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The impact of progressive tuition fees on dropping out of higher education: a regression discontinuity design

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The impact of progressive tuition fees on dropping out of higher education: a regression discontinuity design

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Abstract

In recent years, and under the pressure of increasing public deficits, a number of countries have decided to increase university fees to compensate for reductions in teaching subsidies financed by taxpayers. Perhaps the best known case is that of the UK. In this paper we analyze a similar policy adopted in Catalonia, Spain. Tuition fees increased 66 percent in the 2012-2013 academic year to compensate for the reduction in public subsidies used to finance Catalan university teaching activities. Interestingly, the increase in fees was progressive, meaning that there was a fee waiver in function of family income. We analyze the distributional impact of this policy change, showing that this progressive tuition fee does not have a differential impact on the dropout rate of students of different socioeconomic status. Since eligibility for the full tuition waiver is determined by a sharp cut-off on household income, we use a regression discontinuity design to analyze the effect of the new tuition fees around the full tuition waiver. We find no evidence of any adverse impact of the new fees on the drop out rates.

Keywords: *enrollment rate, dropout behavior, tuition fees, scholarships, regression discontinuity design*
JEL classification: I22, I23, I24

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1 Introduction

The question of private contributions for financing higher education has long attracted the attention of policy makers and public opinion. The general trend in recent years has seen an increase in tuition fees paid by students, and a reduction in subsidies for public universities. The US is a well-known example of this trend. University fees have increased in both private and public institutions leading to an accumulated student loan debt of 1.4 trillion dollars. The average student loan debt of a class of 2016 graduates was 37,000 dollars. While the situation in Europe is not as dramatic, fees have similarly increased in many countries. A widely discussed case is that of the UK, which recently experienced two major changes. In particular, the country passed from a scenario in which the total cost of higher education was paid by taxpayers to a system where students contribute towards the cost. The Teaching and Higher Education Act of 1998 introduced up-front tuition fees and abolished (until 2004) maintenance grants in favor of loans for students. Several years later, tuition fees were raised again for all students (with the possibility of using government-provided fee loans to be paid back after graduation), although higher maintenance grants were reintroduced for lower-income students. The Higher Education Act of 2004 set up, starting with the 2006-07 academic year, variable fees of up to 3,000 pounds a year. Northern Ireland and Wales followed in the steps of England. In 2009-10, the cap rose to 3,225 pounds a year and, in 2010, the latter reached 9,000 pounds a year. Different approaches to financing university education are frequently debated by governments that fear lower participation and higher dropout rates, especially among poorer students. Obviously, public university fees cannot be analyzed in a vacuum. Public fees are part of the revenue of the public sector and it is therefore important to consider the progressiveness of the tax system as a whole and not just each part separately. The share of the cost of public higher education borne by households should depend on the desired progressiveness of the tax system. In aiming to balance the quality of education and equity of access to the university system, especially for low-income students, various policies might be implemented in different countries according to the level of public resources and the degree of progressiveness of the tax system. A policy that might make sense in a country like Germany, with a high level of tax collection over GDP and intense progressiveness of the tax system might instead be regressive in a country with insufficient public resources and a low progressiveness of the tax system.

This trade-off between university fees and the general progressiveness of the tax system is particularly relevant in the context of economic crises, when tax revenues decrease and public expenditure increases. In this situation, there is pressure to reallocate a large proportion of the expenditure to policies aimed directly at confronting the consequences of the crisis (e.g., unemployment benefits, social housing, etc.). Under the pressure of a rapidly increasing public deficit and the oversight of the European Union, some regional governments in Spain decided to reduce subsidies to public universities and allow the latter to increase fees using the tax competences of the regional governments. Each region made its own respective decision relative to increasing fees, mostly in response to pressure from students. In this paper, we analyze the impact of a specific and unique tuition fee structure implemented by the government of Catalonia starting in the 2012-2013 academic year. In particular, tuition fees increased 66 percent, by far the highest increase among all the Spanish regions.[1] The increase in fees was not, however, general. The pricing scheme allows tuition waivers of decreasing proportions, adjusted to income.[2] Only households with an adjusted income above a certain threshold have to pay the full tuition fee. In the aggregate this change implies that, in Catalonia, the private contribution to financing public higher education over the cost of providing those services increased from 15% to about 20% from the 2011-12 to the 2012-13 academic year.

At the same time, the MECD (Ministry of Education, Science, and Sport) grants, or General Scholarships (GS), provided by the central government were complemented by a new partial tuition waiver system called Equitat Grants (Fairness Scholarships, FS), primarily based on family income and aimed at moderating the more stringent

[1]The full tuition fee for a 60 credit registration, or the equivalent of a full course schedule, increased from 1,119 euros to 1,866 euros.

[2]Adjusted income is calculated as household after-tax income divided by members of the household.

requirements needed to benefit from a General Scholarship. The policy[3] aimed to solve, at least in part, the scarce financial adequacy and progressiveness of the tax system; to provide public universities with greater autonomy while managing and redistributing resources; and to allow Catalan universities to fix their own criteria for assigning partial fee waivers to students, other than those established by the central government.

The paper is organized as follows. Section 2 discusses the previous literature on the effect of tuition fees on higher education. Section 3 describes the data. Section 4 describes the details of the policy change under analysis. Section 5 is dedicated to the methodologies used and the empirical evidence. Section 6 provides a final discussion.

2 Literature Review

The analysis of changes in higher education tuition fees[4] commonly focuses on one of two alternative effects: its impact on the participation rate or its effect on the probability of dropping out. The relevant literature is accordingly divided into studies that assess these effects, individually or simultaneously, mostly using aggregate data in the case of participation, and micro data at the student and/or family level when examining the likelihood of dropping out.

In studying the effects of a change in university public fees and of the requirements to receive a scholarship on enrollment rates and dropout behaviors, there are a multiplicity of factors to be considered. One might analyze the counterfactual of what would have happened before the policy change, starting with identifying the differences between pre- and post-periods. Research on the effects caused by a policy such as the one introduced in Catalonia - which implied both change in the public price to enroll in university and new conditions to receive financial aid - can center on those students newly entering the

[3]See Section 4 for a detailed presentation of the policy implemented by the Catalan government from the 2012-13 academic year onwards.

[4]When referring to tuition fees we imply the net cost of tuition taking into account any grants or fee waivers.

university system or on those who decided to quit as a consequence of the change.

Studies on the impact of tuition fees changes on participation are often constrained by data availability.[5] Other than relying on aggregate data at the regional level, researchers must contend with the absence of microdata on those who did not access university, the presence of many factors simultaneously affecting the outcome variable of interest, preventing neatly identifying the causal effect, and challenges in clearly defining a control group.

Hübner (2012) evaluates the effect of the introduction of tuition fees on enrollment probability in seven German states. The author finds a negative effect of tuition fees on enrollment that is larger than other existing studies on European countries (Canton & De Jong, 2005; Fredriksson, 1997; Huijsman et al., 1986) and in line with literature from the U.S. (Deming & Dynarski, 2009). Along similar lines, and examining the same quasi-experiment, Bruckmeier & Wigger (2014) find a non-significant effect. Their study includes as an explanatory variable the timing at which tuition fees were introduced and abolished in different states, and a set of control of variables having a significant impact on enrollment. In contrast with earlier studies of the U.S. and the U.K., which reported negative results (Leslie & Brinkman, 1987; Kane, 1994), Bruckmeier & Wigger (2014) include state-specific effects. Dearden et al. (2011) examine the effect of the introduction of up-front tuition fees and the abolition of maintenance grants on participation in the U.K. They find that higher tuition fees reduce participation and that giving students financial support in the form of maintenance grants raises the enrollment rate. In 2014, after the re-introduction of maintenance grants to support British students in higher education, Dearden et al. (2014), using a difference-in-differences approach, find a positive effect of grants on participation. Dynarski (2003) studies participation and persistence. She analyzes, also using difference-in-differences, the effects of eliminating student benefits under the Social Security Student Benefit Program. Using death of a parent during an individual's childhood as a proxy for benefit eligibility Bruckmeier & Wigger (2014)

[5] Hoxby & Bulman (2016) is an exception to this general difficulty.

find that attendance dropped by one-third when benefits were suspended. Moreover, providing aid increases the probability of completing schooling.

A methodology frequently used when the design can identify a jump in some forcing variable is Regression Discontinuity Design (RDD). This technique can lead to robust results (*internal validity*) under some weak assumptions. Giving settings close to that of a randomized controlled trial, RDD assures a sort of local randomized experiment from which derives an Average Treatment Effect (ATE) on the outcome variable of interest. For instance, Van der Klaauw (2002) examines the effect of aid offers on enrollment in colleges and universities on the U.S. east coast. The author implements regression discontinuity on a quasi-experimental design in which the discontinuities are given by a formula (a continuous measure of academic abilities) used to divide students into several groups. The results show that financial aid is an important element colleges use to compete for students. Bettinger (2004) analyzes the effect of the U.S. federal subsidy program (Pell Grants) on student persistence after the first year. Using student-level data, Bruckmeier & Wigger (2014) notice a small discontinuity in the grant formula that allows identification of the causal effect of the financial aid, also conditional on family characteristics. This is quite relevant as the increase in net tuition fees can have an important distributional effect. The results suggest that grants can reduce college dropouts. Bruckmeier & Wigger (2014) also find evidence of a relationship between need-based aid and college completion. Bradley & Migali (2015) reach similar conclusions in their analysis of the impact of an increase in tuition fees in U.K. universities on dropouts. They find evidence of reduction in the hazard of dropping out due to the policy. However, they also find a heterogeneous effect among different socio-economics groups, field of study, and type of university attended. Focusing on enrollment decisions, persistence, and graduation rates of low-income students, Fack & Grenet (2015) study the impact of a large-scale need-based French grant program which shares some common traits with the policy introduced in Catalonia analyzed in this paper. They use "sharp" discontinuities in the grant eligibility formula to identify the effect of aid on student outcomes through a regression discontinuity design, finding positive effects on enrollment, persistence, and completion of the degree. More recently, Hoxby & Bulman (2016) analyze the effect of tax deductions on college-going. Since eligibility for tax deduction is a sharp function of a cutoff based on household income, Hoxby & Bulman (2016) employ a RDD using "doughnut holes" to avoid the issue of manipulation of the forcing variable they find in their data.

Our paper aims to shed light on the effect of tuition fee changes that try to avoid potential distributional impacts by using a progressive tuition fee waiver. We analyze a policy change that implies a large increase in tuition fees but includes tuition fee waivers depending on the after-tax income of the family/student. The results show that it is possible to devise progressive tuition fees that do not have any effect on the dropout rates of students of different socioeconomic backgrounds. As in previous studies, the forcing variable is household income. Below a certain cutoff level based on after-tax household income, the student receives a full tuition waiver (BG). This is the usual set up for a sharp RDD. As we show below, in the Catalonia case families can not precisely control on which side of the threshold they will land[6] as after-tax income is more difficult to manipulate than income, and changes to the Spanish tax code are frequent.[7] Further away from the cut-off, a standard difference-in-differences specification is commonly adopted under different conditions. Mealli & Rampichini (2012) present an approach similar to ours. They analyze the effect of university grants on student dropout using a sample of Italian universities. In their case, students receive a grant if their family economic indicator is below a certain threshold. Their identification strategy includes both a regression discontinuity design given by the grant's assigning rule at the margin, and a difference-in-differences model for income levels far from the threshold. They find a positive effect of grants in reducing dropout that become smaller and smaller as distance from the income cutoff increases, until it becomes statistically non-significant.

[6] Hoxby & Bulman (2016) find that their forcing variable is subject to manipulation and use doughnut-holes in their regression discontinuity design.

[7] On many occasions such changes are decided even after the fiscal year begins.

3 Data

In order to evaluate the impact of the large increase in tuition fees that occurred in 2012 in Catalan universities, we merge several large administrative datasets. The first dataset contains information on newly enrolled students. It covers the 2010-2011 to the 2013-14 academic year and comes from the official data platform UNEIX, maintained by the Agency for Management of Universities and Research Grants (AGAUR). The UNEIX dataset includes information on the: academic year of reference (AcademicYear), indicator of the entrance year (Newaccess), gender and age of the student, type of access to the university (Access), normalized entrance exam score (Entry Grade), education-level of the parents (Peduc), occupation of the parents (Poccup), name of the university where the student is enrolled (Univ), specific degree, and level of "experimental intensity" of the degree.[8] Using this data we derive both an indicator of dropout in the second academic year (Dropout) and an indicator of re-enrollment,[9] as well as the year of re-enrollment and the degree if the student already had a university degree. There are 126,690 observations corresponding to four academic years. Note that some students may be enrolled for the first time in more than one degree.

The second source of information is databases on grants and financial aid. These contain information on all applicants for financial aid. This dataset merges information from the Spanish Ministry of Education (BGENERAL) on the so-called General Scholarship (GS) and information from the regional government's Secretary of University and Research (*Secretaria d'Universitat i Recerca*)(BEQUITAT) on the Fairness Scholarship (FS; *Equitat Grant*). Both datasets contain the same variables: name of the university (Univ), result of the application (denied/accepted), family income, number of family members, type of grant or financial aid, amount of financial aid obtained conditional

[8]The level of experimental intensity determines the fees. The greater the experimental intensity, the higher the fee. This variable takes three possible values.

[9]This indicator is calculated as being enrolled again after having taken a gap year. It therefore signals a student who is enrolled at the university after at least one not-enrolled year conditional on being enrolled previous to the gap year.

on approval of the application, and reasons for denying the financial aid request. The dataset of applications to the Spanish government grants (BGENERAL) contains 319,412 observations[10]; almost all students apply for these grants. The period covers the 2009-10 to 2014-15 academic year. The regional government database on the Fairness Scholarship contains applications for the program initiated by the regional authority after the increase in the tuition fees.[11] This dataset contains 95,551 observations from the 2012-13 to the 2014-2015 academic year.

The third source of information is a dataset that includes information on students who finished high school and a higher level of vocational studies (SIIU). This dataset includes information on the type of high school/vocational training center in which the student was enrolled during her secondary studies (private, public, or charter), type of access to university (entrance exam, vocational studies, foreign systems, etc.), entrance exam result (pass/fail), and minimum score to enter the preferred field of study.

We merge the four administrative datasets previously described (UNEIX, BGENERAL, BEQUITAT and SIIU) to gain a comprehensive picture of the students enrolling in university for the first time during each academic year.

4 Policy Change

The objective of this paper is to analyze the impact of a policy change that altered the net cost of Catalan universities for students, considering a modification in tuition fees and financial aid implemented in the 2012-13 academic year. Up until that time, the General Scholarship (GS) of the Ministry of Education (MECD) covered 100 percent of tuition fees for students with a family after-tax income[12] below certain threshold (a

[10]This dataset is larger than the previous one since it includes the application for grants of all the students enrolled, not only newly enrolled ones.
[11]The next section describes in detail the institutional set-up and policy change under analysis.
[12]After-tax income is computed as the sum of the general taxable base (salaries, income from professional and commercial activities, etc.) plus interest and other capital income minus taxes. The data is obtained directly from the Spanish IRS.

function of family size), and who reached a certain level of academic performance. The basic academic requirement was passing at least 80 percent of enrolled credits.[13] Figure 1 provides an example of a family of four according to the after-tax income threshold for a full tuition fee waiver.

In Spain, the General Scholarship system is managed by the central government, while regional governments set university tuition fees. Pressured by a large public deficit that had been rising since the beginning of the crisis, the Catalan government decided to reduce public transfers to public universities, and instead increase tuition fees up to 66.6 percent. However, the increase in tuition fees approved by the regional government was not linear. There was a set of fee discounts[14] graded as a function of family after-tax income normalized by the size of the family (normalized adjusted income or NAI). Equation 1 presents the way normalized adjusted (after-tax) income (in thousands of euros) is computed for a household of i members, where x is a vector taking values $x = [14.112, 24.089, 32.697, 38.831, 43.402, 46.853, 50.267, 53.665]$ depending on the size of the family (from 1 to 8+ members), with an additional deduction for households with more than 8 individuals:

$$NAI_i = Income_i - f(x_i) \qquad f(x_i) = \begin{cases} x_i & \text{if } 1 \leq i \leq 8 \\ x_{i=8} - 3,391 * (i-8) & \text{if } i > 8. \end{cases} \tag{1}$$

Beginning the academic course 2012-13 the MECD scholarship (full fee waiver) uses the same income threshold but requires better academic performance. More specifically, students must pass at least 90 percent of their credits (previously 80 percent) in order to qualify for the full tuition waiver.[15] The increase in tuition fees was retained by

[13] This requirement was lowered to 60 percent for students enrolled in engineering, architecture, or health degrees, as the latter are more challenging to pass than courses in the social sciences and humanities.

[14] Formally called *Equitat* Scholarships (or Fairness Scholarships).

[15] For students enrolled in engineering, architecture, or health degrees, this requirement is 65 percent.

universities to cover the discount of tuition fees for those students who did not reach these academic requirements and to finance the discount of fees of some students (who had to pay more than in the previous years). This procedure is relatively low in cost in terms of administration and paperwork. The new financial resources are transfered directly by the university from families with high incomes to families with low incomes. In this manner, the long and expensive process of tax collection, the allocation of resources to the different regions, the decision of the regional government on the allocation of resources across departments and, finally, reception of resources by the universities, are avoided.[16] Figure 2 shows the two-dimensional structure of the new system of fee discounts as a function of after-tax income and the academic requirements after the 2012-13 academic year.

[16]Hoxby & Bulman (2016) also argue that a tax based program to support individual spending on higher education has the advantage of "extremely low paperwork and administrative cost."

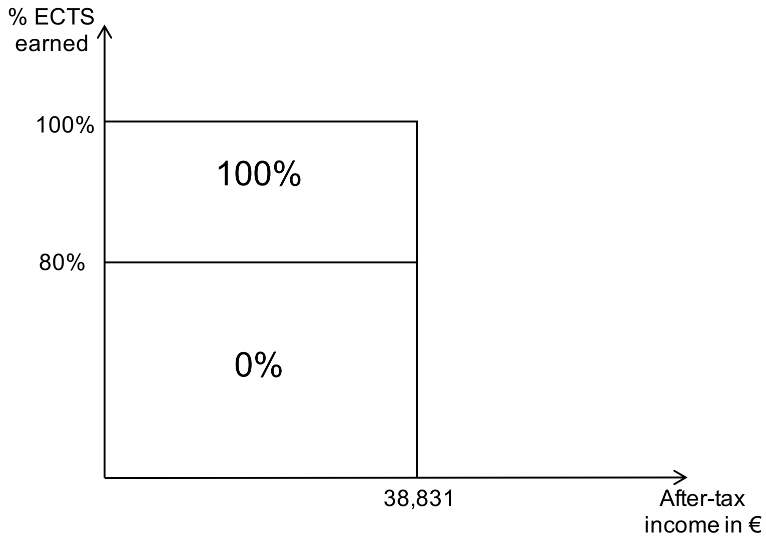


Figure 1: Tuition fee waivers for academic years before 2012-13 (four-member households). *Source: Own elaboration.*

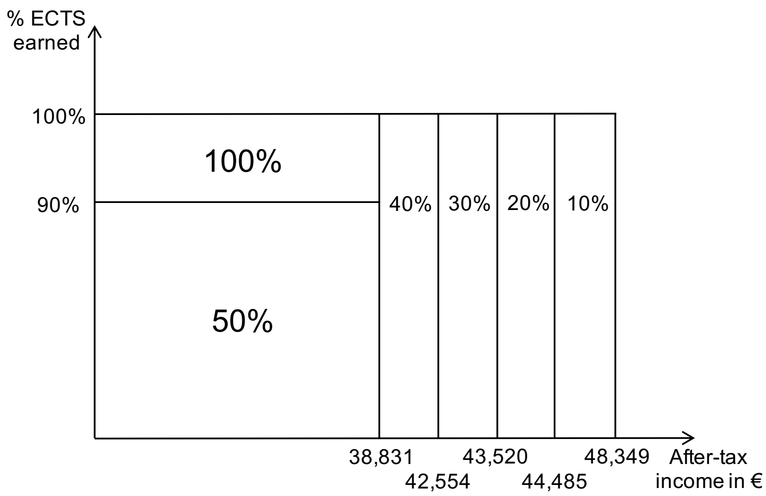


Figure 2: Tuition fee waivers for the 2012-13 academic year (four-member households). *Source: Own elaboration.*

Figure 2 shows the increased academic requirements necessary to be granted the MECD General scholarship, which fully covers tuition. Yet, at the same time, the new Fairness Scholarship (FS) provides a 50 percent tuition reduction for those students whose after-tax family income does not exceed the MECD scholarship maximum limit but who fail to fulfill the General scholarship (GS) academic requirements. Likewise, the Fairness Grant sets four new thresholds, above the maximum income for a full fee waiver of the General Scholarship, where students are granted a partial fee waiver.[17]

[17]Under this new scheme, a family of four who files a joint tax return and has only labor income would need to earn more than 67,000 euros (gross figure) to pay full tuition. This amount is more than twice the average income of a Spanish family.

5 Methodology and Empirical evidence

The basic aim of this paper is to analyze the impact of the change in net tuition fees and scholarship requirements imposed in the 2012-13 academic year. In Section 2 we showed that most of the literature on the effect of tuition fees and scholarships are centered around their effect on participation rates and dropout behavior. Analyses of participation rates, due to information requirements, usually rely on aggregate data, commonly at the regional level. A microeconometric approach is most usually used in the study of the effect on dropout behavior.

5.1 The effect of the 2012-13 increase in fees on the enrollment rate

Research on the effect of change in university fees on the rate of new entrants into university are usually based on aggregate data at the regional level. For example, a recent study on the effect of fees on the rate of enrollment in Germany (Bruckmeier & Wigger, 2014) uses a comparison of the effect on the states that increased fees versus those that kept fees stable in the period 2002-08. The study concludes that the rise in fees in some states did not reduce the entrance of high school graduates into university, and that the most relevant variable for explaining university enrollment rates is the number of secondary school graduates. More broadly, the results of this type of study depend very much on the specific country, the price of university tuition and its respective increase, and the type of intervention under analysis (e.g., whether it is question of an introduction of prices or the elimination of prices, etc). As such, there is no rule that can be generally applied: each case must be analyzed individually. Moreover, the literature provides little direct empirical evidence of the effect of grant programs based on student need on the access of students from low-income families. There are studies on specific groups such as recipients of the Social Security Study Benefit Program in the United States (Dynarski, 2003) or other studies on veterans, etc. However, studies of major programs in the U.K.

(Dearden et al., 2014), the United States (Pell Grant Program) (Bettinger, 2004), the Netherlands, France (Fack & Grenet, 2015), or Germany provide mixed results.

The fundamental challenge in studying the effect of changes in fees on enrollment is the lack of data on potential entrants, the confluence of factors that prevent proper identification of the effect, and the absence of a control group that can be clearly defined. The first problem is clear: it is difficult to obtain information on youth of college age who do not enroll, beyond an approximation of their number, usually calculated as the difference between the relevant age group and the young people who actually enroll in the university. There is no individual information available on income or education level of the parents, nor the high school of origin, etc. of the group of potential entrants to university.[18] The second issue is also relevant. Aggregate enrollment rates in higher education can be affected by demographic factors (reduction of the number of young people in the typical age group for those enrolled in university study), economics (cost of opportunity to study), etc. For example, in Catalonia during the period of analysis there was a significant decrease in the size of the group of young people of college age. If we wanted to analyze whether a rise in fees is associated with a lower proportion of young people entering university, it would be very difficult to know if the motive is the variation in the fees or, for example, the demographic evolution of the region. A recent study (Troiano i Gomà et al., 2016) shows that the confluence of complex transformations in the university and the economy gives rise to a large number of effects that should be taken into account in order to analyze with a reasonable level of reliability data on the evolution of university access. This confluence makes the precise identification of the causes of changes in enrollment rates a complex task.

Keeping in mind these various issues, in this section we provide some hints on the relative impact of fees and demography on the enrollment rate in higher education in

[18]This could be one of the reasons why results on the increase in fees in some German states obtained by Hübner (2012) do not coincide with those later obtained by Bruckmeier & Wigger (2014) using a longer list of control variables.

Spain.[19] We can analyze the relative explanatory power of the variation of fees and population for the typical age group going to university. The top part of Figure 3 shows the change in enrollment rate versus the change in fees between academic years 2011-12 and 2013-14. The dots represent each of the administrative regions in Spain. As shown, there is no correlation between the change in fees and the change in enrollment. The bottom part of Figure 3 shows the change in the proportion of students in the typical age interval of university students in Spain (between ages 18 and 24) and the change in enrollment rate by region for the same period. In this case we observe a positive relationship: the regions where the proportion of young people decreased the most were the regions that suffered the largest drop in enrollment rates. For Spain as a whole the rate of enrollment in university for individuals between the ages of 18 and 24 dropped less than the reduction in the population of this same age group.

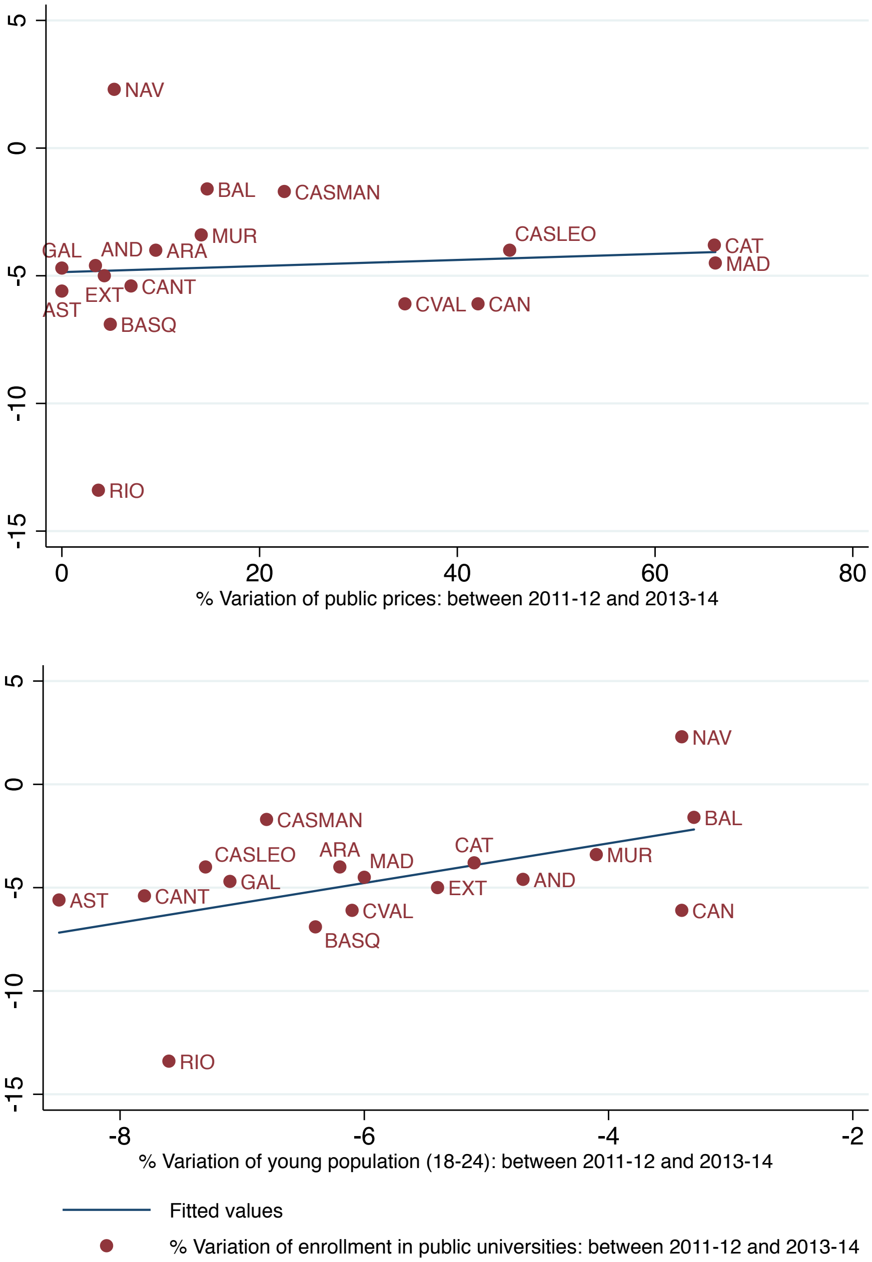
A simple regression (Equation 2) where the dependent variable is the variation of enrollment rate ($VEnroll_i$) and the independent variables are the variation in public prices ($VPrice_i$) and the variation in the size of the cohort of individuals in the typical age range of university students ($VCohort_i$) confirms these results[20]:

$$VEnroll_i = 0,97\,(0,34) + 0,00\,(0,01)\,VPrice_i + 0,96\,(2,13)\,VCohort_i \quad R^2 = 0,25 \quad (2)$$

The coefficient of the regression of the change in the enrollment rate on the size of the cohort between 18 and 24 years old is statistically significant and the estimated coefficient β_2 (0.96) is not statistically different from 1. This means that, on average, there is a one to one translation of the reduction of the population between 18 and 24 years old into the enrollment rates. In addition, the regression of the change in the enrollment rate on the change in tuition fees β_1 produces a parameter estimate close to 0 and statistically not significant. In any case these regressions should not be read in terms of causal interpretation.

[19] For the reasons already mentioned, we consider this exercise merely a descriptive examination of the recent evolution of the enrollment rate in higher education in Spain.

[20] t-statistic values are shown in parenthesis next to the estimated values of the coefficients.



Note: AND-Andalusia, ARA-Aragon, AST-Asturias, BAL-Balearic Islands, BASQ-Basque Country, CAN-Canary Islands, CANT-Cantabria, CASLEO-Castile and León, CASMAN-Castilla-La Mancha, CAT-Catalonia, CVAL-Valencian Community, EXT-Extremadura, GAL-Galicia, MAD-Community of Madrid, MUR-Murcia, NAV-Navarra, RIO-La Rioja.

Figure 3: Relation between enrollment rate and public fees or demography. *Source: Own elaboration on SIIU data.*

Therefore, this descriptive analysis at the regional level shows that the change in the rate of access to university in Spain seems to be a function of the change in the proportion of young people in the typical age range enrolling in higher education, rather than of change in tuition fees.

Another hint that seems to indicate that the increase in tuition fees did not have a relevant impact on the enrollment of low income families is the evolution of students coming from public schools who enroll in Catalan universities. The proportion of Catalan students coming from public schools rose slightly from 2012-13 on, in contrast with a reduction of new entrants who attended private or charter schools. Analysis of the data on access to university shows that during the time period under consideration, there was an increase in the enrollment rate of those students whose parents had completed only compulsory education (Troiano i Gomà et al., 2016).

There exist two possible explanations for the lack of impact of the 66 percent increase in tuition fees on the entry rate at Catalan universities: the low sensitivity of the demand for higher education to an increase in prices and/or the mitigating impact of the new Fairness Scholarships. A relevant proportion of Catalan families are willing to pay for private secondary and high school education,[21] and the provision of Fairness Scholarships moderate the impact of the new requirements for a MECD scholarship. As many Catalan families choose private institutions, or charter schools, for the education of their children, the increase in university tuition fees still implies paying less for tuition than the fees of a private high school. In addition, the progressive tuition fees provided by the Fairness Scholarship partial waivers mean that to pay the full tuition fee, a family/student must have a very high level of after-tax income. For these families, the increase in university tuition fees represents a very low percentage of their income.

[21] The price of a private school is 3 to 4 times more expensive than the university tuition fee. Notice that Catalonia also has the highest proportion of students in private primary and secondary schools in Spain.

5.2 The effect of the 2012-13 increase in fees on dropping out of college

Unlike the issues that arise in the analysis of the impact of the change in university fees on enrollment, the analysis of students dropping out of university can be performed using all the information on the individuals affected by the new tuition fees. Any student who decides to drop out of college has previously enrolled and, therefore, the system has collected information on their demographics, socio-economic status, etc. Therefore, the problem of a lack of information that limits most microeconometric analyses of the effect of tuition fees on access rate are less severe when analyzing the likelihood of dropping out. In addition, the availability of an extensive amount of information allows to control by a plethora of factors (personal, institutional, etc.) that can help to provide a robust explanation of the effect of the increase in tuition fees on student dropout from university.

5.2.1 Preliminary results

As a first descriptive exercise, we can analyze the evolution of the unconditional gross dropout rates (without taking into account entering the system again after a break-year or years) since the 2010-11 academic year. As the large increase in tuition fees could potentially increase the dropout rate of the worst off students, we consider the breakdown of the impact of fees on the probability of dropping out of university by the socioeconomic status of the families, which we proxy using the parents' level of education. The highest dropout rates occur during the first year and, therefore, we consider this as the relevant period for analysis of the probability of dropping out of university.[22]

Figure 4 shows the evolution of the dropout rate of students between the first and the second year of university according to their parents' education levels. There is practically no difference between the rates of university dropouts by socioeconomic origin of the family during the period of analysis. In fact, the differences are not statistically significant

[22]This is the same strategy used by Mealli & Rampichini (2012). Using the dropout rate after two years does not alter the basic results of the empirical exercise.

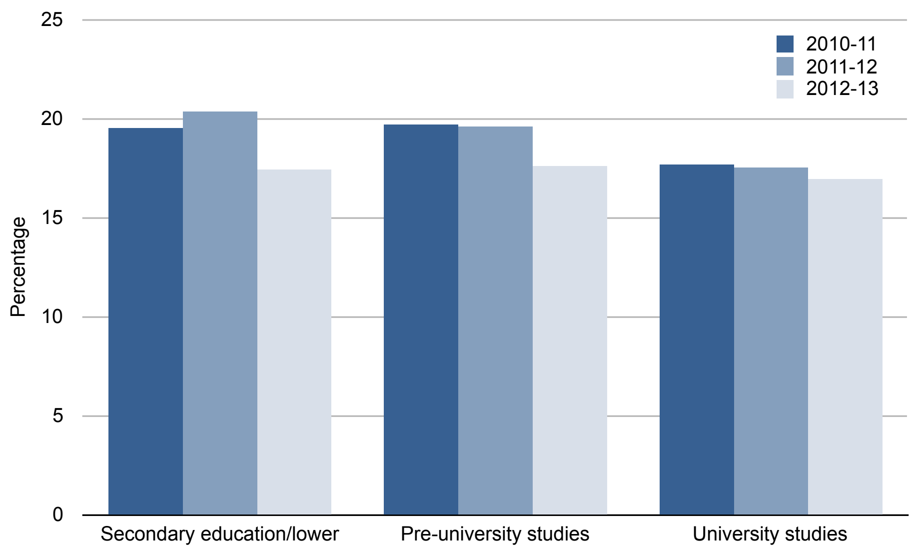


Figure 4: Gross dropout rate by socioeconomic status and academic year. *Source: Own elaboration on UNEIX data.*

with the exception only of the decline in the dropout rate of students with parents with compulsory secondary studies/high school diploma from the 2011-12 to the 2012-13 academic year. Table 1 presents the dropout rate by parental level of education for students who entered in the 2010-11 academic year. The second column of the table shows the t-statistic of the difference between the dropout rate of students who entered in the 2010-11 academic year and, therefore, enjoyed tuition fees previous to the change during their first two years of study, and students who entered in the 2012-13 academic year (hence with the tuition fee change in effect since the initial year). As in Figure 4 there is a significant effect among the mid-level of education in the change in the dropout rate between these two years. Yet this effect is a decrease in the dropout rate and not, as expected, an increase due to the rise in tuition fees.

However, the gross dropout rate is but a rough proxy of actual dropout. Many students re-enter the system after initially dropping out. They may take a year off or, more likely, change universities or studies. If they change universities, then the data of each university reports a dropout. We have devised a procedure to capture those that return to the system, but in another university. Since we have all the data of the system we can determine whether the dropout is temporary or permanent. We henceforth count as a dropout only those students who left their studies during the first year (did not enroll in the second year) and did not subsequently re-enter any university. We define this concept as the net dropout rate. Table 2 contains the same information as Table 1 but where a dropout has been defined as a dropout from the system, meaning dropping out without reentering the system.

Table 1: Gross dropout rate by parental education levels.

Parental education	2010-11	t
No studies/Primary	19.80%	0.38
Secondary school	19.30%	3.19**
High school diploma	19.70%	3.33**
Associate's Degree	18.30%	0.56
Bachelor's Degree/more	17.40%	1.50

Source: Own elaboration on UNEIX data.

Table 2: Net dropout rate by parental education levels.

Parental education	2010-11	t
No studies/Primary	12.47%	0.49
Secondary school	9.02%	0.93
High school diploma	8.27%	-0.14
Associate's Degree	7.76%	0.31
Bachelor's Degree/more	6.09%	-0.46

Source: Own elaboration on UNEIX data.

Table 2 shows that the net dropout decreases when the parental level of education increases. There is not, however, a statistically significant change in the net dropout rate by socioeconomic status of the parents.

There are, of course, other factors that affect the dropout rate. To complement the previous analysis, we run a logistic specification using all the available information. The basic methodology is to compare the probability of dropping out of university before and after the change in tuition fees. With this objective, we compare the dropout rate among the students who enrolled in the 2010-11 academic year with the dropouts of entrants in the 2011-12 academic year.[23] As a robustness test we also compare with the dropout

[23] Students enrolling for the first time in the 2011-12 academic year will suffer an unexpected increase in tuition fees in their second year of studies.

rate among those who entered in the 2012-13 academic year. We define net dropout as a student who enrolled as an entrant in an academic year of reference, did not enroll the following year, and has not subsequently re-entered any university. As indicated above, the use of first-year students as the reference to define the relevant moment of dropout is the criterion commonly used in studies on university dropouts (Mealli & Rampichini, 2012). The reason is simple: most university dropouts occur during the first year. The further along the student progresses, the greater the opportunity cost of dropping out.

In our case, the students who enrolled for the first time in the 2010-11 academic year did not experience, in their second year, the change in tuition fees that occurred in the 2012-13 academic year. However, students who entered in the 2011-12 academic year were subject to the new tuition fees in their second year of study. Analyzing the differences in the dropout rates between these two cohorts of students, we can obtain the effect on dropout due to the combined effect of the increase in tuition fees and the introduction of the new Fairness Grants (FS). The specification is, therefore, (Equation 3):

$$Pr(Dropout|X) = \frac{e^{X\beta}}{1 + e^{X\beta}} = \Lambda(X'\beta) \tag{3}$$

In the above equation, the explanatory variable X includes gender, age, and socio-economic background of each student (using parental education as a proxy), year of initial access, university entrance grade,[24] current university, and level of experimental intensity of the degree. In addition, the specification includes a dichotomous variable that reflects the effect of the increase in tuition fees and the interaction of this variable and familial socio-economic status.[25] Table 3 presents the coefficients from several logistic models containing an increasing number of controls as robustness checks to validate the

[24]The entrance grade is a number between 5 and 14.

[25]The interaction between level of experimental intensity and the new public pricing system is also included as tuition fees for highly experimental degrees are much higher than those for low experimental content degrees. We also include the interaction of entry grades and the policy change.

results.[26]

The idea is to determine whether there exists a difference in dropout rates by student socio-economic status after controlling for all known characteristics of the students and their studies. The estimation shows that gender and age are important determinants of the probability of dropping out of university. In general, males have a higher probability of dropping out, as do older students. As expected, entry grade has a high explanatory power. By contrast, the dummy variable that represents accessing university during the 2011-12 academic year is not statistically significant, nor is the interaction between this variable and familial socio-economic status.

We can represent these last results in a more intuitive way using predictive margins. The upper panel of Figure 5 shows the results for the comparison of the 2010-11 entrants, unaffected in their second year by the increase in tuition fees, and the 2011-12 entrants, affected by the change once they had already spent one year at university. The top part of the figure shows that the difference in dropout rate by level of education of the parents is not statistically significant in any of the cases. Indeed, the difference becomes smaller when going from students with parents with no education to those with parents with a primary education and increases marginally among those whose parents have completed university studies. As a robustness check we can compare the predictive margins of those students who were not subject to the tuition increase and those who paid the new fees upon entering university (2010-11 versus 2012-13). The lower panel of Figure 5 shows the predictive margins in this second case. As in the previous panel there is no sign of a statistically significant change in any of the education levels considered in the figure. These results indicate that the increase in tuition fees did not have an effect on the probability of dropping out of university, independently of the socioeconomic status of the student.

[26] The appendix includes the same estimation for the gross dropout definition. The results are qualitatively very similar using this alternative measure of dropout.

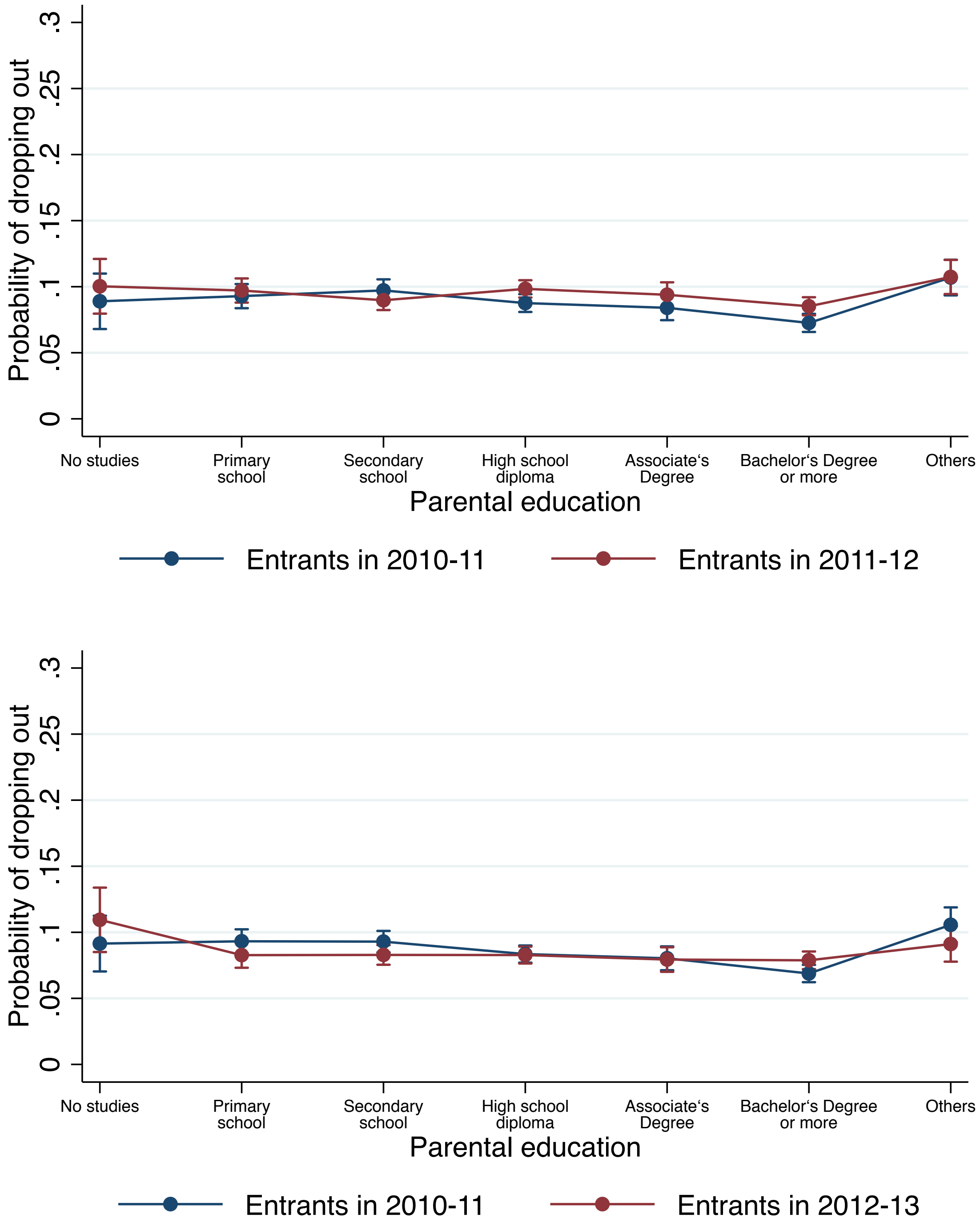


Figure 5: Difference between predictive margins of dropout rates by socioeconomic status.
Source: Own elaboration using merged datasets.

Table 3: Logistic models of net dropout rate: Academic year 2010-11 vs. 2011-12

Net dropout rate	(1)	(2)	(3)	(4)
Academic year *(2011-12)*	0.388*	0.144	0.144	0.392
	(0.181)	(0.189)	(0.189)	(0.204)
Gender *(Male)*	0.348***	0.240***	0.240***	0.211***
	(0.0290)	(0.0315)	(0.0324)	(0.0326)
Age	0.0827***	0.0655***	0.0651***	0.0657***
	(0.00212)	(0.00220)	(0.00222)	(0.00223)
Parental education: reference category No school				
Primary school	0.0794	0.0431	0.0512	0.0386
	(0.143)	(0.153)	(0.154)	(0.149)
Secondary school	0.149	0.0994	0.105	0.0733
	(0.142)	(0.152)	(0.153)	(0.148)
High school diploma	0.0640	-0.0163	-0.0181	-0.0466
	(0.140)	(0.150)	(0.151)	(0.146)
Associate's Degree	-0.0292	-0.0709	-0.0675	-0.104
	(0.146)	(0.157)	(0.158)	(0.154)
Bachelor's Degree or more	-0.210	-0.224	-0.238	-0.283
	(0.142)	(0.153)	(0.154)	(0.150)
Others	0.272	0.218	0.221	0.206
	(0.151)	(0.162)	(0.162)	(0.157)
Interaction Parental education × Academic year				
Primary school × Academic year	-0.155	-0.0851	-0.0904	-0.0549
	(0.197)	(0.206)	(0.207)	(0.204)
Secondary school × Academic year	-0.348	-0.236	-0.239	-0.168
	(0.193)	(0.202)	(0.203)	(0.201)
High school diploma × Academic year	-0.167	-0.00187	-0.00575	0.0595
	(0.189)	(0.199)	(0.199)	(0.198)
Associate's Degree × Academic year	-0.208	-0.00372	-0.0119	0.0598
	(0.199)	(0.209)	(0.210)	(0.209)
Bachelor's Degree or more × Academic year	-0.250	0.0422	0.0429	0.146
	(0.192)	(0.202)	(0.203)	(0.202)
Others × Academic year	-0.281	-0.134	-0.139	-0.0956
	(0.207)	(0.218)	(0.218)	(0.216)
Entry grade: reference category Five				
Six		-0.163**	-0.171**	-0.138
		(0.0533)	(0.0533)	(0.0886)
Seven		-0.436***	-0.452***	-0.266**
		(0.0525)	(0.0527)	(0.0839)
Eight		-0.730***	-0.749***	-0.469***
		(0.0552)	(0.0554)	(0.0851)
Nine		-1.112***	-1.135***	-0.753***
		(0.0622)	(0.0624)	(0.0896)
Ten		-1.466***	-1.495***	-1.094***
		(0.0748)	(0.0753)	(0.103)
Eleven		-1.789***	-1.809***	-1.592***
		(0.0999)	(0.101)	(0.150)
Twelve		-2.298***	-2.338***	-1.983***
		(0.189)	(0.190)	(0.271)
Thirteen		-2.627***	-2.668***	-2.065**
		(0.582)	(0.583)	(0.717)
University: reference category UB				
UAB			-0.0569	-0.0858*
			(0.0428)	(0.0432)
UPC			-0.0535	-0.178**
			(0.0513)	(0.0556)
UPF			-0.0185	-0.0339
			(0.0714)	(0.0715)
URV			-0.0592	-0.0807
			(0.0556)	(0.0557)
UdG			-0.201***	-0.224***
			(0.0598)	(0.0599)
UdL			-0.330***	-0.346***
			(0.0707)	(0.0706)
Experimental intensity of the degree: reference category One				
Experimental intensity: Two				0.156**
				(0.0502)
Experimental intensity: Three				-0.213
				(0.116)
Interaction Experimental intensity of the degree × Academic year				
Experimental intensity: Two × Academic year				0.0416
				(0.0647)
Experimental intensity: Three × Academic year				0.190
				(0.154)
Interaction Entry grade × Academic year				
Six × Academic year				-0.0617
				(0.111)
Seven × Academic year				-0.317**
				(0.107)
Eight × Academic year				-0.505***
				(0.112)
Nine × Academic year				-0.803***
				(0.129)
Ten × Academic year				-0.872***
				(0.157)
Eleven × Academic year				-0.327
				(0.198)
Twelve × Academic year				-0.596
				(0.381)
Thirteen × Academic year				-1.208
				(1.235)
Constant	-4.382***	-3.183***	-3.091***	-3.291***
	(0.149)	(0.164)	(0.167)	(0.171)
Observations	63,037	55,292	55,292	55,292

*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors in parentheses.

5.2.2 Regression discontinuity design

In this section we perform an analysis of dropout behavior using the sharp discontinuity generated by the threshold level of net income that determines the complete waiver of tuition. Regression discontinuity designs have frequently been used in the analysis of fee interventions and educational decisions since first being proposed by Thistlethwaite and Campbell (Thistlethwaite & Campbell, 1960). In recent years it has been used extensively in the field of education economics (Van der Klaauw, 2002, 2008; Angrist & Lavy, 1999; Hoxby & Bulman, 2016). The advantages of this technique have made RDD a standard method in the statistical analysis toolbox (Imbens & Lemieux, 2008), provided that some weak requirements are met.

By applying an analytical microscope to the distribution of new entrants near the threshold that determines eligibility, it is possible to understand in more detail if there is any effect on dropping out. In principle the sharp discontinuity at the level of income to be eligible for the full tuition fee waiver generates a situation close to a random assignment of individuals to a treated group and control group. In this sense, the regression discontinuity design (RDD) is the method closest to the realization of a randomized control trial (RCT). In fact, we can consider discontinuity design as a locally randomized experiment (Lee & Lemieux, 2010). Specifically, the estimator obtained using the discontinuity design can be interpreted as an ATE (average treatment effect) weighted by the relative ex ante probability that the value of the allocation variable of an individual is in the neighborhood of the point of discontinuity.

Using the notation of potential outcomes, $(y_i(0), y_i(1))$ represent a pair of potential outcomes for unit i where $z_i \in \{0, 1\}$ denote the treatment. The realized outcome is $y_i^{obs} = y_i(z_i)$. In our case the treatment is a deterministic monotone function of the pretreatment, or forcing, variable x_i which represents after tax income minus the eligibility threshold level, or what we define as normalized adjusted income. We want to estimate

$$\tau = \tau(0) = E((y_i(0), y_i(1))|x_i = 0) \tag{4}$$

This regression discontinuity design provides credible results under weak assumptions. Our analysis is based on a forcing variable (after-tax income) with a threshold that is strictly enforced. We also assume that other factors that can affect the probability of dropping out do not jump at the threshold. Finally, we consider that individuals cannot manage their after-tax income, and that there is a high density of observations around the threshold of after-tax income. In our case, it is unlikely that individuals can alter their income in order to be eligible for the tuition fee waiver. In fact, the definition of the relevant measure, after-tax income from all sources, makes it difficult to manipulate the forcing variable. Figures A.1 and A.2 in the Appendix depict the distribution of after-tax income for all students for each academic year, respectively. The figures do not show any disturbance in the histogram around the threshold level.[27] In addition, the figures show a high density of observations around the eligibility threshold.

Under these conditions, the average effect of equation 4 can be estimated as the discontinuity in the conditional expectation, at the threshold, of y_i^{obs} as a function of the forcing variable.

$$\tau = \mu_+ - \mu_- = \lim_{x \downarrow 0} E(y_i^{obs}|x_i = 0) - \lim_{x \uparrow 0} E(y_i^{obs}|x_i = 0) \tag{5}$$

Usually these two conditional means are estimated using linear or quadratic functions of x.

The basis of the procedure is to have a threshold in the forcing variable that generates a variation in the treatment which is as good as proceeding to randomly distribute the general scholarship (GS), which implies a full tuition fee waiver, in the area around the

[27] Hoxby & Bulman (2016) do find indications of manipulation of income around the eligibility threshold. They use a optimal doughnut hole around the threshold to overcome this problem.

point of discontinuity. In the case of a full fee waiver, the fact that the after-tax income threshold is a precise number generates this sharp design.

In our case, the regression discontinuity design can be used because the probability of getting a full tuition waiver depends on a continuous variable (normalized adjusted income). The assignment probability is 1 for a family of four with a net income below 38,831 euros or, in general, for any family with a normalized adjusted income below 0. As described above, a family income very close to the threshold may be above or below depending on circumstances beyond the family's control.[28]

Table 4: Balance of the main variables above and below the point of discontinuity.

Variable	Above	Below	t
Proportion of men	41.70%	41.30%	-0.24
Age	20.5	20.7	1.13
Entry Grade	8.8	8.8	0.20
Parental education (proportion of)			
Primary School	13.10%	12.30%	-0.62
Secondary school	22.10%	21.40%	-0.41
High school diploma	29.50%	32.00%	1.35
Associate's Degree	12.80%	13.00%	0.18
Bachelor's Degree/more	15.80%	14.80%	-0.71

Source: Own elaboration on UNEIX data.

Table 4 reports the main characteristics of the students around the income adjusted value that sets the threshold to get the full tuition waiver. For the previously calculated transformation (see Section 3), the threshold corresponds to a normalized family-adjusted income equal to 0. Table 4 shows that the proportion of men above and below the threshold is very similar; this is likewise true for the entry grade and average age. Lastly, the two samples (above and below the threshold) are also very similar in terms of level of parental education. We can therefore conclude that the observed characteristics of students above and below the cutoff point are not statistically different.

[28]The approach of using a sharp discontinuity design to analyze the effect of a change in fees on dropout during the first year of university has been used recently in the examination of four Italian universities (Mealli & Rampichini, 2012).

The econometric analysis is performed using local polynomial with an arbitrary bandwidth selection of 30,000 euros around the cutoff. We control for second-degree polynomials of the forcing variable by avoiding any higher order polynomial following the suggestion in Gelman & Imbens (2017). Figure 6 shows the dropout rate around the income threshold for the full tuition fee waiver by normalized or adjusted income levels. At the same, one can verify that for the 2011-12 academic year the difference in the rate of dropout of the students in the first year that had income adjusted around the threshold was not statistically significant between those that were above and below. This same result is observed for the 2012-13 academic year, as can be seen in Figure 7.[29]

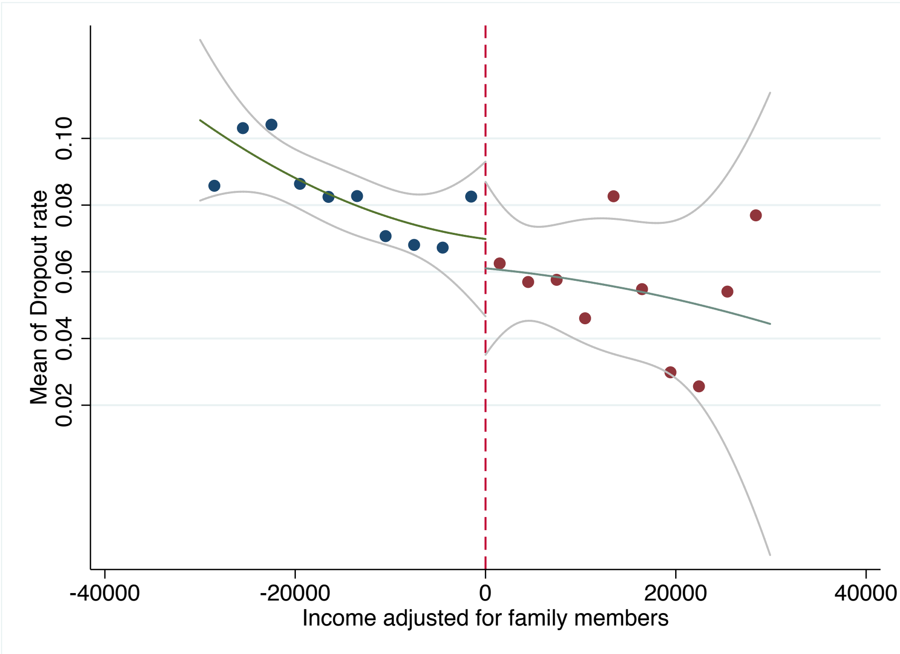


Figure 6: Regression discontinuity design: 2011-12 academic year (range ±30,000). *Source: Own elaboration on UNEIX data.*

[29]Using a first-order polynomial leads to the same conclusions.

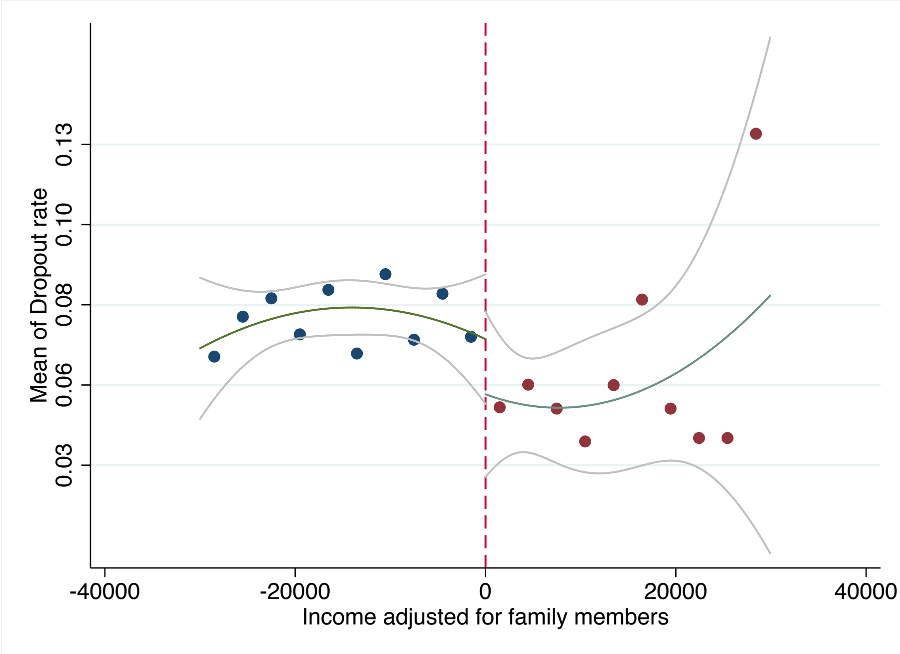


Figure 7: Regression discontinuity design: 2012-13 academic year (range ±30,000). *Source: Own elaboration on UNEIX data.*

To validate the evidence presented above, it is possible to compare the local-polynomial regression-discontinuity estimations with robust confidence intervals obtained by applying the methodology proposed by Calonico et al. (2014). Point estimates are reported in Table 5 and Table 6 for the 2011-12 and 2012-13 academic years, respectively. The first column in each of the two tables presents point estimates computed using a first-degree local polynomial estimator while the second columns consider second-degree local polynomials. In all specifications, the optimal bandwidth selection procedure follows Calonico et al. (2014). From the tables it is possible to verify that the difference in the dropout rate of students around the cutoff was not significant, for both academic years. Finally, the initial analysis of the discontinuity is repeated, this time using the ad-hoc optimal bandwidths obtained with the above mentioned methodology for the 2011-12 and 2012-13 academic years. Results are depicted in Figure 8 and Figure 9, showing even more consistently that the difference in dropout rate between students around the normalized family-adjusted income threshold was not significant. Again, an analysis with a first-order polynomial leads to the same conclusions.

Table 5: Local-polynomial estimations with robust confidence intervals: 2011-12

Variable	Net dropout rate (1)	Net dropout rate (2)
RD_Estimate	-0.016	-0.021
	(0.018)	(0.022)
Observations	4,878	7,438
Robust 95% CI	[-0.051 ; 0.019]	[-0.063 ; 0.021]
BW Type	CCT	CCT
Conventional Std. Err.	0.018	0.022
Conventional p-value	0.381	0.329
Robust p-value	0.328	0.291
Order Loc. Poly. (p)	1	2
Order Bias (q)	2	3
BW Loc. Poly. (h)	15,751	24,783
BW Bias (b)	26,378	35,587

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Table 6: Local-polynomial estimations with robust confidence intervals: 2012-13

Variable	Net dropout rate (1)	Net dropout rate (2)
RD_Estimate	-0.014	-0.012
	(0.018)	(0.021)
Observations	3,984	6,596
Robust 95% CI	[-0.048 ; 0.020]	[-0.052 ; 0.028]
BW Type	CCT	CCT
Conventional Std. Err.	0.018	0.021
Conventional p-value	0.431	0.570
Robust p-value	0.599	0.669
Order Loc. Poly. (p)	1	2
Order Bias (q)	2	3
BW Loc. Poly. (h)	12,584	20,798
BW Bias (b)	23,401	34,778

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

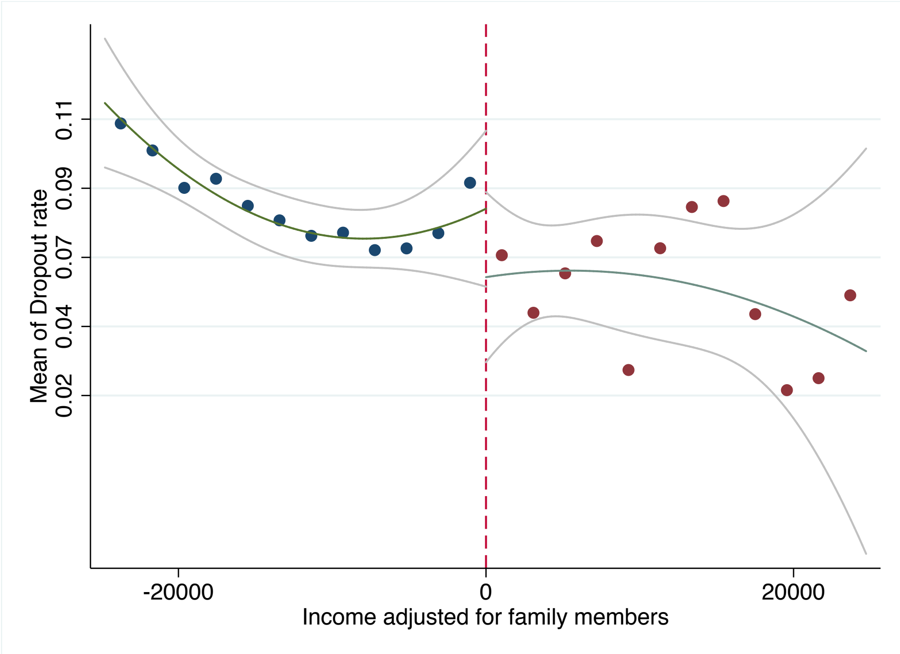


Figure 8: Regression discontinuity design: 2011-12 academic year (range ±24,783). *Source: Own elaboration on UNEIX data.*

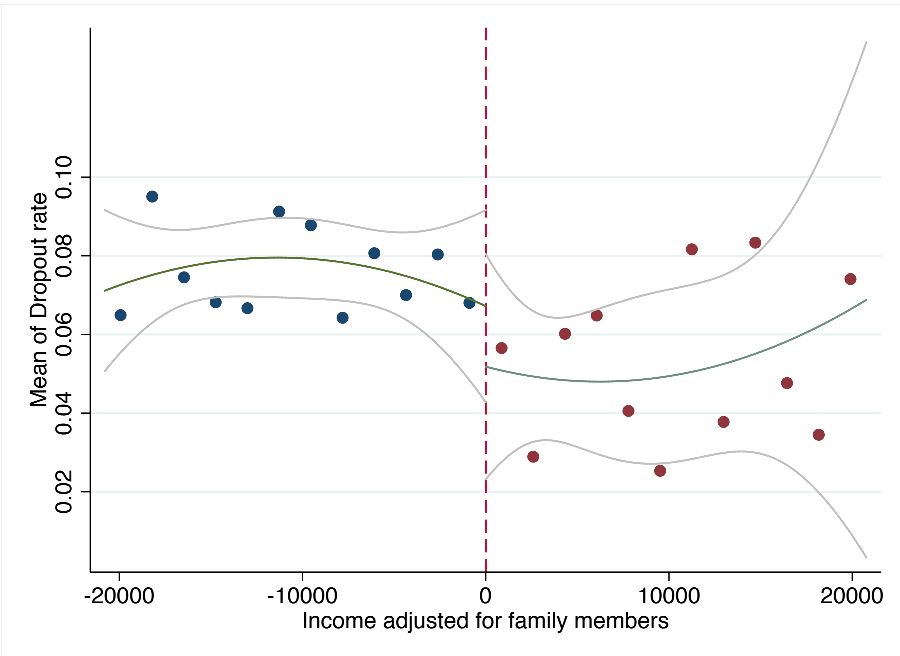


Figure 9: Regression discontinuity design: 2012-13 academic year (range ±20,797). *Source: Own elaboration on UNEIX data.*

Table 7: Net drop out rate change around threshold changes

Net dropout rate	(1)	(2)	(3)	(4)
Post	0.229	0.147	0.175	0.248
	(0.230)	(0.248)	(0.249)	(0.275)
Above income threshold	-0.349***	-0.306**	-0.296**	-0.294**
	(0.0953)	(0.102)	(0.102)	(0.102)
Post × Above income threshold	0.0250	-0.0127	-0.00717	-0.00986
	(0.140)	(0.153)	(0.153)	(0.153)
Gender *(Male)*	0.423***	0.287***	0.302***	0.300***
	(0.0426)	(0.0467)	(0.0479)	(0.0479)
Age	0.0774***	0.0586***	0.0564***	0.0563***
	(0.00360)	(0.00387)	(0.00391)	(0.00391)
Parental education: reference category No school				
Primary school	-0.248	-0.241	-0.227	-0.224
	(0.183)	(0.196)	(0.196)	(0.196)
Secondary school	-0.254	-0.222	-0.218	-0.216
	(0.179)	(0.191)	(0.191)	(0.191)
High school diploma	-0.309	-0.284	-0.285	-0.280
	(0.179)	(0.191)	(0.192)	(0.191)
Associate's Degree	-0.397	-0.429	-0.430	-0.422
	(0.208)	(0.224)	(0.224)	(0.224)
Bachelor's Degree or more	-0.425*	-0.409	-0.424	-0.411
	(0.201)	(0.218)	(0.218)	(0.218)
Others	-0.136	-0.0747	-0.0733	-0.0697
	(0.198)	(0.210)	(0.211)	(0.210)
Interaction Parental education × Post				
Primary school × Post	-0.0268	0.0163	-0.0162	-0.0207
	(0.253)	(0.273)	(0.274)	(0.274)
Secondary school × Post	-0.0885	-0.0811	-0.0977	-0.0996
	(0.244)	(0.263)	(0.264)	(0.265)
High school diploma × Post	-0.00876	0.0258	0.00240	-0.00298
	(0.244)	(0.263)	(0.264)	(0.264)
Associate's Degree × Post	-0.0798	0.0753	0.0563	0.0471
	(0.278)	(0.303)	(0.304)	(0.304)
Bachelor's Degree or more × Post	0.0364	0.257	0.226	0.206
	(0.268)	(0.292)	(0.293)	(0.294)
Others × Post	-0.0374	0.0342	0.00982	0.00489
	(0.276)	(0.295)	(0.296)	(0.297)
Entry grade: reference category Five				
Six		-0.0673	-0.0715	-0.0423
		(0.0815)	(0.0816)	(0.116)
Seven		-0.540***	-0.560***	-0.571***
		(0.0811)	(0.0814)	(0.117)
Eight		-0.796***	-0.827***	-0.752***
		(0.0832)	(0.0836)	(0.117)
Nine		-1.300***	-1.350***	-1.208***
		(0.0953)	(0.0960)	(0.131)
Ten		-1.626***	-1.690***	-1.638***
		(0.114)	(0.115)	(0.160)
Eleven		-2.120***	-2.187***	-2.602***
		(0.171)	(0.173)	(0.318)
Twelve		-2.418***	-2.499***	-3.006***
		(0.325)	(0.326)	(0.712)
Thirteen		-1.332*	-1.417*	-1.091
		(0.596)	(0.594)	(0.607)
University: reference category UB				
UAB			-0.0942	-0.0936
			(0.0623)	(0.0623)
UPC			-0.222**	-0.224**
			(0.0844)	(0.0845)
UPF			0.00710	0.00515
			(0.110)	(0.110)
URV			-0.275***	-0.276***
			(0.0783)	(0.0783)
UdG			-0.344***	-0.345***
			(0.0849)	(0.0849)
UdL			-0.561***	-0.565***
			(0.103)	(0.103)
Interaction Entry grade × Post				
Six × Post				-0.0613
				(0.163)
Seven × Post				0.00762
				(0.162)
Eight × Post				-0.147
				(0.164)
Nine × Post				-0.287
				(0.188)
Ten × Post				-0.107
				(0.225)
Eleven × Post				0.613
				(0.378)
Twelve × Post				0.669
				(0.801)
Constant	-4.133***	-2.950***	-2.740***	-2.773***
	(0.193)	(0.217)	(0.221)	(0.227)
Observations	34,694	30,988	30,988	30,960

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

To further analyze the impact of the changes in the net tuition fees we can formally address the statistical significance of the difference of the jump at the discontinuity before and after the change in tuitions. For this purpose we model $\delta' D_i$ as

$$\begin{aligned}\delta' D_i = \delta_{after,above} D_{i,after,above} + \delta_{after,below} D_{i,after,below} \\ + \delta_{before,above} D_{i,before,above} + \delta_{before,below} D_{i,before,below}\end{aligned} \tag{6}$$

To check if there is a change in the discontinuity we can test the difference-in-differences prediction using the same window that we employ in the regression discontinuity estimation above

$$\begin{aligned}&(\delta_{after,above} D_{i,after,above} - \delta_{after,below} D_{i,after,below}) \\ &- (\delta_{before,above} D_{i,before,above} + \delta_{before,below} D_{i,before,below}) > 0\end{aligned} \tag{7}$$

Table 7 shows the difference-in-difference estimate. The estimate of the test, which corresponds with the post above income threshold variable, is statistically insignificant in all the estimations. This was expected since, from the regression discontinuity design it was quite clear that the difference in the discontinuities between both periods (before and after the tuition fee changes) was very small.

6 Discussion and Conclusions

Government decisions on how to finance higher education have always been a matter of debate. The current tendency in many countries of shifting the burden of higher education costs from taxpayers to beneficiaries (students and their families) is controversial and generates fears about distributional impacts, especially on lower-income students. In this paper, we analyze the distributional effect of a 66 percent increase in the tuition fees of universities in Catalonia. This is an interesting case for study since the increase was introduced jointly with a new tuition fee discount (Fairness Scholarships) that was a negative function of after-tax income. Additionally, the increase in tuition fees was retained by universities so as to cover the discount of tuition fees for those students who did not reach a minimum number of registered credits, and to finance the discount of fees for some students (who had to pay more than in previous years). This procedure is very low cost in terms of administration and paperwork as the new financial resources are transfered directly by the university from families with high incomes to families with low incomes.

Using a difference-in-differences estimator we show that there is no statistically significant effect of the change in tuition fees on the probability of dropping out. We obtain the same result when the analysis is performed by familial socioeconomic status.

Finally, we also examine dropout rates around the eligibility threshold for a full tuition fee waiver using a sharp Regression Discontinuity Design. A comparison in dropout rates below and above the eligibility threshold for the academic year before the increase in the tuition fees and for the academic year after the increase shows no change: in both cases there is no significant difference in the two limits of the regression function at the threshold.

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Appendix A

A1. Data construction, variable definitions, and data sources

As mentioned, the data used to perform the study comes from several large administrative sources: the UNEIX data platform, the BGeneral and BEquitat datasets on grants and financial aid and the SIIU dataset including information on students who finish high school. Below follows a list of the variables introduced in the analysis and the ways they are defined by dataset.

UNEIX dataset

Academic year. Categorical variable including four academic years from 2010-11 to 2013-14.

New access. Indicator of the current year being the entrance year. Is a dummy variable taking value 1 if current year is the entrance year, 0 otherwise.

Gender. Dummy variable taking value 1 for male and 0 for female.

Age. Age of the individuals in the sample expressed as integer.

Access Type of access to the university: High School Degree/UOC (UOC stands for University Orientation Course with Admission Test), Diploma/Bachelor's Degree, VET/Superior-level Training Cycles (VET stands for Vocational Education and Training), Uni/High School Degree/UOC, Uni/VET/Superior-level Training Cycles, More than 25 years, More than 40 years, More than 45 years, Others.

Entry grade. Normalized entrance exam score: integer number varying from 5 to 13. Each value covers the interval between two grades. For instance entry grade=6 implies a grade in the interval (6, 7].

Parental education. Education level of the parents: No studies, Primary school, Secondary school, High school diploma, Associate's Degree, Bachelor's Degree or more, Others, Not Available.

Parental occupation. Type of occupation of the parents: Company manager or Public Institutions, Job related to academic title, Qualified job in agricultural sector, Qualified job in industrial sector, Qualified job in construction or mining sectors, Qualified job in service sector, Not qualified job, Armed forces, Others, Do not know/No answer.

Name of university. The names of the Catalan universities included in the analysis: UB-University of Barcelona, UAB-University Autònoma of Barcelona, UPC-Technical University of Catalonia, UPF-University Pompeu Fabra, URV-University Rovira i Virgili, UdG-University of Girona, UdL-University of Lleida.

Degree name. Names of all the degrees taught in Catalonia.

Level of experimental intensity of the degree. Categorical variable including three levels of experimental intensity.

Dropout. Indicator for individuals who dropped out in their second year.

Re-enrollment. Indicator for individuals who enrolled after having dropped out.

Year of re-enrollment. The year in which an individual re-enrolled in the university system.

BGeneral and BEquitat datasets

Name of university. The names of Catalan universities included in the analysis: UB-University of Barcelona, UAB-University Autònoma of Barcelona, UPC-Technical University of Catalonia, UPF-University Pompeu Fabra, URV-University Rovira i Virgili, UdG-University of Girona, UdL-University of Lleida.

Application status. Denied or accepted.

Family income. Expressed in euros.

Family members. Number of family members: integer number varying from 1 to 13 in our dataset.

Grant type. Type of financial aid grant.

Amount of grant. The amount obtained expressed in euros.

Reasons of denial. Reasons for denying financial aid: low academic performance, high income, high level of wealth.

SIIU dataset

Type of school. Categorical variable divided into: private, public, charter.

Access. Type of access to the university: High School Degree/UOC (UOC stands for University Orientation Course with Admission Test), Diploma/Bachelor's Degree, VET/Superior-level Training Cycles (VET stands for Vocational Education and Training), Uni/High School Degree/UOC, Uni/VET/Superior-level Training Cycles, More than 25 years, More than 40 years, More than 45 years, Others.

Entry exam status. Pass or fail.

Degree of first preference. Name of the degree of first preference.

Minimum score. Minimum score to enter the degree of first preference.

A2. Robustness checks

As a robustness check, the logistic model used in Section 5.2.1 is replicated with a different outcome variable. Specifically, the possibility of dropping out of university and re-entering in a later moment is now allowed. Results are displayed in Table A.1.

Table A.1: Logistic models of gross dropout rate: Academic year 2010-11 vs. 2011-12

Gross dropout rate	(1)	(2)	(3)	(4)
Academic year *(2011-12)*	0.322*	0.133	0.120	0.350
	(0.145)	(0.167)	(0.168)	(0.180)
Gender *(male)*	0.386***	0.196***	0.228***	0.198***
	(0.0206)	(0.0257)	(0.0264)	(0.0266)
Age	0.0470***	0.0481***	0.0472***	0.0482***
	(0.00175)	(0.00200)	(0.00204)	(0.00206)
Parental education: reference category No school				
Primary school	0.161	-0.0178	-0.00553	-0.00955
	(0.113)	(0.135)	(0.136)	(0.133)
Secondary school	0.325**	0.00807	0.0141	-0.00398
	(0.111)	(0.134)	(0.135)	(0.132)
High school diploma	0.346**	-0.0604	-0.0609	-0.0810
	(0.110)	(0.132)	(0.133)	(0.130)
Associate's Degree	0.241*	-0.0652	-0.0526	-0.0843
	(0.114)	(0.138)	(0.139)	(0.136)
Bachelor's Degree or more	0.213	-0.145	-0.160	-0.187
	(0.110)	(0.134)	(0.135)	(0.132)
Others	0.364**	0.160	0.169	0.158
	(0.119)	(0.142)	(0.144)	(0.141)
Interaction Parental education × Academic year				
Primary school × Academic year	-0.107	0.147	0.148	0.167
	(0.156)	(0.181)	(0.182)	(0.181)
Secondary school × Academic year	-0.362*	0.0852	0.0869	0.127
	(0.153)	(0.178)	(0.179)	(0.178)
High school diploma × Academic year	-0.306*	0.239	0.237	0.277
	(0.150)	(0.175)	(0.176)	(0.175)
Associate's Degree × Academic year	-0.289	0.237	0.233	0.284
	(0.156)	(0.183)	(0.184)	(0.183)
Bachelor's Degree or more × Academic year	-0.334*	0.380*	0.389*	0.442*
	(0.151)	(0.176)	(0.177)	(0.177)
Others × Academic year	-0.282	0.0652	0.0667	0.0951
	(0.164)	(0.191)	(0.192)	(0.191)
Entry grade: reference category Five				
Six		-0.171***	-0.182***	-0.145
		(0.0452)	(0.0454)	(0.0757)
Seven		-0.449***	-0.469***	-0.326***
		(0.0443)	(0.0446)	(0.0721)
Eight		-0.777***	-0.802***	-0.588***
		(0.0463)	(0.0466)	(0.0731)
Nine		-1.148***	-1.182***	-0.919***
		(0.0513)	(0.0516)	(0.0771)
Ten		-1.429***	-1.462***	-1.290***
		(0.0591)	(0.0595)	(0.0890)
Eleven		-1.744***	-1.746***	-1.659***
		(0.0750)	(0.0758)	(0.125)
Twelve		-2.226***	-2.244***	-2.124***
		(0.134)	(0.134)	(0.226)
Thirteen		-2.332***	-2.349***	-1.665***
		(0.362)	(0.363)	(0.462)
University: reference category UB				
UAB			-0.0452	-0.0719*
			(0.0343)	(0.0347)
UPC			-0.296***	-0.419***
			(0.0438)	(0.0471)
UPF			-0.217***	-0.239***
			(0.0586)	(0.0588)
URV			-0.0421	-0.0478
			(0.0445)	(0.0448)
UdG			-0.573***	-0.590***
			(0.0535)	(0.0537)
UdL			-0.376***	-0.389***
			(0.0571)	(0.0575)
Experimental intensity of the degree: reference category One				
Experimental intensity: Two				0.232***
				(0.0422)
Experimental intensity: Three				-0.369***
				(0.107)
Interaction Experimental intensity of the degree × Academic year				
Experimental intensity: Two × Academic year				-0.114*
				(0.0535)
Experimental intensity: Three × Academic year				0.169
				(0.132)
Interaction Entry grade × Academic year				
Six × Academic year				-0.0657
				(0.0949)
Seven × Academic year				-0.241**
				(0.0916)
Eight × Academic year				-0.371***
				(0.0944)
Nine × Academic year				-0.483***
				(0.104)
Ten × Academic year				-0.279*
				(0.119)
Eleven × Academic year				-0.0349
				(0.155)
Twelve × Academic year				-0.0891
				(0.281)
Thirteen × Academic year				-1.192
				(0.747)
Constant	-2.903***	-2.335***	-2.174***	-2.361***
	(0.117)	(0.144)	(0.147)	(0.151)
Observations	63,037	55,292	55,292	55,292

*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard errors in parentheses.

Figures A.1 and A.2 show the distribution of net income for all students.

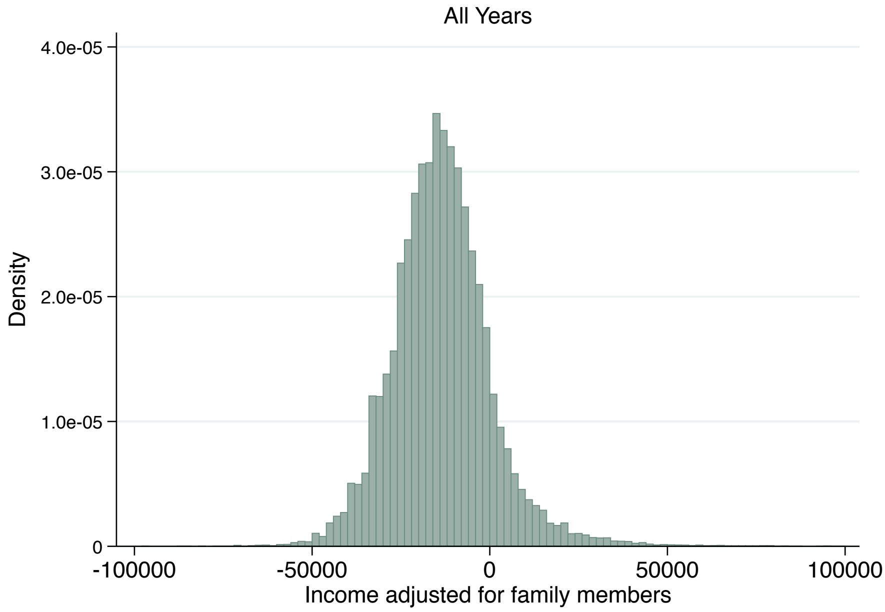

Figure A.1: Distribution of adjusted income of students. *Source: Own elaboration on UNEIX data.*

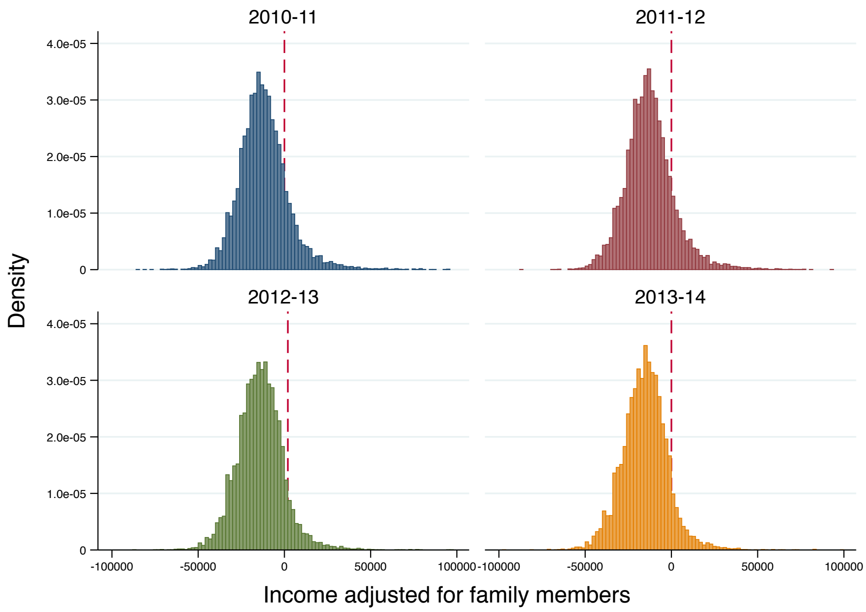

Figure A.2: Evolution of the distribution of adjusted income of students. *Source: Own elaboration on UNEIX data.*