Financial Aid and Student Performance in College: Evidence from Brazil*

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Abstract

This paper studies the effects of a government scholarship program for low-income college students in Brazil, the *Prouni*. In order to deal with selection effects, I use propensity score matching based on observable student characteristics and a proxy for previous student performance. The results are robust across different specifications, and suggest that students who received a scholarship perform better than comparable students and take less time to reach the final year of college. These effects are higher for students with full scholarships than for students with partial scholarships, and seem to be partially driven by a decrease in the proportion of students who work and an increase in time spent studying.

Keywords: Student aid, higher education, propensity score matching

JEL Codes: I22, I23, I28

1 Introduction

Skills and knowledge acquired during higher education have become increasingly important in the labor market, and higher education institutions currently play a key role in economic development and competitiveness. But although access to higher education has globally seen a strong expansion in recent years, it remains relatively low in most developing countries. Among Latin American countries for which OECD data is available,[1] the most recent estimates show that on average

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[1] Organisation for Economic Cooperation and Development. Latin American countries with available data include Chile, Brazil, Mexico, Argentina, Colombia and Costa Rica (data from 2013 and 2014).

19% of the population aged 25–64 had completed higher education, compared to nearly 35% for OECD member countries. One of the reasons behind this phenomenon is the cost of higher education, combined with the presence of credit constraints. A World Bank study by Murakami and Blom (2008) shows that the costs associated with higher education (including the cost of living) in terms of per capita income are much higher in Latin America than in high-income countries. In addition to obstacles related to initial enrollment, many students drop out of college before completing their studies because of poor performance or financial difficulties, and many take longer than expected to finish.

Student financial aid in the form of grants or scholarships, which still plays a limited role in developing countries, can potentially help disadvantaged students access and successfully complete higher education. In addition to reducing the cost of higher education, student aid is expected to allow students to devote more time to their studies and increase their performance, by reducing the need to work while in college.

Most of the available empirical evidence on the effectiveness of student aid is based on programs in the United States, and focuses on the effects of aid on student enrollment. A few examples are Dynarski (2000, 2003), Cornwell, Mustard, and Sridhar (2006), Kane (2003, 2007), and Abraham and Clark (2006), who find positive effects of different student aid programs on enrollment. Outside of the United States, Dearden, Fitzsimons, and Wyness (2014) and Nielsen, Sørensen, and Taber (2010) find evidence that student aid positively affects enrollment using data from the UK and Denmark, respectively.

A few recent papers, which focus on specific populations of disadvantaged students, also reach similar conclusions. Barr (2015, 2019) finds that a change in legislation which increased financial aid for veterans increased enrollment, redirected enrollment towards better institutions and increased degree attainment. Angrist, Autor, Hudson, and Pallais (2016) use a randomized evaluation to study the effects of grants based on grade and financial need in Nebraska, and also find increases in enrollment and positive effects on persistence, with larger gains among the most disadvantaged students.

Given the importance of the acquisition of skills during higher education, it is also crucial to consider the effects of student aid on learning and performance during college. Evidence on the effects of student aid on these outcomes is much more limited, however. Castleman and Long (2016) study the effects of a need-based grant in Florida and find positive effects on attendance, credit accumulation

and bachelor degree completion. Using data from Texas, Denning (2018) also finds positive effects of student financial aid on time to graduation and credits attempted, although he finds no effects on average grades in college. Goldrick-Rab, Kelchen, Harris, and Benson (2016) conduct a randomized experiment in Wisconsin and find that need-based grants increased bachelor degree attainment, but only had a modest effect on grades. Scott-Clayton (2011) assesses the impact of a program in West Virginia that offered free tuition and fees to college students who maintained a minimum grade and course load and finds positive effects on cumulative GPA and credits earned. Finally Cappelli and Won (2016) show that students receiving need-based grants independently of performance perform better than those without aid.

In addition, surprisingly little is know on the channels through which financial aid affects academic outcomes. To my knowledge, the only two papers that provide empirical evidence on such mechanisms are Denning (2018) and Scott-Clayton (2011). Denning (2018) finds that observed positive effects of student financial aid seem to be driven by reduced student earnings while in college, while in a different context Scott-Clayton (2011) finds that financial aid seems to work through increased motivation.

Evidence on the effects of student aid in the context of a developing country is also extremely limited. Canton and Blom (2004) estimate the impact of a student loan program in Mexico (SOFES) and find positive effects on enrollment and performance. A more recent paper by Solis (2017) provides evidence on two merit-based college loan programs in Chile, and finds that it increased enrollment after high school. It is not clear, however, that the findings from these studies would generalize to the case of non-refundable aid such as grants and scholarships.

This paper contributes to the existing literature on higher education and student financial aid in two important ways. First, it provides evidence on the effectiveness of student financial aid in the context of a developing country by assessing the effects of a scholarship program for disadvantaged students in Brazil, the *Prouni* (*Programa Universidade Para Todos*). While students from developing countries who enroll in higher education often face relatively high costs and important credit constraints, financial aid programs are much less common there. As a result, it is possible that these programs will have larger effects in this context compared to high-income countries. Second, by using a rich dataset containing information on student achievement, students'

background characteristics, as well as work and study habits, I am able to assess the effects of the program on outcomes that have not been studied extensively in the literature, such as student performance and the duration of studies, and explore possible channels through which financial aid affects these outcomes.

As *Prouni* scholarship recipients have distinct characteristics from other students, simply comparing the outcomes of the two groups is likely to provide biased estimates related to selection effects. While *Prouni* scholarship recipients are economically disadvantaged, they are also selected based on ability, which means the direction of the bias is not clear. In order to deal with selection effects, I use propensity score matching to create a counterfactual group of students with similar socio-economic characteristics who did not receive any type of scholarship. This method assumes that conditional on observed covariates, assignement to treatment is random.

I take advantage of the fact that I can observe both first-year and final-year students' performance on a specific knowledge test related to their field of study, and on a general knowledge test. The data show that while specific knowledge increases throughout college, as expected, general knowledge is much more stable across time, which allows me to use the general knowledge grade as a proxy for previous student performance before enrolling in college.

Results show that final-year students who have received a *Prouni* scholarship perform significantly better than similar students who have not received a scholarship, and take less time to reach the final year of college. These effects are stronger for students who received full scholarships than for students who received partial scholarships (covering 100% and 50% of tuition respectively), suggesting that the amount of aid received matters. Results also show that scholarship recipients report studying more on average, and that those who received a full scholarship have a lower probability of working while in college, though this is not observed for partial scholarship recipients. These findings are robust to alternative specifications, and do not seem to be driven by differences in college quality.

The remainder of this paper is organized as follows. Section 2 provides background information on the higher education system in Brazil and the *Prouni* program. Section 3 presents the data and details the empirical methodology. Section 4 shows the main results, and a few robustness tests are performed in section 5. Section 6 concludes.

2 Background

2.1 Higher Education in Brazil

Higher education in Brazil is provided by both fee-paying private institutions, which account for the large majority of enrollments, and free public institutions. According to data from the Ministry of Education, around 25% of enrollments in 2014 were in public institutions. The number of enrollments in tertiary education has increased significantly in recent years, rising by around 75% between 2005 and 2014. However, college attainment remains relatively low compared to high-income countries, with only 14% of people aged 25–64 having completed higher education in 2014 according to the OECD, compared to an average of 35% for OECD member countries, and despite the fact that returns to higher education are particularly strong.[2]

A specific characteristic of the Brazilian higher education system is that public institutions are generally of higher quality and more selective than private ones, with a few exceptions. According to Binelli, Meghir, and Menezes-Filho (2008), there were on average 9 applicants for each place at a public institution in 2003, while this ratio was 1.5 in private institutions. The opposite is true for basic education, where private schools generally outperform public schools at standardized tests. It is therefore particularly difficult for students from disadvantaged backgrounds who attended public schools to access the best public universities, and inequalities persist throughout higher education. Student dropout is another important issue, especially in private institutions. Binelli et al. (2008) estimate these rates at around 20% for public institutions and 33% for private ones in 2002, and a more recent study by SEMESP[3] in 2015 estimated the dropout rate at around 27% for private higher education institutions and 18% for public institutions.

The admission process in Brazilian higher education institutions is mainly decentralized, and most colleges have their own admission criteria and entrance tests.[4] Overall, the difficulty of admissions varies significantly across institutions.

[2] Those who completed higher education in Brazil were estimated to earn on average 2.5 times more than those with only upper secondary education, compared to a rate of 1.6 for OECD countries.

[3] *Sindicato das Mantenedoras de Ensino Superior*, an organization that provides services for private higher education institutions in Brazil.

[4] In the case of public institutions, however, there is a tendency towards the centralization of admissions with the creation in 2010 of a single platform to select and allocate students to participating institutions (*Sisu – Sistema de Seleção Unificada*).

The selection of students can be based on performance at specific entrance tests, on test scores obtained at the *Enem* (*Exame Nacional do Ensino Médio*); a standardized test aimed at students finishing high school, and on interviews and curriculum examinations, among others. Students are required to choose their field of specialization (or major) before applying and enrolling, and once students are admitted, change is usually difficult and requires going through the selection process again.

Several initiatives have been taken by the federal government in recent years to increase and democratize access to higher education, such as the introduction of scholarships for disadvantaged students (*Prouni*), the creation of a loan program for disadvantaged students (*Fies – Programa de Financiamento Estudantil*), and quotas for students based on race or socio-economic status. Below, I describe the *Prouni* program in further detail.

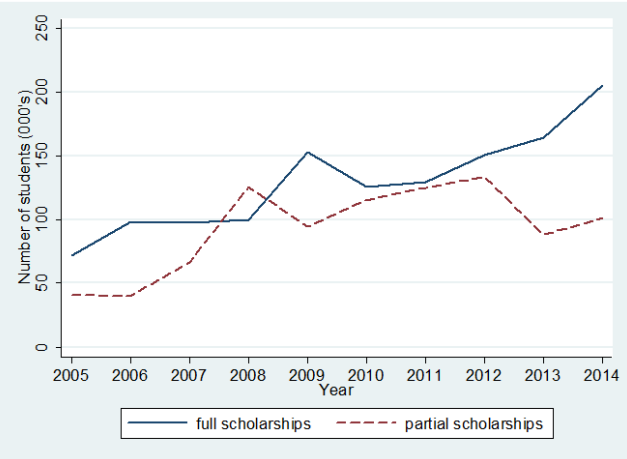
2.2 The *Prouni* Program

The *Prouni* (*Programa Universidade Para Todos*) is a program created in 2005 by the Brazilian Federal Government that offers scholarships to students enrolled in private higher education institutions. Two types of scholarships are available: full scholarships that cover 100% of tuition costs, and partial scholarships that cover 50% of tuition. Private higher education institutions participating in the program agree to reserve a certain number of spots for *Prouni* students, and in return benefit from tax exemptions. The number of *Prouni* spots available in each degree program is calculated based on a formula that takes into account the total number of enrolled students, among other parameters, although the rules allow for some flexibility.[5] The evolution of the number of *Prouni* scholarships between 2005 and 2014 is shown in Figure 1. In 2014, over 300,000 scholarships were awarded, of which nearly 70% were full scholarships.

In order to be eligible, students must satisfy the following criteria: i) they must have previously attended either a public high school, or a private high school while receiving a full scholarship; ii) their household income must not exceed 1.5 minimum wages per capita if applying for a full scholarship or 3 minimum wages per capita if applying for a partial scholarship.[6] Teachers from

[5] Since the program was implemented in 2005, the rules determining the number of scholarships to be offered by institutions have changed slightly over the years.

[6] In 2016 the minimum wage in Brazil was 880 Reais, equivalent to 250 USD approximately. According to Census data, around 50% of households earned up to 3 minimum wages in 2010, and around 15% of households earned up to 1 minimum wage.



Source: Ministry of Education.

Figure 1. Evolution of Prouni scholarships over time.

public schools studying Pedagogy or towards a teaching degree, and students with disabilities are also eligible, regardless of their income or school attended.

Students who wish to apply for a *Prouni* scholarship need to go through an online centralized selection process that happens twice a year, where they are allowed to choose up to two different degree programs, which are institution-specific.[7] Candidates are ranked according to their *Enem* score, and pre-selected based on the program's minimum grade requirements and the number of spots available (information on the availability of spots is updated in real time). The program's rules have changed slightly over the years and in 2009 for example, the requirement that students score above a minimum threshold on the *Enem* exam was added—although the fixed threshold is relatively low and more than half the students taking the *Enem* score above this minimum grade. Once a student is awarded a *Prouni* scholarship, its validity is reviewed on a term basis and students need to pass at least 75% of the classes taken in a given term in order to keep the scholarship.

[7] Students could choose up to five degree programs until 2009, but the number of choices was subsequently reduced.

3 Data and Empirical Strategy

3.1 Data

This paper uses data from *Enade* (*Exame Nacional de Desempenho de Estudantes*), an exam taken each year by a sample of undergraduate students in higher education institutions in Brazil. The *Enade*'s purpose is to assess the quality of undergraduate degree programs in the country, and it is mandatory for final-year students to take the exam in order to graduate, although the exam has low other direct stakes for students. The *Enade* assesses both students' performance in their specific field of study and in general knowledge. In addition to information on student performance, the *Enade* database also provides detailed information on students' socio-economic background, on whether they have received scholarships or loans, as well as on work and study habits. Each year, degree programs from different fields of study are assessed, and roughly the same group of fields is tested every three years, although new fields are added with time. Table 1 shows the fields of study tested between 2004, the first year for which *Enade* data is available, and 2010. As an example, the fields tested in 2004 were tested again in 2007 and 2010. Initially, the sample included both first-year and final-year students, but from 2011 onwards only final-year students were tested.

This paper compares students who received a full or partial *Prouni* scholarship, with a counterfactual group of students who received no scholarship during college (although they may have taken student loans or other types of loans). Next, I describe details concerning the selection of the sample used in the empirical analysis.

As students from different fields of study are likely to be significantly different in terms of both observable and unobservable characteristics, and as the difficulty of the *Enade* exam may vary from year to year, it makes sense to perform the analysis of the effects of receiving a *Prouni* scholarship separately by field and year. Fields included in the analysis therefore need to have a sufficient number of students receiving both full and partial scholarships, as the effects of the two types of scholarships are assessed separately. However, the distribution of scholarship recipients between fields of study and years is very uneven. Traditional fields such as Law or Medicine typically attract a much higher number of students than others fields. Moreover, the number of *Prouni* students in the early years after the program was implemented was very limited in most fields.

Table 1. Fields of study tested in *Enade* in 2004–2010.

2004	Veterinary Medicine, Dentistry, Medicine, Agronomy, Pharmacy, Nursing, Speech Therapy, Nutrition, Physical Education, Physiotherapy, Social Work, Zootechnics, Occupational Therapy
2005	Math, Literature, Physics, Chemistry, Biology, Pedagogy, Architecture, History, Geography, Philosophy, Computer Science, Engineering, Social Sciences
2006	Management, Law, Communication Studies, Economics, Psychology, Accounting, Design, Tourism, Acting, Music, Biomedical Science, Archiving, Library Science, Administrative Assistant Degree, Teaching
2007	Same as 2004 + Biomedical Science, technical degrees in Radiology and Agro-industry
2008	Same as 2005 + technical degrees in Food Science, Systems Analysis and Development, Industrial Automation, Building, Manufacturing Engineering, Production Management, Industrial Maintenance, Chemical Processes, Computer Networks, Environmental Sanitation
2009	Same as 2006 (except Biomedical Science) + International Relations, Statistics, and technical degrees in Design, Marketing, Management, Human Resources, Financial Management, Gastronomy, Tourism
2010	Same as 2007 + technical degrees in Agribusiness, Hospital Management, Environmental Management

In order to obtain a sufficient sample size for the analysis, I take, for each field and year, the minimum number of *Prouni* students of the two categories (full and partial)[8] and rank all combinations of field and year accordingly. I exclude degrees in Pedagogy, which have specific scholarship attribution rules as mentioned earlier, and restrict the analysis to the period before 2011 as information for first-year students, which is used in the analysis, is not available after this period. I then restrict the analysis to the three fields that provide the largest number of observations. According to these criteria, the three fields with the largest sample size are Management, Law and Accounting, obtained from the 2009 *Enade* database, all of which have at least 500 *Prouni* students of each category.[9]

Finally, I exclude students from certain types of colleges from the comparison group. Participation in the *Prouni* program is a choice made by institutions, and those choosing to participate may have different characteristics than non-

[8] This is done by pooling together all colleges offering degree programs in a given field.

[9] The analysis has also been done using the two next fields with the largest number of *Prouni* students, which provides similar results (available upon demand).

participating institutions. I therefore exclude from the analysis students from colleges not participating in the *Prouni*. As I do not directly observe which private institutions officially participate in the *Prouni*, I only include in the analysis degree programs that have at least one *Prouni* student of either type.[10] Degree programs from public institutions, which do not charge fees and are not eligible to participate in the program, are also excluded.

3.2 Descriptive Statistics

Table 2 presents descriptive statistics for final-year students in the three fields of study included in the analysis. Only students with available data on test scores are included, and aged between 17 and 50, as the number of *Prouni* students outside this age range is very limited. I also exclude students with disabilities from the analysis as they have different requirements for receiving *Prouni* scholarships. Overall, scholarship recipients represent about 30% of the total. Students who received a full *Prouni* scholarship account for 8–9%, while by partial *Prouni* scholarship recipients account for 3–5% of the total. The share of students who received other types of scholarship is around 20% in the three fields considered.[11]

Management is by far the most popular field of the three and accounts for the largest number of students, followed by Law and Accounting. The three fields of study differ somewhat regarding their student population. Law students come from a slightly more advantaged background, which translates into a lower proportion of those who attended public high schools, and a higher proportion of students whose parents finished high school. Law degree programs last longer than other degrees: while most non-technical degrees in Brazil have an average duration of 4 years, the Law degree normally takes 5 years. The large majority of final-year students is enrolled in evening classes (over 80% of students when averaging the three fields), although this share is somewhat lower among Law students. Similarly, close to 80% of final-year students report to be working while studying.

An important point should be noted here. As scholarships are reviewed on a term basis and can be suspended if a students' situation changes (for example if their family income increases above the maximum threshold or if they do not

[10] In 2009, 19% of all degree programs in Management, Law and Accounting did not have any *Prouni* students

[11] Students who report receiving more than one type of scholarship represent less than 1% of the sample.

Table 2. Descriptive statistics – sample of final-year students (2009).

	Management	Law	Accounting
No. colleges	581	241	152
No. test-takers	67,450	49,529	16,803
Avg. test-takers per college	114	213	109
% full Prouni scholarship	9	8	8
% partial Prouni scholarship	4	3	5
% other scholarships	23	18	22
% female	55	52	58
% black	6	6	7
Avg. age	27	29	28
% HH income $<$ 3 min. wages	25	22	28
% studied in public high school	62	40	70
% mother finished high school	45	54	38
% father finished high school	43	53	35
% evening study	89	68	95
% working	83	59	89
Avg. years since start of college	3.5	4.3	3.4
Avg. grade – general knowledge	44	48	39
Avg. grade – specific knowledge	37	52	32

Notes: Grades are given in a scale of 0–100. The minimum wage in 2009 was 465 BRL, equivalent to 230 USD at the time approximately.

pass 75% of the classes in a given term), it is possible that some of the final-year students who initially received a scholarship do not have it any longer at the time of the survey. The survey, however, only provides information on whether students have received a *Prouni* scholarship at some point during their studies. In order to get an idea of what this represents, I look at higher education census data for 2009 and 2010. In the three fields of study considered, around 11% of first-year students enrolled in 2009 who had a full *Prouni* scholarship lost it the following year, and for students who had a partial *Prouni* scholarship this share was around 14%.

Table 3 shows similar statistics by *Prouni* scholarship status and type of student (first-year or final-year). As expected, the share of low-income students and the share of students who attended a public high school increase with *Prouni* scholarship status.[12] Interestingly, *Prouni* students score higher in both specific and general knowledge tests, and final-year students who have received a *Prouni*

[12] As mentioned earlier, given that the only available information is whether students have received a *Prouni* scholarship at some point during their studies, it is possible that some *Prouni* recipients do not satisfy the income eligibility requirements at the time the survey was applied.

Table 3. Characteristics of test-takers by scholarship status and type of student.

	Full Prouni		Partial Prouni		No scholarship	
	First -year	Final -year	First -year	Final -year	First -year	Final -year
Management						
No. students	6,194	6,068	3,226	2,038	54,152	43,506
% female	58	59	61	60	56	54
% black	11	14	9	8	6	5
Avg. age	23	25	23	26	24	27
% HH income < 3 min. wages	68	49	56	38	36	20
% studied in public high school	93	93	88	86	60	54
% mother finished high school	36	37	39	37	47	48
% father finished high school	31	32	34	35	44	46
% evening study	84	90	82	89	83	88
% working	64	77	72	84	73	83
Avg. years since start of college	–	3.1	–	3.2	–	3.6
Avg. grade – gen. knowledge	51	53	44	47	38	43
Avg. grade – spec. knowledge	37	46	31	39	28	26
Law						
No. students	4,504	3,320	1,938	1,274	48,704	34,941
% female	50	56	53	53	55	52
% black	13	16	12	12	6	5
Avg. age	24	26	24	27	25	29
% HH income < 3 min. wages	65	59	53	41	25	17
% studied in public high school	89	90	81	77	36	33
% mother finished high school	43	43	45	46	57	57
% father finished high school	38	39	41	43	56	56
% evening study	66	72	65	70	62	67
% working	53	50	59	59	51	59
Avg. years since start of college	–	3.9	–	4.0	–	4.3
Avg. grade – gen. knowledge	55	55	47	49	45	48
Avg. grade – spec. knowledge	51	58	44	51	42	51
Accounting						
No. students	1,796	1,298	1,236	559	15,218	10,951
% female	59	56	63	57	60	57
% black	12	14	8	11	7	6
Avg. age	24	26	23	27	25	28
% HH income < 3 min. wages	70	48	60	37	41	24
% studied in public high school	93	95	92	88	72	64
% mother finished high school	34	32	37	34	40	40
% father finished high school	27	27	29	30	36	38
% evening study	94	96	92	92	92	95
% working	68	84	77	87	81	89
Avg. years since start of college	–	3.1	–	3.2	–	3.5
Avg. grade – gen. knowledge	49	47	42	42	36	38
Avg. grade – spec. knowledge	28	40	25	35	23	31

Notes: Grades are given in a scale of 0–100. The minimum wage in 2009 was 465 BRL, equivalent to 230 USD at the time approximately.

scholarship take less time on average to reach their final year of studies. However, as these students have distinct characteristics and are selected based on ability, it not possible to establish any causal relations at this point.

When comparing first-year and final-year students, some interesting patterns emerge. Final-year students are more likely to be working and contributing to the household income, which is likely to explain the fact that the percentage of final-year students in the lowest income category is smaller. Comparing characteristics of first-year and final-year students that are fixed in time also provides some indications regarding student dropout. Although the number of final-year students is generally lower than the number of first-year students, there are no noticeable differences in most cases regarding mother and father education, gender, and race; although a decrease in the share of students who attended a public high school can be observed among students receiving a partial scholarship or no scholarship.

3.3 Empirical Strategy

Using the potential outcomes notation, if $Y_i(1)$ is the outcome of interest for a treated individual and $Y_i(0)$ is the outcome of interest for a non-treated individual, the treatment effect for a given individual is $\tau_i = Y_i(1) - Y_i(0)$. The average treatment effect for the treated (ATT), which is the parameter of interest in most studies, is therefore $E(Y_i(1)|T_i = 1) - E(Y_i(0)|T_i = 1)$. It is not possible, however, to simultaneously observe an individual that would be both treated and not treated as we only observe either $E(Y_i(1)|T_i = 1)$ or $E(Y_i(0)|T_i = 0)$. Simply comparing the group averages $E(Y_i(1)|T_i = 1)$ and $E(Y_i(0)|T_i = 0)$ may give biased estimates if the treated and control groups differ systematically. Similarly in our case, assessing the effects of the *Prouni* scholarship by comparing the outcomes of scholarship recipients with those of other students is likely to be misleading, given that both groups have distinct characteristics. Moreover, the direction of the bias is not clear ex-ante, as these students come from a more disadvantaged background but are also selected based on ability.

In the absence of experimental data or a natural source of exogenous variation that could be exploited to compare the outcomes of *Prouni* scholarship recipients with those of other students, I use the propensity score matching method suggested by Rosenbaum and Rubin (1983) in order to create a counterfactual group of non-treated students. To deal with the issue of self-selection, this

method uses the conditional independence assumption, which is the equivalent of saying that conditional on observed covariates, assignment to treatment is random. More formally, given a set of observed covariates X_i, it is assumed that $Y_i(1), Y_i(0) \perp\!\!\!\perp T_i | X_i$ (see Dehejia & Wahba, 2002). As the number of covariates increases, Rosenbaum and Rubin (1983) suggest using a function of X_i instead, such as the propensity score $P(X_i)$, which is the estimated probability of being treated given observed covariates. In this case, the identification hypothesis is based on the assumption that $Y_i(1), Y_i(0) \perp\!\!\!\perp T_i | P(X_i)$. A further necessary assumption is that of common support, given by $0 < P(T = 1|X) < 1$, which implies that for each value of X, the probability of being treated lies between 0 and 1.

Following this approach, treated and non-treated individuals are matched based on each individual's propensity score, which is estimated using their observed covariates. If the hypothesis that assignment to treatment is random conditional on observable covariates is met, and if there is sufficient overlap in the distribution of propensity scores of treated and non-treated individuals, this method allows the estimation of the average treatment effect on the treated (ATT). Compared to OLS, propensity score matching has the advantage of restricting the comparison of the outcomes of treated and control individuals to those with similar characteristics, and of allowing for a more flexible functional form.

A limitation of this method is that even after matching individuals based on observed covariates, it is possible that treated and non-treated students still differ on unobserved characteristics, such as intrinsic motivation. To the extent that these unobserved characteristics affect both selection into the treatment and outcomes, estimates could be biased and therefore results should be interpreted with caution. However, the fact that eligibility for *Prouni* scholarships is based on discrete income thresholds and the fact that the number of scholarships available is limited means that, in practice, students who just miss the income or grade requirements but are otherwise very similar to *Prouni* recipients will be part of the control group.

Variables used to predict the probability of treatment should not only reflect students' socio-economic background but also prior performance, given that students compete for a limited number of *Prouni* scholarships and are selected based on *Enem* test scores. Failing to take that into account is likely to introduce bias in the estimations, given that previous ability is usually a strong determinant

of current performance. Although I do not observe *Enem* test scores for students in the sample, I argue that students' performance in the general knowledge test can be used as a proxy for previous ability. Indeed, when comparing test scores of first-year and final-year students, the gap in specific knowledge is much larger than the gap in general knowledge, which seems to be less affected by college education (although it is likely to increase with time). These differences are shown in Table 4, which presents OLS estimates of the effect of being a final-year student on test scores (first-year and final-year students are pooled together, and the coefficient of interest is obtained by including in the regressions a dummy for final-year students). Estimates show that while final-year students score 0.6–0.7 standard deviations higher than first-year students on the specific knowledge test, this difference is much smaller when considering general knowledge grades, which increase by only 0.1 to 0.2 standard deviations. It is important to note that the values of these coefficients are not necessarily representative of the increase in student knowledge over time, given that the population of final-year students may be considerably different than the population of first-year students due to dropout—the objective here is to compare the increase in specific knowledge versus general knowledge test-scores.

The fact that the observed increase in general knowledge grades is slightly larger for Management students can be explained by the fact that many colleges offer basic knowledge courses for first-year students in this field. Despite this, the results obtained for Management students are similar as those for the other fields. Although I cannot entirely rule out the possibility that receiving a scholarship positively affects performance in the general knowledge test, controlling for this variable would result in the true effect of the program being under-estimated.

In order to implement the propensity score matching procedure, I first estimate the probability of being treated for full and partial *Prouni* scholarships separately, and for each of the three fields considered, using a probit model as in equation (1):

$$P(T = 1|X_i) = \alpha + \beta X_i + \epsilon_i, \tag{1}$$

where X_i includes gender, race, age, mother/father education, a dummy indicating whether the student attended a public high school, dummies for income categories and household size, a dummy indicating whether the student is enrolled in evening classes, and the grade obtained at the general knowledge test mentioned previously. In the Robustness Checks section, I further con-

Table 4. Differences between first-year and final-year students' test scores.

		Test scores			
		General knowledge test		Specific knowledge test	
		Simple differences	OLS	Simple differences	OLS
Management					
	Coeff.	0.26***	0.22***	0.64***	0.59***
		(0.00)	(0.00)	(0.00)	(0.00)
	Obs.	200,522	150,713	200,522	150,713
Law					
	Coeff.	0.14***	0.12***	0.57***	0.56***
		(0.01)	(0.01)	(0.01)	(0.01)
	Obs.	158,289	117,080	158,289	117,080
Accounting					
	Coeff.	0.12***	0.08***	0.77***	0.73***
		(0.01)	(0.01)	(0.01)	(0.01)
	Obs.	53,355	40,754	53,355	40,754

Notes: Outcomes are standardized test scores. In each field, the sample is composed by first-year and final-year students pooled together. The coefficients measure the effect of being a final-year student on test scores, obtained by including a dummy = 1 for final-year students. Other OLS controls include: gender (a dummy = 1 for females), race (a dummy = 1 for black students) mother and father education (a dummy = 1 if the mother/father have completed high school), type of high school attended (a dummy = 1 if attended a public high school only), household income (dummies for 3 out of 4 categories of income).
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

sider measures of college quality to assess whether differences in college quality may be driving the results. I then use students' estimated propensity score to match treated and non-treated individuals, using different matching algorithms (described in more detail in the next section).

A limitation of the data used is that I do not have pre-treatment information on household income. Ideally, matching variables should be fixed in time or measured before the intervention, as pointed by Caliendo and Kopeinig (2008), as some variables could be affected by participation. If participation in the *Prouni* program affects household income, and if household income by itself has an effect on student performance, then the program effect estimates obtained should be interpreted as being net of any income effects. However, as there is no *a priori* reason why participation in the program would affect household income, this is unlikely to be an issue in this specific case.

The results of the probit estimations are shown in Table A.1 in Appendix A.[13] As expected, income is negatively correlated with the probability of receiving a *Prouni* scholarship, while having attended a public high school increases the probability of being treated. Similarly, an individual's probability of receiving a scholarship increases with the grade obtained at the general knowledge test.

Before computing the results, I verify whether the matching was successful in creating similar treated and control groups in terms of observable characteristics. First, I check that covariates used in propensity score estimations are balanced among the two groups in the matched sample. When imbalances remain, I re-estimate the propensity score including interactions or quadratics in order to achieve balance, from the same group of covariates. Tables A.2 to A.7 show differences in covariates between treated and control individuals before and after matching. Only differences using the sample obtained through nearest neighbor matching are presented, as results using other matching algorithms are very similar.[14] While differences in the characteristics of treated and control individuals are statistically significant at the 5% level before matching in the majority of cases, no significant differences at the 5% level remain when considering the matched sample. Second, I visually inspect the distribution of propensity scores among the treated and control groups before and after matching. Figures B.1 to B.3 in Appendix B show that the distribution of propensity scores becomes much more similar between groups in the matched sample. Finally, I re-estimate the propensity scores on the matched sample and compare the corresponding pseudo R-squared from that obtained from the unmatched sample, as suggested by Sianesi (2004) and Caliendo and Kopeinig (2008). The idea behind this procedure is that when using the matched sample, the pseudo R-squared should be much lower as in this case covariates should have less explanatory power. As shown in Table A.8 in Appendix A, the pseudo R-squared is greatly reduced when re-estimating propensity scores using the matched sample.

Once these steps are verified, I calculate the differences in outcomes of interest separately for students receiving a full *Prouni* scholarship and for

[13] The eligibility criteria for receiving a *Prouni* scholarship are not perfectly observed in the Enade database. Only information on income ranges is available, and although information on the type of high school attended is provided, it does not say whether students attending private high schools received a scholarship.

[14] Overall, covariates remain unbalanced after matching in 1% of cases, with significant differences at the 5% level.

students receiving a partial *Prouni* scholarship.

Several studies using propensity score matching use bootstrapping to estimate standard errors. The idea is to deal with the issue that classical estimates do not take into account additional variation related to the fact that the propensity score is estimated, and to the matching process itself. However Abadie and Imbens (2008) show that the bootstrap does not provide valid standard errors in the case of matching with a fixed number of neighbors. More generally, although some alternatives have been proposed, there is no consensus in the literature on the optimal way to compute standard errors in this setting. In the present study, bootstrapping does not change the statistical significance of coefficients, and only marginally changes the value of the estimated standard errors. For this reason, I do not present bootstrapped standard errors here.

4 Results

4.1 Effects on performance and duration of studies

Table 5 presents estimates of the effect of receiving a *Prouni* scholarship on performance at the specific knowledge test, in standardized test scores. Column 1 shows simple differences in outcomes between the treated and control groups, while Column 2 shows OLS estimates where the same variables used to estimate propensity scores are used as controls. In columns 3 to 6, estimates obtained through four different matching algorithms are presented. In column 3, nearest-neighbor matching assigns each treated student to the closest non-treated student in terms of the probability of being treated. In column 4 a similar procedure is used, but in this case the 5 closest individuals are used as matches. In column 5 radius matching is used, where all individuals whose propensity scores fall within a given distance of the propensity score of a given treated individual are used as matches. In kernel matching (column 6), all individuals of the control group are used but are given different weights so that the highest weights are given to individuals with the closest probability of treatment to a given treated individual. I make sure that the sort order of observations is random, as the order of observations could affect results when there are observations with identical propensity scores. Only observations in the common support are used.[15]

Overall, results indicate that final-year students who received a *Prouni* scholarship at some point during their studies perform significantly better than

[15] Observations that have a propensity score higher/lower than the maximum/minimum of the other group are excluded.

Table 5. Results – performance on specific knowledge test.

	Simple differences (1)	OLS (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Full Prouni	0.66***	0.61***	0.64***	0.64***	0.65***	0.65***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Treated	6,068	5,857	5,855	5,855	5,846	5,846
Control	43,506	42,130	42,130	42,130	42,130	42,130
Partial Prouni	0.19***	0.23***	0.25***	0.27***	0.25***	0.25***
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)
Treated	2,038	1,972	1,972	1,972	1,972	1,972
Control	43,506	42,130	42,130	42,130	42,130	42,130
Law						
Full Prouni	0.39***	0.36***	0.38***	0.38***	0.38***	0.37***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
Treated	3,320	3,180	3,172	3,172	3,159	3,159
Control	34,941	33,558	33,558	33,558	33,558	33,558
Partial Prouni	0.01	0.08**	0.07**	0.12***	0.11***	0.11***
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	1,274	1,209	1,209	1,209	1,209	1,209
Control	34,941	33,558	33,558	33,558	33,558	33,558
Accounting						
Full Prouni	0.62***	0.59***	0.63***	0.63***	0.62***	0.62***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
Treated	1,298	1,242	1,236	1,236	1,236	1,236
Control	10,951	10,580	10,580	10,580	10,580	10,580
Partial Prouni	0.25***	0.27***	0.32***	0.28***	0.29***	0.29***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.04)	(0.04)
Treated	559	535	535	535	535	535
Control	10,951	10,580	10,580	10,580	10,580	10,580

Notes: Outcomes are standardized test scores. OLS controls include the same variables used in propensity score estimations. Standard errors in parentheses (OLS standard errors clustered at the college level). In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

comparable students, and that this difference is higher for students receiving full *Prouni* scholarships than for students receiving partial scholarships. OLS estimates are very close to those obtained through propensity score matching. The largest effects are observed in Management and Accounting, where full *Prouni* recipients score 0.6–0.7 standard deviations higher than non-scholarship recipients, while partial *Prouni* recipients score 0.2–0.3 standard deviations higher. The estimated effects for Law students are slightly smaller: those who received a full *Prouni* scholarship score 0.4 standard deviations higher than similar students, while those who received a partial *Prouni* scholarship score 0.1 standard deviations higher. A possible explanation for the lower effects found for Law students is that they tend to have more educated parents compared to scholarship recipients from the two other fields, as well as higher grades in the general knowledge test (as show in Table 3). Law students may therefore be overall better prepared, and have better outcomes even in the absence of the scholarship.

Table 6 shows that in all three fields, scholarship recipients also take less time to reach the final year of college. Propensity score matching estimates point to a reduction of 0.1 to 0.3 years (or 2 to 4 months) in the time students take to reach the final year of college since enrolling. As in previous results, the effects are stronger for full scholarship recipients although differences are more modest in this case. The fact that the estimated effects are stronger for Law students reflects the fact that the Law degree takes longer to complete (5 years compared to 4 years for the other two degrees).

I also explore whether there are regional differences in the estimated effects of *Prouni* scholarships. The distribution of higher education institutions is very uneven in Brazil, with the great majority of private universities concentrated in the Southeast region. However, it is possible that the program's impact is stronger in poorer regions such as the North and Northeast, if students in these regions have more difficulty accessing private financing sources. For this purpose, I divide the sample according to Brazil's five regions (North, Northeast, Southeast, South and Midwest), and perform the same matching procedure as previously. A limitation of this analysis is that sample sizes are considerably reduced, which means results should be interpreted with caution. For some regions in particular, the samples of partial *Prouni* scholarship recipients are very small, and therefore I only present results for full scholarship recipients. The results are presented in Tables A.9 and A.10 in the Appendix A. For simplicity,

Table 6. Results – duration of studies.

	Simple differences (1)	OLS (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Full Prouni	−0.47***	−0.22***	−0.20***	−0.23***	−0.22***	−0.22***
	(0.05)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Treated	6,068	5,857	5,855	5,855	5,846	5,846
Control	43,506	42,130	42,130	42,130	42,130	42,130
Partial Prouni	−0.34***	−0.14***	−0.14***	−0.14***	−0.15***	−0.15***
	(0.06)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	2,038	1,972	1,972	1,972	1,972	1,972
Control	43,506	42,130	42,130	42,130	42,130	42,130
Law						
Full Prouni	−0.43***	−0.34***	−0.29***	−0.33***	−0.34***	−0.34***
	(0.06)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	3,320	3,180	3,172	3,172	3,159	3,172
Control	34,941	33,558	33,558	33,558	33,558	33,558
Partial Prouni	−0.31***	−0.26***	−0.21***	−0.25***	−0.26***	−0.26***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)	(0.03)
Treated	1,274	1,209	1,209	1,209	1,209	1,209
Control	34,941	33,558	33,558	33,558	33,558	33,558
Accounting						
Full Prouni	−0.36***	−0.24***	−0.24***	−0.20***	−0.21***	−0.21***
	(0.07)	(0.06)	(0.06)	(0.03)	(0.04)	(0.04)
Treated	1,298	1,242	1,236	1,236	1,236	1,236
Control	10,951	10,580	10,580	10,580	10,580	10,580
Partial Prouni	−0.29***	−0.20**	−0.14*	−0.18***	−0.20***	−0.20***
	(0.09)	(0.09)	(0.08)	(0.06)	(0.06)	(0.06)
Treated	559	535	535	535	535	535
Control	10,951	10,580	10,580	10,580	10,580	10,580

Notes: Outcome is the duration of studies, measured by the number of years since final-year students enrolled in college. OLS controls include the same variables used in propensity score estimations. Standard errors in parentheses (OLS standard errors clustered at the college level). In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

I only present results using nearest neighbor propensity score matching, as results obtained using other matching algorithms are very similar. Although the estimated coefficients vary slightly across regions, the results do not suggest a clear pattern.

4.2 Mechanisms

A possible explanation for previous findings is that scholarship recipients study more because they face the threat of loosing their scholarship if they do not pass at least 75% of classes taken in a given term. Additionally, these students may be able to devote more time to their studies given that they need to work less. In order to explore the possible channels through which receiving a scholarship improves student performance, I estimate the effects of receiving a scholarship on students' decision to work and on time spent studying. Information on these outcomes is available from the Enade's socio-economic survey, which provides information i) on whether students are working at the time of the survey and ii) on the number of hours per week spent studying, excluding time spent attending classes.[16]

Table 7 shows estimates of the effects of receiving a scholarship on the decision of students to work. For simplicity, only propensity score matching results are shown. On average, the percentage of full *Prouni* recipients who report working is between 3% and 7% lower than in the control group depending on the field considered. Interestingly however, partial *Prouni* recipients are not less likely to work than non-scholarship recipients. In Table 8, a similar exercise is performed where the outcome variable is a dummy which equals one if the student reports studying more than three hours a week. Results show that a higher percentage of both full and partial *Prouni* scholarship recipients report studying more than three hours a week compared to students from the control group (between 5% and 10% for full scholarship recipients and between 3% and 5% for partial scholarship recipients). For Management and Law students, these effects are considerably stronger for full scholarship recipients than for partial scholarship recipients.

[16] Information on the number of hours spent studying is provided through 5 different categories: 0; 1–3; 4–7; 8–12; +12 hours. For simplicity, I create a dummy variable indicating whether the student spends more than three hours studying a week.

Table 7. Results – work while in college.

	PSM Nearest neighbor (1)	PSM 5 nearest neighbors (2)	PSM Radius (3)	PSM Kernel (4)
Management				
Full Prouni	−0.04***	−0.04***	−0.03***	−0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
Treated	5,825	5,826	5,817	5,817
Control	41,921	41,921	41,921	41,921
Partial Prouni	0.03**	0.02*	0.02**	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
Treated	1,958	1,958	1,957	1,957
Control	41,921	41,921	41,921	41,921
Law				
Full Prouni	−0.06***	−0.07***	−0.07***	−0.07***
	(0.02)	(0.01)	(0.01)	(0.01)
Treated	3,154	3,154	3,140	3,140
Control	33,378	33,378	33,378	33,378
Partial Prouni	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)
Treated	1,199	1,199	1,199	1,199
Control	33,378	33,378	33,378	33,378
Accounting				
Full Prouni	−0.07***	−0.05***	−0.04***	−0.05***
	(0.02)	(0.01)	(0.01)	(0.01)
Treated	1,227	1,227	1,226	1,226
Control	10,516	10,516	10,516	10,516
Partial Prouni	−0.02	−0.03	−0.02	−0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Treated	532	532	532	532
Control	10,516	10,516	10,516	10,516

Notes: The outcome is a dummy = 1 if the student is working. Standard errors in parentheses. In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 8. Results – time spent studying.

	PSM Nearest neighbor (1)	PSM 5 nearest neighbors (2)	PSM Radius (3)	PSM Kernel (4)
Management				
Full Prouni	0.08***	0.09***	0.09***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Treated	5,825	5,826	5,817	5,817
Control	41,921	41,921	41,921	41,921
Partial Prouni	0.06***	0.05***	0.05***	0.05***
	(0.02)	(0.01)	(0.01)	(0.01)
Treated	1,958	1,958	1,957	1,957
Control	41,921	41,921	41,921	41,921
Law				
Full Prouni	0.10***	0.10***	0.10***	0.10***
	(0.02)	(0.01)	(0.01)	(0.01)
Treated	3,154	3,154	3,140	3,140
Control	33,378	33,378	33,378	33,378
Partial Prouni	0.04**	0.05***	0.05***	0.05***
	(0.02)	(0.02)	(0.02)	(0.02)
Treated	1,199	1,199	1,199	1,199
Control	33,378	33,378	33,378	33,378
Accounting				
Full Prouni	0.06***	0.06***	0.05***	0.05***
	(0.02)	(0.02)	(0.02)	(0.02)
Treated	1,227	1,227	1,226	1,226
Control	10,516	10,516	10,516	10,516
Partial Prouni	0.03	0.03	0.04**	0.04**
	(0.03)	(0.02)	(0.02)	(0.02)
Treated	532	532	532	532
Control	10,516	10,516	10,516	10,516

Notes: The outcome is a dummy = 1 if the student reports studying more than 3 hours a week. In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

5 Robustness Checks

In this section a few robustness checks are considered in order to assess the validity of the results. In the first robustness test, I check whether differences in college quality are driving the results. This might be the case for example if the best or more selective colleges offer a disproportionately high number of spots for *Prouni* students. In order to deal with this possibility, I include measures of college quality in previous OLS and propensity score matching estimations presented in Tables 5 and 6. The results are shown in Tables 9 and 10. Column 1 presents OLS estimates including four alternative measures of college quality as regressors: i) test scores of first-year students obtained at the general knowledge test and ii) at the specific knowledge test; and iii) test scores of final-year students obtained at the general knowledge test and iv) at the specific knowledge test. As an alternative, column 2 reports estimates obtained from OLS regressions including college dummies. Columns 3–6 present propensity score matching estimates where the same measures of college quality used in column 1 are included in the set of matching variables. Overall results are very similar as those obtained in the main specifications, but the estimated effect of receiving a full scholarship on performance is slightly reduced in some cases compared to previous estimates, indicating that there may be some differences in the quality of institutions attended by scholarship recipients.

In the second robustness test, I re-estimate propensity scores using a logit model instead of a probit model, before performing the same matching procedures as previously. The results obtained are very similar, and are not shown here.

Previously, I have argued that the fact that eligibility for *Prouni* scholarships is based on discrete income and grade thresholds means that students who just miss the income or grade requirements but are otherwise very similar to *Prouni* recipients will be part of the control group. However, intrinsic motivation and student's willingness to fill out paperwork is also likely to be a determinant of scholarship attribution. If intrinsic motivation is correlated with test scores, this could confound results. It is unlikely, however, that intrinsic motivation and other unobserved characteristics differ to a great extent between full and partial scholarship recipients, as these two types of students are mainly distinguished by their household income level. As a third robustness test, I estimate the differential effect of receiving a full *Prouni* scholarship relative to a partial *Prouni* scholarship, and then compare it to the difference in coefficients obtained for the two types of scholarship when performing separate estimations. This is

Table 9. Robustness – performance on specific knowledge test with college controls.

	OLS w/ college controls (1)	OLS w/ college dummies (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Full Prouni	0.53***	0.56***	0.57***	0.58***	0.57***	0.57***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Treated	5,780	5,857	5,776	5,775	5,764	5,764
Control	41,793	42,130	41,793	41,793	41,793	41,793
Partial Prouni	0.21***	0.23***	0.19***	0.23***	0.23***	0.23***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Treated	1,936	1,972	1,936	1,936	1,936	1,936
Control	41,793	42,130	41,793	41,793	41,793	41,793
Law						
Full Prouni	0.33***	0.34***	0.35***	0.34***	0.35***	0.35***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Treated	3,161	3,180	3,159	3,159	3,137	3,137
Control	33,438	33,558	33,438	33,438	33,438	33,438
Partial Prouni	0.09***	0.10***	0.13***	0.11***	0.11***	0.12***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	1,201	1,209	1,201	1,201	1,201	1,201
Control	33,438	33,558	33,438	33,438	33,438	33,438
Accounting						
Full Prouni	0.54***	0.58***	0.55***	0.57***	0.56***	0.56***
	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
Treated	1,187	1,242	1,187	1,187	1,181	1,181
Control	10,170	10,580	10,170	10,170	10,170	10,170
Partial Prouni	0.25***	0.29***	0.29***	0.28***	0.28***	0.27***
	(0.04)	(0.05)	(0.06)	(0.05)	(0.04)	(0.04)
Treated	497	535	497	497	497	497
Control	10,170	10,580	10,170	10,170	10,170	10,170

Notes: Outcomes are standardized test scores. OLS controls in column 1 include variables used in previous estimations and average test scores of first-year and final-year students at the general and specific knowledge tests. OLS controls in column 2 include college dummies. Standard errors in parentheses (OLS standard errors clustered at the college level). In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 10. Robustness – duration of studies with college controls.

	OLS w/ college controls (1)	OLS w/ college dummies (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Full Prouni	−0.28***	−0.28***	−0.28***	−0.29***	−0.27***	−0.27***
	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)
Treated	5,780	5,857	5,776	5,775	5,764	5,764
Control	41,793	42,130	41,793	41,793	41,793	41,793
Partial Prouni	−0.15***	−0.12**	−0.16**	−0.16**	−0.16**	−0.16**
	(0.05)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	1,936	1,972	1,936	1,936	1,936	1,936
Control	41,793	42,130	41,793	41,793	41,793	41,793
Law						
Full Prouni	−0.34***	−0.29***	−0.32***	−0.32***	−0.34***	−0.34***
	(0.05)	(0.07)	(0.04)	(0.03)	(0.03)	(0.03)
Treated	3,161	3,180	3,159	3,159	3,137	3,137
Control	33,438	33,558	33,438	33,438	33,438	33,438
Partial Prouni	−0.28***	−0.13***	−0.28***	−0.28***	−0.28***	−0.28***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)
Treated	1,201	1,209	1,201	1,201	1,201	1,201
Control	33,438	33,558	33,438	33,438	33,438	33,438
Accounting						
Full Prouni	−0.26***	−0.27***	−0.22***	−0.25***	−0.24***	−0.25***
	(0.07)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
Treated	1,187	1,242	1,187	1,187	1,181	1,181
Control	10,170	10,580	10,170	10,170	10,170	10,170
Partial Prouni	−0.19**	−0.13*	−0.20**	−0.19***	−0.18***	−0.18***
	(0.09)	(0.07)	(0.09)	(0.07)	(0.06)	(0.06)
Treated	497	535	497	497	497	497
Control	10,170	10,580	10,170	10,170	10,170	10,170

Notes: Outcome is the duration of studies, measured by the number of years since enrolling in college. OLS controls in column 1 include variables used in previous estimations and average test scores of first-year and final-year students at the general and specific knowledge tests. OLS controls in column 2 include college dummies. Standard errors in parentheses (OLS standard errors clustered at the college level). In columns 3 to 5, matching is done with replacement. In column 5, a caliper of 0.01 is used. In column 6, the Epanechnikov kernel function is used and a bandwidth of 0.01.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

done by matching full scholarship recipients to partial scholarship recipients, instead of matching the former group to students who did not receive any type of scholarship. The matching variables used and matching procedures are the same as in the preceding analysis. If previous estimates are biased by unobserved student characteristics, it is likely that estimating differential effects will yield different results, as in this case unobserved characteristics will be balanced between both groups and uncorrelated with treatment status.

The results are shown in Tables 11 and 12. For each field of study, the first line shows the differential effect of receiving a full *Prouni* scholarship relative to a partial *Prouni* scholarship. The second line shows the difference between previously estimated effects of receiving a full and partial *Prouni* scholarship relative to students that received no scholarship. The differential effect of receiving a full relative to a partial scholarship on performance is positive and statistically significant in the three fields of study considered, varying between 0.2 and 0.4 standard deviations. These estimates are very close to the difference in coefficients previously obtained for each type of scholarship, although slightly lower. This suggests that although there may be some unobservable factors not accounted for in the previous analysis, their effect is very modest and is

Table 11. Differential effects – performance on specific knowledge test.

	Simple differences (1)	OLS (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Differential effect	0.46***	0.37***	0.35***	0.35***	0.37***	0.37***
	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
Diff. in coefficients	0.47	0.38	0.39	0.37	0.40	0.40
Law						
Differential effect	0.38***	0.25***	0.20***	0.21***	0.22***	0.22***
	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.04)
Diff. in coefficients	0.38	0.28	0.31	0.26	0.27	0.26
Accounting						
Differential effect	0.37***	0.31***	0.27***	0.32***	0.32***	0.32***
	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
Diff. in coefficients	0.37	0.32	0.31	0.35	0.33	0.33

Notes: Outcomes are standardized test scores. The first line shows the differential effect of receiving a full *Prouni* scholarship relative to a partial *Prouni* scholarship (coefficients are obtained by matching full *Prouni* recipients to partial *Prouni* recipients). The second line shows the difference between previously estimated coefficients for full and partial *Prouni* students separately (obtained by matching full and partial *Prouni* recipients to students without scholarships).
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 12. Differential effects – duration of studies.

	Simple differences (1)	OLS (2)	PSM Nearest neighbor (3)	PSM 5 nearest neighbors (4)	PSM Radius (5)	PSM Kernel (6)
Management						
Differential effect	−0.12***	−0.09**	−0.01	−0.05*	−0.05*	−0.05*
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Diff. in coefficients	−0.13	−0.08	−0.06	−0.09	−0.07	−0.07
Law						
Differential effect	−0.12***	−0.10**	−0.18***	−0.12***	−0.10***	−0.10***
	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
Diff. in coefficients	−0.12	−0.08	−0.08	−0.08	−0.08	−0.08
Accounting						
Differential effect	−0.07	−0.02	−0.01	0.01	−0.01	−0.01
	(0.07)	(0.06)	(0.09)	(0.07)	(0.07)	(0.07)
Diff. in coefficients	−0.07	−0.04	−0.10	−0.02	−0.01	−0.01

Notes: Outcome is the duration of studies, measured by the number of years since enrolling in college. The first line shows the differential effect of receiving a full *Prouni* scholarship relative to a partial *Prouni* scholarship (coefficients are obtained by matching full *Prouni* recipients to partial *Prouni* recipients). The second line shows the difference between previously estimated coefficients for full and partial *Prouni* students separately (obtained by matching full and partial *Prouni* recipients to students without scholarships).
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

not driving the overall conclusions. The direction of the bias when estimating the effect of receiving a scholarship on the duration of studies is less clear: the differential estimates yield slightly lower estimates for Managament and Accounting students, and slightly higher estimates for Law students.

6 Conclusion

With higher education becoming increasingly important in the labor market, student financial aid in the form of grants or scholarships has had a key role in increasing access and improving college outcomes for disadvantaged students in many countries. However, evidence on the effectiveness of student aid in the context of developing countries is limited, and more evidence is needed to understand the effects of these programs on student performance and their mechanisms.

This paper uses propensity score matching to estimate the effects of a scholarship program for disadvantaged college students in Brazil, the *Prouni*, which requires students to pass at least 75% of the classes taken in a given term. Results show that final-year students who received a scholarship at some point during their studies perform significantly better in a test measuring skills specific

to their field of study. In the three fields of study considered in the analysis, full-time scholarship recipients score 0.4–0.7 standard deviations higher than similar students who did not receive aid, while partial scholarship recipients score 0.1–0.3 standard deviations higher. Aid beneficiaries also take slightly less time to reach the final year of college compared to counterfactual students. The results also provide insights on the mechanisms behind these effects, indicating that students who received a full scholarship have a lower probability of working while in college, although this is not observed for partial scholarship recipients. Both types of scholarship recipients also report studying more on average. The finding that students with partial scholarships perform better than non-scholarship recipients, even though they are as likely to be working, suggests that increases in performance cannot be entirely attributed to this channel. An additional possible channel would be an increase in class attendance or in motivation among scholarship recipients, although it is not possible to test these hypothesis with the data available.

The magnitude of the estimated effects on performance is larger than found in previous related studies. A possible explanation for this lies in the fact that important social inequalities persist in Brazil, with a large number of low-income but high-potential students facing financial barriers to higher education and needing to work while in college. By reducing these students' need to work and increasing their available time for study, college scholarships may be especially effective in this context. In addition, as pointed by Solis (2017), it is likely that this type of policy will have a greater impact in countries where financial aid programs are less common, as is the case here.

These results should be interpreted with caution, as their validity rests on the strong hypothesis of selection on observables. The possibility that scholarship recipients have unobserved characteristics that are both correlated with the probability of treatment and with students' outcomes cannot be completely excluded. However, the fact that the results obtained pass a series of robustness tests, and that the estimated coefficients are higher for full scholarship recipients than for partial scholarship recipients provides evidence in favor of the validity of the results, as unobserved characteristics are unlikely to differ strongly between both types of students.

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Appendix A Tables

Table A.1. Probit estimation of propensity scores.

	Management		Law		Accounting	
	Full Prouni (1)	Partial Prouni (2)	Full Prouni (3)	Partial Prouni (4)	Full Prouni (5)	Partial Prouni (6)
Female	−0.07***	−0.02	−0.05*	−0.09***	−0.13***	−0.08*
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)
Age	−0.04***	−0.03***	−0.05***	−0.04***	−0.04***	−0.02***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Black	0.59***	0.22***	0.59***	0.38***	0.49***	0.27***
	(0.03)	(0.04)	(0.04)	(0.05)	(0.06)	(0.08)
Mother with high school	−0.04*	−0.07***	−0.11***	−0.08**	−0.05	−0.04
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
Father with high school	−0.13***	−0.07***	−0.17***	−0.11***	−0.11***	−0.06
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
Public high school	1.03***	0.60***	0.87***	0.80***	0.89***	0.52***
	(0.03)	(0.03)	(0.07)	(0.03)	(0.06)	(0.06)
HH income=3–6 min.wages	−0.44***	−0.22***	−0.54***	−0.20***	−0.35***	−0.16***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
HH income=6–10 min.wages	−0.98***	−0.43***	−1.14***	−0.56***	−0.83***	−0.40***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.06)	(0.07)
HH income >10 min.wages	−1.43***	−0.75***	−1.81***	−0.94***	−1.29***	−0.71***
	(0.04)	(0.05)	(0.06)	(0.05)	(0.01)	(0.01)
Gen. knowledge score	0.02***	0.02***	0.01***	0.00***	0.01***	0.01***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Evening classes	−0.05*	−0.08**	−0.10***	−0.11***	−0.02	−0.31***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.08)	(0.08)
Other HH members: 1–3	0.06*	0.06	0.15***	0.19***	0.07	0.06
	(0.03)	(0.05)	(0.04)	(0.05)	(0.07)	(0.08)
Other HH members: >4	0.23***	0.10**	0.39***	0.26***	0.23***	0.16*
	(0.04)	(0.05)	(0.04)	(0.06)	(0.07)	(0.09)
Obs.	47,987	44,102	36,738	34,767	11,822	11,115
Pseudo R-squared	0.2540	0.1016	0.3936	0.1825	0.1920	0.0775

Notes: In columns 1, 3, 5 the outcome is a dummy which equals 1 if the student has received a full Prouni scholarship, and 0 if the student has received no scholarship. In columns 2, 4, 6 the outcome is a dummy which equals 1 if the student has received a partial Prouni scholarship, and 0 if the student has received no scholarship. Controls include: gender (a $dummy = 1$ for females), age, race (a $dummy = 1$ for black students), mother and father education (a $dummy = 1$ if the mother/father have completed high school), type of high school attended (a $dummy = 1$ if attended a public high school), income (dummies for 3 out of 4 categories: 0-3 minimum wages, 3–6 minimum wages, 6–10 minimum wages, >10 minimum wages), the general knowledge grade, period of study (a $dummy = 1$ if enrolled in evening classes), household size (dummies for 2 out of 3 categories: 0 other members, 1–3 other members, >4 other members). Standard errors in parentheses.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table A.2. Balance in covariates before matching – Management.

	Controls (1)	Full Prouni (2)	Partial Prouni (3)	Diff. (1)−(2)	p-value	Diff. (1)−(3)	p-value
% female	54.0	59.0	59.7	−5.0	0.000	−5.7	0.000
Avg. age	27.2	25.3	25.7	1.9	0.000	1.6	0.000
% black	4.7	13.8	7.9	−9.2	0.000	−3.3	0.000
% father finished high school	46.5	31.7	34.5	14.7	0.000	11.9	0.000
% mother finished high school	48.3	36.9	37.3	11.4	0.000	11.0	0.000
% studied in public high school	54.2	93.2	85.8	−39.0	0.000	−31.6	0.000
% HH income 0–3 min. wages	20.4	49.6	38.4	−29.2	0.000	−17.9	0.000
% HH income 3–6 min. wages	34.5	40.0	41.3	−5.5	0.000	−6.8	0.000
% HH income 6–10 min. wages	22.8	8.5	15.5	14.4	0.000	7.4	0.000
% HH income >10 min. wages	22.2	2.0	4.9	20.3	0.000	17.4	0.000
Avg. grade – gen. knowledge	42.8	53.1	47.2	−10.3	0.000	−4.4	0.000
% evening study	88.1	89.7	88.9	−1.5	0.000	−0.8	0.277
Other HH members: 0	6.6	8.1	7.2	−1.5	0.000	−0.6	0.260
Other HH members: 1–3	62.7	57.2	61.3	5.6	0.000	1.5	0.186
Other HH members >4	30.7	34.7	31.5	−4.0	0.000	−0.8	0.436

Table A.3. Balance in covariates after matching – Management.

	Diff. Controls-Full Prouni	p-value	Diff. Controls-Partial Prouni	p-value
% female	0.6	0.486	1.0	0.536
Avg. age	−0.1	0.125	−0.2	0.316
% black	0.1	0.915	−0.9	0.277
% father finished high school	−0.1	0.952	−1.4	0.347
% mother finished high school	−0.3	0.730	−1.0	0.530
% studied in public high school	0.3	0.577	−0.5	0.681
% HH income 0–3 min. wages	−0.2	0.868	0.2	0.896
% HH income 3–6 min. wages	0.6	0.474	0.0	0.974
% HH income 6–10 min. wages	−0.6	0.252	0.2	0.895
% HH income >10 min. wages	0.1	0.743	−0.3	0.652
Avg. grade – gen. knowledge	−0.5	0.151	−0.4	0.562
% evening study	0.8	0.137	1.8	0.056
Other HH members: 0	−0.9	0.059	−0.6	0.490
Other HH members: 1–3	1.6	0.085	0.8	0.623
Other HH members >4	−0.6	0.460	−0.2	0.891

Note: Nearest neighbor propensity score matching with replacement is used.

Table A.4. Balance in covariates before matching – Law.

	Controls (1)	Full Prouni (2)	Partial Prouni (3)	Diff. (1)−(2)	p-value	Diff. (1)−(3)	p-value
% female	51.7	56.3	53.2	−4.6	0.000	−1.6	0.270
Avg. age	29.0	25.7	26.7	3.4	0.000	2.3	0.000
% black	4.6	15.7	12.3	−11.0	0.000	−7.7	0.000
% father finished high school	55.9	38.7	42.6	17.2	0.000	13.3	0.000
% mother finished high school	56.5	42.6	45.9	13.9	0.000	10.7	0.000
% studied in public high school	32.5	89.5	77.3	−57.0	0.000	−44.8	0.000
% HH income 0–3 min. wages	16.8	59.4	41.9	−42.6	0.000	−25.1	0.000
% HH income 3–6 min. wages	24.7	32.0	39.1	−7.3	0.000	−14.4	0.000
% HH income 6–10 min. wages	22.2	7.0	13.1	15.1	0.000	9.1	0.000
% HH income >10 min. wages	36.3	1.6	6.1	34.8	0.000	30.3	0.000
Avg. grade – gen. knowledge	47.7	54.7	48.6	−7.0	0.000	−0.9	0.132
% evening study	66.6	71.8	69.8	−5.3	0.000	−3.3	0.016
Other HH members: 0	8.6	10.3	8.7	−1.8	0.001	−0.1	0.863
Other HH members: 1–3	62.3	54.8	59.9	7.5	0.000	2.4	0.088
Other HH members >4	29.2	34.9	31.4	−5.7	0.000	−2.2	0.087

Table A.5. Balance in covariates after matching – Law.

	Diff. Controls-Full Prouni	p-value	Diff. Controls-Partial Prouni	p-value
% female	0.6	0.649	0.6	0.775
Avg. age	0.2	0.121	0.3	0.195
% black	0.9	0.354	0.0	1.000
% father finished high school	−1.4	0.245	0.3	0.869
% mother finished high school	−0.3	0.800	−0.3	0.870
% studied in public high school	0.1	0.902	1.9	0.253
% HH income 0–3 min. wages	1.4	0.271	−0.7	0.741
% HH income 3–6 min. wages	−1.7	0.144	0.8	0.677
% HH income 6–10 min. wages	−0.3	0.693	−1.0	0.467
% HH income >10 min. wages	0.6	0.074	0.8	0.408
Avg. grade – gen. knowledge	0.2	0.763	0.1	0.885
% evening study	1.6	0.143	1.4	0.448
Other HH members: 0	0.3	0.682	−1.2	0.295
Other HH members: 1–3	−1.5	0.217	0.8	0.677
Other HH members >4	1.2	0.306	0.3	0.861

Note: Nearest neighbor propensity score matching with replacement is used.

Table A.6. Balance in covariates before matching – Accounting.

	Controls (1)	Full Prouni (2)	Partial Prouni (3)	Diff. (1)−(2)	p-value	Diff. (1)−(3)	p-value
% female	57.4	56.4	56.7	1.0	0.500	0.7	0.756
Avg. age	28.5	25.7	26.7	2.8	0.000	1.8	0.000
% black	5.8	14.4	10.8	−8.6	0.000	−5.0	0.000
% father finished high school	37.6	27.1	30.0	10.5	0.000	7.6	0.000
% mother finished high school	39.7	32.3	34.2	7.5	0.000	5.5	0.009
% studied in public high school	64.4	94.7	88.0	−30.3	0.000	−23.6	0.000
% HH income 0–3 min. wages	24.1	48.4	37.9	−24.4	0.000	−13.9	0.000
% HH income 3–6 min. wages	38.0	41.6	44.1	−3.6	0.012	−6.1	0.004
% HH income 6–10 min. wages	22.8	8.6	14.3	14.2	0.000	8.5	0.000
% HH income >10 min. wages	15.1	1.4	3.6	13.7	0.000	11.5	0.000
Avg. grade – gen. knowledge	38.2	47.3	42.5	−9.2	0.000	−4.3	0.000
% evening study	94.7	95.7	91.9	−1.0	0.127	2.8	0.004
Other HH members: 0	7.2	8.6	7.4	−1.4	0.064	−0.2	0.874
Other HH members: 1–3	61.5	56.7	57.4	4.8	0.001	4.1	0.055
Other HH members >4	31.4	34.7	35.3	−3.4	0.015	−3.9	0.054

Table A.7. Balance in covariates after matching – Accounting.

	Diff. Controls-Full Prouni	p-value	Diff. Controls-Partial Prouni	p-value
% female	1.9	0.329	3.6	0.238
Avg. age	0.0	0.844	0.1	0.770
% black	0.2	0.863	−1.9	0.298
% father finished high school	−1.9	0.273	−3.2	0.251
% mother finished high school	−0.2	0.931	−1.1	0.699
% studied in public high school	−0.2	0.795	2.6	0.166
% HH income 0–3 min. wages	1.7	0.398	1.3	0.661
% HH income 3–6 min. wages	−1.4	0.487	−0.7	0.806
% HH income 6–10 min. wages	−0.8	0.463	−1.1	0.594
% HH income >10 min. wages	0.5	0.339	0.6	0.641
Avg. grade – gen. knowledge	−0.5	0.525	−0.2	0.866
% evening study	0.5	0.544	1.1	0.491
Other HH members: 0	−0.5	0.664	−0.2	0.907
Other HH members: 1–3	−2.2	0.274	3.2	0.290
Other HH members >4	2.7	0.165	−3.0	0.300

Note: Nearest neighbor propensity score matching with replacement is used.

Table A.8. Pseudo R-squared before and after matching.

		After matching			
	Before matching	Nearest neighbor	5 nearest neighbors	Radius	Kernel
Management					
Full Prouni	0.254	0.0009	0.0009	0.0006	0.0005
Partial Prouni	0.1016	0.002	0.0012	0.0004	0.0004
Law					
Full Prouni	0.3936	0.0016	0.002	0.0032	0.003
Partial Prouni	0.1825	0.002	0.0018	0.0025	0.0024
Accounting					
Full Prouni	0.192	0.003	0.0033	0.0036	0.0035
Partial Prouni	0.0775	0.002	0.0018	0.0025	0.0024

Note: McFadden's pseudo R-squared are presented, from probit estimations where the probability of treatment is estimated separately for full and partial Prouni scholarships.

Table A.9. Results by region – performance on specific knowledge test.

	PSM Nearest neighbor				
	North (1)	Northeast (2)	Southeast (3)	South (4)	Midwest (5)
Management					
Full Prouni	0.48***	0.69***	0.67***	0.57***	0.58***
	(0.08)	(0.06)	(0.03)	(0.05)	(0.07)
Treated	282	754	2,990	1,250	546
Control	2,105	6,374	20,948	9,104	3,599
Law					
Full Prouni	0.32**	0.37***	0.39***	0.30***	0.45***
	(0.15)	(0.09)	(0.04)	(0.07)	(0.09)
Treated	89	404	1,696	620	345
Control	1,491	7,099	14,427	6,447	4,094
Accounting					
Full Prouni	0.63***	0.52***	0.62***	0.69***	0.44***
	(0.17)	(0.13)	(0.07)	(0.09)	(0.12)
Treated	90	168	520	280	166
Control	676	2,003	4,595	2,155	1,151

Notes: Outcomes are standardized test scores. Coefficients are obtained through nearest neighbor propensity score matching with replacement. Standard errors in parentheses.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table A.10. Results by region – duration of studies.

	PSM Nearest neighbor				
	North (1)	Northeast (2)	Southeast (3)	South (4)	Midwest (5)
Management					
Full Prouni	−0.16**	−0.11*	−0.14***	−0.28***	−0.18***
	(0.08)	(0.06)	(0.03)	(0.06)	(0.06)
Treated	282	754	2,990	1,250	546
Control	2,105	6,374	20,948	9,104	3,599
Law					
Full Prouni	−0.49***	−0.06	−0.29***	−0.45***	0.01
	(0.17)	(0.10)	(0.05)	(0.10)	(0.10)
Treated	89	404	1,696	620	345
Control	1,491	7,099	14,427	6,447	4,094
Accounting					
Full Prouni	−0.04	−0.20	−0.02	−0.43***	−0.14
	(0.10)	(0.16)	(0.06)	(0.12)	(0.10)
Treated	90	168	520	280	166
Control	676	2,003	4,595	2,155	1,151

Notes: Outcome is the duration of studies, measured by the number of years since final-year students enrolled in college. Coefficients are obtained through nearest neighbor propensity score matching with replacement. Standard errors in parentheses.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Appendix B Figures

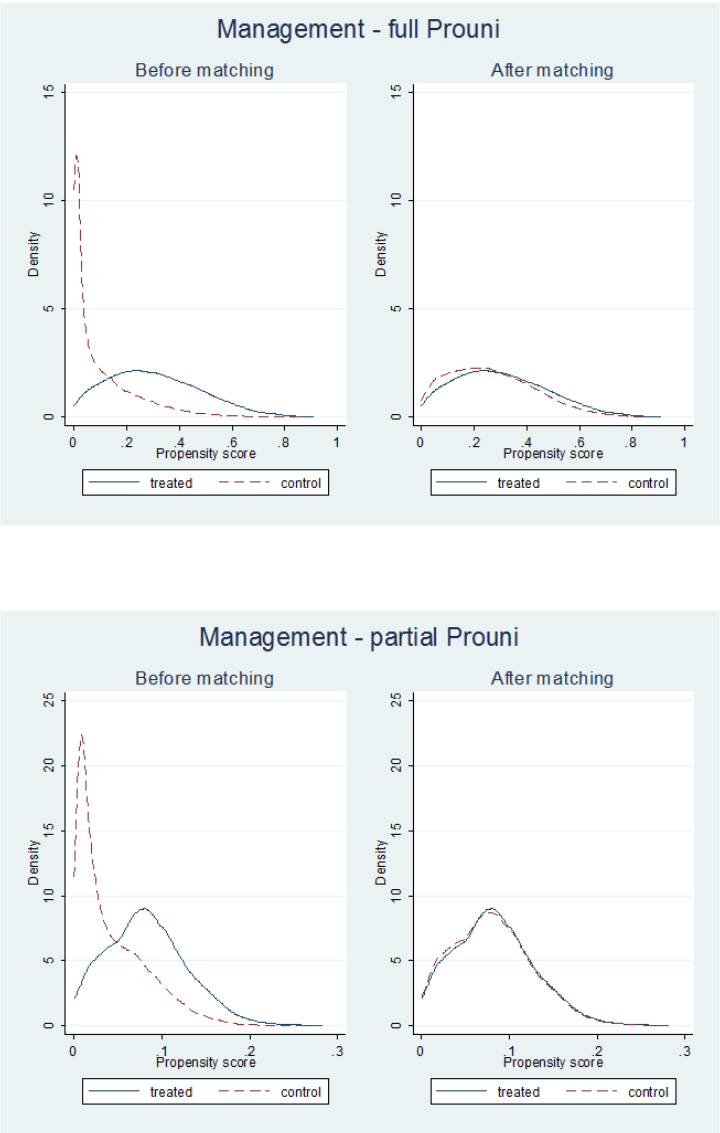

Figure B.1. Kernel density estimates of the distribution of propensity scores for Management students (nearest neighbor matching with replacement).

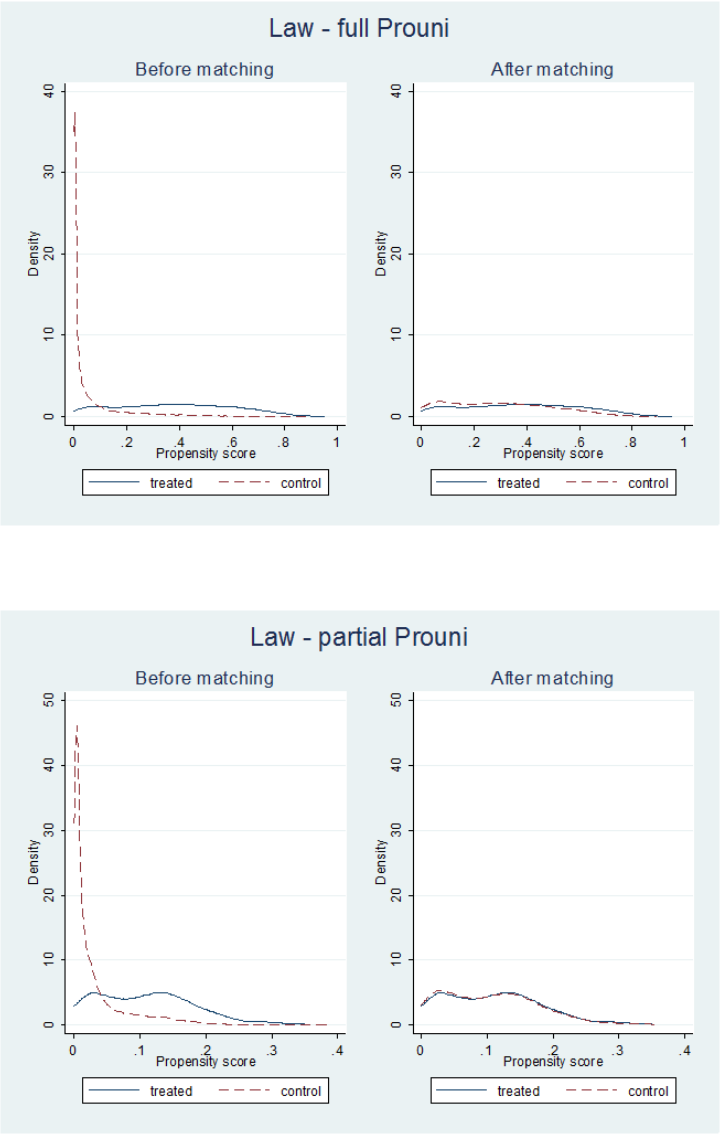

Figure B.2. Kernel density estimates of the distribution of propensity scores for Law students (nearest neighbor matching with replacement).

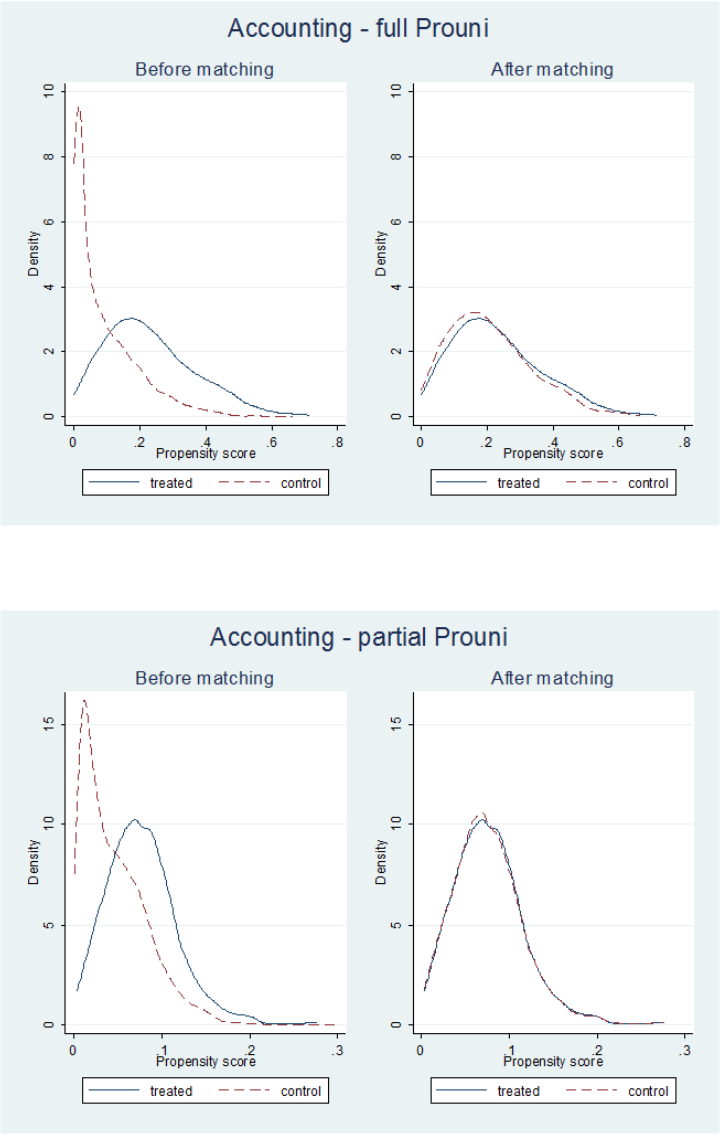

Figure B.3. Kernel density estimates of the distribution of propensity scores for Accounting students (nearest neighbor matching with replacement).