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INCOME-BASED SCHOLARSHIPS AND ACCESS TO HIGHER EDUCATION

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JEL Codes: I22, I24, I25, I28, H52

Keywords: Higher education participation, income-based scholarships, emerging economies, difference-in-differences

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INCOME-BASED SCHOLARSHIPS AND ACCESS TO HIGHER EDUCATION

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Abstract

Financial aid to college students has been widely implemented by governments in developed and emerging economies in an attempt to reduce the entry barriers to higher education (HE). Understanding the extent to which these policies enable access to HE is crucial in order to unravel the effectiveness of such investments on promoting human capital accumulation. In this paper, we address this issue by employing a difference-in-differences framework to investigate the impacts of the Prouni, a Brazilian federal program created in 2005 that grants full and partial college scholarships to students from low-income families. We provide causal evidence that, by 2007, the full Prouni scholarship had increased the odds of enrolling in HE by 37%, while the partial Prouni scholarship had increased these odds by 20%; and that every USD 100 million spent by the government with Prouni's tax waivers, generated an approximate 0.5 percentage points increase in the HE enrolment rate of academic age individuals (or, equivalently, every USD 1,000 per student increased this rate in 1.3 percentage points). Also, our findings suggest that the impacts of the grants on access to HE were greater for women and for non-white individuals.

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1. Introduction

Income constraints and restrictions on access to credit lead to substantial entry barriers to higher education (HE) among disadvantaged groups. This dynamic not only widens educational inequalities but also hinders social mobility and contributes to the perpetuation of inequality in income levels (Lisboa and Menezes-Filho 2001; Barros et al. 2010). Therefore, in order to enhance the participation of underprivileged individuals in HE, a number of student aid programs have been implemented both in OECD and non-OECD countries, such as merit-based and income-based student loans, scholarships and maintenance grants.

Although a significant amount of evidence suggests that these programs have been effective in enabling access to HE and in mitigating educational inequalities, a share of the literature was unable to find statistically significant effects of financial aid policies on HE participation (Long 2004; Baumgartner and Steiner 2006; Tangkitvanich and Manasboonphempool 2010). Additionally, some studies have indicated that college enrolment might be more sensitive to long-run family and school factors than to short-term credit constraints (Cameron and Heckman 2001; Keane and Wolpin 2001; Carneiro and Heckman 2002). Therefore, understanding the extent to which student aid programs contribute to the increase in higher education enrolment among low-income individuals is imperative in order to unravel the effectiveness of such investments on promoting human capital accumulation.

Furthermore, while there has been rapidly accumulating evidence on the effects of these programs on developed economies (especially in the US), studies on non-OECD nations are still limited, an issue largely due to data availability restrictions in less-developed countries. However, understanding the role played by student aid policies in non-OECD economies is critical since barriers to higher education not only exacerbate educational and social inequalities but also generate important obstacles to economic development (Canton and Blom 2004).

In this paper, we assess the effects of a student aid policy on access to HE in a non-OECD economy by exploiting the introduction of a public income-based scholarship program in Brazil. The inequality in access to higher education is large in this country: In 2004, according to PNAD (*Pesquisa Nacional por Amostra de Domicílio*), only 6% of individuals with a per capita family income equal to or below 3 minimum wages were enrolled in or had completed higher education, whereas the same was true for 46% of individuals whose per capita family income was of more than 3 minimum wages. In an attempt to alleviate this issue, in 2005 the Brazilian government created the Prouni, a federal program that grants full scholarships (covering 100% of tuition fees) to individuals attending private higher education institutions and whose monthly per capita family income amounts to at most 1.5 minimum wages, as well as partial scholarships (covering 50% or

25% of tuition fees) to those whose monthly per capita family income lies between 1.5 and 3 minimum wages.

In this research, we study the extent to which the Prouni contributed to the expansion of access to higher education in Brazil among low-income individuals. More precisely, we separately estimate the causal effects of the program on the higher education participation of individuals who were eligible for the full and partial scholarships. To this end, we employ a difference-in-differences approach in which we explicitly control for a set of individual-specific variables contained in the PNAD's database. To the best of our knowledge, this is the first paper to evaluate the causal effects of an income-based scholarship program on participation in HE in a developing country.

Moreover, we estimate the results by population subgroups – gender and race – in order to assess the existence of heterogenous effects, and we also conduct a set of robustness exercises to further qualify our findings, which include the estimation of the treatment effects using alternative strategies, namely, an instrumental variables methodology and a regression discontinuity design.

Our results indicate that, by the year 2007, the Prouni had increased the odds of an individual entitled to the full scholarship enrolling in higher education by 37%, an approximate impact of 1.4 percentage points on this group's higher education enrolment rate. As for the individuals entitled to the partial grant, the program increased the odds of attending higher education by 20%, with an estimated impact of 3.4 percentage points on their higher education enrolment rate. Besides, our estimations suggest that every US$100 million spent with Prouni's tax waivers generated an approximate 0.5 percentage points increase in the HE enrolment rate of academic age individuals (or, equivalently, every US$1,000 per student increased this rate in 1.3 percentage points), and that the impacts of the Prouni on the students' higher education enrolment were greater for women and non-white individuals.

This paper is organized as follows. Section 2 provides a brief literature review on the effects of student aid programs. Section 3 expands on the institutional setting of the Brazilian educational system and of the Prouni. Section 4 describes the data and the empirical strategy employed in the paper. Section 5 presents the results of the models. Section 6 discusses the main implications of our findings. Finally, section 7 concludes the paper.

2. Literature Review

There is a substantial body of evidence suggesting that financial aid to college students is effective on enhancing access to HE. The vast majority of these studies have focused on US policies and programs (Dynarski 2000 and 2003; Cornwell et al. 2006; Kane 2003 and 2007; Abraham and Clark 2006; and Nguyen 2020), although a few of them have investigated these effects on other

developed economies, such as Dearden et al. (2014) in the UK and Nielsen et al. (2010) in Denmark. In general, these empirical studies have found that a US$1,000 increase in grant aid generates an average increase of 3-5 percentage points in HE participation (Dearden et al. 2014).

The effectiveness of such programs on promoting HE enrolment, however, is not that trivial. Indeed, a handful of empirical investigations was unable to find statistically significant effects of student loans (Tangkitvanich and Manasboonphempool 2010), financial assistance schemes (Baumgartner and Steiner 2006) and tax credits (Long 2004) on HE enrolment rates. As stressed by Carneiro and Heckman (2002), there are two –not mutually exclusive– explanations for the gap in college attendance between individuals of different income classes: (i) credit constraint limiting the resources required to finance college education; and (ii) long run family and school factors crystallized in ability. It is therefore crucial to examine the extent to which financial aid programs, which only aim to alleviate factor (i), are effective on promoting college enrolment.

Moreover, evidence of such effects in developing countries are still scarce. Solis (2017) and Canton and Blom (2004) investigate the impacts of limited access to credit on higher education enrolments by examining the implementation of student loan programs in Chile and Mexico, respectively, and both find evidence that the programs had strong positive effects on access to HE. Similarly, Gurgand et al. (2011) compare university enrolment rates in South Africa among students who were granted loans to cover registration fees and those who were not and conclude that credit constraints lead to a significant decrease in enrolments. These investigations, however, study the impacts of loan programs and credit on HE, and, as pointed out by Lepine (2018), it is not clear whether or not the findings from the abovementioned studies would generalize to the case of non-refundable aids.

The closest study to have investigated the impacts of an income-based scholarship program on access to HE in a developing country is Vélez et al. (2020), which examines the effects of the Ser Pilo Paga program in Colombia. In their study, the authors estimate that financial eligibility for the scholarship raised immediate enrollment by 56.5 to 86.5 percent, depending on the complier population. Nonetheless, there is a crucial difference between the Colombian program and the Prouni. The Ser Pilo Paga was not only an income-based, but also a merit-based program, as the scholarships were awarded only to the highest performers on the country's high school exit exam. As argued by Bernal and Penney (2019), the introduction of this program in Colombia not only enhanced access to HE, but also incentivized eligible students to improve their pre-college human capital accumulation – and the merit criteria of the program played a key role in that – which in turn might also have encouraged low-income individuals to enroll in HE. Therefore, the effects of an income-based scholarship program - that is, in which income is the sole criterion for scholarship eligibility - on a developing economy remains unexplored.

The establishment of the Prouni in 2005 in Brazil created an advantageous setup to expand the understanding of the effects of such programs on access to higher education in a non-OECD economy. The studies that were developed so far to evaluate the impacts of the Prouni, however, have focused on its' effects on students' higher education performance. Lepine (2018), for instance, used a propensity score matching methodology to argue that students who receive the scholarship perform better in college and take less time to graduate, while Becker and Mendonça (2019) stated that the program positively impacted the Prouni beneficiaries' scores at the ENADE (the college-exit exam).

The effects of the Prouni on the participation of low-income individuals in HE has, to the best of our knowledge, not yet been assessed. Therefore, in this paper we contribute to the literature by (i) estimating the causal effects of an income-based scholarship program on HE enrolment in a developing country, Brazil; (ii) providing further subsidies for the discussion on the effectiveness of student aid programs on access to HE; and (iii) comparing the effects of these programs between OECD and non-OECD economies.

3. Institutional Background

In this section, we describe the institutional background relevant to this paper. Subsection 3.1 describes the structure of the higher education system in Brazil, while subsection 3.2 provides further information on the Prouni program.

3.1. Higher Education in Brazil

According to the 2019 Higher Education Census, the Brazilian Higher Education system serves 8.6 million students (in 2019 the average enrolment rate of individuals between 18 and 24 years old was 20.4%) and consists of 2,608 institutions, among which 2,306 (or 88%) are private and 302 (or 12%) are public. Private institutions, which are fee-paying, contain the vast majority of enrolments (6.5 million students in 2019, or nearly 76% of total enrollments). Public institutions, in turn, are predominantly free of charge[1] and are managed by either the federal, state or municipal government. Federal (110) and State (132) Higher Education Institutions (HEIs) encompass most of the public enrolments (62% and 32%, respectively), while Municipal institutions (60) contain only 6% of public enrolments.

A particularly relevant dysfunctionality of the Brazilian higher education system regards the inversion in the quality gap between private and public institutions when evaluated in basic and higher education levels. While public HEIs are generally more prestigious and have the most

[1] Institutions maintained by federal and state levels of governments are forbidden by law to charge tuition fees, but municipal institutions are allowed and usually charge some tuition.

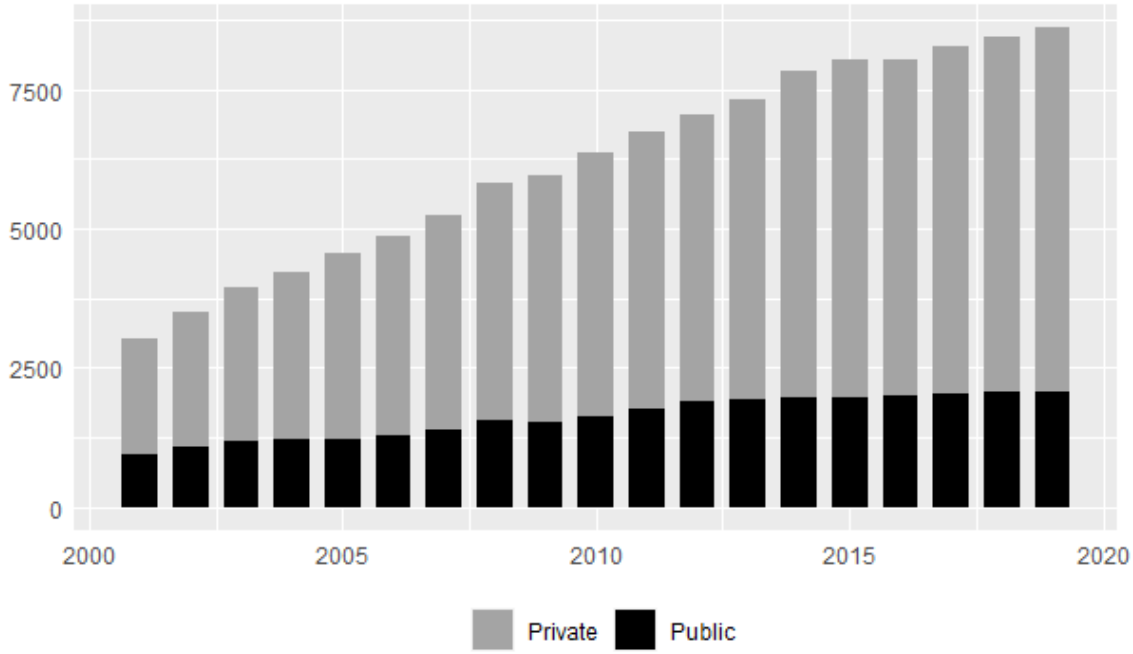
competitive selection processes in the country[2], the opposite is true in primary and secondary school levels, where public institutions are less efficient (Sampaio and Guimaraes, 2009) and have been historically outperformed by private ones in standardized tests[3]. This dynamic amplifies the entry barriers to higher education among disadvantaged students and nourishes a cycle of inequality in higher education. Students from wealthier families who have access to higher-quality private basic education have better conditions to get into public, prestigious and tuition-free universities, while low-income individuals who had previously attended public basic schools often have no choice but to attend private and fee-paying HEIs.

Therefore, in order to democratize access to higher education in the country, a set of federal policies and programs were implemented in Brazil, especially from the beginning of the 21st century onwards (the Prouni, which shall be described in the next subsection, being among the most prominent ones). Indeed, the number of higher education enrolments has significantly risen in Brazil in recent years (Figure 1). From 2001 to 2019, total enrolments in private higher education institutions increased by 212%, whereas in public institutions, this number increased by 120%.

[2] Federal and State universities have higher average scores in the *Índice Geral de* Cursos (IGC), a quality index developed by the Ministy of Education, and comprise most of the higher ranked institutions in the *Ranking Universitário Folha* (RUF), an annual evaluation of the HEIs in Brazil developed by the *Folha de São Paulo* newspaper. According to Binelli et al. (2008), there were on average 9 applicants per seat at public institutions in 2003, while this ratio was of 1.5 in private institutions.

[3] Among the 50 highest ranked schools in the 2019 ENEM (Brazil's college-entrance exam), only 3 institutions were public (INEP).

Figure 1 - Number of Higher Education Enrolments in Brazilian Institutions (in thousands)



Source: Higher Education Census – INEP

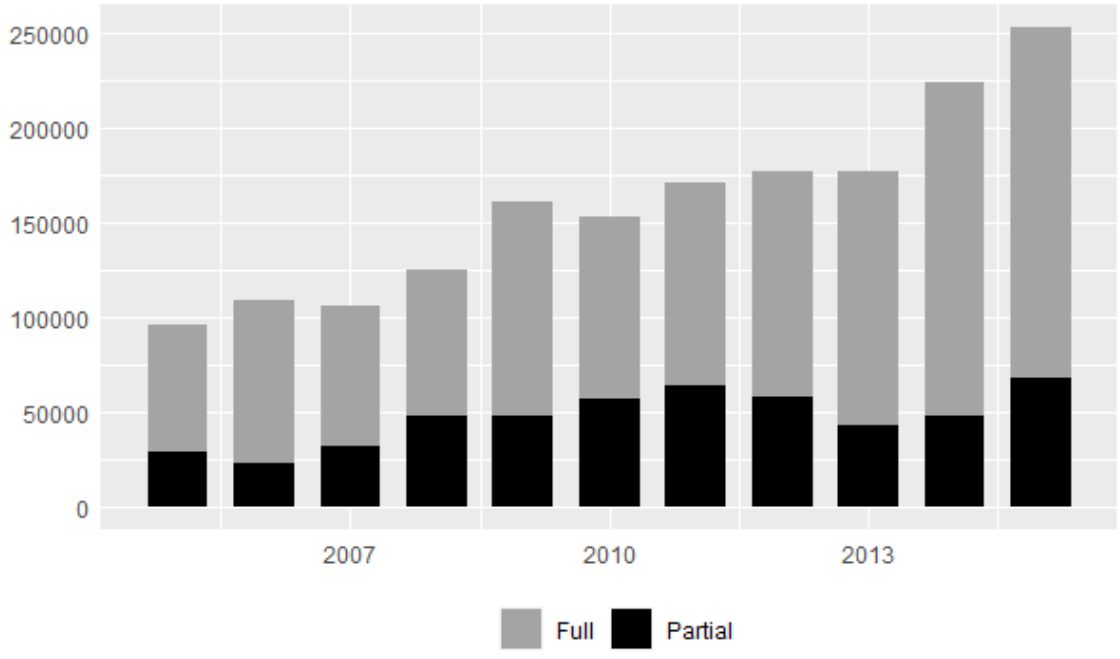
3.2. The Prouni

The Prouni (*Programa Universidade para Todos*) is a federal scholarship program which was implemented by the Brazilian government in 2005 in an attempt to expand the enrolment of low-income young adults in higher education in the country. The program grants the students two different types of scholarships to private HEIs: a full scholarship (covering 100% of tuition fees, awarded to students whose monthly per capita family income amounts to at most 1.5 minimum wages) and a partial scholarship (covering 50% or 25% of tuition fees, awarded to those whose monthly per capita family income lies between 1.5 and 3 minimum wages). Additionally, to be eligible to the program, the student must meet at least one of the following criteria: (i) having attended high school at a public institution; (ii) having attended high school at a private institution with full scholarship; (iii) having a disability; or (iv) being an active professor at the public elementary or middle school network. Furthermore, a share of these grants is designated to non-white students –classified into blacks, browns and indigenous-, according to the share of each race/ethnicity in each Brazilian state[4].

[4] For instance, in the state of Bahia, 76% of the population is non-white (either black, brown or indigenous). Therefore, the HEIs from Bahia that join the Prouni program must reserve 76% of scholarships to non-white persons.

At the other end, participation by HEIs is voluntary and those joining the program agree to reserve a certain fraction of places to Prouni students in exchange for tax exemptions. From 2005 to 2015, a total of 1.75 million Prouni scholarships were awarded in the country. The evolution of the full and partial Prouni scholarships granted by the institutions is displayed in Figure 2. The figure shows an increasing number of granted Prouni scholarships, especially from 2008 onwards. Some remarks are in order regarding this dynamic. First, this trend does not seem to stem from an increasing number of available Prouni seats, since the number of granted scholarships was not restricted by any supply bottleneck over the analyzed period. From 2005 to 2015, the occupation percentage of Prouni reserved places was around 85% for full scholarships and 60% for partial ones (i.e. there were no queues in the access to scholarships). Second, Brazil's demographic trend rules out the possibility that the dynamic from Figure 2 derives from increasing cohorts. All the same, the overall number of HE candidates in Brazil increased by 127% from 2000 to 2011 (Neves, 2015), which indicates that the main driver behind the dynamic observed in Figure 2 might have been the increasing demand for higher education in the country throughout these years[5].

Figure 2 - Number of Prouni Scholarships granted by Institutions (in thousands)



Source: Brazil's Ministry of Education

Students who meet the criteria and wish to apply for the Prouni program must go through an online centralized process, in which they are ranked according to their ENEM scores, and then

[5] A detailed investigation on the evolution of the demand for higher education in Brazil and its' causes during 2000-2015 is presented in Neves (2015).

select a set of desired HEIs as well as complete the specific selection process of each institution. Moreover, once a student is awarded the Prouni scholarship, they must pass at least 75% of their classes at the HEI in order to keep the funding. In 2008, the government implemented the "*Bolsa Complementar*", a different arrangement in which individuals that are eligible for the partial scholarship could receive a 25% Prouni grant, while the remaining 75% of the tuition fees would be covered by the FIES (*Fundo de Financiamento ao Estudante do Ensino Superior* - a federal student loan program). Since 2009, there is an extra requirement that candidates must fulfil in order to be eligible for the Prouni: they must score above a threshold in the ENEM. Anyway, this fixed threshold is relatively low and more than half the students taking the ENEM score above it (Lepine, 2018).

4. Data and methodology

4.1. Data

This paper uses publicly available PNAD microdata (Brazil's national household sample survey), which was published in a yearly basis from 1967 to 2016 by the IBGE (*Instituto Brasileiro de Geografia e Estatística*)[6]. Created with the objective of providing subsidies to the study of Brazil's socioeconomic development, this repeated cross-sectional database provides information on housing, demography, migration, education, labor and income at both individual and household levels. The subjects of the survey are selected through a probabilistic household sample and information is collected by official IBGE's interviewers.

In this paper, we will be looking at young individuals of academic age (17 to 24 years old) from 2001 to 2007. This timespan was selected so as to avoid the presence of concomitant educational policies that could pollute our findings, such as the creation of the FIES (*Fundo de Financiamento ao Estudanto do Ensino Superior)* in 1999 –a federal student loan program– and the SISU (*Sistema de Seleção Unificada*) in 2010 –an online platform that centralizes the admission processes to public universities-. From 2001 to 2007, the Prouni was the only major higher education program to be implemented in Brazil. The year 2007 was also strategically selected as the final year of the analysis since it does not contain the subsequent modifications on the Prouni's design (the implementation of the "*Bolsa Complementar*" and the ENEM threshold criterion). A concern that could naturally arise from our analysis is that a change in the FIES loan volume (the only program to have the same income threshold as the Prouni scholarship in our selected

[6] The PNAD survey was not carried out in the years the Census was conducted; and from 2016 onwards, the PNAD was replaced by its latest version, the *PNAD Contínua*.

timespan) could bias our estimation. However, over the analyzed period, the amount of credit contracts executed within the FIES remained reasonably stable[7].

Tables 1 and 2 provide the definitions and descriptive statistics of the variables from the PNAD database that were included in the models (to be presented in section 5). Table 2 shows that, from 2001 to 2007, the participation in higher education in our sample (i.e., the percentage of individuals enrolled in higher education) increased from 7.7% to 11.5%. As can be seen in Table 2, the percentage of missing information in the database is considerably low (below 2%); these observations were dropped from the analysis.

Table 1 - Variables Description

Variables	Description
Age	Numerical (years)
Gender	Dummy. Woman = 1.
State	State of residence (27 federative units of Brazil)
Race/Ethnicity	White, black, brown, indigenous, or Asian
Work factor	Dummy = 1 if individual was not engaged in wage earning activity
Average income	Monthly per capita family income in minimum wages (US$ 200 in 2020)
Ruralization	Degree of ruralization of household's census area (8 categories)
HE participation	Dummy = 1 if individual was enrolled in HE

Source: PNAD (*Pesquisa Nacional por Amostra de Domicílio*)

[7] The number of yearly FIES contracts signed was also tested as an additional control variable (in the regressions to be presented in sections 4 and 5) but it did not exert significant changes in the estimated treatment coefficients.

Table 2 - Descriptive Statistics

Variables	2001	2002	2003	2004
Age - mean (sd)	20.4 (2.3)	20.4 (2.3)	20.4 (2.3)	20.4 (2.3)
missing	*0%*	*0%*	*0%*	*0%*
Gender (M; F)	49%; 51%	50%; 50%	50%; 50%	50%; 50%
missing	*0%*	*0%*	*0%*	*0%*
Race (white, brown, black)	47%; 47%; 6%	46%; 47%; 6%	46%; 47%; 6%	44%; 49%; 6%
missing	*0%*	*0%*	*0%*	*0%*
Work factor	54% Y; 46% N	55% Y; 45% N	54% Y; 46% N	56% Y; 44% N
missing	*0%*	*0%*	*0%*	*0%*
Average income - mean (sd)	1.5 mw (2.4)	1.5 mw (2.4)	1.3 mw (2.0)	1.3 mw (2.4)
missing	*2.9%*	*2.8%*	*2.8%*	*2.8%*
HE participation	7.7%	8.7%	9.2%	9.2%
missing	*1.9%*	*1.7%*	*1.5%*	*1.5%*
Sample size	56,968	57,929	57,676	59,104

Variables	2005	2006	2007	2001-2007
Age - mean (sd)	20.5 (2.3)	20.5 (2.3)	20.5 (2.3)	20.4 (2.3)
missing	*0%*	*0%*	*0%*	*0%*
Gender (M; F)	50%; 50%	50%; 50%	50%; 50%	50%; 50%
missing	*0%*	*0%*	*0%*	*0%*
Race (white, brown, black)	43%; 49%; 7%	43%; 49%; 7%	42%; 49%; 8%	45%; 48%; 7%
missing	*0%*	*0%*	*0%*	*0%*
Work factor	56% Y; 44% N	56% Y; 44% N	57% Y; 43% N	55% Y; 45% N
missing	*0%*	*0%*	*0%*	*0%*
Average income - mean (sd)	1.3 mw (1.9)	1.2 mw (1.9)	1.2 mw (1.9)	1.3 mw (2.1)
missing	*2.3%*	*2.5%*	*2.9%*	*2.7%*
HE participation	9.8%	10.8%	11.5%	9.6%
missing	*1.3%*	*1.0%*	*1.0%*	*1.4%*
Sample size	60,702	59,786	56,368	408,533

Source: PNAD (*Pesquisa Nacional por Amostra de Domicílio*)

4.2. Methodology

In order to study the causal effects of the implementation of the Prouni on individuals' HE enrolment, we employ a difference-in-differences methodology. The idea behind this approach is fairly simple. Outcomes are observed before and after a specific treatment and between two groups, a treatment group that was exposed to the treatment and a control group that was not exposed to it. The treatment effect is then estimated by comparing the change in outcome between the two groups, while a set of control variables is added to the model in order to control for individuals' specific characteristics. Since the Prouni was applicable only to individuals below a certain income threshold, we were able to construct two groups that are substantially similar to each other with the crucial difference that the treatment group is entitled to the Prouni scholarship while the control group is unaffected by it.

More precisely, we estimate two independent difference-in-differences regressions in order to separately assess the impacts of the full and the partial Prouni scholarships on HE enrolment. We start with the partial Prouni scholarship model. Thus, we observe HE enrolments before and after the Prouni's implementation in 2005 and between two groups: a treatment group composed of individuals whose monthly per capita family income lies between 1.5 and 3 minimum wages -hence, eligible for the partial scholarship- and a control group composed of individuals whose monthly per capita family income lies between 3 and 4 minimum wages –that is, individuals that belong to a slightly greater income class although not eligible for any scholarships at all-. Secondly, we estimate the full Prouni scholarship model. In this case, we again observe HE enrolments before and after the Prouni's implementation in 2005 and using the same control group. However, in this case, our treatment group is now composed of individuals whose monthly per capita family income amounts to at most 1.5 minimum wages –that is, those eligible for the full scholarship-. Table 3 summarizes the grouping of the models.

Table 3 - Model's grouping summary

	Model	
	Partial Prouni Scholarship	Full Prouni Scholarship
Treatment Group	$1.5 <$ p.c. family income ≤ 3	p.c. family income ≤ 1.5
Control Group	$3 <$ p.c. family income ≤ 4	$3 <$ p.c. family income ≤ 4

It should be noted that we are using per capita family income as the sole criterion for scholarship eligibility when we construct our treatment groups. Nonetheless, as stated in subsection 3.3, in order to be eligible for the scholarship the student must also meet at least one of the following criteria: (i) having attended high school at a public institution; (ii) having attended high school at a private institution with full scholarship; (iii) having a disability; or (iv) being an active professor at the public elementary or middle school network. These additional criteria are, however, barely restrictive -especially due to criterium (i)-. From 2005 to 2007 (the treatment period in our models), 91% of high school students with at most 3 minimum wages of per capita family income indeed attended public institutions.

Prior to estimating the treatment effects of the models, we first address the validity of the parallel trends' assumption. The previous trends for the control and treatment groups in the partial Prouni scholarship model are presented in Figure 3, while these trends for the full Prouni scholarship model are presented in Figure 4.

Figure 3 - Partial Prouni Scholarship HE Enrolment Evolution

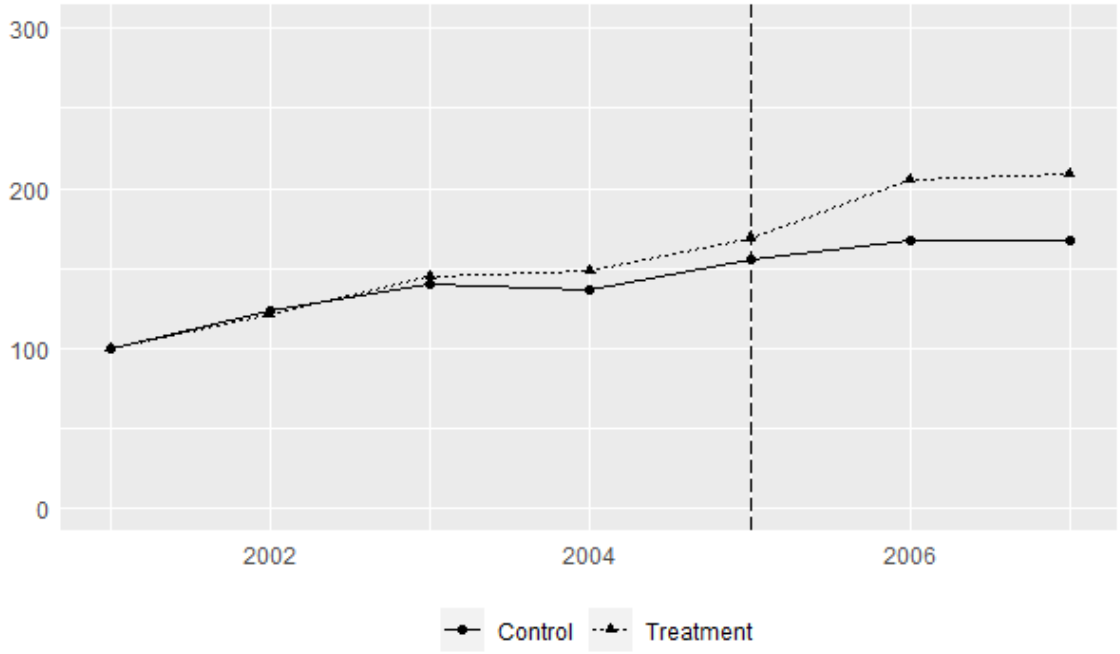
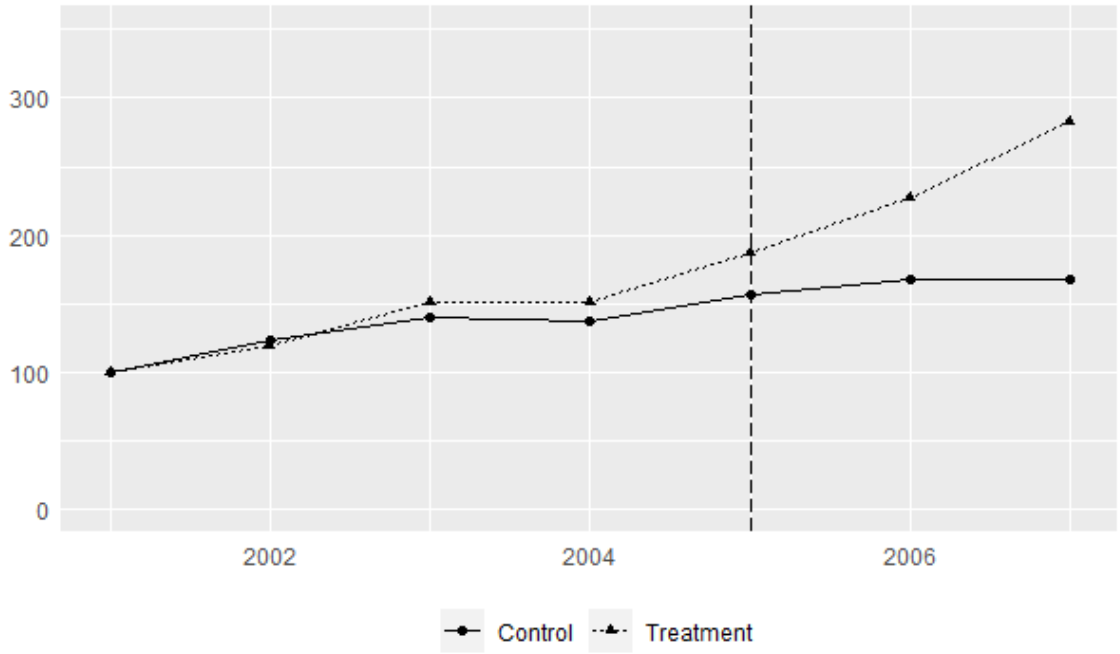


Figure 4 - Full Prouni Scholarship HE Enrolment Evolution



While a simple visual inspection of the figures shows us that the pre-treatment trends seem to be relatively similar between groups, we test for this hypothesis by estimating the following dynamic event study logistic regression:

$$HE_{it} = c_0 + \phi_t + \lambda D_i^t + \gamma X_{it} + \sum_{s \neq 2004} \beta_s \times \mathbb{1}[t = s] \times D_i^t + \varepsilon_{it} \quad (1)$$

Where HE_{it} is a dummy variable that equals one if the individual i is enrolled in higher education in year t, D_i^t is a dummy variable that equals one if they belong to the treatment group; $\hat{\phi}$ and $\hat{\lambda}$ measure the time-specific and group-specific fixed effects, respectively; X_{it} includes the individual-specific control variables described in Table 2; and the coefficients $\{\hat{\beta}\}$ account for the event-study coefficients (which measure the causal effect of the treatment plus the difference in trends between the treatment and control groups), where we take 2004 as our reference period (whence $\hat{\beta}_{2004}$ is normalized to zero). Therefore, we test for the validity of the parallel trends assumption by examining the significance of the pre-treatment beta coefficients ($\hat{\beta}_{2001}$, $\hat{\beta}_{2002}$ and $\hat{\beta}_{2003}$).

After performing the abovementioned examination, we start our analysis by estimating a standard two-periods model (2PDD), in which we divide our timespan into a pre-treatment (2001-2004) and post-treatment period (2005-2007). Therefore, in this setting, we evaluate the average effect of the Prouni on the HE enrolment of the treatment group during the entire post-treatment period. For the 2PDD, the following logistic regression is estimated:

$$HE_{it} = c_0 + \Phi W + \lambda D_i^t + \gamma X_{it} + \beta D_i^t W + \varepsilon_{it} \quad (2)$$

where we introduce W, which is a dummy variable that equals one if $t \geq 2005$, that is, if it belongs to the post-treatment period, and the remaining variables are the same from Equation 1. Moreover, for further reference, we shall refer to the interaction between D_i^t and W ($D_i^t W$) as the treatment dummy, that is, a dummy variable that equals one if the individual belongs to the treatment group and if they are observed after the treatment.

Next, we use the same two-periods difference-in-differences design to investigate if there were any heterogenous effects of the Prouni by gender and race. For this purpose, we simply add to Equation 2 the interactions by the heterogeneity dimensions we are interested in studying. More precisely, we estimate the following two equations:

$$HE_{it} = c_0 + \Phi W + \lambda D_i^t + \gamma X_{it} + \beta D_i^t W + \beta_g D_i^g W + \varepsilon_{it} \quad (3)$$

$$HE_{it} = c_0 + \Phi W + \lambda D_i^t + \gamma X_{it} + \beta D_i^t W + \beta_r D_i^r W + \varepsilon_{it} \quad (4)$$

where D_i^g is a dummy variable that equals one if the individual is female; D_i^r is a dummy variable that equals one if the individual is non-white; and β_g and β_r measure the incremental treatment effect for women and non-whites, respectively.

Lastly, we take a step further and estimate a dynamic event-study regression – for the entire population – in order to explore the effects of the Prouni on HE enrolment at each specific year (from 2005 to 2007). We then finish our analysis with a battery of robustness exercises to scaffold the validity of the results obtained - more specifically, a test for checking the existence of anticipatory effects, a placebo test, and revaluations of the estimations making use of an instrumental variables methodology, a regression discontinuity design and a pre-processes database using Entropy Balancing.

5. Results

5.1. Partial Prouni Scholarship Model

In this subsection, we present the results for the partial Prouni scholarship model, which evaluates the impact of the Prouni on individuals whose monthly per capita family income lies between 1.5 and 3 minimum wages – i.e., eligible for the partial scholarship -. We start this subsection by presenting the results from Equation 1, so as to assess the validity of the parallel trends' assumption.

The first column in Table 4 presents the estimated pre-treatment beta coefficients from Equation 1 ($\hat{\beta}_{2001}$, $\hat{\beta}_{2002}$ and $\hat{\beta}_{2003}$) in a setting without control variables, while the second column presents the same coefficients in a model with controls. As shown in the table, all coefficients are statistically insignificant (all and each of the p-values are greater than 28%), hence providing further evidence that the treatment and control groups indeed share common trends prior to the Prouni's implementation.

Table 4 - Partial Prouni Scholarship Model: Pre-treatment Dynamic Event Study Coefficients

Event Study Coefficients	(1)	(2)
Beta 2001	-0.020 (0.084)	-0.039 (0.086)
Beta 2002	-0.089 (0.083)	-0.081 (0.085)
Beta 2003	-0.067 (0.081)	0.000 (0.085)
Control	No	Yes

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Next, we present the results of the 2PDD analysis. Column 1 from Table 5 contains the results of the estimation for the entire population (equation 2), in which we estimate a significant treatment

effect coefficient of 0.11 (p-value of 1.5%), entailing an increase of 11.8% on the odds of attending HE. A detailed regression output with the controls' coefficients is displayed in Table A.1 in the appendix. Column 2 from the same table presents the incremental treatment effects by subgroups (equations 3 and 4). We find a positive although insignificant coefficient (p-value of 14.9%) for the interaction between the gender dummy and the treatment dummy, that is, there is not sufficient evidence to believe that the Prouni partial scholarship exerted different impacts by gender. For the interaction between the race and the treatment dummies, we find a positive and significant coefficient, which suggests that the Prouni partial scholarship exerted a greater impact on non-white individuals than it did on white persons. Tables A.2 and A.3 in the appendix display the entire set of estimated coefficients from these regressions.

Table 5 - Partial Prouni Scholarship Model Two-Periods Regression: Total Population and Incremental Treatment Effect by Gender and Race

Total Population	(1)	Incremental Effect by Subgroup	(2)
Group Fixed Effect	0.067 (0.042)	Gender Coefficient	0.056 (0.038)
Time Fixed Effect	0.453 *** (0.041)	Gender in Odds Ratio	-
Treatment Effect Coefficient	0.112 * (0.046)	Racial Coefficient	0.108 ** (0.041)
Treatment Effect in Odds Ratio	11.80%	Racial in Odds Ratio	11.40%
Control	Yes		
Observations	73,247		
Nagelkerke R^2	12.1%		

Column (1) presents the results from equation 2, while column (2) presents the estimated coefficients for the interactions from equations 3 and 4
Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Finally, we estimate a dynamic event-study regression for the entire population. The dynamic treatment effect coefficients are presented in Table 6, which indicates that the effect of the partial Prouni scholarship on the HE participation of individuals with per capita family income between 1.5 and 3 minimum wages increased throughout the first three years after its implementation (indeed, $\hat{\beta}_{2005}$ is not statistically significant, i.e., we were unable to detect any treatment effect in 2005). The entire set of estimated coefficients from the regression presented in Table 6 is displayed in Table A.4 in the appendix.

Table 6 - Partial Prouni Scholarship Model: Dynamic Event Study Regression

Independent Variables	
Group Fixed Effect	0.080 * (0.040)
2005 Treatment Effect Coefficient	0.044 (0.068)
2005 Treatment Effect in Odds Ratio	-
2006 Treatment Effect Coefficient	0.134 * (0.066)
2006 Treatment Effect in Odds Ratio	14.3%
2007 Treatment Effect Coefficient	0.179 *** (0.068)
2007 Treatment Effect in Odds Ratio	19.6%
Time Fixed Effect	Yes
Control Variables	Yes
Observations	73,247
Nagelkerke R^2	12.8%

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

5.2. Full Prouni Scholarship Model

In this subsection, we present the results of the full Prouni scholarship model, which evaluates the impacts of the Prouni on individuals whose monthly per capita family income amounts to at most 1.5 minimum wages – i.e., eligible for the full scholarship. For ease of exposition, we present the results in an identical structure as in subsection 5.1, beginning with the examination of the parallel trends' assumption.

Table 7 presents the estimated pre-treatment beta coefficients ($\hat{\beta}_{2001}$, $\hat{\beta}_{2002}$ and $\hat{\beta}_{2003}$) from Equation 1 in this case. The first column from this table displays these coefficients in a setting without control variables, while the second column presents them in a model with controls. All coefficients are again not statistically significant (all and each of the p-values above 32%), hence providing further evidence that the treatment and control groups seem to share common trends prior to the Prouni's implementation in the full scholarship model as well.

Table 7 - Full Prouni Scholarship Model: Pre-treatment Dynamic Event Study Coefficients

Event Study Coefficients	(1)	(2)
Beta 2001	0.033 (0.086)	0.033 (0.090)
Beta 2002	-0.083 (0.085)	-0.041 (0.089)
Beta 2003	-0.038 (0.082)	0.000 (0.086)
Control	No	Yes

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Analogously to subsection 5.1, we first present the results of the 2PDD design estimations. Column 1 from Table 8 contains the results of the estimation for the entire population (Equation 2), while Column 2 presents the incremental treatment effects by subgroups. We estimate a significant treatment effect coefficient of 0.17 for the entire population, which is 54% greater than the treatment effect in the partial Prouni scholarship model and which entails an increase of 18.9% on the odds of enrolling in HE. Moreover, in this case, we find a positive and significant coefficient for both the interaction between the gender dummy and the treatment dummy (p-value lower than 0.01 and for the interaction between the race and treatment dummies (p-value lower than 0.01%). Tables A.5, A.6 and A.7 in the appendix display the entire set of estimated coefficients from these regressions.

Table 8 - Full Prouni Scholarship Model Two-Periods Regression: Total Population and Incremental Treatment Effect by Gender and Race

Total Population	(1)	Incremental Effect by Subgroup	(2)
Group Fixed Effect	2.203 *** (0.072)	Gender Coefficient	0.166 *** (0.038)
Time Fixed Effect	0.479 *** (0.042)	Gender in Odds Ratio	18.1%
Treatment Effect Coefficient	0.173 *** (0.047)	Race Coefficient	0.195 *** (0.042)
Treatment Effect in Odds Ratio	18.9%	Race in Odds Ratio	21.5%
Control	Yes		
Observations	73,247		
Nagelkerke R^2	12.1%		

Column (1) presents the results from equation 2, while column (2) presents the estimated coefficients for the interactions from equations 3 and 4
Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Finally, we also investigate the evolution of the treatment effect for the entire population across the post-treatment period. The dynamic treatment effect coefficients in this model are presented in Table 9 which indicates that the effect of the full Prouni scholarship on the HE participation of individuals with a per capita family income of at most 1.5 minimum wages also increased throughout the first three years after its implementation. Equally to the partial Prouni scholarship model, the $\hat{\beta}_{2005}$ coefficient is not statistically significant in this case (i.e., we were unable to detect any treatment effect in 2005). Additionally, the $\hat{\beta}_{2006}$ coefficient is significant only if we assume a 10% significance level (p-value of 7.2%), hence the evidence as for the effects of the full Prouni scholarship on HE enrolment in 2006 are tenuous. The entire set of estimated coefficients is displayed in Table A.8 in the appendix.

Table 9 - Full Prouni Scholarship Model: Dynamic Event Study Regression

Independent Variables	
Group Fixed Effect	2.236 *** (0.071)
2005 Treatment Effect Coefficient	0.082 (0.069)
2005 Treatment Effect in Odds Ratio	-
2006 Treatment Effect Coefficient	0.119 ' (0.066)
2006 Treatment Effect in Odds Ratio	12.6%
2007Treatment Effect Coefficient	0.314 *** (0.068)
2007 Treatment Effect in Odds Ratio	36.9%
Time Fixed Effect	Yes
Control Variables	Yes
Observations	320,776
Nagelkerke R^2	23.8%

Standard errors in parenthesis
' Significance at 10% level; * Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

5.3 Robustness

The results so far suggest that the individuals that were eligible for the Prouni (both for the partial and for the full scholarships) increased their participation in HE after the program's implementation by significantly more than those who were not eligible for the scholarship. In this subsection, we conduct four robustness exercises in order to further qualify these findings. First,

we check for anticipatory effects of the Prouni; second, we perform a placebo test, in which both the treatment and control groups are not eligible for the program – and, therefore, should be unaffected by it -; third, we reestimate the treatment effect coefficients employing an instrumental variables methodology; fourth, we reestimate the treatment effect coefficients employing a regression discontinuity framework; and fifth, we assess robustness of our results to a pre-processed dataset using an Entropy Balancing methodology.

We start by checking for anticipatory effects of the treatment, that is, whether the Prouni had any impact on individuals' HE participation before it was implemented in 2005. First, it should be noted that it is unlikely that there were any anticipatory effects, since the law ("Lei nº 11.096/2005") that instituted the Prouni was published only on January 13th of 2005, hence it seems implausible that an individual would enroll at a higher education institution at least 6 months prior to the creation of the Prouni (in the second semester of 2004) only with the probability of receiving a scholarship out of a program that was still being discussed in the Congress. Nevertheless, we test for this hypothesis by estimating a dynamic difference-in-differences model, in which we exclude the years right before and right after the Prouni's implementation (2004 and 2005) from the regression. Tables A.9 and A.10 in the appendix present the results of this design for the partial Prouni scholarship and full Prouni scholarship models, respectively. The estimated treatment effect coefficients remain significant and close to the ones estimated in sections 5.1. (Table 6) and 5.2. (Table 10), which strengthens the hypothesis that there were indeed no anticipatory effects.

In our second robustness exercise, we perform a placebo test using only individuals that were not eligible for the scholarship. Our concern here is that the increase in the HE participation of lower-income individuals could be driven by some other factor other than the Prouni, such as noisy data or any unobserved driver. In this exercise, our control group is composed of individuals whose monthly per capita family income lies between 5.5 and 7 minimum wages and our treatment group is composed of individuals with monthly per capita family income between 4 and 5.5 minimum wages. We then estimate a difference-in-differences design that is quite similar to the ones presented in subsections 5.1. and 5.2. – that is, in which the treatment group belongs to a slightly lower income class than the control group – with the crucial difference that both groups are not entitled to any Prouni scholarship. The results of this estimation are presented in Table A.11 in the appendix. The treatment effect coefficient in this case is insignificant, as shown in the table (p-value of 57%), suggesting that the results obtained were not merely a placebo effect and that the Prouni did not exert any impact on higher-income individuals.

Third, we assess robustness of our results to a different estimation strategy. The fact that an individual's grant eligibility is a function of family income could raise some endogeneity concerns

– for instance, there could be an unobserved driver, such as ability or motivation, that impacts higher education attendance and is correlated to family income and hence to our scholarship eligibility dummy D^t-. So as to mitigate this potential bias, we follow a similar strategy to Dearden et al. (2014) and we use the percentage of scholarship-eligible individuals by state and degree of ruralization cluster[8] as instrument for actual scholarship-eligibility. More precisely, we allocate the individuals from our database in 216 clusters (27 states times 8 degrees of ruralization) and for each cluster we calculate (i) the percentage of individuals entitled to the partial Prouni scholarship (i.e., individuals with a per capita family income between 1.5 and 3 minimum wages), which we use as an instrument for actual scholarship-eligibility in the partial Prouni model; and (ii) the percentage of individuals entitled to the full Prouni scholarship (i.e., individuals with a per capita family income of at most 1.5 minimum wages), which we use as an instrument for actual scholarship-eligibility in the full Prouni model. The results of the nonlinear two-stage estimations with control function (two-stage residual inclusion) are presented in Tables A.12 and A.13 in the appendix. The tables show that the IV methodology generates a treatment coefficient of 0.11 for the partial Prouni scholarship model and 0.18 for the full Prouni scholarship model, which are very close to the ones estimated in subsections 5.1. (Table 5) and 5.2. (Table 8).

Fourth, we evaluate the validity of our inferences using yet another estimation strategy, more precisely a regression discontinuity design (RDD), which also allows for the estimation of unbiased causal effects in the presence of unobserved confounding (Shadish, Cook and Campbell 2002). Since we are working with a binary outcome (whether or not the invidual is enrolled in HE), the popular bandwidth procedure by Imbens and Kalyanaraman, (2012), which is developed for the local linear estimator becomes suboptimal (Xu, 2017), and we hence estimate the regression discontinuity treatment effect using a local logistic regression. The results of the estimation for the partial and full scholarship models are displayed in figures A.1 and A.2 and in Table A.14 in the Appendix, which in both cases generate a significant treatment effect (although evidence is tenuous for the partial scholarship model, once the treatment effect coefficient is only significant at a 5% level). For further robustness' sake, we also run a placebo RDD test, in which we use the same placebo treatment and control groups from the difference-in-differences placebo test – individuals with a per capita family income between 4 and 5.5 minimum wages, and 5.5 and 7 minimum wages, respectively. This exercise yields insignificant treatment effects, as shown in Table A.14.

Finally, we assess robustness of our models' results to a pre-processed and re-balanced database. Since the Prouni was not randomly assigned (i.e., applicable to individuals with different levels

[8] We rely on the identifying assumption that the geographical location (interaction between state and degree of ruralization of the individual's census-designated area) does not directly impacts HE enrolment

of income) the causal conclusions derived from such observational data might be somewhat polluted by covariate imbalance. It is worth noting, however, that the treatment and control groups in the original model were chosen so that they belong to the closest possible income groups, precisely in order to mitigate this imbalance. Anyway, we reweight the control groups in both the full and partial Prouni scholarship models using Entropy Balancing (Hainmueller 2012), a method which intends to match the covariate moments for the different experimental groups and is double robust with respect to linear outcome regressions (Zhao and Percival 2017). The results of these estimations are displayed in Table A.15 in the Appendix, and show that the treatment effect coefficients are again significant and similar -slightly lower-, than the ones presented in tables 5 and 8.

6. Discussion

The results obtained suggest that both the partial and the full Prouni scholarships had positive and significant effects on the higher education participation of individuals that were entitled to the program. The dynamic event study coefficients for both models show that the impacts of the Prouni on HE enrolment increased from 2005 to 2007. This is in fact a natural and expected result since there is a cumulative effect of the Prouni on the HE enrolment rate in its initial years of implementation[9]. For this reason, from this point forward we shall focus our discussion on the estimated treatment effects for the year 2007.

For the partial Prouni scholarship model, we estimate an average treatment coefficient of 0.18. There are two main approaches to interpret this result. The first one, already presented in the output tables, is to convert this coefficient into odds ratio, which can be done by simply calculating e^{β}-1, where β stands for the treatment coefficient (in the case we are analyzing, this would yield $e^{0.18} - 1 =$19.6%). To put into words, by 2007 the partial Prouni scholarship had increased the odds of eligible individuals attending higher education by 19.6%. An alternative mean to interpret this coefficient is through its impact on HE enrolment rates. The HE enrolment rate of the treatment group in this model (population between 17 and 24 years old and with a per capita family income between 1.5 and 3 minimum wages) in 2007 was 26.7%. Using the logistic transformation[10] and some simple algebraic manipulations, we are able to infer that, had the Prouni not been implemented, this percentage (i.e., the counterfactual) would have been around

[9] For instance, in 2007, the HE enrolment rate of low-income individuals might be affected by those who received the scholarship in that year as well as those who had received it in the two previous years and were still attending college.

[10] A logistic regression expressed by $\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2$ can be rewritten as $p = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2)}}$.

23.3%. This implies that the partial Prouni scholarship increased this group's HE enrolment rate in approximately 3.4 percentage points.

A similar analysis can be performed for the full Prouni scholarship model. In this case, we estimate a treatment coefficient of 0.31 in 2007, meaning that, by that year, the Prouni had increased the odds of eligible individuals attending higher education by $e^{0.31} - 1 = 36.9\%$ - as expected, a greater effect than in the partial Prouni model. Furthermore, the HE enrolment rate of this model's treatment group (individuals with age from 17 to 24 and per capita family income of at most 1.5 minimum wages) in 2007 was of 5.4%, whereas, had the Prouni not been implemented, we estimate that this percentage would have been around 4.0% - an approximate effect of 1.4 percentage points on this group's HE enrolment rate (which is lower than the one estimated for the partial Prouni model due to a lower baseline rate).

Up to 2007, the government abstained from collecting approximately USD 300 million (in 2020 values) due to Prouni's tax exemptions, with an approximate annual cost per student of USD 621 (Ministry of Education and Federal Revenue). Meanwhile, if we extrapolate the results from the paragraphs above to the entire set of academic age individuals (that is, accounting for all income classes), we estimate an impact of the program on the HE enrolment rate of the overall academic age population of 1.6 percentage points (an average of 0.8 p.p. per year in 2006 and 2007 – recall that no effect was found in 2005). This implies that every USD 100 million spent by the government with tax waiver from the Prouni generates an approximate 0.5 percentage points increase in the HE enrolment rate of these individuals (or, equivalently, that every USD 1,000 spent per student generates an approximate 1.3 percentage points increase in this rate).

The empirical evidence in developed economies (namely, in the US and in the UK) find increases in participation of 3-5 percentage points per $1,000 of student aid (Dearden et al. 2014). Since Brazil has a much lower baseline HE participation rate than these countries, comparing these policies in terms of impacts in percentage points is not the fairest indicator of efficiency. Instead, we compare them in percentage terms. The US and the UK had a HE participation rate of approximately 40% in 2007 (UK Department of Education and US National Center for Education Statistics), hence the 3-5 percentage points impact per US$1,000 of student aid entails a percentage increase in the HE enrolment rate that ranges from 7.5% to 13%. Since the HE participation rate of academic age individuals in Brazil in 2005-2007 was approximately 10-11%, our estimated impact of 1.3 p.p. per year results in a percentage increase in the HE enrolment rate of roughly 11.5% to 12% - i.e., in line with the international cases.

Moreover, besides estimating the effects of the program for the entire population, we have also tested for the presence of heterogenous effects of the Prouni by population subgroups - race and gender -, the main findings being: (i) the program seems to have exerted a greater impact on

women than it did on men - although this heterogeneity could only be detected in the full scholarship model; and (ii) the program seems to have exerted a greater impact on non-white individuals than it did on whites, a result that was obtained in both the partial and full scholarships models. There are a few possible explanations for these results. First, non-white and female individuals might respond more strongly to such financial aid policies. In order to verify this hypothesis, we estimate a logit model with the entire pre-treatment population (PNAD data), in which the HE attendance is the dependent variable and find significant and positive coefficients for the interactions between gender and income, and also race and income (Table A.16 in the Appendix). That is, non-white and female individuals' HE attendance seem to be more sensitive to income restrictions. A second and perhaps complementary explanation for finding (ii) is that this dynamic might stem from the rules of the Prouni, given that, by law, a share of the grants must be designated to blacks, browns and indigenous individuals.

A possible concern that could arise from our estimations regards the suitability of our control group. Since private institutions that joined the program agreed to reserve a certain fraction of seats to Prouni students, it would be plausible to assume that these reserved seats could have increased competition for places in private HEIs among higher-income individuals, and hence could have affected their higher education enrolment as well. This scenario, however, is unlikely once the overall number of seats in private HEIs increased, on average, 7.4% per year from 2005 to 2007 (in fact, the number of new seats surpassed the number of granted Prouni scholarships in the period by 55%).

Finally, whilst the estimated effects of the Prouni were indeed sizeable and contributed to narrow the gap in HE enrolment between individuals from different income classes in Brazil, it is worth underlining that this gap remains substantial still at the time of this study –more than 15 years after the first scholarships were awarded-. Additionally, let us recall that the number of granted scholarships throughout the years was not restricted by any supply bottleneck, since the amount of offered Prouni seats by the institutions outnumbered the amount of granted scholarships in each and every year since its conception. Therefore, it seems likely that the persistent inequality in access to HE in Brazil is affected by two additional -and correlated- fundamental factors: (i) credit and income constraints that affect academic performance and educational attainment since pre-schooling; and (ii) long-run family and school environmental factors that shape young students' abilities and motivations. In this sense, policy makers that are willing to reduce the inequality of access to HE should give due weight not only to financial aid policies during HE, but also to programs that could mitigate inequalities since the early stages of the educational system. Notable Brazilian programs that move in this direction are the *Bolsa Família* (descending from the former *Bolsa Escola*), which provides financial assistance to poor families in the country conditional on children and teenagers between six and seventeen years old having a minimum school attendance;

and the *Brasil Carinhoso*, a cash transfer program entitled to families with children up to four years old, which aims to help them finance early childhood education and health care. Osorio and Souza (2012), Soares et al. (2010), and Bourguignon et al. (2003) have provided evidence of the effectiveness of these policies.

7. Conclusion

Understanding the extent to which financial aid to college students enhances access to higher education is crucial in order to unravel the effectiveness of such policies on promoting human capital accumulation. Furthermore, although there is a significant amount of evidence pointing towards a positive effect of financial aid on college enrolment, whether or not these policies are actually effective on bolstering access to HE is still a matter of controversy – especially in emerging economies where these sorts of empirical investigations are much more limited. In this paper, we contribute to the literature on the effects on non-refundable aids on HE participation in a developing country by exploiting the implementation of Brazil's Prouni.

The Prouni, which was introduced in 2005, grants full and partial scholarships to students from low-income families attending private higher education institutions in the country. We find evidence that the Prouni had a positive and significant effect on the HE participation rate of those who were eligible for the program, increasing the odds of attending HE by 20% and 37% for those entitled to the partial and full scholarships, respectively, by 2007 – which, in turn, entailed an increase in the HE enrolment rate of these individuals of 3.4 and 1.4 percentage points. We estimate that every USD 100 million spent by the government with tax waiver from the Prouni generated an approximate 0.5 percentage points increase in the HE enrolment rate of academic age individuals (every USD 1,000 per student generated an approximate 1.3 percentage points increase in this rate). Although these impacts seem low when compared to studies from OECD countries, this is largely due to Brazil's low baseline HE participation rate. Put differently, every USD 1,000 per student spent by the Prouni increased the HE participation rate by approximately 11% to 12%, which is in line with the findings from developed economies.

Furthermore, we have also tested for the presence of heterogenous effects of the Prouni across a set of different dimensions – race and gender. Albeit no statistically significant heterogenous effect by gender was found in the partial scholarship model, the Prouni seemed to have exerted a greater impact on the HE participation of non-white persons (a result found in both models) and women (in the full scholarship model).

Although a battery of robustness exercises strengthens the validity of our claims, we acknowledge some limitations in our strategy. First, we have controlled for a set of observable individual and

socioeconomic characteristics, others remaining as non-observable. Second, since several educational policies were implemented shortly before and after the Prouni, we had to limit our timespan to the first three years of the program. Third, since the PNAD database does not disclose information on the type of high school institution previously attended by HE students (i.e. public or private), we relied on the income threshold as the sole criterium for scholarship eligibility in the Prouni. Nevertheless, several robustness exercises and alternative estimation strategies allow us to provide strong evidence that the Prouni implemented in Brazil indeed had a sizeable effect on the HE enrolment of students from low-income families – a result that is in line with the majority of the other international studies on the impacts of non-refundable aids on HE participation. Thus, this investigation stresses the importance of governments' and policymakers' commitment to financial aid policies that aim to reduce the entry barriers to higher education, especially in emerging economies where such barriers not only amplify educational and social inequalities, but also hampers economic development.

References

Abraham, K. G., and Clark, M. A. (2006). “Financial aid and students’ college decisions: Evidence from the District of Columbia Tuition Assistance Grant program”. The Journal of Human Resources, 41(3), 578-610.

Barros, R. et al. (2010). “Determinantes da queda na desigualdade de renda no Brasil”. Brasília: Ipea, Discussion Paper.

Baumgartner, H. and Steiner, V. (2006). “Does more generous student aid increase enrolment rates into higher education? Evaluating the German student aid reform of 2001”. IZA Discussion Papers 2034, Institute for the Study of Labor (IZA).

Becker, K. L. and Mendonça, M. J. C. (2019). “Avaliação de impacto do Prouni sobre a performance acadêmica dos estudantes”. Brasília: Ipea, Discussion Paper.

Binelli, C. et al. (2008). “Education and Wages in Brazil”. Latin America and Caribbean Economic Association (LACEA) annual meeting.

Bourguignon, F. et al. (2003). “Conditional cash transfers, schooling, and child labor: Micro-simulating Brazil’s Bolsa Escola program”. The World Bank Economic Review, 17(2), 229-54.

Cameron, S., and Heckman, J. J. (2001). “The dynamics of educational attainment for Black, Hispanic, and White males”. Journal of Political Economy, 109, 455-99.

Canton, E. and Blom, A. (2004). “Can student loans improve accessibility to higher education and student performance? An impact study of the case of SOFES, Mexico”. Working Paper, Washington, DC, The World Bank.

Carneiro, P. and Heckman, J. J. (2002). “The evidence of credit constraints in post-secondary schooling”. Economic Journal, 112, 705-34.

Cornwell, C., et al. (2006). “The enrollment effects of merit-based financial aid: Evidence from Georgia’s HOPE program”. Journal of Labor Economics, 24(4).

Deardon, et al. (2014). “Money for nothing: Estimating the impact of student aid on participation in higher education”. Economics of Education Review, 43, 66-78.

Dynarski, S. M. (2000). “Hope for whom? Financial aid for the middle class and its impacts on college attendance”. National Tax Journal, 53(Part 2), 629-61.

Dynarski, S. M. (2003). “Does aid matter? Measuring the effect of student aid on college attendande and completion”. The American Economic Review, 93(1), 279-88.

Gurgand, et al. (2011). “Student loans: Liquidity constraint and higher education in South Africa”. Agence Française de Développement Working Paper.

Hainmueller, J. (2012). “Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies”. Political Analysis, 20(1), 25-46.

Imbens, G.W., and Kalyanaraman, K. (2012). “Optimal bandwidth choice for the regression discontinuity estimator”. Review of Economic Studies, 79, 933-59.

Kane, T.J. (2003). “A quase-experimental estimate of the impact of financial aid on college-going”. NBER Working Paper.

Kane, T. J. (2007). “Evaluating the impact of the D.C. Tuition Assistance Grant program”. The Journal of Human Resources, 42(3), 555-82.

Keane, M. P., Wolpin, K. I. (2001). “The effect of parental transfers and borrowing constraints on educational attainment”. International Economic Review, 42, 1051-1103

Lepine, A. (2018). “Financial aid and student performance in college: Evidence from Brazil”. Brazilian Review of Econometrics, 38(2), 221-61.

Lisboa, M. and Menezes-Filho, N.A. (2001). “Microeconomia e sociedade no Brasil”. Rio de Janeiro, Ed. Contra Capa.

Long, B.T. (2004). “The impact of federal tax credits for higher education expenses”. C.M. Hoxby (ed.), College Choices: The Economics of Where to Go, When to Go, and How to Pay for It (pp. 101–168). Chicago: University of Chicago Press.

Neves, C.B. (2015). “Demand and supply for higher education in Brazil”. In: Schwartzman, S., Pillay, P., Pinheiro, R., Higher education in the BRICS countries: investigating the pact between higher education and society. Springer, 2015.

Nguyen, H. (2020). “Free college? Assessing enrollment responses to the Tennessee Promise program”. Labour Economics, 66, 101882.

Nielsen, et al. (2010). “Estimating the effect of student aid on college enrollment: Evidence from a government grant policy reform”. American Economic Journal: Economic Policy, 2(2), 185-215.

Osorio, R. and Souza, P. (2012). “O Bolsa Família depois do Brasil Carinhoso: uma análise do potencial de redução da pobreza”. Brasília: Ipea, Discussion Paper.

Sampaio, B. and Guimarães, J. (2009). “Diferenças de eficiência entre ensino público e privado no Brasil”. Revista de Economia Aplicada, 13(1), 45-68.

Shadish, W.R., Cook, T.D., and Campbell, D. T. (2002). “Experimental and quasi-experimental designs for generalized causal inference”. Neww York: Houghton Mifflin.

Soares, F. et al. (2010). “Evaluating the impact of Brazil’s Bolsa Família”. Latin American Research Review, 45(2), 173-90.

Solis, A. (2017). “Credit access and college enrollment”. Journal of Political Economy, 125(2), 562-622.

Tangkitvanich, S. and Manasboonphempool, A. (2010). “Evaluating the student loan fund of Thailand”. Economics of Education Review, 29(5), 710-721.

Xu, K. (2017). “Regression discontinuity with categorical outcomes”. Journal of Econometrics, 201(1), 1-18.

Zhao, Q. and Percival, D. (2017). “Entropy Balancing is doubly robust.” Journal of Causal Inference, 5(1).

Appendix

Figure A. 1 – Full Prouni Scholarship Regression Discontinuity: Local Logistic Regression

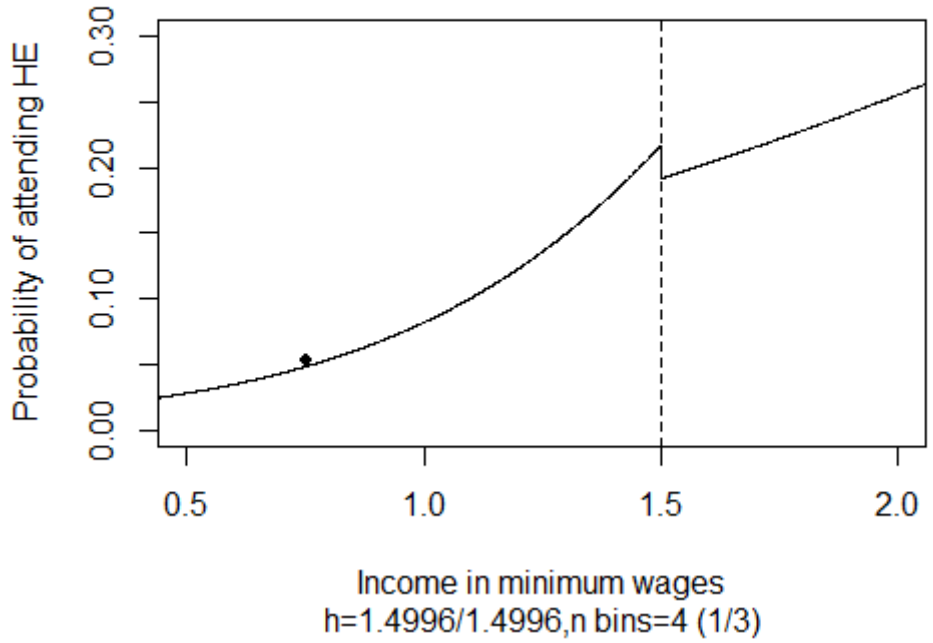


Figure A. 2 - Partial Prouni Scholarship Regression Discontinuity: Local Logistic Regression

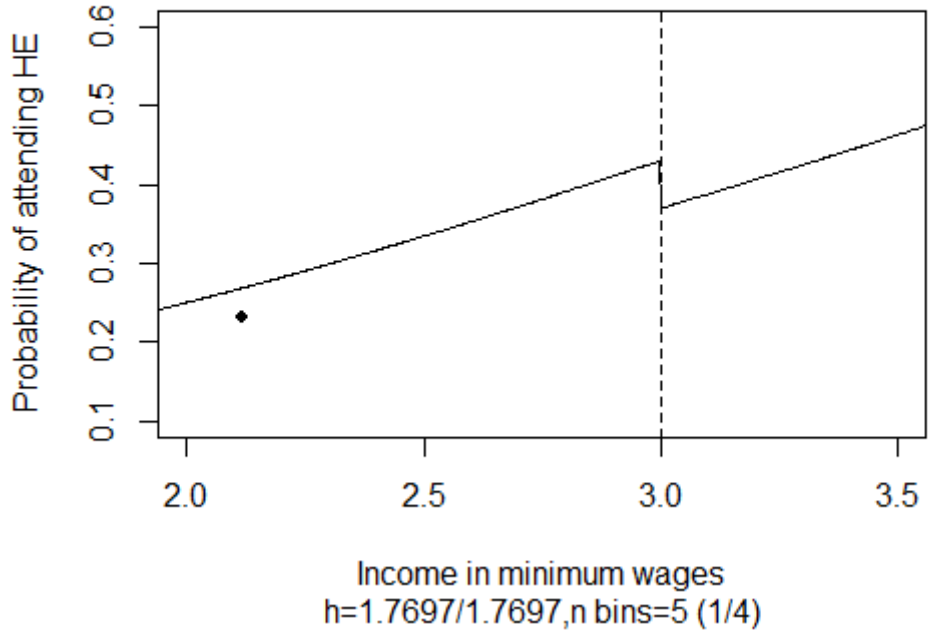


Table A. 1 - Partial Prouni Scholarship Model: Two-Periods Regression

Independent Variables			
Ruralization	Yes ***	Average Income	0.712 *** (0.024)
State	Yes ***	Work Factor	0.456 *** (0.021)
Race	Yes ***	Group Fixed Effect	0.067 (0.042)
Age	0.125 *** (0.004)	Time Fixed Effect	0.453 *** (0.041)
Gender (F = 1)	0.393 *** (0.019)	Treatment Effect	0.112 * (0.046)
Observations	73,247		
Nagelkerke R^2	12.1%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 2 - Partial Prouni Scholarship Model: Two-Periods Regression with Gender Interaction

Independent Variables			
Ruralization	Yes ***	Work Factor	0.456 *** (0.021)
State	Yes ***	Group Fixed Effect	0.068 (0.042)
Race	Yes ***	Time Fixed Effect	0.453 *** (0.041)
Age	0.126 *** (0.004)	Treatment Effect	0.083 (0.051)
Gender (F = 1)	0.372 *** (0.024)	Treatment * Gender	0.056 (0.038)
Average Income	0.712 *** (0.024)		
Observations	73,247		
Nagelkerke R^2	12.1%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 3 - Partial Prouni Scholarship Model: Two-Periods Regression with Race Interaction

Independent Variables			
Ruralization	Yes ***	Work Factor	0.456 *** (0.021)
State	Yes ***	Group Fixed Effect	0.0703 ' (0.042)
Race	Yes ***	Time Fixed Effect	0.455 *** (0.041)
Age	0.125 *** (0.004)	Treatment Effect	0.073 ' (0.041)
Gender (F = 1)	0.372 *** (0.022)	Treatment * Race	0.108 ** (0.041)
Average Income	0.713 *** (0.024)		
Observations	73,247		
Nagelkerke R^2	12.1%		

Standard errors in parenthesis
' Significance at 10% level; * Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 4 - Partial Prouni Scholarship Model: Dynamic Event Study Regression

Independent Variables			
Ruralization	Yes ***	Year Dummy 2001	-0.492 *** (0.033)
State	Yes ***	Year Dummy 2002	-0.255 *** (0.031)
Race	Yes ***	Year Dummy 2003	-0.047 (0.035)
Age	0.125 *** (0.004)	Year Dummy 2005	0.194 *** (0.030)
Gender (F = 1)	0.397 *** (0.019)	Year Dummy 2006	0.323 *** (0.061)
Average Income	0.725 *** (0.024)	Year Dummy 2007	0.331 *** (0.063)
Work Factor	0.458 *** (0.021)	Beta 2005	0.044 (0.068)
Group Fixed Effect	0.080 * (0.042)	Beta 2006	0.134 * (0.066)
		Beta 2007	0.179 *** (0.068)
Observations	73,247		
Nagelkerke R^2	12.8%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 5 - Full Prouni Scholarship Model: Two-Periods Regression

Independent Variables			
Ruralization	Yes ***	Average Income	1.905 *** (0.027)
State	Yes ***	Work Factor	0.414 *** (0.020)
Race	Yes ***	Group Fixed Effect	2.203 *** (0.072)
Age	0.137 *** (0.004)	Time Fixed Effect	0.479 *** (0.042)
Gender (F = 1)	0.437 *** (0.019)	Treatment Effect	0.173 *** (0.047)
Observations	320,776		
Nagelkerke R^2	23.4%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 6 - Full Prouni Scholarship Model: Two-Periods Regression with Gender Interaction

Independent Variables			
Ruralization	Yes ***	Work Factor	0.412 *** (0.020)
State	Yes ***	Group Fixed Effect	2.214 *** (0.072)
Race	Yes ***	Time Fixed Effect	0.477 *** (0.042)
Age	0.136 *** (0.004)	Treatment Effect	0.074 (0.052)
Gender (F = 1)	0.362 *** (0.026)	Treatment * Gender	0.166 *** (0.038)
Average Income	1.907 *** (0.027)		
Observations	320,776		
Nagelkerke R^2	23.4%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 7 - Full Prouni Scholarship Model: Two-Periods Regression with Race Interaction

Independent Variables			
Ruralization	Yes ***	Work Factor	0.412 *** (0.020)
State	Yes ***	Group Fixed Effect	2.130 *** (0.073)
Race	Yes ***	Time Fixed Effect	0.468 *** (0.042)
Age	0.136 *** (0.004)	Treatment Effect	0.106 * (0.050)
Gender (F = 1)	0.435 *** (0.019)	Treatment * Race	0.195 *** (0.042)
Average Income	1.824 *** (0.029)		
Observations	320,776		
Nagelkerke R^2	23.4%		

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 8 - Partial Prouni Scholarship Model: Dynamic Event Study Regression

Independent Variables			
Ruralization	Yes ***	Year Dummy 2001	-0.494 *** (0.035)
State	Yes ***	Year Dummy 2002	-0.303 *** (0.033)
Race	Yes ***	Year Dummy 2003	-0.022 (0.036)
Age	0.136 *** (0.004)	Year Dummy 2005	0.224 *** (0.030)
Gender (F = 1)	0.438 *** (0.019)	Year Dummy 2006	0.340 *** (0.062)
Average Income	1.920 *** (0.027)	Year Dummy 2007	0.369 *** (0.065)
Work Factor	0.422 *** (0.020)	Beta 2005	0.082 (0.069)
Group Fixed Effect	2.236 *** (0.071)	Beta 2006	0.119 ' (0.066)
		Beta 2007	0.314 *** (0.068)
Observations	320,776		
Nagelkerke R^2	23.8%		

Standard errors in parenthesis
' Significance at 10% level; * Significance at 5% level; ** Significance at 1% level;
*** Significance at 0.1% level

Table A. 9 - Partial Prouni Scholarship Model: Check for Anticipatory Effects

Independent Variables			
Ruralization	Yes ***	Average Income	1.032 * (0.498)
State	Yes ***	Work Factor	0.422 *** (0.025)
Race	Yes ***	Group Fixed Effect	0.057 (0.049)
Age	0.126 *** (0.005)	Beta 2006	0.154 * (0.070)
Gender (F=1)	0.401 *** (0.023)	Beta 2007	0.199 ** (0.072)

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 10 - Full Prouni Scholarship Model: Check for Anticipatory Effects

Independent Variables			
Ruralization	Yes ***	Average Income	1.869 *** (0.032)
State	Yes ***	Work Factor	0.397 *** (0.024)
Race	Yes ***	Group Fixed Effect	2.097 *** (0.085)
Age	0.138 *** (0.005)	Beta 2006	0.137 * (0.070)
Gender (F=1)	0.442 *** (0.023)	Beta 2007	0.331 *** (0.072)

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 11 - Placebo Exercise

Independent Variables			
Ruralization	Yes ***	Average Income	0.187 *** (0.038)
State	Yes ***	Work Factor	0.306 *** (0.037)
Race	Yes ***	Group Fixed Effect	0.091 (0.073)
Age	0.112 *** (0.008)	Time Fixed Effect	0.217 *** (0.059)
Gender (F=1)	0.224 *** (0.033)	Treatment Effect	0.041 (0.072)

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 12 - Partial Prouni Scholarship IV Regression

Independent Variables	
First stage	
Percentage of scholarship-eligible individuals[a]	0.240 *** (0.040)
Second stage	
Treatment effect	0.111 * (0.047)

[a] Mean percentage by state*ruralization class
Standard errors in parenthesis
* Significance at 5% level
** Significance at 1% level
*** Significance at 0.1% level

Table A. 13 - Full Prouni Scholarship IV Regression

Independent Variables	
First stage	
Percentage of scholarship-eligible individuals[a]	0.537 *** (0.006)
Second stage	
Treatment effect	0.184 *** (0.049)

[a] Mean percentage by state*ruralization class
Standard errors in parenthesis
* Significance at 5% level
** Significance at 1% level
*** Significance at 0.1% level

Table A. 14 – RDD Treatment Effect Estimations

Model	Treatment effect estimate
Full Scholarship	0.258 ***
	(0.072)
Partial Scholarship	0.253 *
	(0.125)
Placebo Exercise	0.002
	(0.289)

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 15 - Partial and Full Prouni Scholarship Model Two-Periods Regression with Entropy Balancing

Independent Variables	Partial	Full
Group Fixed Effect	0.076	2.210 ***
	(0.042)	(0.075)
Time Fixed Effect	0.468 ***	0.492 ***
	(0.041)	(0.044)
Treatment Effect Coefficient	0.097 *	0.161 **
	(0.046)	(0.049)
Treatment Effect in Odds Ratio	10.20%	17.5%
Control	Yes	Yes

Standard errors in parenthesis
* Significance at 5% level; ** Significance at 1% level; *** Significance at 0.1% level

Table A. 16 – HE attendance regression

Independent Variables			
Ruralization	Yes ***	Average Income	0.092 ***
			(0.001)
State	Yes ***	Work Factor	-0.236 ***
			(0.012)
Race	Yes ***	Gender (F = 1) * Avg. Income	0.012 ***
			(0.002)
Age	-0.096 ***	Race (non-white = 1) * Avg. Income	0.134 ***
	(0.001)		(0.003)
Gender (F = 1)	0.316 ***	-	-
	(0.014)		
Observations	936,372		
Nagelkerke R^2	18.9%		

Standard errors in parenthesis