

When the Need Meets Merit: The Role of Merit Requirements in Need-based Student Aid¹

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Abstract

Performance standards in need-based student aid may exacerbate inequality in higher education, but at the same time they might improve efficiency of aid expenditure, for instance by increasing on-time graduation. Disentangling the effect of the two building blocks of student aid (“need” and “merit”) is therefore of key interest to policy makers, yet it is difficult to achieve since aid comes as a complex package. In this paper, we seek to estimate the causal effect of tightening the merit-based requirements of need-based student aid on short-term and long-term student academic performance. This is done leveraging a reform in an Italian region that increased by 40% (i.e. from 25 to 35 out of a maximum of 60) the number of credits to be passed in the first academic year to maintain aid eligibility. Using administrative data from an Italian university, this study reveals that tightening merit requirements had a statistically significant, positive effect on various dimensions of performance of the “average” student in aid. Aided students in cohorts after the reform acquire more formative credits in the first year, along with better grades. Moreover, these effects persist over time and are conducive to a higher probability to obtain the BA degree on time. However, an analysis of treatment heterogeneity unveils winners and losers from the policy: the positive effects are indeed concentrated among high ability students, while our findings point to a decrease in re-enrolment of low-ability students in student aid. The results have clear policy implications, corroborating the idea that carefully balancing need and merit is a pressing issue for the design of student aid packages that preserve both equity and efficiency of the university system.

Keywords. Student financial aid; merit-based requirements; university; difference-in-differences; Italy

JEL Codes. I21, I22, I28

¹ We gratefully acknowledge comments from participants in seminars and conferences in which this paper was presented, namely the 2019 Association for Education Finance and Policy (AEFP) Conference (Kansas City) and IRVAPP (Trento). The usual disclaimer applies.

1. Introduction

In many European countries, equality of opportunity in the access to Higher Education (HE) is perceived as a fundamental right of individuals within the larger concept of Welfare State. The access to HE is free in many cases and, even when fees are charged, they are very low when compared with those in place in the United States of America or the United Kingdom. When the performance and competitiveness of European universities is debated, the issue of generating enough resources for funding HE activities (including through fees) is a key one (Aghion et al., 2010), but the general view is that access to HE should not be prevented to individuals because of financial constraints. In some countries, such as Italy, this is even written in the Constitutional Law.² In this context, there is a particular attention to develop financial aid packages aiming at maintaining equality of opportunities.

Once accepted that financial aid is a potentially relevant tool for increasing equal access to HE, it remains to be assessed whether it can also be considered as efficient in promoting academic success for the most disadvantaged students. The efficiency goals are generally pursued by the introduction of a merit-based component in student aid: receiving financial aid is conditional on a student's satisfactory academic progression (SAP).

Concerns about efficiency and equity motivate policymakers to understand the role of performance requirements in need-based aid. This is an important issue raised in the existing literature that suggests that the introduction of merit-based student aid may produce unintended effects. In particular, in the attempt to raise the efficiency of student aid, too high merit requirements may cause some students to fail them and lose financial support. The stronger financial constraints, in turn, may lead some of these students to drop out from HE, or to other undesirable behavioral responses such as credit constrained students not enrolling in the most academically demanding majors (e.g. STEM) and institutions, which on average are also those mostly rewarded in the labor market (see Griffith 2011, Sjoquist and Winters 2015). To put it in other words, the introduction of strong merit-based requirements may increase efficiency of student aid but at the cost of harming equality of educational opportunities (*equity-efficiency trade-off*).

Student aid always comes as a package, and in studies assessing the effect of financial aid on student performance it is difficult to disentangle the effect of the "need" component from that of the "merit" component. Indeed, the previous literature is mostly focused on estimating the causal effect of student aid on academic performance, using non-recipients as a "control" group (see Section 3). However, in the current paper we leverage a policy change in 2011, when the Regional government of the most populous Italian region (Lombardy) decided to raise the merit requirements for students to become eligible for a university grant (while the need-based requirements remained practically unchanged). In this paper, we draw from this reform to explore the consequences of tightening the merit requirements on need-based student

² Article 34. "Schools are open to everyone. Primary education, given for at least eight years, is compulsory and free of tuition. Capable and deserving pupils, including those lacking financial resources, have the right to attain the highest levels of education. The Republic renders this right effective through scholarships, allowances to families and other benefits, which shall be assigned through competitive examinations" (Italian Constitutional Law).

aid for the cohorts of students enrolled at the Politecnico di Milano (PoliMi) after the policy change. Specifically, we use a difference-in-differences (DiD) approach to evaluate whether eligible students in cohorts enrolled after the reform experienced changes in academic performance because of the reform itself – namely, due to tightening the merit component of the financial aid (as separate from criteria based on financial need).

In our analysis, we assess the causal impact on a set of short and long-run academic outputs, such as the performance in the first year of bachelor (number of formative credits passed and grades obtained in the first year), retention and credits/grades later in the academic career, probability of graduation and on-time graduation, i.e. within the legal duration of course which is three years. Our analysis focuses on first-time-in-college students enrolled in a bachelor's degree (BA) at PoliMi between the years 2008 and 2013; we follow these cohorts of students until 2017 (the legal duration of BA courses is three years).

PoliMi is a very interesting case to be studied. It is a prestigious, selective public university (ranked #1 for Engineering in Italy, and among the top 20 in Europe) and, therefore, the students have a high level of intrinsic motivation.

The main results of this study, concerning the analysis of cohorts before and after the reform that changed the eligibility criteria (increasing the requirement for the merit-based component) leads to an important conclusion: the policy had a positive and statistically significant impact on several dimensions of academic performance of the treated students. Specifically, they obtain higher grades in their first year, and accumulate more credits both in the first year and later in their academic career; positive effects are also recorded on longer-term outcomes, such as on the probability of obtaining the BA degree on time. This is a very important result, since in Italy many students delay graduation because the system allows them to get better grades while staying longer (i.e. repeating exams until getting the desired grade).

However, the effects are heterogenous and we find that the most of these effects are concentrated among high-ability students, namely those who received a higher score in the admission test. By contrary, the increase in the credit requirement had a negative effect on the probability of the least able students in student aid to re-enroll at the second year. Moreover, quite interestingly, consistent with the theoretical expectation, we also find a “cream skimming” effect in the most recent cohorts investigated, i.e. an increase in the average ability of students in aid, who are also the low-income students, after the reform.

The results obtained by this study are particularly important in the context of Italian and European HE. First, they demonstrate that financial aid packages can be an important tool to help students in their first years of the academic journey. Second, although increasing merit-based requirements can provide the right incentives to disadvantaged students for succeeding in their HE experience, our analysis demonstrates highly heterogenous effects by students' levels of ability, showing that increasing efficiency may come at the cost of also amplifying educational inequalities. Indeed, we find that the reform reduced the re-enrolment probability of low-ability low-income students.

Overall, the main message is that design of financial aid matters: effectively balancing criteria based on financial need and merit could be the key of success for guaranteeing equality

of opportunities for disadvantaged students but at the same time a high efficiency of student aid.

This paper is organized as follows. Section §2 describes the institutional background, namely the financial aid system in the Italian Higher Education system. Section §3 reviews the most important academic literature about the effects of merit-based financial aid on HE students' performance in Europe and USA. Section §4 provides a simple conceptual framework in which discussing the effects of financial aid packages. Section §5 presents the data and the econometric approach. Section §6 contains the results from the empirical analyses and Section §7 some robustness checks. Section §8 critically discusses the main findings and concludes.

2. Institutional background: the financial aid system in Italian Higher Education, Politecnico di Milano and the policy change in 2011/12

In Italy, the role of financial aid in advancing equality of educational opportunity is crucial. The Italian financial aid system is regulated at the national level financial and called *Diritto allo Studio Universitario* (DSU, hereafter). "DSU-aided" students are those receiving the grants under the national financial aid system. Overall, around 13% of all the students enrolled in Italian universities receive a grant. When national financial resources are not available to cover all eligible students, some universities allocate their own money to fill the gap. PoliMi allocates between 3 and 5 million € every year for this purpose, guaranteeing that 100% of its eligible students receive the grant. This is an important feature of the aid mechanism; in cases like the PoliMi's one, it is likely that the institutional attention to the effectiveness of grants is higher. As a substantial amount of money is allocated by the university itself, it constitutes a potential factor of student attraction.

The financial aid package have three components: grants, free lunch and housing. Grants are by far the major component of financial aid; indeed, in addition to a financial transfer per year, eligible students are exempted from tuition fees. The amount of the grants depends on whether the student lives in the city where the university is located (*in sede*), if she is supposed to commute to reach the city (*pendolare*) or if she is out-of-site student (*fuori sede*). In the years covered by this study, the minimum amount of the grant was an average around 2,000€, 3,000€ and 5,000€ for the three categories, respectively (every year, the amount is determined by a national government's decree, and updated to be aligned with inflation). Grants are assigned on the basis of financial need when the students enroll for the first time at a bachelor or master course. Applicants' financial need is assessed through an index that is an equalized economic situation indicator (called ISEE), which is computed on the basis of a student's family income, assets and composition. The threshold for eligibility is set by the national government on a yearly basis. The application is submitted to the university, and eligibility is communicated and confirmed some weeks after enrolment (usually, in October while classes start in September).

In order to maintain aid eligibility after the first year of enrollment, students need to meet merit requirements (number of formative credits passed in a given academic year) as well as maintaining need-based eligibility. The national regulation identifies the threshold for

maintaining eligibility in the second year at 25 credits (out of 60), to be obtained before August 10th (so, before the last window for exams of the first year, which is in September). It is worth noticing that students who did not obtain at least 10 formative credits before the deadline of November 30th not only are not eligible in the second year, but they should pay back to the university the grant received. In this perspective, the merit requirement is a high-stake incentive towards academic results, in the first year. The number of credits to be obtained before August 10th of second and third year, to maintain eligibility in subsequent academic years, are 80 and 135 respectively – so, after the first year, the students are expected to acquire 55 credits (out of 60) every year.

In 2011, the Lombardy Region (Northern Italy, where PoliMi is located) introduced a change in the financial aid system, starting to operate in 2011/12. The Regional government reached an agreement with the universities to allow them to increase the merit requirement for maintaining eligibility for grants in the second year. After analyzing the data about student performance in the past years, the government communicated to universities that the average number of credits obtained by all students (DSU-aided and not aided) was around 35 (out of 60) in the previous three years; the information has been suggested as a benchmark for those universities which would decide to modify the merit-based criteria for grants.

As a result, PoliMI set a new threshold for maintaining the aid eligibility in the second year, increasing it from 25 to 35 (out of 60) credits for individuals who entered as first-year bachelor or master students – and since then on. The number of credits earned to maintain the grant in the second and third year remained unchanged at 80 and 135 credits, respectively. At the same time, PoliMI agreed with students' unions that it would have allocated money to provide grants to all the eligible students, even in case that national and regional funds would not suffice (something that systematically happened every year). The policy and institutional rationale of this choice was that this increase in merit-based requirements would have stimulated grant-recipients to study harder and to obtain their formative credits more rapidly, possibly with a long-term effect of making them able to earn their bachelor more quickly and on time (i.e. within the legal duration of study, three years). All the other rules remained virtually unchanged: the income threshold for obtaining the grant in the first year and maintaining it over time, the amount of the grant (except for the inflation adjustment), exemption from fees, etc.

Some notes are useful about the practical way in which the administrative process of assigning grants actually works at PoliMi. In their first year, students apply for the grant directly to the university in June/July before the start of the academic year; classes start in September. Students receive provisional information about the obtainment of the grant (i.e. eligibility) in October, and then a final confirmation in December. At that moment, the students receive the first half of the grant. Students are then evaluated on August 10th; if they meet the threshold related to the number of credits, they also receive the second half of the grant at that moment – otherwise, they are not eligible for that transfer anymore. If instead students reach the objective of acquiring the required number of credits, they are automatically eligible for the grant in the subsequent year and receive the cash transfer (first half) in September. In case the family's economic situation changed in a substantial way, the students must communicate this and a new assessment is carried out, to verify that they still maintain the eligibility related

to the financial criteria. As anticipated above, the students in the first year also have an additional requirement to fulfil; if they do not reach the merit threshold of the credits to be obtained before August 10th, they are scrutinized again on November 10th. If at that date they do not obtain at least 10 credits, they must also pay back to the university the amount received since then – i.e., the first cash transfer of the grant.

The design of the reform offers a unique setting to test whether a change, limited to the merit component of the grant, had an effect on the performances of students after the introduction of the policy. This paper aims to explore this issue, by employing a difference-in-differences methodology comparing cohorts of students before and after the reform.

3. Related literature

The existing economic studies that aim at evaluating the effects of receiving financial aid on students' performance are mostly concentrated in the USA context. They typically refer to single programs, implemented in given States or universities, and aim to estimate the effects on aid recipients using a series of indicators of academic performance, such as retention, on time graduation, GPA, reduction of drop-out, etc. Particular attention is also paid to the specific features of the financial aid programs, following the intuition that design matters in making some programs working more effectively than others. In reviewing the ample literature in the field, we then focus on those contributions that are designed to better disentangling the effects due to differences in the aid design, and specifically the role exerted by need-based or merit-based incentives. The importance of financial aid's design has been particularly stressed in the notable work of Dynarski & Scott-Clayton (2013). The authors provide an extensive review of the academic evaluations about the effects of financial aid programs for university students in the USA. The authors provide clear evidence that aid increases access to postsecondary education, and at the same time its design matters for effectiveness after enrolment. Specifically, the mentioned study suggests that merit-based incentives within the grant/aid systems are helpful for stimulating better performance of eligible students.

Implications for the equity of the whole HE system have been clear and decisive since the development of empirical research in this area. For example, Alon (2007) used the College & Beyond Database focusing on the most selective colleges and universities in the USA, to explore whether financial aid can increase the probability of black and Hispanic students to complete tertiary education. Analyzing data between 1995 and 1997, and adopting an empirical strategy based on Instrumental Variables, the authors finds that receiving a grant or scholarship can actually increase the probability of these subgroups of students to succeed – namely, to complete college and obtain graduation.

Dynarski (2003) is one of the first academic evaluations of the effects of financial aid on students' performance – namely on college attendance and completion. Until that moment, indeed, most studies looked at the role of financial aid in stimulating enrollment, not academic results. The author here employed a difference-in-differences approach to assess whether the removal of a Federal program for student benefits was detrimental for eligible students' results – and actually she finds it was the case. Data cover the period between 1979 and 1983 for a sample of American students.

A more rigorous evaluation of the role of merit-based incentives is conducted by Scott-Clayton (2011). The author analyzes the program PROMISE, implemented in West Virginia (with data from 2001 to 2004). PROMISE offered free tuition to students with a certain level of GPA. The strategy of analysis is based on a regression discontinuity design, and findings highlight that the financial aid system was able to raise the academic results of recipients. Given the features of the empirical exercise, the author can claim that the mechanism behind the (positive, and statistically significant) effect is related to the merit-based components of the formula for attributing eligibility – and not to the removal of the financial constrain.

Not all the empirical evidence in the field relates to the case of USA, however. In the last decade, there is also growing interest in Europe, where researchers started to rigorously evaluate the impact of financial aid programs (and their reforms) in a number of EU countries.

Belot, Canton & Webbink (2007) took advantage of the financial system's reform in the Netherlands in the late nineties, which reduced the duration of aid (i.e. the number of years that a beneficiary can receive the grant). The authors use a difference-in-differences empirical method to assess the impact of this reform, concentrating on cohorts of students between 1995 and 1997 (one year before and after the reform itself). They find positive effects on students' performance, namely lower propensity to switch to other programs and higher ability of obtaining higher grades. In this circumstance, a clear merit-based modification of the rules for obtaining grants helped the financial aid system to work more efficiently and effectively. The effect estimated is a short-run one, though.

The role of merit-based financial incentives has been explored in a randomized trial conducted in the University of Amsterdam in 2001/02. A sample of first-year students were eligible to receive a cash amount if they pass all their exams in the year. The results of the experiment, reported by Leuven, Oosterbeek & van der Klaauw (2010) reveal that the incentive had a positive effect on high-ability students and a negative effect on the low-ability ones³. This study, albeit interesting to reflect on the merit-based components of financial interventions, cannot be generalized to the problem of designing grants as it was not properly a financial aid – but instead a “pure incentive” (i.e. a performance-based incentive).

Arendt (2013) evaluates the effects of the reform of the Danish financial aid program in 1998, that increased the amount of grants substantially (>50%). Using administrative data for a sample of Danish students between 1984 and 1991, and employing an econometric method based on hazard model, the author finds that eligibility for grant reduced the probability to dropout substantially but had no effects on completion rates. The effect was particularly high but concentrated on students with a very disadvantaged family background.

Gunnes, Kirkeboen & Ronning (2013) study a policy conducted in Norway between 1990 and 1995, when certain students received a financial reward for on-time completion of their tertiary studies. Within a difference-in-differences framework, the authors assess that the

³ A similar experiment conducted in a Canadian campus led to quite different results. The incentive was designed to offer cash incentives for course grade above 70, i.e. to stimulate a strong merit level. The results reported by Angrist, Oreopoluos & Williams (2014) indicate no strong effects of this incentive scheme, with null effect on GPA specifically.

average delay in graduation decreased substantially due to the aid (incentive, merit-based) effect.

The contribution by Montalban (2017) is the one that shares more similarities with the approach proposed in our paper. The author evaluates the effects of the Spanish national grant program on academic results, using administrative data for the University Carlos III in Madrid (cohorts of students from 2010 to 2015); the empirical strategy adopted in the paper is based on regression discontinuity. A particular feature is that the program changed after 2012, with an increase in the merit requirement for eligibility. This way, the analysis can judge whether the eventual effects on academic performance stem from merit or need-based requirements. The author demonstrates no effects for the baseline version of the program, which starts instead exerting a positive and statistically significant influence on academic performance after the increase of a stronger merit component.

Summing up, the bulk of existing literature about USA and Europe (and the small one on Italy) suggests that financial aid programs can have positive effects on students' performance – at least, if carefully designed for including some merit-based incentive. This general result is particularly relevant from an equity viewpoint, as the recipients of aid are usually the students with a disadvantaged socioeconomic background. The design of the interventions matters for determining its specific effects. Deming and Dynarski (2009) already revealed that reducing costs for attending universities can increase the attainment of poor students (they surveyed the existing programs in the USA until that moment), and at the same time they indicate that introducing merit-based incentives can make such effects stronger.

In the current paper, we seek to provide more knowledge about the role of merit-based components for financial aid, in the context of less-studied case of European HE (and Italy's in particular).

4. Conceptual framework

In this section we outline a simple conceptual framework to analyze the potential effects of changing the merit-based requirements of student aid on student academic performance.

We assume that an individual, who may be eligible for student aid according to her family income level (i.e. the *need-based requirement*) and decides to enroll in higher education, maximizes a two-period utility. In the first period the individual studies and consumes; in the second period she only consumes. In the first period consumption can only be financed through family transfers and student aid, while the student cannot work, while in the second period she can consume only out of her labor incomes. We assume that there is no unemployment, i.e. a student is sure to find a job, and that labor supply and the number of hours worked are fixed.

The student receives financial aid only if her academic performance is above a given cutoff g^m , where m stands for “merit”. This is the *merit-based requirement* of student aid. We assume that the academic performance function is linear in student ability (a_i) and student effort (x_i), and also depends on an individual shock u_i , with mean zero, density function $f(u)$ and distribution function $F(u)$. The shock may reflect “luck”, e.g. the fact that an exam was easy or difficult, or that the student was assigned to a class with a “tough” or a “generous” (in terms of grading) instructor. Thus, the academic performance function (or grade generating

function) reads as $g(x_i, a_i, u_i) = \beta_0 x_i + \beta_1 a_i + u_i$. The probability that a student's performance is above the merit-based requirement therefore reads as

$$\begin{aligned} \Pr(\text{aid} = 1) &= \Pr(g(x_i, a_i) > g^m) = \Pr(\beta_0 x_i + \beta_1 a_i + u_i > g^m) \\ &= \Pr(u_i > g^m - \beta_0 x_i - \beta_1 a_i). \end{aligned}$$

We also assume that in order to get a degree, students must perform above a minimum requirement \underline{g} , that is the probability of graduating is

$$\begin{aligned} \Pr(\text{degree} = 1) &= \Pr(g(x_i, a_i) > \underline{g}) = \Pr(\beta_0 x_i + \beta_1 a_i + u_i > \underline{g}) \\ &= \Pr(u_i > \underline{g} - \beta_0 x_i - \beta_1 a_i). \end{aligned}$$

Having a performance below the cutoff \underline{g} means failing to graduate. We assume that the labor market only rewards individuals attaining the final qualification, i.e. there are no returns from being a university drop out compared to individuals who never enrolled at university. The university graduates' wage in the labor market is $B(x_i, a_i)$ and depends on effort and individual ability. For the sake of simplicity, we focus on the long-run returns in the labor market and assume that employers will be able to discover quite soon which part of grades were determined by "luck", and therefore do not reflect student (and future worker) productivity. For this reason, graduate wages are assumed to be a function of effort and ability, and not of grades.⁵

The student income in the first period is m_{0i} if she does not get student aid and $m_{0i} + m_{1i}$ if she does, where m_{0i} is the family transfer and m_{1i} the amount of the scholarship. Both are indexed on the individual i since they are likely to depend on family income (i.e. family background). The two also correspond to first period consumption, with and without the scholarship, respectively. β is the inter-temporal discount rate, that we assume to be the same for all individuals.⁶

We also assume the period utility is linear in consumption, namely $u(C_{1i}) = C_{1i}$ and $u(C_{2i}) = C_{2i}$, where C_{1i} and C_{2i} are first and second period consumption, respectively. Moreover, the individual must bear some direct monetary costs of enrolling in higher education (c_m) and some non-monetary costs $c(x_i, a_i)$ of effort, that are increasing in effort and decreasing in ability ($\frac{\partial c}{\partial x_i} > 0, \frac{\partial c}{\partial a_i} < 0$).

⁵ However, employers may not have enough information to assess individual productivity when graduates first enter in the labor market.} In case the individual enters the labor market in the second period without a university degree she earns the low skilled wage w_L .

⁶ The inter-temporal discount rate may also depend on the student family background. For instance, individuals coming from less privileged backgrounds may have higher inter-temporal discounting.

Putting all the pieces together, we get an individual's expected utility

$$\begin{aligned}
 U^S(x_i; g^m, a_i, m_{0i}, m_{1i}) &= \underbrace{\Pr(\text{aid} = 1) (m_{0i} + m_{1i}) + [1 - \Pr(\text{aid} = 1)]m_{0i}}_{\text{expected first period consumption}} + \\
 &\quad \underbrace{-c_m - c(x_i, a_i)}_{\text{cost of education}} + \\
 &\quad + \underbrace{\beta\{\Pr(\text{degree} = 1) B(x_i, a_i) + [1 - \Pr(\text{degree} = 1)] w_L\}}_{\text{expected second period consumption}} \\
 &= m_{0i} + \left[\int_{\gamma_i^m}^{+\infty} f(u_i) du_i \right] m_{1i} - c_m - c(x_i, a_i) + \beta w_L + \\
 &\quad + \beta \left[\int_{\underline{\gamma}_i}^{+\infty} f(u_i) du_i \right] [B(x_i, a_i) - w_L]
 \end{aligned}$$

where $\gamma_i^m \equiv g^m - \beta_0 x_i - \beta_1 a_i$ and $\underline{\gamma}_i \equiv \underline{g} - \beta_0 x_i - \beta_1 a_i$.

The individual has to decide the optimal level of effort that maximizes her utility.

The first order condition (FOC) reads as

$$\frac{\partial U^S}{\partial x_i} = \beta_0 m_{1i} f(\gamma_i^m) + \beta \beta_0 f(\underline{\gamma}_i) (B(x_i, a_i) - w_L) + \beta \left[\int_{\underline{\gamma}_i}^{+\infty} f(u_i) du_i \right] \frac{\partial B}{\partial x_i} - \frac{\partial c}{\partial x_i} = 0$$

i.e. at the optimal effort level the marginal benefits equal the marginal costs of effort

$$(1) \quad \beta_0 m_{1i} f(\gamma_i^m) + \beta \beta_0 f(\underline{\gamma}_i) (B(x_i, a_i) - w_L) + \beta \left[\int_{\underline{\gamma}_i}^{+\infty} f(u_i) du_i \right] \frac{\partial B}{\partial x_i} = \frac{\partial c}{\partial x_i} .$$

The first term on the left-hand-side (LHS) is the increase in the expected utility determined by the increase in consumption that effort allows to achieve in the first period, by increasing the probability of meeting the merit-based requirements; the second term in the LHS is the increase in second period consumption determined by the increase in the probability of graduation, in turn caused by an increase in student effort, with the same level of labor market returns ($B(x_i, a_i) - w_L$); the third term is the increase in second period consumption enabled by higher returns in the labor market (i.e. an increase in $B(x_i, a_i)$) generated by higher effort, for the same level of the graduation probability.

Using the implicit function theorem, we can sign the effect of increasing the merit-based requirements of student aid on student's optimal effort:

$$\frac{\partial x_i^*}{\partial g^m} = - \frac{\frac{\partial f(\gamma_i^m)}{\partial g^m} \beta_0 m_{1i}}{\frac{\partial^2 U^S}{\partial x_i \partial x_i}}$$

with the denominator (i.e. the second derivative of the utility function with respect to x_i computed at the optimum) that must be less than zero for the second order condition for a maximum to be satisfied.

Thus $\text{sign}\left(\frac{\partial x_i^*}{\partial g^m}\right) = \text{sign}\left(\frac{\partial f(\gamma_i^m)}{\partial g^m}\right)$ and the sign depends on the properties of the density function $f(u)$ and the point in which the derivative is computed (γ_i^m).

For instance, if we assume that u is normally distributed with mean zero, that is average luck shocks are more frequent that very positive or very negative shocks, then we get that the optimal effort is likely to increase for high ability students (say a_h), for which the density function is likely to be increasing (i.e. γ_i^m is very low, see Figure 1). On the contrary, the optimal effort is likely to decrease for low ability students (say a_l), for which the density function is likely to be decreasing (i.e. γ_i^m is very high, see Figure 2). A reduction in the optimal effort of low ability students with a higher g^m also unambiguously implies, *ceteris paribus* (i.e. for the same \underline{g}), an increase in their probability of failing to graduate.⁷

Our simple theoretical framework also enables us to investigate the effect of an increase in g^m on the ability of the marginal student that enters higher education. The utility from not enrolling in higher education (i.e. “low-skilled” utility) is $V^L = (1 + \beta)w_L$, where we have assumed that an individual receives family transfers in the first period only if she enrolls in higher education.

Since V^S is monotonically increasing in ability⁸ while V^L is not (i.e. it is constant), there is a level of ability above which V^S (i.e. the “high skilled” value function) becomes higher than V^L (i.e. the “low skilled” value function), this is the level of ability of the marginal student entering higher education.⁹ Thus only higher ability students enroll in higher education.

How does an increase in g^m change the ability of the marginal student? Since the “high-skilled” utility function is decreasing in g^m (an increase in the merit-based requirements decreases the probability of receiving the scholarship m_{1i} and therefore expected consumption

⁷ In this model we do not introduce heterogeneity in higher education institutions. In case one allows for differences in academic standards (e.g. \underline{g}) across institutions, then dropping out from an institution may not necessarily imply dropping from the higher educational system. A student may simply enroll in a “easier” major or institution, i.e. one with lower standards. In our data, which comes from a single institution, we will not be able to distinguish between the two hypothesis that students change major or higher institutions or simply drop out from tertiary education in response to increasing the merit-based requirement.

⁸ Indeed, $\frac{\partial V^S}{\partial a_i} = \frac{\partial U^S}{\partial a_i} = \beta_0 f(\gamma_i^m) - \frac{\partial c}{\partial a_i} + \beta f(\underline{\gamma}_i) [B(x_i, a_i) - w_L] + \beta \left[\int_{\underline{\gamma}_i}^{+\infty} f(u_i) du_i \right] \frac{\partial B}{\partial a_i} > 0$ under the assumption that $B(x_i, a_i) > w_L$.

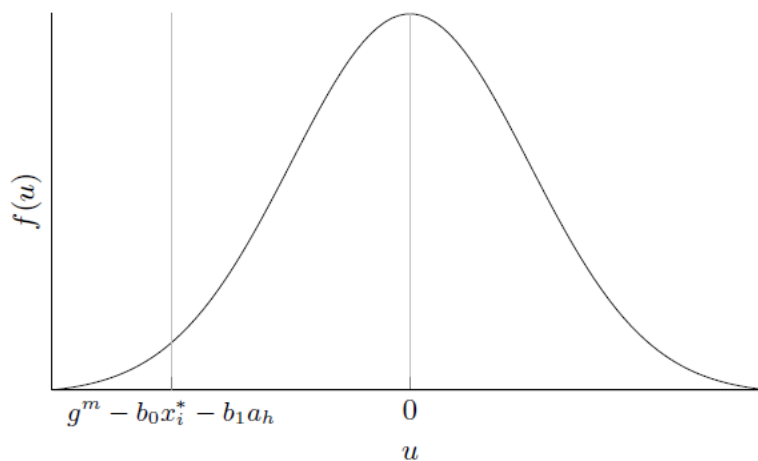
⁹ We assume that the two value functions have a crossing point, i.e. $V^S(x_i^*; g^m, a_i = 0, m_{0i}, m_{1i}) < V^L$, i.e. the lowest ability level individual is better off by not enrolling in higher education than by doing it.

in the first period),¹⁰ an increase in g^m produces a downward shift of the “high-skilled” value function, and therefore an increase in the marginal student's ability. To put in other words, an increase of merit-based requirements produces *cream skimming* of (low income) students by ability.¹¹

Until now, we have considered the utility maximization problem of an individual potentially eligible for student aid according to family income. What about students coming from high income families? Their FOC, i.e. equation (1), does not include the first term on the LHS, i.e. their first period consumption does not depend on satisfying the merit-based requirements.¹² Therefore, we do not expect any effect of changing g^m on their academic performance.¹³ Similarly, we do not expect any *cream-skimming* effect on enrollment of high income students.

To recap, our simple conceptual framework predicts the following three empirical facts from raising the merit-based requirements of student aid: 1) an increase in the (marginal and) average ability of low income (i.e. eligible for student aid) students; 2) an increase in effort and student performance of low income high ability students; 3) an increase in the probability of drop out of low income-low ability students.

Figure 1. High ability individual



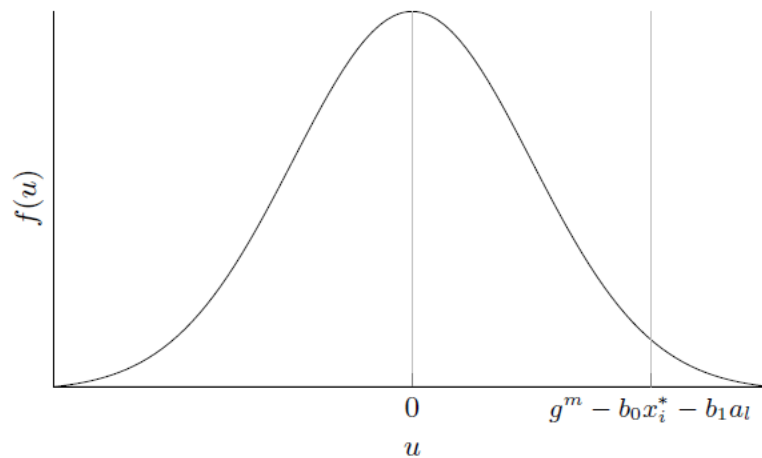
Note. The figure shows the minimum level of the shock u above which a high ability individual satisfies the merit-based requirements in case u is normally distributed with mean zero. An increase in g^m is likely to increase $f(u)$.

¹⁰ Indeed, $\frac{\partial v^S}{\partial g^m} = \frac{\partial U^S}{\partial g^m} = -f(\gamma_i^m)m_{1i} < 0$.

¹¹ This positive selection effect partly compensates the increase in the probability of drop out of low income and low ability students that we have explained above, leading to a lower increase in drop out that we would have observed otherwise.

¹² Under the assumption that family transfers are unrelated to student performance.

¹³ We refer to the Italian case where grading is generally in absolute terms, i.e. an individual's grade does not depend on her performance compared to her class mates. With relative grading, instead, also high income students' performances could be affected.

Figure 2. Low ability individual

Note. The figure shows the minimum level of the shock u above which a low ability individual satisfies the merit-based requirements in case u is normally distributed with mean zero. An increase in g^m is likely to decrease $f(u)$.

5. Data and Methodology

Data

This paper uses administrative data obtained from the Politecnico di Milano.¹⁴ PoliMi's student data-tracking system is very comprehensive and allows us to control for background characteristics (including admission test scores, as obtained in a standardized test obtained during secondary school), information on financial aid received, and transcript and degree information such as year-by-year college enrollment (credits attempted/completed, year and cumulative GPA). One thing the financial data do not include before 2013 is the amount of financial aid and income eligibility measures (e.g., ISEE). However, even in these years we observe an indicator of financial aid reciprocity and university fees tuition levels, and we use this last piece of information in the empirical model as a proxy of socio-economic background (as explained in the subsequent sections).

We focus on first-time in college BA students who entered PoliMi between the 2008/2009 and 2013/2014 academic years, and we follow these cohorts until 2017/2018. We further limit the sample to students who entered PoliMi when they were between 17 and 25 years of age (i.e. non-mature students). Across these six cohorts we have about 49,011 observations, which is the baseline sample used for the descriptive analysis and the econometric analysis based on difference-in-differences.

For each student, the outcome variables of interest were identified at two points in time: (i) short-term academic outcomes measured at the end of their first year of enrollment and

¹⁴ We are grateful to the Offices for Student Support and for Informative Systems who provided us the data and help in cleaning and interpreting the dataset.

persistence from first to second year, and (ii) long-term academic outcomes measured in the last year of enrollment or within three years of enrollment. Long-term academic outcomes for the pre-policy period are estimated only using the 2008 cohort of entrants to avoid contamination (i.e. partial exposure to the policy change) in the treatment status due to the policy change being introduced in 2011 (N=29,070).

Table 1 displays descriptive statistics separately for the periods before and after the change in the merit component of the DSU financial aid program. Almost 4% of the sample received DSU during their first year of enrollment – we label them “DSU-aided” students. DSU-aided students tend to be younger and have higher admission scores. As the last column shows, during the period of analysis there is a statistically significant positive increase on the admission test scores of DSU-aided students. Students receiving DSU are differentially trending towards better pre-college ability. This evidence is consistent with the theoretical prediction of our conceptual framework: since students know the rules of the student aid package, as they apply for aid at the time of enrollment, a tightening of the merit-based component produces “cream skimming” of the low-income students. That is, among the low-income students, relatively abler students enroll at PoliMI after compared to before the reform. Although this is an interesting outcome per se, demonstrating an inequality-enhancing effect of strengthening the merit-based requirement, on the other hand it may confound the effect estimated with DiD, changing the composition of the student cohort in terms of observable, and potentially unobservable characteristics, associated with student performance. We address this potential concern in the next section. In particular, in addition to controlling in all models for the entry test scores, we also estimate heterogenous effects by level of ability. Moreover, in the robustness checks we also apply a semi-parametric DiD model (STILL TO BE DONE), which corrects for potential differences in the student cohort composition.

We consider several outcome variables; some can be considered short-term academic outcomes and others as longer-term measures of academic achievement. The short-term outcomes we examine include first-year credits attempted and earned and GPA; and persistence into the second year. As longer term academic outcomes, we examine repetition, on-time (three-year) BA completion, cumulative GPA and credits earned, excess at the five year follow-up.¹⁵

The statistics computed on raw data shown in Table 1 already hint to some positive effects of the reform on student performance. In particular, in the short run there was a reduction in the probability of being an inactive student, and increases in the number of credits achieved and GPA. In the longer term, the reform seems to produce increases in the probability of on-time graduation and the cumulative number of credits achieved.

[Table 1] around here

As anticipated, the aim of this paper is estimating the effect of changing the merit requirement of the DSU program from 25 to 35 credits (i.e. 40% at the baseline). Such change is equivalent to passing an additional course in the first year (in the first year, most courses are

¹⁵ Repetition is equal to 1 if the student ever repeated an academic year; excess credits is equal to 1 if the student accumulated excess credits at the five year follow-up.

10 credits, with a teaching load of 100 classroom hours) to meet the DSU renewal requirements. The paper uses three cohorts of students before (from 2008 to 2010) and three cohorts after (from 2011 to 2013) this merit requirement changed. We then compare students' short-term academic outcomes at the end of their first year of enrollment. As previously noted, for long-term academic outcomes we only use the 2008 cohort as the pre-policy cohort since the following pre-policy cohorts are likely to be partially treated (i.e. exposed to the new system).

Methodology

A DiD approach enables us to make a comparison between DSU aided and non-aided students before and after the policy change. We estimate the effect of changing the merit requirements of the DSU program on average first-year college outcomes such as GPA, credits attempted and earned, as well as first to second year persistence using the following DiD model:

$$Y_i = \alpha + \beta DSUAided_i * After_i + \delta CohortFE + \sigma DSUAided + \gamma X_i + u_i \quad (1)$$

where Y_i represents the outcome of student i . $After_j$ is a dummy variable that takes the value of 0 if the student entered for the first time at PoliMi between 2008 and 2010, and 1 if the student entered between 2011 and 2013. $DSUAided_j$ takes the value 1 if student received the DSU grant at first entry and 0 if the student did not meet the income eligibility requirements to receive financial aid. $CohortFE$ is a vector of cohort fixed effects, and X_i is a vector of student-level covariates that controls for demographic and pre-college ability and u_i an idiosyncratic error term. Covariates include dummy variables for female, Italian, and admission test scores. The same equation is used for long-term outcomes but only using the earliest cohort of entrants. β is the DiD effect of interest.

The critical identifying assumption in the DiD approach is that the coefficient on the interaction term from Equation (1) would be zero in the absence of the policy change. Pre- and post-policy cohorts of students may be different, and within each cohort, DSU aided and non-aided students may be different; but it cannot be the case that there is something different about being a post-policy student receiving a DSU grant, other than the new merit requirement. To put it in other word, trends in academic achievement of pre-policy cohorts should provide good predictors of what would have happened in the absence of this financial aid reform in the post-reform period. Basically, trends in grades and credits earned should not differ pre- vs. post-policy change. Moreover, since we used pooled cross-section, another condition to apply DiD is that the composition of sample should not have changed across cohorts. To test these assumptions, we provide some graphical evidence of the common trend assumptions in figures 1-3. The stability of the sample is instead tested in Table 1.

As previously noted, it seems that students receiving the DSU grant are relatively getting slightly better admission test scores (about 5 point higher). For this reason, this background characteristic is included as a control variable in the analysis. This may not be enough, if the DiD effects are heterogenous by individual characteristics (e.g. individual ability). For this reason, in the following sections we will report some effect heterogeneity analysis by

individual ability and also apply a semiparametric DiD, after matching the pre- and post-policy samples by individual observable characteristics (STILL TO BE DONE).

Yet, the parallel trend assumption may also be invalidated by unobserved differences between DSU aided and non-aided students. To test this, Figures 1 to 3 show pre-trends to assess if there were differential pre-treatment trends in credits earned and GPA during the first year of enrollment and persistence rates. Overall, the trends in short-term academic outcomes strongly changed after the policy change was implemented, while no striking different trends can be detected looking at the years before the policy change (i.e. 2008-2010).

[Figures 1, 2 and 3] around here

Finally, the parallel trend assumption also implies that in the absence of the policy change students receiving the DSU grant would have been exposed to the same institutional policies or environment as the students who did not receive the grant. As we already mentioned, no other institutional feature of the aid system was touched by the reform (e.g. post first year credit requirements). The amount of the scholarships were only marginally increased, to adjust them to inflation.

6. Results

The baseline results for the estimation of the effects of the policy change on students' performance is reported in Table 2. In Model 1, the DiD estimation does not include individual-level controls, such as gender, ability (i.e. admission test scores) and immigrant status.

There is no change in the number of credits attempted; from the descriptive statistics, they were around 59.6 for cohorts before and after the policy change. By contrast, coherently with expectations and with the objectives of the policy change, we find substantial positive effects on short-term academic results. Indeed, treated students passed 3.2 credits more than the pre-reform cohorts in aid, on average – a positive increase of 6.5% if calculated at the mean level of credits obtained by DSU recipients before the policy (it was around 49, out of a maximum of 60). Also, aid-students in cohorts after the reform report a higher GPA in the first year – the positive effect is 0.28, on a scale of 18 (minimum) to 30 (maximum). Finally, there is not a statistically significant effect in the retention rate, probably because the retention rate of DSU recipients was already very high before the reform, at 91.2%. Overall, the positive effect of the increase in merit-based component of the grant eligibility seems stemming from an increase in the academic performance as measured from the total number of formative credits passed and average grade obtained in the first year.

It is worth noticing that the impact of the policy reform persists over time and is substantial in affecting longer academic results. Specifically, it reduces the probability to ever repeating a year by 8% - from 54% to 45% before and after the reform, respectively. Moreover, DSU recipients benefit of a relevant improvement in their ability of earning their bachelor degree on time: the effect is around 9 percentage points, or 20% as calculated at the mean level before the reform. Lastly, the effect on the cumulative credits at the end of the third academic year is also statistically significant, and equal to 6.5 (out of a maximum of 180).

Thus, our analysis demonstrates that the increase in the merit requirements created a positive incentive to DSU recipients to perform better (more credits acquired and better grades)

that extends after the first year, and is conducive to higher ability to accumulate credits over time and to obtain the BA degree more rapidly (i.e. more frequently on time). When including a set of covariates at student level, which control for individual characteristics (gender, immigrant status and admission test scores) the results are substantially confirmed (Table 2, Model 2). It must be noted that the estimated coefficients are slightly lower in magnitude, though (with the only exception of the average GPA at the end of the first year; the estimated effect is now 0.32, to be compared with 0.28 estimated when student-level controls are not included). Therefore, the academic outputs that are found to be impacted by the policy are the same identified through the Model 1.

[Table 2] around here

A graphical illustration of the policy's impact on the number of credits obtained in the first year is displayed in Figure 4. Its Panel (a) reports the distribution of credits earned by non-aided students before and after the reform, while the Panel (b) reports the same distribution for DSU-aided students. Vertical bars are set at the average level for the relevant subgroup of students. As it is evident, although the distribution remains stable for non-aid students, there is a right-shift in the distribution of credits obtained for DSU-aided students after the reform; the magnitude of this shift is the causal impact of the policy implemented as estimated through the difference-in-difference methodology. The figure shows a potential heterogeneity in the effects: the positive effects seem to be particularly important in the right end of the distribution (e.g. on the probability of achieving the maximum of credits, 60), i.e. for high ability students.

[Figure 4, Panels (a) and (b)] around here

7. Robustness check

Different control groups

With the aim of checking robustness of our results, we test our findings using different control groups, i.e. restricting the comparison to students who have some degree of socio-economic disadvantage. Indeed, it can be the case that estimates in Table 2 suffer of using too large a sample of students in the control group, introducing heterogeneity that stems from unobserved structural differences in the socioeconomic background.¹⁶ We use a particular feature of the fee system used at PoliMi, which consists in applying discounts to the fee level for students whose family has predetermined levels of income. Students and their families have the incentive to declare the income level, with the aim of obtaining a reduction in the fee to be paid upfront. Students are then classified in "tuition levels", ranging from 1 to 10 – from lower income level to higher ones. DSU-eligible students are all classified in the income levels 1 and 2.

¹⁶ Since student aid eligibility according to needs is based on family income and wealth, there might be too few overlapping between students if all students from all fee tuition levels are included in the analysis. To put it in other words, it is not possible to observe in the data high income students in aid, and therefore to separately identify the effect of low income and of student aid.

In [Table 3](#), we analyze the robustness of our results when progressively including as students in the control group only those classified in the tuition levels 3, 4, 5 and 6 (Model 3). All the estimations include student-level controls (gender, immigrant status, test score in the admission test). The results generally show the robustness of our baseline findings, although two differences must be highlighted. First, the magnitude of the estimated effects increase when “richer” students are included in the analysis. especially for the number of credits obtained in the first year. Second, the effect on average grades in the first year although is quite similar across columns, is statistically significant only when considering students in tuition levels 5 and 6.

Overall, the robustness check provided in [Table 3](#) is reassuring that results are not driven by specific peculiarities of DSU-aided students related with their socio-economic status; indeed, the results are still confirmed when comparing them with students from more similar backgrounds.

[\[Table 3\]](#) around here

Heterogeneous effects

Lastly, we explore whether the effects of the policy change are related with the different initial ability of students, i.e. if the policy has heterogenous effects over the distribution of student ability. For this purpose, we classify two different groups of students: “low ability” students are those whose admission test scores are less than 40.25 (25th percentile); “high ability” ones are those with a score higher than 76.2 (75th percentile). The results are presented in [Table 4](#); results are reported for Model 2, which includes individual-level controls. Interestingly, the effects are concentrated in the group of students with high ability. For them, also the magnitude of the reform’s impact is higher. For example, high-ability DSU-aided students have a GPA which is 0.4 point higher than non-treated students. Moreover, they are more likely to be enrolled in the 2nd year (+5.6%); this effect on retention is particularly relevant as it was not detected as an average effect on the whole population. This positive impact at the margin of decision to drop-out is however concentrated in the groups of high-ability disadvantaged students; indeed, the policy caused a negative impact on low-ability students, who are more likely to drop-out (the negative effect on retention is around -6%). Also, the effect on cumulative GPA holds only for high-ability students, while it is not statistically significant for their low-ability peers. It must also be noticed that the significant positive impact disappears when we consider the probability to earn a BA degree on time; it seems that high-ability students do not receive a stimulus towards graduating on time more than their less-able colleagues already do – this positive effect of the policy is then acting on all the DSU-aided students, as the average impact reported in [Table 1](#) and [Table 2](#) showed.

Overall, the findings reveal the effect heterogeneity of the policy. While the stimulus towards higher levels of performance benefit the subgroup of high-ability students, it constitutes an obstacle for low-ability students, and even cause a higher probability of dropping out.

[\[Table 4\]](#) around here

8. Discussion and concluding remarks

Merit-based requirements are a key feature of student-aid programs in many countries. While the need-based component of these programs helps more disadvantaged students to get access to higher education, the goal of merit-based requirements is to increase the efficiency of student aid, by raising student effort and performance.

Too high merit-based requirements, however, may induce some students to fail the standards set for aid renewal, and drop out from university. To put it in other words, merit-based requirements may create an “equity-efficiency trade-off”. Despite the importance of this issue, research studying the role played by merit-based requirements on student performance is still scant.

In this paper we aim to fill this gap using quasi-experimental evidence provided by a policy change that increased first-year credit requirements for student aid renewal by 40% in an Italian region. Our analysis on data from an Italian university shows that the reform increased student performance along several dimensions. Credits earned in the first year increased by 6.5% and first year GPA by about 1/3 of a point (over a maximum of 30 points). The effect was not limited to the first year but persisted over time, showing a reduction in the probability of being an “inactive student” of 7.2 percentage points and an increase in the probability of on-time graduation of 7.6 percentage points. On the other hand, our analysis of effect heterogeneity uncovers winners and losers from the policy. Indeed, in spite of the average positive effect of the policy change, the reform decreased the probability of low ability students (i.e those in the bottom quartile of the entry test score) of re-enrolling in the second year by about 6 percentage points.

Although our analysis shows some robust evidence on the effect of tightening merit-based requirements in a specific institutional setting, the results could not be easily generalizable to all contexts. On the one hand, the university considered in our analysis is located in the major town of Northern Italy (Milan), where students face very high costs of living. Thus, losing financial aid may be particularly harmful to students, which may drop out from university or relocate to other cities to continue in their tertiary education studies. This probably makes our results on low-ability students an “upper-bound” (in absolute value). On the other hand, the university we consider in our analysis, the Polytechnic of Milan, is a highly selective institution offering degrees in STEM majors, which command very high returns in the labor market, and attracting highly motivated and able students. This probably makes the positive results on high-ability student performance an “upper-bound” too. Thus, as a suggestion for future research, it would be useful to carry out similar analysis using data from other higher education institutions, or on the whole Italian higher education system, leveraging similar regional reforms to provide evidence on the level of generality of our results.

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Table 1. Descriptive Statistics (2008-2013 first-time in college BA Entrants)

	Before The Policy		After the Policy		Difference-in-Difference
	No DSU Aid	DSU Aided	No DSU Aid	DSU Aided	
<i>Background Characteristics</i>					
Female (%)	0.333	0.367	0.322	0.338	-0.018
Student is Italian (%)	0.958	0.788	0.955	0.816	0.030
Age at entry (Years)	19.329	19.526	19.351	19.304	-0.243 ***
Admission test score	58.939	58.798	60.960	65.999	5.179 ***
<i>Short-Term Outcomes</i>					
Credits Attempted, Year 1	59.621	60.077	59.666	60.146	0.025
Credits Earned, Year 1	44.769	49.276	44.694	52.611	3.410 ***
GPA, Year 1	24.071	24.337	24.050	24.612	0.296 **
Enrolled, Year 2	0.726	0.912	0.747	0.954	0.022
<i>Long-Term Outcomes</i>					
If ever repeated a year	0.453	0.543	0.447	0.454	-0.083 **
Earned a BA degree	0.715	0.906	0.646	0.857	0.020
Earned a BA degree, by Year 3	0.519	0.430	0.508	0.512	0.092 **
Excess Credits	0.217	0.332	0.183	0.283	-0.015
Cummulative GPA	24.221	24.570	24.260	24.709	0.100
Cum. Credits Earned	151	164	146	166	6.601 **
Number of Observations	19,575	780	21,978	678	43,011

Note: Summary statistics for the sample of students at Politecnico di Milano University from 2008-2013 who are between 17 and 25 years of age, enter for the first time as bachelors and are pursuing only one career. The sample size before the policy change for long-term outcomes is 6,149 for non-aided students and 265 for DSU recipients. This sample only includes the 2008 pre-treatment cohort to avoid contamination within the first three years of enrollment before the policy change. Sample sizes may vary for certain variables due to missing values. Statistical significance in the difference-in-difference column controls for cohort fixed effects.

*** $p < .01$, ** $p < .05$, * $p < .1$.

Table 2. DID Estimates of the Policy Change

Outcome	Model 1		Model 2	
	Coef.	(S.E.)	Coef.	(S.E.)
Credits Attempted, Year 1	0.024	(0.327)	-0.058	(0.328)
Credits Earned, Year 1	3.243	(0.618)***	2.510	(0.614)***
GPA, Year 1	0.285	(0.139)**	0.324	(0.138)**
Enrolled, Year 2	0.017	(0.014)	0.009	(0.014)
<i>N</i>		41,656		41,302
If ever repeated a year	-0.083	(0.037)**	-0.072	(0.037)**
Earned a BA degree	0.019	(0.023)	0.017	(0.023)
Earned a BA degree on time	0.092	(0.037)**	0.076	(0.036)**
Excess Credits	-0.015	(0.034)	-0.024	(0.034)
Cummulative GPA	0.100	(0.175)	0.145	(0.170)
Cum. Credits Earned	6.577	(2.585)**	5.655	(2.544)**
<i>N</i>		28,840		28,840

Note. Difference-in-difference results for the sample of students at Politecnico di Milano University from 2008-2013 who are between 17 and 25 years of age, enter for the first time as bachelors and are pursuing only one career. The sample size before the policy change for long-term outcomes is 6,149 for non-aided students and 265 for DSU recipients. This sample only includes the 2008 pre-treatment cohort to avoid contamination within the first three years of enrollment before the policy change. Sample sizes may vary for certain variables due to missing values. Model 1 does not include controls. Model 2 include controls for female, Italian, and admission test scores.

*** $p < .01$, ** $p < .05$, * $p < .1$.

Table 3. DID Estimates by Tuition Level

Outcome	Model 3. Control Group- Tuition Level 3		Model 4. Control Group- Tuition Level 4		Model 5. Control Group- Tuition Level 5		Model 6. Control Group- Tuition Level 6	
	Coef.	(S.E.)	Coef.	(S.E.)	Coef.	(S.E.)	Coef.	(S.E.)
Credits Attempted, Year 1	-0.033	(0.367)	-0.100	(0.354)	-0.111	(0.343)	-0.198	(0.335)
Credits Earned, Year 1	1.465	(0.728)**	2.013	(0.693)***	2.189	(0.659)***	2.346	(0.634)***
GPA, Year 1	0.223	(0.151)	0.228	(0.147)	0.278	(0.144)*	0.304	(0.141)**
Enrolled, Year 2	0.000	(0.017)	0.007	(0.016)	0.016	(0.015)	0.018	(0.014)
<i>N</i>	8,986		11,335		15,849		22,904	

Note. Difference-in-difference results for the sample of students at Politecnico di Milano University from 2008-2013 who are between 17 and 25 years of age, enter for the first time as bachelors and are pursuing only one career. Subgroup analysis by comparison groups based on tuition levels. Sample sizes may vary for certain variables due to missing values. Models 3-6 include controls for female, Italian, and admission test scores. Tuition levels are based on family income (lowest to highest). DSU-aided students are in Tuition Level 1.

*** $p < .01$, ** $p < .05$, * $p < .1$.

Table 4. DID Estimates by Ability

Outcome	Low Ability		High Ability	
	Coef.	(S.E.)	Coef.	(S.E.)
Credits Attempted, Year 1	-0.790	(0.869)	0.252	(0.555)
Credits Earned, Year 1	0.581	(1.384)	2.434	(0.974)**
GPA, Year 1	-0.000	(0.243)	0.405	(0.235)*
Enrolled, Year 2	-0.068	(0.034)**	0.056	(0.022)**
<i>N</i>		9,928		10,720
If ever repeated a year	0.002	(0.085)	-0.063	(0.066)
Earned a BA degree	-0.083	(0.058)	0.036	(0.038)
Earned a BA degree on time	-0.005	(0.081)	0.079	(0.067)
Excess Credits	0.008	(0.068)	-0.021	(0.066)
Cummulative GPA	-0.271	(0.377)	0.582	(0.323)*
Cum. Credits Earned	2.762	(6.852)	2.909	(4.423)
<i>N</i>		6,504		7,539

Note. Difference-in-difference results for the sample of students at Politecnico di Milano University from 2008-2013 who are between 17 and 25 years of age, enter for the first time as bachelors and are pursuing only one career. The sample size before the policy change for long-term outcomes is 6,149 for non-aided students and 265 for DSU recipients. This sample only includes the 2008 pre-treatment cohort to avoid contamination within the first three years of enrollment before the policy change. Sample sizes may vary for certain variables due to missing values. Model 1 does not include controls. Model 2 include controls for female and Italian. Low ability students are those whose admission test scores are less than 40.25 (25th percentile); high ability students score higher than 76.2 (75th percentile).

Figure 1. Pre-Trends on Credits Earned, Year 1

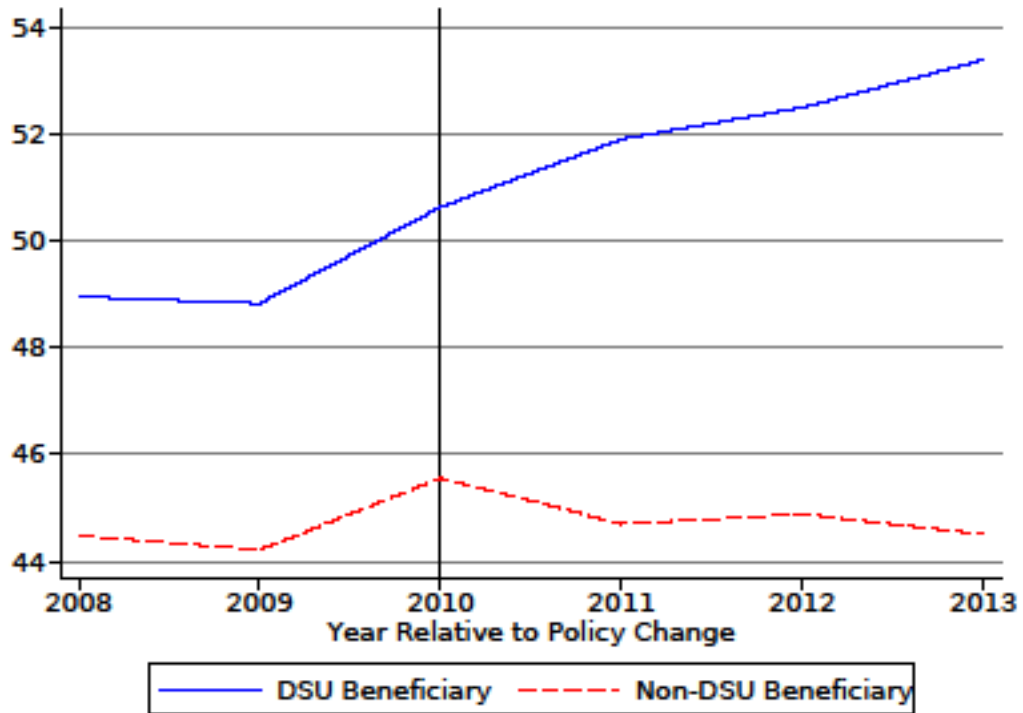


Figure 2. Pre-Trends on GPA, Year 1

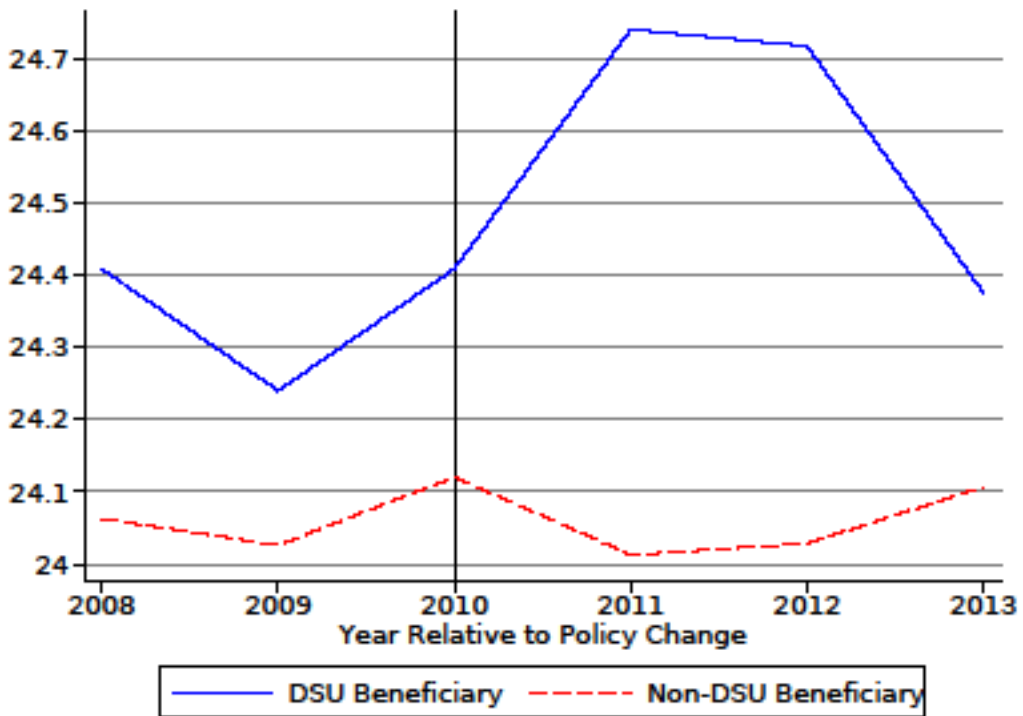


Figure 3. Pre-Trends on Enrollment, Year 2

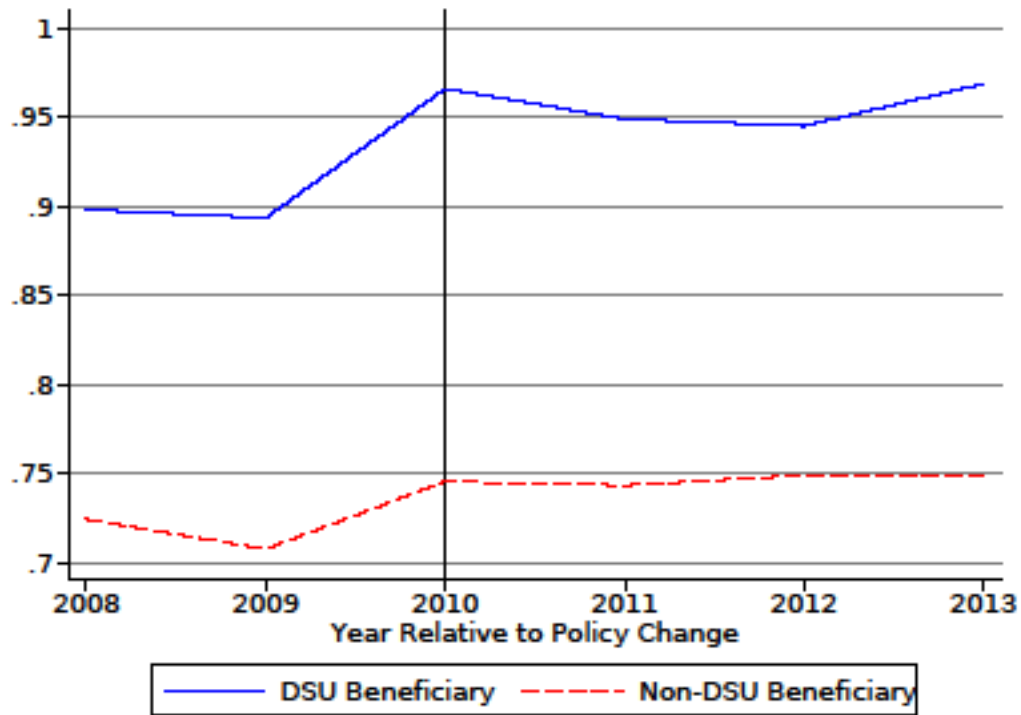
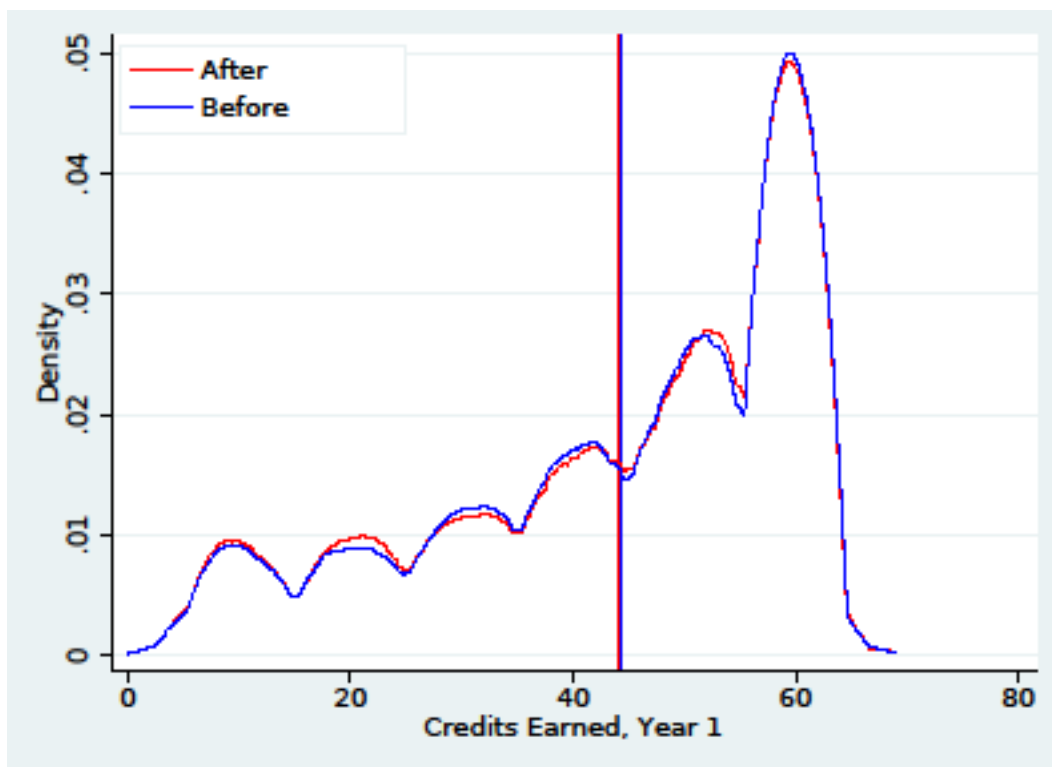


Figure 4. Distribution of Credits Earned, Year 1

Panel a. Non-Aided Students



Panel b. DSU-Aided Students

