools changes more relative to their male counterparts following the AA policy.

Triple Interaction

The triple difference estimator of equation (4) is equivalent to the difference between two difference-in-differences. Following Olden and Møen (2022), we define the triple difference estimator as

$$\begin{aligned}\hat{\beta}_6 = [(&\bar{S}_{Public=1,Female=1,\text{ Post}=1} - \bar{S}_{Public=1,Female=1,\text{ Post}=0}) \\ &- (\bar{S}_{Public=0,Female=1,\text{ Post }=1} - \bar{S}_{Public=0,Female=1,\text{ Post}=0})] \\ &-[(\bar{S}_{Public=1,Female=0,\text{ Post }=1} - \bar{S}_{Public=1,Female=0,\text{ Post }=0}) \\ &- (\bar{S}_{Public=0,Female=0,\text{ Post}=1} - \bar{S}_{Public=0,Female=0,\text{ Post}=0})].\end{aligned}$$

Using the notation of the theoretical framework developed in Section 3, we write β_6 as

$$\begin{aligned}\beta_6 = \Delta y^* = [(y^{*\prime}_{BF} - y^{*}_{BF}) - (y^{*\prime}_{PF} - y^{*}_{PF})] - \\ [(y^{*\prime}_{BM} - y^{*}_{BM}) - (y^{*\prime}_{PM} - y^{*}_{PM})]\end{aligned}$$

Substituting definitions of y_g^* and $y_g^{*\prime}$, we find that:

$$\beta_6 = \frac{9\left(\frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}} - \frac{1}{a_{BF}+\delta} - \frac{1}{a_{BM}}\right)}{\tau\left(\frac{1}{a_{PM}} + \frac{1}{a_{PF}} + \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}+\delta}\right)^2}.$$

Claim 4. Since $a_{BF} < a_{BM}$, then $\beta_6 > 0$.

Proof.

$$\begin{gathered}
a_{BF} < a_{BM} \\
a_{BM}a_{BF} + \delta a_{BF} < a_{BF}a_{BM} + \delta a_{BM} \\
(a_{BM}+\delta)a_{BF} < (a_{BF}+\delta)a_{BM} \\
\frac{1}{(a_{BM}+\delta)a_{BF}} > \frac{1}{(a_{BF}+\delta)a_{BM}} \\
\frac{a_{BF}+a_{BM}+\delta}{(a_{BM}+\delta)a_{BF}} > \frac{a_{BF}+a_{BM}+\delta}{(a_{BF}+\delta)a_{BM}} \\
\frac{a_{BF}}{(a_{BM}+\delta)a_{BF}} + \frac{a_{BM}+\delta}{(a_{BM}+\delta)a_{BF}} > \frac{a_{BF}+\delta}{(a_{BF}+\delta)a_{BM}} + \frac{a_{BM}}{(a_{BF}+\delta)a_{BM}} \\
\frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}} > \frac{1}{a_{BF}+\delta} + \frac{1}{a_{BM}} \\
\implies \frac{1}{a_{BM}+\delta} + \frac{1}{a_{BF}} - \frac{1}{a_{BF}+\delta} - \frac{1}{a_{BM}} > 0
\end{gathered}$$

It is straightforward to show that $\beta_6 > 0$. □

Prediction 3. Using **Claim 4**, we conclude that the AA policy response in the performance of female applicants from public schools relative to their male counterparts and controlling for difference among private school applicants is positive ($\beta_6 > 0$).