Whether and What to Study: the Role of Financial Aid*

Adriano De Falco
European University Institute

Yannick Reichlin
European University Institute

July 31, 2022

Abstract

Using administrative data from Chile, we analyze whether financing higher education through student loans or grants affects the joint decision of enrollment and field choice of prospective students. We exploit institutional arrangements that allocate either type of financing based on a standardized test to locally identify exogenous variation in access. Students that are marginally eligible for grants are more likely to enroll in higher education and do so predominantly in STEM related fields. This is particularly true for students whose parents do not have a university degree themselves. Access to grants also narrows gender-gaps in STEM enrollment. Our findings highlight that financial aid matters for students' choices both at the extensive margin and for the choice of major.

Keywords: major choice, financial aid, education policy, regression-discontinuity-design
JEL classification numbers: H52, H81, I22, I28

*We are grateful for valuable comments by Russell Cooper, Thomas Crossley, Andrea Ichino, Alex Monge-Naranjo, Alex Solís, and seminar participants at the EUI. We thank the Departamento de Evaluación, Medición y Registro Educacional (DEMRE) for providing the databases of the Higher Education Admission System for the development of this research.
Contact: European University Institute, Department of Economics, Via delle Fontanelle 18, 50014 San Domenico di Fiesole, Italy
E-mail: adriano.defalco@eui.eu and yannick.reichlin@eui.eu

1 Introduction

Two key questions faced by most high school students towards the end of their secondary education are whether to pursue a tertiary degree and if so, which major to enroll in. Given the vital importance of both questions for the accumulation of human capital and the subsequent labor-market careers and lives of students, it is not surprising that economists and other social scientists took an interest in understanding the role of higher education policy in shaping these decisions. In this paper, we focus on the financial aspects of these policies and investigate how policy-induced changes in the price of higher education affect both enrollment decisions and field choices.

One way in which policy-makers exert direct influence on prices is by regulating tuition fees or alternatively the access to different types of financial aid. In the presence of tuition, prospective students financing their higher education with either student loans or grants face vastly different incentives for enrollment given the varying potentials for a post-university debt burden. This is true both at the extensive margin and for the question of which major to enroll in, since majors differ in aspects such as expected labor market earnings, employment prospects, and their ex ante likelihood of degree completion (Kirkeboen, Leuven and Mogstad, 2016; Patnaik, Wiswall and Zafar, 2020).

To investigate the role of different types of financial aid in shaping students' choices, we focus on the higher education system of Chile, which presents an optimal setting for at least three reasons. First, in our study period Chilean universities charge relatively high tuition fees of typically around 50% of yearly median family income per year of study. The need for financial assistance is consequently widespread. Second, there is variation in the type of financial aid available. Students can either borrow up to a reference tuition from a state-backed student loan system or receive the same amount in the form of a grant. Access to either student loans or grants – and this is the final and crucial point – is determined fully by a combination of family income requirements and the result of a centralized admissions test, the *Prueba de Seleccion Universitaria (PSU)*. Conditional on income, a sharp test score threshold allows us to identify local exogenous variation in eligibility for either type of financing.

Using administrative data on individual-level college enrollment and PSU test results for the universe of test takers in Chile between 2008 and 2015, we follow a regression-discontinuity approach and study changes in the likelihood of enrolling in higher education and science, technology, engineering, and mathematics (STEM) majors around the test-score thresholds that permits access to grants. STEM fields are a particularly interesting group of fields to consider, since – as we show below – they are characterized by high mean monetary returns and employment probabilities, but also by high drop out rates and earnings uncertainty. The direction of the theoretical effect of different types of financing on enrollment in STEM fields is thus not clear. On the one hand, we might expect students with access to a grant to value pecuniary aspects of their field of study (i.e., expected earnings) relatively less than students that need to worry about repayment of loans. On the other hand, higher expected dropout rates and earnings uncertainty can make STEM fields the riskier choice for which grants can act as insurance mechanisms.

Our analysis yields three main findings. First, we show that prospective students who are marginally eligible for grants are more likely to enroll in university than those that would have to rely on student loans to finance their studies. This is particularly true for enrollment in traditional universities and not driven by more vocationally-oriented institutions. It is also more pronounced in the second-half of our sample period, where an expansion of financial aid increased the share of potential grant recipients. Second, students passing the grant eligibility cut-off choose STEM related fields significantly more often. Enrollment in STEM degrees jumps on average by 1.5 percentage points at the threshold, against an overall STEM enrollment rate of 22% in our sample. Finally, the average effects we find mask a fair degree of heterogeneity. The effect on higher enrollment in STEM is most pronounced for students coming from so-called first-generation backgrounds. That is, students with parents that do not themselves have a university degree. We also find gender differences in the effect of financing schemes on student choices. Male students seem to be more price-sensitive in their general enrollment decisions than female students, which enroll regardless of the type of allocated financial aid. At the same time we see a shrinking gender enrollment gap in STEM fields in response to grant eligibility.

The finding that STEM enrollment responds to the structure of higher education financing relates to a small literature studying the impact of universities' pricing system (Andrews and Stange, 2019; Stange, 2015) and aid provision (Cornwell, Mustard and Sridhar, 2006; Rothstein and Rouse, 2011; Sjoquist and Winters, 2015*a*,*b*; Stater, 2011) on major choices. Focusing on a set of US universities, this body of work finds lower enrollment rates in STEM fields for students with access to financial aid. While this generally supports a story in which financial aid shifts the relative importance of pecuniary and non-pecuniary aspects of fields of study for students' choices, we demonstrate that more generous financial aid does not necessarily have to imply an outflow out of high return fields. In fact, relying on large administrative records, our results point in the opposite direction: students that are marginally eligible for grants are more likely to enroll in STEM related fields than those that have to finance their education through student loans. We discuss uncertainty about future earnings and degree completion as potential channels, focusing explicitly on the interaction between higher education financing policies and individual choices under uncertainty.

In recent years economists demonstrated an increased interest in understanding the choice of field of study through the lens of subjective expectations (Arcidiacono, Hotz and Kang, 2012; Boneva and Rauh, 2017; Hastings et al., 2016; Wiswall and Zafar, 2015; Zafar, 2013; Patnaik, Wiswall and Zafar, 2020). Given oftentimes biased beliefs about benefits from attending university and pursuing a given major, a series of studies such as Conlon (2021), Hastings et al. (2016), and Wiswall and Zafar (2015) demonstrate that correcting earning beliefs significantly alters field choices. Note that this literature focuses on comparisons of (perceived) returns of majors. Relatively less is known about the sensitivity of major choices to cost shocks when relative gross returns are unaffected – as is the case in our setting of policy-induced changes in the price of all majors.

The choice of university majors significantly impacts future earnings (Kirkeboen, Leuven and Mogstad, 2016). It has a gender component by preconditioning occupational sorting (Sloane, Hurst and Black, 2019) and plays a role in determining household-level inequality through assortative matching (Eika, Mogstad and Zafar, 2019). All these aspects have potential welfare implications. A sound understanding of how different types of higher education financing affect the choice of college majors should therefore be part of any thorough policy evaluation, even if the composition of majors is not an immediate policy goal but rather an unintended consequence. The results in this paper are therefore informative for the optimal design of higher education financing schemes (Colas, Findeisen and Sachs, 2021). Particularly so, if – in the light of technological change and the accompanying fast-changing skill demand in the labor market (Deming and Noray, 2020) – the aim is to increase general enrollment in STEM fields (Atkinson and Mayo, 2010), as well as adressing socio-economic (Boneva and Rauh, 2017) and gender-gaps (Cimpian, Kim and McDermott, 2020).

Given basic economic theory, it is perhaps less surprising that potential students with access to financial aid are more likely to enroll in university than those without any access to aid (Dynarski, 2003; Dynarski and Scott-Clayton, 2013). Empirically, it is less clear, however, whether the same prediction holds when contrasting different types of financial aid such as loans and grants. In fact, previous work by Solís (2017, 2021) that also uses data from Chile highlights that while easing borrowing constraints through access to student loans drastically increases enrollment rates in higher education, substituting loans with grants seems to have no additional effect on enrollment rates or degree completion. Our study makes clear that this null effect is largely driven by a shorter considered study period, in which institutional arrangements heavily restricted access to scholarships based on income and program type. This induced price changes only for a small share of the population of applicants to financial aid. By considering a longer time period, we are able to observe price variation for all accredited Chilean higher education institutions and find that grants indeed increase enrollment rates in higher education, even when subsidized student loans are available.

Road Map. For the rest of the paper we proceed by first introducing the institutional setting of the Chilean higher education system and the data we use to study the effect of financing schemes on students' choices. Section 3 lays out our empirical strategy, whereas section 4 presents our results. Finally, section 5 offers a discussion and some concluding remarks.

2 Institutional Setting and Data

In this section, we outline how we can make use of the higher education system of Chile to replicate as closely as possible exogenous variation in the access to two types of financing schemes: student loans and grants. We then move on to describe our data sources and the sample restrictions we impose.

2.1 Institutional Setting

Until recent years the higher education system of Chile was characterized by relatively high tuition fees compared to other OECD countries.[1] For our study sample, students at the tenth percentile pay a yearly tuition fee of approximately $1800, whereas the median student pays $3000. For comparison, the yearly median household income over the same period is roughly $5600. Only few students can consequently afford to fully cover the costs of their studies on their own and the majority requires external financing.

The Chilean government provides assistance to students both in the form of direct grants and by backing loans. Both types of financing cover up to a maximum of 90% of a set reference tuition and access to either is granted using a combination of merit- and need-based arguments.

[1] From 2016 onward, the Chilean government enacted a needs-based system of tuition-free public universities that increasingly covers also private institutions. We focus our attention on the years up to and including 2015.

Students are not allowed to combine grants and loans to cover more than this amount. The need component is ensured by restricting eligibility to students from families below a strict household income level, while the merit-component consists of a minimum achievement in a standardized nation-wide test called *Prueba de Selección Universitaria (PSU)*. Conditional on being eligible in terms of income, a single test score threshold determines whether a given student can receive funding either in form of a loan or in form of a scholarship.

The PSU test is administered by a department of the University of Chile called DEMRE *(Departamento de Evaluación, Medición y Registro Educacional)* and is offered once a year in December in nation-wide local testing centers. It is a classic multiple choice test that requires students to take two mandatory components – mathematics and language – and at least one of two voluntary components – science and/or history, social science, and geography. For each component the raw results are standardized at the national level to result in a distribution of scores ranging from 150 to 850, with a mean of 500 and a standard deviation of 110. The relevant test score influencing allocation of financial aid is an equally-weighted average of the two mandatory components only.

The combination of household income and PSU test result necessary to obtain a grant is not constant over time, since the access to grants has been extended between 2011 and 2015. Table 1 summarizes this extension by showing the test score thresholds on a yearly basis for several family income bins. While only the bottom 40% of the income distribution was eligible for grants before 2012, this number rose to 70% in 2015. A similar extension happened with respect to the necessary PSU requirement. A student in the bottom income quintile in 2012 had to obtain at least a math-language average of 550 points, whereas a score of 500 would have been sufficient for the same student in 2015.

Note that Table 1 also illustrates that the source for financing of grants differs by institution type. The Chilean higher education system is broadly divided into two groups of institutions. The first group consists of the so-called traditional universities that are part of a network called *CRUCH* and typically considered to be of higher prestige.[2] Conditional on meeting the income and PSU requirements, students enrolled at a CRUCH university are eligible to the *Beca Bicentenario* or Bicentennial Grant (BG), covering up to 90% of reference tuition. The second group of higher education providers includes all other private universities and vocational institutions. As outlined in Table 1, eligible students at the latter schools are financed through the *Beca Juan Goméz Millas*

[2]CRUCH is short for Consejo de Rectores de Universidades Chilenas or Council of Rectors of Chilean Universities. Universities in this network can be both public and private.

(JGM), which covers up to $2000 of yearly tuition.

Table 1: PSU Threshold for Grant Eligibility

Bicentennial and Juan Gomez Millas (JGM)					
	$2008-2011^{*}$	*2012*	*2013*	*2014*	*2015*
Quintile 1	550	550	500	500	500
Quintile 2	550	550	525	525	500
Quintile 3	N.E.	550	550	550	500
Decile 7	N.E.	N.E.	N.E.	N.E.	500
Decile 8	N.E.	N.E.	N.E.	N.E.	N.E
Quintile 5	N.E.	N.E.	N.E.	N.E.	N.E.

Note: Displayed are the minimum test score averages of math and language that grant eligibility to either of the two scholarships, by year and family income quintile. N.E.: not eligible. Bicentennial and JGM grants are received conditional on enrolling in CRUCH and accredited universities, respectively.
$*$ JGM was introduced in 2012.

Two features of the institution-specific financial aid setting are relevant here. First, irrespective of the institution type, any student that is marginally ineligible for a grant in terms of his or her test score is still eligible for a subsidized student loan. This implies that students close to the PSU threshold have access to either types of financing for any accredited institution in Chile.[3] It also implies that close to the respective thresholds, assignment to either type of financing is essentially random – a feature that is crucial for our identification strategy outlined in the following section.

Second, while grants and loans are institution-specific, they differ little between programs.[4] That is, an economics-major at university A and an engineering-major at the same university are eligible to similar amounts of funding. This is in line with pricing behavior of Chilean universities more generally. Most of the variation in tuition we observe in the data is between institutions. Within any given university or vocational school, individual programs seem to be priced rather homogeneously.[5] This is also true between students. Contrary to other countries as for example the US, Chilean universities do not price-discriminate in the form of reduced tuition fees for disadvantaged students or minorities.

[3]Also here, the type of loan is institution-specific, where the loan obtainable when enrolled at a CRUCH university has more favorable conditions. Its interest rate is fixed at 2%, repayment starts 24 months after graduation, with a maximum repayment period of 15 years. Loans at non-CRUCH insitutions are closer to market interest rates, repayment starts 18 months after graduation, with a maximum repayment period of 20 years. In 2011 the Chilean government changed the structure on the latter, making it more comparable to loans at CRUCH institutions both in terms of interest rate and income contingent repayments.

[4]Some variation exists because the maximum covered amount depends on a reference tuition, which is set by the Ministry of Education based on estimates about the value-added of institutions and programs.

[5]Within the average (median) institution, the standard deviation in tuition fees between programs is 485 (464) thousand Chilean pesos. The standard deviation in tuition fees across institutions on the other hand is 880 thousand pesos. Using the average exchange of our last sample period (2015), this amounts to approximately $1,320.

A final relevant piece of information concerns the enrollment and major-choice setting in Chile. In line with most European countries, students in Chile enroll immediately in a given institution-major combination and do not choose their field of study after enrolling. They do so after having received their PSU test result and thus fully aware of which type of funding they will be able to access.

2.2 Data and Sample Construction

Through DEMRE we have access to the universe of Chilean PSU test takers for the academic years 2008 through 2015. Besides detailed information on the disaggregated test results of each individual, the data contains unique identifiers that allow us to merge prospective students to administrative records of the Chilean ministry of education. This way we are able to obtain rich socio-demographic information on family background, gender and academic performance in high school, as well as enrollment decisions at the institution-major level. We are furthermore able to track the application and assignment of financial aid for each individual in our sample.

To study the effect of various financing types on student choices, we impose the following sample restrictions: (i) students applied for financial aid, (ii) students pre-qualify for grants in terms of the necessary family income quintile requirements outlined in Table 1, (iii) students are first-time PSU test takers and recent high school graduates in the respective academic year. Requirements (i) and (ii) ensure that each individual in our sample is at least theoretically eligible for both types of financing. Conditional on applying for aid and fulfilling the income requirement, it will allow us to focus our attention on those applicants that are close to the grant eligiblity cut-off in terms of their PSU test scores. Requirement (iii) on the other hand excludes repeated test takers. Since our identification strategy will rely of a regression-discontinuity design, repeated test taking would violate the central assumption of a non-manipulable test score.

A final necessary requirement for our analysis is the exclusion of all individuals for whom the relevant test score threshold for grant eligibility is 500. This excludes all individuals in the year 2015 and the lowest income quintile in the years 2013 and 2014. As we detail in Appendix A.3, a large subset of Chilean universities partially base their admission decisions on obtaining a minimum PSU result of 500 - the mean of the standardized test score distribution. This leads to a situation, in which passing the threshold of 500 not only opens the possibility to obtain a grant but also significantly enlarges the choice sets in terms of university programs that are available to prospective students. In other words: for the excluded subjects, two treatments discontinuously change at the cut-off of 500, which we would not be able to disentangle.[6]

Imposing the restrictions (i) to (iv) leaves us with a sample of 487,636 test takers, out of which 67% end up enrolling in a higher education institution in the year of test taking. Table A1 provides an overview over the socio-demographic composition of our study sample. Roughly three-quarters come from the central regions of Chile, and a third have at least one parent with a university degree. A slight majority of 56% is female and approximately one out of five is enrolled in a science, technology, engineering, or mathematics (STEM) field.

3 Empirical Strategy and Identification

Given the nature of grant assignment in Chile, a straightforward way to proceed empirically is to estimate regression-discontinuity (RD) models, treating the PSU test result as a running variable. Let $c_{i,q,t}$ be the relevant PSU cut-off for grant eligiblity for an individual i with family income in quintile q, applying in year t (see Table 1). Pooling over all the years in our sample described above, we define $PSU_i^* = PSU_i - c_{i,q,t}$ as a normalized running variable and our targeted estimand as the standard sharp RD parameter:

$$\tau = \lim_{z \to 0^+} \mathbb{E}[Y_i | PSU_i^* = z] - \lim_{z \to 0^-} \mathbb{E}[Y_i | PSU_i^* = z]. \tag{1}$$

Here Y_i can be either an indicator for enrollment in higher education or in a specific field, respectively (see below), and τ captures the change in the average enrollment decisions for those becoming eligible for a grant. As discussed above, any student marginally below the cut-off has access to a student loan. Our empirical strategy consequently allows us to contrast two types of higher education financing.[7] Note that as in all RD studies, our results should be interpreted as valid for the population of individuals around the cut-off and not as average treatment effects for the full population.

In practice we estimate (1) using a kernel-weighted linear regression of the form:

$$Y_i = \beta_0 + \beta_1 \mathbb{1}\{PSU_i^* \geq 0\} + \beta_2 \mathbb{1}\{PSU_i^* \geq 0\} \times PSU_i^* + \beta_3 PSU_i^* + X_i' \delta + \epsilon_i. \tag{2}$$

[6] One potential attempt at doing is by noticing that prior to 2013, a PSU score of 500 did not yet grant access to a grant, but did already alter students' choice sets. Under some assumptions, we can then disentangle the two effects by studying differences in the discontinuities over time. In Appendix A.4 we show that this strategy confirms the results we obtain in our main analysis below.

[7] We focus on the effect of grant eligiblity instead of take-up, since the take-up of any type of financing is conditional upon enrollment. Therefore by definition any individual taking a grant will be enrolled in higher education.

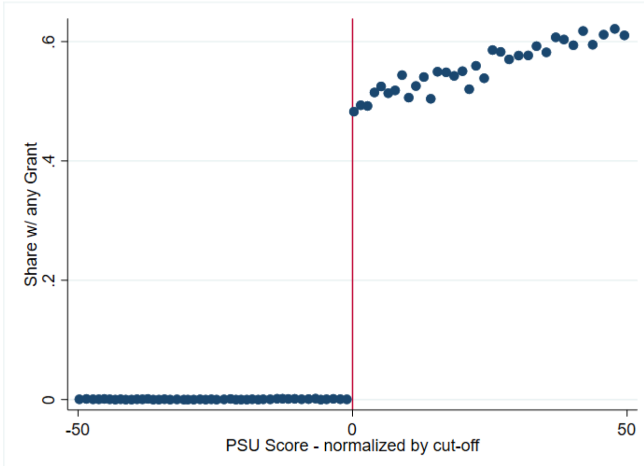
The parameter of interest then is β_1, which quantifies potential discontinuous jumps around the normalized cut-offs. We construct weights to estimate (2) following a triangular kernel-weighting around the cut-off, within an optimally set bandwidth according to Calonico, Cattaneo and Farrell (2020). To gain precision in our estimation, X_i adjusts for a vector of covariates that include the individual's gender and high school GPA, parental education, the number of other studying and working family members, an indicator for single mother households, as well as location (far north, near north, central, near south, far south) and year by family income quintile fixed effects.

Identifying Assumptions. Before moving on to the empirical results, we want to briefly discuss the plausibility of the conditions under which β_1 identifies a causal effect. As is standard, the necessary identifying assumption for sharp RD models requires continuity in potential outcomes around the threshold. We might expect a violation of the continuity assumption, if students were able to manipulate their PSU score around the cut-off. Bear in mind, however, that the final PSU test result determining grant eligibility is the product of a blind evaluation procedure and a nation-wide standardization of raw test scores that ensures an approximately normal distribution of results, with a mean of 500 and a standard deviation of 110. It is therefore unlikely that there is a local correlation of the threshold with any observed or non-observed factor that is non-ignorable in terms of our analysis.

In line with this, Figure A1 presents estimates of model (2) treating standard socio-demographic covariates as outcome variables. We find our sample balanced among covariates, which lends additional credibility to our identifying assumption. A final check for manipulation around the threshold is based on McCrary's (2008) idea of testing for discontinuities in the density of the running variable around the cut-off. Figure A2 plots the histogram of our running variable, PSU_i^*, together with confidence bands based on a local polynomial density estimator proposed by Cattaneo, Jansson and Ma (2020, 2021). We find no evidence for discontinuities in the density of test scores around the cut-off.

Given that our main identifying assumption is plausibly satisfied, β_1 identifies the causal effect of crossing the grant eligibility cut-off. As discussed in Section 2.2, our sampling procedure excludes combinations of income quintiles and years in which threshold crossing is also associated with changing choice sets for students. Figure 1 on the other hand shows that, not surprisingly, there is in fact a discontinuous increase in grant take-up for marginally eligible students. This implies that the setting we study allows us to focus our analysis on exogenous variation in the

Figure 1: Take up of any grant around cut-off



Note: The figure presents shares of individuals holding either the Bicentennial (BG) or the JGM grant in 1.25 PSU point bins around the grant eligibility cut-off (normalized to zero across years and income quintiles). Grant take-up is not at 100% right of the cut-off for two reasons. First, grant take-up is conditional on enrollment, whereas we plot the unconditional probability of taking a grant. Second, only the BG was available to students for the period before 2012. If a student did not want to attend a CRUCH university in that period, the only financing option was a student loan, even after passing the relevant threshold.

access to two different schemes of higher education financing.

Outcomes of Interest. We study two outcomes of interest: enrollment in higher education and enrollment in a STEM field. If not explicitly mentioned otherwise, we treat all Chilean higher education institutions identically and construct an indicator equal to one in case an individual enrolls either in a public or private university or in a vocational institution.[8] We define STEM fields as those categorized by the Chilean ministry of education as basic sciences or technology. This includes mathematics and statistics, chemistry, physics, the life sciences, computer science, engineering, and a variety of technology-related vocational degrees. According to this classification, the residual category of majors comprises of agriculture, the humanities, the social sciences, business and management, arts and architecture, education, law, and health.

4 Results

In this section we present and discuss our empirical results in two steps. First, we focus on the average treatment effect for individuals around the threshold both in terms of enrollment and

[8] Vocational institutions in Chile include so called Professional Institutes and Technical Formation Centers. Both offer undergraduate degrees focused on a more technical, labor-market oriented training that typically last 2 to 3 years.

the choice of STEM. We then move on to exploring heterogeneous impacts of higher education financing along the lines of gender, parental education and income.

4.1 Average Effect of Grant Eligibility

Table 2 contains point estimates for the effect of grant eligibility on enrollment decisions. As indicated by column (1), those prospective students that do marginally qualify for a grant are 2.3 percentage points more likely to enroll in a higher education institution than those that would have to rely exclusively on student loans to finance their education. Alongside the effect at the extensive margin, we estimate that grant eligibility increases enrollment in STEM related fields by 1.5 percentage points (column 3). To put this into perspective, note that for our sample the average enrollment rate in STEM fields is approximately 22% (Table A1). Both estimates are essentially unaffected by bandwidth choices. Limiting our estimation samples to a window of 25 PSU test points around the cut-offs does not influence the results.[9]

Table 2: Effect of Grants vs. Loans on Enrollment and STEM

	Enrolled (=1)		STEM (=1)	
	(1)	(2)	(3)	(4)
RD Estimate	0.023***	0.022***	0.015***	0.015**
	(0.006)	(0.007)	(0.005)	(0.007)
Bandwidth	31.2	25	47.5	25
Effective N	92,084	73,224	136,846	73,224

Note: ** $p < 0.05$, *** $p < 0.01$.
All dependent variables are binary indicators. Reference category for STEM: non-enrollment or enrollment in any other major. The table presents estimates for β_1 in equation (2). All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to year by family income quintile fixed effects. Bandwidths are chosen optimally according to Calonico, Cattaneo and Farrell (2020) in columns (1) and (3). Standard errors are clustered at the PSU test score level and reported in parentheses.

Effect on Enrollment in Higher Education. Overall, 77% of students that are marginally ineligible for grants choose to enroll in higher education. Compared to this baseline, the estimated increase in enrollment through the provision of grants is, albeit non-negligible, still modest. Note, however, that we define enrollment in higher education broadly to also include shorter vocational degrees

[9]This stability is especially reassuring since a window of 25 points excludes observations with PSU scores around 500, which, as discussed in section 2.2, is a problematic value given the admission policies in Chile.

offered outside of traditional universities. In fact, in our study sample, 60% of the students that are enrolled in higher education without a grant pursue such a vocational degree, 14% study at traditional universities (CRUCH), and the remainder is enrolled at non-traditional private universities.

Recall from the discussion of the institutional setting in section 2 that up until 2012 there was only one type of grant available, the Bicentennial Grant, which was applicable exclusively to CRUCH institutions. Only from 2012 onward Chile introduced the JGM grant that could be used at any accredited institution. This implies two things. First, we expect enrollment to respond more strongly to grant eligibility in the second half of our sample period, where passing the cut-off resulted in a change in the available types of financing for the full set of higher education institutions. Second, average effects over the full study period are more likely to be carried by increased enrollment in CRUCH institutions, for which grants were always available.

Addressing the latter point first, we indeed find that the extensive margin effect is to a large extent driven by higher enrollment in CRUCH universities (see Table A2). Being marginally eligible for a grant increases enrollment at CRUCH institutions by 2.5 percentage points over the full period from 2008 to 2014, but has no effect on enrollment at other institutions. Since in this time frame overall enrollment is increasing to a lower extent than enrollment in CRUCH institutions, we can conclude that grants (i) enable new students to enter higher education that are reluctant to finance their studies with debt, and (ii) allow some students to substitute vocational degrees with enrollment in higher-quality, academically-oriented programs. The presence of these two channels emphasizes the idea that different types of higher education financing affects both the extensive and the intensive margin of students' choices, even when not focusing on the choice of majors yet.

Concerning the notion of more pronounced effects in later years, Table 3 contains our main results, splitting the sample into the periods 2008 to 2011 and 2012 to 2014. The results support our hypothesis of time-varying effects, since enrollment is in fact more sensitive to grant eligibility in the latter period, where it increases by 3.2 percentage points, as opposed to 1.6 percentage points in the former.[10] The fact that students with access to grants are more likely to enroll, even with the alternative of subsidized income-contingent loans at hand, stands in contrast with the idea that borrowing constraints are the only factor inhibiting higher enrollment rates. In this way our estimates differ from previous work by Solís (2017), who also uses Chilean data and shows that providing prospective students with grants does not additionally influence enrollment decisions.

[10] As is the case for the full sample period, this result is not sensitive to bandwidth choices – see Table A3.

However, the time-variation we highlight in Table 3 can reconcile the different findings by noting that we study an extended period of time (2008-14, instead of 2007-09), in which the allocation of grants became increasingly generous – both in terms of its applicability to all accredited institutions and by granting eligibility to an additional income quintile. As we are particularly interested in observing variation in different financing types for as large a population as possible, this is the more relevant period to us.

Table 3: Effect of Grants vs. Loans on Enrollment and STEM: Split Sample Period

	2008 - 2011		2012 - 2014	
	Enrolled	STEM	Enrolled	STEM
RD Estimate	0.016**	0.008	0.032***	0.029***
	(0.008)	(0.005)	(0.008)	(0.008)
Bandwidth	34.8	66.3	32.6	41
Effective N	56,414	104,212	42,751	53,138

Note: ** $p < 0.05$, *** $p < 0.01$.
All dependent variables are binary indicators. Reference category for STEM: non-enrollment or enrollment in any other major. The table presents estimates for β_1 in equation (2), splitting the sample into the periods 2008-2011 and 2012-2014, respectively. All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to year by family income quintile fixed effects. Bandwidths are chosen optimally according to Calonico, Cattaneo and Farrell (2020). Standard errors are clustered at the PSU test score level and reported in parentheses.

Effect on Major Choices: Enrollment in STEM. On average, we observe an increased enrollment in STEM fields of 1.5 percentage points for students that are marginally eligible for grants. In line with the discussion above, we expect variation in the effect sizes across time, since the years from 2012 on provide a cleaner setting for our analysis. Indeed, we find that in this period, STEM enrollment increases in response to grant eligibility by 2.9 percentage points (Table 3) over a baseline of 25 percent, while the effect for the years 2008 to 2011 is much smaller in magnitude (0.8pp) and measured with too much noise to conclude it is statistically different from zero.

To better understand these changes in students' field choices, we next want to understand the characteristics of STEM programs relative to other fields.[11] To do so, we focus on two dimensions: expected monetary returns (both in terms of first and second moments) and ex ante degree completion probabilities. Chilean high school students contemplating a university study have

[11]We do not find significant changes in the enrollment in other fields of studies, as demonstrated in Figure A3.

access to a large publicly available data set provided by the ministry of education called *My Future* (www.mifuturo.cl). Since 2011, prospective students can use this portal to obtain information about average labor market earnings of past graduating cohorts at the institution by major level. It also contains information about the 10th, 25th, 75th, and 90th percentile of graduate earnings, one and five years after graduation, for institution type (university, vocational) by major combinations. We use this information to summarize mean expected earnings and coefficients of variation at the aggregated field level and display the results in Table A4.

Looking at mean earnings by fields, it becomes immediately clear that STEM graduates have the highest average earnings. Even though we do not have data on subjective earnings expectations of students, it is reasonable to assume that these figures serve as anchors for prospective students' beliefs, given the easily accessible nature of the information and the popularity of the website. Our results are thus at odds with a story in which students substitute STEM with lower return fields, if they have to worry less about repayment – a finding that seems to be present for some US universities (Rothstein and Rouse, 2011; Stater, 2011). Taking into account second moments of the data, however, Table A4 also indicates that STEM fields are associated with larger uncertainty about future earnings. The relative importance of pecuniary aspects in informing major choices might therefore very well be affected by the provision of different types of financial aid, albeit through an uncertainty channel rather than through average expected earnings.

A more immediate degree of uncertainty that can affect major choices, is expectations about the likelihood of degree completion. Students financing their studies with a loan accumulate debt for every year of study. This implies that dropping out can come at high monetary costs and also prolonging studies through switching to easier to complete majors can be costly. Both constraints are significantly less pronounced when students have access to grants. STEM fields have notoriously low completion rates and we indeed find that this is also true for Chile. Relying again on data provided by *My Future* for past cohorts, prospective students have open access to information about the share of students persisting with their studies after one and two years of study, respectively. In Table A5, we present field-specific dropout probabilities. They range between 20.1% and 28.3% after one year of study, and between 22.6% and 37.3% after two years of study. For both time frames, STEM fields are those with the highest share of students not continuing their studies.

The Supply-Side of Fields of Study: an alternative Explanation. The observation that grant eligibility both increases enrollment at universities (as opposed to vocationally-oriented institutions) and in STEM fields raises the question of whether the observed changes in field choices are driven by supply side considerations. If universities happened to be more specialized in STEM related fields than vocational institutions, we might misinterpret a desire for enrollment in more prestigious institutions with the choice of STEM. We think this alternative story is unlikely to be true for two reasons. First, grants for the most prestigious CRUCH universities are available throughout all of our study period, but STEM enrollment increases more strongly in the years 2012 to 2014, where the JGM was introduced, which primarily targets non-CRUCH institutions. Second, 31.2% of all programs that are offered by universities can be classified as STEM, whereas the respective number is 31.7% for vocational institutions (see Table A6). Both institution types thus seem to have similar levels of specialization at the aggregated field measure we use.

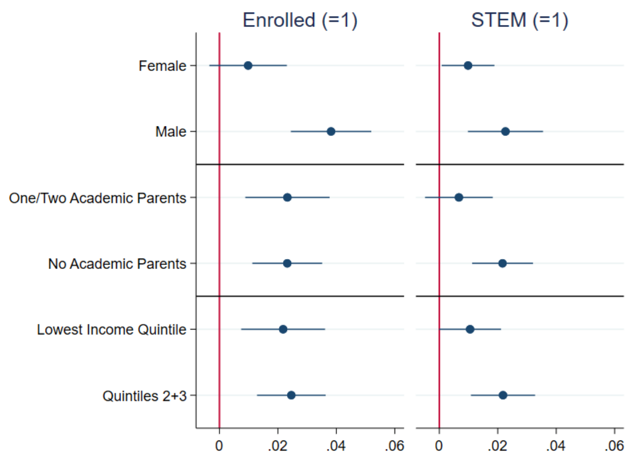
The picture changes somewhat, if we focus on CRUCH universities separately from other universities. For them, 40.7% of all programs are STEM related according to our classification. The higher share of STEM fields at CRUCH universities relative to vocational institutions is driven exclusively by the natural science, whose share at vocational institutions is essentially zero. If the alternative story of supply-side driven changes in enrollment in STEM were correct, we would expect to see a stronger impact of grant eligibility on enrollment in natural science than in engineering. This, however, is the exact opposite of what we observe in the data, where grant eligibility increases STEM enrollment mainly through engineering programs (see Table A7).

We conclude from this analysis that, while it is the case that students use grants to enroll in more-prestigious universities, the composition of majors offered at these institutions is unlikely to drive the sorting patterns we observe with respect to enrollment in STEM fields. A direct impact of the type of financial aid on field choices through the distinct field characteristics we outlined above, is the more plausible mechanism.

4.2 Heterogeneity Analysis

We explore heterogeneity in the effect of financial aid along three dimensions: gender, parental education, and parental income. To do so, we separately estimate equation (2) for six subgroups: female and male students, students with no or at least one parent with a university degree, and students coming from either the bottom quintile of the family income distribution or from quintiles

Figure 2: Heterogeneous Effects of Grants vs. Loans



Note: The figure presents estimates and confidence intervals for β_1 in specification (2) treating enrollment or enrollment in STEM as outcomes and limiting the sample to the respective sub-groups. Bandwidths are chosen optimally for each sub-group following Calonico, Cattaneo and Farrell (2020). Each specification includes the covariates outlined in Table A1 and year by family income quintile fixed effects.

two and three.[12]

Figure 2 summarizes the main results of our heterogeneity analysis by presenting point estimates and confidence intervals for the estimated discontinuous jumps. Focusing first on general enrollment in higher education, we can see that grant eligibility increases enrollment rates almost uniformly across the considered subgroups. The notable exception are female students, for whom we do not find a statistically significant effect. Testing explicitly for differences in the two effects for female and male students, we can conclude that the differences are unlikely to be driven exclusively by chance (p-value=0.021). There are no gender differences in enrollment rates for marginally ineligible students. The different magnitudes are therefore neither driven by varying baselines. On average, potential female students therefore appear to be less price-sensitive than their male peers and tend to enroll regardless of the type of available financial aid. As highlighted in Figure A4 in the Appendix, however, this conclusion partially hinges on the considered time period. As is the case for the full samples, effect sizes are larger in the later years of our considered study period and enrollment is positively and significantly affected for both genders from 2012 onward. Given the applicability of grants to a wider set of institutions in this time window, gender differences at the extensive margin of enrollment could partially reflect varying tastes for institution types.

We see larger variation in effect sizes for the question of whether or not to enroll in STEM

[12]Recall that students from the top two income quintiles are not eligible for grants in any of the years we consider.

fields in response to having access to student grants. Point estimates are smaller for female than for male students, for people with at least one academic parent and for students from poorer backgrounds. Note that contrary to the case of general enrollment, there are baseline gender differences in STEM enrollment. While only 12.9% of marginally ineligible female students enroll in STEM fields, 38.1% of male students do. Relative to these baseline figures, grant eligibility actually increases STEM enrollment more strongly for female than for male students. This is again particularly true for the second half of our study period, where female (male) STEM enrollment increases by 15.4% (9.4%) relative to baseline enrollment. In fact, we cannot reject the null hypothesis of equal absolute effects for male and female students. Substituting student loans with grants could consequently shrink gender gaps in STEM enrollment, which has been a target of a series of former policy initiatives (see e.g., Cimpian, Kim and McDermott, 2020).

As is the case for gender, we cannot rule out equal effects on STEM enrollment for students coming from either the poorest family income quintile or from quintiles two and three. Parental education on the other significantly moderates the impact of grant eligibility. Since parental education and income are positively correlated, our finding on distinct impacts of the two dimensions of heterogeneity might appear surprising at first. It is, however, in line with the idea, formalized by Lefgren, Sims and Lindquist (2012), that parental education and financial resources are separate intergenerational transmission channels. Conditional on enrollment, first-gen students tend to have a higher likelihood to choose STEM majors also in the US (Patnaik, Wiswall and Zafar, 2020). Given the, on average, high labor market returns, this difference in field choices might be a positive factor in increasing intergenerational mobility. The results we present in this section, however, highlight an important bottleneck: first-gen students seem to be more price-sensitive in their choice of STEM than children from academic families. The right design of financial aid thus has implications for addressing mobility issues that go beyond the question of increasing general enrollment gaps.

5 Discussion and Concluding Remarks

We find that students that are marginally eligible for grants differ at both margins of the joint decision of enrollment and field choice from students that have to rely on loans. They are more likely to enroll in higher education in general, but particularly so in more-prestigious universities and in STEM related fields. Given the institutional setting in Chile, being marginally eligible corresponds to being among the average students in terms of academic preparedness, since the necessary requirement for eligibility is scoring 525 or 550 points in the standardized PSU test, which ranges from 150 to 850 and has a mean of 500. Contrary to other studies looking at merit-aid targeted towards particularly qualified students (Sjoquist and Winters, 2015*b*), our results are therefore informative for policies targeted at a broader set of students.

Our results complement the ones by Solís (2017) in illustrating that while it is indeed the case that easing borrowing constraints through the provision of student loans goes a long way in increasing enrollment in universities, there is a non-negligible subset of students that is not willing to take on debt to finance their university education. As we documented, it is interestingly not the case that these are students with a higher inclination to enroll in low return fields, for which the wealth effect brought about by grants might be necessary to make enrollment worthwhile. While we discussed uncertainty about future earnings and degree completion as potential mechanisms for this effects, debt aversion (Field, 2009) is a complementary force that could rationalize our findings.

The changes in enrollment we observe could potentially be driven by two groups of students. One group that enrolls regardless of the type of allocated financial aid, but switches to higher quality places and/or STEM fields if it receives a grant. And a second group that decides not to enroll in the case of receiving a student loan, but does so in case of receiving a grant. Since we observe only students' choices with either a grant or a loan, we unfortunately cannot disentangle the two groups from one another in the reduced form analysis we report on in this paper. This is a shortcoming of our study, since the policy implications of the two forces are quite different. If the effects are mainly driven by newly enrolling students, a scaling-up of the provision of student grants would likely result in higher enrollment in STEM fields, yet change the composition of the enrolled by including more students with a lower general propensity to attend university. It is not clear what this would imply for the average academic preparedness of students enrolled in STEM.[13] If the increase in STEM enrollment is on the other hand driven mainly by students switching their major, this concern would be mitigated. The results of our heterogeneity analysis are more in line with this latter channel, since female enrollment at the extensive margin does not significantly respond to grant eligibility, yet their enrollment in STEM fields increases. This implies adjustments along the margin of field choice. Nonetheless we consider an extension of our analysis that introduces a more structured discrete choice problem, which allows for cleaner separation of the two mechanisms, as a promising next step for future research.

[13] Recent work by Ichino, Rustichini and Zanella (2022) for instance argues that the aggressive expansion of university access in the UK since the 1960s decreased measured intelligence scores of universities graduates and led to a lower college wage premium over time.

When interpreting our results in the light of the financial aid environment of other countries, it is important to keep in mind that students in Chile make their enrollment decisions fully aware of their financial aid status and that the aid application and allocation setting is relatively transparent. Previous studies point to uncertainty about eligibility as a strong determinant of financial aid effectiveness (Bettinger et al., 2012; Dynarski et al., 2021). Contrary to other institutional settings, this type of uncertainty is strongly mitigated in Chile. Policy conclusions drawn for the results should take this into account.

References

Andrews, Rodney J, and Kevin M Stange. 2019. "Price regulation, price discrimination, and equality of opportunity in higher education: evidence from Texas." *American Economic Journal: Economic Policy*, 11(4): 31–65.

Arcidiacono, Peter, V Joseph Hotz, and Songman Kang. 2012. "Modeling college major choices using elicited measures of expectations and counterfactuals." *Journal of Econometrics*, 166(1): 3–16.

Atkinson, Robert D, and Merrilea Joyce Mayo. 2010. "Refueling the US innovation economy: Fresh approaches to science, technology, engineering and mathematics (STEM) education." *The Information Technology & Innovation Foundation, Forthcoming*.

Bettinger, Eric P, Bridget Terry Long, Philip Oreopoulos, and Lisa Sanbonmatsu. 2012. "The role of application assistance and information in college decisions: Results from the H&R Block FAFSA experiment." *The Quarterly Journal of Economics*, 127(3): 1205–1242.

Boneva, Teodora, and Christopher Rauh. 2017. "Socio-economic gaps in university enrollment: The role of perceived pecuniary and non-pecuniary returns." CESifo Working Paper Series 6756, CESifo Working Paper Series.

Calonico, Sebastian, Matias D Cattaneo, and Max H Farrell. 2020. "Optimal bandwidth choice for robust bias-corrected inference in regression discontinuity designs." *The Econometrics Journal*, 23(2): 192–210.

Cattaneo, Matias D, Michael Jansson, and Xinwei Ma. 2020. "Simple local polynomial density estimators." *Journal of the American Statistical Association*, 115(531): 1449–1455.

Cattaneo, Matias D, Michael Jansson, and Xinwei Ma. 2021. "Local regression distribution estimators." *Journal of Econometrics*.

Cimpian, Joseph R, Taek H Kim, and Zachary T McDermott. 2020. "Understanding persistent gender gaps in STEM." *Science*, 368(6497): 1317–1319.

Colas, Mark, Sebastian Findeisen, and Dominik Sachs. 2021. "Optimal need-based financial aid." *Journal of Political Economy*, 129(2): 492–533.

Conlon, John J. 2021. "Major Malfunction A Field Experiment Correcting Undergraduates' Beliefs about Salaries." *Journal of Human Resources*, 56(3): 922–939.

Cornwell, Christopher, David B Mustard, and Deepa J Sridhar. 2006. "The enrollment effects of merit-based financial aid: Evidence from Georgia's HOPE program." *Journal of Labor Economics*, 24(4): 761–786.

Deming, David J, and Kadeem Noray. 2020. "Earnings dynamics, changing job skills, and STEM careers." *The Quarterly Journal of Economics*, 135(4): 1965–2005.

Dynarski, Susan, and Judith Scott-Clayton. 2013. "Financial aid policy: Lessons from research."

Dynarski, Susan, CJ Libassi, Katherine Michelmore, and Stephanie Owen. 2021. "Closing the gap: The effect of reducing complexity and uncertainty in college pricing on the choices of low-income students." *American Economic Review*, 111(6): 1721–56.

Dynarski, Susan M. 2003. "Does aid matter? Measuring the effect of student aid on college attendance and completion." *American Economic Review*, 93(1): 279–288.

Eika, Lasse, Magne Mogstad, and Basit Zafar. 2019. "Educational assortative mating and household income inequality." *Journal of Political Economy*, 127(6): 2795–2835.

Field, Erica. 2009. "Educational debt burden and career choice: Evidence from a financial aid experiment at NYU Law School." *American Economic Journal: Applied Economics*, 1(1): 1–21.

Grembi, Veronica, Tommaso Nannicini, and Ugo Troiano. 2016. "Do fiscal rules matter?" *American Economic Journal: Applied Economics*, 1–30.

Hastings, Justine S, Christopher A Neilson, Anely Ramirez, and Seth D Zimmerman. 2016. "(Un) informed college and major choice: Evidence from linked survey and administrative data." *Economics of Education Review*, 51: 136–151.

Ichino, Andrea, Aldo Rustichini, and Giulio Zanella. 2022. "Expanding university access: Lessons from the UK experience in 1960-2004."

Kirkeboen, Lars J, Edwin Leuven, and Magne Mogstad. 2016. "Field of study, earnings, and self-selection." *The Quarterly Journal of Economics*, 131(3): 1057–1111.

Larroucau, Tomás, and Ignacio Rios. 2020. "Dynamic college admissions and the determinants of students' college retention." Technical Report 2020. and,"Do "Short-List" Students Report Truthfully.

Lefgren, Lars, David Sims, and Matthew J Lindquist. 2012. "Rich dad, smart dad: Decomposing the intergenerational transmission of income." *Journal of Political Economy*, 120(2): 268–303.

McCrary, Justin. 2008. "Manipulation of the running variable in the regression discontinuity design: A density test." *Journal of Econometrics*, 142(2): 698–714.

Patnaik, Arpita, Matthew J Wiswall, and Basit Zafar. 2020. "College majors." *National Bureau of Economic Research Working Paper Series*, , (w27645).

Rothstein, Jesse, and Cecilia Elena Rouse. 2011. "Constrained after college: Student loans and early-career occupational choices." *Journal of Public Economics*, 95(1-2): 149–163.

Sjoquist, David L, and John V Winters. 2015*a*. "The effect of Georgia's HOPE scholarship on college major: a focus on STEM." *IZA Journal of Labor Economics*, 4(1): 1–29.

Sjoquist, David L, and John V Winters. 2015*b*. "State merit aid programs and college major: A focus on STEM." *Journal of Labor Economics*, 33(4): 973–1006.

Sloane, Carolyn, Erik Hurst, and Dan Black. 2019. "A cross-cohort analysis of human capital specialization and the college gender wage gap." National Bureau of Economic Research.

Solís, Alex. 2021. "University Loans vs. Grants, How They Affect Educational And Labor Market Outcomes." *mimeo*.

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

Stange, Kevin. 2015. "Differential pricing in undergraduate education: Effects on degree production by field." *Journal of Policy Analysis and Management*, 34(1): 107–135.

Stater, Mark. 2011. "Financial aid, student background, and the choice of first-year college major." *Eastern Economic Journal*, 37(3): 321–343.

Wiswall, Matthew, and Basit Zafar. 2015. "Determinants of college major choice: Identification using an information experiment." *The Review of Economic Studies*, 82(2): 791–824.

Zafar, Basit. 2013. "College major choice and the gender gap." *Journal of Human Resources*, 48(3): 545–595.

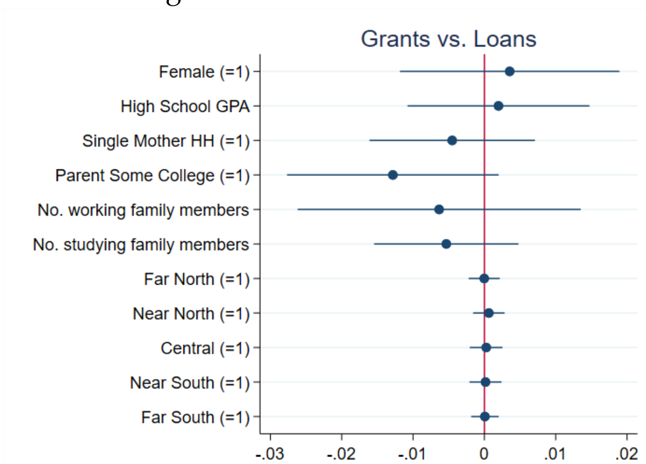
Appendix

Whether and What to Study: the Role of Financial Aid

Adriano De Falco and Yannick Reichlin

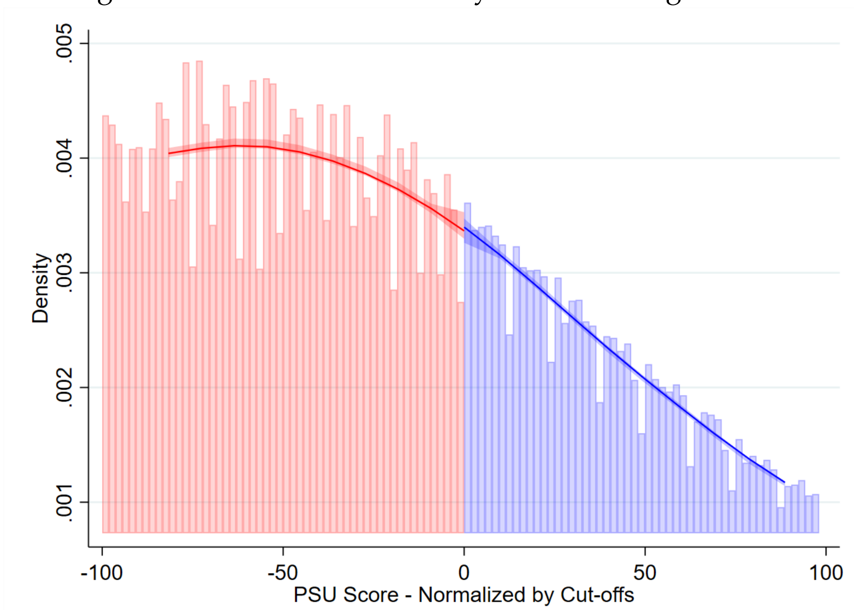
A.1 Additional Figures

Figure A1: Covariate Balance



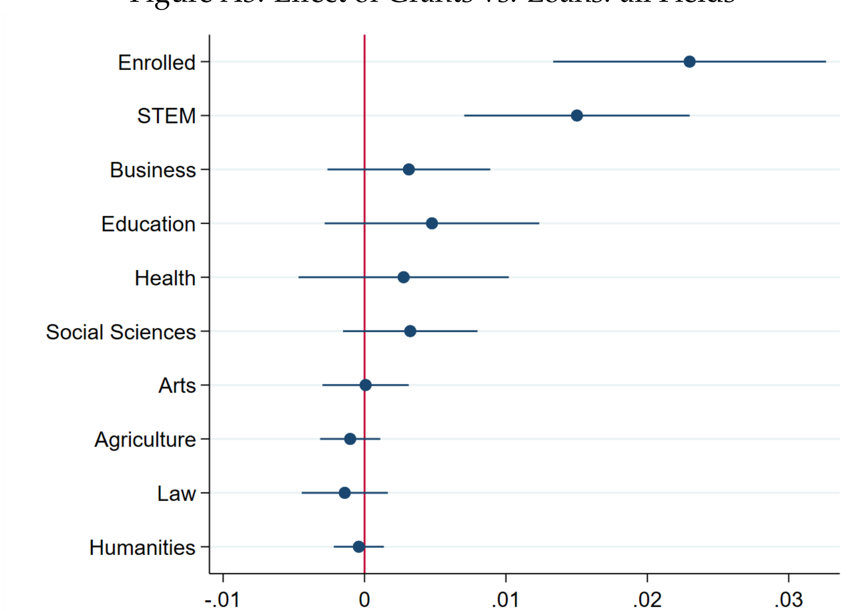
Note: The figure presents estimates and 95% confidence intervals for β_1 in specification (2) using the respective covariates as outcomes.

Figure A2: Test for discontinuity in the running variable



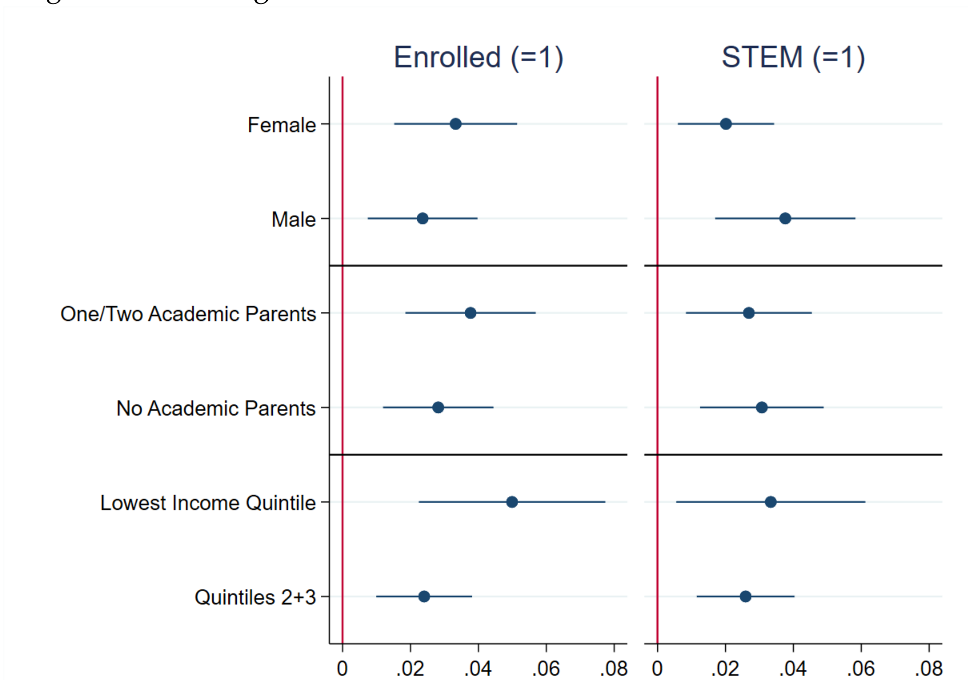
Note: The figure presents a histogram of PSU_i^*, together with confidence bands obtained from the local polynomial density estimator proposed by Cattaneo, Jansson and Ma (2020, 2021).

Figure A3: Effect of Grants vs. Loans: all Fields



Note: The figure presents estimates and confidence intervals for β_1 in specification (2) using the respective variables as outcomes. Reference categories for the fields of study: non-enrollment or enrollment in any other field. Each specification includes the covariates outlined in Table A1 and year by family income quintile fixed effects.

Figure A4: Heterogeneous Effects of Grants vs. Loans: Years 2012 to 2014



Note: The figure presents estimates and confidence intervals for β_1 in specification (2) treating enrollment or enrollment in STEM as outcomes and limiting the sample to the respective sub-groups and the years 2012, 2013, and 2014. Bandwidths are chosen optimally for each sub-group following Calonico, Cattaneo and Farrell (2020). Each specification includes the covariates outlined in Table A1 and year by family income quintile fixed effects.

A.2 Additional Tables

Table A1: Sample Summary Statistics

	Mean	S.D.	Min	Max	N
Enrolled	0.671	0.470	0	1	487,636
Enrolled in STEM	0.221	0.415	0	1	487,636
Female	0.567	0.495	0	1	487,636
Single Mother HH	0.178	0.382	0	1	463,464
Academic Parents	0.325	0.468	0	1	458,789
High School GPA	5.626	0.476	1	8.3	481,783
# Working Family Members	1.140	0.709	0	16	487,636
# Studying Family Members	0.104	0.333	0	7	487,636
Region:					
Far North	0.046	0.210	0	1	487,636
Near North	0.067	0.251	0	1	487,636
Central	0.739	0.439	0	1	487,636
Near South	0.128	0.335	0	1	487,636
Far South	0.012	0.109	0	1	487,636

Note: far north includes the administrative regions of Antofagasta, Arica y Parinacota, and Tarapaca; near north includes Atacama and Coquimbo; central includes Valparaiso, Libertador General Bernardo O'Higgins, Maule, Biobio, and the capital city of Santiago; near south includes Araucania, Los Lagos, and Los Rios; far south inludes Aysen, and the Magallanes and Chilean Antarctica. Reference category for Enrolled and Enrolled in STEM: non-enrollment or enrollment in any other major. Academic Parents is an indicator equal to one in case at least one parent has a university degree.

Table A2: Effect of Grants vs. Loans on Enrollment in Different Institution Types

	Enrolled in...		
	CRUCH University	Private University	Vocational Institution
RD Estimate	0.025***	-0.003	-0.003
	(0.005)	(0.006)	(0.005)
Bandwidth	40.4	34.3	31.6
Effective N	124,866	106,886	99,508

Note: ** $p < 0.05$, *** $p < 0.01$.
All dependent variables are binary indicators. Reference category: non-enrollment or enrollment in respective other types of institutions. The table presents estimates for β_1 in equation (2). All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to year by family income quintile fixed effects. Bandwidths are chosen optimally according to Calonico, Cattaneo and Farrell (2020). Standard errors are clustered at the PSU test score level and reported in parentheses.

Table A3: Results for Split Sample Period: Bandwidth 25

	2008 - 2011		2012 - 2014	
	Enrolled	STEM	Enrolled	STEM
RD Estimate	0.012	0.005	0.034^{***}	0.026^{**}
	(0.009)	(0.011)	(0.008)	(0.010)
Bandwidth	25	25	25	25
Effective N	40325	40325	32669	32669

Note: ** $p < 0.05$, *** $p < 0.01$.
All dependent variables are binary indicators. Reference category for STEM: non-enrollment or enrollment in any other major. The table presents estimates for β_1 in equation (2), splitting the sample into the periods 2008-2011 and 2012-2014, respectively. All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to year by family income quintile fixed effects. Standard errors are clustered at the PSU test score level and reported in parentheses.

Table A4: Earnings Information by Field of Study and Institution Type

	Universities		IP		CFT	
	Mean	$\frac{SD}{Mean}$	*Mean*	$\frac{SD}{Mean}$	*Mean*	$\frac{SD}{Mean}$
Business	10.03	0.24	7.58	0.23	6.42	0.19
Arts	7.19	0.19	5.48	0.19	5.04	0.15
Humanities	5.56	0.19	6.98	0.45		
Law	10.77	0.25	5.96	0.27	5.96	0.13
Social Sciences	7.34	0.20	6.90	0.17	6.03	0.22
STEM	11.51	0.27	7.61	0.23	6.96	0.22
Agriculture	7.71	0.23	5.77	0.24	5.22	0.17
Health	8.72	0.18	4.90	0.13	5.19	0.15
Education	6.54	0.14	4.70	0.13	4.19	0.12

Monthly earnings in 100,000 Chilean Pesos (approx. $125). Standard deviation imputed using empirical mean and 90th percentile of earnings, assuming a log-normal distribution. Data from mifuturo.cl.

Table A5: Dropout Probabilities by Field of Study

	Pr(Dropout After Year 1)	*Pr(Dropout After Year 2)*
Business	0.266	0.359
Arts	0.252	0.350
Humanities	0.264	0.328
Law	0.228	0.305
Social Sciences	0.225	0.290
STEM	0.283	0.373
Agriculture	0.227	0.290
Health	0.203	0.226
Education	0.201	0.241

Dropout probabilities by field after 1 and 2 years of study respectively. Data from mifuturo.cl.

Table A6: Shares of Programs per Field in Different Institutions

	Universities	**Vocational**	**CRUCH**	**Private Univ.**
Total Number	13,889	7,409	7,830	6,060
Share (%):				
Business/Management	8.9	26.6	8	10.1
Agriculture	3.1	3.5	3.2	10.15
Arts/Architecture	7.5	9.5	5.3	10.4
STEM:	30,1	31.8	40,8	18.2
Engineering	25.3	31.0	33.0	16.3
Natural Sciences	4.8	0.8	7.8	1.9
Social Sciences	11.4	5.6	8.5	15.2
Law	2.7	2.3	1.9	3.8
Education	19.9	8.6	19.6	20.4
Humanities	2.5	1.4	2.4	2.5
Health	13.8	10.8	11.6	16.5

Note: The Table displays shares of each field among all programs offered by the respective type of institutions. Programs are selected, if at least one enrolled student is a recent high school graduate, PSU test taker, and applied for financial aid. Data for the years 2008 to 2015. The number of programs per year is fairly stable, and so is the distribution of fields, conditional on year and type of institution.

Table A7: Results for STEM subfields: Engineering and Natural Sciences

	Engineering (=1)		Natural Sciences (=1)	
RD Estimate	0.014***	0.014**	0.001	0.001
	(0.005)	(0.007)	(0.002)	(0.002)
Bandwidth	49.7	25	51.9	25
Effective N	142,998	72,994	148,525	72,994

Note: ** $p < 0.05$, *** $p < 0.01$.
Both dependent variables are binary indicators. Reference category: non-enrollment or enrollment in any other major. The table presents estimates for β_1 in equation (2). All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to year by family income quintile fixed effects. Bandwidths in column (1) and (3) are chosen optimally according to Calonico, Cattaneo and Farrell (2020). Standard errors are clustered at the PSU test score level and reported in parentheses.

A.3 Choice Set Changes Around Grant Eligibility Cut-Off

In this section we present evidence for why our regression-discontinuity analysis cannot include observations for which the relevant PSU cut-off for grant eligibility is 500 points. This excludes all observations from 2015 and the lowest 20% of the income distribution in 2013 and 2014 from our main study sample (see Table 2.2 and the discussion in Section 2). The argument boils down to the fact that a subset of Chilean universities, including all CRUCH institutions and few additional private universities, participate in a centralized admission system, which partially relies on PSU scores for admission and matches students and programs (institution $\times$ major combinations) following a Deferred Acceptance algorithm.[14] As we show below, the setting of this admission system creates a second treatment besides grant eligibility coinciding with the 500 PSU test score threshold: a change in students' choice sets.

Admission is based on two components. First, a score which we call program score (PS) and which is calculated as a weighted average of high school gpa, relative performance within the high school graduating cohort, and all sub-components of the PSU test – including the mandatory math and language components that are used to determine grant eligibility, but also the voluntary components of science or history. The relative weights for the PS are program specific.[15] Second, programs can require students to fulfill minimum requirements, in terms of the unweighted math-language average PSU score and the PS. In Figure A5, we plot the histogram of program-specific minimum requirements for each year of our analysis. As we can see, while only a subset use minimum requirements on the PS, every program imposes a minimum PSU requirements.[16] It is worth noticing that, due to the presence of capacity constraints, passing the minimum PS score might not be sufficient for admission. Therefore admission rules based on minimum scores would not bind in case of competitive programs, yet do so in less demanded programs.

Using administrative data on decision weights used by each program and information about admitted students, we determine realized admission thresholds for each program. By definition, they correspond to the score of the last admitted student.[17] With this information we construct hypothetical choice sets for each student in our sample, taking into account both realized thresholds and minimum requirements. Figure A6 plots the average number of available

[14] See Table A8 for an overview over the number of programs participating in the central admission system and Larroucau and Rios (2020) for a detailed discussion of the algorithmic implementation of admission in Chile.

[15] High school rank has been introduced as a mandatory component to determine the program score only in 2012.

[16] Admission rules became stricter over time. For example, the fraction of programs requiring 500 as minimum PSU score more than tripled between 2010 and 2011.

[17] As discussed, realized thresholds might differ from minimum requirements in competitive programs.

programs in students' choice sets as a function of the math-language PSU score used to determine grant eligibility. Students experience discontinuous changes in the dimension of their choice sets, corresponding to PSU values used as minimum admission requirement.[18] Importantly for our analysis, from 2013 onward, one of the cut-offs driving a discontinuous change in the choice set coincides with the grant eligibility cut-off of 500.

This would not be a problem by itself, if we conjectured that the number of available options alone does not influence enrollment decisions. However, students who are marginally eligible for a grant see the composition of fields in their choice sets changing. Similarly to Figure A6, in Figure A7 we plot the average shares of options from each respective field included in the choice set of students. As we can see, the share of STEM programs discontinuously decreases at 500, at the expense of an increase in the share of education programs. It is reasonable to argue we are in the presence of different relevant treatments happening at the 500 cut-off. Disentangling the two is not possible in a regression-discontinuity analysis and we consequently exclude the respective individuals from our sample.

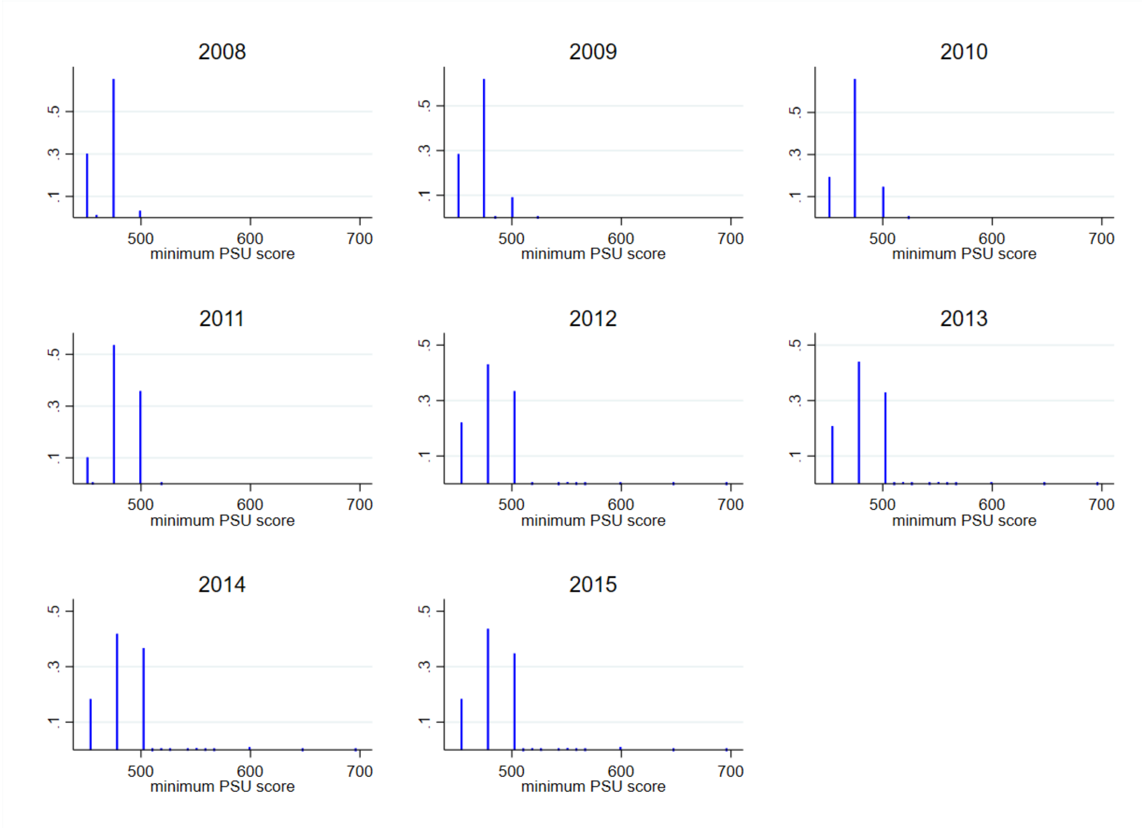
Table A8: Shares of programs per field participating in the centralized system

	2008	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Total Number	940	938	960	976	1319	1374	1398	1413
Share (%):								
Business/Management	7.1	6.9	7.1	7.3	8.2	8.4	8.1	8.2
Agriculture	3.4	3.4	3.6	3	2.58	2.5	2.2	2.4
Arts/Architecture	5.3	5.4	5.3	4.8	5.8	5.7	5.7	5.8
STEM	39.9	38	39.9	39.5	34.5	34.6	34.1	33.4
Social Sciences	8.8	9.1	8.8	8.7	10	10.1	10.6	10.8
Law	2	2	2	2	2.6	2.5	2.6	2.5
Education	19.7	21	21.1	20.8	18.6	18.1	18.1	18.6
Humanities	2.2	2.4	2.2	2.3	2.9	2.8	2.4	2.4
Health	11.3	11.4	11.5	11.6	14.6	15.1	16.1	16.1

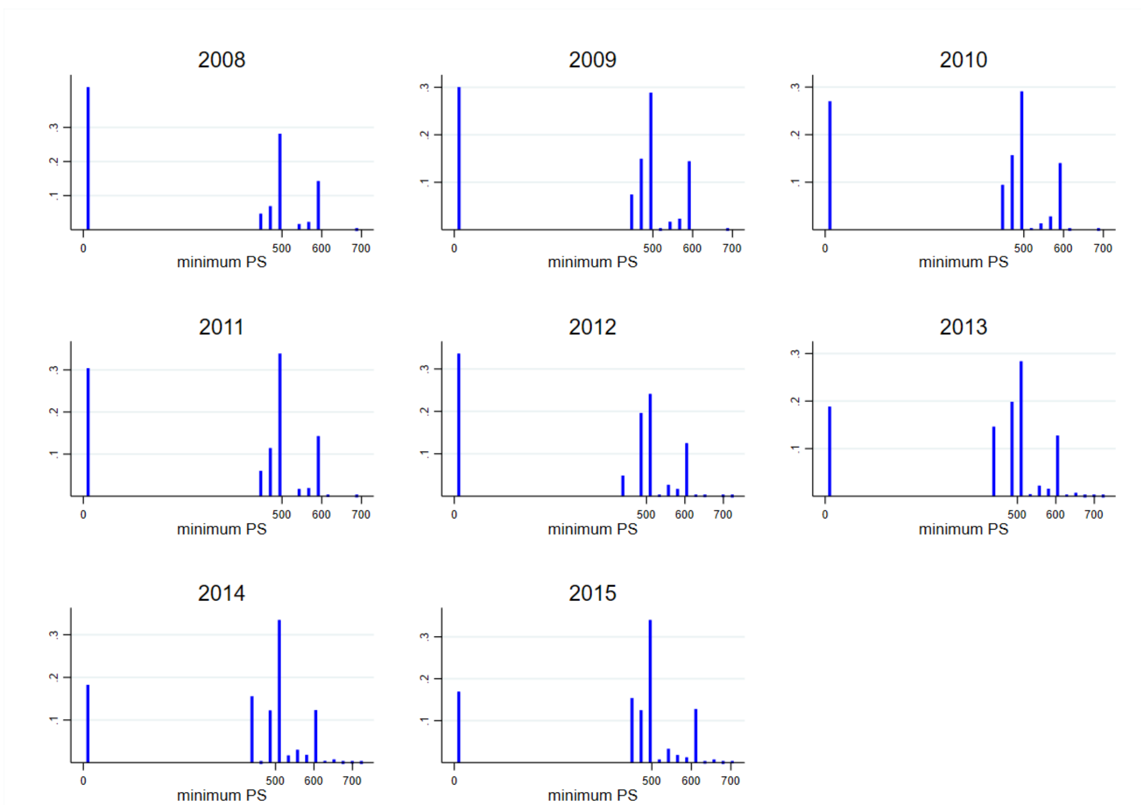
Note: The table displays the number of all programs participating in the centralized admission system from 2008 to 2015, as well as the share of each of our 9 aggregated fields of study among the programs.

[18]Note that we can conclude from this observation that de-facto thresholds imposed by capacity constraints are not systematically larger than minimum entry requirements. Otherwise we would have observed a smoother change in the dimension of the choice set.

Figure A5: Distribution of minimum requirements over the years

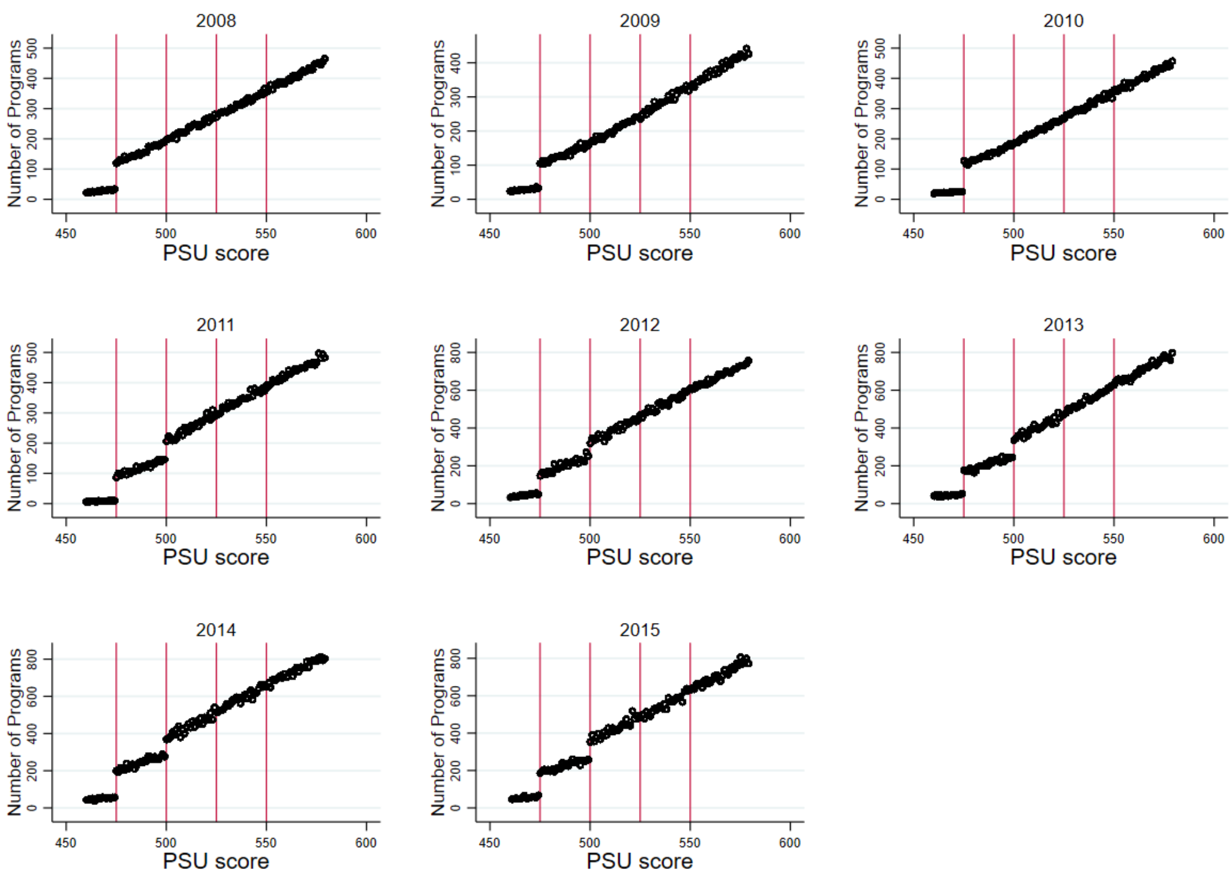


(a) Density Minimum PSU Score.



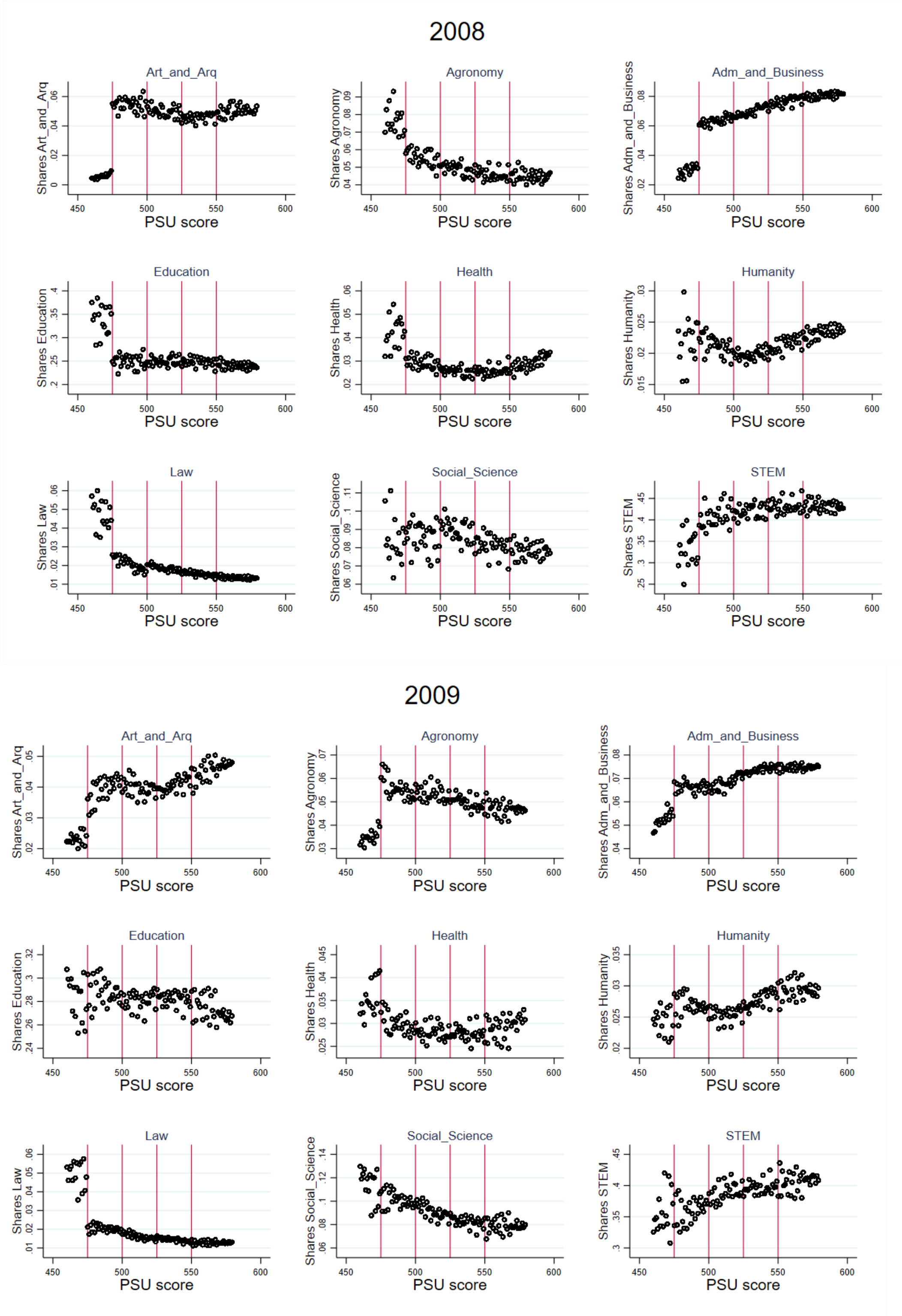
(b) Density minimum PS

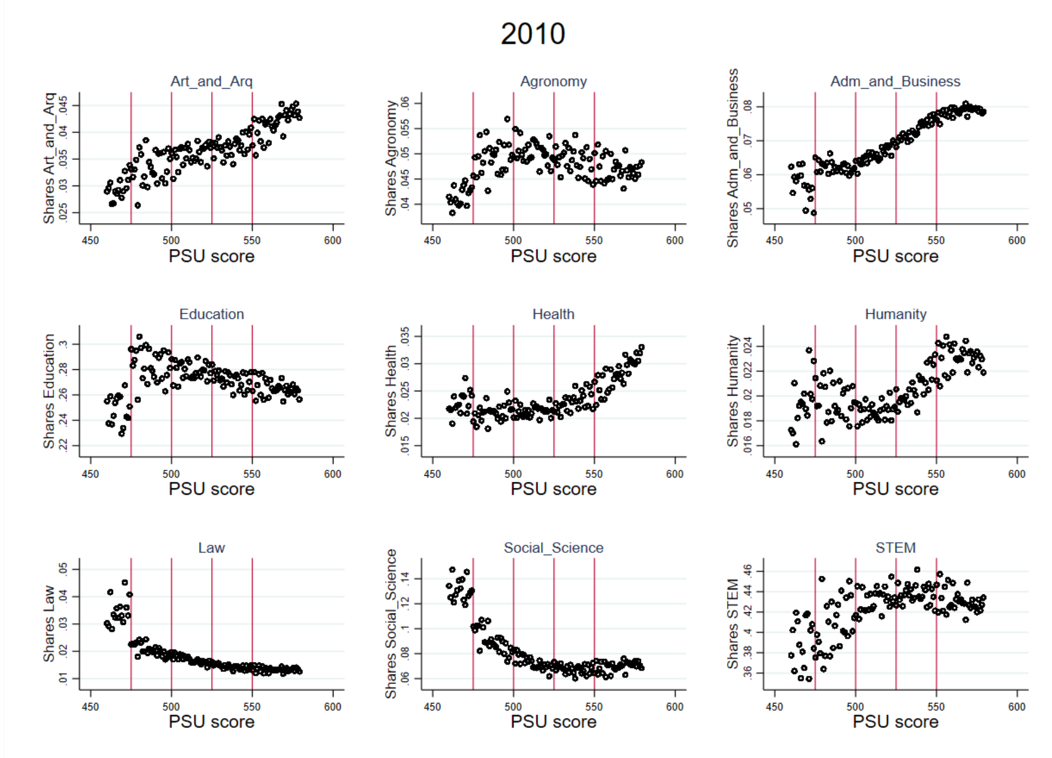
Figure A6: Number of centralized programs in the choice set as a function of PSU

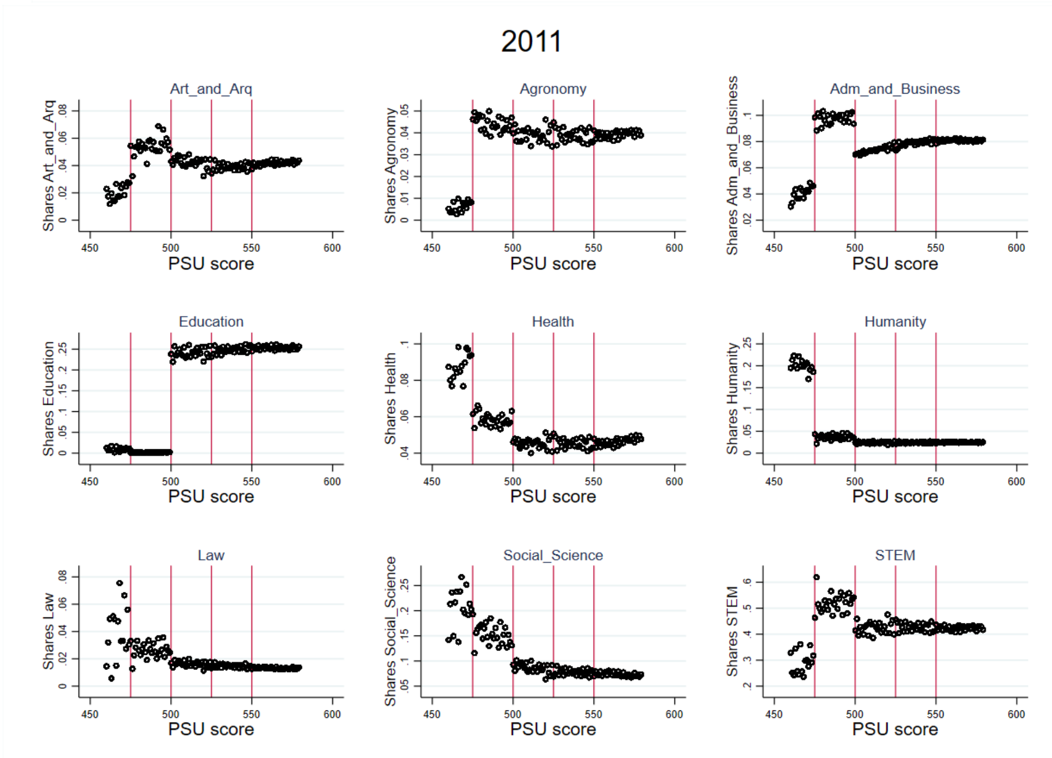


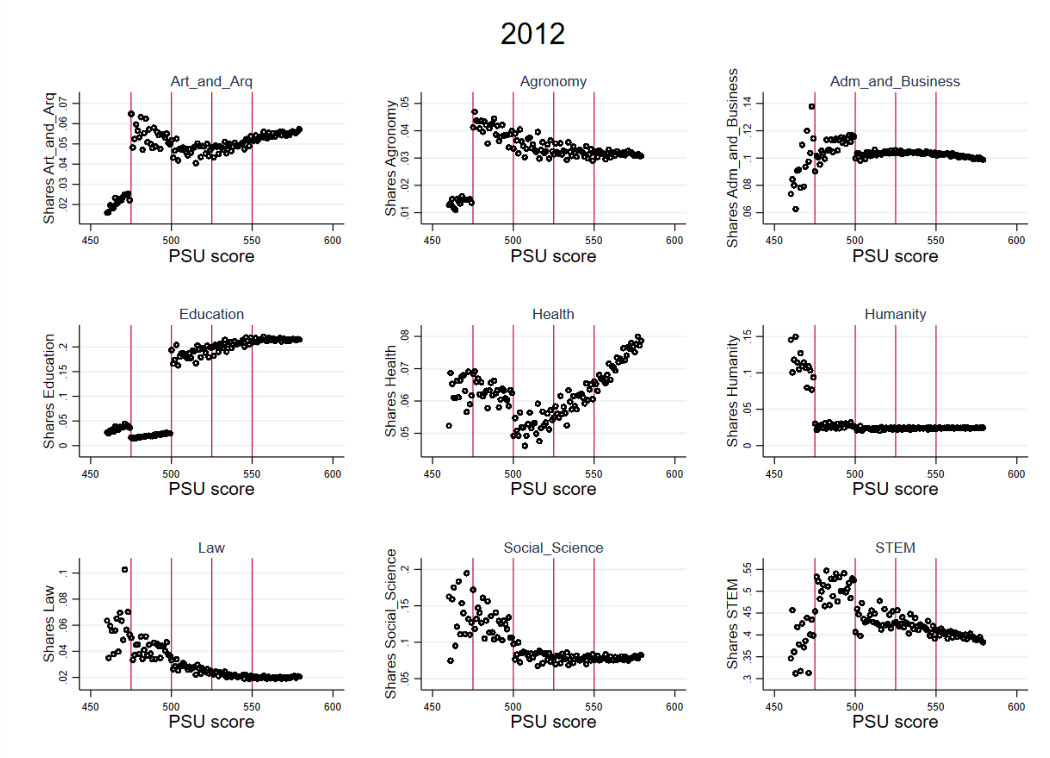
Note: The figures show the average number of available programs in students' choice sets as a function of PSU scores – PSU bins correspond to one point. The red lines refer to PSU scores of 475, 500, 525, and 550. The first threshold corresponds to eligibility for student loans. The last three are used for grant assignment (see also Table 1).

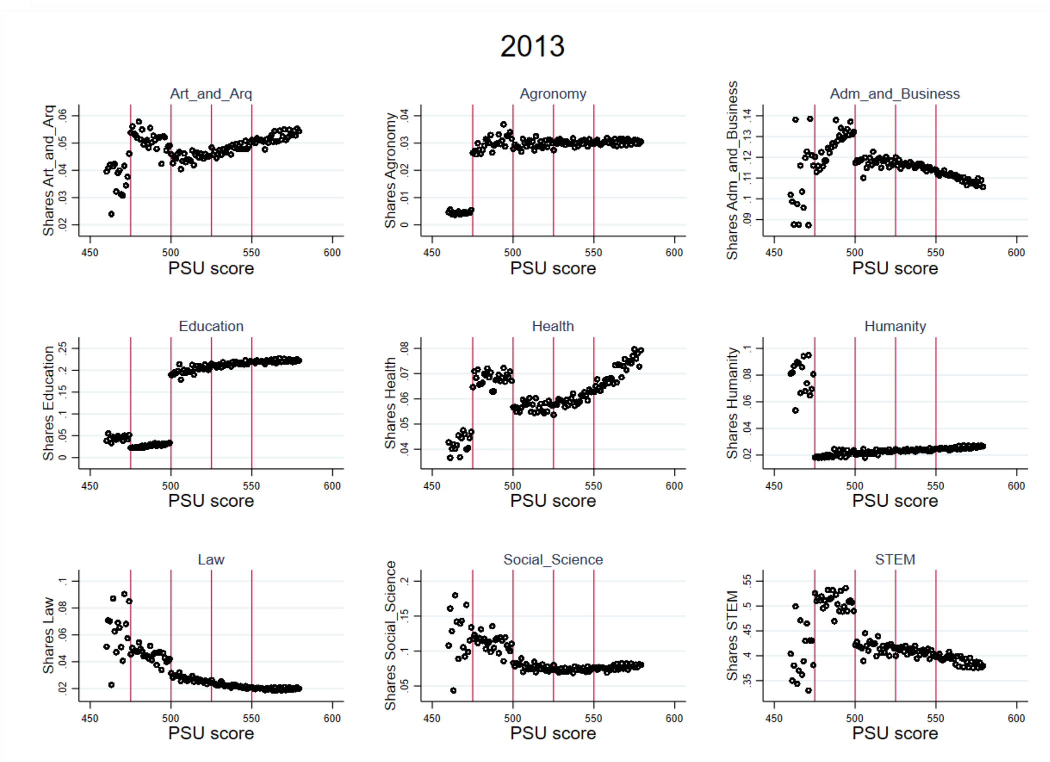
Figure A7: Shares of fields in the choice set as a function of the PSU score

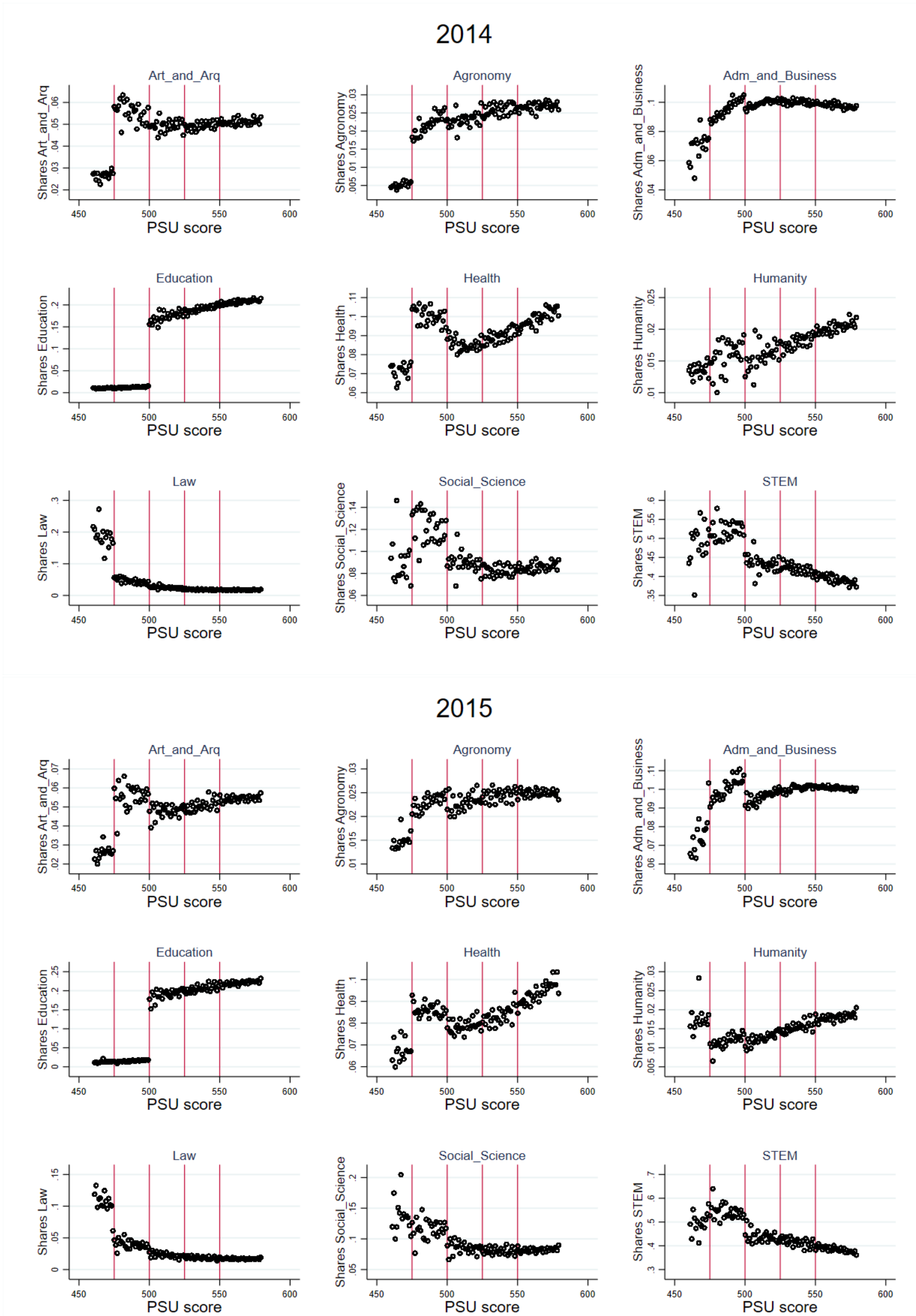



2010
Art_and_Arq
Shares Art_and_Arq
Agronomy
Shares Agronomy
Adm_and_Business
Shares Adm_and_Business
Education
Shares Education
Health
Shares Health
Humanity
Shares Humanity
Law
Shares Law
Social_Science
Shares Social_Science
STEM
Shares STEM
PSU score


2011
Art_and_Arq
Shares Art_and_Arq
Agronomy
Shares Agronomy
Adm_and_Business
Shares Adm_and_Business
Education
Shares Education
Health
Shares Health
Humanity
Shares Humanity
Law
Shares Law
Social_Science
Shares Social_Science
STEM
Shares STEM
PSU score


2012
Art_and_Arq
Agronomy
Adm_and_Business
Education
Health
Humanity
Law
Social_Science
STEM
Shares Art_and_Arq
Shares Agronomy
Shares Adm_and_Business
Shares Education
Shares Health
Shares Humanity
Shares Law
Shares Social_Science
Shares STEM
PSU score


2013
Art_and_Arq
Agronomy
Adm_and_Business
Education
Health
Humanity
Law
Social_Science
STEM
Shares Art_and_Arq
Shares Agronomy
Shares Adm_and_Business
Shares Education
Shares Health
Shares Humanity
Shares Law
Shares Social_Science
Shares STEM
PSU score



Note: The figure shows the average shares of the nine fields of study among available programs in students' choice sets as a function of PSU scores – PSU bins correspond to one point. The red lines refer to PSU scores of 475, 500, 525, and 550. The first threshold corresponds to eligibility for student loans. The last three are used for grant assignment (see also Table 1).

A.4 Difference-in-Discontinuity Analysis

In this section, we discuss a difference-in-discontinuity approach as an alternative identification strategy for the effect of financial aid on enrollment decisions. In line with the discussion in the previous section, such a strategy is needed if one wants to include observations for whom a PSU test result of 500 is the relevant cut-off determining aid eligibility. Note that prior to 2013, a PSU score of 500 did not yet grant access to a grant, but did already alter students' choice sets. Under the difference-in-discontinuity framework this structure allows us to disentangle the two effects of grant eligibility and choice set changes by studying differences in the discontinuities over time.

As in section 3, let PSU_i be individual i's test result. In our framework, we have two treatments that are potentially correlated with the threshold 500. Define $G_{i,t}$ as an indicator equal to 1 if the student is eligible for a grant and 0 otherwise, and $C_{i,t}$ as an indicator equal to 1 if the student experiences a change in the choice set, and 0 otherwise.[19] The assignment mechanism works as follows:

$$G_{i,t} = \begin{cases} 1, & \text{if } PSU_i \geq 500 \ \ \& \ \ t \geq t_0 \\ 0, & \text{otherwise} \end{cases}$$

$$C_{i,t} = \begin{cases} 1, & \text{if } PSU_i \geq 500 \\ 0, & \text{otherwise} \end{cases}$$

In our setting, $t_0 = 2013$, the year from which on a subset of PSU takers were eligible for both grants had their score passed 500.[20]

Empirical Model. Following Grembi, Nannicini and Troiano (2016), we estimate the following specification for our difference-in-discontinuity approach:

$$Y_{i,t} = \delta_0 + \delta_1 \mathbb{1}\{PSU_{i,t} \geq 500\} + \delta_2 \mathbb{1}\{PSU_{i,t} \geq 500\} \times PSU_{i,t} + \delta_3 PSU_{i,t} + \tag{3}$$

[19]Note that here we treat $C_{i,t}$ as a dummy variable. We therefore do not consider differences between the effect of the number of available options and the impact of variation in the field-composition of choice sets. If changes in the number of available options and changes in shares are close to constant over time, lumping both treatments together does not pose threats to identification.

[20]We condition our analysis on individuals that are eligible in terms of their family income. See Table 1.

$$\mathbb{1}\{t \geq t_0\}(\alpha_0 + \alpha_1 \mathbb{1}\{PSU_{i,t} \geq 500\} + \alpha_2 \mathbb{1}\{PSU_{i,t} \geq 500\} \times PSU_{i,t} + \alpha_3 PSU_{i,t}) + X'_{i,t}\gamma + \epsilon_{i,t}.$$

Our outcomes of interests are enrollment in higher education and enrollment in STEM. The parameter of interest then is α_1, which estimates the differences in the effect of marginally passing the 500 cut-off before and after t_0. As for the regression-discontinuity approach, we construct weights to estimate (3) following a triangular kernel weighting around the cut-off of 500, within optimally set bandwidths according to Calonico, Cattaneo and Farrell (2020). We compute them separately for $t \geq t_0$ and $t < t_0$. $X_{i,t}$ is a vector of covariates that includes the individual's gender and high school gpa, parental education, the number of other studying and working family members, an indicator for single mother households, location (far north, near north, central, near south, far south) and family income quintile and year fixed effects.

Identifying Assumptions. As for the regression discontinuity strategy, the first assumption we need to make in order to give a causal interpretation to α_1 is that all potential outcomes are continuous at the cut-off. This ensures consistent estimators for the effect of crossing the cut-off before and after t_0. As discussed in Section 3, given the structure of the test, non-ignorable unobservables are likely uncorrelated with being just above the threshold.

In addition to this standard requirement, we require two additional assumptions. The first imposes that the effect of choice set changes is constant over time. The second assumes the absence of interaction effects between the two treatments. In our case, this assumption would be violated if the effect of having a grant interacts with the change in choice sets. That is, if students that do not react to changes in their set of available options without access to a grant do so in response to being eligible. While the assumption is fundamentally untestable, we do not expect significant interaction effects, since it would require financial aid to particularly matter for a small set of mainly non-competitive programs.[21]

One could provide evidence in favor of the first assumption of constant effects of choice set changes by estimating regression-discontinuity models of enrollment for each year before the reform. However, the relationship between choice sets and the PSU test is not constant over time as illustrated in Figures A6 and A7 – partially due to changing participation of programs in the centralized admission system. Over the years we might therefore interpret choice set changes as different treatments, which makes the interpretation of time trends in RD estimates before the

[21] Recall that the additionally available programs around the cut-off are mainly those for which the minimum requirement of 500 points in the PSU test are binding. I.e., the less demanded options.

reform problematic. By looking at Table A8, we can identify two periods in which the number of programs participating in the centralized admission system remained fairly constant: from 2008 to 2011 and from 2012 to 2015. This suggests that how the 2012 cohort reacts to changing choice sets might be informative for the behavior of cohorts after the reform of 2013. Using this year as a benchmark to disentangle the two treatments therefore is the most credible way to identify the difference-in-discontinuity parameter.

On the other hand, despite the jump in the total number of program participating in the centralized system from 2011 to 2012, 2011 holds relevant similarities with future years in terms of discontinuous choice set changes (see Figures A6 and A7). Also for 2011 we see changes in the number of available options and similar movements in the share of fields per choice set. We thus present results for models using only 2012 as benchmark and for models that use both 2011 and 2012.

Results. Table A9 contains the difference-in-discontinuity estimates for the effect of grant eligibility on enrollment in higher education and STEM, respectively. Columns (1), (2), (5) and (6) indicate that students marginally above the cut-off after the reform are more likely to enroll in higher education institutions than students marginally above the cut-off in the years before. This is true both using only 2012, or 2011 and 2012 as benchmarks. Estimates vary between 3.5 and 6.3 percentage points, depending on the reference year and the chosen bandwidth and are therefore slightly more pronounced than the results from our main RD analysis in section 4. Importantly, they are robust to restricting the sample to individuals in a bandwidth of 25 after 2012.

It is interesting to notice that we cannot reject a null effect of choice set changes on general enrollment in the years before the reform. The absolute number of available programs does therefore not seem to influence enrollment in higher education. This stands in contrast to the pre-reform results on STEM enrollment, suggesting a larger role for compositional changes in the available choice set options. We observe a significant influence of choice set changes before the reform. In particular, students marginally scoring above 500 decrease enrollment in STEM fields by 1.5-2.2 percentage points. Netting out these changes to isolate the effect of grant eligibility, our preferred specification estimates a 1.2 percentage point increase in STEM enrollment. This is close in magnitude to the values presented for the RD analysis in Section 4. However, standard errors are large and the estimation is too imprecise to draw valid inferences.

We want to stress that the results of this section should be taken with a grain of salt. Our setting does not allow us to provide much support for the assumptions required for the difference-in-discontinuity strategy to be valid. We see this section as a sanity check to the more cleanly identified main results presented in section 4.

Table A9: Effect of Grants vs. Loans on Enrollment and STEM: Diff-in-Disc

Using 2012 to estimate effect of choice sets	Enrolled (=1)		STEM (=1)	
	(1)	(2)	(3)	(4)
Diff in Disc Estimate	0.050***	0.063***	0.012	0.009
	(0.015)	(0.011)	(0.013)	(0.016)
RD Estimate Before 2012	-.016		-0.022***	
	(0.011)		(0.008)	
Bandwidth	(41 34.7)	(41 25)	(54.5 63.5)	(54.5 25)
Effective N	68,909	57,222	109,233	65,017
Using 2011-2012 to estimate effect of choice sets	**Enrolled (=1)**		**STEM (=1)**	
	(5)	(6)	(7)	(8)
Diff in Disc Estimate	0.033***	0.046***	0.005	0.002
	(0.013)	(0.011)	(0.011)	(0.014)
RD Estimate Before 2012	0.001		-0.015***	
	(0.009)		(0.008)	
Bandwidth	(35.7 34.6)	(35.7 25)	(52.9 63.5)	(52.9 25)
Effective N	90,567	78,880	144,299	100,083

Note: ** $p < 0.05$, *** $p < 0.01$.
All dependent variables are binary indicators. Reference category for STEM: non-enrollment or enrollment in any other major. The table presents estimates for α_1 in equation (3). All specifications are estimated using weighted local linear regressions and include the covariates outlined in Table A1 in addition to income quintile and year fixed effects. Bandwidths in columns (1), (3), (6) and (8) are estimated separately for the periods before 2013 and from 2013 onward, using the method proposed by Calonico, Cattaneo and Farrell (2020). Standard errors are clustered at the PSU test score level and reported in parentheses.