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ANALYSIS OF THE QUOTA POLICY IN FEDERAL INSTITUTIONS OF HIGHER EDUCATION[1]

Análise da política de cotas nas instituições federais de ensino superior

Análisis de la Política de Cupos en las Instituciones Federales de Educación Superior

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Abstract: Since its inception, the policy of reserved seats in higher education has sparked criticism. One of these criticisms, known as the incompatibility hypothesis, argues that quota students, potentially less academically prepared, face additional challenges in keeping up with their coursework, which would result in higher dropout rates and lower graduation rates. To examine this hypothesis in a comprehensive context, an analysis was conducted across the entire federal higher education network in Brazil. The probabilities of dropout and graduation for quota and non-quota students were compared using a multinomial logistic model. Additionally, the time taken to complete the degree was estimated using the Cox proportional hazards model. No support was found for the incompatibility hypothesis.

Keywords: higher education; affirmative action; student dropout.

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Resumo: Desde seu aparecimento, a política de reserva de vagas na educação superior tem suscitado críticas. Uma delas, conhecida como a hipótese da incompatibilidade, argumenta que os estudantes cotistas, possivelmente menos qualificados, enfrentam desafios adicionais para acompanhar os cursos, o que resultaria em maiores taxas de evasão e menores índices de conclusão. Para examinar essa hipótese em um contexto abrangente, conduziu-se uma análise para toda a rede federal de ensino superior. Compararam-se as probabilidades de desligamento e conclusão de alunos cotistas e não cotistas, mediante um modelo logístico multinomial. Além disso, estimaram-se os tempos levados para a conclusão do curso por meio do modelo de sobrevivência de Cox. Não foi encontrado apoio para a hipótese da incompatibilidade.

Palavras-chave: educação superior; ações afirmativas; evasão escolar.

Resumen: Desde su aparición, la política de reserva de cupos en la educación superior ha suscitado críticas. Una de ellas, conocida como la hipótesis de la incompatibilidad, argumenta que los estudiantes beneficiarios de cupos, posiblemente menos calificados, enfrentan desafíos adicionales para seguir los cursos, lo que resultaría en mayores tasas de deserción y menores índices de finalización. Para examinar esta hipótesis en un contexto amplio, se llevó a cabo un análisis en toda la red federal de educación superior. Se compararon las probabilidades de deserción y finalización de estudiantes beneficiarios de cupos y no beneficiarios, mediante un modelo logístico multinomial. Además, se estimaron los tiempos requeridos para la finalización del curso utilizando el modelo de supervivencia de Cox. No se encontró apoyo para la hipótesis de la incompatibilidad.

Palavras clave: educación superior; acción afirmativa; deserción estudiantil.

1 INTRODUCTION

Social inequalities are reflected in the educational system, especially in competitive and high-quality universities. Attending higher education has been considered an important factor for social mobility (Menezes Filho; Oliveira, 2014). In this context, one-quarter of the countries in the world have adopted some form of affirmative action policy for university admissions, with the goal of democratizing access and promoting greater inclusion of minority groups (Jenkins; Moses, 2014).

However, theory alone cannot predict the effectiveness of such access policies. On the one hand, they offer gains in equity by enabling underrepresented groups to enter higher education. On the other hand, critics argue that prioritizing these groups at the expense of non-targeted students may render the policy ineffective, allowing the admission of less academically prepared candidates who may not succeed at the institutions to which they are admitted an argument known as the "mismatch hypothesis" (Sander, 2004).

This hypothesis is based on the premise that less academically prepared students, when faced with difficulties in keeping up with coursework, have stronger incentives to drop out of their programs. However, it relies on the assumption that entrance examinations are effective in predicting and distinguishing the future academic performance of students. Moreover, it is plausible that such difficulties can be mitigated by student retention policies. It is also argued that low-income students would be more inclined to leave their studies in favor of entering the labor market. Nevertheless, it is higher-income students who face greater opportunity costs meaning they have more attractive alternatives should they choose to abandon their studies. Therefore, it is important not to overlook that, from the perspective of affirmative action target students, attending a public university may provide future opportunities that would otherwise be inaccessible to them, making them more resilient. Evaluating this hypothesis is thus an empirical question that the present study aims to investigate through a large dataset of students enrolled in Brazilian higher education institutions.

The brazilian educational landscape provides a favorable setting for this investigation, as in 2012 the "Quota Law" was enacted (Brazil, 2012). This law mandated that by 2016, at least 50% of the seats in Federal Higher Education Institutions (Ifes) be reserved for students who completed their secondary education in public schools. The law also requires a subdivision of these reserved seats based on income, race/ethnicity, and disability criteria. The Ifes comprise universities and institutes within the federal system that offer high-quality, tuition-free higher education programs, playing a role comparable to that of state universities in the United States. Furthermore, among the 7.3 million undergraduate students enrolled in higher education in 2013, only 26% attended tuition-free programs, making these public institutions highly competitive.

In the present study, microdata from the Higher Education Censuses (CES) were used. The CES is a data collection instrument that gathers information from all higher education institutions in the country and is conducted annually by the Anísio Teixeira

National Institute for Educational Studies and Research (Inep), an autonomous agency linked to the Ministry of Education (MEC). Students who entered Ifes in 2013, the year of the first large-scale admission of quota students (the target population of the affirmative action policies implemented by the 2012 Quota Law), were identified and their academic trajectories were monitored through 2019, the last year for which student-level data were made available by the CES. In 2020, Inep declared it would no longer provide this level of information, citing violations of the General Data Protection Law (LGPD).

Quota students were then compared with those who occupied non-reserved seats (i.e., the target and non-target populations of the affirmative action policy, respectively) regarding the probabilities of dropout and graduation. For this purpose, a multinomial logistic model was employed, in which the student "chooses" between remaining enrolled in the program or exiting through dropout or graduation. The results do not support the so-called "mismatch hypothesis".

It could further be argued that even if quota students achieved the same graduation rates as non-quota students, they would tend to take longer to complete their degrees due to being less academically prepared. This issue was also examined using survival models, which are appropriate when data includes censored information - at the end of the observation period, 10% of students were still enrolled in their programs. Again, no evidence was found in support of this argument.

This article is organized into five sections, including this introduction. Section 2 presents a historical overview and a review of previous studies relevant to this research. Section 3 details the materials and methods used. Section 4 presents the results, and Section 5 offers some concluding remarks.

2 BACKGROUND

Affirmative action policies for access to higher education can be understood as a set of efforts aimed at increasing diversity and the representation of minority groups within the higher education system. Although pioneering initiatives emerged in the 1950s and 1960s in countries such as India and the United States, the majority of these policies, now present in a quarter of the countries worldwide, have been implemented over the past 35 years (Jenkins; Moses, 2014). Operating under various names – affirmative action, reserved seats, quota systems, or positive discrimination – these policies are based on multidimensional criteria, including race, ethnicity, social class, income, gender, physical disabilities, or the type of secondary education attended, in order to prioritize certain candidates during the admissions process.

Once access policies are implemented, the focus of analysis shifts to their effectiveness. Most empirical studies on the impact of such policies have concentrated on the United States and India. Bowen and Bok (1998) argue that affirmative action not only increased diversity on U.S. university campuses but also had a positive impact on educational outcomes and career opportunities for the students who benefited from it. The prohibition in some U.S. states of public institutions adopting affirmative action in

their admissions processes has been used as a natural experiment in a series of studies, which initially differ in their objects of analysis. While some studies examined the effects of suspending affirmative action on minority enrollment rates, others investigated its impact on graduation rates. The results show little to no change in the overall proportion of enrolled black students (Hinrichs, 2012; Backes, 2012), but they do indicate a shift in composition, with a decrease in minority enrollments and an increase in white students admitted to more selective colleges (Hinrichs, 2012). Regarding graduation rates, estimates suggest that fewer black and hispanic students graduated following the bans, and those who did graduate tended to do so at less prestigious institutions (Backes, 2012).

In Brazil, the first initiatives to implement quotas in universities emerged in the early 2000s. In 2001, the State University of Rio de Janeiro (UERJ) became the first institution to adopt a quota system for undergraduate admissions. From that point on, other universities began to implement isolated seat reservation policies until, in 2012, the "Quota Law" (Law nº 12,711/2012) was enacted. This law established that at least 50% of the seats per program and per shift in federal higher education institutions must be reserved for students coming from public high schools. The law provided for a gradual implementation schedule (with 12.5% of seats reserved in the first year, 25.0% in the second, and 37.5% in the third), with the goal of reaching 50% by 2016. Moreover, it stipulated that 50% of the reserved seats for public school students must be allocated to individuals from families with a per capita income equal to or below 1.5 times the minimum wage, and that part of these 50% must be reserved for students who self-identify as black, brown, or indigenous, in accordance with their demographic representation in each state. Subsequently, Law nº 13,409/2016 expanded the scope of the policy to include persons with disabilities (Brazil, 2016). For a description of the historical roots that underpin affirmative action in Brazil, see the work by Lloyd (2015).

Studies conducted with Brazilian data consistently report improvements in equity achieved through access policies (Childs; Stromquist, 2014; Otero; Barahona; Dobbin, 2021; Senkevics; Mello, 2019; Vieira; Arends-Kuenning, 2019). Vieira and Arends-Kuenning (2019) found that in institutions that adopted affirmative action policies, there was a significant increase in enrollment among students from disadvantaged groups targeted by such policies, namely, students from public schools and black students. These effects were particularly concentrated in the most competitive and prestigious universities. Otero, Barahona, and Dobbin (2021) estimated that the representation of black high school graduates in the most selective federal institutions increased by 73% following the implementation of the quota policy. These results are not surprising, given that the design of these policies is aimed precisely at the inclusion of minority groups.

Some critics of quota policies argue that quota students do not possess the same educational background as their peers and, for this reason, tend to exhibit poorer academic performance, potentially leading to negative effects on overall student performance. Motivated by this debate, several empirical studies have been conducted to compare the performance of quota and non-quota students. Among these, particular

attention should be given to studies that analyzed the entire system of higher education institutions, rather than focusing on a single institution or a limited set of institutions. To this end, researchers employed data from the National Student Performance Exam (Enade), which is administered to students in the final year of undergraduate programs. The evidence found is mixed: while some authors found no relationship between the admission method and academic performance (Valente; Berry, 2017), others observed poorer performance among quota students (Carvalho; Waltenberg, 2012). Additionally, some studies reported heterogeneous results depending on the type of quota analyzed (Vidigal, 2018; Araujo *et al*., 2020). Vidigal (2018), in particular, found no significant difference in academic performance between students admitted through racial quotas and those who, despite being eligible, were admitted through regular (non-quota) pathways. However, he found that low-income quota students scored, on average, 14% lower than eligible students admitted outside the quota system. Araujo *et al*. (2020) reported that ethnic-racial quotas (-3%), income-based quotas (-8.8%), and other types (-6.8%) had negative effects on overall Enade scores. In contrast, public school quotas (3.2%) and combined criteria quotas (2%) showed positive effects on scores, indicating that students admitted through these mechanisms performed better than those in the control group.

Another hypothesis put forth by critics of quota policies is that quota students tend to exhibit lower graduation rates and higher dropout rates than their non-quota counterparts, due to greater difficulties in keeping up with coursework and supporting themselves financially during their studies. Indeed, securing access to university does not guarantee inclusion. The challenge of student retention may be particularly significant for entrants from less privileged socioeconomic backgrounds. Several factors may influence student attrition, including educational gaps in prior schooling, prejudice from administrators and faculty members who oppose quota policies, and, most importantly, financial hardship. Student assistance policies aim to mitigate the difficulties faced by low-income students by providing retention scholarships and subsidies for housing, food, and transportation, among other forms of support. However, these policies often fail to achieve satisfactory results due to their limited reach, either in terms of the number of students served or the design of the programs implemented (Sousa; Portes, 2011).

Despite the shortcomings of student assistance policies, empirical studies using national data have not found higher dropout rates among quota students (Benatti, 2017; Bezerra; Gurgel, 2011; Cespedes *et al*., 2021; Cicalò, 2008; Corbari, 2018; Costa, 2015; Gabriel, 2013; Machado, 2013; Mendes Junior, 2014; Silva; Pacheco, 2013). Regarding graduation rates, the results are inconclusive, as some studies reported higher rates for quota students (Corbari, 2018; Machado, 2013; Mendes Junior, 2014), while others found higher rates for non-quota students (Cordeiro, 2008; Costa, 2015; Gabriel, 2013).

However, these studies present certain limitations: i) they analyzed a restricted sample of students – belonging to a single institution or a limited group of institutions and/or specific courses or fields of study; ii) they did not account for course completion

time in addition to dropout and graduation rates. This study, therefore, aims to fill these gaps in the discussion about the effectiveness of quota policies in Brazil. To this end, we compare quota and non-quota students (beneficiaries and non-beneficiaries of affirmative action policies, respectively) with regard to the probabilities of dropout and graduation, as well as the time to degree completion, considering the entire population of students enrolled in the federal higher education system.

3 METHODOLOGY

3.1 Materials

The dataset used in this study was constructed by merging the annual "students" and "courses" microdata from the CES, conducted annually by Inep. As previously mentioned, students who entered IFES in 2013 were tracked until 2019. From 2020 onwards, Inep ceased to provide microdata at the individual student level, citing violations of the LGPD. For the same reason, since 2017, the datasets made available by the institution no longer include student identification keys, which are necessary to link data across years. As a result, it was necessary to construct a synthetic identification key based on course code, gender, and date of birth to identify students in the 2018 and 2019 datasets. This strategy resulted in the random exclusion of approximately 20% of tracked students. Additionally, students who were admitted through means other than the university entrance exam (*vestibular*) or the Unified Selection System (SiSU), the only pathways through which quota policies are applicable, were excluded. Consequently, the resulting cohort consisted of 245,475 students who entered IFES in 2013 and were tracked for seven years.

Since the objective of this study is to compare the academic trajectories of quota and non-quota students (general admission), ideally this comparison should be restricted to students entering their first undergraduate program, as students pursuing a second degree may have their time to completion reduced through credit transfer. Because this information is not available in the dataset, the analysis considered, in addition to the full sample, a subset consisting of students under 21 years of age in an attempt to mitigate this issue. This sampling restriction reduced the number of observations by approximately half.

Limiting the analysis by age may also mitigate the absence of information on income and household composition. It is known that students with greater family responsibilities are more likely to abandon their studies, and these responsibilities tend to increase with age. For robustness and to enrich the discussion, results are presented for the full sample as well as for an intermediate sample subset that includes students under 25 years of age. Table 1 presents the descriptive statistics for the three sample subsets considered, outlining the characteristics of students, courses, and institutions.

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Table 1 - Descriptive statistics

Variable	Full sample	< 25 Years	< 21 Years	Description
Quota	0,211	0,215	0,209	Binary: 1 if student was admitted through the quota reservation program
Female	0,501	0,520	0,535	Binary: 1 for female students
Age	23,36	19,70	18,72	Age of student at the year of admission (2013)
Program duration	4,20	4,27	4,30	Minimum time to complete the degree
Social support	0,079	0,087	0,087	Binary: 1 if student received any social support during their studies
Scholarship	0,051	0,061	0,065	Binary: 1 if student received any scholarship/remuneration during their studies (internship, extension, teaching or research)
IFECT	0,151	0,132	0,120	Binary: 1 for Federal Institutes of Education, Science and Technology (0 = Federal Universities)
Public	0,588	0,554	0,526	Binary: 1 if student completed high school in a public school
Entrance exam	0,491	0,470	0,466	Binary: 1 if student was admitted via traditional university entrance exam (0 = Enem/SiSU
Race	self-declared race of the student			
Not declared	0,231	0,231	0,228	
White	0,241	0,250	0,256	
Black	0,063	0,063	0,062	
Brown	0,186	0,185	0,181	
Asian	0,011	0,011	0,011	
Indigenous	0,002	0,002	0,002	
No information	0,265	0,259	0,259	
Bachelor's	academic degree conferred upon the graduate by the program			
ABI/sequential	0,028	0,030	0,032	programs with sequential academic level of specific training or programs with a basic area of admission
bachelor's degree	0,606	0,673	0,704	
teaching licensure	0,282	0,229	0,205	
Technological	0,084	0,068	0,059	
Study shift	study shift to which the student is enrolled			
Distance Learning	0,084	0,032	0,020	programs offered in Distance Education mode
Morning	0,118	0,126	0,132	
Afternoon	0,072	0,074	0,075	
Evening	0,316	0,276	0,244	
Full-time	0,409	0,491	0,529	
Field	course classification based on an adaptation of the international classification methodology by Eurostat/Unesco/OCDE			
ABI/interdisciplinary studies	0,007	0,007	0,006	classification introduced by the authors
Education	0,291	0,239	0,216	
Humanities and Arts	0,039	0,040	0,038	
Social Sciences, Business, and Law	0,183	0,171	0,169	

Science, Mathematics, and Computing	0,127	0,138	0,141
Engineering, Manufacturing, and Construction	0,161	0,193	0,213
Agriculture and Veterinary	0,067	0,078	0,082
Health and Welfare	0,100	0,115	0,116
Services	0,025	0,020	0,018
Nationality	student nationality		
Brazilian	0,989	0,989	0,989
Foreign-born or naturalized	0,010	0,010	0,010
Foreign national	0,001	0,001	0,001
State of birth (UF)	controls for the student's state of birth		
Institution (IES)	controls for the Federal Institutions of Higher Education (IFES)		
Observations	245.475	177.336	127.737

Source: Elaborated by the authors.

It is observed that 21.1% of the students enrolled through the quota reservation program, surpassing the minimum percentage (12.5%) stipulated by the "Quota Law" for each institution in the first year of the policy's implementation. Around 8% of the students received some form of social support during their undergraduate studies, such as housing assistance or a maintenance scholarship.

The annual CES databases provide information on the student's status at the end of each year. Each student was tracked as long as they remained enrolled in the program: either actively enrolled or with enrollment temporarily suspended. Thus, this follow-up continued until the end of 2019, or until the student's status was reported as: withdrawn (formally left the program), transferred (moved to another program within the same Ifes), graduated, or deceased.

Table 2 shows the status at the end of the academic trajectory from a comparative perspective between students admitted through the quota reservation policy and those admitted through the regular admission process. It is noted that approximately 13.5% of the 2013 entrants included in this study remained enrolled in their programs until the end of 2019 – corresponding to the sum of the percentage of students who completed their undergraduate program uninterruptedly (9.54%) and those who took a leave of absence for one or more semesters (3.92%). Across all sample subsets, the percentages of quota students who dropped out of their programs were lower than those of non-quota students, with differences ranging from 2 to 4 percentage points. Although less pronounced, completion rates and average time to graduation were also higher for quota students in all sample subsets.

Table 2 - Status as of the end of 2019 of students who entered Federal Institutions of Higher Education (Ifes) in 2013

	Complete Sample			Under 25 Years Old			Under 21 Years Ol		
	General Admission	Quota Students	Total	General Admission	Quota Students	Total	General Admission	Quota Students	Total
Enrolled	17.761	5.646	23.407	13.321	4.284	17.605	9.452	2.910	12.362
	9,17%	**10,91%**	**9,54%**	**9,57%**	**11,21%**	**9,93%**	**9,35%**	**10,91%**	**9,68%**
Leave of absence	7.223	2.408	9.631	4.471	1.522	5.993	3.027	954	3.981
	3,73%	**4,65%**	**3,92%**	**3,21%**	**3,98%**	**3,38%**	**3,00%**	**3,58%**	**3,12%**
Dropped out	91.163	22.291	113.454	58.478	15.123	73.601	40.012	10.025	50.037
	47,05%	**43,09%**	**46,22%**	**42,03%**	**39,59%**	**41,50%**	**39,59%**	**37,58%**	**39,17%**
Transferred	4.999	1.395	6.394	4.206	1.160	5.366	3.316	837	4.153
	2,58%	**2,70%**	**2,60%**	**3,02%**	**3,04%**	**3,03%**	**3,28%**	**3,14%**	**3,25%**
Graduated	72.505	19.977	92.482	58.594	16.099	74.693	45.203	11.943	57.146
	37,42%	**38,61%**	**37,67%**	**42,11%**	**42,14%**	**42,12%**	**44,73%**	**44,77%**	**44,74%**
Duration (years)	**5,22**	**5,33**	**5,24**	**5,29**	**5,36**	**5,31**	**5,35**	**5,38**	**5,35**
Deceased	90	17	107	64	14	78	50	8	58
	0,05%	**0,03%**	**0,04%**	**0,05%**	**0,04%**	**0,04%**	**0,05%**	**0,03%**	**0,05%**
Total	193.741	51.734	245.475	139.134	38.202	177.336	101.060	26.677	127.737

Note: The statuses 'Enrolled' and 'Leave of Absence' include students who remained enrolled in their courses through the end of 2019. 'Leave of Absence' refers to students who suspended their enrollment for at least one semester during their studies, while 'Enrolled' refers to students who never suspended their enrollment.

Source: Elaborated by the authors.

Based on these statistics, suspicions of lower academic performance by quota students do not appear to be supported. In this comparison, the only indicator in which the targeted students of the quota policy have a worse performance is the time to graduation which is only ten days longer in the sample subset of the youngest entrants. However, it is worth noting that observing these rates may not be informative if the distribution of quota and non-quota students is non-random across programs of varying duration, in more or less demanding fields of study, and so on. For this reason, the use of multivariate techniques, which control for the effects of other variables when analyzing the probabilities of completion or dropout, is necessary. It is also important to note that, if a large proportion of students have not yet completed their programs but have also not dropped out, this is due to the interruption of the tracking of this cohort of students in 2019. Therefore, it is essential to employ statistical techniques that account for this censoring in the data.

3.2 Methods

To analyze the probabilities of completion and dropout, the possible student statuses in 2019, as described in Table 2, were first aggregated into three categories. Students who remained enrolled in the program until the end of the follow-up period, regardless of whether they temporarily suspended their enrollment for one or more semesters (the first two categories listed in Table 2), were classified as "active". Students who formally withdrew or transferred (the third and fourth categories listed in Table 2) were classified as "disconnected". The third category, "graduated," included students who completed their degree programs. Students who passed away were excluded from subsequent analyses.

A multinomial logistic regression was employed to analyze the probability of each of these three outcomes. The multinomial logit model is suitable for categorical, non-ordinal, and polytomous dependent variables. The numerical values assigned to each category (0 - Active, 1 - Disconnected, 2 - Graduated) are arbitrary; that is, the model does not assume that 0 < 1 < 2. The probability that the dependent variable *y* takes the value i is given by:

$$P(y = i|X) = \frac{e^{X\beta_i}}{e^{X\beta_i + \sum_{j \neq i} e^{X\beta_j}}} \quad (1)$$

where X is a 1×K vector with the first element equal to one, and β_i are K×1 parameter vectors.

To ensure the unique identification of the β_i vectors, one of them is set to zero and treated as the reference category. The estimated coefficients thus represent changes relative to this baseline category. In cases where *y* assumes three values, as in the present study where i = 0, 1, 2, and i = 0 is taken as the reference category, the probabilities are given by:

$$P\ (y = 0|X)\ = \frac{1}{1+e^{X\beta_1}+e^{X\beta_2}} \quad (2)$$

$$P\ (y = 1|X)\ = \frac{e^{X\beta_1}}{1+e^{X\beta_1}+e^{X\beta_2}} \quad (3)$$

$$P\ (y = 2|X)\ = \frac{e^{X\beta_2}}{1+e^{X\beta_1}+e^{X\beta_2}} \quad (4)$$

In the tables presented in this study, the reported results are relative risk ratios (the exponential of the coefficients), which represent variations in probability relative to the reference category, given a one-unit change in the covariate of interest.

As shown in Table 2, the time taken by quota students to complete their courses is slightly longer than that of students admitted through the general competition (differences ranging from 0.6% to 2.1%). However, these estimates are underestimated for both groups: since some students remained enrolled in their programs at the end of the observation period of this study (2019), their course completion times are not observed. It is therefore considered that there is right-censoring, since only the minimum

time of the students enrolled until 2019 is known. The set of econometric procedures that address the problem of censoring in measuring the time until the occurrence of a given event is known as duration (or survival) analysis.

In the terminology of duration analysis, when the event of interest occurs, it is said that a "failure" has been observed. Otherwise, if the event does not occur within the observed time frame, the information is referred to as "censored". In this study, the variable analyzed is the length of enrollment in the course, and the event of interest is course completion. Students who withdrew or transferred during the observation period are excluded from this stage of the analysis so that the censoring only considers those still enrolled in 2019, with the potential to complete their courses. This exclusion is reasonable as long as the probabilities of withdrawal are the same for both groups, quota and general competition students, which we will see is a plausible assumption.

Considering a random variable *t*, with density function *f(t)* and cumulative distribution function *F(t)*, the survival function is defined by:

$$S(t) = 1 - F(t) = P(T > t) \tag{5}$$

and the hazard function is given by:

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T < t + \Delta t | T \geq t)}{\Delta t} = \frac{f(t)}{1 - F(t)} = \frac{f(t)}{S(t)} \tag{6}$$

While the survival function indicates the probability of remaining enrolled in the course up to a specific time *t*, the hazard function is a rate that represents the potential for course completion at a given moment, conditional on the student not having withdrawn up to that point.

The most common method incorporating explanatory variables is the so-called Cox proportional hazards model. The model is specified through the hazard function *h*, whose form is:

$$h(t, X) = h_0(t) e^{X\beta} \tag{7}$$

where *X* is the vector of explanatory variables, β is the vector of parameters, and $h_0(t)$ is the so-called baseline hazard function, which is common to all individuals. Therefore, this model assumes that the risk for each individual, determined by their individual characteristics, is a multiple of the common risk for all individuals (PH). An important property of the Cox model is that the baseline hazard function $h_0(t)$ does not require specification, which makes it a semiparametric model.

One of the main reasons for the popularity of the Cox model is that, despite the baseline hazard function not being specified, good estimates of the regression coefficients can be obtained in a wide range of contexts. That is, the model is robust in the sense that the results of the Cox model approximate those of the correctly specified parametric model (Kleinbaum; Klein, 1996).

Both the multinomial logistic regression and the Cox model were estimated using the statistical software Stata. It is important to note that these models only allow inference regarding the factors associated with dropout and retention in higher education; that is, they do not establish causal relationships between the dependent variable and the explanatory variables. If this were the objective, other econometric techniques would

need to be employed to address the problem of omitted variable bias. Examples of such variables include the entrance exam score or the National High School Exam (Enem) score, the quality of education received prior to entering higher education, and the student's family income, information not available in the database used.

4 RESULTS

Table 3 presents the relative risk ratios estimated through the multinomial logistic regression. Considering the sample restricted to students who were under 21 years old at the time of entry into the Ifes, the relative risk ratio of 1.054 calculated for quota students indicates that, all else being equal, students admitted through the quota policy have a 5.4% higher probability of completing the course than those admitted through open competition. This result is statistically significant at the 10% level. When the age restriction is loosened, this propensity increases to 5.8% (sample of those under 25 years old at the time of entry), statistically significant at the 5% level, but loses significance in the full sample. Given that age was controlled for, this variation may be linked to other factors that affect older entrants, such as the need to balance studies with paid work, greater household responsibilities (marriage, children, etc.), or the fact that it might be a re-entry into higher education, among other aspects.

Table 3 - Multinomial logistic regression

	Complete Sample				Under 25 Years Old				Under 21 Years Old			
	Dropped Out		Graduated		Dropped Out		Graduated		Dropped Out		Graduated	
Quota student	1,018		1,014		1,047		1,058	**	1,047		1,054	*
Female	0,981		1,563	***	1,017		1,534	***	1,044	**	1,557	***
Race (ref.: white)												
Not declared	1,108	***	0,870	***	1,096	***	0,856	***	1,066	*	0,848	***
Black	0,926	**	0,903	***	0,925	*	0,908	**	0,954		0,941	
Brown	0,967		0,946	**	0,978		0,959		0,965		0,972	
Asian	0,929		0,814	***	0,948		0,852	**	0,928		0,891	
Indigenous	0,815		0,942		0,935		0,735	*	0,878		0,677	*
No information	1,091	***	0,963		1,074	**	0,953		1,089	**	0,984	
Age	0,990	***	0,961	***	0,967	***	0,889	***	0,926	***	0,849	***
Course duration	0,792	***	1,029	**	0,775	***	1,072	***	0,755	***	1,060	***
Degree (ref.: ABI/sequential)												
Bachelor's	1,873	***	2,930	***	2,028	***	3,050	***	2,044	***	2,870	***
Licentiate	1,669	***	1,982	***	1,613	***	1,867	***	1,686	***	1,856	***
Technological	3,036	***	6,763	***	3,233	***	6,950	***	3,318	***	6,579	***
Schedule (ref.: distance learning)												
Morning	0,553	***	0,995		0,517	***	1,466	***	0,534	***	1,923	***
Afternoon	0,621	***	0,995		0,548	***	1,369	***	0,570	***	1,824	***

Evening	0,532	***	0,790	***	0,492	***	1,183	**	0,510	***	1,594	***
Full-time	0,521	***	1,149	***	0,492	***	1,645	***	0,527	***	2,209	***
Social support	0,060	***	0,174	***	0,060	***	0,178	***	0,061	***	0,177	***
Scholarship	0,142	***	0,560	***	0,134	***	0,534	***	0,125	***	0,519	***
Public High School	1,012		0,976		1,012		0,964	*	1,028		0,983	
IFECT	4,302	***	4,104	***	4,607	**	3,934	*	5,810	*	4,260	
Field (ref.: ABI/interdisciplinary)												
Education	0,524	***	1,838	***	0,422	***	1,628	**	0,406	***	1,880	***
Humanities and arts	0,363	***	1,002		0,283	***	0,903		0,264	***	1,037	
Social sciences, business and law	0,317	***	1,407	**	0,229	***	1,215		0,226	***	1,508	*
Sciences, mathematics and computing	0,418	***	0,772		0,291	***	0,660	**	0,289	***	0,842	
Engineering, manufacturing and construction	0,309	***	0,671	**	0,220	***	0,548	***	0,219	***	0,668	*
Agriculture and veterinary	0,343	***	0,826		0,243	***	0,656	**	0,252	***	0,808	
Health and social welfare	0,452	***	1,962	***	0,321	***	1,646	**	0,330	***	1,999	***
Services	0,491	***	1,421	**	0,376	***	1,103		0,364	***	1,304	
Nationality (ref.: Brazilian)												
Born abroad or naturalized	1,044		0,963		1,082		0,981		1,218		1,069	
Foreign	1,263		1,355		1,386		1,328		1,434		1,222	
Entrance exam	0,556	***	0,799	***	0,583	***	0,852	***	0,594	***	0,853	***
Control for birth state	sim		sim		sim		sim		sim		sim	
Control for Ifes	sim		sim		sim		sim		sim		sim	
Observations	245.368				177.258				127.679			
LR chi2(314)	62669,43 ***				45046,73 ***				30889,51 ***			
Pseudo R^2	0,1293				0,1280				0,1226			

Note: *p-value*: *< 0,10, **< 0,05, ***< 0,01.

Source: Elaborated by the authors.

Although the descriptive statistics in Table 2 point to a higher dropout rate for non-quota students compared to quota students, no significant effect differentiating the two groups was detected when controlling for course and student characteristics. This result adds to the body of empirical evidence from individual institutions or groups of institutions that have not found higher dropout rates among students targeted by affirmative action policies (Benatti, 2017; Bezerra; Gurgel, 2011; Cespedes *et al.*, 2021; Cicalò, 2008; Corbari, 2018; Costa, 2015; Gabriel, 2013; Machado, 2013; Mendes Junior, 2014; Silva; Pacheco, 2013).

A noteworthy finding is the effect of gender on the probability of completion. Women have a probability more than 50% higher of completing their courses compared to men, an effect significant at the 1% level in all sample segments. This result aligns with previous research: using microdata from the Enade and logistic models, Knop and Collares (2019) showed that women graduate in higher proportions than men, controlling for factors such as race, age, field of study, family income, and father's education level. A

possible explanation suggested in the literature for this phenomenon is that groups discriminated against in the labor market resort to formal education as a way to signal their skills (Lang; Manove, 2011; Nielsson; Steingrimsdottir, 2018). This occurs because employers may have difficulty accurately assessing the productivity of these groups due to their lower presence in higher-level positions. Consequently, women tend to place more importance on formal education than men do, using it as a tool to signal their abilities and thus investing more in their education (Nielsson; Steingrimsdottir, 2018).

The effects of race on graduation outcomes remain inconclusive. While, in the complete sample, black, brown, and asian students are less likely to graduate than white and indigenous students, in the more restricted sample (students under 21 years old at the time of admission), only indigenous students are less likely to graduate than white students. The lack of information on income and family structure may be responsible for these fluctuations, assuming, for instance, that black and brown racial categories are inversely correlated with income. It can therefore be anticipated that older individuals within these population strata face greater household demands, both in domestic labor and in contributing to family income, thereby hindering graduation. Furthermore, the race variable suffers from a reporting problem, as Table 2 shows that nearly half of the individuals do not have racial information or have not declared their race.

All else being equal, age at entry decreases the probability of dropping out of the course. This finding aligns with that obtained by Gomes and Hirata (2022) and may be associated with greater maturity at the time of career choice and with more life experience, which enables students to better cope with the challenges of university life. However, age at entry also contributes negatively to the probability of graduation, which, as we will see through the results of the Cox model, is explained by the longer time that older students at entry take to complete their degrees.

The longer the minimum required time for degree completion, the lower the probability of dropout: an additional year reduces the likelihood of withdrawal by 20.8% (complete sample), with statistical significance at the 1% level. Moreover, it increases the probability of graduation by 2.9%. This result may stem from the fact that the controls included pertain to the field of study rather than the specific course. Although the length of a university program is not necessarily linked to its prestige, it is worth noting that the so-called "imperial" professions – Medicine, Law, and Engineering – tend to have longer durations. Thus, it is possible that this variable is partially capturing the effect of these imperial professions on the probability of dropout and graduation. Another plausible explanation is that as the time invested in higher education increases, so too does the student's investment in terms of time and resources. This creates an intrinsic motivation to complete the program while simultaneously reducing the incentive to abandon it.

Students enrolled in technological courses have a probability of withdrawal more than three times higher than that of students in Basic Entry Areas (ABI) or sequential courses. This finding is consistent with that of Azevedo (2019), who compared dropout rates across the entire Brazilian national higher education system, identifying higher rates

in technological programs, followed by bachelor's degrees and licentiate degrees. The lower occupational prestige observed in the labor market for technologist training may help explain this difference. Silva (2018), using linear regression models, estimated the effect of the type of higher education degree on the prestige and occupational status of the worker. To this end, two measures of social position in the labor market were employed: the International Socio-Economic Index of Occupational Status (ISEI) and the International Socioeconomic Index of Occupational Prestige (SIOPS). The results revealed a clear stratification and hierarchy within the higher education system based on degree type, with traditional degrees (i.e., bachelor's and licentiate degrees) from public institutions ranking highest, followed by traditional degrees from private institutions, then public technological degrees, and finally private technological degrees.

Students enrolled in in-person courses exhibit a substantially lower probability of dropout compared to those enrolled in distance education programs. For example, studying full-time reduces the propensity for withdrawal by 47.9% relative to the DE modality. These findings corroborate the existing literature, which highlights a higher dropout rate in distance education compared to in-person courses (Azevedo, 2019; Bielchowsky, 2023).

Students who received some form of social support during their undergraduate studies are less likely to withdraw from their programs: the probabilities of dropout in these cases are over 90% lower than those observed for students who did not receive such benefits. These findings align with those of Saccaro, França, and Jacinto (2019), who employed parametric models to analyze the survival of students in the fields of Science, Mathematics and Computing, and Engineering, Production and Construction within Brazil's in-person higher education system. These authors found that most support programs help reduce dropout rates. This outcome reflects the importance of student assistance policies, which, in Ifesare organized through the National Student Assistance Program (PNAES). Such policies aim to reduce socioeconomic barriers within institutions, ensuring the retention of students in situations of socioeconomic vulnerability. However, beneficiaries of these policies also showed a lower propensity to complete their programs by the year 2019 compared to non-beneficiaries. The results concerning the effect of receiving scholarships point in the same direction, although to a lesser extent.

Although they were found to be more likely to complete their undergraduate studies within the period observed, students at the Federal Institutes of Education, Science and Technology (IFECT) are more than four times as likely to drop out of their programs compared to those at Federal Universities. This result may be associated with the low prestige and recognition that technical and vocational education holds in Brazil. According to Schwartzman (2005), professional and technological education tends to be perceived, by both students and teachers, as the acceptance of a lesser option, unable to provide the most valued educational credentials.

Relative to the interdisciplinary field, the other areas of knowledge exhibit a lower probability of dropout, with particular emphasis on the fields of Engineering, Production

and Construction, and Social Sciences, Business and Law, which show the lowest relative risks in this regard. These areas include Engineering and Law programs, professions associated with higher prestige and social status, and which offer higher economic returns in the labor market, as demonstrated by Neri (2005), Reis and Machado (2016), and Ribeiro and Schlegel (2015).

To explore the effect of being a quota student on the time to degree completion, the Cox model was estimated, and its results (hazard ratios) are reported in Table 4.

Table 4 - Hazard ratios from cox regressions for the time to graduation

	Full sample		Under 25 years old		Under 21 years old	
Quota student	0,988		1,022	*	1,038	***
Female	1,253	***	1,252	***	1,244	***
Race (ref.: white)						
Not declared	0,926	***	0,940	***	0,958	***
Black	0,923	***	0,934	***	0,947	**
Brown	0,966	***	0,983		0,990	
Asian	0,900	***	0,921	**	0,937	
Indigenous	1,024		0,923		0,861	
No information	1,000		0,989		1,020	
Age	0,984	***	0,971	***	0,936	***
Program length	0,778	***	0,781	***	0,769	***
Degree (ref.: ABI/sequential)						
Bachelor's	1,817	***	1,787	***	1,742	***
Licentiate	1,382	***	1,344	***	1,262	***
Technological	2,997	***	2,923	***	2,857	***
Study shift (ref.: Distance education)						
Morning	0,874	***	1,178	***	1,327	***
Afternoon	0,891	***	1,161	***	1,327	***
Night	0,755	***	1,021		1,169	***
Full-time	0,928	***	1,225	***	1,372	***
Social support	0,255	***	0,263	***	0,275	***
Scholarship	0,480	***	0,462	***	0,455	***
Public high school	1,035	***	1,029	***	1,037	***
IFECT	1,344		1,165		1,175	
Field of study (ref.: ABI/interdisciplinary)						
Education	1,168		1,008		1,116	
Humanities and arts	0,757	***	0,666	***	0,705	**
Social sciences, business and law	0,907		0,797	*	0,860	
Science, mathematics and computing	0,719	***	0,640	***	0,713	**
Engineering, production and construction	0,638	***	0,557	***	0,587	***
Agriculture and veterinary	0,731	***	0,626	***	0,668	***
Health and social well-being	0,930		0,804	*	0,874	
Services	0,988		0,822		0,878	
Nationality (ref.: brazilian)						
Foreign-born or naturalized	1,053		1,110	*	1,118	
Foreigner	1,325	***	1,348	***	1,416	***
University entrance exam	0,898	***	0,925	***	0,900	***
State of birth fixed effects	sim		sim		sim	
Ifes fixed effects	sim		sim		sim	
Observations	125.520		98.291		73.489	
LR chi^2 (156)	39.152,54	***	30.982,58	***	23.313,03	***

Note: p-value: *<0,10, **<0,05, ***<0,01.

Source: Elaborated by the authors.

Students who withdrew or transferred during the follow-up period are excluded from this stage of the analysis. Three sample groups are once again considered: the so-called "complete" sample; the sample comprising students who were under the age of 25 at the time of enrollment in higher education; and the sample comprising those who were under 21 at the time of admission.

The results for the complete sample, holding all other variables constant, reveal no difference in the time taken to complete the degree between quota students and non-quota students. However, for those who entered Ifes before the age of 21, the results favor quota students, who exhibit a "hazard" of course completion that is, on average, 3.8% higher than that of students admitted through open competition, an effect that is statistically significant at the 1% level. There is still limited empirical evidence for these results, given the scarcity of longitudinal studies that compare, using survival models, the time to degree completion of quota and non-quota students in Brazilian federal higher education institutions.

Regarding the other covariates, it is observed that a woman has, on average, a 25.3% higher hazard of completing the degree than a man. This effect maintains its magnitude and statistical significance at the 1% level across all sample groups. As for race, it is noted that black and brown students have, on average, a 7.7% and 3.4% lower hazard of completing the degree, respectively, compared to white students. For black students, this effect remains in the other sample groups, although it loses some intensity; for brown students, the effect becomes statistically insignificant. Although a proxy for the students' socioeconomic status – a binary variable indicating the receipt of any social support during undergraduate studies – was included as a control, it is necessary to acknowledge that this proxy is imperfect. Thus, the lower hazard of course completion for black students may be associated with their socioeconomic background, as they have fewer family resources to support their persistence in higher education.

The older the student at the time of entry, the lower their hazard of completing the degree, which supports the hypothesis that age brings greater family responsibilities. On the one hand, this factor may push the student to enter the labor market; on the other, and particularly for women, it may impose a double work burden. In both cases, the student may face difficulties in reconciling their professional and family responsibilities with their studies, thereby extending their time in higher education.

The program length naturally extends the student's duration in higher education, negatively impacting their hazard of completion. An additional year reduces this hazard by 22.2%. However, it is noteworthy that the minimum required time to complete the degree for the sample including dropouts and those who transferred or suspended their studies is, on average, only 4.2 years (Table 1).

Technological programs exhibit the highest hazard of completion, followed by bachelor's and licentiate degrees. The effect of course schedule on the hazard of completion shows opposite results depending on the sample considered. For the full sample, in-person programs show a lower hazard of completion relative to distance

learning. However, when focusing on the younger cohort of entrants, studying during daytime hours (morning, afternoon, or full-time) increases, on average, the hazard of completion by more than 30%, while studying at night increases this hazard by 16.9%, compared to distance learning. This difference in results may be due to the greater burden of family and professional responsibilities for older students, which may make distance learning a faster path to completion since it provides the necessary flexibility to reconcile studies with these other responsibilities.

The receipt of social support during undergraduate studies is, among all covariates in the model, the factor that most significantly contributes to reducing the hazard of course completion. As previously mentioned, this variable can be interpreted as a proxy for the student's socioeconomic status, since low household income is generally a requirement to be eligible for such benefits. Thus, it is evident that when students fall within this socioeconomic bracket, their hazard of course completion is reduced by between 72.5% (for those who entered before age 21) and 74.5% (for the full sample). This result further suggests that the benefits granted to socioeconomically vulnerable students in Ifes are insufficient to neutralize the impact of socioeconomic background on the time required to complete higher education.

Although the receipt of scholarships – such as those for internships, tutoring, extension activities, or scientific initiation – is not conditioned on family income, it is commonly used as a strategy by low-income students to ensure their continued enrollment in higher education. Therefore, this variable can also be considered a proxy for socioeconomic status, which may help to explain its negative effect on the hazard of course completion across all samples considered.

Students from public high schools have a 3.5% higher risk of completing their degree compared to those from private schools. It is noteworthy that no significant differences were found in the probabilities of dropout between students from public and private schools, and only in the intermediate sample was a small difference found indicating that students from public high schools have a lower likelihood of completion (Table 2). However, the hazard ratio is a rate that approximates the probability over time, suggesting that even when the probabilities of graduation are similar or differ between groups, those from public high schools tend to complete their degrees more quickly. This result may indicate that the need to finish their degree to enter the job market may outweigh the challenges these students face regarding their educational background.

5 FINAL CONSIDERATIONS

Since the first experiences of affirmative action were implemented in Brazil, they have become the subject of studies aimed at assessing the performance of quota students. One of the motivations for these analyses is the concern that these students might not be adequately prepared to attend competitive institutions with high academic standards, leading to poor performance and, ultimately, dropping out – an assumption known in the literature as the "mismatch hypothesis". Although there is a considerable

volume of studies addressing this issue, few have been conducted in a more comprehensive manner, analyzing the entire network of federal higher education institutions in Brazil.

In this article, we aimed to contribute to the understanding of the effectiveness of affirmative action policies by comparing quota and non-quota students regarding their probabilities of dropout and graduation, as well as the time taken to complete their courses. Uniquely, the cohort of students who entered Federal Higher Education Institutions in 2013, the year marking the first large-scale intake of quota students following the implementation of the "Quota Law" in 2012, was tracked through to 2019. Using a multinomial logistic regression and the Cox survival model, no significant differences were found in the probabilities of dropout, graduation, or in the time taken to complete the course between quota and non-quota students. These results support the findings of previous studies, which had been limited to isolated institutions, groups of institutions, or specific fields of knowledge.

In this analysis, efforts were made to account for confounding factors that could bias the results. However, due to the lack of information in the CES, some of these factors, such as the student's family income, could not be controlled for. Generally, students from low-income families – like those benefiting from the quota policy – have lower chances of completing their degree (Knop; Collares, 2019). Therefore, not including this control variable in the models could have led to unfavorable results for quota students – something that was not observed. Consequently, while this limitation exists, it does not invalidate the results obtained.

The field for future analyses is prolific and encompasses, on the one hand, the cross-referencing of CES microdata with that of Enade and Enem, in order to fill the gap in the variables mentioned above, and, on the other hand, the cross-referencing with data from the Annual Social Information Report (Rais) - an administrative record managed by the Ministry of Labor – in order to compare the performance of quota and non-quota students in the labor market. Moreover, it will be necessary to assess the impact of the changes added to the "Quota Law" during its review, carried out in the second semester of 2023.

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Danilo Braun Santos – Research planning, data processing, preparation of computational routines, results analysis, and writing.

Daniela Verzola Vaz – Results analysis, writing, and final text revision.

Maria Angélica Pedra Minhoto – Research planning and supervision, final text revision.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest regarding the article Analysis of the reservation policy in Federal Institutions of Higher Education.

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