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Returns to Higher Education: Vocational Education vs College[*]

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Abstract

Students scoring above a given threshold in the college admission test are eligible for education loans in Chile. Given the random variation in college enrollment induced by this cutoff rule, we use a regression discontinuity design to identify the marginal returns of vocational education versus college education. We use individual-level data on educational background and labor history for the universe of test takers in 2007. We find no differences in earnings, employment, or participation in the formal sector. Given the more expensive tuition fees, more years of instruction, and lower probability of graduation, the students induced to enroll in college have suffered from high-income losses in the margin.

1 Introduction

Numerous countries aim at fostering higher education to offset increasing wage inequality and increase long-run productivity without a precise measure of the returns to college. Massive and controversial evidence shows that the returns to college education of the marginal student are highly heterogeneous and, in fact, in many cases negative (Biewen and Tapalaga [2017] in Germany, McIntosh and Morris [2016] in the UK, Krafft [2017] in Egypt, González-Velosa et al. [2015] in Chile and Colombia, and Hanushek et al. [2017] in 18 countries.).

How to estimate marginal returns to traditional college education over vocational education remains as an open question. As it is well-known, estimating returns to schooling is difficult because of the endogeneity problem, where unobservable variables, such as the student's ability or household's background, explain earnings but are also correlated with education. Moreover, the endogeneity issue should be stronger in marginal low-income students due to the presence of unobservable credit constraints (Card [1999, 2001]), and the typical sorting in abilities (Carneiro and Heckman [2002]).

Using a regression discontinuity (RD) design, we estimate the marginal return to college education in a context where students were borrowing constrained and randomly granted with credit access. We use two loan programs that have been allowing low-income students to study in higher education based on a cutoff-rule at the college admission test. We argue that the requirements for loan eligibility create exogenous variation in schooling that can be used to identify the marginal returns to college relative to vocational education. Given that students cannot manipulate the admission test score, the position around the cutoff is as good as random.[1] The students who missed the cutoff by few points offer a good comparison group to those students who are eligible for publicly sponsored loans. Solis [2017] shows

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[1]Rau et al. [2013] argue a potential problem of a weak instrument for vocational students. We discuss this issue in turn.

that access to loans increases their education enrollment. Moreover, Card and Solis [2017] show that this finding also applies for dropout and graduation rates.[2]

Using individual-level data from social security records we identify whether students who barely score above the cutoff and receive college education display higher salaries relative to those who did not achieve the test cutoff and had to choose among vocational programs. We use data on earnings and labor experience from several years after the expected graduation of the students who took the college admission test in 2007. Social security records of legal contributions keep track of the mandatory payments that a worker in the formal sector must pay. We assume that a long spell without contributions implies unemployment and that some missing payments over the year imply a less stable job (perhaps part-time).

Based on our regression discontinuity estimates, we find a precise zero effect on earnings. Moreover, the impact of college relative to vocational education is not significative on unemployment rates and the probability of a more stable job. Furthermore, given more expensive tuition fees, more years of instruction, and lower likelihood of graduation, the students induced to enroll in college have suffered from high-income losses relative to those who study vocational programs.

We contribute to the literature on the analysis between two alternative paths of schooling for the marginal low-income student. We think community colleges in the US also fits in this debate, as they are considered the bridge between vocational educational (including 2-year college degrees) and standard 4-year degree at traditional universities (See Belfield and Bailey [2017] for an updated review). Many estimates of the return to community college education started after Kane and Rouse [1995] who present evidence of positive returns to

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[2]Using RD design to measure returns to schooling is prominent in the literature. Kirkeboen et al. [2016] and Hastings et al. [2013] identify returns to education between fields and institutions within college education. Hoekstra [2009] and Zimmerman [2014] use an RD design to estimate the marginal student choosing college education, and Goodman et al. [2017] use a similar approach to study whether the access to 4-year colleges affects degree completion for students who would otherwise attend 2-year colleges.

community college based on OLS regressions including test scores as a measure of ability. Also, given student's earnings previous to obtaining the community college degree, many papers use student fixed effects to measure the marginal return to schooling (Bettinger and Soliz [2016], Jepsen et al. [2014], Dadgar and Trimble [2015], Turner [2016]). Other papers have used an exogenous tuition increase (Denning [2017]), or instrumental variables based on the distance to community college and traditional universities (Mountjoy [2017]).

We also contribute to the literature on policy evaluation of state-guaranteed loans as the tool to increase college enrollment where policymakers have been discussing the convenience of free tuition for college versus vocational education (Beyer et al. [2015]). Estimating the returns to higher education in Chile, but using a completely different methodology, Rau et al. [2013] and Rodríguez et al. [2016] estimate a factor model (Hansen et al. [2004]) to measure returns to college accounting for sorting in unobserved heterogeneity. Using this structural approach, they found significant negative returns to the marginal student at the university. The authors suggest that the poor design of state-guaranteed-loan policies have induced low-quality colleges.

Finally, we show evidence on the effects of educational debts on labor outcomes. In recent papers, using data from the US, Field [2009] and Rothstein and Rouse [2011a] have shown that students holding debt have different labor outcomes relative to the students receiving grants. Our RD approach can also identify the effect on labor outcomes between students who receive a scholarship and those who paid the tuition with a loan. We find no difference in any labor outcome.

The paper proceed as follows: Section 2 describes the institutional background, Section 3 presents our data, Section 4 introduces the estimation strategy, Section 5 presents the results, and Section 6 concludes.

2 Institutional background

College tuition fees in Chile are relatively expensive and similar across institutions. As in the US, the Chilean university system contains public and privately-owned universities with considerable heterogeneity regarding quality and prestige.[3] The average annual tuition is about 4,200 dollars, equivalent to 47 percent of the median household income.[4] Even at the cheapest public universities, a family in the poorest quintile would pay about 84 percent of their available income to cover one-year tuition.[5] Since the average student takes 6.5 years to graduate (from a five-year program), students need to finance their higher education with aid and loans.

Moreover, lending institutions offer college loans to a very restricted portion of the population. Households seeking for student loans would be subject to a strict income eligibility criteria from banks. For the year 2007, the most generous Bank (a partly state-own bank, BancoEstado) had a minimum income requirement that was above the average income of the 40th percentile of the income distribution. Furthermore, banks required earnings from the more stable formal sector to process a loan, which is a very restrictive condition as the 36 percent of the labor force belongs to the informal sector (CASEN 2009).

Paying tuition fees with student's labor income is not a plausible strategy either. The average labor income for high-school graduates (between 18 and 20 years old) is about the minimum wage (about 420USD per month), implying that one year of college tuition fees requires the yearly earnings of a full-time job.

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[3]The universities in Chile are categorized as "traditional" or "private" universities. The traditional universities are 25 institutions founded before 1981, some of which are public (e.g., University of Chile) and some of which are private (e.g., Catholic University of Chile). All of these traditional universities receive substantial direct funding from the government. The so-called "private" universities are 33 institutions founded after 1981. These schools receive no direct aid from the government and are mainly financed by student tuition.

[4]Median household income is calculated using the household survey CASEN in 2009.

[5]For households in the second and third quintiles, the amounts are 50 and 32 percent respectively.

Given the tight credit constraints, students from households below the median income strongly rely on government scholarships and loans to finance higher education. By far, the most relevant source of funding is provided by the Ministry of Education. Although universities offer loans and scholarships to attract outstanding students at the top-end of the admission test score distribution, that selective group is not relevant for our analysis that focuses on students about the cutoff that is near the average admission test score. The assignment of public funding is highly centralized and linked to the performance on the national college admission test, PSU.

The *PSU score* is the average score on the two mandatory tests in mathematics and language. The scores are normalized to have a mean of 500 and standard deviation of 110 which is similar to the SAT in the US.[6] The PSU outcome and high school GPA are the only variables that factor into college admission decisions.[7] The Ministry of Education determines eligibility for scholarships and loans strictly based on the *PSU score* that is taken by all students at the same time and only once per admission process.

We briefly describe the timeline of the application and selection process for college admission in Chile. Before graduating from high school in November, students register for the PSU test. Students aiming at receiving financial aid (or loans) from the Ministry of Education have to submit a declaration of socioeconomic status (Formulario Único de Acreditación Socioeconómica, FUAS hereafter), which is used to determine the income percentile of the student household by the tax authority. Students take the PSU test in the second week of December and receive their scores and the information about income classification in the first week of January. Based on this information, students know whether

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[6]The SAT has the same mean and standard deviation as the PSU. PSU scores range from 150 to 850 points, while SAT scores range from 200 to 800. The registration fee the PSU and SAT are in the same range of 50 dollars. The PSU registration fee is waived for all students graduating from public and voucher schools who apply for a waiver.

[7]The PSU also contains optional tests in History and Science used by universities to rank applicants but not considered by the Ministry of Education for financial aid eligibility.

they are eligible for financial aid or government-sponsored loans. From the second week of January, students apply to different college programs and eventually enroll if admitted by an educational institution. Universities and other educational institutions inform the Ministry of Education about the enrollment of all their students to collect potential payments of loans and scholarships. All educational institutions only have access to information on students' income once the enrollment period is over.

The data ensure top quality information for the universe of students who participated in the PSU test regarding their scores and subsequent enrollment activities.

2.1   The Loan Programs and Eligibility

The most relevant higher education financing programs offered by the government are the Traditional University Loan (TUL) and the State-Guaranteed Loan (SGL). Both programs cover tuition fees up to an upper-limit amount, referred as the *reference tuition*, which was close to 90% of the tuition costs for the years considered here.[8] These loans do not cover any other expenses associated with attending college (board and room, books, transportation, etc.) and therefore, there is still scope for credit constraints.

To be eligible for loans for college, students need to satisfy two requirements. First, students need to be in an income quintile below the highest. The income distribution is calculated using the household survey CASEN, and each household classification is determined by the tax authority using official records. Second, students need to score at least 475 points in the PSU test. Importantly, students that score below 475 can obtain the SGL loan only if they enroll in accredited vocational programs. As a consequence, most students substitute college for a vocational program when they score below the cutoff.

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[8]The reference tuition for each program is determined by the Ministry of Education and is the maximum amount that can be financed by loans and grants. The amount depends on the quality of institutional assets, and the labor market prospects of graduates of each program.

Our identification strategy exploits this cutoff rule within eligible income quintiles. The assignment to loan indices credit constrained students to choose between college and vocational education. Given that at the cutoff eligibility for loans is "as good as random" (Lee [2008]), students are induced by this rule to enroll in different type of education.

The TUL program allows traditional universities to use public funds to lend loans to their students.[9] Each university is in charge of assigning the loans among their students and collecting loan repayments after graduation.[10] The TUL real interest rate was 2 percent per year and the repayment was contingent to borrower's income with a maximum amount of 5 percent of the student's income. Students have to start repaying two years after graduation, and after 15 years the debt is written off.

The SGL program relies on commercial banks using private funds to lend loans to students enrolled in accredited institutions. The loans are guaranteed by the educational institution while the student is studying and by the State up to a 90 percent. The program was specifically designed to give a market alternative to students in private universities and vocational schools who did not have access to TUL. Thus, students have to decide the amount to borrow, up to their respective reference tuition.

A key feature of the SGL program is that, for the period analyzed in this paper, resembles available loans in the conventional credit market regarding interest rates, installment calculations and the enforceability of the repayments. Initially, the real interest rates were about 6 percent per year, that was slightly higher than the average mortgage rate observed in the same period. Repayment is scheduled in fixed monthly installments for 20 years (regardless borrower's income), with a grace period of 18 months after graduation. If a bank

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[9]There are 25 traditional universities and about 35 so-called "private." The universities founded after the reform in 1981, do not receive direct funding from the State.

[10]The TUL loan was introduced in 1981 and has been the primary source of financial aid for students until the introduction of SGL in 2006. Previous to 2006, eligibility was determined independently by each university, based on the public budget granted to each institution by the government.

cannot collect the loans, the guarantors (the state and the educational institution) must pay the bank and become responsible for enforcing collection from the student.[11]

The third most important form of aid is the Bicentenario Scholarship that covers the reference tuition. Eligible students must score at or just above 550 PSU-points and belong to the poorest 40 percent of the households. This program reaches about 5% of the population of students and more than 50% of all eligible. Solis [2017] shows that at the Bicentenario-cutoff there is no change in enrollment, and therefore, only the amount of debt the student holds changes at the cutoff. We use this cutoff rule to study the effects of tuition debt on labor outcomes and to test the sensibility of the educational returns to tuition costs.

3   Data

3.1   Data Sources

We combined five sources of administrative records from graduation from high school to labor market participation.

3.1.1   Education Data

We observe a student from the moment she registers for the PSU test (just before high school graduation) until she left the educational system. To do that, we combine administrative individual-level data from four different sources. The first data source is the records of students who enroll for the PSU test for the year 2007. The student´s records contain PSU scores, high school GPAs, age at PSU, school of graduation as wells as a rich set of

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[11]The educational institution is responsible for repaying the bank with the 90% (70%) [60%] of the capital and interest accumulated if the student drops out in her first year (second year) [third year or later], and the state covers the difference up to a 90 percent. After the student graduates, the state guarantees 90 percent of the total debt.

demographics, socioeconomic and family backgrounds, such as household size, self-reported household income, parental education and parents labor status.

The second source of data is an administrative record from the Ministry of Education that track enrollment in all higher education institutions. For the cohort 2007, the data is a 10-year panel of students, containing information about the specific programs chosen.

The third source of information is the FUAS form, which provides information on the family income quintile determined by the tax authority. This classification defines the eligibility for the two loan programs and the six scholarships supported by the public sector. Moreover, the data contain the assignment to financial aid and loan take-up of the TUL program. The fourth data set identifies the loans approved under the SGL program as recorded by the INGRESA commission, the organization created in 2006 to manage the program.[12]

3.1.2 Labor Market data

We obtain information on labor market outcomes from the unemployment insurance registry from the Ministry of Labor of Chile, that keeps track of the monetary contributions to the individual retirement account of each worker. The unemployment insurance covers almost the entire formal sector, equivalent to 63 percent of the total labor force in 2016.[13] The groups excluded from the insurance are workers with training contracts, workers under the age of 18, domestic service, pensioners, self-employed or own-account workers, and public-sector employees. Workers in the informal sector are encouraged to buy unemployment

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[12]The assignment rule for SGL was only rightfully in place from 2007. During the first year of implementation in 2006, the SGL program erroneously assigned the loans to the wealthiest families among the applicants due to a severe mistake in the income ranking. Once the critical error was public, the students already have been informed about the approved loans. The solution was to issue a new set of credits based on the correct income ranking. We do not consider 2006 in the analysis.

[13](The National Institute of Statistic of Chile, INE).

insurance, but only 2.2 percent do so.[14]

The data contain individual-level records, with detailed information on participation in and earnings from the formal sector, that is available for all the students taking the PSU test in 2007. The database provides information on monthly income, labor status (open-ended contract, short-term contract or unemployment status), municipality of residence, ID identifying the employer and the economic sector where they work in the 2002 to 2016 period.

We infer unemployment status in the formal sector as interpreting zero monthly contributions for consecutive periods as being unemployed in the formal sector.

Finally, we infer part-time vs. full-time job in the formal sector as we interpret isolated missing contributions as a signal that worker did not have a stable full-time job in the formal sector.

3.2 Sample

We restrict the analysis to students who are *pre-selected* for loans and are first-time PSU-takers. We refer as pre-selected to the students in any of the four poorest income quintiles. The tax authority determines the income quintile for those students who filled the FUAS form. Students who do not complete the FUAS are ineligible at either side of the cutoff, and thus, unaffected by the policy. We use the group of ineligible students, in turn as a placebo test. For pre-selected students, obtaining more than 475 PSU-points implies a change in the available educational choice set, as college becomes an outstanding option.

The outcome of interest occurs ten years after the initial assignment, generating a dynamic selection problem. Students can take the PSU test more than once (only once per year) to improve their score and achieve loan eligibility. We address in part this problem

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[14]Superintendence of Pensions, 2010. "Unemployment Insurance in Chile"

by limiting the sample to first-time takers to avoid initial self-selection to eligibility. To be more precise, we restrict the sample to the students who just graduated from high school, and therefore, have not taken the test before. This restriction prevents overrepresentation of high-income students, who may have more chances to repeat and prepare the admission test, self-selecting into the treatment.

However, the initial assignment to treatment for this balanced sample can potentially vary over time, when students retake the test or change their enrollment choices. We now describe the dynamic of the assignment process in detail. We refer to the students who graduated from high school in November 2006 and take the PSU test that same month as the "2007 cohort".

Our analysis can be representative of a broader population for two reasons: two-thirds of high school graduates take the PSU test, and the eligibility cutoff is close to the population average. To test whether the students who participate in the college admission process differ from the overall population of students in Chile, we check administrative records from all students enrolled in eighth grade, where we observe 98 percent of the children of that age. From that group, about 80 percent graduate from high school. Conditional on high school graduation, over 80 percent take the PSU test. Secondly, the test has is standardized to have a mean of 500 which means that the marginal complier in the RD setting is very similar to the average student.[15]

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[15]The loan cutoff does not provide long-term variation in the number of students entering in higher education (college and vocational). Instead, the variation seems to change the choice of type of education. At the first year, the number of students entering higher education was 20 percent larger for students above the threshold. Some students tried many times until they obtained the eligibility for loans, some students prepare the test, and others entered the labor market. That difference goes down the following years and becomes indistinguishable from zero in the year 2012.

4   Estimation Strategy

To estimate the effects of the type of education on labor outcomes we could estimate a regression like the following:

$$W_i = \pi_0 + \pi_1 Education_i + \pi_1 \mathbf{X}_i + \epsilon_i \tag{1}$$

where $Education_i$ is an indicator whether the students enroll in college or vocational education and $\mathbf{X}_i$ is a set of observable characteristics. W_i corresponds to our three labor outcomes of interest: Annual income, labor participation, and job stability. Annual income refers to the sum of all labor earnings from the formal sector in the year 2016, the latest year in the sample. Labor participation corresponds to an indicator whether the person receives at least one income from formal sector employment (in 2016 or during the whole period 2007-2016). Job stability refers to receiving income for 12 consecutive months in 2016 in the formal sector.

If some unobservables that explain W_i are correlated with college enrollment, then the estimate of parameter π_1 is biased due to endogeneity. To address this issue, we perform a regression discontinuity analysis exploiting the discontinuity at 475 PSU points.[16] We estimate the local average treatment effect (LATE) at the score cutoff, i.e., we use the score at or above the cutoff as an instrument for college enrollment. The instrument is valid since it generates variation in college enrollment and is arguably uncorrelated to the error term. We discuss the validity of the instrument in Subsection 5.1.

Intuitively, for students very close to the cutoff, an arguably random shock determines their positions above or below the threshold. Students that score at or above 475 are eligible for loans inducing the decision to enroll in college. Students slightly below the threshold cannot finance college but opt for cheaper vocational or technical education.[17]

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[16]The PSU score distribution is normal with mean 500 and standard deviation of 110.

[17]See Section 2.1 for details on loan programs.

We use a 2SLS estimation to determine the effect of upgrading from technical to university institutions on the three labor outcomes. We use the cutoff as an instrumental variable for type of education. The exogenous variation in education type is then used to estimate the effect of college or vocational education on the three labor outcomes.

We follow Imbens and Lemieux [2008] to run the following specification:

$$Education_{it} = \alpha_2 + \beta_2 \cdot \mathbb{1}(T_{i0} \geqslant c) + f_2(T_{i0} - c) + \nu_{it} \tag{2}$$

$$W_{it} = \alpha_3 + \beta_3 \cdot Education_{it} + f_3(T_{i0} - c) + \xi_{it} \tag{3}$$

where T_{i0} corresponds to i's PSU score in 2007, and c the eligibility threshold in 475. The variable of interest, $\mathbb{1}(T_{i0} \geqslant c)$, is an indicator of whether student i scores at least the eligibility cutoff, $T_{i0} \geqslant c$.

To increase precision, we estimate the RD using a local linear regression that controls for the influence of the PSU score in the probability of enrollment, $f_j(T_{i0} - c)$.[18] We use a rectangular kernel on a window of 50 points to each side of the cutoff. However, we test the robustness of this decision using a third order polynomial estimated over the whole PSU domain. Also, in the Appendix, we present a sensibility analysis.[19] Equation (2) corresponds to the first stage regression that estimates the magnitude of the exogenous variation in college enrollment. Equation (3) correspond to the 2SLS estimate of the effect of college enrollment on different outcomes. The parameter of interest, β_3, corresponds to the ratio between β_2, and β_1 from the reduced form estimation given in Equation (4), as follows:

$$W_{it} = \alpha_1 + \beta_1 \cdot \mathbb{1}(T_{i0} \geqslant c) + f(T_{i0} - c) + \epsilon_{it} \tag{4}$$

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[18] $f(T_i) = \phi_0 T_i + \phi_1 T_i \cdot \mathbb{1}(T_i \geqslant c)$.

[19] In the sensibility analysis we test the outcomes for a set of bandwidths from 4 to 100 PSU-points, we find that the outcomes do not vary qualitatively over the whole range of bandwidths. An alternative way of testing the specification implies the calculation of the optimal bandwidth. We performed the Calonico et al. [2014] and Imbens and Kalyanaraman [2012] giving qualitatively comparable results.

The parameter β_1 in Equation (4) estimates the local intention to treat effect as in Angrist et al. [1996] capturing the direct effect of the instrument over the outcome. Given that $H_0 : \beta_1 = 0$ is a sufficient condition for $H_0 : \beta_3 = \frac{\beta_1}{\beta_2} = 0$, we report estimates from the reduced form in the main tables.

Students can dynamically select into treatment by retaking the PSU test in the following years to score above the cutoff. The indicator of scoring above the cutoff is still a valid instrument as long as students were not completely able to manipulate the score in future attempts in the PSU. We show in 5.1 that the variation in college enrollment is persistent and stable after the third year despite some students being able to select into treatment.

5 Results

5.1 Validity of the RD

We assess the validity of our RD approach by presenting the three tests suggested by Lee and Lemieux [2010].

The first test assesses the relevance of the instrument based on the first stage estimates to ensure, in our application, there is an exogenous variation in enrollment. We show the figures with the intuition of the change in enrollment and below we present the formal test. Figure 1 shows the changes in college and overall higher education enrollment about the eligibility cutoff for the students who took the PSU test for the first-time in the 2007 admission. The top-left figure shows the effect on college enrollment in 2007 while the top-right graph shows the aggregated enrollment in higher education in 2007. Above the cutoff, college enrollment increases by 14 percentage points while the enrollment in overall higher education increases by only 8 percent, hence there must be a smaller in enrollment in vocational education above the cutoff. We see the exogenous changes in education choices

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based on the randomness about the cutoff: students below the cutoff are more likely to choose vocational education while students above the cutoff are more likely to opt for a college education.

The bottom panel in Figure 1 shows the long-run effect on enrollment. The bottom-left figure measures whether the student has ever enrolled in college in any admission process from 2007 until 2014, the last year of our enrollment data. Some students retake the test in the following years and might become eligible for loans. As a consequence, the difference in enrollment decrease. For college, the discontinuity at the cutoff is still a sizable 10 percent, while for higher education, the discontinuity disappears, consistent with a negative effect on vocational enrollment. The bottom-right figure shows that virtually all students have enrolled at least for one semester during our time span. Hence, our sample is not suitable to measure the marginal return of entering to labor market without any higher education.

Table 1 presents the formal analysis of the first-stage estimates. Panel A shows that the effect was 14 percent increase in enrollment in 2007, and it varies across income quintiles as presented in columns (3) to (7). In fact, the increase in enrollment is about 16 percent for the poorest quintiles whereas for the fourth quintile there is no effect even though they are eligible.[20] Panel B shows that about 60 percent of the students have enrolled in college at least for one semester in the time span 2007-2014, and for students just above the cutoff, that rate increases up to 69 percent. The most substantial effect occurs in the third income quintile reaching an enrollment rate of 77 percent just above the cutoff.

Panels C and D in Table 1 present the same analysis for the overall higher education. Panel D confirms that virtually all students have enrolled in some higher education program between 2007 and 2014.[21] Therefore, the effect we observe in the long-run corresponds to a change in the *type of higher education* that the student received. The compliers above

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[20]The fifth quintile can be seen as a placebo test that is consistent with our approach.
[21]Note that enrollment does not imply graduation.

the cutoff tend to enroll more in college, while the compliers below the cutoff tend to enroll more in technical or vocational education.

Figure 2 shows the impact on enrollment as captured by the first stage estimates considering only a single admission process per year. The left graph shows that the effect on college enrollment has been close to 10 percent and stable in the last five years. This long-run impact on college enrollment suggests a significant effect for the years 2015 and 2016 when we measure income and labor participation but do not observe new enrollments. The same figure for the aggregated higher education shows that the effect on overall enrollment is zero from 2012 onwards. Thus, we confirm that the long-run effect drove the *type of higher education* that the student received, but all the 2007 cohort enrolled in some higher education after 2012.

The second test for the validity of the RD verifies whether groups with scores below and above the cutoff are balanced in terms of the observables. Table 2 shows the balance of covariates. Each row represents the estimation of Equation (4) where the dependent variable is the covariate indicated in the first column. Column (1) shows the average for students just below the cutoff. Column (2) presents the change in that covariate for the group just above the cutoff using a local linear regression around the cutoff in a window of 45 points for each side.[22] Instead, estimates in column (3) apply a fourth order polynomial in the same spirit. The columns (4) to (8) show the estimates for each quintile using a linear control function. The standard errors are robust to heteroskedasticity.

Most of the pre-determined characteristics are balanced as Columns (2) and (3) show non-significant estimates. The exception is "age at the PSU," which indicates that students just above the cutoff are about 0.4 years older (4.8 months). The analysis by different income quintiles shows that characteristics are not systematically correlated with the position of

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[22]Corresponds to the optimal bandwidth of Calonico et al. [2014]

the student around the cutoff.

The third test for the validity of the RD corresponds to the manipulation test from McCrary [2008]. Figure 3 shows that the empirical density of students around the cutoff of 475 PSU-points. Each dot indicates how many students there are in each bin of 4 points. The absence of bunching confirms that students are not able to manipulate the PSU score and therefore the position around the cutoff is random after we condition for being close to the cutoff.

5.2 Labor market outcomes

The change in education does not translate into a change in income ten years later. Figure 4 shows the reduced form estimates of Equation (4) using the annual income obtained in the formal sector as the dependent variable for 2016 (left) and 2015 (right). Table 3 presents the estimates of these regressions. Our preferred specification in column (1) shows a small effect of 9 USD for the year 2016 and 64 for 2015, from a baseline income of almost 7,000 USD in 2016. These effects are remarkably small and consistent across quintiles.[23]

Figure 5 shows the evolution of the annual income over time. The top figures include all individual imputing zero earnings for those months with missing income. The bottom figures show the same analysis using individuals conditional on having positive income. Both figures show that in the first five years the group below the cutoff earns more relative to students above the cutoff who are likely attending college education. After the fifth year of the PSU test, the best students start graduating and likely to find a job in the formal sector, making the catch-up after 2012. The peak was achieved in 2013, and in 2014 the gap is reduced to become close to zero. This trend after 2013 could be explained by the graduation of less able students that earn lower earnings or are less likely to participate in

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[23]All the local linear regressions in this section use the optimal bandwidth of Calonico et al. [2014] and a rectangular kernel.

the formal sector.

We do not find effects on the labor participation either, where we define participation as having at least one month with positive income in the formal sector. Figure 6 shows that the participation in the formal sector is the same below and above the cutoff. The top-left figure shows that in the year of 2016, 65 percent of the students had at least one month with positive earnings from the formal sector, and about 40 percent have jobs that employ them for 12 consecutive months that we associate to a full-time position (the top-right figure). Moreover, the bottom figure shows the likelihood of ever participating in the formal sector. About 90 percent of the students have ever worked in the formal sector, and there is no difference between students across the cutoff. These results are confirmed in Table 3. Panel C shows that the participation in the formal sector is 65 percent, and is the same across the cutoff. Panel D shows that 92 percent of the students have participated at least one month in the formal sector since 2007. The difference between the current and the overall participation may indicate that students are still transitioning from the education to the labor market. The average student takes 3 and 6 years to graduate from vocational and college respectively. Hence, the 2007 cohort probably have been available to the labor market between 4 and 7 years.

We also explore the intensive margin in the labor market, that is whether a college student benefits from being more likely to have a full-time job (probably a higher quality job), or having longer employment spells. We define full-time jobs as an indicator taking the value one if an individual appears 12 consecutive months in a given year and zero otherwise. Figure 7 shows that the rate of full-time is the same across the cutoff. Panel A in Table 4 confirms this finding since about 38 percent of the individuals have a full-time job and there is no discontinuity at the 475 cutoff. Panel B shows that the average individual works for six months per year, and it is the same below and above the 475 cutoff. The amount of

months in the formal sector seems robust across income quintiles.

Figure 7 shows the evolution over time of our measures of labor participation in the formal sector. The top graphs in Figure 7 show that the participation has been similar above and below the 475 cutoff from the initial year. The second pair of middle figures shows a similar pattern for the number of months the individuals participate in the formal sector. An interesting feature is that seems that the participation rate in the formal sector is reaching a plateau suggesting a more long-run outcome. On the contrary, the bottom figures indicate that the steady-state in full-time jobs has not yet been reached, however, there are no differences between eligible and non-eligible students.

5.3   The effects of loans

Students who score barely above the PSU cutoff tend to have more college education but also a more onerous debt burden. The financial burden would be exacerbated due to the longer duration of the college programs, on average two years longer than the vocational alternatives. We test whether the outstanding debt affects labor participation decisions using the cutoff around the Bicentenario Scholarship that grants full tuition and no debt to those students who score above 550 in the PSU test. As detailed in Section 2.1 students from the first two income quintiles who are at or above the 550 PSU-points are eligible for the Bicentenario Scholarship that covers the reference tuition that is the same amount that students would be cover with the SG loans. Students who score above the 550 cutoff will be granted with the reference tuition, while students below the 550-cutoff student need to pay the tuition fees which can be covered by the SG loan.

Figure 1 shows no discontinuity of enrollment in any type of higher education at the 550 cutoff (depicted by a red vertical line). Therefore, we conclude that the only thing that changes at the margin is the form of financing education, but there is no change in the

choice of higher education

We find similar conclusions for labor outcomes. Figure 4 shows the annual income as a continuous function in the neighborhood of the 550 PSU-points. Students above and below the 550 cutoff display similar behavior regarding participation, full-time jobs and intensity of participation in the formal sector as apparent in Figure 6. Our evidence indicates that labor market decisions of students holding debt do not differ from students who finance their education with scholarships or other means. This finding is at odds with Rothstein and Rouse [2011b] who show that US students bearing debt choose high-pay jobs and less public sector employment, probably because of their responsibilities of repaying.

5.4   Gender heterogeneity

We also explore whether there is any effect that differs by gender. Figure 8 shows the results for annual income by gender. The left figures correspond to females and right figures to males. The four first graphs show that discontinuities are not significant on yearly earnings considering all students or restricting the analysis to students with positive earning in a given year. Interestingly, and despite the similarities of the students at the cutoff, [24] we observe a wage differential. Males, earn on average about 10,000 USD per year while women about 9,000, and the gap is statistically significant. However, the 550 cutoff does not play a role.

Figures 9 and 10 show the similar patterns for participation over time. The only difference appears in the trajectory, while females have been increasing their relative participation over the years (relative to their control group), males have been decreasing in participation. Both measures indicate that women participate less in the formal sector. However, the differences are not as big as the income gap, which captures the difference in participation

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[24]They present very similar baseline characteristics shown in Table 2 and all of them score around 475 in the PSU which is a good measure of ability.

and the likely lower wage.

6   Conclusion

We present evidence of the marginal effects of education using a regression discontinuity design. We exploit the eligibility rules for two financing programs of higher education that creates exogenous variation in the enrollment behavior. Additionally, we use detailed administrative data from the universe of students merged with administrative data on income from the formal sector.

Our findings indicate that the original change in the rate of enrollment in higher education disappear after six years, but the change in the college enrollment stays stable about ten percentage points. Hence, we conclude that the loan eligibility cutoff rule created an exogenous variation in the type of education students opted in. The SG loans induced students above the cutoff to pursue a college education which requires more years of training, higher tuition fees per year, and a higher rate of dropping out, relative to vocational education.

Despite these higher costs, the benefits in term of income, participation, and the quality of the job contract, in the formal sector, appear to be negligible. These findings are similar to Rau et al. [2013], who use a factor model to conclude that the incentives of the SG loan prevent the drop-out of students at the marginal college alternatives reducing the education quality and making vocational education more attractive for students near the 475 cutoff.

An important limitation is that we only observe labor earnings coming from the formal sector. Availability of all type of income will provide a more precise picture. Also, a more detailed data on the actual characteristics of the loan, such as interest rates and repayment rate, would be suitable for a more thorough analysis of the cost-benefits of the decisions

induced by the SG loan and other similar public policies.

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7 Figures and Tables

7.1 Figures

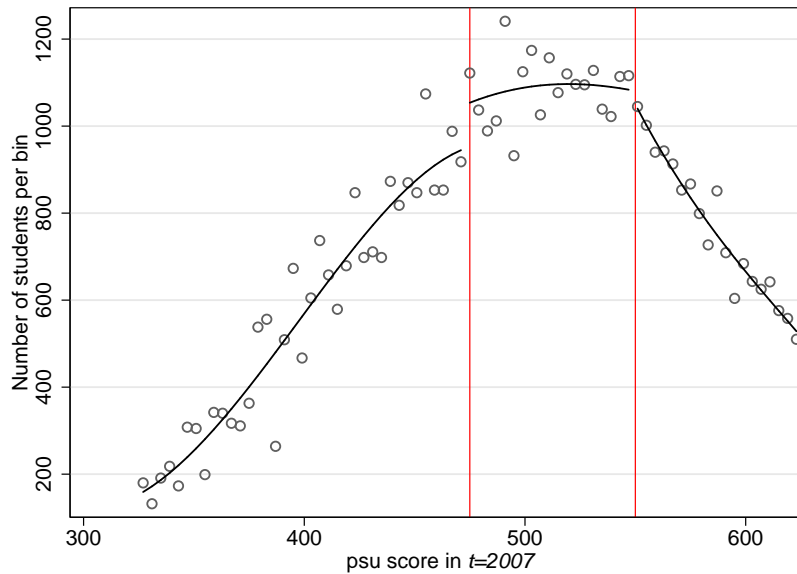Figure 1: RD in College enrollment and Higher Education enrollment (First Stage)
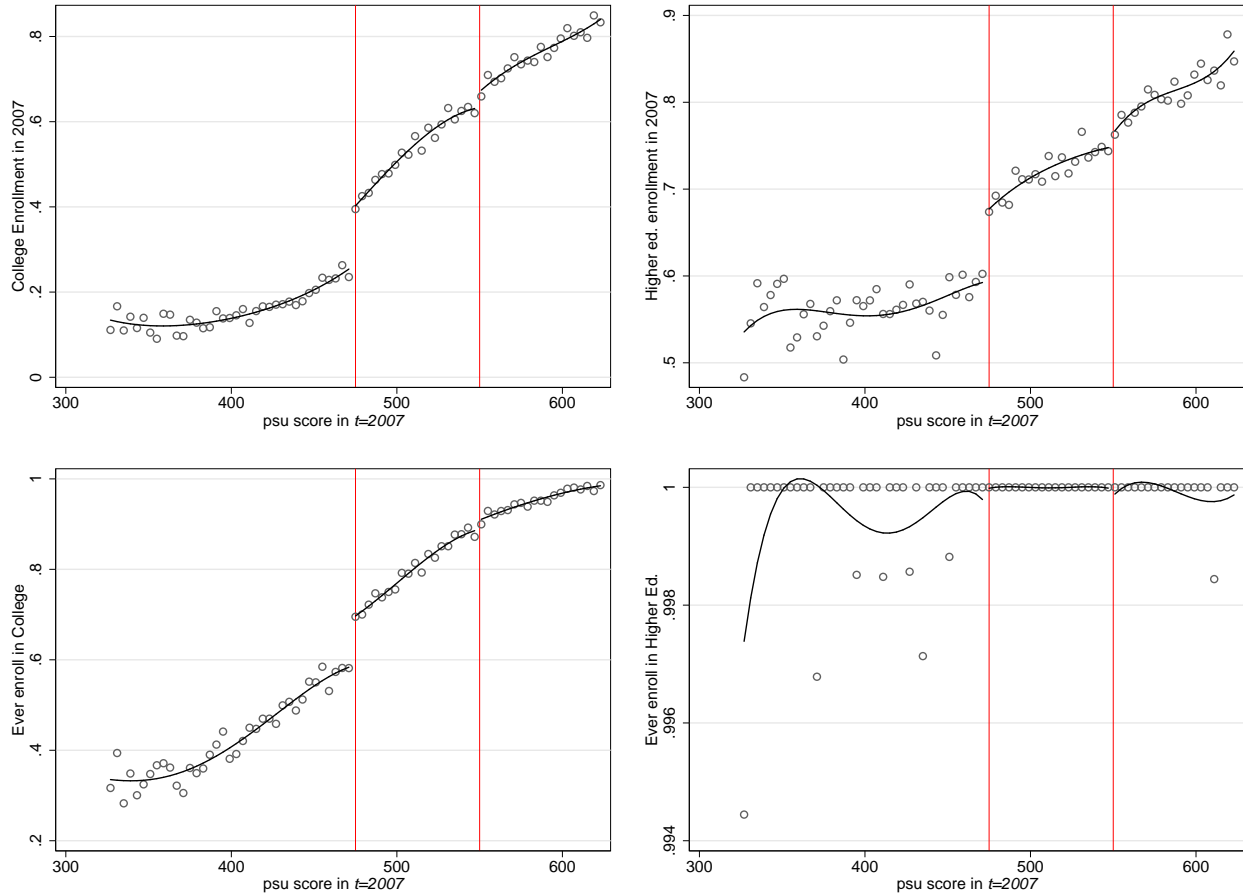
Note: Each dot represents the average among students in a bin of 4 PSU-points. The solid line represents fitted values from a fourth order polynomial for the PSU score, as described in Equation (2). The vertical lines correspond to the SG loan cutoff (475) and the Bicentenario scholarship cutoff (550). The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

Figure 2: RD in College enrollment and Higher Education enrollment over time
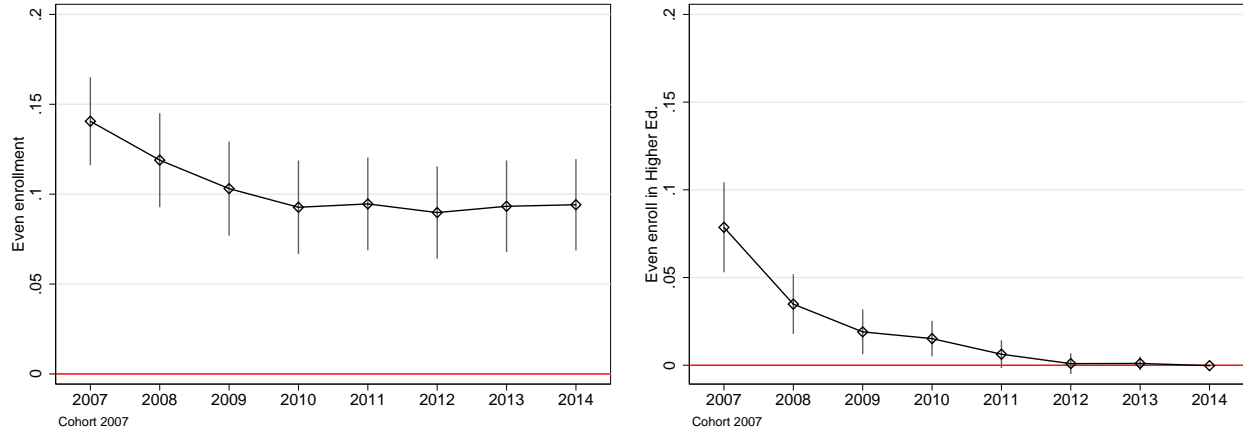
Note: The figures show the estimates of Equation (2) using as the dependent variable the enrollment at the cutoff using different years of the admission process. The left figure presents the college enrollment, and the right figure presents overall higher education enrollment. The sample only considers the first time-takers of the PSU test in the 2007 admission process.
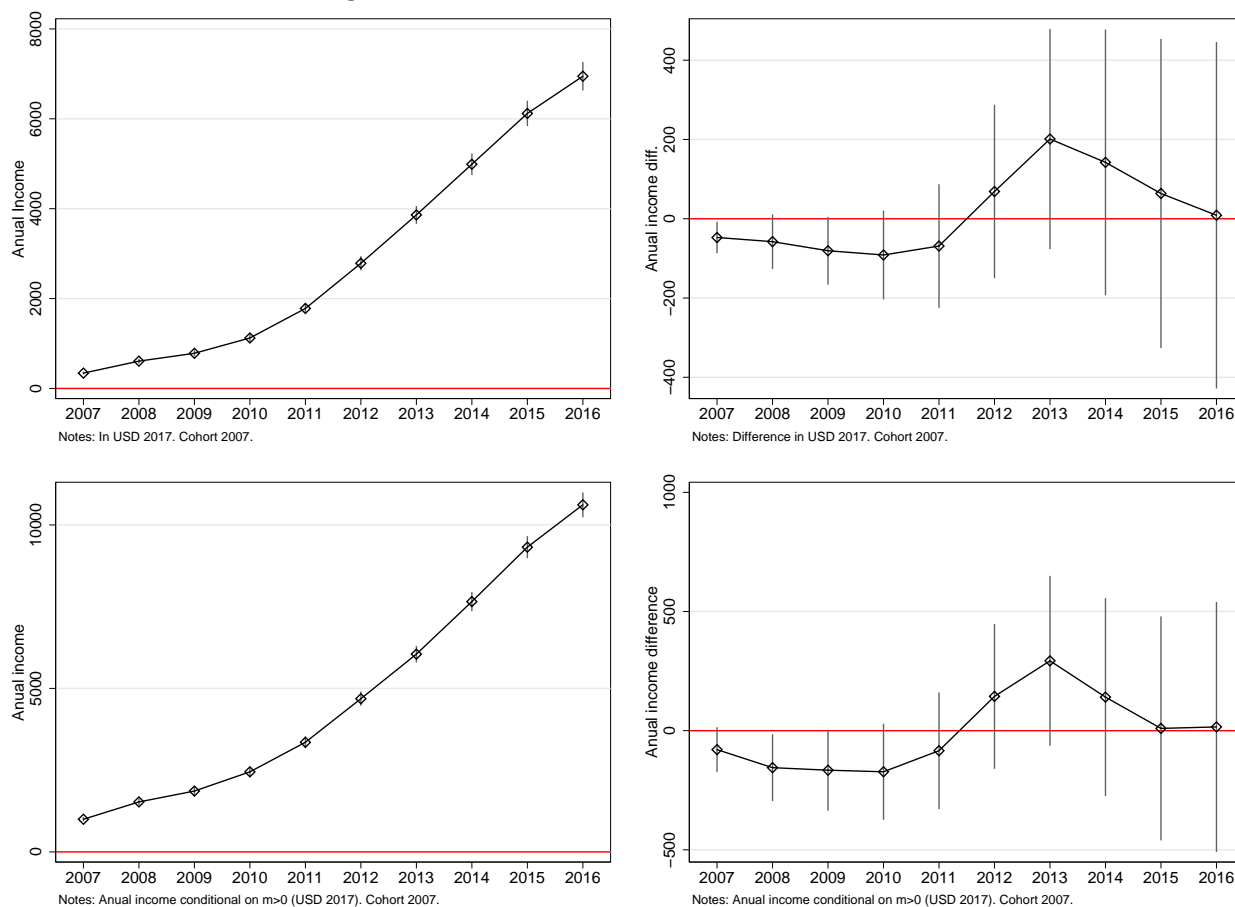
Figure 3: The McCrary Test

Note: Each dot represents the number of students in a bin of 4 PSU-points. The solid line represents fitted values from a fourth order polynomial for the PSU score. The vertical lines correspond to the SG loan cutoff (475) and the Bicentenario scholarship cutoff (550). The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.
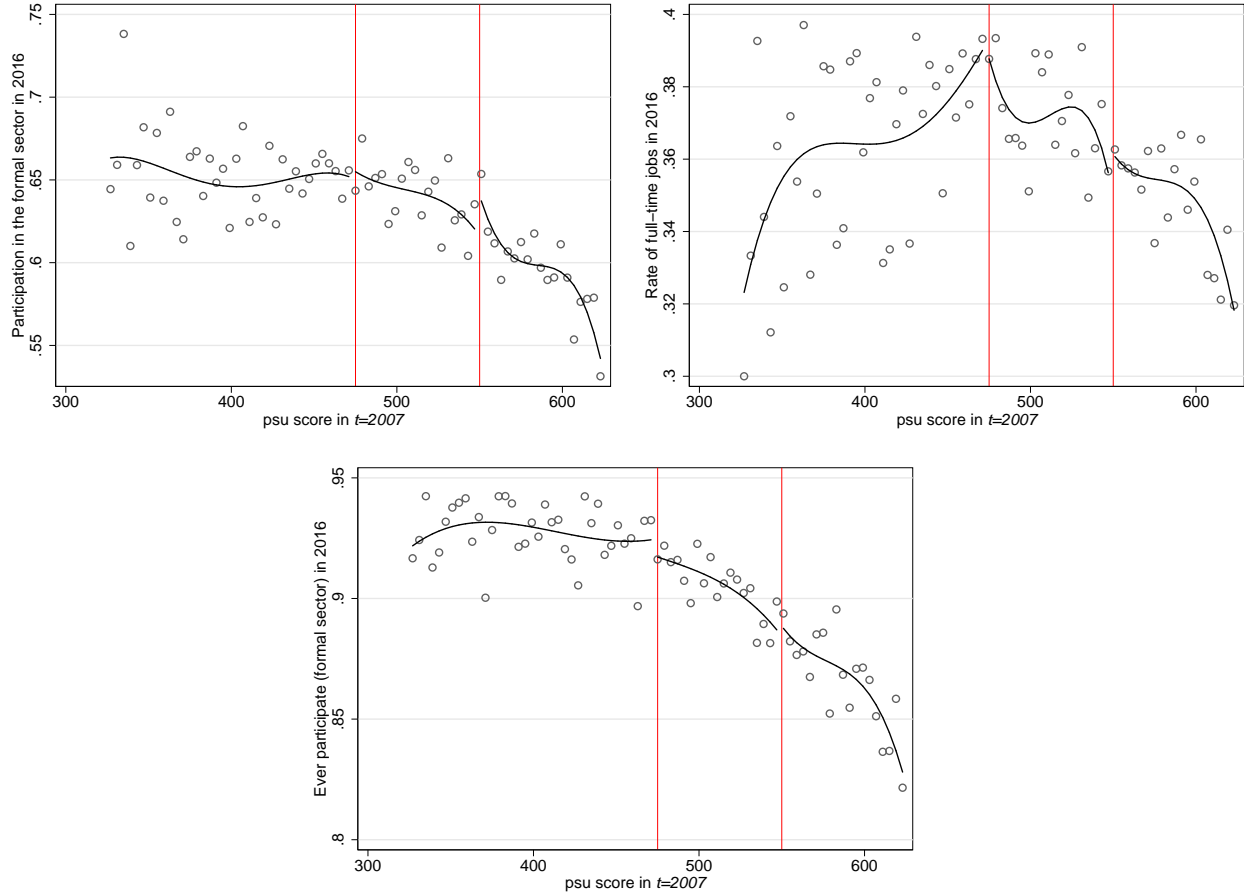
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Figure 4: RD in Anual Income
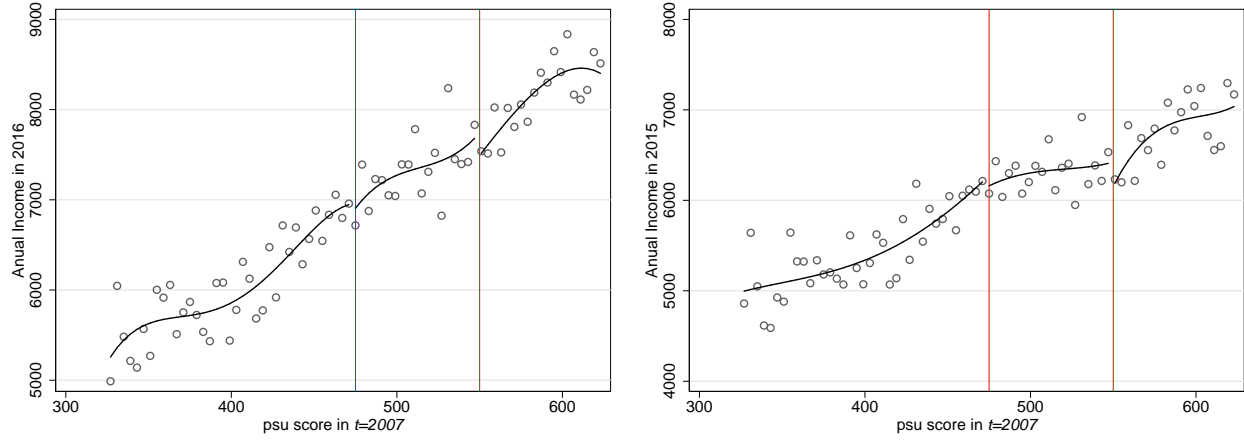
Note: Each dot represents the average of annual income for students in bins of 4 PSU-points. The solid line represents fitted values from a fourth order polynomial for the PSU score. The left figure considers earnings from the formal sector in 2016, and the right figure the income in 2015. The vertical lines correspond to the SG loan cutoff (475) and the Bicentenario scholarship cutoff (550). The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

Figure 5: RD in Annual income over time.

Notes: In USD 2017. Cohort 2007.

Notes: Difference in USD 2017. Cohort 2007.

Notes: Anual income conditional on m>0 (USD 2017). Cohort 2007.

Notes: Anual income conditional on m>0 (USD 2017). Cohort 2007.

Note: The figures show the estimates of Equation (4) using as the dependent variable the annual income in the year indicated in the x-axis. The left figures show the average value at the cutoff (given by the intercept of these regressions), and the right figures show the size of the discontinuity. The figures at the top consider the whole sample, while the figures at the bottom considers the sample conditional on having positive income in each given year. The initial sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

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Figure 6: RD in Participation in the formal sector in 2016

Note: Each dot represents the average of the variable for students in bins of 4 PSU-points. The top left figure depicts the participation in the formal sector in 2016, the top right figure the share of individuals with stable (full-time) jobs, and the bottom figure shows whether individuals have ever participated in the formal sector. The solid line represents fitted values from a fourth order polynomial for the PSU score. The vertical lines correspond to the SG loan cutoff (475) and the Bicentenario scholarship cutoff (550). The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

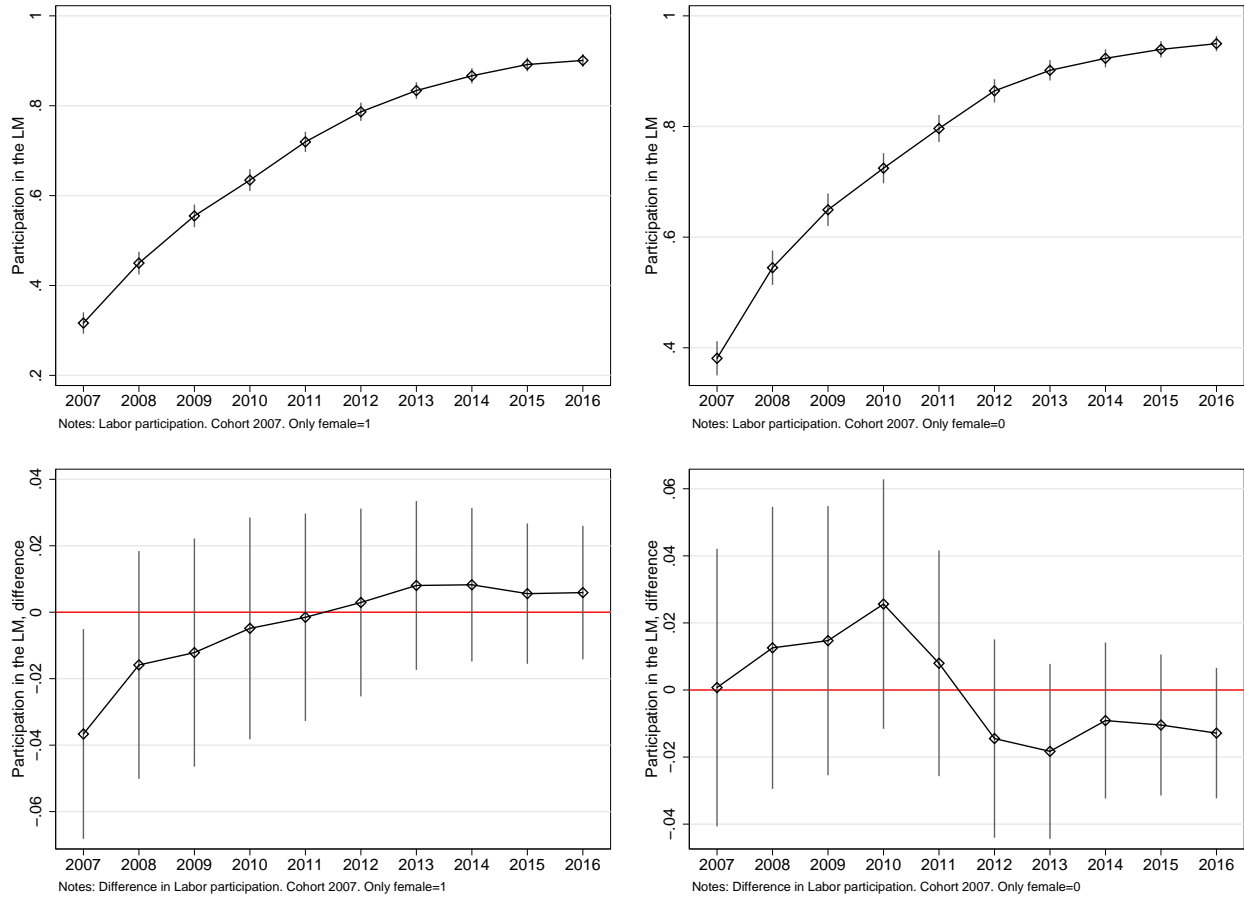Figure 7: RD in Participation in the formal sector over time
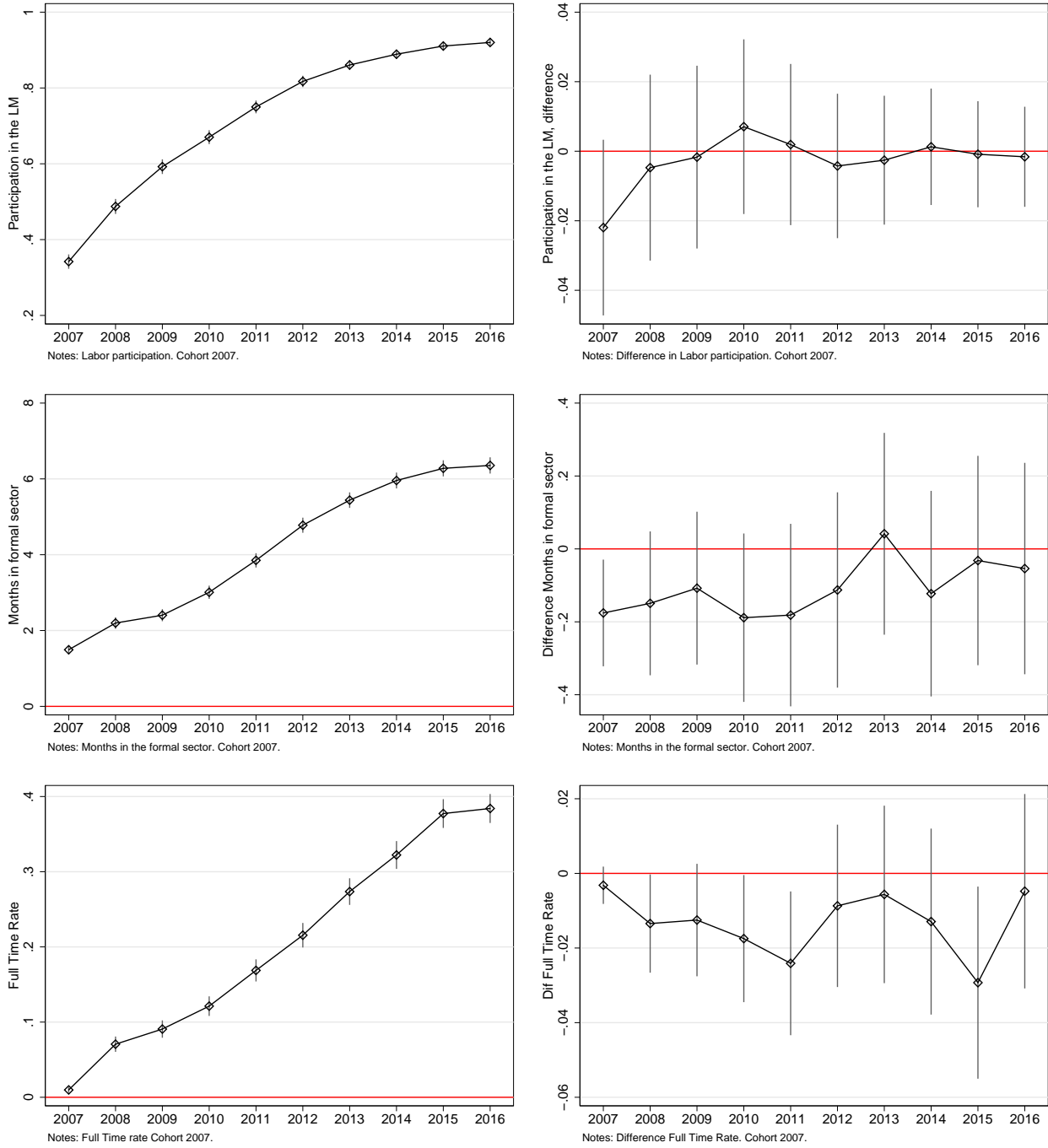
Note: The figures show the estimates of Equation (4) using as the dependent variables the participation in the formal sector, the number of months worked in each year, and the share of stable (full-time) jobs for each year indicated in the x-axis. The left figures show the average value at the cutoff (given by the intercept of these regressions), and the right figures show the size of the discontinuity. The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

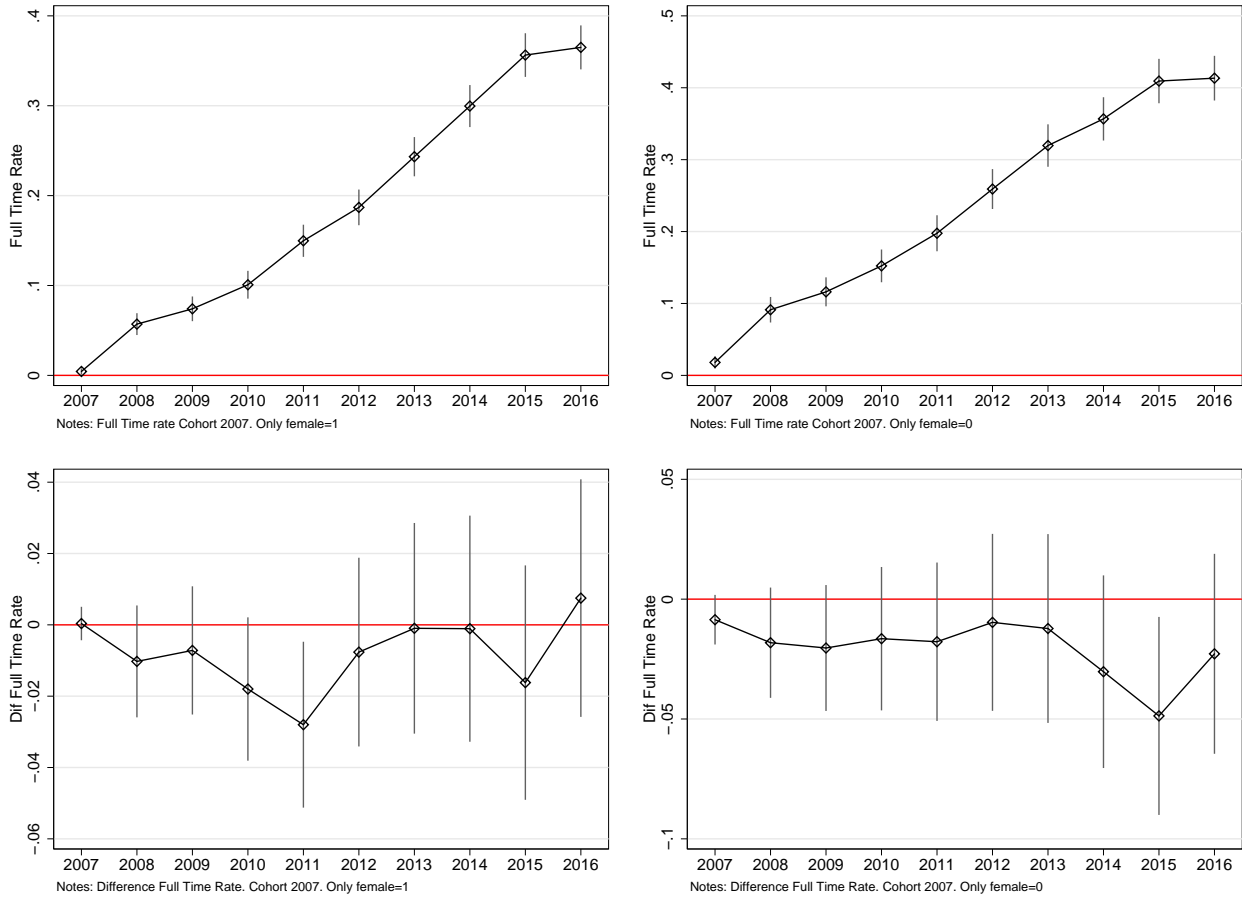Figure 8: RD in Annual Income over time by gender.
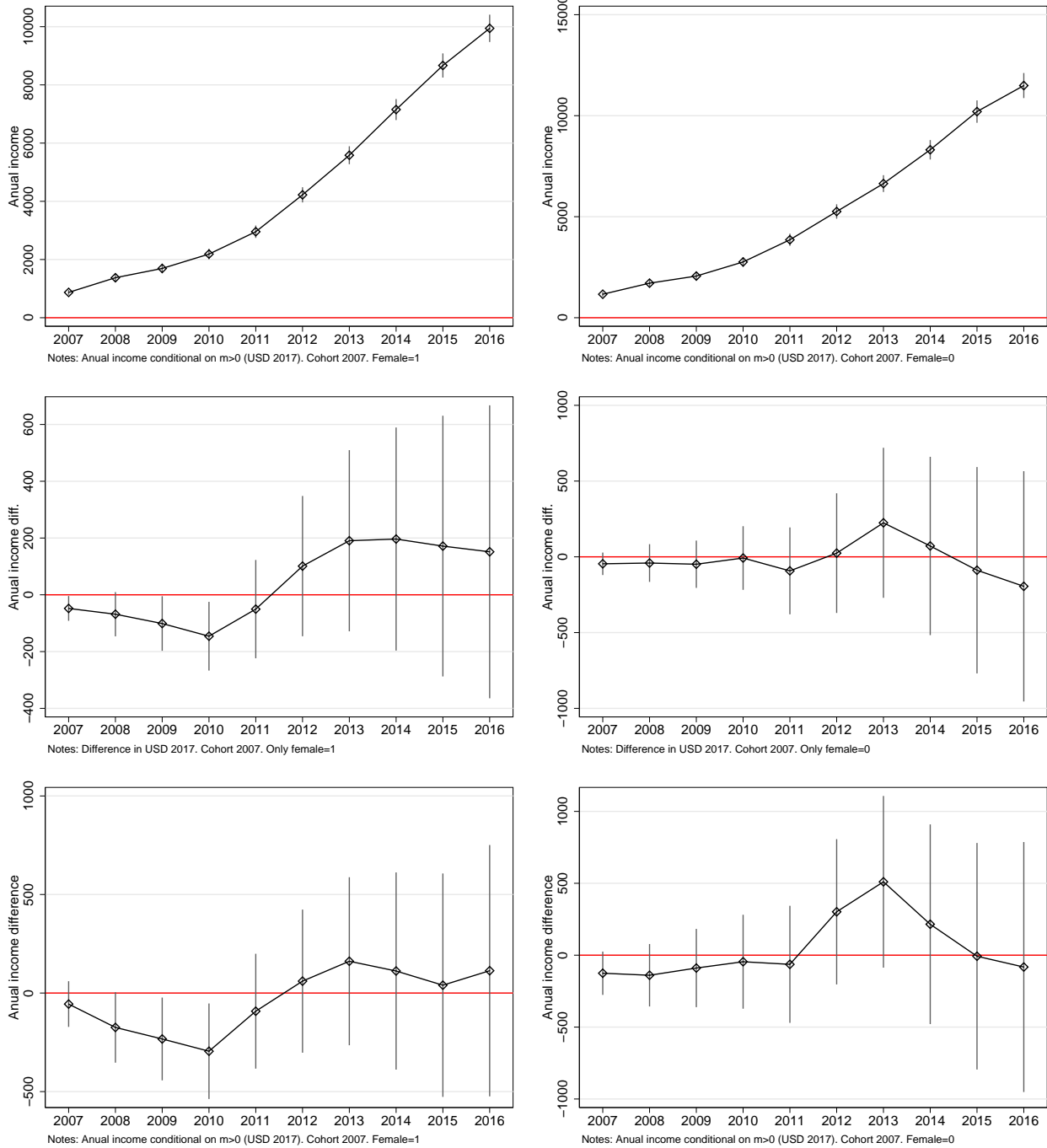
Note: The figures show the estimates of Equation (4) using as the dependent variable the annual income over time by gender (female to the left). The figures at the top show the average value at the cutoff (given by the intercept of these regressions) conditional on having positive income. The two figures in the middle show the size of the discontinuity considering all individuals, while the two figures at the bottom show the size of the discontinuity considering individuals with strictly positive income in each given year. The initial sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

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Figure 9: RD in Participation in the formal sector over time by gender.

Notes: Labor participation. Cohort 2007. Only female=1

Notes: Labor participation. Cohort 2007. Only female=0

Notes: Difference in Labor participation. Cohort 2007. Only female=1

Notes: Difference in Labor participation. Cohort 2007. Only female=0

Note: The figures show the estimates of Equation (4) using as the dependent variable the labor participation in the formal sector over time by gender (female to the left). The two figures at the top correspond to the average value at the cutoff (given by the intercept of the regressions). The figures at the bottom show the size of the discontinuity at the cutoff. The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

Figure 10: RD in the rate of Full-time Employment over time by gender

Notes: Full Time rate Cohort 2007. Only female=1

Notes: Full Time rate Cohort 2007. Only female=0

Notes: Difference Full Time Rate. Cohort 2007. Only female=1

Notes: Difference Full Time Rate. Cohort 2007. Only female=0

Note: The figures show the estimates of Equation (4) using as the dependent variable the rate of full-time employment in the formal sector over time by gender (female to the left). The two figures at the top correspond to the average value at the cutoff (given by the intercept of these regressions). The figures at the bottom show the size of the discontinuity at the cutoff. The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.

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7.2 Tables

Table 1: First Stage Estimates: College, Higher Eduction and Ever Enrollment.

| | Eligible quintiles | | By quintile | | | | |
	Linear	Pol. 4th	q1	q2	q3	q4	q5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

A. College Enrollment in 2007

Above cutoff	0.14***	0.14***	0.16***	0.17***	0.14***	-0.0091	-0.066
	(0.012)	(0.013)	(0.016)	(0.029)	(0.035)	(0.036)	(0.053)
Cons.	0.26***	0.26***	0.22***	0.25***	0.30***	0.40***	0.47***
	(0.0085)	(0.0097)	(0.011)	(0.020)	(0.025)	(0.027)	(0.042)

B. Ever enroll in college (2007-2014)

Above cutoff	0.094***	0.085***	0.11***	0.061**	0.14***	0.0061	-0.051
	(0.013)	(0.014)	(0.018)	(0.031)	(0.034)	(0.033)	(0.045)
Cons.	0.60***	0.60***	0.55***	0.62***	0.63***	0.71***	0.80***
	(0.0100)	(0.012)	(0.013)	(0.024)	(0.027)	(0.026)	(0.035)

C. Higher ed. Enrollment in 2007

Above cutoff	0.079***	0.085***	0.099***	0.12***	0.035	-0.018	-0.044
	(0.013)	(0.014)	(0.018)	(0.031)	(0.035)	(0.035)	(0.050)
Cons.	0.60***	0.60***	0.57***	0.59***	0.64***	0.68***	0.68***
	(0.0099)	(0.011)	(0.013)	(0.024)	(0.027)	(0.026)	(0.038)

D. Ever enroll in higher ed. (2007-2014)

Above cutoff	-0.00023	-0.00026	-0.00027	0.00041	-0.0012	0	0
	(0.00023)	(0.00019)	(0.00027)	(0.00041)	(0.0012)	(.)	(.)
Cons.	1.00***	1.00***	1.00***	1.00***	1.00***	1	1
	(0.00023)	(0.00018)	(0.00027)	(0.00041)	(0.0012)	(.)	(.)

Obs.	21,395	63,159	11,543	3,843	3,042	2,967	1,466

Note 1: This table shows the first-stage estimates as described in Equation (2) using four different measures of education enrollment as dependent variables. Columns (1) presents the change in the dependent variable for the group just above the cutoff using a local linear regression, and column (2) shows the same estimate but using fourth order polynomials. The columns (3) to (7) show the estimates for each quintile separately using a linear control function. Panel A shows the first stage using the college enrollment in 2007. Panel B considers the college enrollment including all the admissions between 2007 and 2014. Panel C shows the first stage estimates using overall higher education enrollment in 2007 as the dependent variable, and Panel D shows the effects on overall higher education enrollment including all the admissions between 2007 and 2014. The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.
Note 2: *: p-value$< .1$; **: p-value$< .05$; ***: p-value$< .01$. Robust to heteroskedasticity standard errors in parenthesis.

Table 2: Balance of Covariates

Covariate	Eligible quintiles			By quintile				
	Average at cutoff	Linear	Pol. 4th	q1	q2	q3	q4	q5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	0.60***	0.0021	0.0033	0.016	-0.036**	0.024	-0.017	0.020
	(0.0044)	(0.0069)	(0.0062)	(0.0095)	(0.015)	(0.019)	(0.021)	(0.024)
Age at PSU	18.8***	0.040**	0.039**	0.037	0.046	-0.019	0.10*	0.080
	(0.011)	(0.019)	(0.019)	(0.026)	(0.041)	(0.055)	(0.053)	(0.073)
High School GPA	55.6***	-0.071	-0.13	-0.12	0.041	0.16	-0.23	-0.35
	(0.071)	(0.12)	(0.11)	(0.16)	(0.25)	(0.32)	(0.34)	(0.41)
Father Edu. (years)	10.6***	-0.0055	-0.029	-0.061	0.048	0.19	-0.22	-0.27
	(0.035)	(0.055)	(0.049)	(0.077)	(0.11)	(0.13)	(0.14)	(0.17)
Mother Edu. (years)	10.6***	0.0014	-0.031	-0.082	0.11	0.10	-0.15	-0.26
	(0.032)	(0.050)	(0.045)	(0.069)	(0.099)	(0.12)	(0.14)	(0.16)
Single	0.99***	-0.000058	-0.00051	0.0018	0.00096	-0.0069*	-0.0018	-0.0017
	(0.00091)	(0.0015)	(0.0014)	(0.0020)	(0.0034)	(0.0040)	(0.0042)	(0.0060)
Not Work	0.96***	0.0048	0.0051	-0.0026	0.017*	-0.011	0.029**	-0.015
	(0.0030)	(0.0047)	(0.0042)	(0.0064)	(0.0099)	(0.013)	(0.014)	(0.016)
Household Size	4.38***	-0.019	-0.026	0.0075	-0.044	0.018	-0.13**	-0.023
	(0.017)	(0.026)	(0.023)	(0.037)	(0.054)	(0.061)	(0.067)	(0.079)
Father work formal	0.65***	0.0066	0.0069	-0.0018	0.020	0.011	0.00097	0.011
	(0.0042)	(0.0067)	(0.0059)	(0.0094)	(0.014)	(0.017)	(0.018)	(0.021)
Mother housewife	0.51***	0.0021	0.0013	0.0083	0.017	-0.019	-0.030	0.011
	(0.0044)	(0.0071)	(0.0063)	(0.0097)	(0.015)	(0.019)	(0.021)	(0.024)
Public School	0.50***	0.0099	0.016**	0.0016	0.015	0.043**	0.011	0.047**
	(0.0044)	(0.0070)	(0.0063)	(0.0097)	(0.015)	(0.018)	(0.019)	(0.022)
Obs.	79,888	79,888	235,801	41,540	17,379	11,584	9,385	7,162

Note 1: This table shows the estimates of Equation (2) using different covariates as the dependent variable. Column (1) shows the average covariate for compliers below the cutoff, column (2) presents the change in that covariate for the group just above the cutoff using a local linear regression, and column (3) shows the same estimate but using fourth order polynomials. The columns (4) to (8) show the estimates for each quintile separately using a linear control function. The sample corresponds to the first time-takers of the PSU test in the 2007 admission process.
Note 2: *: p-value$< .1$; **: p-value$< .05$; ***: p-value$< .01$. Robust to heteroskedasticity standard errors in parenthesis.

Table 3: Marginal Returns to Education: Income and Labor Participation in the formal sector

	Eligible quintiles		By quintile				
	Linear	Pol. 4th	q1	q2	q3	q4	q5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

A. Anual Income in 2016

Above cutoff	8.78	19.8	-79.2	655.4	-189.7	-427.1	683.0
	(222.9)	(247.1)	(294.7)	(541.6)	(604.4)	(636.1)	(970.8)
Cons.	6947.6***	7019.6***	6762.6***	6822.0***	7378.6***	7475.9***	6721.3***
	(161.7)	(183.5)	(209.2)	(395.1)	(446.4)	(489.9)	(722.1)

B. Anual Income in 2015

Above cutoff	63.7	101.3	27.5	513.8	310.6	-848.1	937.6
	(198.9)	(219.0)	(263.7)	(482.3)	(547.4)	(554.1)	(893.8)
Cons.	6119.1***	6212.0***	5939.1***	6098.6***	6268.9***	6820.4***	5441.6***
	(143.6)	(162.5)	(186.5)	(350.6)	(394.5)	(430.5)	(667.7)

C. Formal sector participation in 2016

Above cutoff	-0.00034	-0.0020	-0.0088	0.021	-0.027	0.031	0.022
	(0.013)	(0.014)	(0.018)	(0.031)	(0.035)	(0.035)	(0.053)
Cons.	0.65***	0.66***	0.66***	0.65***	0.66***	0.64***	0.57***
	(0.0096)	(0.011)	(0.013)	(0.023)	(0.027)	(0.027)	(0.041)

D. Ever Participate in the formal sector

Above cutoff	-0.0016	-0.0038	0.0022	0.0081	-0.025	-0.0085	0.031
	(0.0073)	(0.0081)	(0.0099)	(0.017)	(0.020)	(0.021)	(0.034)
Cons.	0.92***	0.93***	0.92***	0.92***	0.94***	0.91***	0.86***
	(0.0053)	(0.0060)	(0.0069)	(0.013)	(0.014)	(0.015)	(0.027)
Obs.	21,395	63,159	11,543	3,843	3,042	2,967	1,466

Note 1: This table shows reduced form estimates of Equation (4) using income and labor participation in the formal sector as dependent variables. Columns (1) presents the change in the dependent variable for the group just above the cutoff using a local linear regression, and column (2) shows the same estimate but using fourth order polynomials. The columns (3) to (7) show the estimates for each quintile separately using a linear control function. Local linear regressions use the optimal bandwidth of Calonico et al. [2014]. All regressions use a rectangular kernel. Panel A shows the effects on annual income from the formal sector in year 2016 and Panel B in 2015 (in USD of 2017). Panel C shows the effects on participation in the formal sector in 2016. Panel D shows the effects on ever participating in the formal sector (from 2002 to 2016).
Note 2: *: p-value< .1; **: p-value< .05; ***: p-value< .01. Robust to heteroskedasticity standard errors in parenthesis.

Table 4: Marginal Returns to Education: Full-Time employment and Months worked in the formal sector

| | Eligible quintiles | | By quintile | | | | |
	Linear	Pol. 4th	q1	q2	q3	q4	q5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

A. Rate of full-time jobs in 2016

Above cutoff	-0.0048	-0.0094	-0.0062	0.0095	-0.0089	-0.015	0.014
	(0.013)	(0.014)	(0.018)	(0.031)	(0.036)	(0.036)	(0.050)
Cons.	0.38***	0.39***	0.39***	0.38***	0.38***	0.40***	0.32***
	(0.0098)	(0.011)	(0.013)	(0.024)	(0.027)	(0.028)	(0.039)

B. Months in the formal sector 2016

Above cutoff	-0.054	-0.100	-0.10	0.16	-0.34	0.12	0.15
	(0.15)	(0.16)	(0.20)	(0.35)	(0.40)	(0.40)	(0.58)
Cons.	6.36***	6.41***	6.37***	6.30***	6.49***	6.24***	5.47***
	(0.11)	(0.13)	(0.14)	(0.26)	(0.30)	(0.31)	(0.45)
Obs.	21,395	63,159	11,543	3,843	3,042	2,967	1,466

Note 1: This table shows reduced form estimates of Equation (4) using full-time employment and months in the formal sector as dependent variables. Columns (1) presents the change in the dependent variable for the group just above the cutoff using a local linear regression, and column (2) shows the same estimate but using fourth order polynomials. The columns (3) to (7) show the estimates for each quintile separately using a linear control function. Local linear regressions use the optimal bandwidth of Calonico et al. [2014]. All regressions use a rectangular kernel. Panel A shows the effects on the share on individuals that are full-time employed in the formal sector defined as individuals with income for 12 consecutive months in 2016. Panel B shows the effects on the average number of months each individual worked in 2016.
Note 2: *: p-value< .1; **: p-value< .05; ***: p-value< .01. Robust to heteroskedasticity standard errors in parenthesis.

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