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Liquidity constraints, opportunity cost and post-secondary education. Evidence from Colombia

Preliminary versión - please do not cite* †
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Abstract

We provide new and clear evidence about the importance of liquidity constraints for post-secondary vocational education. Using two discontinuities that are used to allocate seats in free vocational education and eligibility for educational grants, we exploit the relationship between OLS and IV estimates of returns to education to test for the presence of short run liquidity in the fashion of Card (2001). Eligibility to financial aid increases enrollment in vocational education between 8 to 13 percentage points. Furthermore, we find that when we instrument post-secondary schooling with eligibility for financial aid IV estimates are larger than OLS estimates, suggesting that compliers to this instrument are individuals with high returns to education but who were not enrolling in post-secondary education before due to liquidity constraints. However, when the instrument is not linked with the cost of education IV estimates are not significantly larger than OLS estimates. Our analysis focuses on access to free vocational education, hence our results shed lights on the importance of the opportunity cost.

JEL: I26, C36, J21.

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† This is a preliminary work. Any errors are only the responsibility of the authors and do not represent the view of any public or private institution. Previously circulated as Reducing credit constraints to post-secondary technical education in developing countries: evidence from Colombia.

1 Introduction

The income gap in tertiary education enrollment is well documented in both developed economies (Carneiro and Heckman, 2002, Lochner and Monge-Naranjo, 2011, Murakami and Blom, 2008, Belley et al., 2014) and developing economies (González-Velosa et al., 2015, Murakami and Blom, 2008). By 2015 in Colombia, among the individuals who finished high school and took the national test to enter in university more than 40% belonged to the lowest socioeconomic status (SES) group and less than 1% belonged to the highest SES group. Nevertheless, the gap in tertiary education enrollment was about 50 percentage points (Álvarez et al., 2017).[1] Despite the evidence about the difference in enrollment rates by income, there is no consensus in the literature about how much of this difference is explained by the presence or not of short run liquidity constraints.

The evidence for developed countries is inconclusive. On the one hand, some studies show that even when controlling for ability, family income and access to credit are strongly correlated with enrollment in tertiary education (Lochner and Monge-Naranjo, 2011, Brown et al., 2011, Belzil et al., 2017, among others). On the other hand, Keane and Wolpin (2001), Carneiro and Heckman (2002) and Cameron and Taber (2004), show small effects of short run liquidity constraints on enrollment in tertiary education. According to these authors, long run and structural differences such as the *ability* or *readiness* to study, explain the differences in enrollment rates shown in the data, over the existence or not of credit constraints.

In Latin America the evidence is in favor of the existence of liquidity or borrowing constraints in tertiary education, as it has been documented in multiple papers, such as Attanasio and Kaufmann (2009), Rau et al. (2013) and Solis (2017). Still, Alfonso (2009) used data from Chile, Colombia, Mexico and Peru, to argue that short run monetary constraints lose importance when one takes into account long run factors such as the education of parents or the ownership of assets.

Independently of these results, the discussions around liquidity constraints focuses on the analysis of changes in tuition fees. However, the literature has overlooked the importance of other costs associated to enrolling in post-secondary education such as maintenance cost and the opportunity cost. Some authors acknowledge the effect of changes in the opportunity cost on school decisions using variations in local labour markets, for example Fuller et al. (1982), Cameron and Taber (2004) and Flannery and ODonoghue (2013).

The contribution of this paper is twofold. First, we provide new evidence to the literature on the importance of short-term liquidity constraints on post-secondary education. Second, our results quantify the importance of the opportunity cost of tertiary education.

We take advantage of two different discontinuities that affect enrollment in free vocational education in Colombia. The first discontinuity exploits the conditions to participate in a nationwide program known as Youth in action, *Jóvenes en Acción* in Spanish (JeA). The program offers a monthly grant around 68 USD to poor youths who enroll in vocational education (Prosperidad-Social, 2017).[2] JeA beneficiaries are selected principally by using a poverty score known as Sisben. The second discontinuity comes from the selection process of Sena.[3] Sena is a national institution that offers free vocational education through a scheme of one-year or two-year courses. When a given course has an excess of demand, the institution select the participants by means

[1] Enrollment in any kind of tertiary education was about 10% and 60% for the lowest and highest SES respectively.
[2] The grant is around 34% of the average monthly wage of a young individual with secondary education
[3] Servicio Nacional de Aprendizaje in Spanish, which translates to Learning National Service

of an entry exam where the individuals with the highest scores get offered a position in the course first.

Therefore, we have an ideal scenario for analyzing two sources of exogenous variation in enrollment to vocational education. However, only the variation around the cutoff used by JeA to select beneficiaries affects enrollment in Sena by reducing the liquidity constraints of eligible individuals. Comparing the effects of these two discontinuities on enrollment on vocational education and the subsequent behavior in the labor market, we provide evidence of the existence of liquidity constraints even in the case of free post-secondary education.

To test the presence of liquidity constraints we follow Card (2001)'s argument. Even though, *ordinary least square* (OLS) estimates of the returns of education should be upper biased due to unobserved ability, the literature shows that *instrumental variable* (IV) estimates are usually larger than OLS estimates. Card (2001) argues that IV estimates should be interpreted as the weighted local average treatment effect (LATE) of compliers. Then, when one instrument schooling with a variable related with changes in the cost of education and the IV estimate are larger than the OLS, one can argue that the IV estimate represents the LATE of a set of compliers whose expected returns of education are larger than the expected returns of education of non-compliers. As a result, one can argue that these compliers did not achieve more education in the past due to the existence of liquidity constraints.

We exploit the analogy between fuzzy regression discontinuity (RD) and IV estimations (Lee and Lemieux, 2010). We use both discontinuities as instruments for enrolling in vocational education, but one of our instruments represents changes in the cost of education (poverty score) and the other (entry exam) does not. Therefore, we test the argument made by Card (2001) through comparing OLS and IV in both cases.

Carneiro and Heckman (2002) and others pointed out some limitations of testing for liquidity constraints by comparing OLS and IV estimates. The main flaws come from (1) weak or invalid instruments, (2) unobserved comparative advantages in the labor markets and (3) the choice of school quality. However, our multiple RD estimates and the fact that all individuals in our analysis applied for the same educational institution, allow us to overcome these limitations.

We complement the analysis using both discontinuities together in the fashion of a Multiple Regression Discontinuity design (MRD) (Papay et al., 2011). In this case, we constrain our analysis to individuals who are closely affected by both discontinuities to understand the scenarios where one discontinuity explains variations in enrollment better than the other. Specifically, we use this strategy to show that when the opportunity cost increases, access to financial aid gains importance with respect to getting the first offer to join a course thanks to an exam score.

To summarize, eligibility for financial aid increases the probability of enrolling in vocational from 13% to 20% for one-year courses, and from 15% to 28% for two-year courses. We also find that IV estimates are larger than OLS estimates when we instrument enrollment with the eligibility for financial aid, while the IV estimates are not significantly different than the OLS estimates when we use the discontinuity of the entry exam as instrument of enrollment. This result is stronger in individuals who applied to a two-year course. In addition, when we use the MRD we find that for one-year courses enrollment reacts strongly to the exam discontinuity. However, in the case of two-year courses the effect of the eligibility for financial aid overcomes the effect of the exam discontinuity. The latest result shows that liquidity constraints gain importance when the opportunity cost increases, as individuals are expected to leave the labor market for longer periods in order to study.

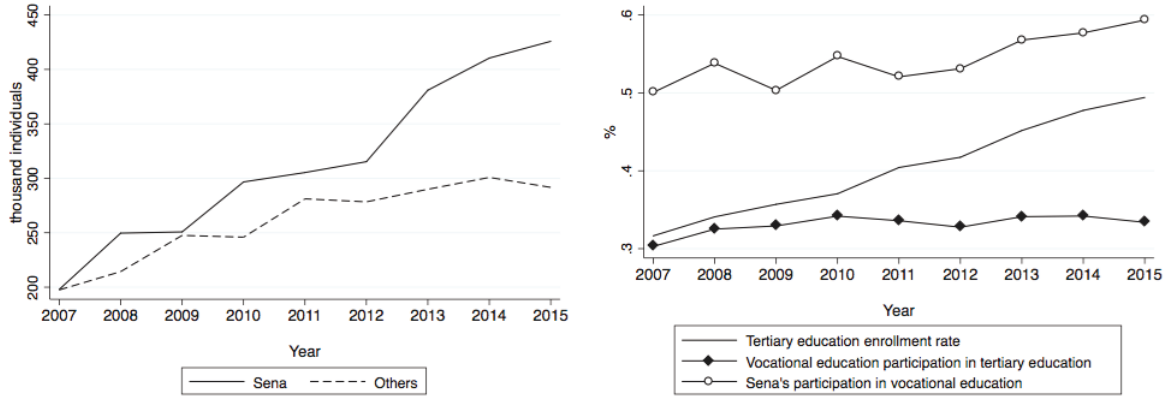
It is very important to point out that we focus our analysis on the case of free vocational education. Hence, our results are quantifying the importance of liquidity constraints regarding the opportunity cost of studying. This cost is usually forgotten in the literature and most important in the public policy debate. In particular, many countries in Latin America have been discussing reductions in college tuition fees or loans/scholarships to cover tuition fees (Solis, 2017, Didriksson, 2018). Our results contribute to policy makers by illustrating the limitation of public policies that only focus on tuition fees.

This paper is organized as follow: in section 2 we describe some characteristics of the Colombian education system including a description of Sena and JeA. In section 3 we describe the data. In section 4 we explain our estimation strategy. We present and discuss the main results in section 5. Section 6 concludes.

2 Institutional context

Tertiary education in Colombia has been growing constantly over the last two decades. The total enrollment rate increased from 23.7% to 48.9% between 2002 and 2015.[4] Within tertiary education, by 2015 one third was enrolled in vocational studies: 27,0% in technological two-year and 3,6% in technical one-year courses. As explained above, Sena is the largest public institution dedicated to offering vocational studies in Colombia. By 2015, Sena's enrollees added up to 425847 individuals, with these representing 60% of total individuals in vocational education. As shown in figure 1, the growth of total vocational education was helped by an increase in Sena's enrollees. However, the total participation of vocational education in tertiary education remains relatively constant because the large increase in tertiary education is driven by an increase in college level degrees.

Figure 1: Enrollees in tertiary education, vocational education and Sena. Total and participation rates



(a) Enrollees in vocational education by institution

(b) Enrollment rate in tertiary and vocational education

Source: SNIES

The supply of education in Sena is present throughout Colombia, covering both rural and urban areas in every Department. There are three main characteristics of Sena's education: (1) both one-year and two-year courses are free of charge (no tuition fees). (2) as part of the educational program individuals enter into an internship system; and (3) Sena uses an entry exam to allocate places in each course when there is an excess of demand.

[4] Information from the National System of Information for Higher Education (SNIES) - Sistema Nacional de Información de la Educación Superior, in Spanish

To meet the aim of facilitating the demand for post-secondary education in low income young individuals, the Colombian government created the nationwide program JeA under the management of *Prosperidad Social* (Department of Social Prosperity in charge of social policy).[5] This program includes support for students in Sena.

JeA has three strategies to support students in Sena. First, the Program offers a USD 139 bimonthly grant to its beneficiaries on the condition that they remain enroll in Sena. Second, JeA provides a *preferential entry* to Sena. The Program reserves of 30% of seats in each course regarding of the score obtained at the entry exam. Finally, there is an additional optional component intended to strengthen their non-cognitive abilities called *Habilidades para la Vida*. In appendix B we provide detailed and strong evidence that the first component of JeA drives all the impacts.

From August 2014 until October 2015 JeA selected its beneficiaries mainly based on a *poverty-based* score called Sisben.[6]. Among the established criteria, 87% of the total beneficiaries were admitted by the Sisben III which is a poverty index that assigns a score between 0 o 100 from the most to the least vulnerable households.[7] Then, this score allow us to exploit one discontinuity in the access for our empirical strategy.

The main objective of the JeA is to help poor individuals to join vocational education in order to increase their wealth in the future. In Colombia young high school graduates earn about USD 198 monthly. Therefore, JeA financial aid is equivalent to 34% of the monthly income of its beneficiaries. Moreover, income increase to USD 245 monthly when an individual has a vocational education degree. In addition, the probability of formal employment rises from 14% to 24%. Using detailed information about the probability of working (in the formal or the informal market) and the average income for different educational levels and ages, we calculate that the present value of lifetime benefits from vocational education is around USD 6960. Meanwhile, the forgone income for studying two years is USD 2640.[8]

The latest data means that in the case of perfect credit markets, young poor individuals should loan enough to stay out of the labor market for two years and get education in Sena. However, in Colombia credit markets are strongly segmented and only 20% of low income households get access to any kind of formal credit (Murcia, 2007). In addition, educational loans focus on supporting university level education and do not take into account individuals who want to enroll in Sena, given that education is free for them.

This is initial evidence of liquidity constrains for vocational education. In section 4 we show our strategy to estimate how important these constraints are.

3 Data

We combine information from different sources. First, we use administrative data from Sena about all the individuals who applied for a one-year or two-year courses since the second half of 2014 to the first semester of

[5] See the Resolution No. 1970 of 21/nov 2012 and Prosperidad-Social (2017) for details.

[6] There was a previous version -JeA-2005- studied in Attanasio et al. (2017) and Attanasio et al. (2011). The intervention in the first version was different to the one we study and focuses in professional training to employed youths in private educational institutions

[7] Targeted people also includes individuals in the adoption list of the ICBF *"Instituto Colombiano de Bienestar Familiar"*, Individuals from recognized indigenous groups, individuals from *Red Unidos* (RU) which is the program which coordinates different social welfare interventions, and victims Registry from the Colombian armed conflict.

[8] Using information from the National Life Quality Survey 2016 (Dane)

2015. Second, we merge this data with the administrative registries of Sisben scores at household level.[9]. By using this combined database, it is possible to determine which individuals were eligible for the program and also observe whether the individuals joined Sena or not. It is also possible to observe their trajectory during the course, for example if they dropped out or completed their studies. Third, we use JeAs information to identify which individuals were beneficiaries of the Program.

After studying at Sena, individuals move into the labor market. In order to assess the medium/long term effects of financial aid for post-secondary students, we combine our data with the information of the Social Security contributions from the Colombian Ministry of Labor (PILA), from August 2014 until December 2017. The PILA database contains information about compulsory contributions made by employed individuals to social security. Attanasio et al. (2017) defined an individual as a formal worker if she makes her compulsory contributions to social security. Therefore, if a given month we find an individual in PILA's database is because that individual has a formal job that month. Individuals with no reports to PILA are either not working (unemployed or inactive) or working in the informal market.

Given that our strategy is based on exploiting changes around discontinuities in the Sisben score and the entry exam, we constrained our sample to the individuals who may be affected by both discontinuities. Hence, we only include individuals who applied to courses with excess of demand and without a second entry exam, because in these courses the entry exam cutoff determines who gets the first offer to enroll. We also eliminated all the individuals who were younger than 18 years old when they applied to Sena, because it is not possible to merge them with the PILA registry.

[9]We use the data from Sisben version III, which was used to allocate social benefits from 2011 to 2016

Table 1: Sena applicants to one-year courses by position with respect to Sisben's and exam's cutoffs - descriptive statistics

	one-year courses								2 years courses							
	By Sisben's cutoff				By exam's cutoff				By Sisben's cutoff				By exam's cutoff			
	below the cutoff		above the cutoff		below the cutoff		above the cutoff		below the cutoff		above the cutoff		below the cutoff		above the cutoff	
Variable	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Observations	52915	.	11171	.	48810	.	15276	.	55527	.	20042	.	49549	.	26020	.
Individuals	37909	.	7514	.	32892	.	12531	.	35272	.	11940	.	27059	.	20153	.
Individual level variables																
Enrolled	0.17	0.38	0.14	0.34	0.06	0.23	0.51	0.50	0.25	0.43	0.16	0.36	0.08	0.27	0.51	0.50
Certified	0.05	0.22	0.04	0.19	0.02	0.13	0.14	0.35	0.01	0.10	0.01	0.08	0	0.05	0.02	0.14
Certified[1]	0.29	0.45	0.29	0.45	0.29	0.46	0.28	0.45	0.04	0.19	0.04	0.21	0.04	0.19	0.04	0.20
Dropout[1]	0.21	0.41	0.29	0.45	0.22	0.42	0.22	0.42	0.31	0.46	0.38	0.49	0.32	0.47	0.32	0.47
Enrolment period																
2014-II	0.35	0.48	0.40	0.49	0.36	0.48	0.36	0.48	0.58	0.49	0.57	0.50	0.55	0.50	0.62	0.49
2015-I	0.65	0.48	0.60	0.49	0.64	0.48	0.64	0.48	0.42	0.49	0.43	0.50	0.45	0.50	0.38	0.49
Targeting area																
Area 1	0.41	0.49	0.59	0.49	0.46	0.50	0.37	0.48	0.44	0.50	0.55	0.50	0.50	0.50	0.41	0.49
Area 2	0.53	0.50	0.36	0.48	0.49	0.50	0.56	0.50	0.47	0.50	0.39	0.49	0.42	0.49	0.50	0.50
Area 3	0.06	0.23	0.05	0.22	0.05	0.22	0.07	0.25	0.09	0.28	0.06	0.24	0.07	0.26	0.09	0.29
Male	0.43	0.50	0.57	0.49	0.44	0.50	0.51	0.50	0.46	0.50	0.55	0.50	0.47	0.50	0.50	0.50
Age	20.60	1.90	21.16	1.98	20.72	1.93	20.62	1.90	20.48	1.89	21.16	1.97	20.70	1.95	20.59	1.90
Entry exam score	37.01	17.24	37.76	17.13	33.50	17.63	48.77	8.53	41.48	16.30	42.23	16.29	36.76	17.46	51.05	7.56
Eligible FeA	0.61	0.49	0.11	0.31	0.51	0.50	0.54	0.50	0.52	0.50	0.08	0.27	0.38	0.49	0.45	0.50
Other support	0	0.07	0	0.07	0	0.04	0.01	0.12	0.01	0.09	0.01	0.10	0	0.06	0.02	0.13
Course level variables																
Courses	1263	.	1116	.	1227	.	1252	.	1788	.	1661	.	1724	.	1751	.
Seats	35.08	16.01	35.40	16.89	35.21	16.20	35.09	16.05	42.48	34.11	43.16	36.55	43.02	36.15	42.61	35.26
Demand	149.98	196.16	161.75	205.57	153.52	197.95	149.29	196.95	130.98	178.02	137.48	184.58	135.80	181.59	128.45	166.32
Takeout prop	0.51	0.28	0.53	0.28	0.51	0.28	0.51	0.28	0.50	0.33	0.50	0.33	0.50	0.32	0.50	0.33
Simulated cutoff	41.04	11.93	43.19	11.10	42.54	10.98	40.17	12	43.73	10.93	45.42	10.16	45.41	9.88	42.50	10.97
Labor market variables																
Formal job at least 1 month	0.53	0.50	0.68	0.47	0.54	0.50	0.61	0.49	0.69	0.46	0.78	0.42	0.69	0.46	0.73	0.44
Formal job at least 1 month [2]	0.49	0.50	0.64	0.48	0.50	0.50	0.57	0.49	0.61	0.49	0.71	0.46	0.62	0.49	0.66	0.47
Proportion of months working [2]	0.20	0.28	0.32	0.34	0.21	0.29	0.25	0.30	0.31	0.32	0.44	0.36	0.35	0.35	0.33	0.32
Longest employment spell [2]	4.99	7.29	7.54	8.53	5.22	7.53	5.91	7.66	5.51	6.22	7.19	6.71	5.90	6.53	5.98	6.21
Longest employment spell [2] [3]	10.01	7.52	11.73	8.03	10.39	7.70	10.29	7.57	8.88	5.67	10.06	5.87	9.44	5.89	8.92	5.56
Longest unemployment spell [2]	18.10	8.96	14.81	9.77	17.84	9.13	16.82	9.29	9.13	6.65	7.17	6.47	8.75	6.82	8.48	6.44
Working in the last semester	0.33	0.47	0.48	0.50	0.35	0.48	0.38	0.48	0.49	0.50	0.62	0.49	0.52	0.50	0.53	0.50

Notes: Authors' calculations using data from Sena and Sisben. Only includes Sena centers where JeA beneficiaries applied.

[1] Conditional on being enrolled. [2] 12 months after applying to Sena. [3] Conditional of having work at least 1 month.

As a result, we obtain information about 139 thousand applications of 92.6 thousand individuals, given that one individual can apply to more than one course. 64 thousand applications were made to one-year courses and 75 thousand to the two-year. For both one- and two-year courses, the proportion of men is marginally below 50% (See table 1). There are a considerable proportion of students below the Sisben cutoff in one- and two-year courses (83.45% and 77.65%, respectively), which shows that vulnerable people are being targeted with vocational education.

Regarding of the benefits provided by these courses, enrollment levels are lower in one-year courses even if they obtain a score above the entry exam cutoff. There is a higher proportion of individuals enrolled in the last period (2015-I) in shorter courses, with the opposite trend for longer courses. However, there is no evidence in favor of sorting or discontinuities based on the type of course. The average score in the entry exam are similar between vulnerable and non-vulnerable applicants, as shown in table 1 and figure 18 in the appendix. Nevertheless, it is observed that scores are higher for applicants to longer courses. Table 1 also shows that the average individual is about 20 years old and more than 90% applications were living in urban areas (area 1 and 2) when they were assessed for the Sisben score.

The characteristics of applicants according to the courses exhibit some patterns. First, the unconditional average size is higher in two-year courses, but there is no difference in wealth or ability as it is expected. Therefore, there is a considerable excess of demand in that courses which implies that about one in five individuals gain a place.

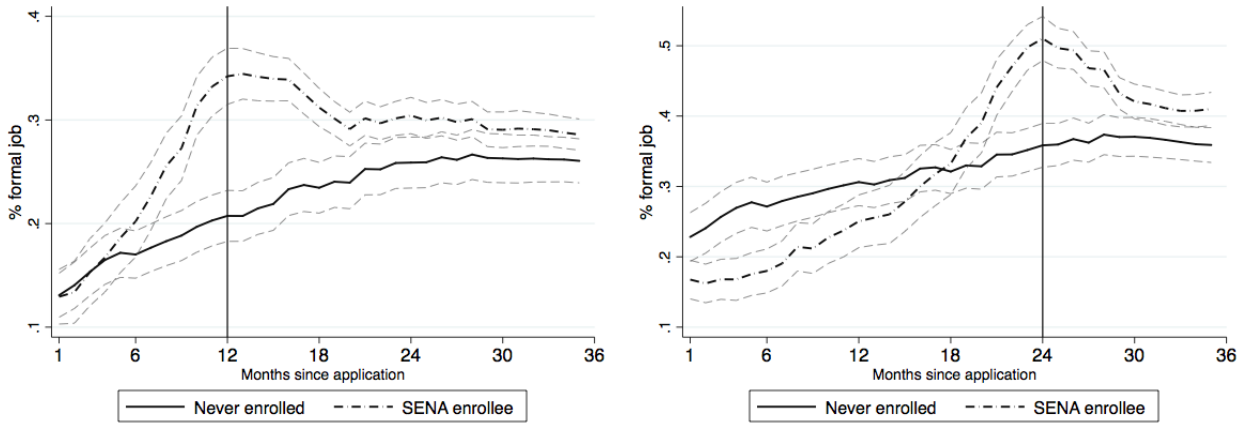
In terms of labor market indicators, there are unconditional differences in labor participation according to vulnerability and ability that grows with the length of the courses. In fact, the proportion of months working in one- and two-year courses is lower in most vulnerable individuals (0.2 and 0.31) than individuals in better socioeconomic conditions (0.32 and 0.44), respectively. This pattern also persists for other labour outcomes.

Figure 2 shows the evolution of the labor market participation over time, from the month each individual applied to Sena.

Once an individual complete her education at Sena, the main question is about her economic returns of education proxied by performance in the labor market, in the absence of available wages. We assessed the importance of liquidity constrains through the following labor market indicators: (1) working at least one month, (2) the proportion of months working, (3) working in the last semester, (4) longest employment and (6) longest unemployment spell. The first three indicators measure participation and the last two stability in labor market. To construct this indicators we use registries that are available at PILA, from August 2014 to December 2017.

As evidence of the role played by monetary aid, figure 2 compares labor market participation trends since the moment each individual applied to Sena by course type (one- and two-year courses). After applying, enrollees in Sena work less than individuals who did not enroll. Thereafter, enrollees' formal employment grows sharply during the internship months period. After the internship, formal employment drops but remains above the employment rate of the non-enrolled. This patter is stronger for the case of two-year courses. This fact reveals some evidence in favor of the importance of financial aid for covering expenses different than tuition fees. That is, individuals are able to study instead of working for a period in order to increase their participation after completing the vocational courses. In addition, it is observed that a higher fraction of individuals obtain formal

Figure 2: Formal labor market participation by enrollment in Sena



(a) one-year course

(b) two-year course

jobs during the internship provided by the program, but this difference tends to disappear after some period of time.

There are two main limitations to our data. First, the match PILA data uses national identification numbers, but individuals only obtain these numbers when they are 18 years old. Therefore, we cannot include individuals who applied to Sena when they were 16 or 17 years old. These may be individuals with greater preferences for tertiary education because they applied soon after finishing high school.

Second, PILA only reports on formal labor market participation. As we explained before, when and individual is not in the PILA database she may be either unemployed, working informally or outside the labor market. This is a challenge for our analysis, as Colombia has the largest informal employment rate among the OECD countries. By 2016, the self-employment rate in Colombia was 51.3%, while the average among OECD countries was 16.2%.[10] Therefore, our estimations are not taking into account the returns of education through informal employment.

4 Estimation strategy

The main purpose of this paper is to exploit two different discontinuities in Sena's enrollment and JeA's selection criteria to disentangle the importance of liquidity constraints on enrollment on vocational education. The advantage of comparing these two discontinuities is having two variables that exogenously affect enrollment in post-secondary education, but only one of them is linked with changes in the cost of education. In this section we describe our two approaches to test for the existence of short run liquidity constraints.

4.1 RD-IV and OLS comparisons

We begin our analysis by exploring each discontinuity independently to take advantage of two sources of exogenous variation in enrollment in free vocational education.

The first discontinuity we explore is JeA eligibility criteria using Sisben's score. As mentioned in the last

[10]Self-employment measure as the proportion of self-employed workers among all workers. Data from OECD employment and labor market statistics database.

section, the Sisben score is a mechanism used by Colombian authorities to allocate different social services. JeA uses this score as its main targeting strategy, enrolling more than 80% of its participants through this mechanism.[11] The second discontinuity comes from the existence of an admission test which is designed to allocate the seats for over demanded courses.

We declare υ_i as the difference between individual i's Sisben score and the cutoff of her area.[12] We can then declare $D_i = 1\left[\upsilon_i \leq 0\right]$, which represents a dummy variable equal to one if the individual i is eligible for JeA. Furthermore, μ_{ij} is the distance between an individual's exam score and the admission cutoff in the course she applied to. $A_{ij} = 1\left[\mu_{ij} \geq 0\right]$ is a dummy value with the value of one if the individual i gets the first offer to enroll on a course j. Finally, S_{ij} takes the value of one if the individual i enrolls in Sena's course j and zero if not.

Our first step is to show that both discontinuities change the probability of enrolling in Sena. As explained previously, Sena offers one- and two-year courses. Given that longer courses may imply a larger the opportunity cost of studying, we always separate the analysis by course type.

Figure 3 shows how for both discontinuities, the Sisben score and the entry exam , there is a significant change in the probability of enrolling in Sena around the cutoffs. However, in the case of the Sisben score, the discontinuity is significantly larger for the applications to two-year courses than for one-year courses. This is our first piece of evidence for the existence of liquidity constraints. The effect of eligibility for financial aid increases with the length of the course as the opportunity cost increases. It is possible that the differences in the effect of the Sisben discontinuity come from individuals choosing different course length. However, figure 18 in the appendix C shows that there is no sorting for one- or two-year courses around both discontinuities.

Formally, followingLee and Lemieux (2010) and others, we estimate a simple RD reduced form of the shape:

$$S_i = \beta_0 + \beta_1 D_i + g\left(\upsilon_i, D_i\right) + \epsilon_i \tag{1}$$

And

$$S_i = \rho_0 + \rho_1 A_i + f\left(\mu_i, A_i\right) + \eta_i \tag{2}$$

Where, β_1 captures the effect of being eligible for financial aid in the probability of enrolling in Sena, and ρ_1 captures the effect of receiving the first offer to join a course in the probability of enrolling in Sena. $g\left(\upsilon_i, D_i\right)$ and $f\left(\mu_i, A_i\right)$ are polynomial forms of each forcing variables in both sides of each cutoff.

In order to provide evidence in favor of the hypothesis that reductions in liquidity constraints caused the changes in enrollment in figure 3, we follow the discussion in Card (2001) and others. In the standard estimation of returns to schooling (Mincer, 1974), OLS estimates are upper biased due to unobserved ability and/or taste for education. Nevertheless, in the literature IV estimates are usually larger that OLS estimates.[13] Following Imbens and Angrist (1994), Card (2001) argues that IV estimates cannot be interpreted as an average treatment effect (ATE), but instead they represent the weighted local average treatment effect (LATE) of the compliers.

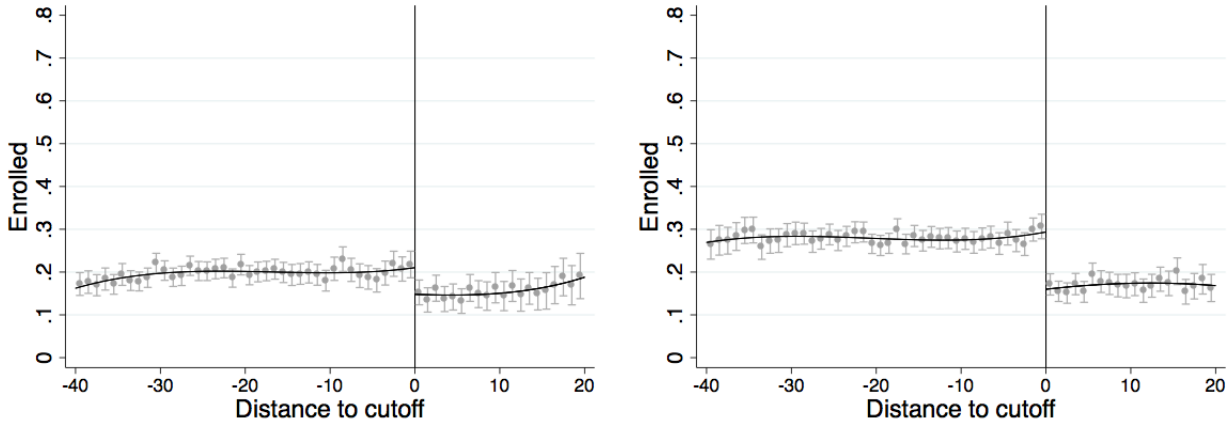
[11] As explained before, 87% of JeA participants entered the program through the Sisben score Prosperidad-Social (2017). In our analysis, we exclude all other targeted populations.

[12] It is important to remember that JeA uses three different cutoffs for different areas

[13] See the revisions by Card (2001), Brown et al. (2011)

Figure 3: Enrollment in Sena by distance to the Sisben and entry exam cutoffs

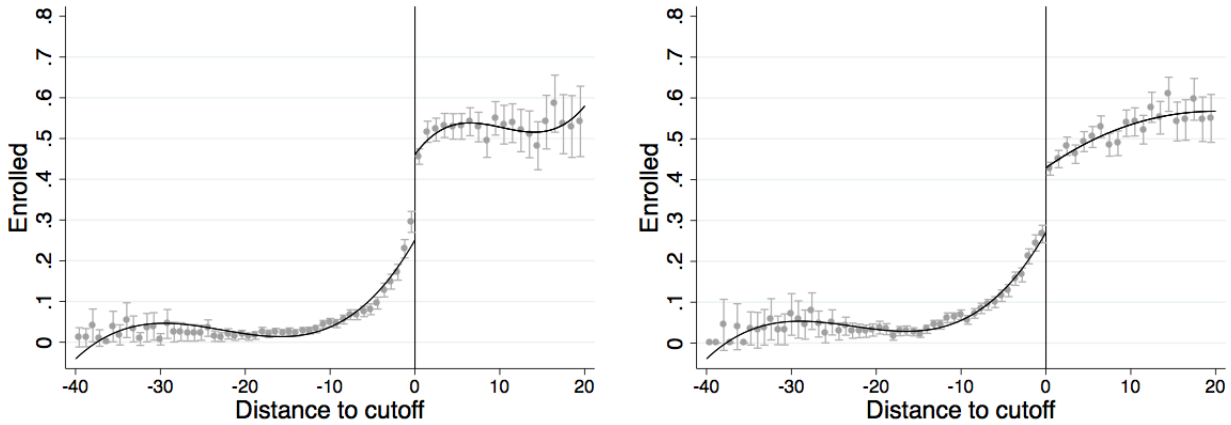
Sisben score υ_i



(a) one-year course

(b) two-year course

Entry exam μ_i



(c) one-year course

(d) two-year course

Notes: Authors' calculations using Sena's inscriptions and Sisben's data. Exam's cutoffs are simulated by considering JeA's preferential entry scheme. 95% CI in dashed lines. Bin size of 1 point. Adjusted function form using 3 degree polynomial.

Therefore, instrumenting schooling with a variable related with changes in the cost of education will result in IV estimates larger than OLS because the compliers to these instruments are individuals whose expected returns to education are larger than the expected returns of education of non-compliers. However, these compliers did not achieve more education in the past due to the existence of liquidity constraints.

Following Lee and Lemieux (2010), our RD estimates are analogous to IV estimations around each cutoff. Given that we do not have data on wages we will estimate the returns to education on formal labor market participation. Then, if Y_i is the formal labor market indicator of i, then the RD-IV estimator around the Sisben cutoff is:

$$\tau_Y = \frac{lim_{c\uparrow 0} E\left[Y|\upsilon_i = c\right] - lim_{c\downarrow 0} E\left[Y|\upsilon_i = c\right]}{lim_{c\uparrow 0} E\left[S|\upsilon_i = c\right] - lim_{c\downarrow 0} E\left[S|\upsilon_i = c\right]} \tag{3}$$

Additionally, the RD-IV estimator around the exam cutoff is:

$$\gamma_Y = \frac{lim_{c\uparrow 0} E\left[Y|\mu_i = c\right] - lim_{c\downarrow 0} E\left[Y|\mu_i = c\right]}{lim_{c\uparrow 0} E\left[S|\mu_i = c\right] - lim_{c\downarrow 0} E\left[S|\mu_i = c\right]} \tag{4}$$

Conditional on some basic assumptions that we discuss later on, both τ_Y and γ_Y are unbiased estimates of the effect of enrolling in Sena on the labor market indicator Y. Following Imbens and Angrist (1994), Lee and Lemieux (2010) and Card (2001), each estimator represents the LATE of different type of compliers. τ_Y quantifies the effect of Sena's education on the labor market for those individuals who enrolled because they were eligible for receiving financial aid through JeA.[14] One can expect that the expected returns of Sena's education for these individuals is larger than the expected return for the non-compliers, because their decision to enroll is a response to changes in the cost of education. Therefore, one can argue that these compliers were not entering in Sena before being eligible to financial aid due to liquidity constraints.

γ_Y quantifies the effect of Sena's education on the labor market for those individuals who receive the first chance to enroll. In this case, characterizing the compliers may not be that simple. One can argue that compliers are individuals with higher implicit utility from education, which may be also correlated with higher productivity and better returns in the labor market. In this case, IV estimates may also be higher than OLS estimates. Another possibility is that compliers in this case are individuals who were able to enter in their first-choice course. Once again, if the correlation between studying in the first-choice course and productivity is positive, then one may expect that IV estimates are larger than OLS ones. Finally, if the decision of compliers is not correlated with the expected returns in the labor market, one can expect that IV estimates are lower than OLS estimates because we are correcting the ability bias.

Thus, if β_Y is the OLS estimate of the effect of S on Y, one can expect that in the presence of liquidity constraints $\tau_Y > \beta_Y$. Although, we do not have any prior beliefs about the relationship between γ_Y and β_Y. Indeed, if γ_Y represents the ATE, one can even expect that $\gamma_Y < \beta_Y$.

There are some limitations and criticism to this strategy. Griliches (1977) and Angrist and Keueger (1991) argue that IV estimates may be larger than OLS estimates due to measurement error. Additionally, Carneiro and Heckman (2002) discusses the limitations of this type of analysis. First, instruments are usually weak or invalid. Second, even if the instruments are valid, then IV can be larger than OLS due to some unobserved comparative advantage in labor markets. Third, instruments usually neglect school quality choice.

In the following section we will show evidence of how our estimations overcome the latest shortcomings in the strategy.

4.2 Multiple regression discontinuity design (MRD)

We can also compare the discontinuities in υ_i and μ_i using double discontinuity analysis in the fashion of Papay et al. (2011). We can estimate the following equation:

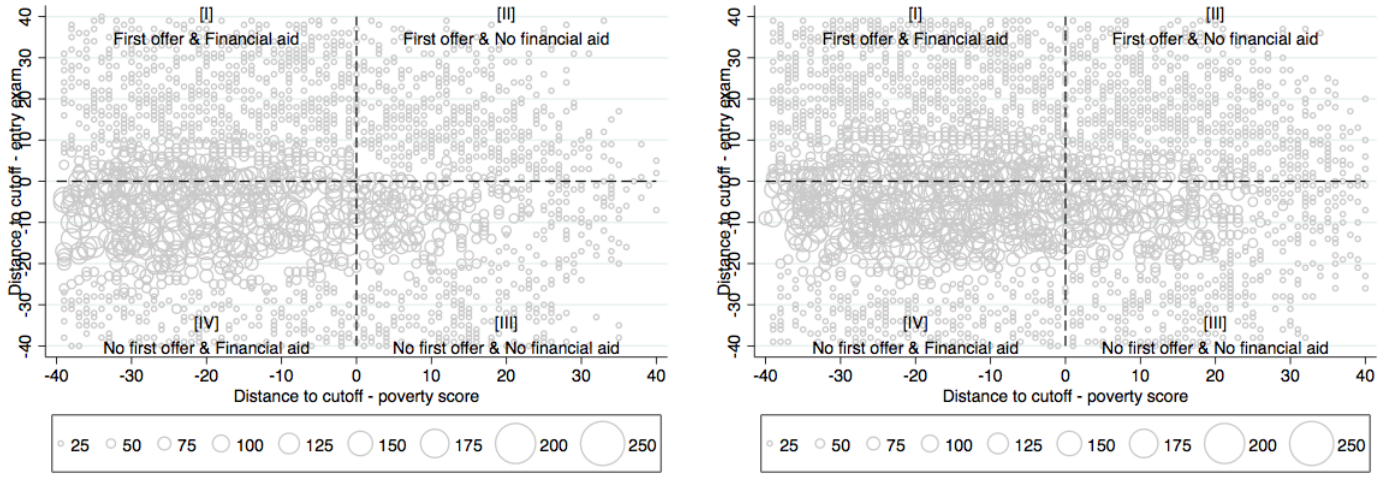
$$S_{ij} = \alpha_0 + \alpha_1 D_i + \alpha_2 A_{ij} + \alpha_3 D_i \times A_{ij} + g(\upsilon_i) + f(\mu_{ij}) + \phi_{ij} \tag{5}$$

In this case, α_1, α_2 and α_3 provide information on which forces are stronger when we focus on those individuals who are marginally affected by both discontinuities. Then, we can investigate in which cases the possibility of receiving monetary aid gains importance. Figure 4 shows that there is no correlation between both forcing variables. Additionally, in the same figure we see that for this analysis we can divide the population into

[14] Indeed τ_Y includes the aggregated effect of monetary aid, preferential entry and soft skills training. In appendix B we show sufficient evidence to support JeA's impacts are driven by the financial aid above all the other benefits.

four areas. Quadrant $[I]$ shows the individuals who received the first offer to join a course and also are eligible for financial aid. Individuals in quadrant $[II]$ received the first offer to join a course, but are not eligible for financial aid. Quadrant $[III]$ includes individuals who did not get either the first offer nor financial aid, and quadrant $[IV]$ includes individuals who did not get the first offer, but are eligible for financial aid.

Figure 4: Poverty score vs entry exam (distance to cutoff) by course length



(a) one-year course

(b) two-year course

Notes: Grid size 1 x 1 points per variable. Circle size represents the number of individuals by grid.

Then, when we link estimates from equation 5 and figure 4 we can estimate the average value of any outcome variable $\bar{Y}$ (including enrollment in Sena S_i) as:

- $\bar{Y}^I = \hat{\alpha_0} + \hat{\alpha_1} + \hat{\alpha_2} + \hat{\alpha_3}$, is the average of Y for individuals who are eligible for financial aid and received the first offer to join a course.
- $\bar{Y}^{II} = \hat{\alpha_0} + \hat{\alpha_2}$, is the average of Y for individuals who are not eligible for financial aid but received the first offer to join a course.
- $\bar{Y}^{III} = \hat{\alpha_0}$, is the average of Y for individuals who are not eligible for financial aid and did not received the first offer to join a course.
- $\bar{Y}^{IV} = \hat{\alpha_0} + \hat{\alpha_1}$, is the average of Y for individuals who are eligible for financial aid but did not receive the first offer to join a course.

Comparing $\bar{Y}^I, \bar{Y}^{II}, \bar{Y}^{III}$ and $\bar{Y}^{IV}$, we can infer in which cases and for which outcome variables financial aid gains importance.

5 Results

As explained previously, our first analysis uses the analogy between RD and IV estimations. Appendix A discusses the results of the tests of continuity of confounding factor and manipulation around the cutoffs for both forcing variables, the Sisben score and the entry exam following Lee and Lemieux (2010).

Figure 3 already showed graphically the effects of both discontinuities on the probability of enrolling in Sena. Additionally, table 2 shows the resulting estimates of each discontinuity on the probability to enroll in Sena by course type and gender (as equations 1 and 2).

Table 2: Effect of discontinuities in Sisben score and Sena's entry exam on enrollment in Sena

	one-year course						2 years course					
	All		Female		Male		All		Female		Male	
Discontinuity in the Sisben score												
Sisben score $\leq cutoff$	0.075**	0.053**	0.093*	0.057*	0.055*	0.043*	0.127**	0.109**	0.156**	0.117**	0.119**	0.110**
	(0.025)	(0.017)	(0.039)	(0.025)	(0.021)	(0.018)	(0.027)	(0.017)	(0.032)	(0.030)	(0.038)	(0.016)
Constant	0.133**	-0.074*	0.127**	0.451**	0.136**	-0.106**	0.157**	0.241**	0.129**	0.301**	0.166**	0.236**
	(0.023)	(0.029)	(0.031)	(0.104)	(0.027)	(0.034)	(0.014)	(0.053)	(0.019)	(0.061)	(0.017)	(0.073)
Controls and FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
F test	9.33	9.75	5.62	5.29	6.55	5.59	21.78	40.41	24.38	15.30	10.05	45.26
R^2	0.00	0.25	0.01	0.26	0.00	0.27	0.02	0.27	0.02	0.31	0.01	0.26
Bandwidth	10.72	11.44	10.45	11.47	12.18	12.80	9.09	8.44	10.59	8.92	11.34	9.34
N	16110	17278	7595	8410	9495	10017	20145	18744	11398	9566	12832	10738
Discontinuity in the entry exam												
Entry exam $\geq cutoff$	0.147**	0.143**	0.159**	0.130**	0.113**	0.092**	0.134**	0.113**	0.133**	0.122**	0.125**	0.096**
	(0.023)	(0.021)	(0.034)	(0.032)	(0.025)	(0.027)	(0.021)	(0.019)	(0.040)	(0.037)	(0.021)	(0.019)
Constant	0.309**	0.231*	0.326**	1.636**	0.304**	1.202**	0.282**	0.402**	0.275**	0.456**	0.299**	0.337**
	(0.025)	(0.113)	(0.038)	(0.160)	(0.022)	(0.101)	(0.026)	(0.053)	(0.044)	(0.057)	(0.020)	(0.063)
Controls and FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
F test	40.67	47.38	22.55	16.80	21.08	12.02	41.88	34.15	11.18	10.75	34.63	25.55
R^2	0.11	0.26	0.14	0.31	0.13	0.27	0.08	0.26	0.09	0.29	0.09	0.25
Bandwidth	3.56	3.86	3.67	5.32	6.42	5.11	4.48	4.35	5.08	4.92	5.65	5.40
N	12152	12982	6377	8950	10015	8143	20793	20256	11384	11069	12971	12499

Notes: Standard errors clustered at municipality level, + 0.1 * 0.05 ** 0.01. Bandwidths following Calonico et al. (2014). We use a 3rd degree polynomial for the distance to each cutoff. Controls include gender, age, participation in FeA, application year, Sisben area, number of applications, course takeout (%), Sena center fixed effects and Sena program fixed effect. F test is the Cragg-Donald Wald F statistic.

With respect to the Sisben score (upper panel), the effect of being eligible for financial aid is stronger for individuals who applied to two-year courses than for individuals who applied for one-year courses. This is reflected by larger and more significant coefficients (the total effect is around 4 percentage points and 10 percentage points for 1 years and 2 years courses respectively). As previously explained, the heterogeneity in the results is our first piece of evidence about the importance of liquidity constraints for the opportunity cost. In the case of free education, the only difference in the cost of education is the time you have to leave the labor market in order to study. Therefore, we can assume that longer courses imply higher opportunity cost and a larger need for financial aid.

The table also shows the F test for being eligible for financial aid. Given that our estimates are weaker for one-year courses, F tests are consequently small. This limits our analysis because the Sisben's discontinuity will be a weak instrument for enrollment in one-year courses. For two-year courses we have a strong instrument regardless of the gender.

The lower panel shows the results with respect to the entry exam discontinuity. In this case the results are more homogeneous and the effect of the exam discontinuity on enrollment varies from 9 to 15 percentage points. Additionally, the F test is always larger than 10 in all cases, which is evidence the this discontinuity is a strong instrument for enrollment in Sena.

Using Sena's data we can also examine the effect of each discontinuity on the completion of individuals vocational education. Table 3 shows the resulting estimates. In this case, for both discontinuities the effects are weaker than the ones on enrollment. Regarding Sisben's discontinuity, we only find positive effects for the unconditional case, meaning that most of the difference between eligible and non-eligible individuals comes from changes in enrollment rates. Once we compare to individuals who are enrolled, being eligible for financial aid

makes no difference to the probability of finishing their studies.

With respect to the exam's discontinuity, when we analyze the effect on the unconditional probability of obtaining a diploma from Sena we find positive effects in one a two-year courses. This results come from the strong effect we found on enrollment rates. However, when we constrained to individuals who enrolled in Sena, we only find a 2.2 percentage points effect for the case of males in two-year courses.

Even though there are some positive and statistically significant coefficients, the F tests are always very small regardless of the discontinuity or the course type. Therefore, we will not use studies completion in our instrumental variable analysis. It is also important to point out that the few positive significant effects we find are only for males but not females, which can reflect asymmetries in the opportunity cost by gender.

Table 3: Effect of discontinuities in Sisben score and Sena's entry exam on vocational studies completion

	Completed studies						Completed studies | enrolled					
	one-year course			2 years course			one-year course			2 years course		
	All	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male
Discontinuity in the Sisben score												
Sisben score $\leq cutoff$	0.022*	0.032	0.023	0.009+	0.008	0.010*	0.012	0.048	0.044	0.024	0.018	0.042
	(0.009)	(0.023)	(0.014)	(0.004)	(0.005)	(0.005)	(0.050)	(0.156)	(0.124)	(0.019)	(0.028)	(0.027)
F test	6.36	1.90	2.75	3.65	2.48	4.31	0.05	0.09	0.13	1.55	0.41	2.47
R^2	0.09	0.11	0.09	0.05	0.06	0.05	0.16	0.26	0.21	0.14	0.20	0.16
Bandwidth	12.25	11.55	11.89	13.88	13.74	12.74	13.10	10.77	10.30	12.47	12.46	10.53
N	18635	8470	9279	30961	14984	14534	3158	1138	1354	5807	2657	2634
Discontinuity in the entry exam												
Entry exam $\geq cutoff$	0.023+	0.024	0.026*	0.006*	0.001	0.009*	-0.053	-0.066	-0.001	0.017+	-0.018	0.021+
	(0.013)	(0.023)	(0.011)	(0.003)	(0.003)	(0.004)	(0.038)	(0.055)	(0.033)	(0.009)	(0.026)	(0.011)
F test	3.45	1.02	5.17	4.76	0.15	4.71	1.88	1.41	0.00	3.63	0.48	3.39
R^2	0.11	0.14	0.10	0.05	0.07	0.05	0.16	0.19	0.17	0.13	0.20	0.13
Bandwidth	5.71	7.54	7.83	9.99	8.95	11.55	7.71	8.08	8.45	7.93	6.50	6.92
N	18563	12361	11895	40635	18375	22799	6832	3682	3418	10075	4172	4887

Notes: As per table 2.

5.1 RD-IV estimations

In this section we present the results from our RD-IV estimations. Given the results showed in tables 2 and 3, we focus our analysis comparing IV and OLS results for both discontinuities on the effect of enrolling in two-year courses.[15]

Recalling from the previous section, IV estimates represent the LATE of compliers. Therefore, if they are larger than OLS estimates we can conclude that the average return of schooling of compliers is larger than the average return of non-compliers. If the instrument is related to changes in the cost of education and the IV estimates are larger than OLS estimates, one can argue that compliers with high returns to education were not entering into tertiary education due to the existence of short run liquidity constraints.

In our case, the Sisben discontinuity reflects changes in the cost of education through eligibility for financial aid. Meanwhile, the exam discontinuity effect to enrollment has no relationship with changes in the relative cost of education. Table 4 shows OLS and IV estimates for the case of three variables related to labor market participation: i) the probability of working at least one month, ii) the proportion of periods an individual works,

[15]The results for one-year courses are in tables 10, 11 in appendix C.

and iii) the probability of working in the last semester of 2017. It is important to remember that we only analyze labor market participation 24 months after applying to Sena to exclude the period individuals should have left the labor market in order to work and to not include the effect of Sena's internship.

Table 4: Effect of enrollment in Sena for applicants to two-year courses on formal labor market participation. OLS vs IV estimates using Sisben and entry exam discontinuities as instruments.

	Work at least 1 month				Proposition of months working				Work in the last semester			
	Sisben disc.		Exam disc.		Sisben disc.		Exam disc.		Sisben disc.		Exam disc.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: All												
Enrolled	0.068**	0.607+	0.069**	0.266	0.041**	0.771**	0.042**	-0.033	0.027**	0.715*	0.034**	0.007
	(0.012)	(0.335)	(0.008)	(0.195)	(0.007)	(0.245)	(0.007)	(0.124)	(0.009)	(0.280)	(0.008)	(0.120)
F test		20.23		31.06		27.70		26.27		26.42		31.64
R^2	0.17	0.02	0.18	0.16	0.16	-0.22	0.17	0.17	0.13	-0.08	0.14	0.14
Bandwidth	9.40	9.40	7.04	7.04	10.36	10.36	6.31	6.31	10.43	10.43	7.35	7.35
N	20847	20847	30756	30756	22939	22939	28020	28020	23102	23102	31862	31862
Panel B: Women												
Enrolled	0.062**	0.009	0.086**	0.092	0.026+	0.194	0.048**	-0.097	0.017	0.052	0.039**	-0.109
	(0.014)	(0.500)	(0.012)	(0.289)	(0.013)	(0.343)	(0.010)	(0.147)	(0.016)	(0.342)	(0.011)	(0.213)
F test		8.34		14.17		11.83		13.40		12.29		14.40
R^2	0.17	0.17	0.18	0.18	0.15	0.13	0.17	0.15	0.13	0.13	0.13	0.12
Bandwidth	9.67	9.67	7.16	7.16	10.70	10.70	9.09	9.09	12.56	12.56	7.27	7.27
N	10361	10361	15329	15329	11573	11573	18602	18602	13633	13633	15512	15512
Panel C: Men												
Enrolled	0.066**	0.882**	0.053**	0.692*	0.049**	1.166**	0.031**	0.208	0.038**	1.017**	0.030**	0.449
	(0.012)	(0.255)	(0.007)	(0.284)	(0.005)	(0.267)	(0.006)	(0.211)	(0.008)	(0.302)	(0.007)	(0.366)
F test		44.37		25.71		45.85		27.67		46.01		22.94
R^2	0.19	-0.17	0.21	-0.09	0.18	-0.75	0.19	0.16	0.14	-0.32	0.16	0.05
Bandwidth	12.65	12.65	6.07	6.07	12.99	12.99	5.66	5.66	13.01	13.01	5.38	5.38
N	14435	14435	13815	13815	14800	14800	12971	12971	14816	14816	12426	12426

Notes: As per table 2.

The results are conclusive. For all three variables in the case of the Sisben's discontinuity IV estimates are significantly larger than OLS estimates. However, when we instrument with the exam discontinuity IV and OLS estimates are not significantly different from each other.

According to Carneiro and Heckman (2002) the latest analysis have some important weaknesses. First, instruments in the literature are usually invalid or weak. We already showed that both discontinuities are strong instruments of enrollment. Furthermore, the RD environment supports the validity of our instruments. According to Lee and Lemieux (2010), if (1) there is no manipulation of the forcing variable by the cutoff, and (2) observable and unobservable variables are continuous around the cutoff, then RD estimations represent a experiment by the cutoff. Appendix A contains the evidence supporting the validity of both RD estimations. Hence, both our instruments are strong and valid.

Second, the difference between IV and OLS can be explained by differences in individuals' comparative advantage in the labor market. This drawback is common when instruments come from regional variations in the cost of education. In our estimations we control for Sena center and program type fixed effects. Therefore, applicants on both sides of each cutoff are likely to be facing the same labor markets. In addition, following the assumption of continuity of observable and unobservable factors around the cutoff, one can argue that individual

Table 5: Effect of enrollment in Sena for applicants to two-year courses on formal labor market stability. OLS vs IV estimates using Sisben and entry exam discontinuities as instruments.

	Longest employment spell				Longest employment spell[1]				Longest unemployment spell			
	Sisben disc.		Exam disc.		Sisben disc.		Exam disc.		Sisben disc.		Exam disc.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: All												
Enrolled	0.404**	15.391*	0.469**	0.413	-0.156	15.079	-0.140	-3.158	-0.690**	-13.600**	-0.651**	1.899
	(0.109)	(7.040)	(0.130)	(1.769)	(0.136)	(9.362)	(0.183)	(2.730)	(0.110)	(4.369)	(0.095)	(2.621)
F test		21.02		27.66		17.70		33.06		27.48		32.52
R^2	0.18	-0.41	0.18	0.18	0.10	-0.64	0.08	0.04	0.13	-0.29	0.15	0.12
Bandwidth	9.51	9.51	7.49	7.49	7.03	7.03	7.73	7.73	10.36	10.36	4.43	4.43
N	21109	21109	32331	32331	10601	10601	21953	21953	22931	22931	20619	20619
Panel B: Women												
Enrolled	0.145	1.899	0.490**	-1.951	-0.537**	5.952	-0.136	-2.304	-0.498*	-4.074	-0.835**	4.176
	(0.160)	(5.503)	(0.131)	(2.319)	(0.173)	(5.522)	(0.211)	(3.636)	(0.207)	(6.148)	(0.158)	(2.557)
F test		11.06		23.28		9.04		18.47		12.52		12.13
R^2	0.16	0.16	0.17	0.15	0.11	-0.02	0.08	0.06	0.13	0.11	0.16	0.08
Bandwidth	11.69	11.69	12.39	12.39	8.40	8.40	8.50	8.50	11.74	11.74	6.69	6.69
N	12640	12640	23604	23604	6048	6048	11359	11359	12700	12700	14462	14462
Panel C: Men												
Enrolled	0.519**	22.701**	0.306*	5.471	-0.114	22.412**	-0.199	-4.326	-0.760**	-14.704**	-0.468**	-6.258
	(0.102)	(6.472)	(0.126)	(4.205)	(0.142)	(6.637)	(0.191)	(2.988)	(0.086)	(4.161)	(0.103)	(4.005)
F test		44.20		21.22		35.80		24.41		47.71		14.98
R^2	0.21	-1.14	0.21	0.10	0.10	-1.66	0.10	0.02	0.14	-0.42	0.16	0.02
Bandwidth	12.62	12.62	5.25	5.25	13.88	13.88	7.78	7.78	12.83	12.83	4.98	4.98
N	14384	14384	12165	12165	10906	10906	11437	11437	14648	14648	11634	11634

Notes: As per table 2.
[1] Conditional on having work at least one month.

comparative advantage in the labor market does not change radically around the cutoffs.

Finally, according to Carneiro and Heckman (2002) the OLS and IV comparison neglects the choice of quality of schooling. In our analysis all individuals applied to the same institution (Sena). What is more, we show that eligibility to financial aid did not create any kind of sorting in two-year courses. Hence, the quality argument does not apply in our case.

5.2 MRD estimations

As explained before, MRD estimations allow us to see how both discontinuities work for those individuals who are close to both cutoffs. Tables 6 and 7 summarize the results.

The estimated coefficients in Table 6 suggest that financial aid is important for encouraging enrollment to longer courses, while receiving the first offer is crucial for one-year courses. For one-year courses, the coefficient of being eligible for financial aid alone (region IV in figure 4) is not statistically significant – α_1 in table 6. This means that eligibility for financial aid does not make a difference in enrollment if you do not get the first offer. Nevertheless, receiving the first offer without any financial aid does create a significant change in enrollment rates (region II in figure 4).

For two-year courses, the forces change. Individuals in region II, who received the first offer but were note eligible for financial aid, do not have a differential enrollment rate comparing with individuals who did get the first offer (α_2 is not statistically significant). However, in this case eligibility for financial aid does increase

Table 6: Double discontinuity estimation on enrolment in Sena

	one-year course			2 years course		
	All	Female	Male	All	Female	Male
Sisben discontinuity (α_1)	0.092	0.084	0.137	0.075*	0.014	0.146**
	(0.061)	(0.087)	(0.129)	(0.033)	(0.044)	(0.040)
Exam discontinuity (α_2)	0.166**	0.188*	0.166**	0.055	0.120	0.013
	(0.038)	(0.071)	(0.059)	(0.035)	(0.096)	(0.070)
Sisben x Exam (α_3)	0.021	0.021	-0.014	0.048**	0.037	0.034
	(0.021)	(0.048)	(0.025)	(0.016)	(0.039)	(0.026)
Joint significance tests						
$H_0 : \alpha_1 + \alpha_3 = 0$	0.122	0.187	0.346	0.001	0.441	0.000
$H_0 : \alpha_2 + \alpha_3 = 0$	0.000	0.001	0.003	0.005	0.030	0.429
$H_0 : \alpha_1 + \alpha_2 + \alpha_3 = 0$	0.001	0.008	0.050	0.000	0.014	0.002
Sisben's bandwidth	11.67	11.67	11.67	9.83	9.83	9.83
Exam's bandwidth	3.85	3.85	3.85	4.38	4.38	4.38
R^2	0.30	0.36	0.33	0.27	0.32	0.28
N	3562	1644	1918	5923	2757	3166

Notes: Standard errors clustered at municipality level, + 0.1 * 0.05 ** 0.01. 10 points bandwidth for both scores. We use a 3rd degree polynomial for the distance to each cutoff. All estimations includes control variables as table 2. α_1, α_2 and $\alpha 3$ as equation 5. We report the p-values of a Wald test on each null hypothesis.

enrollment, independently of receiving the first offer. In addition, the interaction of both discontinuities is only statistically significant for the case of two-year course. This does not mean that individuals in region I of the figure 4 do not have a larger probability of enrolling in one-year courses. When we test if the sum of $\alpha_1 + \alpha_2 + \alpha_3$ the result is a p value below 0.05. However, what we can conclude is that for two-year courses, receiving the first offer only increases the probability of enrolling if the individual is eligible for financial aid.

Combining results from the estimations in one- and two-year courses we can conclude that financial aid gains importance when the opportunity cost of studying increases. This is the case when individuals need to stay not one year but two years outside the labor market in order to study.

Table 7 presents the importance of our running variables on the chance of completing the instructional period and obtaining a diploma at Sena. However, none of these discontinuities have any effect on completion once the individual has taken part in Senas educational process. A feasible interpretation of the results shown in this table is that once the admitted student obtains a quantity of money to pay for her daily expenses, the probability of obtaining the diploma depends on reasons other than the cost of maintenance and the difficulty of the course. Furthermore, our hypothesis is reaffirmed by the fact that the size of the coefficients for the completion outcome are smaller than that of the models whose outcome variable is completed on the condition of being enrolled.

5.3 Heterogeneity of results

In this section, we study how our results may change for different types of individuals. Our focus is further understanding the role of liquidity constraints checking if our estimates do change when the economic environment is more or less likely to have higher constraints to post-secondary education.

The two previous sections show differential effects by gender. First, table 2 show no heterogeneous effect on enrollment rates by gender in the case of the Sisben and the exam's discontinuity. Although, when we analyze the returns to Sena schooling on labor market participation, we found no returns to women. When we instrument schooling, the resulting coefficient for women is never significantly different than zero (tables 4 and 5). In addition, MRD estimations showed the positive effect of financial aid in enrollment for individuals who

Table 7: Double discontinuity estimation on studies completion in Sena

	one-year course			2 years course		
	All	Female	Male	All	Female	Male
Panel A: Completed studies						
Sisben discontinuity (α_1)	0.031	0.018	0.056	0.008	0.007	0.011
	(0.023)	(0.051)	(0.037)	(0.008)	(0.009)	(0.009)
Exam discontinuity (α_2)	0.002	-0.013	0.041	-0.006	-0.013^{+}	0.001
	(0.036)	(0.056)	(0.029)	(0.004)	(0.007)	(0.004)
Sisben x Exam (α_3)	0.005	0.017	-0.014	0.006*	0.005	0.006
	(0.016)	(0.019)	(0.018)	(0.003)	(0.006)	(0.004)
Joint significance tests						
$H_0 : \alpha_1 + \alpha_3 = 0$	0.233	0.570	0.275	0.045	0.068	0.110
$H_0 : \alpha_2 + \alpha_3 = 0$	0.784	0.941	0.305	0.949	0.361	0.026
$H_0 : \alpha_1 + \alpha_2 + \alpha_3 = 0$	0.321	0.738	0.132	0.296	0.906	0.051
Sisben's bandwidth	12.93	12.93	12.93	13.86	13.86	13.86
Exam's bandwidth	5.70	5.70	5.70	9.96	9.96	9.96
R^2	0.12	0.16	0.14	0.07	0.09	0.07
N	5677	2606	3071	16792	7824	8968
Panel B: Completed studies | enrolled						
Sisben discontinuity (α_1)	0.064	0.048	0.145	0.012	-0.000	0.021
	(0.081)	(0.153)	(0.137)	(0.025)	(0.045)	(0.024)
Exam discontinuity (α_2)	-0.104	-0.236*	0.082	-0.019	-0.048	-0.015
	(0.082)	(0.108)	(0.081)	(0.027)	(0.045)	(0.024)
Sisben x Exam (α_3)	-0.024	-0.029	-0.051	0.024^{+}	0.013	0.034
	(0.027)	(0.042)	(0.051)	(0.014)	(0.019)	(0.025)
Joint significance tests						
$H_0 : \alpha_1 + \alpha_3 = 0$	0.604	0.898	0.467	0.215	0.706	0.160
$H_0 : \alpha_2 + \alpha_3 = 0$	0.088	0.020	0.677	0.810	0.498	0.158
$H_0 : \alpha_1 + \alpha_2 + \alpha_3 = 0$	0.568	0.284	0.275	0.513	0.464	0.177
Sisben's bandwidth	13.09	13.09	13.09	12.43	12.43	12.43
Exam's bandwidth	7.82	7.82	7.82	7.89	7.89	7.89
R^2	0.20	0.27	0.24	0.19	0.27	0.19
N	2067	961	1106	3508	1523	1985

Notes: As per table 6.

applied to two-year courses. This effect is only significant for men.

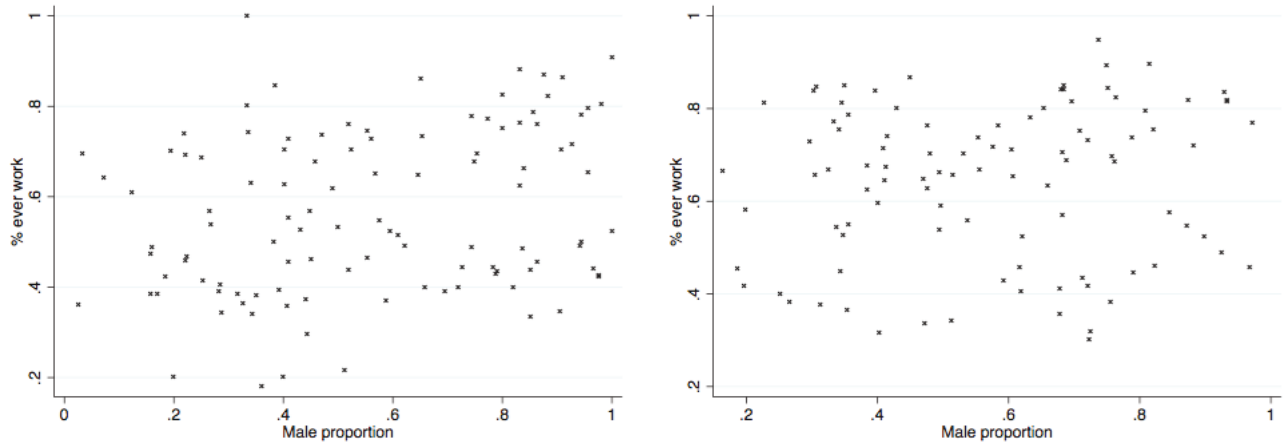
The latest findings show two things. First, our evidence of liquidity constraints only applied for men. Second, we do not find positive returns to Sena schooling for women. Multiple hypotheses can explain this difference.

Firstly, women and men may choose different courses with lower average returns. Figure 5 shows evidence that there is no sorting with respect to gender. The figure compares the average return by course type as the probability of working in the formal sector after studying with the proportion of males applying to each course type. The figure shows no correlation between male participation and average returns for neither one- or two-year courses.

Another possible explanation is related to the effects of fertility and informality. Our sample includes individuals from 18 to 24 years old (around 20 to 26 years old when we analyze labor market participation). According to our data, labor market participation is larger for men (63% and 56% for men and women respectively). In addition, by age 25, 51% of women already have their first child, the percentage increase to 73.5% by age 29 (Profamilia, 2016). Given that we do not observe neither unemployment, informal labor market participation or the likelihood of being outside of the labor market, we cannot test if women prefer informality or leaving the labor market in order to take care of their children.

Additionally, we explore four other dimensions. First, we compare individuals who were assessed in area

Figure 5: Average labor market participation and male proportion by course type



(a) one-year course

(b) two-year course

Notes: Authors calculations using Sena and PILA information. 246 courses in total.

1 (main urban areas) with individuals from areas 2 and 3. Second, we divide the population into individuals who studied in a departmental capital city, which are usually cities where labor markets are more dynamic and also the supply of tertiary education is larger. Third, we separate individuals according to their age when they applied to Sena in two groups, individuals from 18 to 20 years old and individuals from 21 to 24 years old. Fourth, we analyze individuals using a proxy for migration. We define as migrant an individual who applied to study in a municipality different from the municipality where she was assessed for the Sisben score.

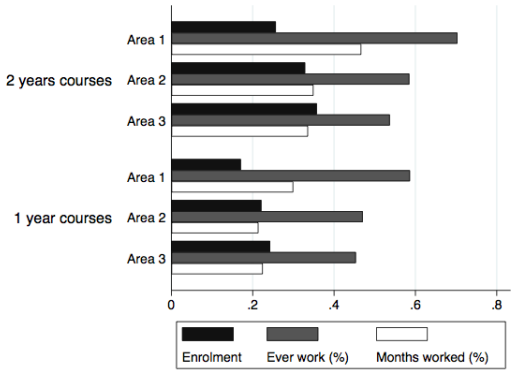
Figure 6 shows the average enrollment and labor market participation by each category of analysis. There are some patterns in the data. Enrollment is lower in area 1 but labor market participation is larger. The comparison between capital and non-capital cities follow a similar pattern. Moreover, enrollment decreases and labor market participation increases with age. Finally, there are not difference in average enrollment and labor market participation with respect to migration.

We estimate equations 1 and 2 for each category and show the estimated coefficients in figure 7. For one-year courses we do not find any significant difference by any variable and group. However, for two-year courses the area of origin seems to have an effect on the estimated impact of each discontinuity. On the one hand, individuals in Area 1 (main metropolitan areas) seem to react less to eligibility to financial aid than individuals from other areas. On the other hand, individuals in Area 1 seem to react more to receiving the first offer than individuals from other areas.

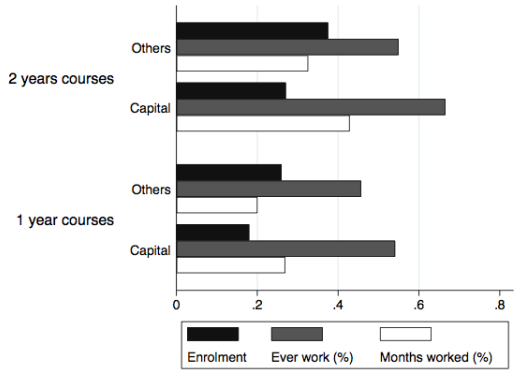
To explain the latest differences we have some hypotheses. The first factor that could explain this difference is migration. Individuals from area 1 are less likely to migrate than individuals from rural areas. A migrant individual may have higher maintenance costs and is therefore more likely to need financial aid. In addition, without financial aid, a migrant individual is less likely to use her place in a course and therefore the effect of the exam discontinuity is smaller. However, as we can see in the same figure, even though the estimated impacts of each discontinuity have the expected relationship, the differences between migrants and non-migrants are not statistically significant.

A second factor explaining the difference between areas could be access to other sources of credit – formal

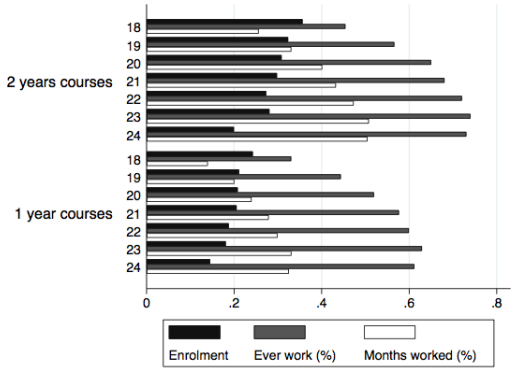
Figure 6: Labor market participation and enrollment rates by groups (one- and two-year courses)



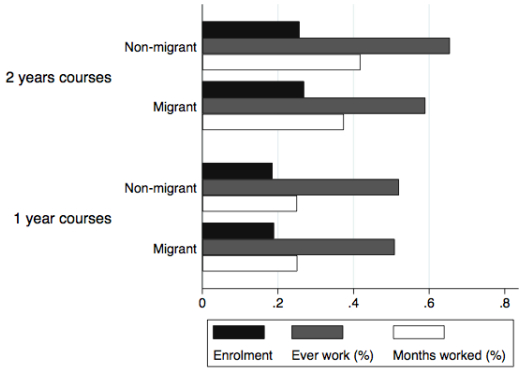
(a) By area



(b) Capital city and others



(c) By age

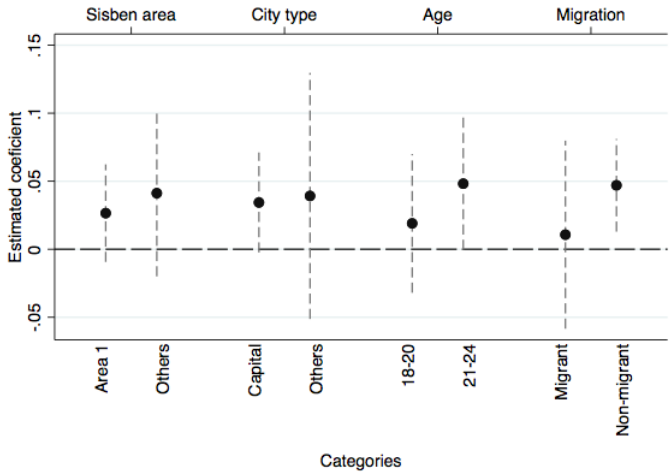


(d) By migration status

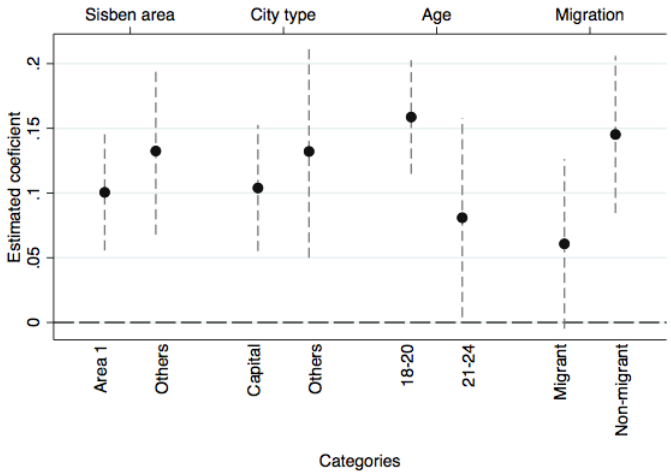
Notes: Authors calculations using Sena and PILA information. 246 courses in total.

Figure 7: Estimated RD coefficients on enrollment for each discontinuity by categories

one-year courses

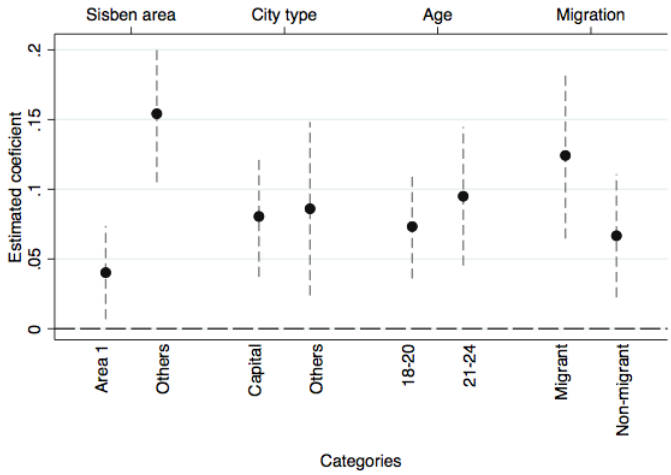


(a) Sisben discontinuity - β_1

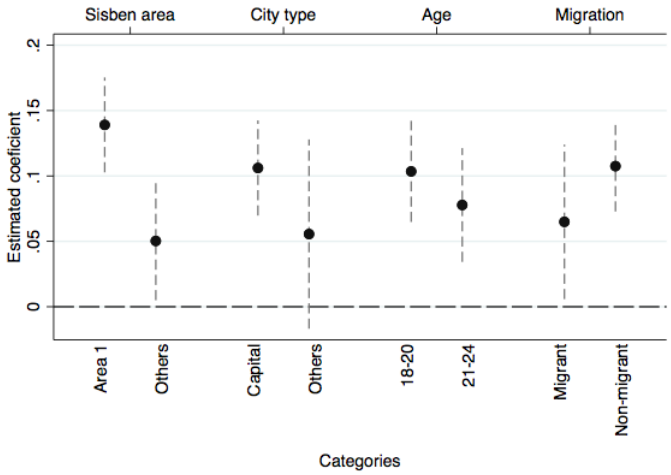


(b) Exam discontinuity - ρ_1

two-year courses



(c) Sisben discontinuity - β_1

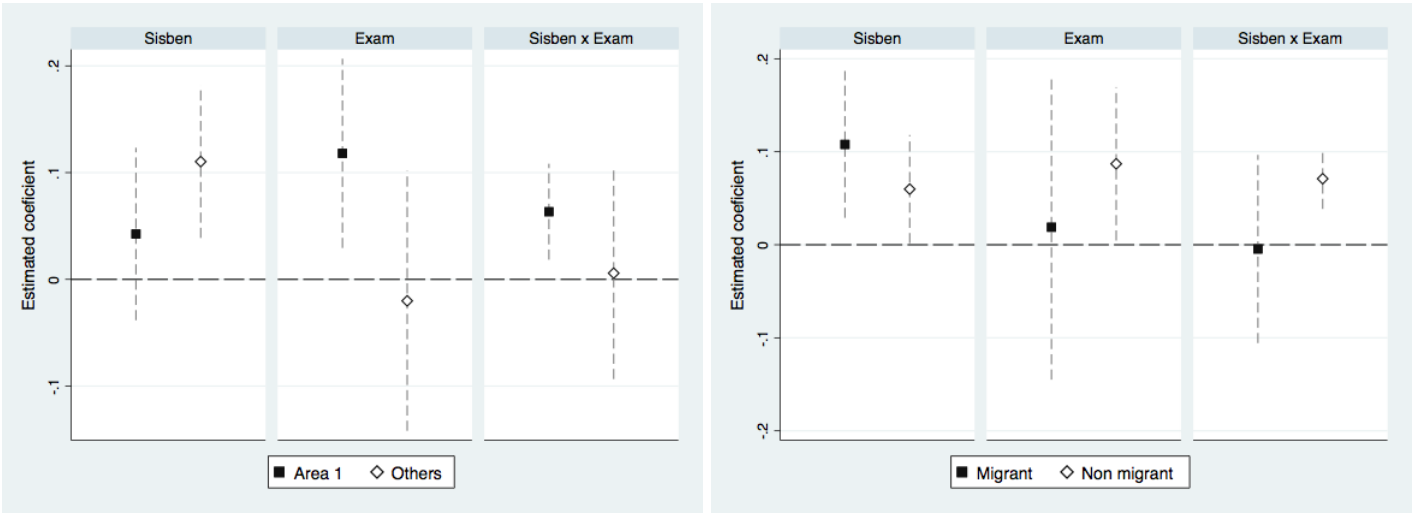


(d) Exam discontinuity - ρ_1

Notes: Following equations 1 and 2. Control variables as per table 2. 95% coefficients intervals.

and informal. Individuals from area 1 may have access to larger social networks that could allow them to borrow money or even study without working. Therefore, their sensibility to financial aid is smaller than the sensibility of those who come from more rural areas. Unfortunately, with our data we cannot test this hypothesis.

Figure 8: Double discontinuity estimations on enrollment in Sena by Sisben area and migration status (For applicants to two-year courses)



(a) By area

(b) By migration status

Notes: As per table 6.

Using the MRD analysis we can check if individuals by both margins, poverty and exam discontinuity, react differently when they come from different areas. Therefore, we estimate equation 5 for individuals in each group. We also check differences by migration status to support the analysis by area. Figure 8 shows the resulting estimates. The differences we found before disappear. Therefore, in the margin, we do not find evidence of differential effects by region or migration status.

5.4 Measurement error

According to Griliches (1977) and Angrist and Keueger (1991), another reason from which IV estimates are large than OLS estimates is that measurement error could overcome the effect of the ability bias. In our case, we can argue that the possibility of measurement error comes from other alternatives of post-secondary education different from Sena. Therefore, our estimations of returns to schooling are not capturing the returns of individuals that may have taken other vocational courses or may have even joined college. There are some results in our estimations that support the idea that our estimations capture the effect of liquidity constraints and not the effect of measurement error.

The use of two RD designs allows us to think that both instruments are orthogonal to the possible measurement error. If the instruments were not orthogonal and the results were driven by the possibility of measurement error, we would have found that IV estimates are larger than OLS estimates for the case of discontinuity in the entry exam as well.

Another possibility is that the likelihood of demanding post-secondary education different from Sena decreases with the availability of financial aid. Therefore, the effect of measurement error is larger for individuals who are eligible for JeA, which explains why IV estimates are larger than OLS in the case of the Sisben discon-

Table 8: Effect of enrollment in Sena for applicants to two-year courses on formal labor market participation. OLS vs IV estimates using Sisben discontinuities as instrument. Capital city vs non-capital city.

	Proportion of months working		Work in the last semester	
	Capital	Others	Capital	Others
OLS	0.041^{**}	0.037^{*}	0.030^{**}	0.036^{*}
	(0.008)	(0.014)	(0.010)	(0.015)
IV	1.043^{**}	0.799^{+}	0.978^{*}	0.778
	(0.377)	(0.447)	(0.458)	(0.758)
F test	15.41	14.55	15.05	14.37
R^2	-0.49	-0.32	-0.25	-0.12
Bandwidth	10.79	14.67	10.45	14.56
N	18258	7152	17674	7079

Notes: As per table 2.

tinuity.

Following this logic, one can expect that the bias was even stronger in cities with a larger supply of tertiary education, such as capital cities. However, when we estimate the differences between OLS and IV for individuals who applied to Sena in capital cities and other cities, we find that the effect is similar in both. The only difference arises because our estimates are less precise for the estimations using individuals who did not apply in a capital city.

6 Conclusions

Nobody doubts the importance of investing in human capital for individual and social welfare. However, access to tertiary education is strongly correlated with initial individual welfare. Different factors such as ability, taste and access to credit explain this correlation. In this paper, we provided evidence in favor of the effect of monetary aid to increase enrollment in vocational studies for vulnerable low-income young individuals.

We used different approaches to show that liquidity constraints do reduce enrollment rates, even in the case of free vocational education in Colombia. We found evidence of liquidity constraints for men, but we did not find statistically significant returns to vocational education for women.

This paper expands the debate about the ways to increase access to post-secondary education for low-income individuals. Despite tuition are still the most important cost of tertiary education, policies that only take into account reducing these fees may have limited efficiency, especially when the maintenance and opportunity cost increase.

References

Alfonso, M. (2009). Credit constraints and the demand for higher education in latin america. Working paper 3, IADB. Education Division.

Álvarez, M. J., Castro, C., Corredor, J., Londoño, J., Maldonado, C., Rodríguez, C., Sánchez, F., Pulido, X., et al. (2017). El programa ser pilo paga: Impactos iniciales en equidad en el acceso a la educación superior y el desempeño académico. Technical report, UNIVERSIDAD DE LOS ANDES-CEDE.

Angrist, J. D. and Keueger, A. B. (1991). Does compulsory school attendance affect schooling and earnings? *The Quarterly Journal of Economics*, 106(4):979–1014.

Attanasio, O., Guarín, A., Medina, C., and Meghir, C. (2017). Vocational training for disadvantaged youth in colombia: A long-term follow-up. *American Economic Journal: Applied Economics*, 9(2):131–143.

Attanasio, O. and Kaufmann, K. (2009). Educational choices, subjective expectations, and credit constraints. Working Paper 15087, National Bureau of Economic Research.

Attanasio, O., Kugler, A., and Meghir, C. (2011). Subsidizing vocational training for disadvantaged youth in colombia: Evidence from a randomized trial. *American Economic Journal: Applied Economics*, 3(3):188–220.

Belley, P., Frenette, M., and Lochner, L. (2014). Post-secondary attendance by parental income in the us and canada: Do financial aid policies explain the differences? *Canadian Journal of Economics/Revue canadienne d'économique*, 47(2):664–696.

Belzil, C., Maurel, A., and Sidibé, M. (2017). Estimating the value of higher education financial aid: Evidence from a field experiment. (23641).

Brown, M., Karl Scholz, J., and Seshadri, A. (2011). A new test of borrowing constraints for education. *The Review of Economic Studies*, 79(2):511–538.

Calonico, S., Cattaneo, M. D., and Titiunik, R. (2014). Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica*, 82(6):2295–2326.

Cameron, S. V. and Taber, C. (2004). Estimation of educational borrowing constraints using returns to schooling. *Journal of political Economy*, 112(1):132–182.

Card, D. (2001). Estimating the return to schooling: Progress on some persistent econometric problems. *Econometrica*, 69(5):1127–1160.

Carneiro, P. and Heckman, J. J. (2002). The evidence on credit constraints in post-secondary schooling. *The Economic Journal*, 112(482):705–734.

Cattaneo, M. D., Jansson, M., and Ma, X. (2016). rddensity: Manipulation testing based on density discontinuity. *The Stata Journal (ii)*, pages 1–18.

Didriksson, A. (2018). The new agenda for the transformation of higher education in latin america. Technical report, Global University Network for Innovation.

Flannery, D. and ODonoghue, C. (2013). The demand for higher education: A static structural approach accounting for individual heterogeneity and nesting patterns. *Economics of Education Review*, 34:243–257.

Fuller, W. C., Manski, C. F., and Wise, D. A. (1982). New evidence on the economic determinants of postsecondary schooling choices. *Journal of Human Resources*, pages 477–498.

González-Velosa, C., Rucci, G., Sarzosa, M., and Urzúa, S. (2015). Returns to higher education in chile and colombia. Technical report, Inter-American Development Bank.

Griliches, Z. (1977). Estimating the returns to schooling: Some econometric problems. *Econometrica: Journal of the Econometric Society*, pages 1–22.

Imbens, G. W. and Angrist, J. D. (1994). Identification and estimation of local average treatment effects. *Econometrica*, 62(2):467–475.

Keane, M. P. and Wolpin, K. I. (2001). The effect of parental transfers and borrowing constraints on educational attainment. *International Economic Review*, 42(4):1051–1103.

Lee, D. S. and Lemieux, T. (2010). Regression discontinuity designs in economics. *Journal of economic literature*, 48(2):281–355.

Lochner, L. J. and Monge-Naranjo, A. (2011). The nature of credit constraints and human capital. *The American Economic Review*, pages 2487–2529.

Mincer, J. (1974). Schooling, experience, and earnings. human behavior & social institutions no. 2.

Murakami, Y. and Blom, A. (2008). Accessibility and affordability of tertiary education in brazil, colombia, mexico and peru within a global context.

Murcia, A. (2007). Determinantes del acceso al crédito de los hogares colombianos. *Ensayos sobre Política Económica*, 25(55):40–83.

Papay, J. P., Willett, J. B., and Murnane, R. J. (2011). Extending the regression-discontinuity approach to multiple assignment variables. *Journal of Econometrics*, 161(2):203–207.

Profamilia (2016). Encuesta nacional de demografía y salud 2015. Technical report, Profamilia.

Prosperidad-Social (2014). Aseguramiento al sistema general de seguridad social en salud. Technical report, Departamento Administrativo para la Prosperidad Social, Bogotá - Colombia.

Prosperidad-Social (2017). Manual operativo programa jóvenes en acción. Technical report, Departamento Administrativo para la Prosperidad Social, Bogotá - Colombia.

Rau, T., Rojas, E., and Urza, S. (2013). Loans for higher education: Does the dream come true? Working Paper 19138, National Bureau of Economic Research.

Solis, A. (2017). Credit access and college enrollment. *Journal of Political Economy*, 125(2):562–622.

A Validity of the RD design

According to Lee and Lemieux (2010), in order to estimate a policy's causal effect using RD, two conditions must be fulfilled. (*i*) All observable and unobservable characteristics are continuously related with the factor variable. (*ii*) Individuals are not able to manipulate the factor variable. In this section we show evidence that both assumptions hold for in the cases of the Sisben score and the entry exam score.[16]

Figure 9 shows graphical representation of the continuity in confounding characteristics around Sisben's cutoff (panels a to e for one-year courses and panels f to j for two-year courses). We do not observe any strong change (a jump) around the cutoff for all the observable variables. However, the Sisben is employed to select the beneficiaries for many other social programs in Colombia. Consequently the same cutoffs are used by JeA as well as subsidised healthcare (RSS).[17] RSS provides access to medical services without paying periodical contributions and reduced co-payments to low-income households, specifically to individuals without a formal job (or in a household where the head has no formal job) and living in a household with a Sisben score below the cutoff points we use in this paper.[18]

Hence, identification could be compromised because individuals just below the cutoff are not only eligible to JeA, but also to the RSS. Possible bias comes from the correlation between the decisions of demanding education in Sena and RSS's benefits. On the one hand, correlation may be negative because seeking tertiary education in Sena is a signal of a desire to obtain a job in the formal labor market, but once an individual signs a contract, she losses her RSS benefits. On the other hand, RSS means lower expenditure in healthcare. Therefore, individuals may have less pressure to work after finishing high school and require more income to cover the costs of studying at Sena.

Figure 10 shows the change in enrollment in Sena due to the Sisben's discontinuity by application semester. As we can see, when we take into account the participants in JeA the coefficients change from a positive sign to a negative sign. This result can support the idea of a negative correlation between eligibility to RSS and JeA. As result, our estimates may underestimate the total impact of being eligible for financial aid.

Regarding the entry exam, figure 11 shows the behavior of observable variables around each course cutoff. It is important to remember that the cutoffs were simulated using the effect that JeA's AA has on enrollment. We do not find again significant jumps around the cutoffs. The small discontinuities in the Sisben score are the result of changes in the cutoff due to the AA. However, in appendix B we discuss that these changes only affect a small proportion of our sample and do not change the ability distribution of enrollees.

The second assumption for RD estimations means that individuals cannot manipulate their score. Figure 12 shows the distribution of each score around the cutoffs following Cattaneo et al. (2016). Based on the figure and the discontinuity test we reject the hypothesis of manipulation of Sisben or exam scores by the cutoff.

Finally, for the estimation of the multiple regression discontinuity, we show that over the area around both discontinuities there are no drastic changes. Figure 13 shows that for our set of observable covariates there are not strong changes in the level of grey.

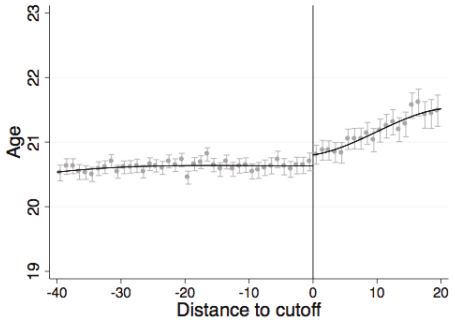
[16] It is important to point out that we test both assumptions only with our study sample, as explained in section 3

[17] RSS stands for Régimen Subsidiado en Salud in Spanish

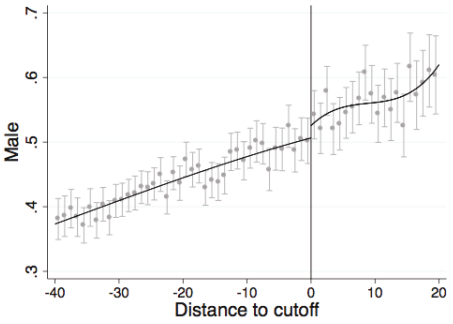
[18] Details about RSS in Prosperidad-Social (2014)

Figure 9: Continuity in observables around the Sisben's cutoff

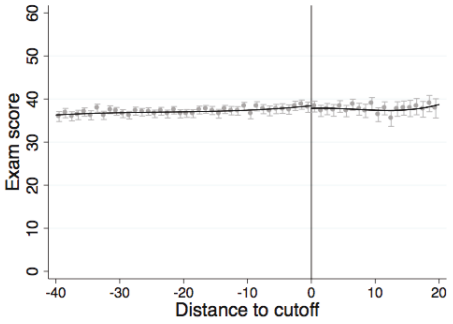
one-year course



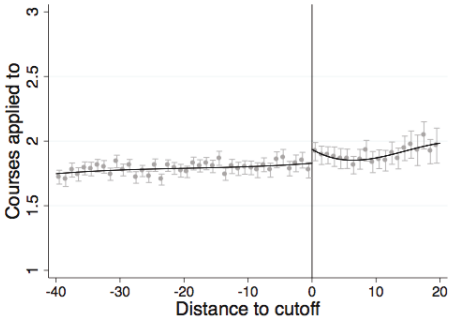
(a) Age



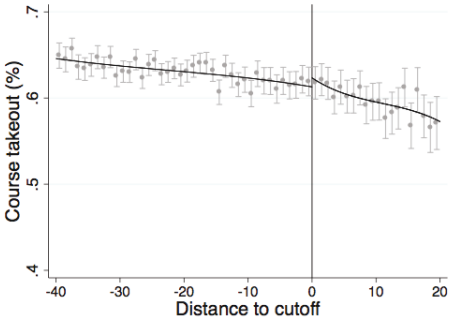
(b) Gender (% male)



(c) Entry exam score

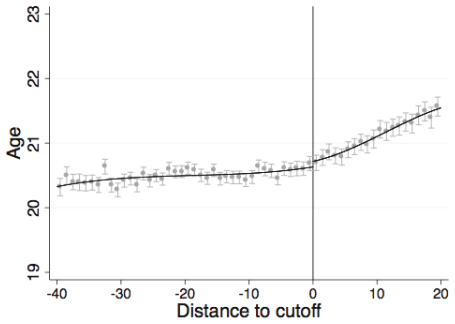


(d) Applications

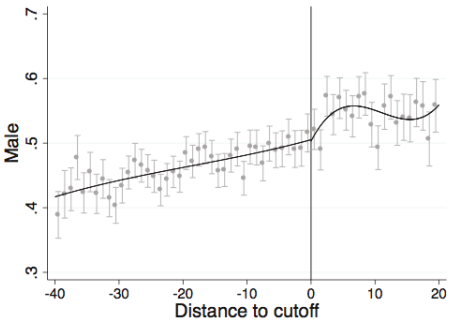


(e) % takeout

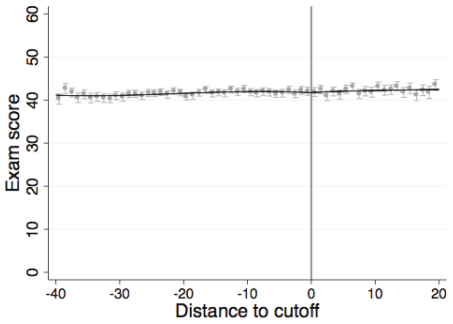
two-year course



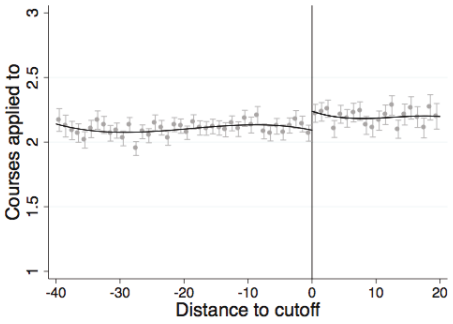
(f) Age



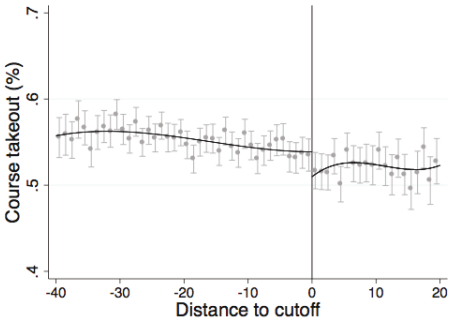
(g) Gender (% male)



(h) Entry exam score

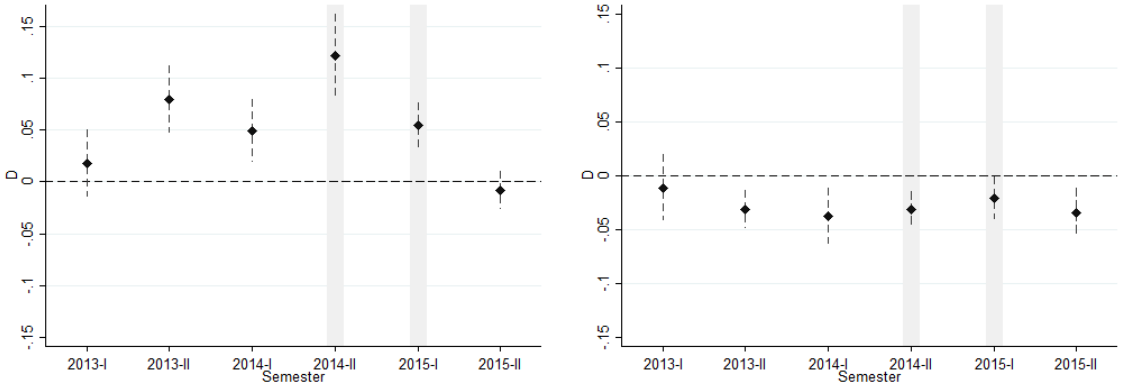


(i) Applications



(j) % takeout

Figure 10: Sisben discontinuity on enrollment in Sena by enrollment semester. Conditional and unconditional of JeA participation)

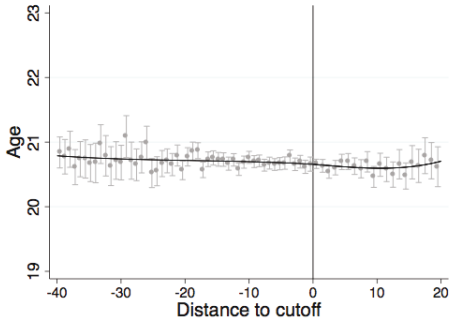


(a) Unconditional (b) Controlling by the effect of JeA

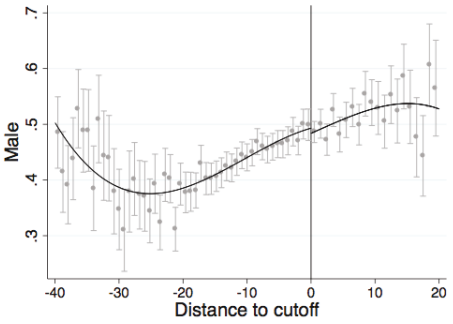
Using all applications from August 2013 to August 2015. The shades represent the period of our analysis. 95% confidence intervals in dashes lines.

Figure 11: Continuity in observables around the entry exam's cutoff

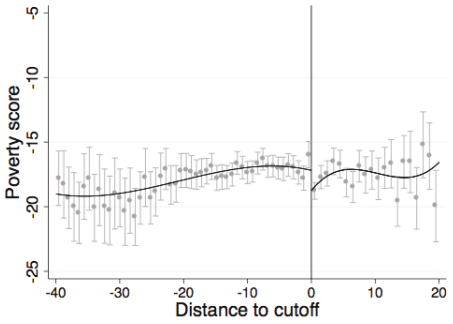
one-year course



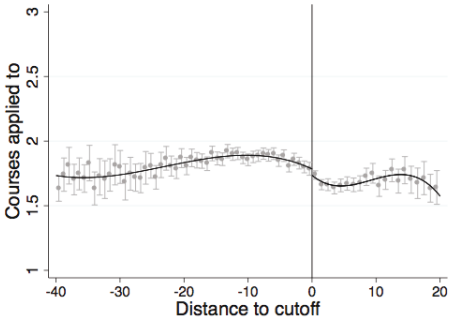
(a) Age



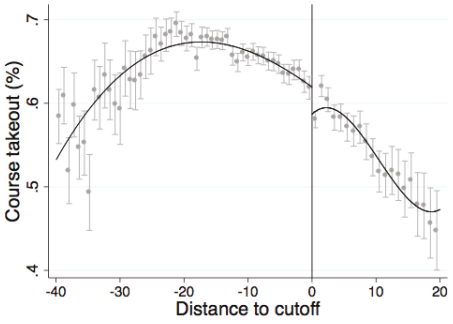
(b) Gender (% male)



(c) Sisben score

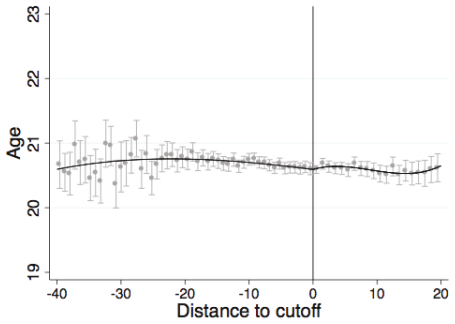


(d) Applications

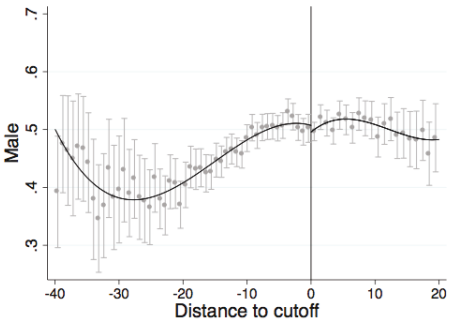


(e) % takeout

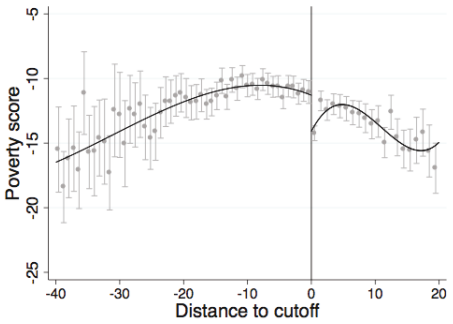
two-year course



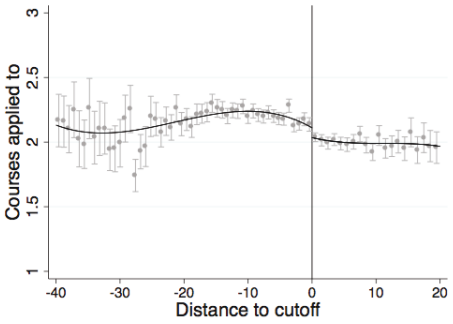
(f) Age



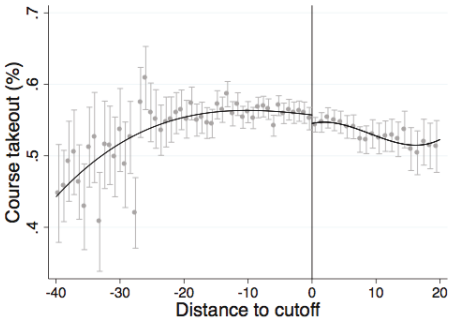
(g) Gender (% male)



(h) Sisben score



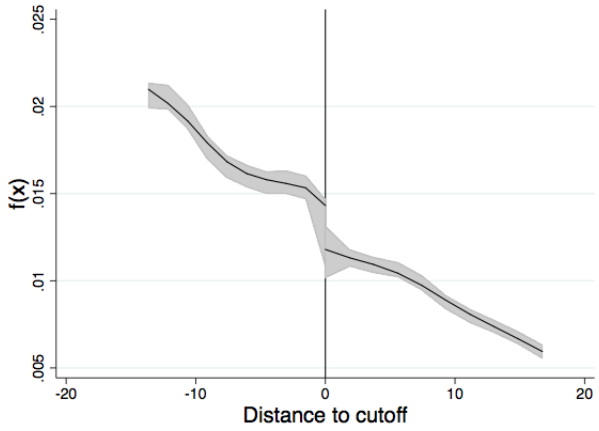
(i) Applications



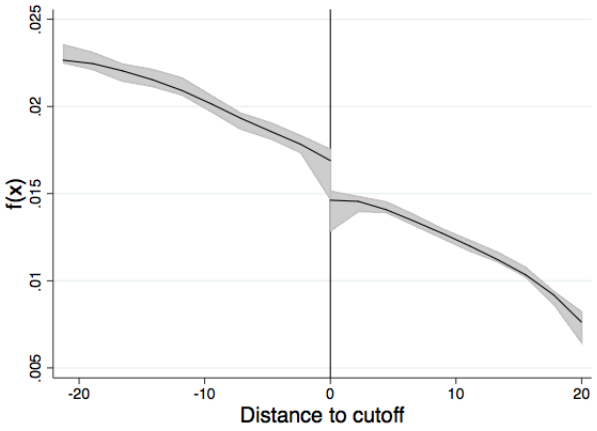
(j) % takeout

Figure 12: Manipulation test - density around the cutoff

Sisben score

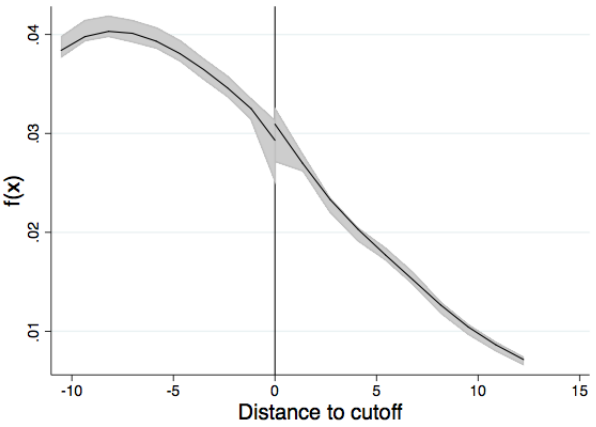


(a) 1y. course

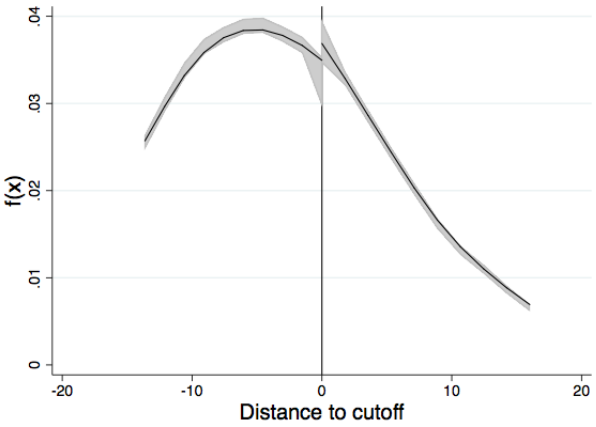


(b) 2y. course

Entry exam



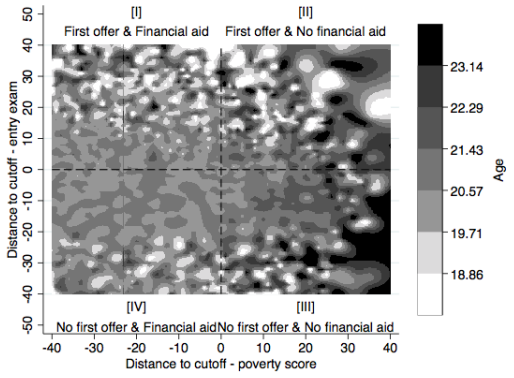
(c) 1y. course



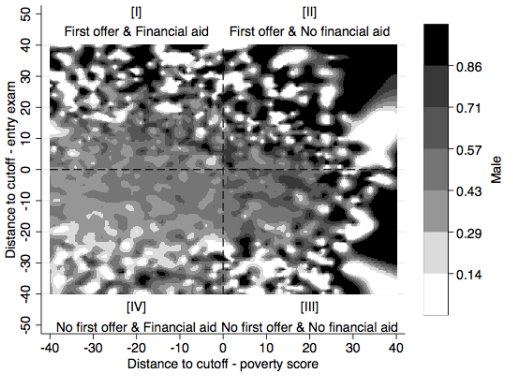
(d) 2y. course

Figure 13: Continuity in observables around the entry exam and Sisben's cutoff

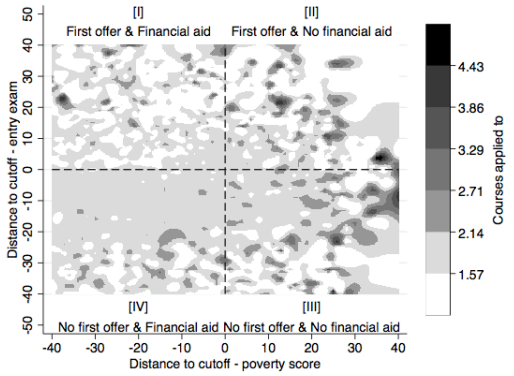
one-year course



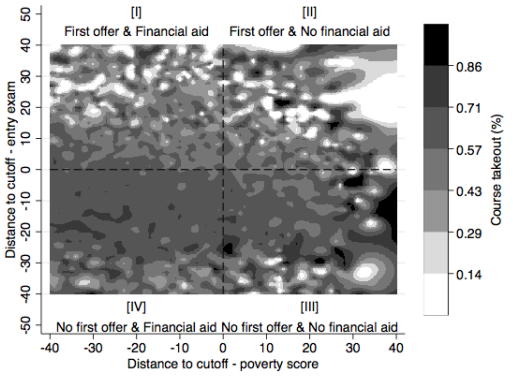
(a) Age



(b) Gender (% male)

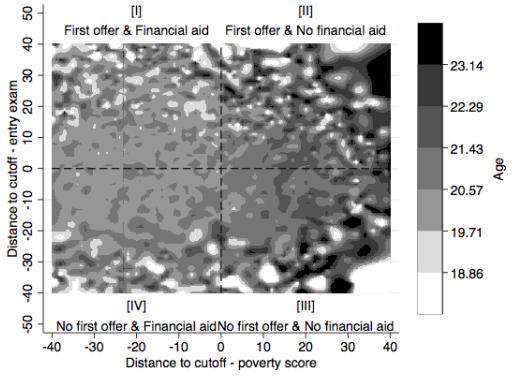


(c) Applications

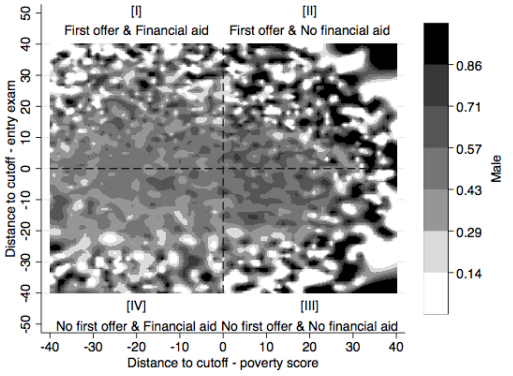


(d) % takeout

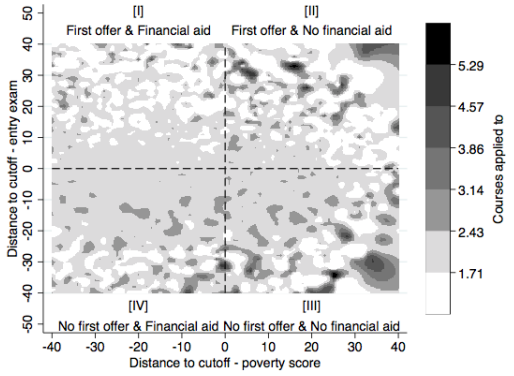
two-year course



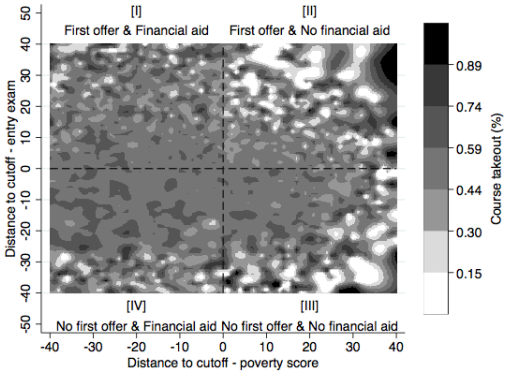
(e) Age



(f) Gender (% male)

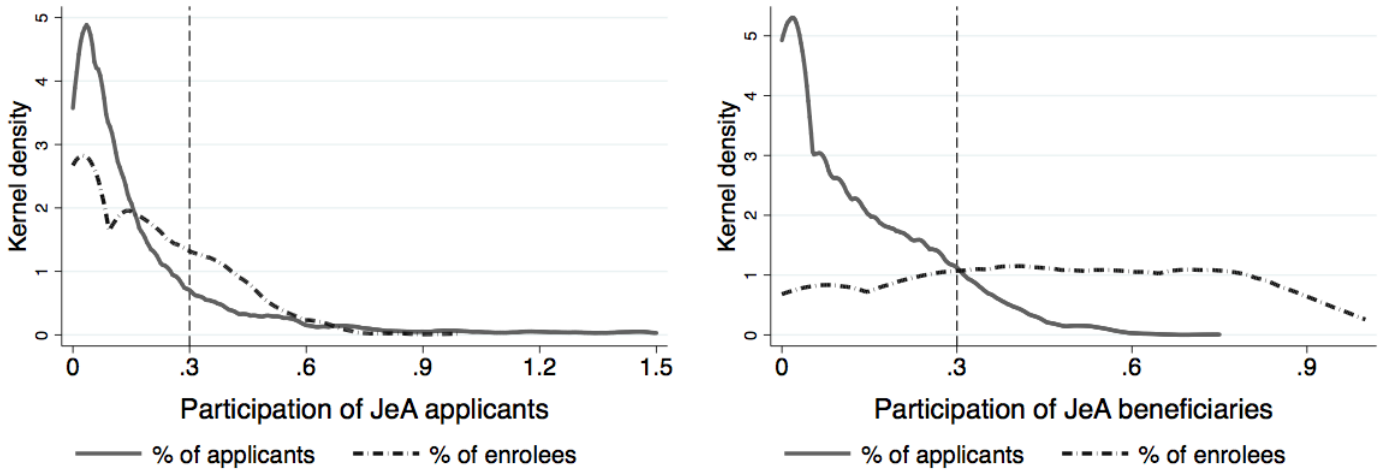


(g) Applications



(h) % takeout

Figure 14: Important of preferential entry. Distribution of the proportion of JeA applicants and JeA enrollees in a given course



(a) JeA applicants

(b) JeA beneficiaries

Notes: Authors' calculations using Sena applicants data.

B Affirmative action vs financial aid

As explained in section 4, τ_Y includes the effect of all JeA components on Y. In this section, we show evidence that, despite that the preferential entry do help some individuals to access into Sena, monetary aid does explain most of our results. Table 9 shows the affirmative action's effect on the composition of Sena applicants and enrollees.

Table 9: Preferential entry effect on Sena's composition

	Never offered first	First offer due to AA	Lost first offer due to AA	Always offered first
Entry exam's score	41.984	43.426	49.292	51.436
	(0.470)	(0.528)	(0.787)	(0.473)
% enrolled	0.072	0.467	0.291	0.505
	(0.008)	(0.026)	(0.025)	(0.017)
Individuals	78222	4799	3032	33736

Notes: Authors' calculations using data from Sena. Standard error is parentheses. Simulations based on the entry exam results using only courses with excess of demand and at least one JeA applicant.

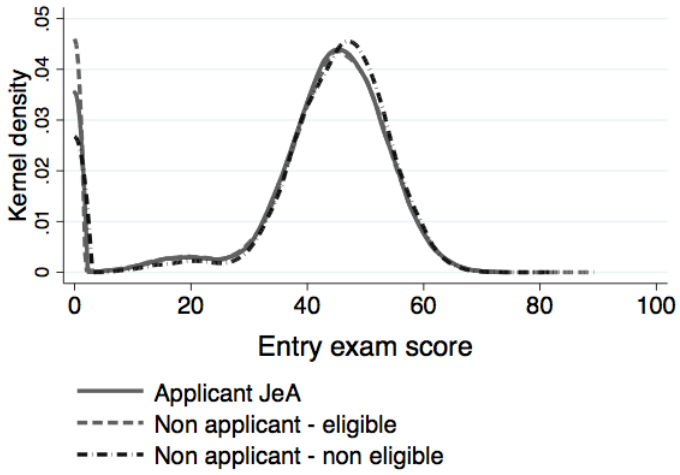
As we can see, 4799 individuals gain an offer due to JeA's preferential entry. This means that without being part of JeA, their score would not have been enough to gain a first offer to join a course. Among these individuals 47% enrolled in Sena. Furthermore, 3032 individuals who are not part of JeA did not get the first offer because their exam cutoff increased due to JeA's preferential entry. Nevertheless, 30% did enrolled in Sena. This means the preferential entry affected 6.5% of total applicants.

In addition, figure 14 shows that both the proportion of JeA applicants and beneficiaries among the total number of applicants and enrollees per course. None of these distributions jump around the preferential entry quota. The continuity around 30% shows that the preferential entry is not more binding than usual which is evidence of its low importance.

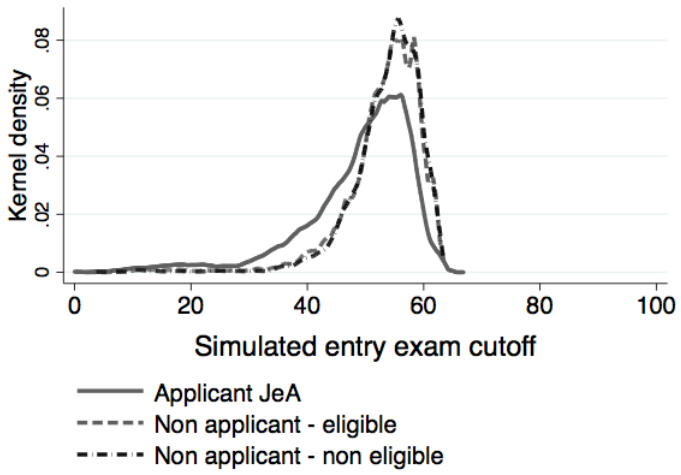
We can also test if the affirmative action changed the abilities distribution among Sena's applicants and enrollees. Panel a in figure 15 shows that there is no difference in the exam distribution among JeA applicants

and non-applicants (neither eligible or non-eligible ones). Therefore, one can say that JeA does not attracts better or worse applicants. However, panel b shoes how the simulated exam entry cutoff distribution for possible beneficiaries of the Program moves left with respect to the distribution of those who did not ask for the benefits of the Program. Nevertheless, when we see the distribution of the individuals that finally enroll in Sena, there are no differences in the exam score of JeA applicants and non-applicants. Then, the distribution of abilities of individuals enrolled in Sena did not depend on the effect that the affirmative action had on enrollment.

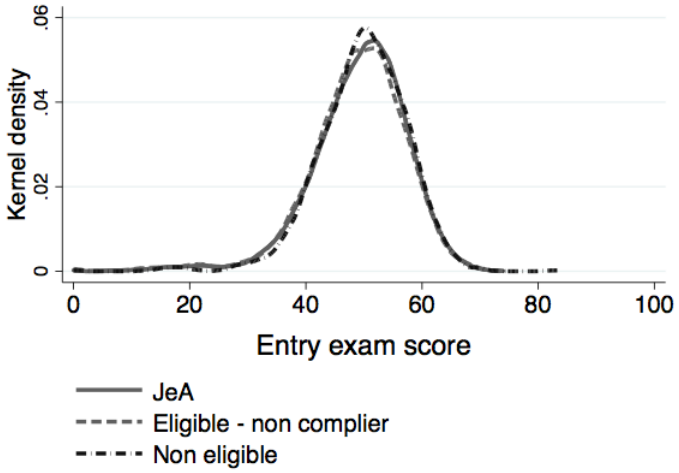
Figure 15: Sena entry exam and distribution of entry cutoffs for JeA applicants and non-applicants and enrollees



(a) Applicants



(b) Entry cutoff

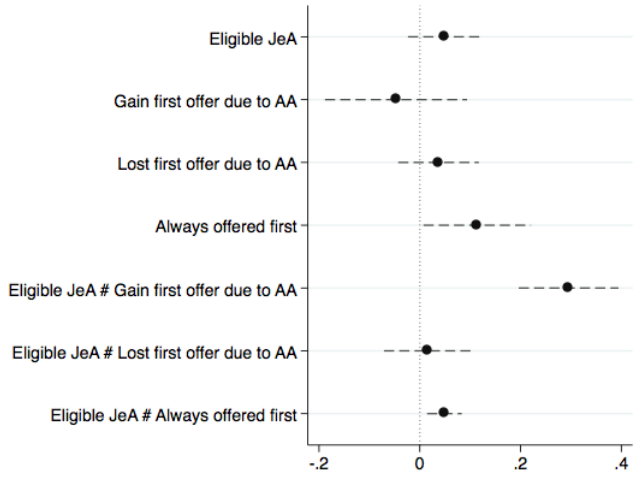


(c) Enrolled

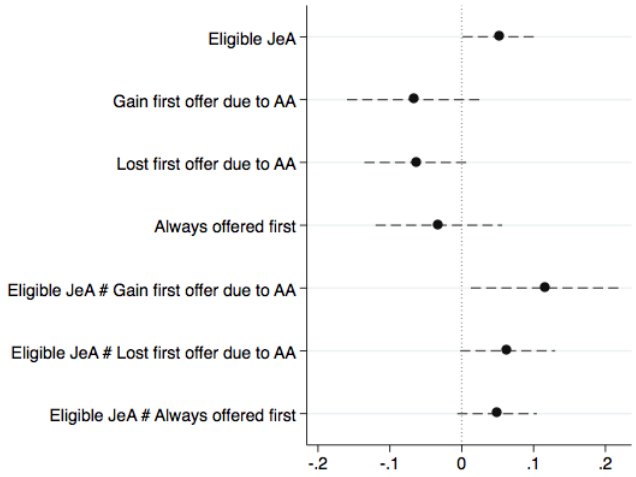
Notes: Authors' calculations using Sena applicants data.

Finally, figures 16 and 17 show the resulting coefficients of the interaction between being eligible for JeA and the different groups created due to the existence of the AA. Panel a in both figures show the effect of the AA on Sena enrollment. As expected, the effect of the Sisben discontinuity on enrollment is larger for those who got a first offer thanks to the AA. However, when we examine labor market outcomes, the latest difference vanishes.

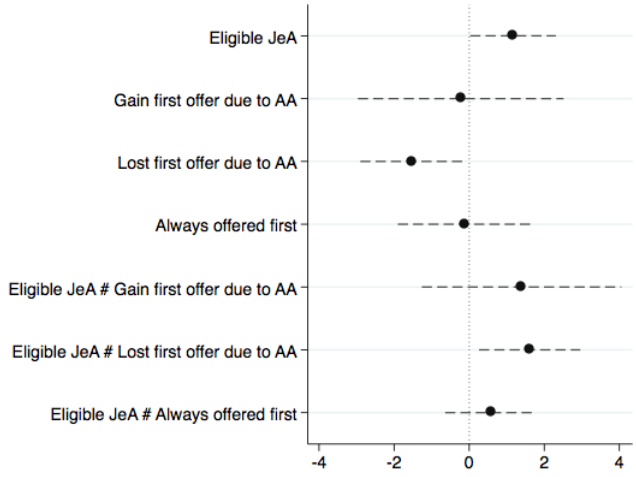
Figure 16: Coefficients of the interaction between JeA eligibility and preferential entry group on different outcome variables - one-year course



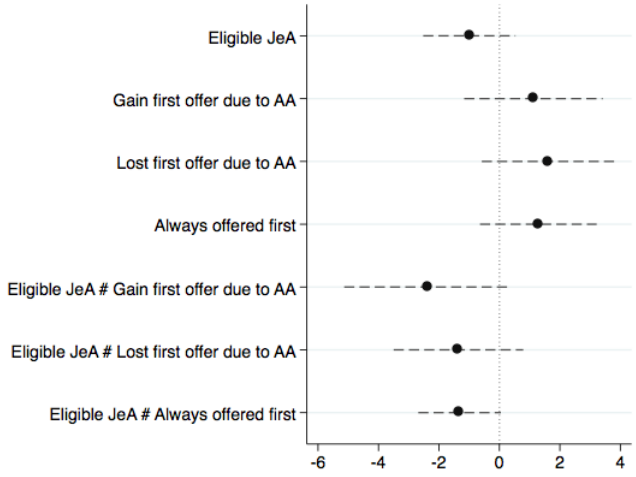
(a) Enrollment



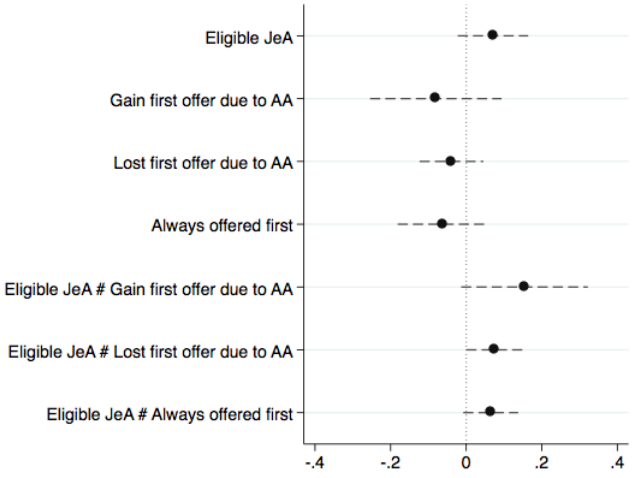
(b) Periods work



(c) Longest employment spell

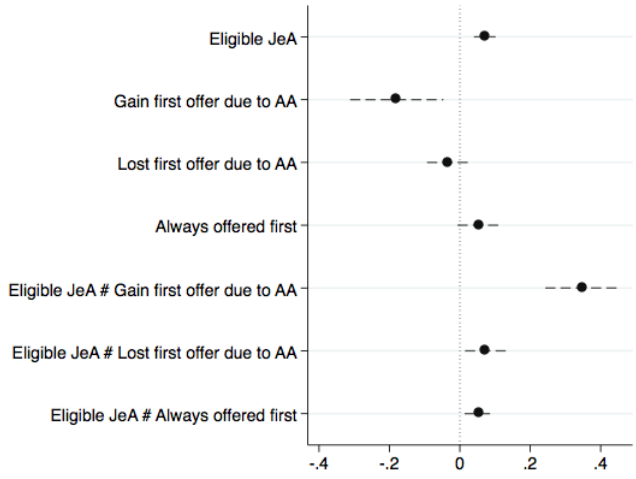


(d) Lonngest unemployment spell

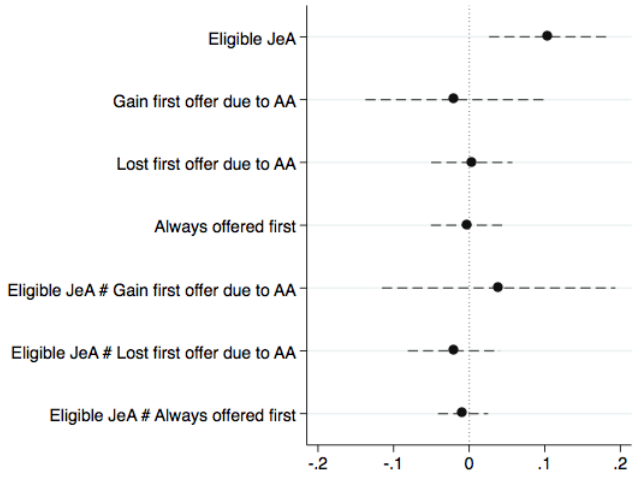


(e) Formal job in the last 6 months

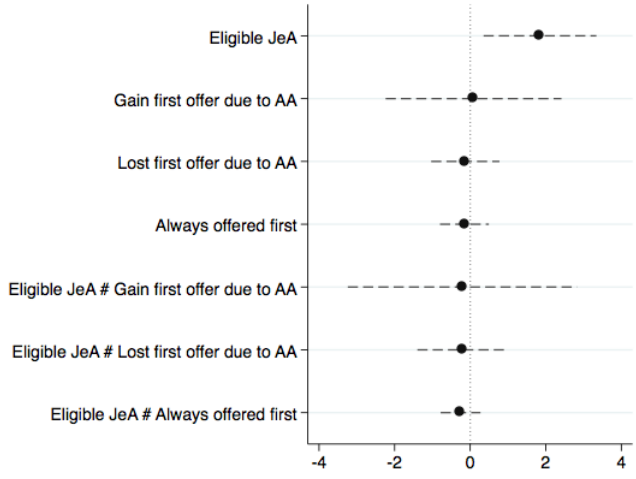
Figure 17: Coefficients of the interaction between JeA eligibility and preferential entry group on different outcome variables - two-year course



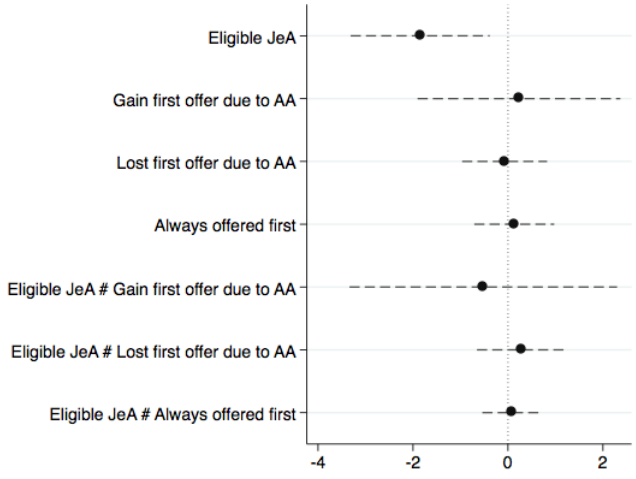
(a) Enrollment



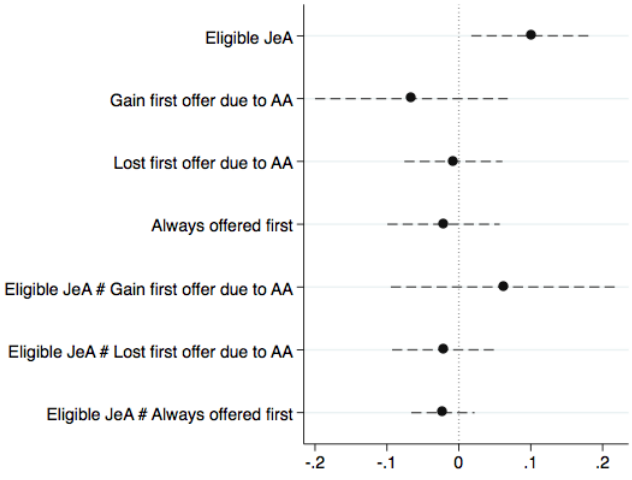
(b) Periods work



(c) Longest employment spell



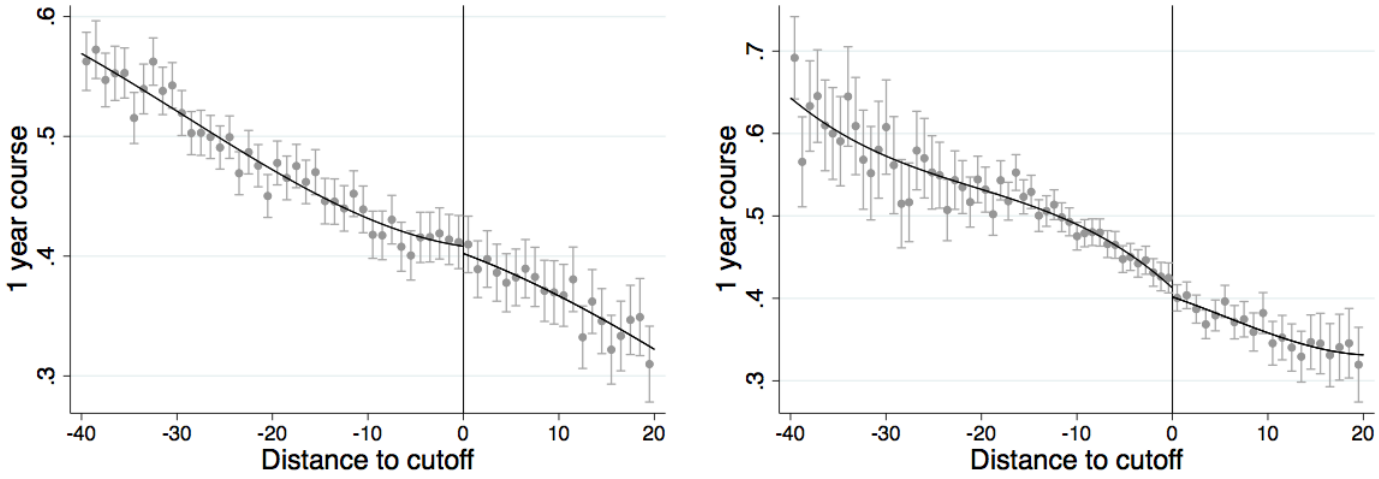
(d) Longest unemployment spell



(e) Formal job in the last 6 months

C Supplementary tables and figures

Figure 18: Probability of applying to a one-year course by Sisben score and entry exam



(a) Sisben score

(b) Entry exam

Table 10: Effect of enrollment in Sena on formal labor market participation for applicants to one-year course. OLS vs IV estimates using Sisben and entry exam discontinuities as instruments.

	Work at least 1 month				Proposition of months working				Work in the last semester			
	Sisben disc.		Exam disc.		Sisben disc.		Exam disc.		Sisben disc.		Exam disc.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: All												
Enrolled	0.086**	1.208+	0.096**	0.588*	0.041**	1.194	0.047**	0.284**	0.010	2.067+	0.017	0.484*
	(0.021)	(0.728)	(0.023)	(0.261)	(0.012)	(0.793)	(0.013)	(0.107)	(0.012)	(1.149)	(0.012)	(0.211)
F test		5.74		30.33		5.18		37.60		5.46		32.39
R^2	0.17	-0.28	0.18	0.02	0.16	-0.81	0.17	0.09	0.12	-1.42	0.12	-0.02
Bandwidth	12.34	12.34	4.71	4.71	12.49	12.49	4.33	4.33	12.28	12.28	5.18	5.18
N	18777	18777	15584	15584	19041	19041	14366	14366	18706	18706	16991	16991
Panel B: Women												
Enrolled	0.150**	3.968	0.132**	0.341	0.068**	2.416	0.062**	0.080	0.076**	7.561	0.026*	0.152
	(0.034)	(11.638)	(0.029)	(0.310)	(0.018)	(5.190)	(0.016)	(0.195)	(0.020)	(22.463)	(0.011)	(0.189)
F test		0.18		20.53		0.28		21.10		0.14		25.48
R^2	0.16	-4.33	0.15	0.13	0.14	-3.80	0.15	0.15	0.11	-17.93	0.10	0.09
Bandwidth	7.78	7.78	6.55	6.55	9.73	9.73	5.95	5.95	6.70	6.70	8.48	8.48
N	5692	5692	10855	10855	7040	7040	9946	9946	4883	4883	13746	13746
Panel C: Men												
Enrolled	0.066**	0.952	0.062**	0.602	0.037**	1.781	0.037**	0.589**	-0.003	2.208+	0.017+	0.899*
	(0.013)	(1.039)	(0.012)	(0.374)	(0.009)	(1.261)	(0.008)	(0.214)	(0.015)	(1.209)	(0.010)	(0.366)
F test		5.38		16.19		4.04		17.01		4.09		15.39
R^2	0.21	-0.10	0.21	0.02	0.19	-1.95	0.20	-0.17	0.14	-1.71	0.15	-0.33
Bandwidth	11.37	11.37	5.99	5.99	10.75	10.75	5.37	5.37	12.33	12.33	5.92	5.92
N	8830	8830	9381	9381	8324	8324	8507	8507	9648	9648	9290	9290

Notes: As per table 4.

Table 11: Effect of enrollment in Sena on formal labor market stability for applicants to two-year courses. OLS vs IV estimates using Sisben and entry exam discontinuities as instruments.

	Longest employment spell				Longest employment spell[1]				Longest unemployment spell			
	Sisben disc.		Exam disc.		Sisben disc.		Exam disc.		Sisben disc.		Exam disc.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: All												
Enrolled	0.861**	18.574	0.861**	5.879+	0.056	7.564	0.025	3.512	-1.052**	-35.388	-1.175**	-4.265
	(0.215)	(13.907)	(0.235)	(3.102)	(0.155)	(7.978)	(0.179)	(3.341)	(0.329)	(23.929)	(0.389)	(3.142)
F test		4.50		30.36		6.26		26.28		4.50		47.27
R^2	0.16	-0.27	0.17	0.10	0.08	-0.00	0.09	0.06	0.14	-1.01	0.16	0.14
Bandwidth	11.99	11.99	4.87	4.87	12.26	12.26	6.40	6.40	11.99	11.99	3.61	3.61
N	18211	18211	16004	16004	10835	10835	11656	11656	18211	18211	12322	12322
Panel B: Women												
Enrolled	1.511**	87.065	1.199**	0.113	0.348	3.615	0.148	-6.875	-1.867**	-98.006	-1.603**	-3.755
	(0.331)	(502.285)	(0.292)	(4.224)	(0.426)	(39.657)	(0.245)	(4.453)	(0.511)	(300.427)	(0.499)	(6.181)
F test		0.03		21.02		0.17		9.26		0.14		18.21
R^2	0.14	-9.78	0.14	0.14	0.10	0.08	0.08	-0.05	0.13	-8.28	0.15	0.14
Bandwidth	8.62	8.62	6.38	6.38	8.44	8.44	7.09	7.09	8.96	8.96	4.82	4.82
N	6246	6246	10614	10614	3289	3289	6088	6088	6483	6483	8152	8152
Panel C: Men												
Enrolled	0.633**	37.608	0.641**	13.436*	-0.110	32.670	-0.152	17.502**	-0.668*	-34.638	-0.900**	-17.891**
	(0.161)	(27.992)	(0.157)	(5.626)	(0.314)	(42.526)	(0.222)	(5.315)	(0.273)	(24.607)	(0.228)	(6.670)
F test		3.46		15.51		1.18		18.73		5.52		12.82
R^2	0.20	-1.61	0.20	-0.18	0.13	-1.39	0.11	-0.60	0.16	-0.99	0.17	-0.33
Bandwidth	10.65	10.65	5.77	5.77	8.25	8.25	8.44	8.44	11.33	11.33	4.84	4.84
N	8250	8250	9098	9098	4007	4007	7667	7667	8801	8801	7755	7755

Notes: As per table 4. [1] Conditional on having work at least one month.