Pontifícia Universidade Católica
do Rio de Janeiro

**Guilherme Noronha Jardim**

# Competition and Public Provision in Higher Education

**Dissertação de Mestrado**

Thesis presented to the Programa de Pós–graduação em Economia, do Departamento de Economia da PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Economia.

Advisor : Prof. Juliano Junqueira Assunção
Co-advisor: Prof. Leonardo Bandeira Rezende

Rio de Janeiro
April 2023

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# Abstract

Jardim, Guilherme Noronha; Assunção, Juliano Junqueira (Advisor); Rezende, Leonardo Bandeira (Co-Advisor). **Competition and Public Provision in Higher Education**. Rio de Janeiro, 2023. 47p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

This paper investigates the impact of public provision on competition within the Brazilian higher education sector. We develop and estimate an empirical model of demand for higher education that incorporates tuition-free institutions and consumer choice constraints. Our model produces more realistic substitution patterns than a logit model without constraints, indicating that selectivity is an essential dimension of product differentiation. We find that the most selective public programs exert comparable competitive pressure to the most selective private programs, but the least selective public programs exert more competitive pressure than the least selective private programs. Our estimates of the supply response of private institutions suggest that, in the absence of public programs, tuitions would be about 7 percent higher. These findings provide important insights into the competitive dynamics of Brazilian higher education and highlight the role of public provision in promoting competition in this sector.

## Keywords

Education; Public provision; Discrete choice model.

# Resumo


Jardim, Guilherme Noronha; Assunção, Juliano Junqueira; Rezende, Leonardo Bandeira. **Competição e Provisão Pública no Ensino Superior**. Rio de Janeiro, 2023. 47p. Dissertação de Mestrado – Departamento de Economia, Pontifícia Universidade Católica do Rio de Janeiro.

Este artigo investiga o impacto da provisão pública na concorrência dentro do setor de ensino superior brasileiro. Desenvolvemos e estimamos um modelo empírico de demanda por ensino superior que incorpora instituições gratuitas e restrições de escolha do consumidor. Nosso modelo produz padrões de substituição mais realistas do que um modelo logit sem restrições, indicando que a seletividade é uma dimensão essencial da diferenciação de produtos. Mostramos que os programas públicos mais seletivos exercem pressão competitiva comparável aos programas privados mais seletivos, mas os programas públicos menos seletivos exercem mais pressão competitiva do que os programas privados menos seletivos. Nossas estimativas da resposta de oferta das instituições privadas sugerem que, na ausência de programas públicos, as mensalidades seriam cerca de 7% mais altas. Esses resultados fornecem informações importantes sobre a dinâmica competitiva do ensino superior brasileiro e destacam o papel da provisão pública na promoção da concorrência nesse setor.





# Palavras-chave

Educação; Provisão pública; Modelos de escolha discreta.

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## List of Abreviations

ENEM — *Exame Nacional do Ensino Médio* (National Secondary Education Examination)

FIES — *Fundo de Financiamento ao Estudante do Ensino Superior*

IGC — *Índice Geral de Cursos* (General Index of Programs)

INEP — *Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* (National Institute of Educational Studies and Research)

MEC — *Ministério da Educação* (Ministry of Education)

PROUNI — *Programa Universidade para Todos*

SISU — *Sistema de Seleção Unificada* (Unified Selection System)

UFRJ — *Universidade Federal do Rio de Janeiro* (Federal University of Rio de Janeiro)

# 1
# Introduction

Over the last two decades, the higher education sector has undergone remarkable growth, as the number of students enrolled in higher education globally has risen from 89 million in 1998 to approximately 200 million in 2018. Over the same period, enrollment rates in higher education have risen from 17.3% to 38.4% globally (World Bank, 2020).

Latin America and the Caribbean have also witnessed a significant growth trend in their higher education sector, as evidenced by the nearly doubling of the number of students in the 2000s decade (World Bank, 2018). This growth was accompanied by distinct patterns of public funding and provision across countries, which is reflected in their current higher education system. The region exhibits two primary models of funding for higher education. In the first model, public higher education institutions offer free or nearly free tuition, but no funding is provided for students attending private institutions. This approach predominates in Argentina, Bolivia, Ecuador, Mexico, Panama, and Uruguay, where the majority of higher education students attend public institutions. In the second model, tuition fees are charged at public higher education institutions, but funding is available for students attending private institutions through scholarships and loans. Private institutions attract the majority of higher education students in these countries (Ferreyra et al., 2017). Brazil presents a hybrid case where public institutions offer free education but are highly selective, capturing less than 30% of the market, and public funding is available for students attending private institutions through grants and loans.

These differences in public funding and provision across countries underscore the importance of understanding how private and public institutions interact in the higher education market. More specifically, this paper studies the degree of competition that exists between the two sectors, in the context of Brazilian higher education. On one hand, public institutions may act more competitively than a profit-maximizing entity if they value consumer welfare. On the other hand, if public provision leads to product differentiation, public institutions may exert little to no competitive pressure on the private side of the industry.

The Brazilian experience provides an interest setting to explore this question. The expansion of the higher education sector in the last two decades has been characterized by significant growth in the private market. This growth was facilitated by a series of regulatory changes in 1997 that permitted the entry of for-profit colleges, which culminated in the establishment of education conglomerates. In conjunction with this process, two programs were introduced to subsidize access to private higher education: PROUNI (Programa Universidade para Todos), a federal scholarship program, and FIES (Fundo de Financiamento ao Estudante do Ensino Superior), a subsidized loan program. These developments have transformed the distribution of students between the public and private sectors dramatically. The proportion of enrolled students in private institutions increased from approximately 60% to 70% of all undergraduate students in in-person programs between 1991 and 2018, as depicted in Figure 1.1.

Previous empirical work has focused on the effects of competition from a subsidized sector on prices and quality of primary and secondary education (Card et al., 2010; Neilson, 2013; Neilson et al., 2020; Dinerstein & Smith, 2021). However, these studies have not investigated how the degree of competition may vary based on the type of provider. Unlike primary and secondary education, higher education is a more complex and heterogeneous market that allows for greater differentiation in terms of selectivity, curriculum, hours, and course load. As a result, the interaction between public and private institutions may lead to ambiguous predictions regarding the effects on competition. This study aims to fill this gap in the literature by examining the competitive dynamics between public and private institutions in the Brazilian higher education sector.

We construct a panel dataset from 2011 to 2019 at the level of major-institutions by combining various publicly available datasets. This dataset provides detailed information on majors offered by both private and public institutions. Furthermore, we utilize administrative data from FIES and PROUNI to obtain data on tuition fees, which is not usually available in administrative datasets.

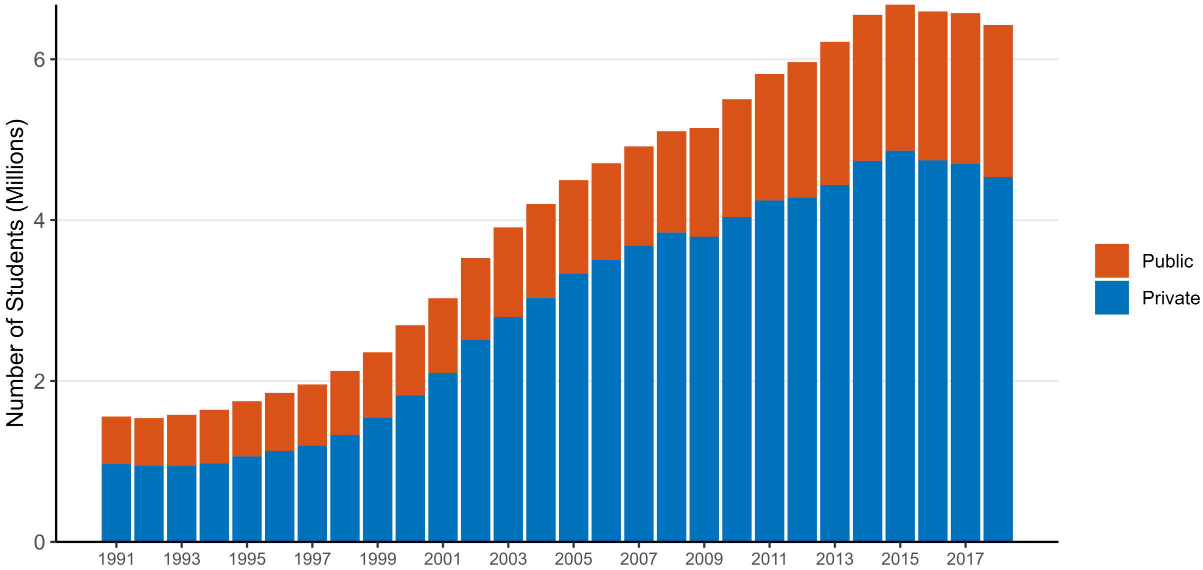
In order to assess the impact of public provision on competitive pressure, we develop and estimate an empirical model of demand for higher education that incorporates both private and public institutions. A key challenge in estimating a model that incorporates public institutions into the choice set is that public majors are tuition-free. Without adding constraints to consumer choices, the model rationalizes the relatively low market share of those options by attributing a low quality to public programs, which is inconsistent with the Brazilian higher education sector. To address this issue, we introduce public institutions in the markets along with constraints defined by the interaction between the major-institution's grade cut-off and the distribution of grades used in admission. These constraints account for the fact that, unlike standard consumer choice models, students cannot simply choose their preferred program, but rather must select from the set of major-institutions that accept them.

In comparison with a logit model without constraints, our model attributes a higher mean utility to public programs. Our estimates suggest that the public programs would have to charge, on average, a tuition of R$126 — with the average tuition for private programs in our sample being R$946.92 — to have the corresponding mean utility implied by the logit model. The constraints on consumer choices also allow for a model with more realistic substitution patterns, highlighting the importance of selectivity as a dimension of product differentiation. Using the estimated cross-price elasticities, we find that the most selective public programs exert comparable competitive pressure to the most selective private programs, but the least selective public programs exert more competitive pressure than the least selective private programs.

To quantify the relevance of the competition exerted by public institutions, we simulate a counterfactual scenario with no public programs. Our estimates of the supply response of private institutions indicate that, in the absence of public programs, tuition fees would increase by approximately 7% on average. This increase is heterogeneous across majors, ranging from a 24-26% average increase for Chemistry and Library Science to a 0.6-1% average increase for Actuarial Science and Medicine. While the predominance of public programs in some majors may partly explain this heterogeneity, it does not fully account for it: Library Science and Chemistry are majors with mostly public programs (97% and 82% of all programs are public, respectively), and Medicine has a relatively low presence of public institutions (39% of all programs are public). However, Actuarial Science also has a high share of public institutions (95% of all programs are public), which suggests that the impact on prices may be linked to other factors captured by the model as well.

Our paper has important implications. From an empirical industrial organization perspective, it shows why and how to incorporate both public and private institutions in empirical models of demand for Brazilian higher education — without relying on micro data or random-coefficients —, and it highlights the role of selectivity for substitution patterns across institutions. From a development standpoint, our paper sheds light on the extent to which private institutions are affected, through competition, by the presence of public and subsidized provision.

Figure 1.1: Number of Undergraduate Students in Public and Private In-Person Programs from 1991 to 2018 in Brazil






## 1.1 Related Literature

This paper contributes to three different strands of literature. A first and growing strand of literature studies the interplay between public and private providers, exploring the effects on competition, prices, and quality. Coelho et al. (2013) measures the competitive effect of public banks in concentrated local markets in Brazil using branch location patterns and finds that the presence of a public bank does not affect the conduct of private banks. Atal et al. (2021) find that the entry of public pharmacies in Chile leads to an increase in prices and market segmentation, while Hernández (2021) find the entry of new government milk suppliers in Mexico to lead to price decreases in the private market. In education markets, the literature has mainly focused on primary and secondary education. Neilson et al. (2020) studies how the level of public provision affects the overall level of quality in the market in the context of a large expansion of public schools. Dinerstein & Smith (2021) use a model of demand for and supply of private schooling to study school policies that cause a large demand shift between public and private schooling and their consequences for private school entry and exit. Neilson (2013) shows that the introduction of a voucher targeted at poorer students led private schools to improve quality through its effects on competition.

A second and vast strand of literature studies empirical models of demand. Berry et al. (1995) develop methods for empirically analyzing demand and supply in differentiated products markets and then applies these techniques to analyze equilibrium in the automobile industry. Nevo (2001) estimates an empirical model of demand for ready-to-eat cereal in order to examine price-cost margins and conduct. Berry et al. (2004) show how rich sources of information on consumer choice can help to identify demand parameters in a widely used class of differentiated products demand models. Goolsbee & Petrin (2004) examine direct broadcast satellites as a competitor to cable by estimating a structural consumer level demand system for satellite, basic cable, premium cable and local antenna using micro data.

This paper also adds to a large body of research that studies education markets through the lens of structural models. Dobbin et al. (2021) investigate the equilibrium effects of subsidized student loans in Brazil on tuition costs, enrollment, and student welfare. Duarte (2020) develop and estimate a structural discrete choice model of demand to evaluate how the availability of credit impacts major choice. Ferreyra & Kosenok (2018) propose and estimate an equilibrium model of charter school entry and school choice where households choose among public, private, and charter schools. Neilson et al. (2019) develop a structural model of school choice and competition where price and quality are chosen endogenously and schools face capacity constraints.

We move beyond the existing literature by examining how public and private providers may differ in the competitive pressure exerted in education markets, rather than focusing on the effects of competition. We also contribute to the literature by exploiting constraints in consumer choice to include free and costly options in choice sets. To the best of our knowledge, this is the first structural model of demand for higher education in Brazil (Duarte, 2020; Dobbin et al., 2021; Otero et al., 2021) to incorporate both private and public institutions in the markets.

# 2
# Background

## Brazilian Higher Education System

Based on the 2019 Census of Higher Education, the Brazilian Higher Education System comprises 2,608 institutions, of which 302 are public and 2,306 are private. The public system includes federal (110), state (132), and municipal (60) institutions, which respectively account for 16%, 8%, and 1% of the total undergraduate enrollment of approximately 6.2 million students[1]. Federal and state institutions are, by law, free of any charge, while municipal institutions usually charge some tuition. Private institutions, on the other hand, consist of both profit (1,389) and non-profit (917) organizations, which are subject to federal regulations and standards but are independent in terms of tuition fees and administration.

Public institutions (especially federal) are widely recognized in the country by their average superior quality. In the 2019 General Index of Programs (IGC), a quality index developed by the Ministry of Education based on the performance of undergraduate and graduate programs, the federal institutions scored, on average, 3.3 on a scale of 0 to 5. State institutions scored 2.8, municipal institutions 2.3, and private institutions 2.5. A similar pattern emerges in the Ranking Universitário Folha 2019, created by Folha de São Paulo — the most circulated newspaper in Brazil —, where 17 out of the top 25 universities are federal, 6 are state, and 2 are private.

Due to their high quality and free tuition, public institutions usually attract a large number of applicants. The median public degree program has five applicants per available spot, whereas the top 10% of selective degree programs receive more than twenty applicants per vacancy. On the other hand, over 90% of the degrees in the private sector fill fewer than 80% of their spots (Dobbin et al., 2021). This highlights the fact that competition is highly heterogeneous by institution and field of study.

[1]Considering only undergraduate on-campus programs and students with an active enrollment status.

### Private Higher Education

In 1997, a series of regulations (Law 9.394, of December 20, 1996; and Decree 2.207, of April 15, 1997) facilitated the expansion of the private sector in the higher education market by allowing the entrance of for-profit colleges, resulting in a significant expansion of the private sector. The total enrollment in private institutions went from 960 thousand to 4.5 million in the period between 1991 and 2018, while public institutions witnessed a comparatively modest increase, from 605 thousand in 1991 to 1.9 million in 2018 (Senkevics, 2021).

This expansion is characterized by a shift in the configuration and funding of private institutions. Entrance of for-profit colleges culminated in the establishment of education conglomerates, and the process was accompanied by the creation of two programs designed to subsidize access to private higher education: PROUNI (Programa Universidade para Todos) — a federal scholarship program — and FIES (Fundo de Financiamento ao Estudante do Ensino Superior) — a subsidized loan program.

PROUNI was established in 2005 under Law 11.096/2005, providing scholarships to students in private higher education institutions based on selection criteria such as family income, race, and previous school career. In its first year, the program provided around 112,000 scholarships. Since 2014, the program has awarded over 300,000 scholarships annually, with a peak of around 362,000 in 2017.

FIES was created in 1999 by Executive Order 1.856-5/1999, offering subsidized credit to low-income students in private higher education institutions. The program remained relatively small until 2010 when it was restructured, leading to a substantial increase in loans. The number of students enrolled in private higher education with FIES financing increased from around 130,000 in 2009 to almost 1.5 million in 2015 (Duarte, 2020). However, budget limitations forced another restructuring in 2015, this time with the aim of reducing public fund disbursement and targeting subsidies towards students with greater financial need. Between 2015 and 2017, the federal government introduced new rules to achieve these objectives.

### Admission Process

In 2010, the Brazilian Ministry of Education introduced a centralized admission system called the Unified Selection System (SISU) to expand access to higher education, increase student mobility, and incentivize changes in the high school curriculum. SISU is an online platform where universities offer their vacancies and students apply using only their scores on the national standardized exam.

Only federal and state institutions could adopt the SISU and they were free to choose if and how to do so. For instance, they could choose to adopt the system for all the available vacancies, partially or only for some degrees. Institutions adopted the system progressively, and by 2015, all but two federal institutions had adopted SISU (fully or partially) (Mello, 2022).

The SISU admission system is based solely on the score students obtain in the National Secondary Education Examination (ENEM). Introduced in 1998 by the National Institute of Educational Studies and Research (INEP), ENEM is an annual, non-mandatory, standardized national exam that assesses students' proficiency in four different areas: languages, codes and related technologies; human sciences and related technologies; natural sciences and related technologies; and mathematics and its technologies, as well as an essay.

In 2009, ENEM was reformulated to become more rigorous and more similar to the admission exams used by public universities. Since then, the exam has become a widely accepted selection criterion for higher education admissions in both public and private institutions. In the case of private institutions, ENEM also serves as an element in the selection process for PROUNI and FIES.

# 3
# Data

We combine several publicly available datasets to build a panel at the major-institution level from 2011 to 2019 in order to characterize majors offered by private and public institutions, with the purpose of studying the interaction between the two sectors.

First, to establish the universe of majors offered in each year, we use data from the Higher Education Census from 2011 to 2019 of all in-person undergraduate degrees. This dataset is based on a questionnaire filled out by each higher education institution and supplemented with data from the Ministry of Education (MEC). It provides detailed information on courses, alumni, faculty, and academic organization for each institution, allowing us to observe all degrees offered, as well as other relevant information such as the number of enrolled students, applicants, maximum cohort size, and total course load. Additionally, we collected institution-level variables, including the number of majors offered, the proportion of staff with a doctoral degree, whether the institution is public, and its expenses on faculty and maintenance costs.

Unfortunately, the Higher Education Census does not provide data on tuitions. To address this gap, we utilize the FIES and PROUNI Administrative Records, which are provided by the Ministry of Education and cover the universe of student loans and scholarships awarded by the federal government. These records contain information on the full tuition for each participating student. In order to obtain tuition data for a given major-year, we compute the average of all tuitions by year and major, which should provide information for all degrees with at least one beneficiary in each year. By following this approach, we are able to recover the tuition information for around 80% of all majors offered by private institutions during the period under analysis. Although our tuition data comes exclusively from students participating in FIES or PROUNI, we will treat these tuitions as representative of the entire market. This assumption is supported by descriptive statistics from Duarte (2020), which uses a private dataset from Hoper, a consultancy firm specializing in the education sector, to recover tuition values.

Finally, in order to measure the selectivity of majors, we employ data from the Ministry of Education on grade cut-offs for SISU and PROUNI. Specifically, SISU provides information on the minimum ENEM scores required for admission to most public programs each year, with and without quotas. Unfortunately, we don't observe directly the minimum grades for admission in private institutions. To overcome this issue, we turn to PROUNI grade cut-offs as a proxy for selectivity of private majors. Since PROUNI uses ENEM in its selection process, those grades are comparable to the ones from SISU.

This approach raises two potential concerns. The first concern is that the number of spots allocated to PROUNI in each major-institution may affect the use of grade cut-offs as a measure of selectivity. To investigate this issue, we examine the distribution of PROUNI beneficiaries and grade cut-offs in private programs from 2011 to 2019, as shown in Figure A.1. The figure suggests that there is no clear relationship between the number of beneficiaries and the grade cut-offs, which mitigates this concern. The second concern is that the use of PROUNI grade cut-offs as a proxy for private institutions' selectivity may over or underestimate the actual cut-offs due to its selection criteria. Nonetheless, it is reasonable to assume that PROUNI grade cut-offs provide useful information for comparisons between majors.

Table 3.1 presents descriptive statistics for our sample of major-institutions by year. The data indicate that the average demand for higher education increased between 2011 and 2015, as reflected by the number of enrolled students and applicants. However, beginning in 2016, there was a steady decline in the number of enrolled students, applicant students, and maximum cohort size. Additionally, the data reveal a declining trend in average tuition, which decreased by over 20% from 2011 to 2019.

Figure 3.1 displays the distribution of grade cut-offs for both private and public major-institutions in our sample. The vertical lines depict the average grade cut-off for each sector. The graph highlights that private institutions offer a higher number of majors than public ones. Additionally, it demonstrates that the average grade cut-off for private programs is lower than that of public universities, which is consistent with the highly competitive admission process in public universities. Nonetheless, it is noteworthy that the overlap between the distributions is relevant, indicating that some private programs are just as selective as their public counterparts and highlighting the fact that selectivity is highly heterogeneous by institution and field of study.

Figure 3.1: Distribution of Grade Cut-Offs from Private and Public Programs, 2011 to 2019

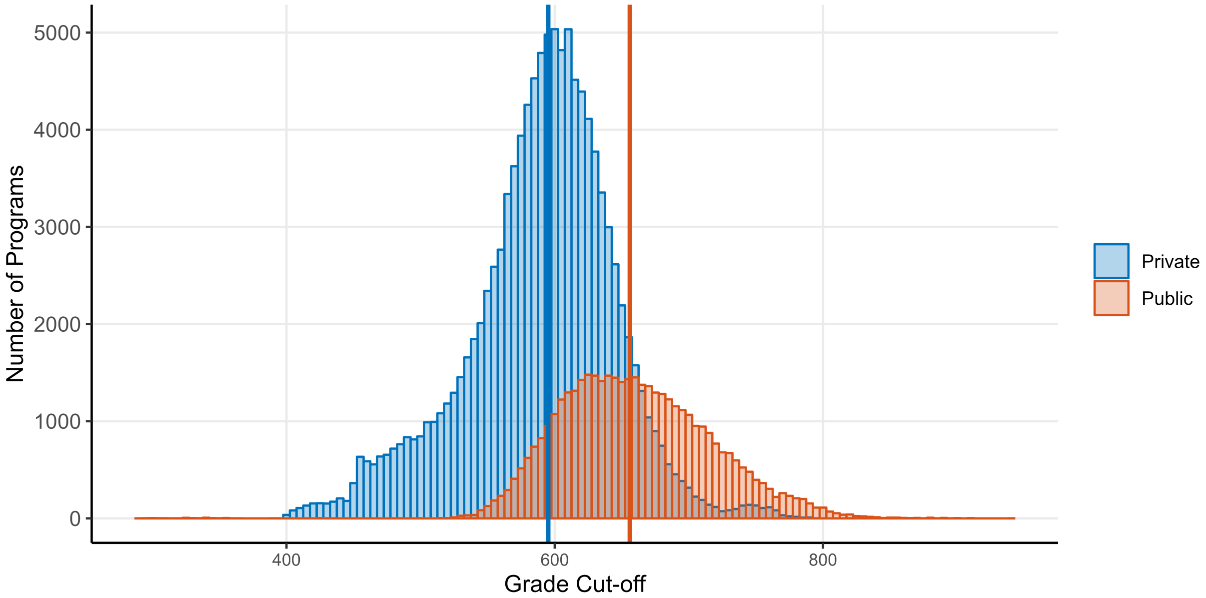


Table 3.1: Descriptive Statistics — Variables at the Major-Institution Level

| Variable | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|
| Enrolled Students (institution) | 2710.89 | 2952.31 | 3228.45 | 3675.9 | 3959.4 | 4058.3 | 3564.9 | 3307.6 | 3291.8 |
| | (7115.50) | (7374.19) | (8541.82) | (9416.5) | (9557.0) | (9527.7) | (8813.6) | (8386.8) | (8302.1) |
| Number of Majors Offered (institution) | 10.86 | 11.54 | 12.50 | 13.5 | 14.6 | 15.5 | 14.2 | 13.8 | 13.7 |
| | (23.43) | (24.88) | (29.51) | (29.8) | (29.9) | (29.4) | (27.2) | (27.4) | (25.7) |
| Percentage of Staff with Doctorate (institution) | 0.93 | 0.99 | 1.01 | 1.1 | 1.2 | 1.3 | 1.5 | 1.8 | 1.8 |
| | (2.55) | (2.58) | (2.74) | (2.8) | (2.9) | (2.8) | (3.4) | (3.6) | (3.2) |
| Public (institution) | 0.07 | 0.08 | 0.09 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | | | | | | | | | |
| Expense with Faculty (institution) | 44837.59 | 51200.91 | 62474.14 | 74483.1 | 72200.1 | 73158.9 | 71580.9 | 61758.6 | 74175.2 |
| | (111224.73) | (105435.71) | (140293.42) | (207275.7) | (143839.9) | (146282.6) | (283987.2) | (128729.6) | (150032.9) |
| Expense with Social Security (institution) | 31113.75 | 36899.90 | 40555.94 | 45338.6 | 46065.9 | 49914.2 | 51455.7 | 38370.9 | 35279.9 |
| | (79562.88) | (108813.19) | (116324.42) | (138071.9) | (122712.5) | (134643.2) | (385206.7) | (110656.7) | (88829.9) |
| Expense with Maintenance Costs (institution) | 42711.86 | 46566.34 | 91922.57 | 97270.4 | 83437.8 | 85764.3 | 65565.6 | 74719.0 | 82753.7 |
| | (113896.37) | (121200.32) | (253520.50) | (253167.3) | (217942.7) | (202853.3) | (174930.9) | (214078.5) | (220567.6) |
| Expense with Investment (institution) | 17818.73 | 17149.98 | 21473.11 | 21618.2 | 15589.2 | 17946.1 | 14505.0 | 19387.2 | 18913.0 |
| | (57442.48) | (69886.69) | (53449.72) | (55881.1) | (40059.3) | (52196.3) | (65189.5) | (59406.2) | (58554.2) |
| Tuition | 799.49 | 708.56 | 739.67 | 683.1 | 663.5 | 633.1 | 627.6 | 639.9 | 621.0 |
| | (614.60) | (608.88) | (655.28) | (635.2) | (659.2) | (664.7) | (679.5) | (730.6) | (772.0) |
| Grade Cut-Off | 591.04 | 578.87 | 616.70 | 613.7 | 612.7 | 617.2 | 615.3 | 610.4 | 622.4 |
| | (75.66) | (75.24) | (56.16) | (57.1) | (65.7) | (57.3) | (78.6) | (72.0) | (72.9) |
| Enrolled Students | 249.60 | 255.79 | 258.36 | 273.0 | 270.7 | 262.4 | 252.0 | 240.0 | 241.0 |
| | (322.66) | (313.21) | (316.27) | (338.2) | (339.3) | (320.0) | (308.1) | (289.7) | (284.5) |
| Maximum Cohort Size | 137.32 | 136.45 | 165.83 | 201.5 | 211.6 | 215.4 | 202.1 | 198.9 | 188.2 |
| | (123.80) | (145.60) | (369.72) | (228.3) | (272.5) | (309.6) | (266.0) | (264.7) | (255.8) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Applicants | 414.86 | 533.78 | 585.02 | 673.5 | 675.4 | 636.0 | 626.0 | 525.7 | 526.7 |
| | (854.22) | (1164.75) | (1172.61) | (1330.2) | (1293.4) | (1178.1) | (1128.0) | (907.0) | (930.5) |
| Number of Graduating Students | 36.20 | 35.54 | 32.51 | 31.9 | 34.3 | 34.7 | 34.4 | 35.6 | 34.6 |
| | (59.00) | (58.30) | (48.68) | (48.3) | (50.2) | (49.2) | (50.0) | (53.3) | (48.7) |
| Night Course | 0.82 | 0.81 | 0.81 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Percentage of Semi-Presential Coursework | 4.32 | 3.94 | 4.41 | 5.6 | 6.0 | 6.1 | 6.8 | 7.3 | 7.8 |
| | (7.73) | (7.36) | (7.74) | (8.4) | (8.7) | (8.6) | (8.9) | (9.0) | (9.5) |
| Course with Laboratory | 0.95 | 0.96 | 0.95 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Total Course Load in Hours | 3224.63 | 3309.13 | 3298.47 | 3333.1 | 3352.4 | 3389.4 | 3420.0 | 3473.1 | 3552.6 |
| | (985.46) | (1022.63) | (1031.22) | (996.0) | (996.1) | (1023.8) | (995.2) | (1043.2) | (1097.0) |
| N | 13891 | 13804 | 14458 | 15918 | 17598 | 17829 | 18332 | 18948 | 17235 |

Note: This table presents descriptive statistics for the sample of major-institutions in Brazil by year. Information is obtained from the Higher Education Census editions from 2011 to 2019, except for the "Tuition" variable, which comes from PROUNI and FIES Administrative Records, and the "Grade Cut-Off", which comes from SISU and PROUNI. At the institution level, the table presents information on average number of enrolled students, proportion of staff with a doctorate, proportion of public institutions, expense with faculty, social security, maintenance costs, and investment. At the major-institution level, the table presents information on average tuition, grade cut-off, number of enrolled students, maximum cohort size, number of applicants, number of graduating students, proportion of night course majors, percentage of semi-presential coursework, proportion of courses with laboratory, and total course load in hours. Expenses are shown in R$ 1000. Expenses and Tuitions are shown in January 2019 constant prices (inflation adjusted by IPCA).

# 4
# Model

In this section, we develop an empirical model of demand for higher education that incorporates both private and public institutions, in order to understand how they interact in this market.

The main issue when estimating a model that incorporates public institutions into the choice set is that public majors are tuition-free. Without adding constraints to consumer choices, the model rationalizes the relatively low market share of those options by attributing a low quality to public programs, which is inconsistent with the Brazilian higher education sector. We deal with this problem by introducing public institutions in the markets along with constraints defined by the interaction between the major-institution's grade cut-off and the distribution of ENEM grades used in admission.

We define a market as a choice set, so that students $i = 1, \ldots, I$ facing a choice between major-institutions $j = 1, \ldots, J$ at a given state, year and major's area $t = 1, \ldots, T$ are in the same market. The major's area is given by the International Standard Classification of Education adapted to Brazil — examples are Social and Behavioural Sciences, Business and Management, Engineering, Health, etc. We base this definition by state on the finding by Mello (2022) that only 10% of incoming students in public higher education institutions choose to attend college in a different state.

Assume the utility obtained by student $i$ from enrolling in major-institution $j \in J_t$, in state, year and major's area $t$ is given by:

$$u_{ijt} = \delta_{jt} + \varepsilon_{ijt}$$

where

$$\delta_{jt} = \alpha p_{jt} + x_{jt}\beta + \gamma_j^{institution} + \gamma_j^{major} + \gamma_t^{year} + \xi_{jt}$$

$$\varepsilon_{ijt} \sim \text{i.i.d. Extreme Value Type I}$$

$\delta_{jt}$ denotes the mean utility level of major-institution $j$ in market $t$, $\alpha$ measures the sensitivity of students to tuition values, $x_{jt}$ is a 1 $\times$ K vector of characteristics for major-institution $j$ in market $t$. We'll also include institution fixed effects $\gamma_j^{institution}$, and year and major fixed effects $\gamma_t^{year}$ and $\gamma_j^{major}$.

$\gamma_j^{institution}$ is related to a persistent component of unobserved quality at the institution-level (Nevo, 2001) — this captures additional unobserved reasons individuals may systematically prefer institution $j$ over other institutions in their market —, $\gamma_j^{major}$ captures a component of quality at the major-level, and $\gamma_t^{year}$ control for trends in the demand. The variable $\xi_{jt}$ represents a measure of major-institution quality that is not observed by us, but it's known by the students and institutions. The outside option $j = 0$ represents choosing a different major or not enrolling in higher education.

Unlike standard consumer choice models, students cannot simply choose their most preferred program. Each consumer's choice set is given by the set of major-institutions that accept the student:

$$O_i = \{j \in J_t : g_{ij} \geq \text{Grade Cut-Off}_j\} \cup \{0\}$$

where $g_{ij}$ is the ENEM score obtained by student $i$ for admission in major-institution $j$. In order to simplify the model, we consider that the relevant grade is the unweighted average of grades in the four sections and the essay ($g_{ij} = g_i$), even though different major-institutions may define distinct weights for each part. We also assume that the student's decision does not affect the grade cut-offs.

Thus, we have that student $i$ considers all $j' \in O_i$ and enrolls in his preferred institution $j$:

$$j = \arg\max_{j' \in O_i} u_{ij'}$$

Given a choice set $O_i$, the logit model implies that the probability that individual $i$ selects major-institution $j \in J_t$ is given by:

$$s_{ij}^{O_i} = \begin{cases} \frac{e^{\delta_j}}{\sum_{j' \in O_i} e^{\delta_{j'}}} & \text{if } j \in O_i \\ 0 & \text{if } j \notin O_i \end{cases} \tag{4-1}$$

Since we observe $O_i$ via the grade cut-offs, we can estimate the predicted market share of major-institution $j$ in market $t$ by using the distribution of ENEM grades $P_g(\cdot)$, for a given $\delta$:

$$s_{jt}(\delta_{\cdot t}) = \int s_{ijt}^{O_i}(g_{it}, \delta_{\cdot t}) \, dP_g(g_{it}) \tag{4-2}$$

We estimate this integral in the following way, using an importance sampling approach to reduce computational burden:

1. Draw a sample of grades from the distribution of grade cut-offs $\hat{Q}_g$ (biased distribution)

2. This will define a choice set $O_i$ of possible programs for each draw $i$

3. For each program $j$ and draw $i$, we compute $s_{ij}^{O_i}(g_i)$

4. To keep the value of the integral the same, the oversampled part of the distribution places less weight $w(g_i) = \frac{\hat{P}_g(g_i)}{\hat{Q}_g(g_i)}$ on each point, and more on undersampled parts

5. We can then approximate the integral by $\frac{1}{ns}\sum_{i=1}^{ns} s_{ij}^{O_i}(g_i) \cdot w(g_i)$

Then, we solve for each market the implicit system of equations:

$$s(\delta_{\cdot t}) = S_{\cdot t}, \text{ for } t = 1, \ldots, T$$

where $s(\cdot)$ are the market shares given by equation 4-2, and $S$ are the observed market shares.

With the computation of the market share, we then invert the system of equations using the contraction mapping suggested by Berry et al. (1995) to recover the vector $\delta_{\cdot t}$, which amounts to computing the series:

$$\delta_{\cdot t}^{h+1} = \delta_{\cdot t}^{h} + \ln S_{\cdot t} - \ln s(\delta_{\cdot t}^{h}), \text{ for } t = 1, \ldots, T \text{ and } h = 0, \ldots, H.$$

where $H$ is the smallest integer such that $||\delta_{\cdot t}^{H} - \delta_{\cdot t}^{H-1}||_\infty < 10^{-5}$. The approximation to $\delta_{\cdot t}$ is then given by $\delta_{\cdot t}^{H}$.

To determine the observed market shares, we define the total market size for each major by multiplying the number of people between 15 and 24 years in Brazil for each state and year by the proportion of enrolled students in each major's area. Then, the market share is given by the number of enrolled students divided by the total size of the market.

Finally, we can estimate the parameters $(\beta, \alpha)$ using standard instrumental variables techniques (Berry, 1994):

$$\delta_{jt} = \alpha p_{jt} + x_{jt}\beta + \gamma_j^{institution} + \gamma_j^{major} + \gamma_t^{year} + \xi_{jt} \tag{4-3}$$

Since the unobservable major-institution quality $\xi_{jt}$ is typically correlated with tuitions, the estimation requires instruments $z_{jt}$ that are correlated with tuitions but uncorrelated with the error term. It is reasonable to assume that the tuition charged for a given major is a function of the maintenance costs — expenses with water, energy, telephony, surveillance, cleaning, maintenance, support for events, ... — of its institution, and that, once we control for tuition, the decision of individuals is not influenced by these costs when choosing a major (conditional on fixed effects and $x_{jt}$). Therefore, the institution expenses with maintenance costs should serve as a suitable instrument for tuition.

# 5
# Results

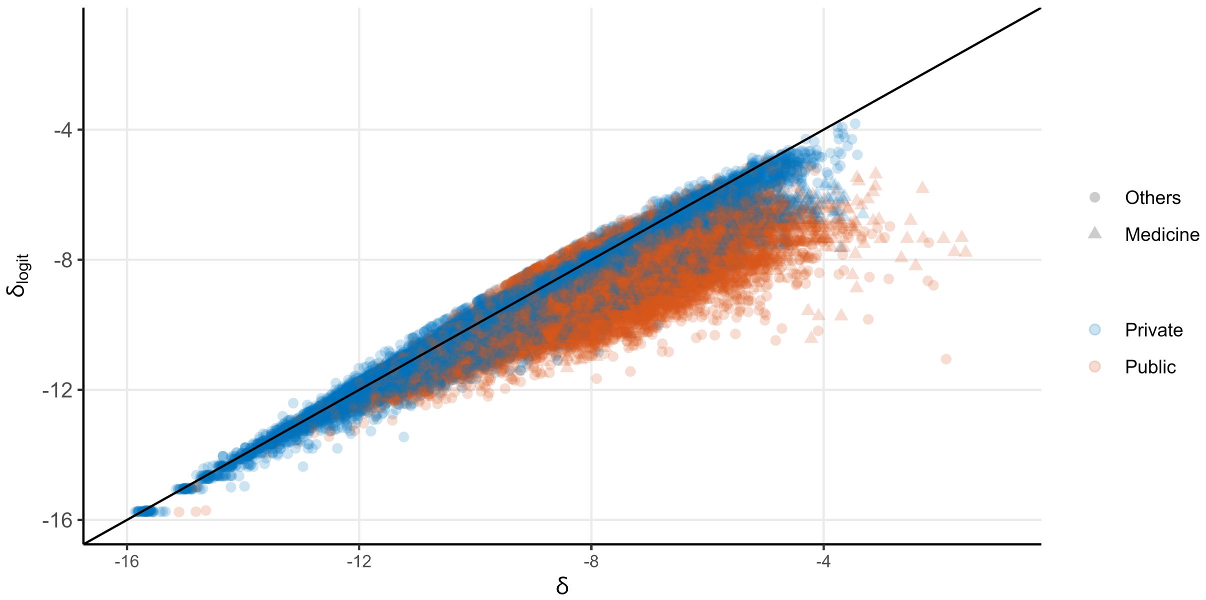
To compare the mean utilities generated by our model with a logit model without consumer choice constraints, we first plot the $\delta$'s from the two models against each other. As shown in Figure 5.1, the x-axis represents the $\delta$'s generated by our model, while the y-axis represents the $\delta$'s generated by the logit model. The black line in the figure represents the 45-degree line. We observe that most private programs fall along the 45-degree line, while the majority of public majors fall below it. This indicates that our model attributes a higher mean utility to public programs, as anticipated. Those results underscore the importance of incorporating the selectivity dimension in our demand estimation.

To illustrate how the mean utilities for the most selective programs are affected by the consumer constraints, we focus on Medicine programs, which have the highest average grade cut-off. As these programs are most impacted by the constraints, we expect to observe the largest differences in mean utilities. Our analysis reveals that a significant proportion of Medicine programs are situated far away from the 45-degree line, indicating that our model effectively captures the patterns for these highly selective programs.

In summary, our results show that the logit model tends to underestimate the mean utilities of public programs, specially when they are highly selective. For instance, in 2019, Medicine at the Federal University of Rio de Janeiro (UFRJ) and Nursing at Celso Lisboa were ranked by the logit model as the third and fourth best health programs in Rio de Janeiro, respectively. However, when we compare the selectivity of these two majors, we observe that UFRJ is the most selective program in this market, with a grade cut-off of 821, while Celso Lisboa has a cut-off of 614. Moreover, according to the Ranking Universitário Folha 2019, Medicine at UFRJ is considered the best Medicine program in the state out of 15, while Nursing at Celso Lisboa is ranked 19th out of 40 Nursing programs in the state. By introducing constraints in consumer choice, our model effectively mitigates these issues. Specifically, our model attributes the highest quality to Medicine at UFRJ and ranks Nursing at Celso Lisboa as the 28th highest mean utility program out of 179.

We also compare the ranking of all Medicine programs in the country

Figure 5.1: Estimated $\delta$'s for Logit and Main Model






implied by our model and the Ranking Universitário Folha for 2019. Table 5.1 presents the ten programs with the highest mean utilities and their respective rankings, along with their corresponding rankings when considering only institutions in their respective state. We observe that all institutions listed are federal — which is consistent with their average superior quality — and located in the Midwest, North and Northeast regions of the country. We also see a significant discrepancy between both rankings. The model seems to attribute a higher mean utility to institutions in the Midwest, North and Northeast when compared to the alternative ranking — where 9 out of the 10 top programs are located in the South and Southeast regions. This is likely due to differences in market structure: with the exception of one institution, all others are located in markets with fewer competitors than the average for Health majors in 2019. This results in a higher relative market share and, consequently, a higher mean utility.

Table 5.1: Programs with the Highest Mean Utilities (Medicine in 2019)

| Institution | Ranking - Model | Ranking - Folha | Ranking - Folha (State) |
|---|---|---|---|
| UFRN | 1 | 14 | 1 |
| UFAC | 2 | 148 | 1 |
| UFRR | 3 | 139 | 1 |
| UFMA | 4 | 61 | 1 |
| UNB | 5 | 12 | 1 |
| UNIFAP | 6 | 117 | 1 |
| UFPR | 7 | 11 | 1 |

| | | | |
|---|---|---|---|
| UFPI | 8 | 29 | 1 |
| UFPB | 9 | 36 | 1 |
| UFMT | 10 | 35 | 1 |

Table 5.2 presents the results for our structural estimation of demand. All regressions include year, major and institution fixed effects, and all programs in our sample are considered. The columns show different model specifications and all standard errors are clustered by institution. The first column presents estimates from a logit model without consumer constraints and the second column estimates from our model. Additionally, Table A.1 reports the findings of our estimates using alternative specifications. As expected, we find a negative relation between tuition and demand for higher education. Results also indicate that courses with more semi-presential coursework and night courses are less demanded, whereas courses with laboratories and a higher proportion of staff with doctorate degrees are more demanded. It is worth noting that both columns display similar estimates for tuitions and major-institution characteristics. However, due to the inclusion of consumer choice constraints in our model, this doesn't imply that the elasticities will be similar across both models.

Table 5.2: Demand Estimates

| | Logit | Main Model |
|---|---|---|
| Tuition (in R$100) | −0.502*** | −0.558*** |
| | (0.107) | (0.115) |
| Night Course | −0.144** | −0.293*** |
| | (0.066) | (0.071) |
| Percentage of Semi-Presential Coursework | −0.006** | −0.006** |
| | (0.003) | (0.003) |
| Course with Laboratory | 0.196*** | 0.198*** |
| | (0.030) | (0.033) |
| Proportion of Staff with Doctorate | 0.726** | 0.546* |
| | (0.285) | (0.308) |
| N | 147 053 | 147 053 |
| FE: Year | X | X |
| FE: Institution | X | X |
| FE: Major | X | X |
| F-stat (1st stage) – Tuition | 21.95 | 21.95 |
| Std.Errors – Clustered by: | Institution | Institution |

* p < 0.1, ** p < 0.05, *** p < 0.01

In order to better demonstrate the impact of consumer constraints on the mean utilities in our model, we estimate the difference between the $\delta$'s in both models and translated them in terms of tuitions using our estimated price sensitivity $\alpha$. Figure 5.2 displays the tuitions that public programs would have to charge, as per our model, to attain the corresponding mean utility implied by the logit model. Our estimates suggest that the counterfactual tuition would be approximately R$126 on average — with the average tuition for private programs in our sample being R$946.92 —, but the tuitions are heterogeneous across the selectivity dimension. Table 5.3 presents the majors that are most affected by the consumer choice constraints, highlighting this heterogeneity.

Table 5.3: Majors with Highest Average Counterfactual Tuitions (Public Universities)

| Major | Average Counterfactual Tuition (R$) |
|---|---|
| Medicine | 466.51 |
| Dentistry | 289.77 |
| Law | 288.13 |
| Chemical Engineering | 257.20 |
| Civil Engineering | 242.15 |

| | |
|---|---|
| Computer Engineering | 237.49 |
| Biomedicine | 236.88 |
| Industrial Engineering | 228.78 |
| Mechanical Engineering | 226.84 |
| Petroleum Engineering | 223.11 |

## 5.1 Elasticities

To evaluate our estimate for price sensitivity, we compute the own-price elasticities of private programs, shown in Figure 5.3. The red vertical line highlights the -1. The mean of the distribution of own-price elasticities is $-5.5$, and the median is $-4.7$. Less than 0.3% of the observations are predicted to have inelastic demand. This is consistent with theoretical predictions and argues in favour of the instrument's exogeneity, as endogenous instruments would result in an overestimation of $\alpha$ and impact the level of own-price elasticities.

Finally, in order to understand the substitution patterns, we compute cross-price elasticities implied by our model, given by:

$$\eta_{jkt} = \frac{\partial s_{jt}}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}} = \alpha \cdot \frac{p_{kt}}{s_{jt}} \int s_{ijt}^{O_i} \cdot s_{ikt}^{O_i} \, dP_g(g_{it})$$

Those cross-price elasticities show how the market share of program $j$ is affected by a change in the tuition of program $k$. A higher elasticity means that programs $j$ and $k$ are closer substitutes in the market, and that they exert a higher competitive pressure on each other. Table 5.4 presents a sample of estimated cross-price elasticities from Medicine programs in Rio de Janeiro for 2019. Each elasticity gives the percentage change in market share of the column major-institution associated with a 1% increase in the price of the row major-institution. The programs are sorted in descending order of mean utility.

When examining the first column, for example, we can observe that a 1% increase in the price of Medicine at Estácio leads to a 0.089% increase in the market share of Medicine at UFRJ. In contrast, a 1% increase in the price of FACREDENTOR results in a much smaller increase of only 0.025% in the market share of UFRJ. These findings suggest that UFRJ, the most selective public program, exerts higher competitive pressure than all other private programs in this market, including Estácio, which is the most selective among them. In general, Table 5.4 shows cross-price elasticities that are higher for programs with higher grade cut-offs.

Figure 5.2: Differences in $\delta$'s in Terms of Tuitions for Public Programs

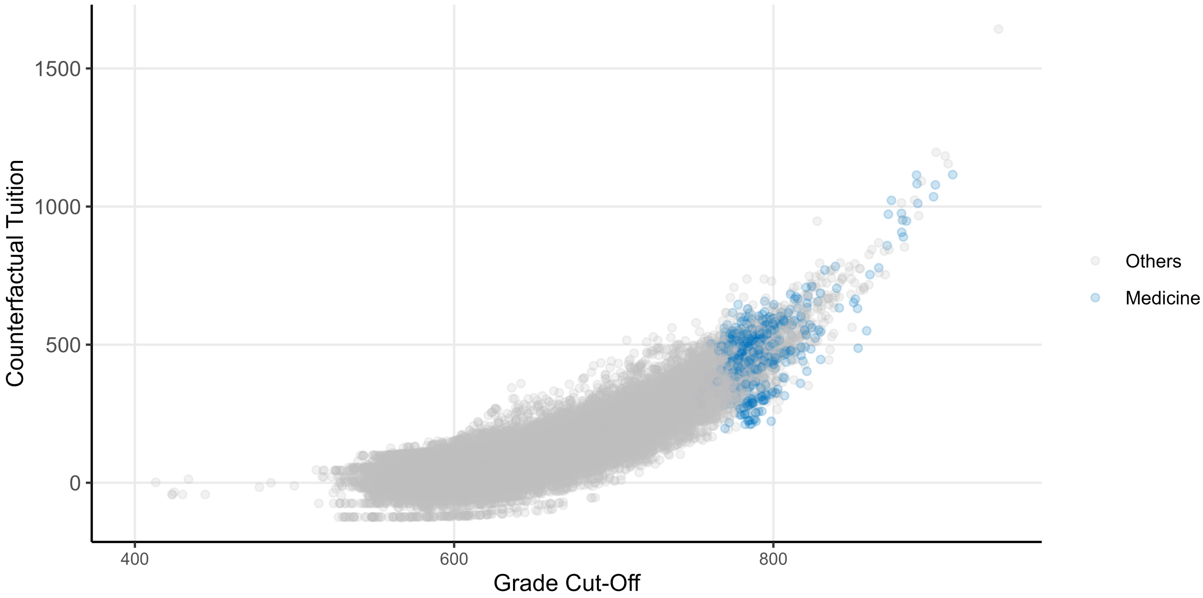





Figure 5.3: Distribution of Own-Price Elasticities of Private Programs

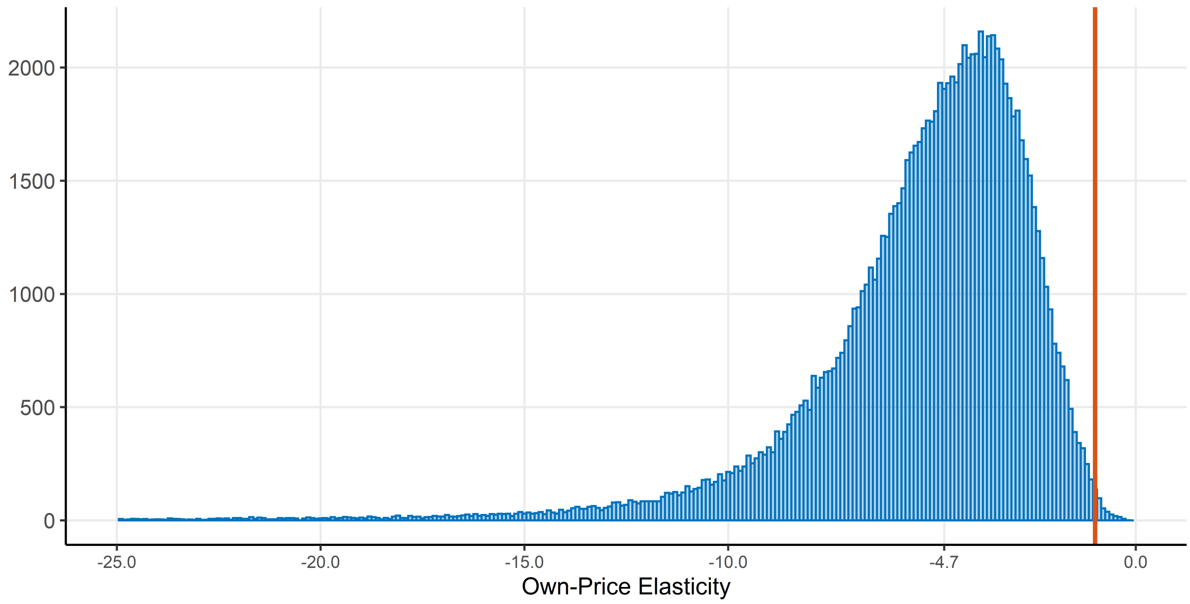


Table 5.4: A Sample of Estimated Cross-Price Elasticities from Medicine Programs in Rio de Janeiro for 2019

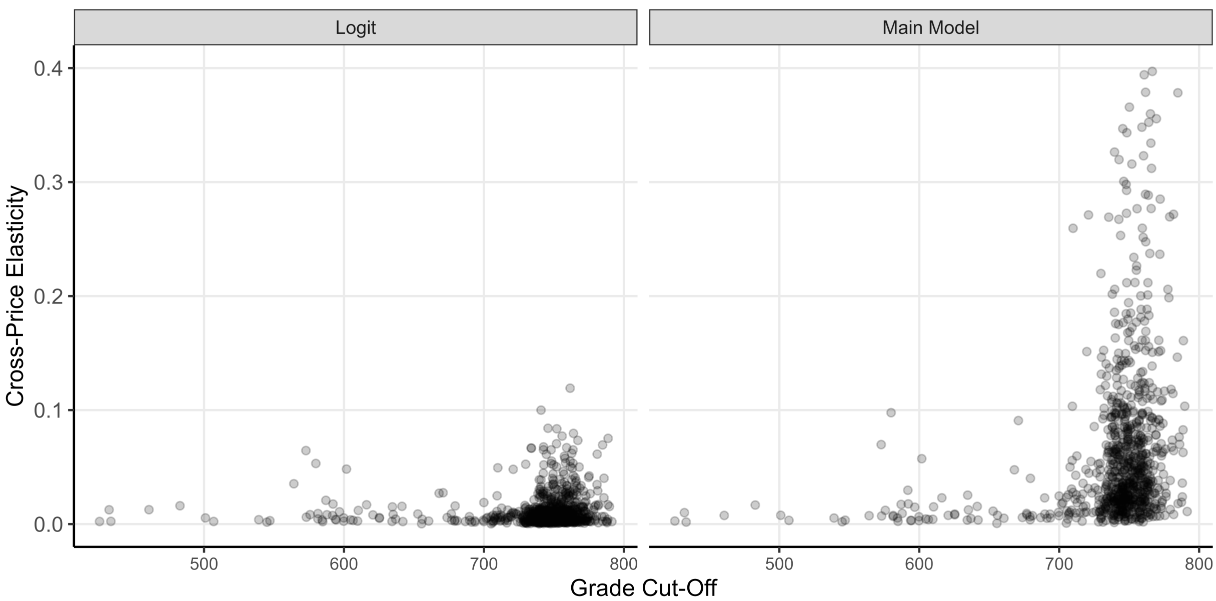
| Program | UFRJ | ESTÁCIO | UNIFESO | USS | UNIGRANRIO | FMP | CESVA | FACREDENTOR |
|---|---|---|---|---|---|---|---|---|
| ESTÁCIO | 0.089 | - | 0.084 | 0.079 | 0.083 | 0.084 | 0.078 | 0.080 |
| UNIFESO | 0.061 | 0.056 | - | 0.053 | 0.055 | 0.057 | 0.052 | 0.053 |
| USS | 0.058 | 0.054 | 0.054 | - | 0.054 | 0.055 | 0.053 | 0.053 |
| UNIGRANRIO | 0.046 | 0.043 | 0.043 | 0.041 | - | 0.044 | 0.041 | 0.042 |
| FMP | 0.047 | 0.044 | 0.045 | 0.042 | 0.044 | - | 0.041 | 0.042 |
| CESVA | 0.045 | 0.043 | 0.043 | 0.042 | 0.043 | 0.043 | - | 0.042 |
| FACREDENTOR | 0.025 | 0.024 | 0.024 | 0.023 | 0.024 | 0.024 | 0.023 | - |

Note: Cell entries i, j where i indexes row and j column, give the percentage change in market share of j with a 1% increase in the price of i.

In order to better illustrate the contribution of consumer constrains to the patterns of substitution between different programs, we investigate how changes in tuitions of certain programs affect the market share of the most selective programs. We analyze both the logit model without consumer choice constraints and our model. Figure 5.4 shows the cross-price elasticities for degrees in Medicine. We consider $j$ as the private programs with the highest grade cut-off and $k$ as the remaining private programs in each market. Each point represents the effect on the market share of the most selective private program in the market of increasing the price of another given private program in 1%, according to its grade cut-off.

We observe a significant difference between the two models, especially for programs with grade cut-offs above 700. In the logit model, a price increase of a low selectivity program leads to a similar increase in the market share of the most selective private program, compared to a high selectivity program. In contrast, our model shows much more variability in the effects, which tend to increase with higher grade cut-offs. This result is consistent with the notion that programs with similar grade cut-offs are closer competitors, exerting a higher degree of competition on each other. We find that selectivity is an essential factor for product differentiation, and our model accurately captures the distinct substitution patterns that arise due to consumer choice constraints.

Figure 5.4: Cross-Price Elasticities between Private Program with Highest Grade Cut-Off and Private Programs, Medicine only




To explore the interaction between public and private programs, we compute elasticities with $j$ as the public and private programs with highest grade cut-off, and $j$ as the public and private programs with lowest grade cut-off, in each market. Table 5.5 presents the difference between the cross-price elasticities of public, for-profit, and non-profit private institutions. Our findings show that for programs with the highest grade cut-off, the level of elasticities is comparable. This result suggests that the most selective public institutions exert similar competitive pressure as the most selective private programs. However, we observe that the least selective public programs exert more competitive pressure than the least selective private institutions. In both cases, we do not find any significant differences between non-profit and for-profit programs.

Table 5.5: Effect of Public Provision on Cross-Price Elasticities

| | Highest Grade Cut-Off | Lowest Grade Cut-Off |
|---|---|---|
| Public Institution | $6.99 \times 10^{-5}$ | $2.81 \times 10^{-4}$*** |
| | $(5.14 \times 10^{-5})$ | $(2.61 \times 10^{-5})$ |
| Non-Profit Private | $1.53 \times 10^{-4}$ | $-2.00 \times 10^{-5}$ |
| | $(2.35 \times 10^{-4})$ | $(8.98 \times 10^{-5})$ |
| N | 195 180 | 195 180 |
| FE: Market | X | X |
| Mean of Dep. Var. | 2.28e-03 | 1.23e-03 |
| Std.Errors – Clustered by: | Institution | Institution |
| Median Grade Cut-Off – Public | 756.7 | 616.9 |
| Median Grade Cut-Off – Private | 699.1 | 456.7 |

* p < 0.1, ** p < 0.05, *** p < 0.01



## 5.2 Counterfactual with no Public Programs

To quantify the relevance of the competition exerted by public institutions, we simulate a counterfactual scenario with no public programs. Our goal is to assess how the prices of private programs vary with the presence of public institutions.

Suppose there are $F$ firms, each of which offers some subset, $\mathcal{F}_f$, of the $j = 1, \ldots, J$ different programs. The profits of firm $f$ are

$$\Pi_f = \sum_{j \in \mathcal{F}_f} (p_j - mc_j)\, M s_j(p) - C_f,$$

where $s_j(p)$ is the market share of program $j$, which is a function of prices of all major-institutions, $M$ is the size of the market, $mc_j$ is the constant marginal cost of production, and $C_f$ is the fixed cost of production.

Assuming (1) the existence of a pure-strategy Bertrand-Nash equilibrium in prices and (2) that the prices that support it are strictly positive, the price, $p_j$, of any product $j$ produced by firm $f$ must satisfy the first-order condition (Nevo, 2000)

$$s_j(p) + \sum_{r \in \mathcal{F}_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0$$

These $J$ equations imply price-costs margins for each product. The markups can be solved for explicitly by defining

$$\Omega_{jr}(p) = \begin{cases} -\partial s_j(p)/\partial p_r, & \text{if } \exists f : \{r, j\} \subset \mathcal{F}_f; \\ 0, & \text{otherwise.} \end{cases} \tag{5-1}$$

In vector notation, the first-order conditions become

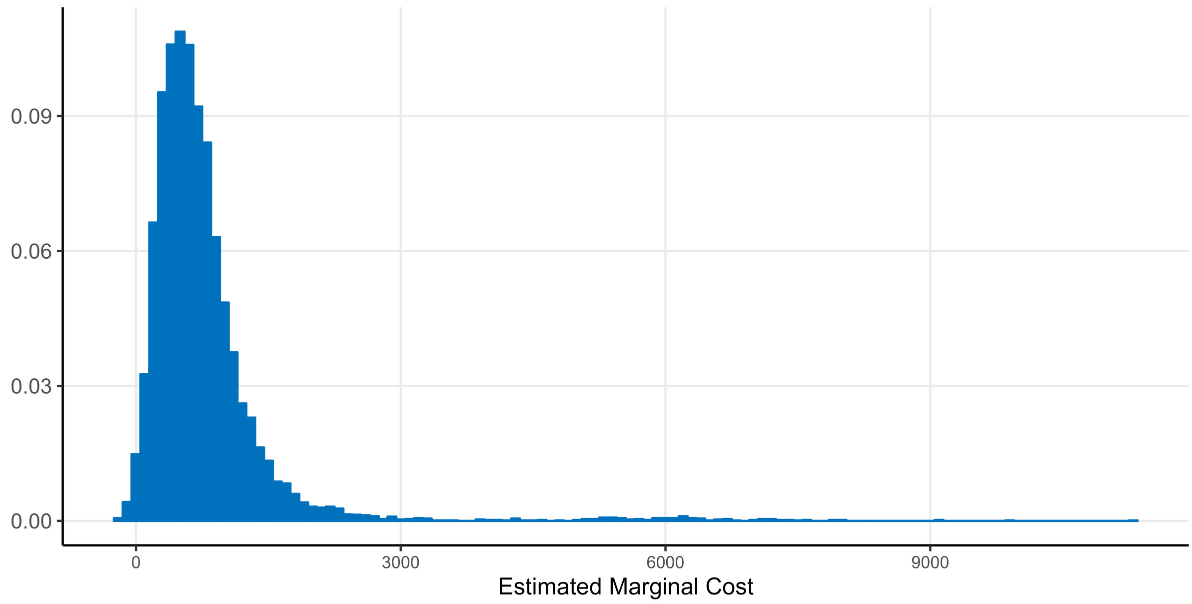
$$s(p) - \Omega(p)(p - mc) = 0$$

This implies a markup equation and implied marginal costs

$$p - mc = \Omega(p)^{-1} s(p) \Rightarrow mc = p - \Omega(p)^{-1} s(p) \tag{5-2}$$

First, we use (5-2) and the estimates of the demand system to compute the implied marginal costs for all private major-institutions in 2019. The resulting distribution of these costs is displayed in Figure 5.5. The mean marginal cost is R\$766, while the median is R\$616.7. Notably, less than 1% of observations have negative estimated marginal costs.

Figure 5.5: Distribution of Estimated Marginal Costs from Private Programs in 2019





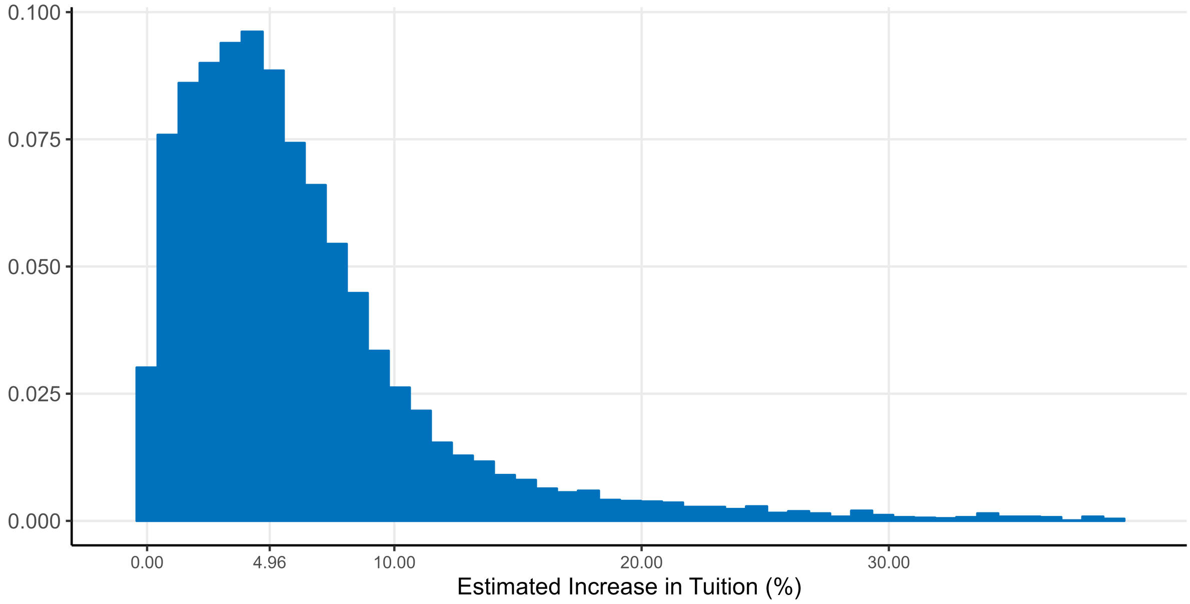

Second, to simulate the equilibrium without public programs, we re-estimate the model removing the public institutions and use the same Nash-Bertrand equilibrium assumption as before. Let $\Omega_{without}$ be a matrix defined by (5-1) using the structure of the industry without public programs, the predicted equilibrium price, $p^*$, solves

$$p^* = \hat{mc} + \Omega_{without}(p^*)^{-1}s(p^*)$$

where $\hat{mc}$ are the marginal costs implied by the demand estimates and the industry structure with public institutions.

Finally, we can compute the differences in observed and estimated counterfactual prices. The distribution of the percentage increases in tuitions across all private programs in 2019 is illustrated in Figure 5.6. These estimates reveal that, in the absence of public programs, tuitions would be, on average, 6.7% higher.

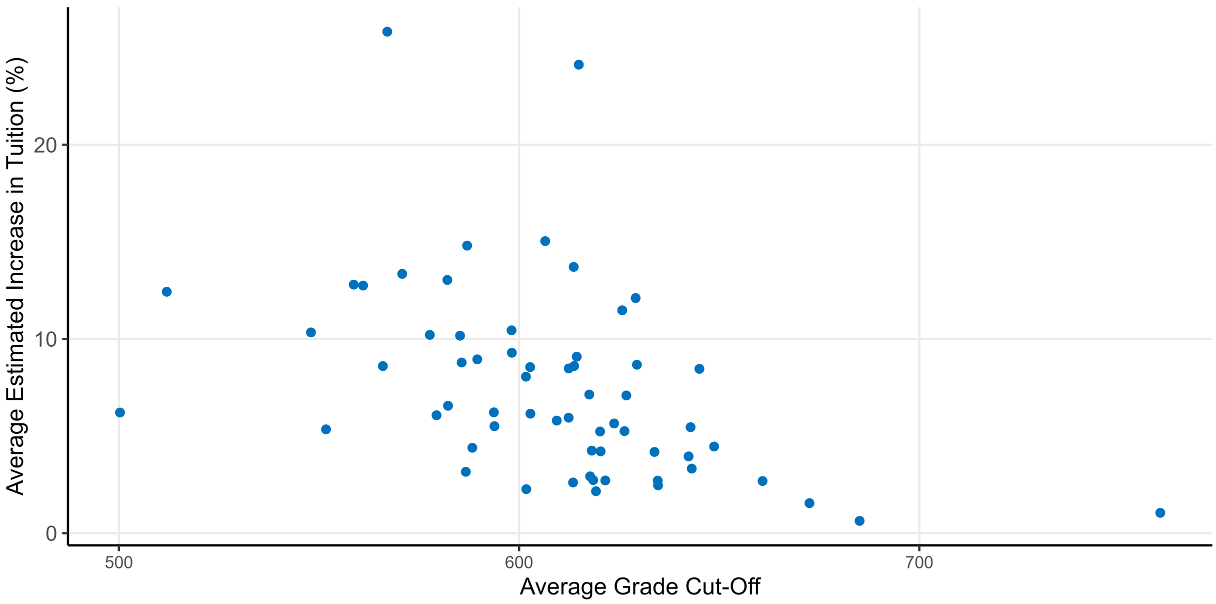
Figure 5.6: Distribution of Estimated Increase in Tuitions from Private Programs in 2019






Furthermore, we highlight the presence of notable heterogeneity in the estimated changes in tuitions across various programs. To better comprehend this variability, we compute the average estimated increase in tuition for each major. Figure 5.7 displays the average estimated increases in tuition for all majors in 2019, based on their respective average grade cut-offs. Library Science (26% increase; grade cut-off of 567) and Chemistry (24% increase; grade cut-off of 615) majors exhibit the highest estimated increases, while Actuarial Science (0.6% increase; grade cut-off of 685) and Medicine (1% increase; grade cut-off of 760) programs reflect the lowest increases. In general, we observe a negative relationship between the average grade cut-off and the average estimated increase in tuitions.

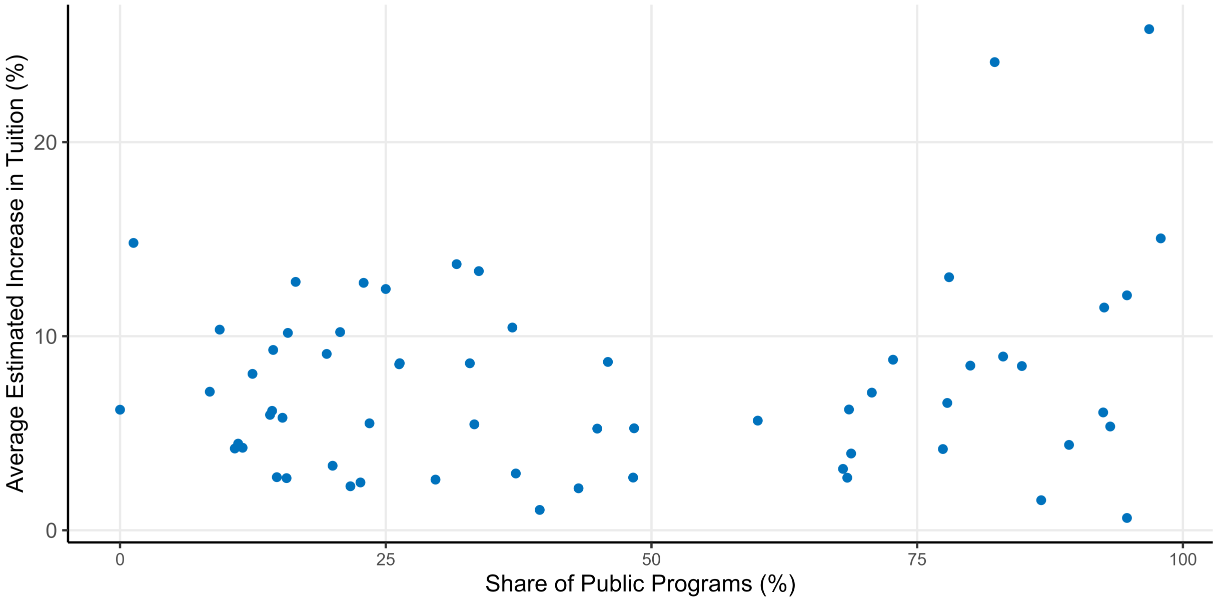
Figure 5.7: Average Estimated Increase in Tuitions and Grade Cut-Offs from Private Programs in 2019, by Major






This heterogeneity could just be a direct consequence of the predominance of public programs in certain majors. Figure 5.8 shows the estimated increase in the y-axis and the corresponding share of public programs for each major, and we see no clear relationship between the two. Examining the most and least affected majors, Library Science and Chemistry are majors with mostly public programs (97% and 82% of all programs are public, respectively), and Medicine has a much lower presence of public institutions (39% of all programs are public). However, Actuarial Science also has a high share of public institutions (95% of all programs are public), which suggests that the impact on prices may be linked to other factors captured by the model as well.

Figure 5.8: Average Estimated Increase in Tuitions by Major and Proportion of Public Programs in Major from Private Programs in 2019



# 6 Conclusion

In this paper, we study the effects of public provision on competition in the context of Brazilian higher education. We develop and estimate an empirical model of demand for higher education that incorporates tuition-free institutions, along with constraints in consumer choice. Our model does not rely on micro data or random-coefficients, representing an advantage not only because of the data requirements, but it also reduces the computational burden of estimation.

In comparison with a logit model without constraints, our model attributes a higher mean utility to public programs, which is consistent with what we expect for the Brazilian higher education market. Our estimates suggest that the public programs would have to charge, on average, a tuition of R$126 to have the corresponding mean utility implied by the logit model. The constraints on consumer choices also allow for a model with more realistic substitution patterns, highlighting the importance of selectivity as a dimension of product differentiation. Using the estimated cross-price elasticities, we find that the most selective public programs exert comparable competitive pressure to the most selective private programs, but the least selective public programs exert more competitive pressure than the least selective private programs.

To quantify the relevance of the competition exerted by public institutions, we simulate a counterfactual scenario with no public programs. Our estimates of the supply response of private institutions indicate that, in the absence of public programs, tuition fees would increase by approximately 7% on average. This increase is heterogeneous across majors, ranging from a 24-26% average increase for Chemistry and Library Science to a 0.6-1% average increase for Actuarial Science and Medicine. These findings provide important insights into the competitive dynamics of Brazilian higher education and highlight the role of public provision in promoting competition in this sector.

Our paper has important implications. From an empirical industrial organization perspective, it shows why and how to incorporate both public and private institutions in empirical models of demand for Brazilian higher education, and it highlights the role of selectivity for substitution patterns across institutions. From a development standpoint, our paper sheds light on the extent to which private institutions are affected, through competition, by the presence of public and subsidized provision.

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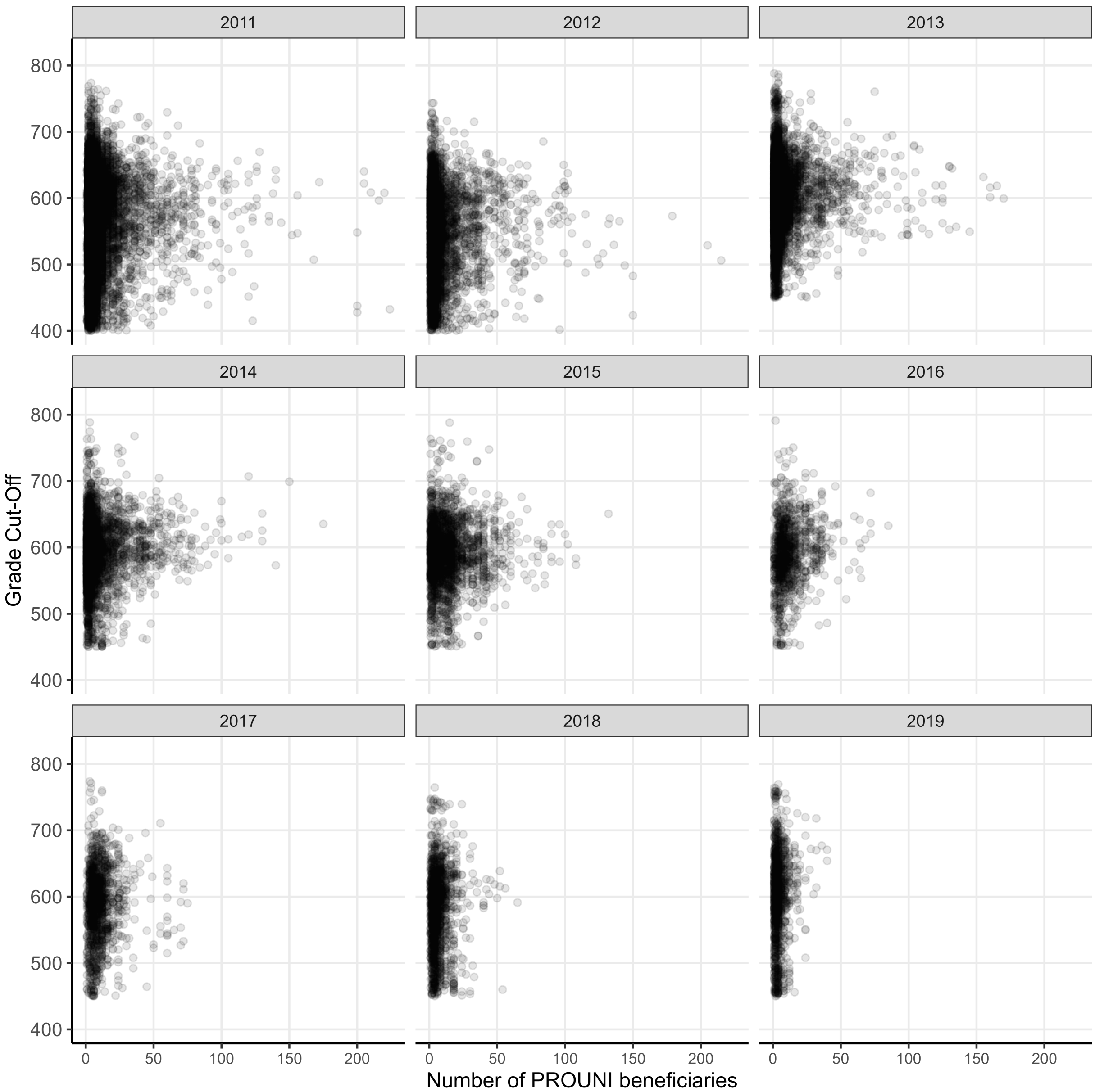
# A
# Appendix

## A.1
## PROUNI and Grade Cut-Offs

Figure A.1: PROUNI beneficiaries and Grade Cut-Offs in Private Programs from 2011 to 2019



## A.2
## Alternative Specifications for Demand Model

Table A.1 reports results of our estimates with alternative specifications for the demand model. Column (1) corresponds to our preferred specification, Column (2) corresponds to a model without public programs, and Column (3) corresponds to a specification where we use an alternative instrument for tuition, where the instrument takes the value of the institution expenses with maintenance costs for private programs, and zero for public programs.

Table A.1: Demand Estimates

| | Main Model | Private Only | Zeroed IV |
|---|---|---|---|
| Tuition (in R$100) | −0.558*** | −0.749*** | −0.543*** |
| | (0.115) | (0.148) | (0.099) |
| Night Course | −0.293*** | −0.840*** | −0.284*** |
| | (0.071) | (0.206) | (0.061) |
| Percentage of Semi-Presential Coursework | −0.006** | 0.007*** | −0.006** |
| | (0.003) | (0.001) | (0.003) |
| Course with Laboratory | 0.198*** | 0.444*** | 0.201*** |
| | (0.033) | (0.051) | (0.031) |
| Proportion of Staff with Doctorate | 0.546* | 0.959** | 0.528* |
| | (0.308) | (0.457) | (0.295) |
| N | 147 053 | 105 067 | 147 053 |
| FE: Year | X | X | X |
| FE: Institution | X | X | X |
| FE: Major | X | X | X |
| F-stat (1st stage) – Tuition | 21.95 | 27.54 | 27.33 |
| Std.Errors – Clustered by: | Institution | Institution | Institution |

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$