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Silvia Granato
European Commission (JCR) and University of Warwick

Enkelejda Havari
IESEG School of Management and IZA

Gianluca Mazzarella
European Commission (JCR)

Sylke V. Schnepf
European Commission (JCR) and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Study Abroad Programmes and Students' Academic Performance: Evidence from Erasmus Applications*

Erasmus+ is one of the most popular programmes financed by the European Union. It provides international mobility grants to university students while staying enrolled at their home university. This paper brings novel evidence on the effect of participating in the programme on students' academic outcomes, using rich administrative data from one of the largest public universities in Italy. We rely on a fuzzy Regression Discontinuity Design, since the selection of applicants to Erasmus mobility programmes depends on a continuous score assigned during the application process. Our results show that Erasmus mobility does not delay graduation at the home university and, in addition, it has a positive and significant impact on undergraduates' final degree mark. Investigating possible heterogeneous effects, we find that Erasmus mobility improves graduation results for undergraduate students in scientific and technical fields (STEM) and for those who apply for the Erasmus grant in the first year of their studies. Finally, the positive impact on performance at graduation appears to be stronger for students who visit foreign universities of relatively lower quality compared with their home university and for those who stay abroad for more than six months.

JEL Classification: I23, D04

Keywords: Erasmus+ programme, international student mobility, university, administrative data, Regression Discontinuity Design

Corresponding author:
Silvia Granato
European Commission - Joint Research Center
B-1049 Brussels
Belgium
E-mail: silvia.granato@ec.europa.eu

* We are extremely grateful to Danilo Cinti, Carmela Tanzillo and Camilla Valentini from the University of Bologna (Italy) for the provision of the data used in the study. We also thank Massimiliano Bratti, Jesse Bruhn, Ana Hidalgo, Zoe Kuehn, Arieda Muco and Eugenio Zucchelli for their suggestions, as well as participants in the COMPIE 2021 conference, ESPE 2021 annual conference, SOLE Conference 2021, AIEL conference 2020 and seminar participants at JKU Linz, Universidad Autonoma Madrid, Warwick University and European Commission. Any views expressed in this paper are those of the authors and do not reflect those of the European Commission.

1 Introduction

The Erasmus[1] programme is one of the oldest policies financed by the European Union (EU) and among the most popular ones. It was established in 1987 to enable European university students to spend a period of study in an EU member state, supported by mobility grants. Over time it has widened its scope, with the current Erasmus+ 2021-2027 programme covering further aspects in education including vocational training, school and adult education and sport, with a budget of €26.2 billion. As of 2017, thirty years after its creation, the Erasmus programme had promoted the mobility of approximately 4.5 million higher education students in more than 30 countries.[2]

The stated aims of the Erasmus programme are to "*promote common European values, foster social integration, enhance intercultural understanding and a sense of belonging to a community*".[3] In particular, it is expected that the policy generates positive effects on a wide spectrum of young people's outcomes, including improved learning performance, enhanced employability and improved career prospects, as well as increased motivation for continuing education, improved foreign language and development of soft skills (EC, 2020).

This study analyses the effect of participating in the Erasmus programme on students' graduation outcomes using administrative records from the University of Bologna, the second-largest public university in Italy. Every year, the available grants funding specific Erasmus programmes[4] are assigned to students who position highest in programme-specific rankings based on a score calculated as function of previous academic performance, language skills and the quality of the application. Students can turn down offers and both renouncing and rejected students can reapply and participate in the programme later in their study career. We exploit this allocation mechanism in a fuzzy regression discontinuity design, which allows us to tackle the bias deriving from selection into the Erasmus programme and to estimate its causal impact on short-term outcomes.

Studying abroad is associated with considerable time-intensive organisation tasks, the need to improve language skills and the need to adapt to a new learning environment characterised

[1] *Erasmus* is the acronym of '*European Region Action Scheme for the Mobility of University Students*'.

[2] Source: https://ec.europa.eu/commission/presscorner/detail/en/MEMO_17_83

[3] Source: Erasmus Programme Guide 2020, version 3, page 5. Available at https://ec.europa.eu/programmes/erasmus-plus/sites/default/files/erasmus_programme_guide_2020_v3_en.pdf.

[4] A specific Erasmus programme is defined by the foreign university of destination and the length of the study period abroad. The number of grants available for each exchange programme are determined yearly by agreements between the home and the foreign university departments. For more details on the institutional background see section 2.

by differing abilities of peers, varying teaching approaches and different student networks. These organisational tasks and learning alterations could impact on students' academic performance. On one hand, by '*meeting the unfamiliar*' and broadening one's horizon, studying abroad may be thought of as a positive input in building human capital, making students acquire skills they would not have acquired at their home universities (Messer and Wolter, 2006) that are potentially relevant for achieving better academic outcomes. On the other hand, the investment required by the experience abroad in terms of time and effort to adapt to a new environment, or the fact that students might simply put less effort into their studies while abroad because they are mainly seeking adventure and excitement rather than improvements in their careers (Di Pietro, 2015), are potentially translated into worse academic performance and a delay in the study career. The latter might be particularly relevant in the Italian context, where the duration of studies is among the highest in Europe (Schnepf, 2017).

Furthermore, a potential impact of international students' mobility (ISM) on students' academic performance could affect their employability and earnings[5] (see, for example, for Italy, Aina and Casalone, 2020; Aina and Pastore, 2020) and, in addition, access to certain graduates jobs might be conditional on students' achievement at university (Naylor and Mcknight, 2002). The latter has been historically the case for competitions for public sector jobs in Italy where either access is conditional to having a minimum graduation mark, or applicants CVs are attributed a score and a higher graduation mark correspond to higher scores.

A number of studies have attempted to estimate the impact of studying abroad (through Erasmus or other programmes) on university students' subsequent outcomes, mainly focusing on future mobility and labour market performance, finding positive effects on the probabilities of living and/or working abroad (Parey and Waldinger, 2011; Oosterbeek and Webbink, 2011; Rodrigues, 2013) and on employment status and earnings (Messer and Wolter, 2006; Di Pietro, 2015). Other studies have documented positive impacts on the development of specific skills, including foreign languages proficiency (Sorrenti, 2017) and intercultural competence (Salisbury et al., 2013).

However, not much is known about the impact on students' academic performance, mainly

[5]Both the human capital theory and the signalling theory predict that graduates' performance contributes to their employability and earnings: the student who does better at university could be thought of as having acquired more human capital through more productive study (educational performance *augments* individual productivity); moreover, a better university performance could be interpreted as a signal of higher underlying ability (educational performance *signals* inherent productivity (Castagnetti and Rosti, 2009)).

due to limited availability of administrative data on individual study careers with information both on mobility and on students' outcomes measured before exit from education. In fact, previous literature has largely used survey data measured after the study experience abroad[6] and, in order to address the endogeneity of the choice of studying abroad, has relied either on propensity score matching methods (Rodrigues, 2013; Salisbury et al., 2013; Waibel et al., 2018)[7] or on instrumental variable approaches, with supply-side measures of Erasmus grants availability used as an arguably exogenous instrument for students' mobility (Parey and Waldinger, 2011; Di Pietro, 2015; Sorrenti, 2017).[8]

This paper contributes to the literature threefold. First, it provides novel evidence on the causal effect of studying abroad on students' outcomes, which was largely unexplored in previous literature. Second, this study uses rich administrative data on students' applications to the Erasmus programme matched with administrative records on their performance at university which include information on time to degree completion and final graduation mark. To the best of our knowledge, this is the first study that uses administrative data on Erasmus applications and students' outcomes at graduation, allowing to take the selection in the programme into account and to look at the short-run effects of studying abroad. Third, our data contain rich information on characteristics of the study abroad experience, including the length and the foreign host institution. This allows exploring heterogenous effects of participating in Erasmus as well as investigating potential mechanisms.

We estimate the causal impact of participating in the Erasmus programme on both bachelor and master students' time to graduation and final graduation mark and show that studying abroad through the Erasmus programme does not have an impact on the probability of graduating on

[6] One exception is Oosterbeek and Webbink (2011), who use data on applications for a study abroad scholarship targeted at talented students who complete an undergraduate programme in the Netherlands to estimate the causal impact on the probability to live abroad later on.

[7] Rodrigues (2013) uses survey data on students from 14 European countries with rich info on students' background, including parents' education and high school career as well as proxies for ability, motivation and initiative, and finds a positive association between mobility and future mobility and earnings, while the transition to employment seems to be slightly delayed. Similarly, Waibel et al. (2018) apply propensity score matching to a multi-cohort representative dataset of the German population and document a positive effect of mobility on early career occupational status driven by compositional differences. Salisbury et al. (2013) use the same methodology with a sample of US students and show a positive influence of students' experiences abroad during their studies on awareness and acceptance of "both similarities and differences that exist among people".

[8] The method was proposed by Parey and Waldinger (2011), who use data on the number of Erasmus grants holders at the university-subject-year level in Germany since the programme's introduction in 1987, exploiting exogenous students' exposure to the programme, as an instrument for students' mobility. A similar strategy is applied by Sorrenti (2017) on a sample of Italian graduates. Similarly, Di Pietro (2015) uses university-department (time-invariant) exposure to Erasmus as an instrument for participation in the programme of a representative sample of the 2007 cohort of Italian graduates.

time, while it has a positive effect on the final graduation mark for bachelor students only. For the latter, we investigate potential heterogeneities of the impacts and show that the effect on the final graduation mark is remarkably stronger for graduates in the scientific and technical fields (STEM) and for students applying for the Erasmus programme earlier in their careers, for whom we also observe a reduction in time to graduation. Finally, the positive effect on the final graduation mark appears to be driven by certain programme characteristics, namely lower relative quality of the foreign host institution as measured by the Shanghai Academic Ranking of World Universities, and a longer duration of the stay abroad.

The remainder of the paper is organised as follows. Section 2 describes the functioning of the selection process for participating in the Erasmus programme at the University of Bologna and the data on applications. Section 3 discusses how the regression discontinuity design is implemented in order to estimate the causal impact of participating in the Erasmus programme and describes the final sample. Section 4 presents the results and discusses possible mechanisms potentially explaining the findings. Section 5 concludes.

2 Institutional background and data

2.1 The Erasmus programme at the University of Bologna

The University of Bologna is the oldest in Europe and one of the largest public universities in Italy, attracting approximately 5% of all students enrolled in higher education in Italy every year.[9] Among Italian universities, the University of Bologna has also one of the strongest traditions of participation in the Erasmus programme: of all students graduating in 2019, 11.2% spent a period of study abroad with an Erasmus scholarship (or other EU programmes), while this figure is 9.6% on average across the majority of all other Italian higher education institutions.[10]

At the beginning of every calendar year (January of year t), the University of Bologna publishes

[9] In the academic year 2019/2020, 4.6% of all Italian students enrolled in higher education were enrolled at the University of Bologna. This is the second-highest share among all higher education institution: the highest share of enrolled students is registered at the University of Rome *La Sapienza*, which received 6% of all Italian students enrolled at higher education institutions (data extracted from http://dati.ustat.miur.it/dataset/iscritti). The same holds for previous academic years, at least since the first academic year for which these data are available from the Ministry of Education, i.e. 2010/2011. Table B1 in the Appendix presents some basic statistics to compare the sample of students starting a study career at the University of Bologna with the population of Italian higher education students across some basic characteristics, including the share of female and foreign students and the distribution of students by field of study.

[10] Source: AlmaLaurea, *Profilo dei Laureati 2019* https://www.almalaurea.it/universita/profilo/profilo2019

a call for applications for taking part in the Erasmus programme in the following academic year (i.e. for spending a period of study abroad of varying duration between September of calendar year t and July of calendar year $t+1$). Each department[11] has agreements with departments of other universities that are part of the Erasmus programme.[12] The number of grants available for each specific exchange study program at a specific host institution is defined within the agreement between the departments of the University of Bologna and those of the host institutions.

Until 2018, in a given year each student could submit a maximum of two applications for the available Erasmus opportunities within her department. To be considered eligible to participate in the Erasmus programme and potential recipient of the mobility grant, a student needs to have at least an elementary level (level A2 according to the Common European Framework of Reference for Languages) of the language spoken in the destination country and a study plan for their period abroad. Once students apply, they are assigned a score of 0 to 100 based on their study career and the quality of their application. More specifically: up to 60 points are assigned based on the average grade and the number of exams credits (measured according to the European Credit Transfer System -ECTS) accumulated up to the year and month of application (generally February t)[13]; the remaining 40 points are assigned by the university staff member managing the exchange program based on the quality of the student's study project, her motivation letter and language proficiency.

All students applying for a specific exchange programme are ranked based on this score and the available grants are assigned to the highest ranked eligible students. After the results of the rankings are published, students have approximately one week to decide whether to accept the

[11] An academic department is a division of a university or school faculty devoted to a particular academic discipline.

[12] The pre-requisite for all higher education institutions located in a programme country and willing to participate in learning mobility of individuals and/or cooperation for innovation and good practices under Erasmus+ is being awarded the *Erasmus Charter for Higher Education* (ECHE). The ECHE provides the general quality framework for European and international cooperation activities a higher education institution may carry out within the Erasmus programme.

[13] More in details: for students enrolled at least to the second year of a bachelor, single-cycle or master degree the calculation of study career points considers the student's average grade normalised to the average grade in the department and cycle of the student's degree course, and the number of ECTS credits registered during her study career with respect to the first year of enrolment (regularity of studies). For students enrolled in their first year of a master degree the calculation of study career points comprises 6/7 of the previous courses of study (applicant's graduation date and graduation mark normalised to the average grade in the department and cycle of the student's degree course) and 1/7 of individual student's current course of study (the student's average grade normalised to the average grade in the department and cycle of the student's degree course, and the number of ECTS credits registered until the application).

grant.[14] Then, based on these decisions, the mobility grants are reallocated to the next students in the ranking until reaching the last eligible student. If some places remain vacant after this process, a second round of applications is launched and the entire process is repeated.

Students can apply several times during their studies and they can receive more than one Erasmus mobility grant even within the same study cycle, provided that the cumulative duration of the period abroad does not exceed 12 months (or 24 months for single-cycle degrees).[15]

2.2 Data on applications

We use data on the applications for all the Erasmus grants funding a period of study abroad available to students of the University of Bologna between the academic years 2013/2014 and 2018/2019.[16] A rich set of information is available for each specific exchange programme funded, including the department of the home university managing the agreement, the number of available grants, the length of the period abroad according to the initial agreement[17], the country of destination and the name and location of the foreign host institution. These data were made available by the office responsible for the management of exchange programmes at the University of Bologna.

Overall in the period considered there are approximately 36,500 applications to 10,127 exchange programmes. Table B2 in the Appendix reports some descriptive statistics on this sample. It shows that, over the entire period considered, the average number of grants available for each specific exchange programme was 2.3, and each exchange programme received on average 3.6 applications, indicating that there is some competition to obtain the available grants. The majority of exchange programmes funds periods of study abroad of 5 to 6 months (slightly more than half) and 7 to 8 months (another approximately 40%). Overall the University of Bologna established agreements for students exchanges with more than 700 universities in 47 countries[18]; most of the

[14] Students can also decide to renounce to the scholarship after acceptance, at a later stage. Another possibility is that the student accepts the scholarship but she is then rejected by the host institution because she didn't fulfil specific requirements from the host institution (e.g. specific deadlines, etc.)

[15] Single-cycle degrees are 5 or 6 years study careers in law, architecture, pharmacy, medicine and veterinary and primary education.

[16] We exclude applications to *Erasmus placement*, the programme offering scholarships to do a traineeship abroad during the study career.

[17] This period can be reduced or extended upon a specific request from the student once she is abroad and approval from both home and foreign university.

[18] More specifically, 32 European countries (all Erasmus programme countries except Liechtenstein), 15 third countries (only 0.6% of all the agreements) and Switzerland (grants for mobility periods in Switzerland are financed by the Swiss Universities).

agreements are with universities in Spain (25%), followed by France and Germany (respectively 15 and 11%).

3 Empirical strategy

The main identification issue that arises in trying to estimate the causal effect of participating in the Erasmus programme is that students are not randomly assigned to the "treatment" and, thus, are likely to have observable as well as unobservable characteristics (e.g., ability, motivation and open-mindedness) potentially correlated both with the probability of participating in the Erasmus programme and with graduation outcomes. To solve this selection problem we exploit the allocation mechanism of the Erasmus mobility grants at the University of Bologna in a fuzzy regression discontinuity design: close to each programme-specific qualifying cutoff the grants assignment is *as good as random*. The fuzziness of our RD desing is given by the fact that offers are randomized while actual participation in the program remains a choice.

Our starting population is composed of students who applied for an Erasmus mobility grant at least once over their higher education career. An individual is 'treated' if she ever participated in the Erasmus programme over her study career. We observe the yearly final outcomes of the mobility grants assignment process, i.e. the final applicants ranking for each specific exchange programme including students' decisions to accept or turn down the offer(s) and their final decision to leave for the study period abroad.

Within each of these rankings, we identify the qualifying cutoff score as the score of the last student who is offered one of those grants, regardless of whether she has accepted it or not.[19] The running variable for each student in the ranking is constructed as her score normalised to the cutoff score, so that it has value zero for the last student who is offered the scholarship and takes a positive (negative) value for those higher (lower) ranked.

Students can participate in several calls for applications in different academic years as well as apply for different exchange programmes within the same academic year (maximum 2), and thus each student will have as many running variables as rankings to which she participates. To

[19]It is worth noting that in each programme-specific ranking, because of students rejecting the offer, the position of the last student who is offered a grant can be higher than the number of available grants. We consider as pivotal the last student who receives an offer for the mobility grant after all the renounces. On the other hand, the student just below the threshold is the first of the ones not receiving the grant offer.

deal with these features of the allocation mechanism, first, for each student, we focus on the first academic year of participation to a call for applications; one can indeed think that every subsequent participation to other calls is partly affected by the outcome of the first participation.[20] Then, for students applying for two specific programmes in the same call for applications we take the running variable with the maximum value, which proxies the student's effective probability of receiving *at least* one grant offer. In fact, these students' preference ordering of applications -if any- is not made explicit at the moment of the application and does not affect ex-ante the probability of receiving any grant offer. Thus, we argue that the cutoff of the ranking in which the applicant's running variable has the maximum value is the only 'relevant' cutoff, and that we can eliminate selection bias by comparing individuals that have their best score just above and just below this cutoff.

In our setting being above or below the cutoff does not exactly determine the treatment status. More in detail, non-compliance is given by: non-treated students at or above the cutoff, i.e. who have been offered at least one mobility grant in the first academic year of application within their study career but rejected (or turned down) all offered grants even at later stages of their study career; treated students below the cutoff, i.e. who have not been offered any grant in the first academic year of application but participated in an Erasmus programme as outcome of applications done in subsequent years of their study career.

We estimate the effect of participating in the Erasmus programme on students' academic outcomes, namely time to graduation and final graduation mark, via an instrumental variable approach. Namely, our equation of interest is:

$$Y_{ir} = \beta_1 T_{ir} + \beta_2 f_2(\tilde{x}_{ir}) + \mu_r + \epsilon_{ir} \tag{1}$$

where Y_{ir} is the outcome of student i who has her maximum normalised score, among her applications in the first year of application, in ranking r. T_{ir} is the treatment variable, which takes the value 1 if the student has ever studied abroad through an Erasmus programme in her study career. $\tilde{x}_{ir}$ is the running variable measured in ranking r, i.e. the maximum of the student's normalised

[20] This is similar to Fort et al. (2020), who study the causal effect of time spent at age 0–2 in day care on cognitive and non-cognitive skills at age 8-14 by using a RD strategy that exploits admission thresholds to the Bologna day care system. In their context, parents apply to as many day care facility programs as they wish in the grade-year combination for which their children are eligible. Similar to what we do, the authors consider only the first application of each child, and the fuzziness in the RD design is given by the possibility to turn down an offer (or to be rejected) and to reapply and attend later.

scores among applications of her first year of application, and $f(\cdot)$ is a polynomial in the running variable. Our model includes ranking fixed-effects μ_r. ϵ_{ir} is an individual specific error term.

The corresponding first stage equation reads as follows:

$$T_{ir} = \alpha_1 Z_{ir} + \alpha_2 f_1(\tilde{x}_{ir}) + \zeta_r + \eta_{ir}, \tag{2}$$

where Z_{ir} is is a dichotomous indicator for having a (normalised) score equal or above the (zero) cutoff, i.e. $Z = \mathbf{1}(x \geq 0)$. We estimate our model both using linear and quadratic polynomials of the running variable and with different bandwidths around the cutoff and cluster standard errors at the ranking level. Our research design is close in spirit to the methodology developed in Abdulkadroğlu et al. (2021) in the context of centralised school assignment. We discuss the similarities between the two approaches in Appendix A, and we provide some robustness checks using their approach.

The estimation of the causal parameter of interest relies on the assumption of monotonicity of the treatment in the instrument being satisfied, i.e. absence of defiers. In our context, this implies assuming that there are neither applicants who would participate in the Erasmus programme during their study career only if they were not offered an Erasmus grant in their first year of application, nor applicants who would not participate in the Erasmus programme only if they were offered an Erasmus grant in their first year of application. Under this assumption, our coefficient of interest, β_1, measures the local average treatment effect for compliers at the cutoff.

3.1 Final sample and summary statistics

Data on applications are matched with administrative records on individuals' demographic and study career information (course of study, number of exams and ECTS credits accumulated and average grades by calendar year, date and grade of graduation if graduated) for students who enrolled in the first year of a study career at the University of Bologna from the academic year 2007/2008 onward, which were made available by the statistical office of the University of Bologna.[21] We focus on bachelor and master students[22] whose study career, as of the end of 2019 (the time at which data are extracted) should have already been concluded, according to the legal duration of

[21] Administrative records on students enrolled in the first study career before the academic year 2007/2008 are not available. Approximately 6.4% of all applicants are not matched with administrative records on students' study careers. These are either students who first enrolled before the academic year 2007/2008 or students who first enrolled in another university and migrated to the University of Bologna at a later stage of their study career.

[22] Students enrolled in single-cycle study careers, which are 13% of the sample, are excluded.

their study course.[23] We then focus on students who have graduated, excluding those who dropped out (1.6% of the sample of students whose study career should have been concluded by 2019) and those who are still enrolled with delay (another 16.4%).[24]

To ensure that with our empirical strategy we are identifying and comparing students who *just* received or *just* didn't receive the Erasmus grant, we further restrict our sample to students for whom all exchange programmes they applied for in their first year of application have a number of applicants higher than (or at least equal to) the number of available grants. For rankings in which there are not enough eligible students applying and not all the grants available are offered to students, indeed, it is not possible to identify the last offered and the cutoff score. Consequently, for students participating in at least one of these rankings, the maximum value of the running variable is not defined. These students are 36% of the sample and they are excluded from the analysis.

The final sample is made of 4,592 bachelor students and 3,097 master students.[25]

Table 1 displays some summary statistics for the two final samples, separately for students who never participated in the Erasmus programme during their study career (columns "No Erasmus") and students participating in the Erasmus programme at least once over their study career (columns "Erasmus").[26] Approximately 62% of bachelor students and 61% of master students participated in the Erasmus exchange programme at least once during their study career.[27] Females and students from education, arts and humanities appear to be slightly over-represented among Erasmus participants, in particular in the bachelor students sample. On average, bachelor and master students who participated in an Erasmus programme at least once during their study career accumulated a smaller number of passed exams and ECTS credits when they first participate in a call for applications. This is explained by the fact that, relatively to non-treated students, they are more likely to have applied for the first time earlier during their university studies.

The last rows of the table report summary statistics for the four main outcomes of interest

[23] Thus, bachelor students enrolled in the first year of their study career in 2017/2018 (6% of all bachelor students in the sample) and master students enrolled in the first year of their study career in 2018/2019 (0.8% of all master students in the sample) are excluded.

[24] Table B4 in the Appendix reports the RDD results from the estimation of the causal effect of participating in the Erasmus programme on the probability of having graduated among all students whose career should have already been concluded, showing that there is no effect.

[25] We can observe the same student with more than one career if she graduated from a bachelor degree and later from a master degree over the period considered. 210 students are both in the sample of bachelor and master students.

[26] Table B3 in the Appendix reports some summary statistics for the two final samples not split by treatment status.

[27] Only 1.1% of bachelor students and 0.5% of master students participated in an Erasmus exchange programme twice over their study career.

measuring success in students' university career, namely: the probability of graduating on time, time to graduation, the final graduation mark and the probability of graduating with *distinction*. In the Italian higher education system, each student has to pass exams for a given number of ECTS credits every year to be able to enrol in the next year of the study career and be on time. The first outcome measures the probability of being on time when graduating. The time to graduation is the number of months between October of the academic year of enrolment in the first year of the study career, which is considered the conventional month of first enrolment, and the month of graduation. Final graduation mark ranges between 66 and 110, and particularly high achieving students can obtain their qualification *cum laude*, indicated here as *distinction*. The figures in Table 1 indicate that in the bachelor sample only, Erasmus participants take less time to graduate, as indicated by both a higher probability of graduating on time and a lower time to graduation in months. In both samples, Erasmus participants on average obtain a higher final graduation mark and have a higher probability of graduating with distinction.

3.2 First stage and tests of the identifying assumptions

Figure 1 is a graphical representation of the first stage, i.e. the relationship between the running variable and the treatment variable. We use a cubic specification and do not condition on other covariates. The figure shows a clear jump in the probability of participating in the Erasmus programme due to the grants assignment mechanism, both for the sub-sample of bachelor students -panel (a)- and the sub-sample of master students -panel (b). Table 2 reports the results of the estimation of the first-stage equation. We estimate specifications with varying polynomial order (linear and quadratic), for two increasingly narrower bandwidths around the cutoff.[28] The first stage coefficient is always positive and significant at the 1% level. Having a score above the cutoff increases the probability of participating in the Erasmus programme by approximately 48 to 52 percentage points for bachelor students, and 51 to 61 percentage points for master students.

The identifying assumption of our design is that individuals do not have precise control over the received score ("no manipulation" of the running variable). Hence, being the last student who is offered the mobility grant or the first excluded can be considered "as good as random'.

[28] All the estimations are performed using triangular kernels, which have optimal properties in estimating boundary points (see Imbens and Kalyanaraman, 2012).

This assumption ensures that, on average, treated and control units around the cutoff have similar observable and unobservable characteristics. Given that each ranking has its own cutoff score, normalising the running variable according to the score of the last student who is offered a mobility grant generates bulk of values exactly equal to zero. This will produce a discontinuity in the distribution of the running variable that translates into a failure in the standard test of manipulation of the running variable (McCrary, 2008), as shown in the left panel of Figure B1 in the Appendix. Including ranking fixed-effects in the analysis and, thus, exploiting only within-ranking variability, allow addressing this issue, as illustrated by the right panels of Figure B1, which show that, in both sub-samples, the distribution of the residuals of the running variable after the inclusion of ranking fixed effects is not discontinuous at the cutoff.

Furthermore, we run a series of estimations to check that there is no jump at the cutoff for pre-treatment variables of interest. Specifically, we look at academic performance before the application, measured by the number of exams and of ECTS credits the students accumulated until their first application.[29] Moreover, we investigate potential discontinuities in both the gender and the country of birth of the applicants, through an indicator for being female and an indicator for being born outside Italy, and in a potential measure of attitudes towards mobility, namely the probability of having moved region to study at the University of Bologna (similar to Sorrenti, 2017). Table 3 reports the results of these estimations for the five variables described above, showing that the selected pre-treatment variables are balanced around the cutoff.

4 Results

This section discusses the results for the four different students' outcomes at graduation, namely the two measures of time to graduation -i.e. the probability of graduating on time and the number of months to graduate- and the two measures of performance at graduation -i.e. final graduation mark and the probability of graduating with distinction. Time to graduation and performance at graduation are related because in the Italian university system the final graduation mark is assigned based on both the study career results, i.e.the average exams grade that determines the starting graduation mark and the time to graduation (additional marks are attributed for shorter

[29] We can only measure number of exams and ECTS credits until the end of the calendar year before the calendar year of application.

time to graduation), and on the evaluation of a final essay. While the information on the precise correspondence between time to graduation and additional marks at graduation is not available, given also that the rules can vary across different degree courses, if participation to Erasmus has an impact on time to graduation we would expect that this is translated in an impact on final graduation mark.

Table 4 reports the results for the two outcomes measuring time to graduation, respectively for bachelor students in panel (a) and master students in panel (b). All the estimations are performed on the sample obtained imposing a bandwidth of 0.1 around the cutoff.[30] The table displays both results of the estimation of a reduced form equation, with polynomials in the running variable of order one (columns 1 and 4 of both panels) and two (columns 2 and 5 of both panels), and results of an Instrumental Variable regression (columns 3 and 6 of both panels). No significant effect emerges across the different specifications and models, for both sub-samples. We test the robustness of these results to alternative ways of measuring time to graduation, in particular investigating the effect on the probabilities of graduating within different, increasing, intervals of time. The results are reported in table B5 in the Appendix and confirm that participation in the Erasmus programme does not significantly delay time to graduation. This result is particularly relevant in the Italian context, where higher education is subsidized and late graduation rates are among the highest among OECD countries (Sorrenti, 2017), and where late graduation implies significant penalties in terms of employment probability and earnings (Aina and Casalone, 2020) and of the quality of the job match (Aina and Pastore, 2020).[31]

The same estimations are performed on the two outcomes measuring performance at graduation, and the results are reported in Table 5. A significant positive effect is observed on the final graduation mark for bachelor students only (columns 1, 2 and 3 of the top panel). In particular, Erasmus participation causes an increase in the final graduation mark by up to 2 points, which is significant at the 5% level. The magnitude is approximately one third (namely 32%) of

[30] In a setting with a high number of rankings and ranking fixed effects, calculating the optimal bandwidth proposed by Calonico et al. (2014) reveals to be unfeasible because the calculation is computationally too intense. Our preferred bandwidth is arbitrarily chosen, guided by the Calonico-Cattaneo-Titiunik optimal bandwidth calculated in a setting without ranking fixed effects (which is approximately 0.13) The robustness of the results across different bandwidths is tested.

[31] Aina and Pastore (2020) find that in a sample of Italian university graduates delayed graduation increases the probability of being overeducated, i.e. employed in a job for which a university degree is not required.

one standard deviation of the final grade in the estimation sample.[32] All the results on the four main outcomes of interest are robust across different bandwidths, as shown in Figure B2 in the Appendix. Given that no significant impact is found on time to graduation, we can exclude that the positive effect on graduation grade derives from the points premium attributed for reduced time to graduation. In addition, it is worth mentioning that some degree courses attribute one additional point at graduation to students who have participated in the Erasmus programme. Precise information on this system at the degree course level has never been collected systematically and it is difficult to retrieve.[33] On the other hand, we can investigate whether participation to Erasmus has an impact on average exam grades calculated on all the exams passed until the end of the study career, which are clean from any effect on marks attributed at graduation. Table B6 displays the results and shows a positive effect on average grades before graduation, of a magnitude similar to the effect on final graduation mark (30% of one standard deviation of average grades in the estimation sample)[34], allowing to exclude that the impact on final graduation marks is driven by the policy of attributing a premium to Erasmus participants.

For master students, results suggest that Erasmus mobility does not produce any impact on academic performance. These students have specific characteristics that might play a role in whether and how a study experience abroad might affect their academic outcomes. On one hand, they are not at their first degree and being both more senior and older might make them less sensitive to the shock of moving abroad and to a change in learning inputs. On the other hand, they might have already participated in study abroad experiences in their previous degree, with similar implications.[35]

As a consequence, the rest of the paper focuses more deeply on explanations for the effects on the sample of bachelor students.

First, we explore the heterogeneity of effects across some characteristics of interest, namely

[32] The average final graduation mark in the estimation sample is 104.1 and the standard deviation is 6.29.

[33] Students in our final sample graduate from more than 260 different degree courses.

[34] In the estimation sample, the average mark before graduation is 27 with a standard deviation of 1.68.

[35] For approximately 50% of the master students in the final sample of applicants, we were able to identify that they did their bachelor at the University of Bologna. The remaining ones either have done their bachelor in another university, or they enrolled on the first year of their bachelor at the University of Bologna before the academic year 2007/2008 and we don't observe them in the administrative data on students' careers. Within the first group, we can identify that approximately 12% participated in the Erasmus programme also during their bachelor at the University of Bologna. The remaining ones either didn't participate in Erasmus during their bachelor or applied for Erasmus before the academic year 2013/2014 and we don't observe them in the administrative data on Erasmus applications.

students' pre-determined characteristics including gender and field of study, as well as the timing of their first application to Erasmus within the study career. The latter both can be interpreted as a proxy for their motivation for participating to Erasmus and should be a predictor of the effective timing of the study experience abroad during the study career. While no differential effect emerges across students of different gender, as indicated by panel (a) of table 6[36], panel (b) of the same table shows that the positive effect on the final graduation mark (column 3) for bachelor students is almost entirely driven by students in the scientific and technical fields (STEM). For STEM students, participation in Erasmus causes an increase in final graduation mark of approximately 3.6 points, which is more than 50% of one standard deviation of the average final grade in this sub-sample, and the coefficient is significant at the 1% confidence level.[37] This effect is not driven by reduced time to graduation, as indicated by columns 3 and 4 of the same table. When looking at the timing of the first application (panel (c) of table 6), it emerges that only bachelor students who first apply for Erasmus earlier in their study career, i.e. when enrolled in the first year, benefit from participating in the programme, as demonstrated by the negative and significant coefficient on time to graduation (column 2) and the positive and significant effects on final graduation mark and probability of graduation with distinction (respectively columns 3 and 4). For these students, participating in the Erasmus programme produces a decrease in the number of months to graduate of approximately 1.4 (36% of one standard deviation of this outcome for this sub-group in the estimation sample), and increases respectively the final graduation mark of 2.2 points and the probability of graduating with the distinction of 10 percentage points (respectively 42 and 24% of one standard deviation of these outcomes for this sub-group in the estimation sample).[38] On one hand, independently of the effective timing of the experience abroad, these students could be the ones who are most motivated to participate in the programme, and this implies both that they start applying earlier and that they put more effort into their studies while abroad. On the other hand, the year of first application should be a good predictor of the effective timing of the period abroad, which could influence both the learning process and the time management within the study career.

[36] P-value from the test of the hypothesis that the coefficients for females and males on the final mark are equal (column 3) is 0.76, hence equality of the coefficients cannot be rejected.

[37] For students in the estimation sample who graduated from STEM fields (9.5% of the estimation sample) the average final graduation mark is 104.5, with a standard deviation of 6.95.

[38] For students in the estimation sample who first apply to Erasmus in their first year of study career (31% of the estimation sample) the average number of months to graduate is 35 (with a standard deviation (s.d) of 3.85), the final graduation mark is 105.2 (s.d of 5.36) and the probability of graduating with distinction is 0.24 (s.d of 0.43).

Column 2 shows also that for students first applying for Erasmus during or beyond their last year of study, the study period abroad delays their study career, by increasing the time to graduation by more than 9 months.[39]

4.1 Potential mechanisms

The impacts of the Erasmus experience on students' graduation results are plausibly a combination of a direct effect through the students' achievement during the study period abroad and a more general impact on students' learning performance, which in turn affects academic results after the study period abroad until the end of the study career.

In this section, we exploit the information on specific characteristics of the mobility programmes to shed some light on potential mechanisms of the observed effects. In particular, we focus on the quality of the host institution and the length of the mobility programme. The former is measured with data from the *Shanghai Academic Ranking of World Universities*[40], which ranks approximately 2,000 universities every year based on several indicators of academic or research performance. These data are used to construct two measures of the relative quality of each host institution, namely being among the top 100 ranked institutions and being ranked above the University of Bologna.[41]

Clearly, the actual characteristics of the study abroad experience are only observed for those students who are treated. Thus, we adapt the RD design to estimate the causal impact of having participated in an Erasmus programme with a certain characteristic. More in details, we construct indicators of the individual being, in her first year of application, above the cutoff score in *at least* one ranking relative to applications to programmes with the relevant characteristics, and indicators of being, in the first year of application, above the cutoff score only in rankings relative to applications to programmes that do not have the characteristics of interest.

Table 7 reports the results of this empirical exercise.[42] The top and middle panels show

[39] For students in the estimation sample who first apply to Erasmus in their third year of study career (5% of the estimation sample, with only 0.5% applying when beyond the legal duration of their studies) the average number of months to graduate is 45.9 (with a st.dev. of 13.9).

[40] The yearly rankings are published online at http://www.shanghairanking.com. Details on the methodology can be found at the same link.

[41] We take the Shanghai ranking in 2012, the year before the starting year of our sample, to avoid that the ranking is endogenously determined by the inflow of Erasmus students in the foreign institutions. In this year, the University of Bologna was in the group ranked between the 201st and 300th position (only institutions up to the 200th position are precisely ranked).

[42] More in details, the four main outcomes are regressed on two variables: one takes the value 1 if the student, in

that only participating in mobility programmes in institutions of lower quality has a positive and significant effect on the final graduation mark (columns 3 of both panels). The evidence does not appear to confirm the theoretical hypothesis according to which a study experience abroad could improve students' learning performance by exposing them to better quality education. Alternative hypotheses could be formulated: one is that students who spend a period of study in an institution of lower quality have higher likelihood of obtaining better grades while abroad, because, for example, the subjects taught and/or the relative exams are 'easier' or the average quality of peers is lower, thus getting higher grades requires a lower level of effort compared to home university. Moreover, even conditional on the same subject/exam content, teachers at host institutions might be more 'lenient' in grading foreign students. On the other hand, the students' relative higher ranking among degree course mates or the acknowledgment of the relative better quality of education at the home university might motivate students to put more effort and do better both abroad and when back. Unfortunately, our data do not contain information on exams grades separately for exams taken abroad and before and after participation in Erasmus, and this does not allow us to directly test the alternative hypotheses.

We investigate whether the length of the period spent abroad has a role in explaining the observed effects. Similarly to above, the outcomes are regressed on a variable that takes the value 1 if the student, in her first year of application, has a score above the cutoff in *at least* one ranking relative to applications for mobility programmes of more than 6 months and a variable that takes the value 1 if the student, in her first year of application, has a score above the cutoff only in rankings relative to applications for programmes of shorter duration. The results are reported in panel (c) of table 7 and show that a positive and significant effect on the final graduation mark is observed when the impact of the probability of spending a longer period abroad is estimated. Finally, results from the estimation of the impact of quality of the host institution and length of the exchange program interacted, reported in table 8, show that the positive effect on the final graduation marks is observed for exchange programmes of higher duration in host institutions of relatively lower quality. On one hand, this evidence potentially indicates that a greater time investment in the experience abroad is not detrimental to the management of the student's time within the

her first year of application, is above the cutoff score in *at least* one ranking relative to applications to institutions of higher quality; the other takes the value 1 if in her first year of application the student is above the cutoff score only in rankings relative to applications in institutions of lower quality.

study career. On the other hand, it is compatible both with an improved learning performance mechanism, where a longer period of study abroad allows better adapting and maximising any potential positive effects on learning, as well as with the hypothesis that a longer period of study in the host institution allows accumulating a higher number of exams with potentially higher grades while abroad.

5 Concluding remarks

We estimate the impact of studying abroad with an Erasmus mobility grant on students' academic performance in one of the oldest universities in Europe, the University of Bologna in Italy. For this purpose, we exploit unique data on applications to the Erasmus programme submitted during the academic years 2013/2014-2018/2019 matched with administrative records on students who enrolled at a study career at the same university from the academic year 2007/2008 onwards.

Applications are ranked based on a score and the available mobility grants are assigned to the highest-ranked students. This allocation mechanism allows us to account for selection bias and to identify the causal impact of participating in the Erasmus programme on students' final graduation mark and time to graduation using a fuzzy regression discontinuity design.

Our main results show a positive effect on final graduation mark for bachelor students only and no significant effect on time to graduation for both bachelor and master students. We look at heterogeneous effects and find higher returns for bachelor students who graduate in a STEM field (science, technology, engineering and mathematics) and for those who apply for Erasmus in their first year of studies. Investigating potential mechanisms, we find that the positive effect on the final graduation mark seems to be driven by the relatively lower quality of the hosting university compared with the home university, and it is stronger for longer periods spent abroad.

Overall, our findings suggest that participating in a study abroad programme does not delay students' time to graduation, which is particularly relevant for the Italian context, where the duration of studies is among the highest in Europe. Whether better graduation marks of Erasmus participants reflect a higher accumulation of human capital or are rather driven by other mechanisms related, for example, to differences in exams and grading standards among home and host institutions, remains an open question. Additional data on Erasmus students' performance abroad

and at the home university before and after the study abroad program would help answering this question.

Future research should also look at the relationship between effects of ISM on academic performance and effects on labor market outcomes and potentially at how this relationship is shaped by the characteristics of the study abroad program.

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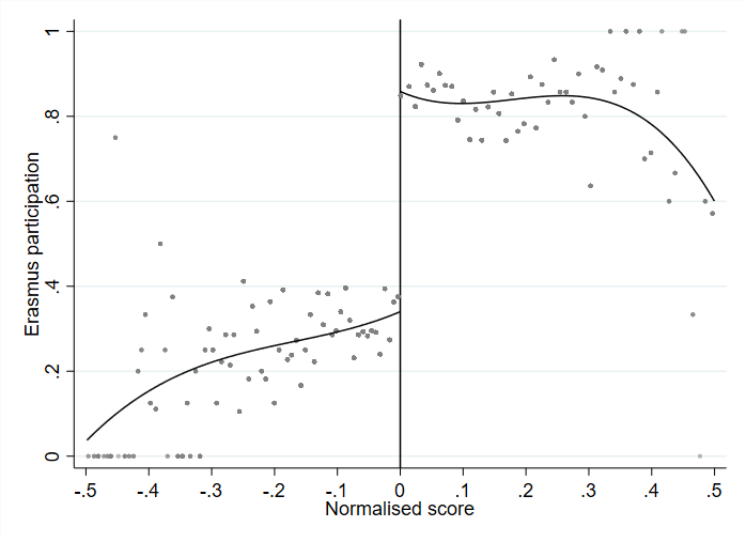
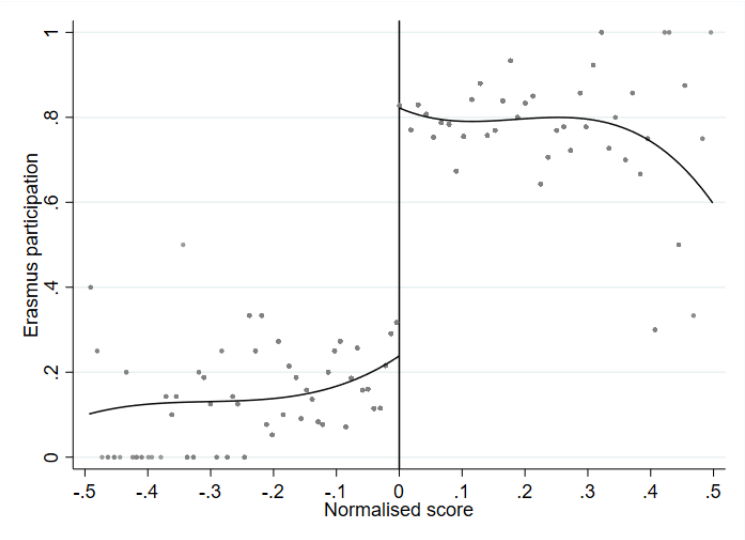
Figures and Tables

Figure 1: First stage plot

(a) Bachelor



(b) Master



Notes: The figure plots averages within bins of the running variable on the x-axis and a dummy for being 'treated' on the y-axis. The running variable is defined as the maximum of the normalised distances to the cutoff scores from different applications in the first year of participation to the call for applications. The cutoff score is the score of the last student offered the scholarship in each ranking. The dummy for being treated is constructed as being 1 for any student who has participated in the Erasmus programme at least once during his study career. The number of bins is calculated with the mimicking variance evenly-spaced method using spacings estimators. The relationship is fitted with a polynomial of order three.

Table 1: Descriptives by treatment status

	Degree Level							
	Bachelor				Master			
Variables:	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**
	No Erasmus		Erasmus		No Erasmus		Erasmus	
Students' characteristics								
Female	.58	(.49)	.66	(.48)	.51	(.5)	.55	(.5)
Moved from other region	.51	(.5)	.56	(.5)	.63	(.48)	.64	(.48)
Foreign born	.07	(.26)	.05	(.23)	.14	(.35)	.1	(.3)
Field of study:								
Education-Arts-Humanities	.23	(.42)	.38	(.49)	.17	(.37)	.24	(.43)
Social sciences	.37	(.48)	.38	(.49)	.31	(.46)	.29	(.46)
Business-Admin-Law	.18	(.38)	.1	(.31)	.18	(.38)	.13	(.34)
STEM	.15	(.35)	.08	(.28)	.31	(.46)	.3	(.46)
Health-Welfare	.05	(.22)	.03	(.18)	.01	(.09)	.01	(.12)
Agriculture-Veterinary	.02	(.15)	.02	(.14)	.02	(.15)	.02	(.16)
Applications								
Total nr. of applications:	1.86	(.94)	2.15	(.95)	1.75	(.73)	1.84	(.68)
Nr. of applications by ac.year:	1.65	(.64)	1.83	(.56)	1.69	(.64)	1.77	(.57)
Number exams at 1st application	5.88	(4.39)	4.39	(3.33)	.69	(1.5)	.6	(1.56)
Number ECTS at 1st application	50.09	(35.94)	38.55	(28.66)	5.33	(11.55)	4.4	(11.05)
Career year of first application (bachelor):								
First	.24	(.43)	.35	(.48)	-	-	-	-
Second	.6	(.49)	.62	(.49)	-	-	-	-
Third and beyond	.16	(.36)	.03	(.18)	-	-	-	-
Career year of first application (master):								
First (or 3rd bachelor)	-	-	-	-	.93	(.26)	.94	(.24)
Second and beyond	-	-	-	-	.07	(.26)	.06	(.24)
Outcomes at graduation								
Graduated on time	.85	(.35)	.91	(.29)	.79	(.41)	.79	(.41)
Time to graduation (months)	38.4	(7.89)	37.4	(6.68)	29.28	(6.6)	29.27	(5.72)
Final graduation grade	100.4	(8.06)	104.07	(6.39)	106.35	(5.16)	107.54	(4.04)
Prob. Distinction	.15	(.36)	.24	(.43)	.37	(.48)	.46	(.5)
Observations	1,728		2,864		1,212		1,885	

Notes: The table reports summary statistics for the final samples of bachelor and master students, separately for students who never participated in the Erasmus programme during their study career (columns "No Erasmus") and student participating in the Erasmus programme at least once over their study career (columns "Erasmus". The final sample is made of students who enrolled at the first year of a study career at the University of Bologna from the academic year 2007/2008 onward and applied to the Erasmus programme for a study abroad period between academic years 2013/2014 and 2018/2019, and who have graduated by the end of 2019 (the time at which data are extracted).

Table 2: First stage

	(a) Bachelor			(b) Master		
Dependent variable:	Erasmus participation			Erasmus participation		
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.523***	0.480***	0.505***	0.613***	0.495***	0.514***
	(0.039)	(0.051)	(0.054)	(0.058)	(0.080)	(0.087)
Observations	1,946	1,946	1,194	1,014	1,014	558
R-squared	0.633	0.634	0.642	0.686	0.690	0.709
Bandwidth	.1	.1	.05	.1	.1	.05
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of different specifications of the first stage equation (eq. 2), for both samples of bachelor and master students, namely: with varying order of the polynomial -order 1 in columns (1),(3) and (4),(6), and quadratic in columns (2),(4)- and varying bandwidth - from 0.1 in columns (1),(2) and (4),(5) to 0.05 in columns (3),(6). Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 3: Smoothness of pre-determined covariates

	(a) Bachelor		(b) Master	
Dependent variables:	(1)	(2)	(3)	(4)
Female	-0.0203	0.0146	-0.0355	-0.0476
	(0.0447)	(0.0591)	(0.0849)	(0.1154)
Foreign born	-0.0238	-0.0202	-0.001	-0.094
	(0.0243)	(0.0329)	(0.0538)	(0.0767)
Moved from other region	-0.0319	-0.0156	0.0906	0.1505
	(0.0467)	(0.0604)	(0.0745)	(0.101)
Nr. credits at 1st application	0.6797	0.1428	-1.6422	-2.906
	(2.2564)	(2.9488)	(1.2312)	(1.8112)
Nr. exams at 1st application	0.1362	0.0408	-0.2214	-0.4204*
	(0.2585)	(0.3348)	(0.1743)	(0.2517)
Observations	1,946	1,946	1,014	1,014
Bandwith	0.1	0.1	0.1	0.1
Model	Linear	Quadratic	Linear	Quadratic

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the coefficients and standard errors from the estimation of a reduced form equation, with a bandwidth of 0.1, for five pre-treatment variables, namely: an indicator of being female; an indicator of being born outside Italy; an indicator for having moved to another Italian region to study at the University of Bologna; the number of ECTS credits accumulated and the number of exams passed at the end of the calendar year preceding the calendar year of the application. Results from the estimation of specifications with polynomial of the running variables both of order 1 -columns (1) and (3)- and of order 2 -columns (3) and (4)- are reported. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 4: Main results – Time to graduation

(a) Bachelor sample

Dependent variables:	Prob. graduating on time			Time to grad.(months)		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.010	-0.001		-0.158	-0.071	
	(0.017)	(0.023)		(0.367)	(0.439)	
Erasmus participation			0.020			-0.302
			(0.032)			(0.701)
Observations	1,946	1,946	1,946	1,946	1,946	1,946
R-squared	0.562	0.563		0.619	0.620	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

(b) Master sample

Dependent variables:	Final graduation mark			Distinction		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.004	-0.032		-0.014	0.135	
	(0.042)	(0.062)		(0.595)	(0.899)	
Erasmus participation			0.006			-0.023
			(0.068)			(0.971)
Observations	1,014	1,014	1,014	1,014	1,014	1,014
R-squared	0.559	0.560		0.614	0.615	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of a reduced form equation (columns (1), (2), (4), (5) of both panels) and of an IV regression (columns (3) and (6) of each panel) for samples of bachelor -panel (a)- and master -panel (b)- students with a running variable within a bandwidth of 0.1, for two outcomes: namely, the probability of graduating without delay and the time to graduate measured in months. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 5: Main results – Graduation results

(a) Bachelor sample

Dependent variables:	Final graduation mark			Distinction		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	1.053**	1.224*		0.058	0.026	
	(0.508)	(0.650)		(0.038)	(0.049)	
Erasmus participation			2.012**			0.111
			(0.947)			(0.073)
Observations	1,946	1,946	1,946	1,946	1,946	1,946
R-squared	0.606	0.606		0.516	0.516	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

(b) Master sample

Dependent variables:	Prob. graduating on time			Time to grad.(months)		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.698	1.166		0.042	0.047	
	(0.653)	(0.825)		(0.074)	(0.106)	
Erasmus participation			1.139			0.068
			(1.071)			(0.121)
Observations	1,014	1,014	1,014	1,014	1,014	1,014
R-squared	0.519	0.520		0.516	0.516	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of the reduced form equation (columns (1), (2), (4), (5) of both panels) and of the IV regression (columns (3) and (6) of each panel) for samples of bachelor -panel (a)- and master -panel (b)- students with a running variable within a bandwidth of 0.1, for two outcomes: namely final graduation mark (which ranges between 66 and 110) and a dummy for graduating with distinction. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 6: Heterogeneity of effects across students characteristics - Bachelor sample

(a) Differential effects by gender

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
Female	0.014	-0.361	1.079**	0.058
	(0.018)	(0.379)	(0.515)	(0.041)
Male	0.004	0.176	1.010*	0.059
	(0.019)	(0.443)	(0.597)	(0.043)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.619	0.606	0.516

*** p<0.01, ** p<0.05, * p<0.1

(b) Differential effects by field of study

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
Arts & Humanities	0.015	-0.031	-0.050	0.027
	(0.025)	(0.486)	(0.566)	(0.052)
Social sciences, business and law	0.008	-0.033	1.273**	0.078*
	(0.021)	(0.430)	(0.641)	(0.046)
Science, Engineering & Maths	0.015	-1.266	3.541***	0.006
	(0.042)	(1.061)	(1.061)	(0.076)
Health & Welfare	0.008	-0.778	0.983	0.107
	(0.015)	(1.249)	(1.394)	(0.120)
Agriculture & Veterinary	-0.007	-1.944	2.829	-0.002
	(0.020)	(1.774)	(2.549)	(0.410)
Observations	1,946	1,946	1,946	1,946
R-squared	0.562	0.620	0.609	0.516

*** p<0.01, ** p<0.05, * p<0.1

(c) Differential effects by study career year of first application

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
1st year	0.018	-1.371***	2.255***	0.104**
	(0.020)	(0.479)	(0.635)	(0.048)
2nd year	0.010	-0.057	0.588	0.041
	(0.018)	(0.382)	(0.539)	(0.040)
3rd and beyond	-0.050	9.556***	-1.025	-0.026
	(0.056)	(2.184)	(1.157)	(0.095)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.655	0.611	0.517

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of the reduced form equation on the sample of bachelor students, with a running variable within a bandwidth of 0.1, for four outcomes, namely: the probability of graduating without delay, the time to graduate measured in months, the final graduation mark and a dummy for graduating with distinction. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 7: Heterogeneity of effects across program characteristics - Bachelor sample

(a) Differential effects by quality of host institution - top 100

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
Top 100	0.044	-0.286	-0.268	-0.005
	(0.036)	(0.707)	(0.964)	(0.083)
Lower ranked	0.007	-0.146	1.172**	0.064
	(0.017)	(0.374)	(0.515)	(0.039)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.619	0.606	0.516

*** p<0.01, ** p<0.05, * p<0.1

(b) Differential effects by quality of host institution - relative to UniBO

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
Ranked above UniBo	0.028	0.147	0.704	0.076
	(0.024)	(0.480)	(0.688)	(0.064)
Ranked below UniBo	0.006	-0.240	1.148**	0.054
	(0.017)	(0.387)	(0.529)	(0.040)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.619	0.606	0.516

*** p<0.01, ** p<0.05, * p<0.1

(c) Differential effects by duration of Erasmus scholarship

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
6 months or more	0.003	-0.105	1.261**	0.042
	(0.019)	(0.421)	(0.550)	(0.040)
Below 6 months	0.026	-0.268	0.621	0.091*
	(0.019)	(0.505)	(0.640)	(0.055)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.619	0.606	0.516

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of the reduced form equation on the sample of bachelor students, with a running variable within a bandwidth of 0.1, for four outcomes, namely: the probability of graduating without delay, the time to graduate measured in months, the final graduation mark and a dummy for graduating with distinction. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table 8: Interaction of quality of host institution and length of exchange programme

(a)

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
6 months or more & top100 uni	0.054	0.386	-0.459	-0.068
	(0.055)	(1.050)	(1.191)	(0.096)
6 months or more & below100 uni	-0.001	-0.116	1.383**	0.048
	(0.019)	(0.421)	(0.545)	(0.040)
below 6 months & top100 uni	0.066	-1.968	-0.827	0.068
	(0.057)	(1.907)	(1.227)	(0.074)
below 6 months & below100 uni	0.024	-0.127	0.688	0.089
	(0.020)	(0.510)	(0.657)	(0.057)
Observations	1,946	1,946	1,946	1,946
R-squared	0.563	0.619	0.607	0.517

*** p<0.01, ** p<0.05, * p<0.1

(b)

Dependent variables:	Grad. on time	Time to grad.	Final mark	Distinction
	(1)	(2)	(3)	(4)
6 months or more & above UniBo	0.012	0.388	0.869	0.064
	(0.023)	(0.517)	(0.714)	(0.069)
6 months or more & below UniBo	0.001	-0.293	1.393**	0.035
	(0.021)	(0.464)	(0.588)	(0.041)
below 6 months & above UniBo	0.110*	-1.240	0.043	0.123
	(0.064)	(1.161)	(1.160)	(0.115)
below 6 months & below UniBo	0.012	-0.093	0.709	0.086
	(0.018)	(0.535)	(0.680)	(0.058)
Observations	1,946	1,946	1,946	1,946
R-squared	0.564	0.620	0.606	0.516

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of the reduced form equation on the sample of bachelor students, with a running variable within a bandwidth of 0.1, for four outcomes, namely: the probability of graduating without delay, the time to graduate measured in months, the final graduation mark and a dummy for graduating with distinction. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Appendix A

Similarities with centralised school assignment

Our research design shares common features with the recent literature developing a methodology that generalises regression discontinuity designs to allow for multiple cutoffs and multiple running variables (Abdulkadroğlu et al., 2021).

In their context, i.e. centralised school assignment, the matching of kids to schools is realised through a scheme that takes as inputs information on applicants preferences (parents provide a preference ordering of schools for which they apply) and school priorities (in each school kids are assigned to priority groups based on observable family characteristics). Given preferences and priorities (labeled parental "type"), the offer of scarce school seats is determined by tie-breaker rules that can be lottery or 'general' (non-lottery, e.g. test scores). Parental type is likely correlated with potential outcomes; general tie-breakers play the role of an RD running variable and are likewise a source of omitted variables bias. The authors show how in their context the bias is eliminated controlling for a *local propensity score*- i.e. the ex-ante probability of receiving an offer quantified as a function of few features of student type and tie-breakers such as proximity to the admissions cutoffs and the identity of key cutoffs for each applicant- which they show having a distribution much coarser than the underlying type distribution. Conditional on the local propensity score, school assignments are shown to be asymptotically randomly assigned and school seat assignment provides a credible instrument for school enrolment.

More in details, for each school, they classify applicants as: *conditionally seated* if their (school-specific) tie-breaker value is in a neighborhood of the school admission cutoff (i.e. in the range $[\tau - h; \tau + h]$), where τ is the admission cutoff and h the selected bandwidth); *always seated* if the tie-breaker value is above the neighborhood of the admission cutoff (higher than $(\tau + h)$); *never seated* if the tie-breaker value is below the neighborhood of the admission cutoff (lower than $(\tau - h)$). The limiting local probability of assignment of a seat at each school is 0.5, 1 and 0 respectively for the three groups of applicants. The probability of being assigned to a specific school is derived as the school seat assignment probability at that school times the probability of being excluded in preferred schools (i.e. the disqualification rates at preferred schools, which depend on priorities and key cutoffs at preferred schools). The propensity score for assignment at any school with a

given characteristic is the derived as sum of the propensity scores for the single schools with the characteristic of interest (because the assignment algorithm generates a single offer for each kid). The authors then estimate a 2SLS model with saturated control for the local propensity scores and implementing local linear control for screened tie-breakers. Saturated regression-conditioning on the local propensity score eliminates applicants with score values of zero or one, and only local linear control for general tiebreakers for applicants to schools in which students are "conditionally seated" is implemented.

Relative to Abdulkadroğlu et al. (2021), our setting differs in some key features. Namely: the matching of students to Erasmus grants does not depend on program priorities (no applicant is granted priority at any program); preference ordering of applicants to two programs are not explicit at the moment of application and only when the first rankings are published preferences are potentially revealed, when students sort in the preferred program among the ones offered. Given only the participants set of applications, ties are broken in favor of applicants with the highest tie-breaker value, i.e. the score, which is the single non-lottery tie-breaker characterising our setting. For these reasons, the propensity score in our setting is just the probability of being conditionally seated in *at least* one programme and it can take only the values of 0, 1/2, 3/4 or 1.

More in details, the propensity score takes the values: 0 for students who submit two applications and in both they are classified as never seated; 1 for students who submit two applications and are classified as always seated in at least one application; 1/2 for students who submit one application and are conditionally seated, and for students who submit two applications and are conditionally seated in one and never seated in the other; 3/4 for students who submit two applications and are conditionally seated in both of them. Estimating our model by means of local linear regressions makes our approach comparable to the one proposed by Abdulkadroğlu et al. (2021): in particular, excluding individuals with their maximum score above (below) the selected bandwidth, i.e. the always (never) seated is implies excluding individuals with propensity score equal to 1 (0). Including in our model controls for the remaining two values of the propensity score leaves the results unchanged, as shown in tables A1 and A2. The tables report the results from the estimation of the model described in equations 1 and 2 with the inclusion of indicators of the propensity score taking values 1/2 or 3/4, for the four main outcomes.

Table A1: Time to graduation

(a) Bachelor sample

Dependent variables:	Prob. graduating on time			Time to grad.(months)		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.011	-0.001		-0.152	-0.057	
	(0.017)	(0.023)		(0.368)	(0.442)	
Erasmus participation			0.020			-0.291
			(0.032)			(0.704)
Observations	1,946	1,946	1,946	1,946	1,946	1,946
R-squared	0.563	0.563		0.619	0.620	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

(b) Master sample

Dependent variables:	Final graduation mark			Distinction		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.003	-0.031		-0.009	0.118	
	(0.041)	(0.062)		(0.591)	(0.909)	
Erasmus participation			0.005			-0.014
			(0.068)			(0.968)
Observations	1,014	1,014	1,014	1,014	1,014	1,014
R-squared	0.559	0.560		0.615	0.615	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of a reduced form equation (columns (1), (2), (4), (5) of both panels) and of an IV regression (columns (3) and (6) of each panel) including the control for whether the propensity score takes value 1/2 or 3/4, for samples of bachelor -panel (a)- and master -panel (b)- students with a running variable within a bandwidth of 0.1, for two outcomes: namely, the probability of graduating without delay and the time to graduate measured in months. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table A2: Graduation results

(a) Bachelor sample

Dependent variables:	Final graduation mark			Distinction		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	1.050**	1.215*		0.058	0.026	
	(0.508)	(0.651)		(0.038)	(0.049)	
Erasmus participation			2.007**			0.111
			(0.948)			(0.073)
Observations	1,946	1,946	1,946	1,946	1,946	1,946
R-squared	0.606	0.606		0.516	0.516	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

(b) Master sample

Dependent variables:	Prob. graduating on time			Time to grad.(months)		
	Reduced form		IV	Reduced form		IV
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.695	1.177		0.041	0.049	
	(0.652)	(0.824)		(0.074)	(0.106)	
Erasmus participation			1.140			0.067
			(1.077)			(0.122)
Observations	1,014	1,014	1,014	1,014	1,014	1,014
R-squared	0.519	0.520		0.517	0.517	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

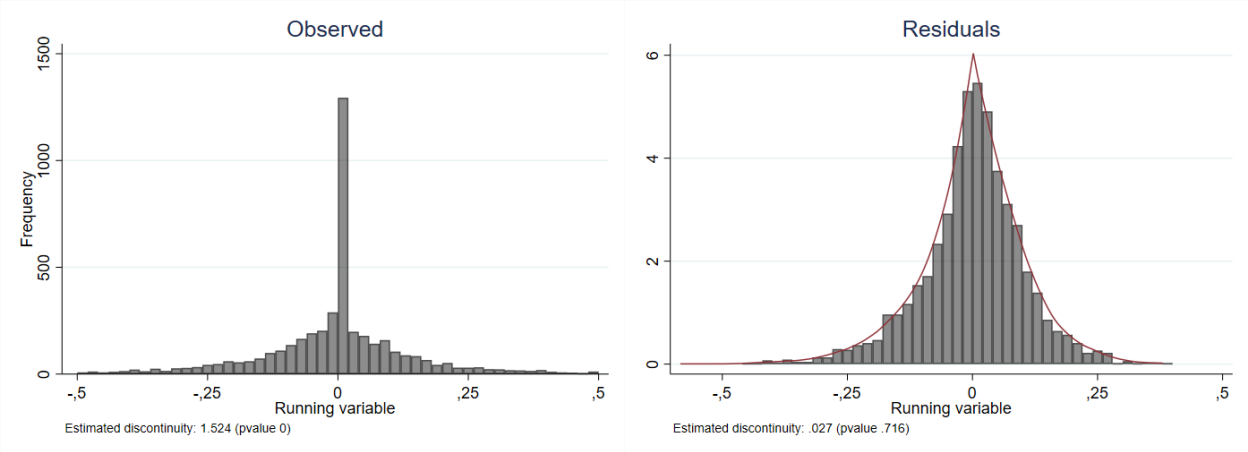
Notes: The table reports the results from the estimation of the reduced form equation (columns (1), (2), (4), (5) of both panels) and of the IV regression (columns (3) and (6) of each panel) including the control for whether the propensity score takes value 1/2 or 3/4,, for samples of bachelor -panel (a)- and master -panel (b)- students with a running variable within a bandwidth of 0.1, for two outcomes: namely final graduation mark (which ranges between 66 and 110) and a dummy for graduating with distinction. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Appendix B

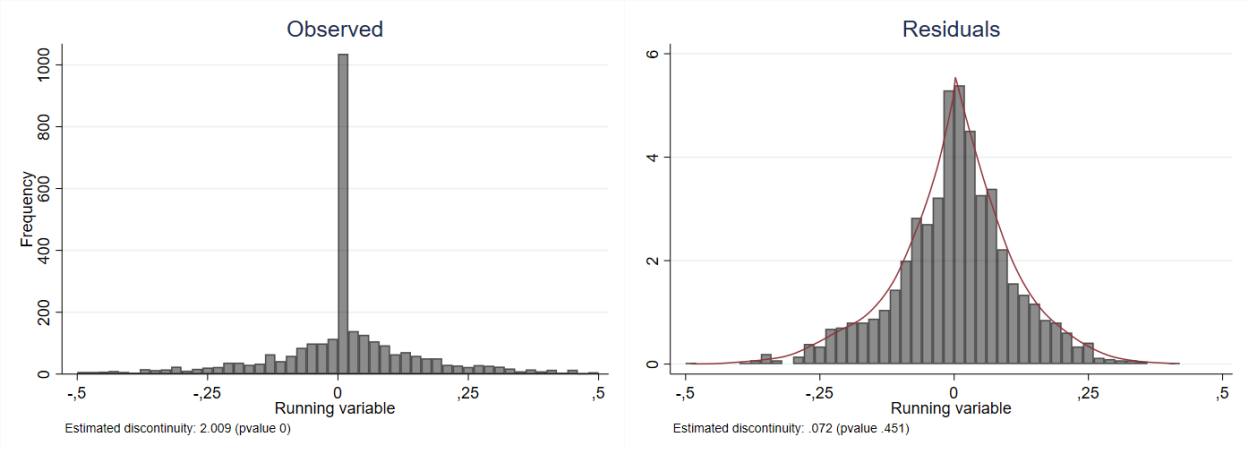
Additional Figures and Tables

Figure B1: Density of the running variable

(a) Sample of bachelor students



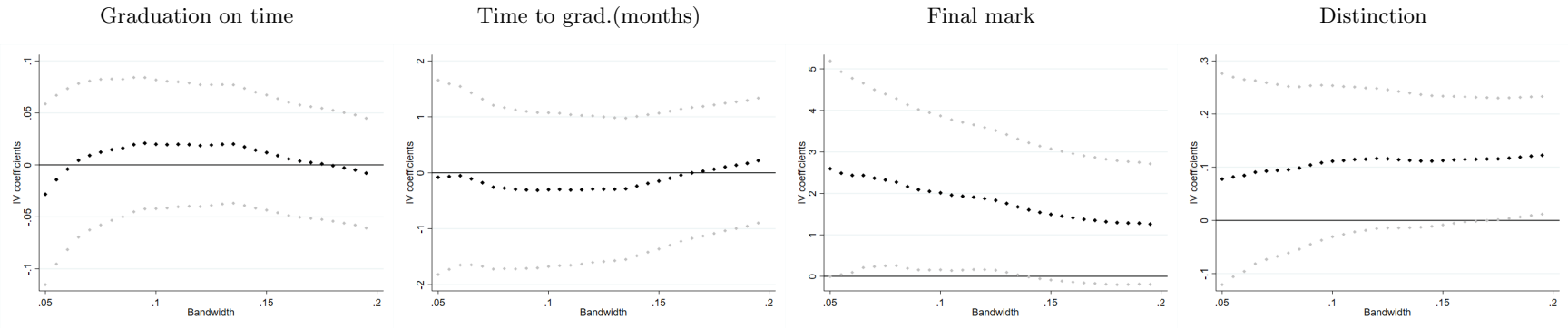
(b) Sample of master students



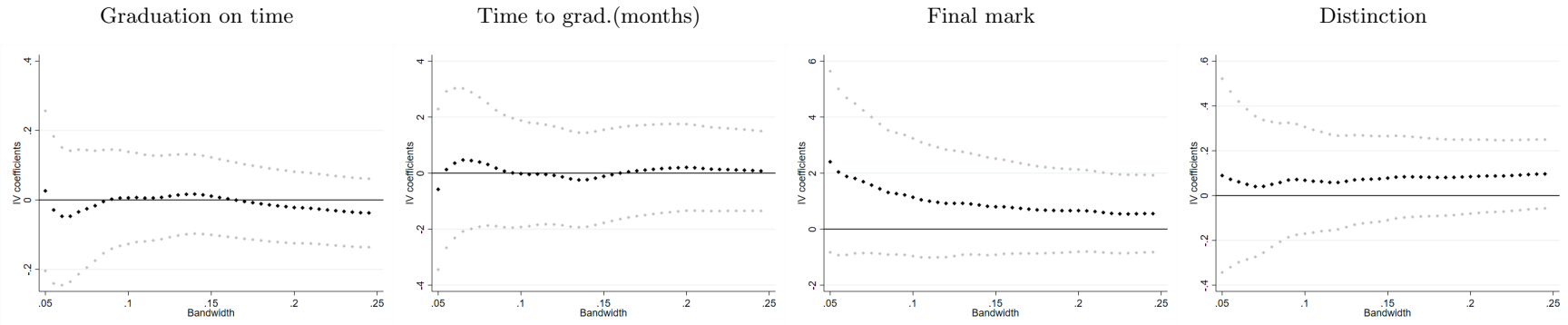
Notes: The figure plots the density of the running variable within a distance of 0.5 from the cutoff normalised to 0. The left graph of both panels displays the unadjusted density. The right graphs plot the density of the running variable net of the ranking fixed effects.

Figure B2: IV results - Different bandwidths

(a) Bachelor



(b) Master



Notes: The four figures of each panel plot the coefficients (dark dotted line) and the 95% confidence intervals (grey dotted lines) from the estimation of an IV regression with a 1st order polynomial of the running variable and a triangular kernel as function of different bandwidths for the four main outcomes, respectively for the samples of bachelor -panel (a)- and master -panel (b)- students. The four outcomes are: an indicator of the probability of graduating without delay, the number of months to graduate, the final graduation mark (which ranges between 66 and 110) and a dummy for graduating with distinction.

Table B1: Representativeness of sample of students from the University of Bologna

	University of Bologna	**All Italian Universities**
	(1)	(2)
Statistics:		
Nr. students first enrolled	136,046	2,848,842
Share of female students	0.56	0.55
Share of foreign students	0.08	0.05
Share of students by field of study:		
Education-Arts-Humanities	0.25	0.19
Social sciences	0.15	0.15
Business-Admin-Law	0.17	0.19
STEM	0.27	0.3
Health-Welfare	0.11	0.13
Agriculture-Veterinary	0.04	0.03

Notes: The table reports some selected statistics on the composition of respectively the sample of students enrolled to their first university career at the university of Bologna from academic years 2010/2011 to 2019/2020 -in column (1)- and the population of higher education students first enrolled in any Italian university within the same time period - column (2). Source: Italian Ministry of Education (data extracted from http://dati.ustat.miur.it/dataset/immatricolati).

Table B2: Descriptives on initial sample of calls for applications

Variables:	Mean	(s.d.)
Academic year:		
2013/2014	.14	(.35)
2014/2015	.15	(.36)
2015/2016	.17	(.37)
2016/2017	.18	(.38)
2017/2018	.18	(.38)
2018/2019	.18	(.38)
Nr. grants by call	2.31	(1.8)
Nr. Applications by call	3.6	(4.17)
Length:		
3-4 months	.03	(.17)
5-6 months	.56	(.5)
7-8 months	0	(.07)
9-10 months	.37	(.48)
11-12 months	.03	(.17)
Country of destination:		
Spain	.25	(.43)
France	.15	(.36)
Germany	.11	(.31)
UK	.06	(.24)
Belgium	.06	(.24)
Portugal	.05	(.22)
Others	.32	(.47)
Obs.	10,127	

Notes: The table displays summary statistics for the sample of all applications for an Erasmus grant funding a period of study abroad made from students enrolled at the University of Bologna between academic years 2013/2014 and 2018/2019.

Table B3: Descriptives on final samples

	Degree Level			
	Bachelor		Master	
Variables:	**Mean**	**S.d.**	**Mean**	**S.d.**
Students' characteristics				
Female	.63	(.48)	.54	(.5)
Moved from other region	.54	(.5)	.64	(.48)
Foreign born	.06	(.24)	.11	(.32)
Field of study:				
Education-Arts-Humanities	.32	(.47)	.21	(.41)
Social sciences	.38	(.48)	.3	(.46)
Business-Admin-Law	.13	(.34)	.15	(.36)
STEM	.11	(.31)	.3	(.46)
Health-Welfare	.04	(.19)	.01	(.11)
Agriculture-Veterinary	.02	(.14)	.02	(.15)
Applications				
Total nr. of applications:				
1	.28	(.45)	.33	(.47)
2	.52	(.5)	.55	(.5)
3	.11	(.32)	.09	(.29)
4to7	.09	(.29)	.02	(.14)
Nr. of applications by ac.year:				
1	.32	(.47)	.34	(.48)
2	.59	(.49)	.57	(.49)
3	.09	(.28)	.08	(.27)
Career year of first application (bachelor):				
First	.31	(.46)	-	-
Second	.61	(.49)	-	-
Third and beyond	.08	(.27)	-	-
Career year of first application (master):				
First (or 3rd bachelor)	-	-	.93	(.25)
Second and beyond	-	-	.07	(.25)
Number exams at application	4.95	(3.83)	.64	(1.54)
Number ECTS at application	42.89	(32.08)	4.76	(11.25)
Nr. Erasmus experiences:				
1	.61	(.49)	.6	(.49)
2	.01	(.11)	0	(.07)
Outcomes at graduation				
Graduated on time	.89	(.32)	.79	(.41)
Time to graduation (months)	37.78	(7.18)	29.27	(6.08)
Final graduation grade	102.69	(7.29)	107.08	(4.55)
Prob. Distinction	.21	(.41)	.43	(.49)
Observations	4,592		3,097	

Notes: The table reports summary statistics for the final samples of bachelor and master students. The final sample is made of students who enrolled at the first year of a study career at the the University of Bologna from academic year 2007/2008 onward and applied to the Erasmus programme for a study abroad period between academic years 2013/2014 and 2018/2019, and who have graduated by the end of 2019 (the time at which data are extracted).

Table B4: Graduates' sample selection

Dependent variable:	Probability of having graduated			
	(a) Bachelor sample		(b) Master sample	
	(1)	(2)	(3)	(4)
Above cutoff-score	-0.004	-0.000	-0.060	-0.073
	(0.018)	(0.024)	(0.037)	(0.049)
Observations	2,200	2,200	1,406	1,406
R-squared	0.633	0.633	0.737	0.737
Model	Linear	Quadratic	Linear	Quadratic

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of a reduced form equation with a triangular kernel and a bandwidth of the running variable of 0.1, where the outcome is the probability of being graduated. The samples are bachelor -panel (a)- and master -panel (b)- students who enrolled to the first year of a study career at the University of Bologna from academic year 2007/2008 and applied for Erasmus between academic year 2013/2014 and 2018/2019, and whose study career as of end of 2019 (the time at which data are extracted) should have already been concluded, according to the legal duration of their study course. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table B5: Alternative measures of time to graduation

(a) Bachelor sample

Dependent variables:	Grad. by July		Grad. by October		Grad. by December		Grad. by March	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Above cutoff-score	0.025	0.043	-0.012	-0.012	-0.018	-0.033	0.013	-0.003
	(0.042)	(0.055)	(0.027)	(0.034)	(0.028)	(0.034)	(0.019)	(0.025)
Observations	1,946	1,946	1,946	1,946	1,946	1,946	1,946	1,946
R-squared	0.536	0.536	0.723	0.723	0.564	0.564	0.553	0.554
Model	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic

*** p<0.01, ** p<0.05, * p<0.1

(b) Master sample

Dependent variables:	Grad. by July		Grad. by October		Grad. by December		Grad. by March	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Above cutoff-score	-0.037	-0.046	-0.077	-0.092	-0.034	-0.022	0.015	-0.020
	(0.039)	(0.047)	(0.059)	(0.078)	(0.069)	(0.096)	(0.041)	(0.062)
Observations	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014
R-squared	0.446	0.447	0.603	0.603	0.602	0.602	0.559	0.559
Model	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results for the estimation of the reduced form equation on the sample of bachelor and master students -respectively in panel (a) and panel (b)- for four alternative measures of the time to graduation, namely the probability of graduating within: July of the last year of the degree's legal duration (3rd for bachelor students and 2nd for master students) -columns (1) and (2) of both panels; October of the last year of the degree's legal duration-columns (3) and (4) of both panels; December of the last year of the degree's legal duration-columns (5) and (6) of both panels; March of the year following the last year of the degree's legal duration-columns (7) and (8) of both panels. The estimations are performed on samples within a bandwidth of 0.1. Errors are clustered at the ranking level. Robust standard errors in parentheses.

Table B6: Effect on GPA before graduation

Dependent variable:	GPA before graduation					
	(a) Bachelor Sample			(b) Master Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
Above cutoff-score	0.265**	0.299*		0.084	0.190	
	(0.131)	(0.169)		(0.188)	(0.241)	
Erasmus participation			0.507**			0.136
			(0.246)			(0.306)
Observations	1,946	1,946	1,946	1,014	1,014	1,014
R-squared	0.631	0.631		0.565	0.565	
Model	Linear	Quadratic	Linear	Linear	Quadratic	Linear

*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results from the estimation of the reduced form equation (columns (1), (2), (4), (5) of both panels) and of the IV regression (columns (3) and (6) of each panel) for samples of bachelor -panel (a)- and master -panel (b)- students with a running variable within a bandwidth of 0.1, for the average exams mark before at the end of the study career before graduation. Errors are clustered at the ranking level. Robust standard errors in parentheses.