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University student achievements and international mobility. The case of University of Cagliari

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We investigate if Erasmus mobility has a positive impact on the career of students. The focus is on graduation bonus, the difference between the final degree grade and the base degree score computed before graduation, that depends from the average mark obtained at the exams. Observing students graduated at the university of Cagliari, Italy, graduation bonus is modeled as a function of other student-specific variables concerning characteristics of students, academic performance and international mobility. The statistical analysis is framed within the case-control studies and utilizes model averaging to obtain robust results. The same approach is used to evaluate the effectiveness of different Erasmus programs through post-hoc tests. Results document the effect of international mobility on the graduation bonus is context-specific as it depends on the faculty and the type of degree a student is enrolled. Moreover, the positive effect of international mobility is more evident for the Erasmus Studio program.

keywords: Mobility experience, Grade Point Average, Final Degree Grade, Graduation Bonus, Placement and traineeship, Erasmus, Case-control, Model averaging, post-hoc test

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1 Introduction

Several international study programs have been developed in the last decades. They offer students the opportunity to move abroad and study in different foreign universities, writing their own thesis or taking a business traineeship up. This kind of programs can be realized during different levels of degree: short cycle, Bachelor, Master or PhD. Generally, their aim is to refine and complete the students' career. Complementarily, the aim of these programs is to favorite the mobility of the university students around the world, so as to develop cultural sharing and to improve their knowledges, competences and skills (Kehm, 2005; Camiciottoli, 2010; Wilson, 2011; Jacobone and Moro, 2015; dalle Rose, 2015; Durán Martínez et al., 2016; Amendola and Restaino, 2017).
Among the different programs, Erasmus and Globus are the most well-known. Erasmus has been developed by European Union in 1987 (Teichler, 2004; Kehm, 2005; Otero, 2008; Camiciottoli, 2010; Parey and Waldinger, 2010; Wilson, 2011; González et al., 2011; Rodrigues, 2012; Özdemir, 2013; Varela, 2016; Turhan et al., 2016). It can be defined as *an educational program that gives the university students the opportunity to study from three to twelve months at an EU university or a candidate country* (Özdemir, 2013, p. 686). Its aim is to promote and to support students exchanges between institutions of higher education (Kehm, 2005; Camiciottoli, 2010; Parey and Waldinger, 2010). The results obtained by Erasmus have been being significant. At the end of 2008, roughly two million European students had studied abroad on Erasmus exchanges in more than 3,100 institutions across 31 participating countries (Camiciottoli, 2010; Parey and Waldinger, 2010). The European Commission European Commission (2019) has stated that over nine million students have chosen to realize an Erasmus experience since the launch of the program in 1987.
Globus has the same characteristics and aims of Erasmus, the unique difference concerns the area of exchange. In this case, the study-abroad period can be done in universities located outside of Europe.
Several researchers have investigated the effects of realizing an international study program either on the students' final degree grade or on their grade point average (GPA). Generally, the differential score between the Final Degree Grade (FDG) and GPA, named *graduation bonus*, is determined by different elements, such as the quality of the thesis, the regularity of the carrier but also the mobility experience. The aim of this work is to evaluate the effects of experiencing an international study program on the graduation bonus $\delta = \text{FDG} - \text{GPA}$. The measurement of the differential score δ is an innovative aspect. In fact, we believe that the GPA has the limitation to be affected mainly by the grades of the exams and by the credits attributed for each exam, that usually are not uniformly distributed across the exams. In view of that, it is difficult to evaluate the increase of FDG generated by the international study programs. In the same way, FDG has the limitation to be defined starting from GPA, that is, it is directly linked to GPA and strongly conditioned by it. Consequently, we believe it is difficult to comprehend the real impact of realizing a mobility program on the FDG. We estimate the impact of the international study programs on university careers of graduated students who enrolled at University of Cagliari (Italy), a mid-size Italian university located in the region of

Sardinia. No other studies evaluate this aspects taking into account this area and this type of university. The results demonstrate that the effect of the international experience on students' academic performance is context-specific and thus it is not generalizable.
The remainder of the paper is organized as follows. Contribution to the research and related literature are presented in Section 2. The research design, which includes data and methodology, is described in Section 3 and Section 4. The results are presented in Section 4. Finally, Section 5 ends the paper with some concluding remarks.

2 Literature review

Several researchers have investigated the effects of international study programs on students' carriers, particularly the Erasmus program. They have analyzed the main factors pointing out that a mobility experience is connected with the personal profile, family and relationship context of the student, as well as with the features of the program, the promotion that takes place in the universities and the characteristics of the countries (see, for instance: Otero et al. (2006); Pineda et al. (2008); González et al. (2011); Wei (2013)).
Some researches have analyzed the impact of Erasmus on the subsequent professional activity evaluating the benefits in terms of employment (see, for instance: Bracht et al. (2006); Teichler and Janson (2007); Rodrigues (2012); Bryła (2015); Amendola and Restaino (2017); Petzold (2017)), the effects on the international labour market mobility of graduated students (see, for instance: Parey and Waldinger (2010); Rodrigues (2012)), the effects on professional training and personal development of students (see for instance Rodrigues (2012); European Commission (2014); Dolga et al. (2015); Jacobone and Moro (2015); dalle Rose (2015); Turhan et al. (2016)), and the impact on the development of the specific skills such as the cultural intelligence and intercultural competences (see for instance dalle Rose (2015); Durán Martínez et al. (2016); Ramsey and Lorenz (2016); Schartner (2016)). Furthermore, other researchers have focused on the impact of Erasmus on European identity in order to comprehend whether the promotion of the university exchange within the European countries can support the development of European citizens (see, for instance: Sigalas (2010); King and Ruiz-Gelices (2003); Oborune (2013); Jacobone and Moro (2015)). Finally, some researchers have studied the impact of realizing an Erasmus program on the students' performance.
Generally, these studies concern the identification, and quantification, of a direct impact of the Erasmus experience on the university carrier. Specifically, Sanz-Sainz and Roldán-Miranda (2006) have studied the effect of Erasmus on the academic performances. They have analyzed the academic performances of 174 English Department students enrolled at University of Granada who realized an Erasmus experience between 1997 and 2000. In order to comprehend the real impact of the international study program, they have realized two different analyses. Firstly, they have compared the academic performance by estimating the difference in the mean GPA before and after the mobility through the paired-sample t-test and, in a similar manner, the difference in the mean GPA before and during the mobility. Secondly, they have compared the GPA of the students who

have realized an Erasmus experience with those who have spent all time at University of Granada. The results evidenced generally a significant increase of GPA for the students who have realized an Erasmus program and higher results obtained during the mobility with respect to the grades obtained before it. Finally, they have highlighted how the students with higher grades maintain steady university performance before and after the mobility.

Later, González-Baixauli et al. (2018) have evaluated the academic performance of the students from the Faculty of Economics of the University of Valencia over a period of 13 academic years, from 2001-02 to 2013-14. Their aim was to comprehend if the academic mobility program had a direct effect on the students' performance. In order to reach this goal, they estimated a regression model using GPA as response variable. The model evidenced a significant contribution of the mobility to the academic performance, and higher GPA during the mobility period with respect to the prior GPA. Their results also highlighted that women obtained better results in all stages of the university years as well as Bachelor students had a slightly better academic performance than the other students. To sum up, the variables that impact significantly on the GPA are the academic background of the parents, the gender (female status) and the mobility.

A similar study has been realized by Czarnitzki et al. (2018), where the impact of the mobility on the academic performance of the students enrolled in the KU Leuven University in Belgium has been evaluated. Specifically, 5,138 students who started their studies from 2006 to 2010 were observed. The students were enrolled in four different faculties: Economics and Business, Law, Engineering and Science. Variables related to the students' carrier, family and mobility were considered for the statistical analysis. The influence of the mobility program on the academic performance has been assessed through a regression model using the *Grade difference* as response variable. The latter is the difference between the *weighted average grade of the student after exchange* and the *weighted average grade of the student before application for exchange*. The results showed a general negative effect of Erasmus on students' academic performance. The worst results have been obtained for the Faculties of Economics and Business, Engineering and Science. On the contrary, it was not possible to identify significant effects for the students in Law. In addition, a greater positive effect for students leaving on exchange with the Erasmus program compared to mobile students leaving for a destination outside Europe has been identified. In this case, the variables that impact significantly on the *Grade difference* are the gender (female status), the Erasmus program experience and the faculty (Economics has a negative impact).

Finally, Meya and Suntheim (2014) have analyzed the effect of Erasmus program on university students' success. They have taken into account two different aspects. Firstly, they have studied the effect of Erasmus on FDG. Secondly, they have examined whether a study-related visit abroad affects the probability of finishing the bachelor studies in time. In order to reach the first aim, they have used a dataset about more than 2,500 students in the Göttingen University (Germany) who successfully completed their bachelor studies between 2006 and 2011. They have estimated a regression model with FDG as response variable. The results have showed that spending time to study abroad has a positive effect on FDG. Moreover, it has been highlighted that the variables gender

(female status), High School GPA and Private Health Insurance have a positive impact on the final degree vote.
The present study is in line with most of the above-mentioned ones. It focuses on the Italian university system which has not been considered so far and, in particular, on the University of Cagliari, a medium-sized Italian university located in the isle of Sardinia. Beside previous literature, this study considers a different metric of students' performance, that we call *graduation bonus*. It is the additional mark that students' receive in almost all Italian universities to increase the final mark of the degree awarded. It depends on many elements that concur to quantify its magnitude: among them, the most important ones are timeliness of the student career, quality of the graduation thesis and its public defense, GPA and international mobility experience. The main aim of this study, that distinguishes it from previous literature, is precisely to quantify the impact of the international mobility experience on the graduation mark. The analysis is carried out using an innovative research design based on a case-control modeling framework, that is described in Section 4.

3 Data and descriptive statistics

The study is based on data about 10,559 students graduated at the University of Cagliari from 2015 to 2017. Hereinafter, we refer to the whole dataset with the acronym UNI. These students have been enrolled in six faculties: Biology and Pharmacy (BP), Sciences (S), Engineering and Architecture (EA), Medicine and Surgery (MS), Economic, Legal and Political Sciences (ELPS) and Human Sciences (HS).
The data allows us to consider two different information. The first one contains student's school record and university career, specifically: personal information (sex, residence, age); high school grade; years of enrollment at the university and attainment of the degree; years late with studies; faculty and study course; final degree grade (FDG) and average mark of the exams (GPA). Instead, the second group contains information about the mobility experiences: number of international experiences; destination country; duration expressed in days; credits achieved during the experience; program type (Erasmus or Globus) and typology of experience (placement, study or traineeship).
In this dataset, about 62% of the graduated students are women (6,580 units), as shown in Table 1. They are quite uniformly distributed over the three years: 3,329 in 2015, 3,563 in 2016 and 3,667 in 2017. Concerning the faculties, the majority of students is enrolled in Human Sciences (3,049 students, about 29%), followed by Economic, Legal and Political Sciences (2,826, about 27%), Engineering and Architecture, (1,986, about 19%) Medicine and Surgery (1,311, about 12%), Pharmacy and Biology (736, about 7%) and Science (651, about 6%).
The number of students who experienced an international mobility program is significantly lower than the total graduated students ($< 20\%$), as evidenced in Table 2. Moreover, these students preferred the Study program more than the Traineeship and Placement ones. This preference could be also justified by the higher number of places for the Study program rather than the Traineeship and Placement program. Figures 1 and 2

show that the favorite destinations are Spain, England and Germany for Erasmus, and USA for Globus. The graduated students who experienced international mobility during their university career have achieved better results in terms of average final graduation mark (average FDG: it ranges between 66 and 110 cum laude), average mark at the exams (average GPA: it ranges between 18 and 30 cum laude) and timeliness of the career compared to those who graduated without experiencing international mobility. This positive effect is observed in all faculties, as highlighted in Table 3. This result is consistent with the results obtained by Sanz-Sainz and Roldán-Miranda (2006) and Meya and Suntheim (2014). It is supposed that students who move from their home-country university to a foreign university are more motivated and with the better performances than students who stay in their university without moving abroad and, for this reason, they graduate with higher marks.

Table 1: Students per courses and gender

	2015		2016		2017		Tot	
	Male	Female	Male	Female	Male	Female	Male	Female
Uni	1245	2080	1319	2234	1405	2257	3969	6571
Uni_{IE}	176	268	239	418	309	496	724	1182
MS	142	255	159	278	171	305	472	838
MS_{IE}	22	12	38	38	41	66	101	116
BP	52	173	70	202	82	157	204	532
BP_{IE}	6	19	12	37	30	45	48	101
EA	387	255	386	280	423	255	1196	790
EA_{IE}	48	40	64	64	84	56	196	160
S	127	100	138	76	145	64	410	240
S_{IE}	13	13	12	4	14	6	39	23
ELPS	384	539	386	572	378	561	1148	1672
ELPS_{IE}	61	67	88	114	88	117	237	305
HS	153	758	180	826	206	915	539	2499
HS_{IE}	26	117	25	161	52	199	103	477

The subscript IE indicates the statistics concern the subset of the students who have realized an international experience.

4 Inference about the effect of international mobility on graduation bonus

The main aim of the statistical analysis is understanding whether students experiencing international mobility are able to increase the graduation bonus, called δ, as well as if there are differences in the effect of international mobility on δ for different categories of

Table 2: The mobility experience: placement, study or traineeship (percentage) - 2015/2017

	No experience	Traineeship	Study	Placement
UNI	82	4	11	3
MS	83	4	11	2
BP	80	6	12	2
EA	82	4	11	3
ELPS	81	5	9	5
S	90	2	7	1
HS	81	5	11	3

students, i.e.: students enrolled in a (two-years or at least four-years) Bachelor degree compared to those enrolled in a Master degree, or for students enrolled in the different faculties (schools) of the University of Cagliari. As in all Italian universities, the graduation bonus is the difference between the final degree grade and the base graduation score, the latter computed multiplying the grade point average by 11/3.
As it has emerged from the descriptive statistics, the number of students experiencing international mobility in the period 2015-2017 is rather reduced compared to the total number of enrolled students, thus a rough comparison of the students who experienced the mobility with those who did not is not adequate due to this imbalance. In view of that, we decided to follow a different strategy in the analysis. The latter is based on modeling the graduation bonus δ as a linear function of some of the observed student-specific variables but, at the same time, framing the modeling step within the case-control study context to derive the estimated model parameters through model averaging.
Notationally, for the n observed students we consider a matrix $\mathbf{D} = \{\mathbf{d}_1, \ldots, \mathbf{d}_n\}$ where each element $\mathbf{d}_i = (\mathcal{F}_i, \boldsymbol{\delta}_i, \mathbf{x}_i)$ corresponds to a row vector with $\mathbf{x}_i = (\mathbf{g}_i, \mathbf{v}_i)$. Specifically:

- $\mathcal{F}_i$ is a categorical variable indicating the faculty in which students are enrolled;
- $\boldsymbol{\delta}$ is the vector of the values of the graduation bonus δ;
- $\mathbf{G} = [\mathrm{B4}, \mathrm{M2}]$ is a $(n \times 2)$ matrix made up of the column vectors B_4 and M_2, which are two dummy variables indicating the type of degree. They concern, respectively, the bachelor degree (B_4) that lasts at least four years (4yrs Bachelor) and the two-years master degree (M_2, Master). This matrix is equivalent to a design matrix that considers the bachelor degree that lasts three years (3yrs Bachelor) as the baseline category;
- $\mathbf{V}$ is a $(n \times 5)$ matrix made up of the following variables:
  - Reg: a dummy variable that equals one if the student is regular;

Table 3: Academic performance indicators

	UNI	UNI_{IE}	MS	MS_{IE}	BP	BP_{IE}	EA	EA_{IE}	S	S_{IE}	ELPS	ELPS_{IE}	HS	HS_{IE}
Ave(FDG)	102.494	106.352	107.943	109.839	105.01	107.268	102.335	106.441	101.9	107.129	98.679	105.67	103.253	105.312
Std.err	7.604	5.140	3.741	0.906	6.061	4.189	7.045	5.274	8.396	4.625	8.535	5.563	6.483	5.249
CV	0.074	0.048	0.035	0.008	0.058	0.039	0.069	0.050	0.082	0.043	0.086	0.053	0.063	0.050
Ave(GPA)	26.344	27.334	27.621	28.410	26.634	27.146	25.886	27.140	25.993	27.444	25.492	27.169	26.886	27.24
Std.err	2.032	1.545	1.382	0.806	1.795	1.589	2.152	1.732	2.332	1.579	1.965	1.532	1.750	1.474
CV	0.077	0.057	0.050	0.028	0.067	0.059	0.083	0.064	0.090	0.058	0.077	0.056	0.065	0.054
Ave(δ)	1.867	2.097	2.368	2.472	2.413	2.646	2.220	2.241	2.056	2.257	1.560	2.009	1.518	1.790
Std.err	0.740	0.723	0.597	0.654	0.791	0.814	0.421	0.480	0.729	0.777	0.771	0.739	0.582	0.656
CV	0.396	0.345	0.252	0.265	0.328	0.308	0.190	0.214	0.355	0.344	0.494	0.368	0.383	0.366
Ave(Yrs Late)	1.464	0.941	0.479	0.240	1.487	0.819	1.910	1.444	1.105	0.581	1.675	0.924	1.492	0.979
Std.err	1.664	1.077	1.053	0.567	1.710	1.109	1.753	1.311	1.572	0.915	1.656	0.977	1.653	0.995
CV	1.136	1.145	2.196	2.368	1.150	1.355	0.918	0.908	1.422	1.576	0.989	1.056	1.108	1.016
n	8,634	1,906	1,093	217	587	149	1,630	356	588	62	2,278	542	2,458	580

The subscript IE indicates the statistics concern the subset of the students who have realized an international experience. The Ave(FDG) is the average final degree grade. The Ave(GPA) is average grade point (GPA) of entire career. δ is the graduation bonus, i.e., the differential score between the final mark of the degree awarded (FDG) and the grade point average (GPA). It corresponds to the additional points attributed for the degree by the graduation commission. The Ave(Yrs Late) identifies the average years off course of the students at the time of discussion of the thesis. Moreover, Std.err is for standard error, CV is the coefficient of variation and n indicates the size of the sets.

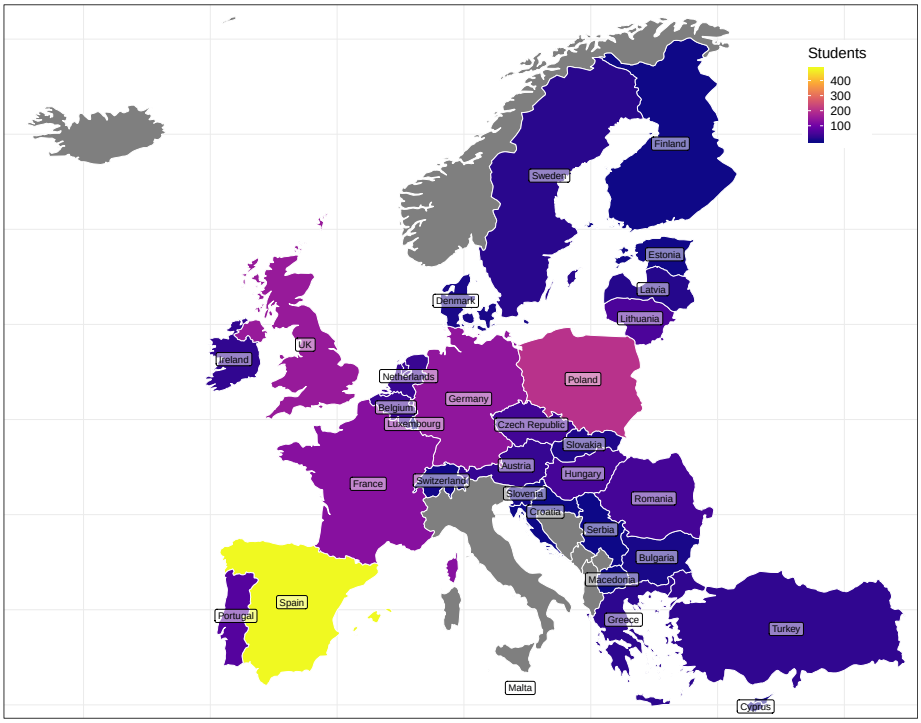

Figure 1: Destinations of Erasmus program of the students of University of Cagliari from 2015 to 2017.

- HDegree: a dummy variable that equals one if the student has been graduated cum laude;
- Gender: a dummy variable that equals one if the student is male;
- HSGrade: the grade obtained by the student at the high school diploma;
- IExp: a dummy variable that equals one if the student has been involved at least once in an international mobility program during his academic career.

Next, we model $\boldsymbol{\delta}$ as $\boldsymbol{\delta} = f(\mathbf{X}) + \boldsymbol{\epsilon}$. Among the set of possible specifications of $f(\mathbf{X})$, we consider a linear model specified as follows:

$$\begin{aligned} \delta_i = f(\mathbf{x}_i) + \epsilon_i \quad &= \quad \beta_0 + \beta_1 \text{IExp}_i + \beta_2 \text{Reg}_i + \beta_3 \text{HDegree}_i + \beta_4 \text{Gender}_i + \beta_5 \text{B4}_i \\ &+ \quad \beta_6 \text{M2}_i + \beta_7 \text{HSGrade}_i + \beta_8 (\text{Reg}_i \times \text{IExp}_i) + \beta_9 (\text{HDegree}_i \times \text{IExp}_i) \\ &+ \quad \beta_{10} (\text{Gender}_i \times \text{IExp}_i) + \beta_{11} (\text{B4}_i \times \text{IExp}_i) + \beta_{12} (\text{M2}_i \times \text{IExp}_i) \\ &+ \quad \beta_{13} (\text{HSGrade}_i \times \text{IExp}_i) + \epsilon_i \end{aligned} \tag{1}$$

where ϵ is the error term.
The model (1) is estimated within a case-control study framework considering the students who experienced international mobility as the *cases* (IExp = 1) whilst those who did not had that experience as the *controls* (IExp = 0). Case-control studies have specific

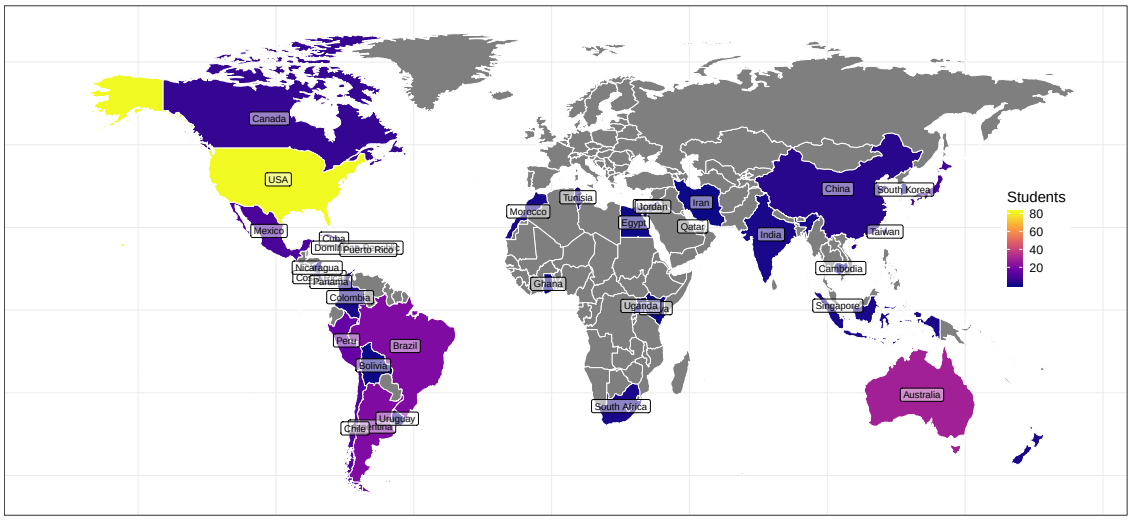

Figure 2: Destinations of Globus program of the students of University of Cagliari from 2015 to 2017.

advantages compared to other study designs. They are comparatively quick, inexpensive, easy and useful when investigating about events which are rare or still uncommon. From the medical and epidemiological literature (e.g. Baughman et al. (2001)) it is well known that this kind of study is designed to help determining if an exposure is associated with an outcome (i.e., disease or condition of interest). The transposition of model (1) to the case-control framework is straightforward. First, we identify the cases and the controls according to the variable IExp. Next, we inspect the data to learn which subjects in each group had the exposure, comparing the intensity of δ in the case group to that in the control group. This intensity is provided by the estimated coefficient $\hat{\beta}_1$ in Eq. 1. Thus, the exposure is δ and a first indicator of the effect of the exposure on the status of the cases with respect to that of the controls is the difference in δ between students who moved and those who did not move. If all other variables included in model 1 are kept fixed, the estimated graduation bonus corresponds to $(\hat{\beta}_0 + \hat{\beta}_1)$.

Although we have data from 2015 to 2017, our main interest is not in estimating trends or inter-annual variations. Instead, the main interest is in estimating the effect of international mobility on δ. Thus, we consider a particular design where data are observational and cross-sectional. The main goal is contrasting students who experienced mobility (cases) with students who did not (controls). Thus, model averaging is used

because the reference linear model is applied on different sub-samples of the original data and the results are averaged. In practice, we consider the subset of students who experienced international mobility and select many random samples of students who did not experienced international mobility. Each time, the observed subset of cases is joined with the selected sample of controls and the model specified in the Eq. 1 is estimated. The random sample of students who did not move has the same size of the observed subset of students who did move, thus the experiment is balanced with respect to the number of students who had international mobility and those who did not had this experience. The final estimated coefficients are computed from averaging the estimated model coefficients obtained from each balanced experiment.

Notationally, the above-described procedure corresponds to partition $\mathbf{D}$ into two complementary subsets $\mathbf{I}$ and $\mathbf{N}$ such that $\mathbf{I} = \{\forall \mathbf{d}_i \in \mathbf{D} : \text{IExp}_i = 1\}$ is the case group and $\mathbf{N} = \{\forall \mathbf{d}_i \in \mathbf{D} : \text{IExp}_i = 0\}$ is the control group. Since $|\mathbf{N}| \gg |\mathbf{I}|$, a new balanced set $\mathbf{S} = \mathbf{I} \cup \mathbf{N}^*$ in which the elements of $\mathbf{N}^*$ are drawn with replacement from $\mathbf{N}$ is defined. In $\mathbf{S}$, the number of elements of $\mathbf{N}^*$ equals $|\mathbf{I}|$. Resampling B times ($B \gg 0$), we consider $\mathbf{S}_b = \mathbf{I} \cup \mathbf{N}^*_b$, with $b = 1, \ldots, B$, and $\mathbf{X}_b = \{\forall \mathbf{x}_i \in \mathbf{X} : \mathbf{s}_i \in \mathbf{S}_b\}$. Next, B models $\boldsymbol{\delta} = f(\mathbf{X}_b) + \boldsymbol{\epsilon}$ are estimated and the final value of the estimated coefficients is obtained from averaging the estimated coefficients as follows:

$$\hat{\beta}_k = B^{-1} \sum_{b=1}^{B} \hat{\beta}_k^{(b)} \quad \text{with } k = 0, \ldots, 13. \tag{2}$$

The central role in the model specified in Eq. 1 is played by the variable IExp and the interaction effects between this variable and the other ones. As for the expected sign of the regression coefficients, we expect a positive effect of the variables IExp and Reg whilst it is not possible to conjecture a specific effect of other variables and their interactions. For them, the analysis is carried out in an explorative manner.
Moreover, another peculiarity of both the proposed case-control setting and the related model averaging approach is that it allows to quantify the net effects of the international mobility on δ. For a single model estimated according to Eq. 1, it corresponds to $(\hat{\beta}_1 + \sum_{i=8}^{13} \hat{\beta}_i)$ and measures the direct effect that IExp has on δ at the net of all other considered factors. Since we estimate different models taking into account of the Faculty and the type of degree, it is necessary to link the net effect computation to the specific estimated model, also considering that the coefficients $\beta_8, \ldots, \beta_{13}$ are each one associated to pairs of dummy variables that can assume values zero or one. Thus, all the possible combinations of outcomes of the interaction effects obtained from pairs of dummy variables must be considered when computing the net effect. To this purpose, we set $\mathbf{C} = \{\phi(\text{Reg}) \times \phi(\text{HDegree}) \times \phi(\text{Gender}) \times \phi(\text{B4}) \times \phi(\text{M2}) : \text{B4} = 1 \implies \text{M2} = 0 \wedge \text{M2} = 1 \implies \text{B4} = 0\}$ as the cartesian product of the unique elements of the variables Reg, HDegree, Gender, B4 and M2. It excludes those elements that imply the impossible situation $\text{B4} = 1 \wedge \text{M2} = 1$, since a student can not be enrolled in more than one degree at the same time. $\mathbf{C}$ is a matrix $|\mathbf{C}| \times 5$ of all the possible outcomes the variables involved can assume, thus it has a cardinality $|\mathbf{C}| = 24$. Considering $\hat{\boldsymbol{\beta}} = (\hat{\beta}_8, \hat{\beta}_9, \hat{\beta}_{10}, \hat{\beta}_{11}, \hat{\beta}_{12})'$ as the vector of the β coefficients of the interaction terms estimated in Eq. 2, the net

effect of the international mobility, called $\boldsymbol{\eta}$, is defined as:

$$\boldsymbol{\eta} = \mathbf{1}\hat{\beta}_1 + \mathbf{C}\hat{\boldsymbol{\beta}} \tag{3}$$

where $\mathbf{1}$ is a vector of five ones. In practice, the vector $\boldsymbol{\eta}$ measures the effects of the international mobility net of the other effects for all possible models. Since $\boldsymbol{\eta}$ depends from all the possible combinations of outcomes of the interaction effects obtained from pairs of dummy variables, in the results of the analysis (next Section) we report the minimum and maximum value that the net effect can assume for each model. We expect all values of $\boldsymbol{\eta}$ to be positive as it is conjectured that international mobility is able in itself to positively influence δ.
Finally, we apply the Tukey's Honest Significant Difference test to investigate about significant differences in the mean values of δ comparing the results obtained by the students who moved and those who did not move as well as by comparing different Erasmus mobility programs (Placement, Studio and Traineeship).

5 Empirical evidence

5.1 Impact of international mobility on graduation bonus

In the following, we report and discuss the results obtained from the linear model introduced in Section 4. It has been estimated on the whole dataset (UNI) and separately for each of the six faculties according to four different designs: for each faculty, we contrasted the results obtained for UNI with those obtained for the three subsets concerning the three types of degree (i.e. 3yrs Bachelor, 4yrs Bachelor, and Master). To highlight the most important results, reported in Tables from 4 to 7, in the following only the significant coefficients and the net effects are commented. A net effect is considered positive when both its maximum and minimum values are larger than zero.

The estimated coefficients obtained for the UNI dataset and the six faculties are reported in Table 4. As for UNI, a positive association between IExp, Reg, HDegree, Gender and HSGrade and the graduation bonus δ can be observed. These results are in line with the studies realized by Czarnitzki et al. (2018); Meya and Suntheim (2014). Moreover, it is worth noticing that attending a four-years Bachelor Degree (B4) has a positive effect on δ compared to the 3yrs Bachelor degree, whose effect on δ is included in the intercept. On the contrary, attending a two-years Master degree (M2) has a negative effect on δ compared to the three-years Bachelor degree. As for the interaction between IExp and the other variables, we observe a significant negative effect for Reg, Gender and HSGrade whereas the other coefficients are not significantly different from zero. This result is particularly interesting: IExp has per-se a positive impact on δ in UNI and in most of its faculties, but this positive impact is reduced if we consider the interaction effects. International mobility reduces the graduation bonus δ if a student is on time with the exams (Reg=1), is male (Gender=1) and is graduated cum-laude (HSGrade=1). This result indicates that international experience is not important for well-adjusted students, that is, those students who pass the exams regularly with high

marks. They are good candidates to be graduated with honors regardless of international mobility as they obtain a high average mark from the passed exams. Instead, the negative coefficient associated to the interaction of IExp with Gender indicates that international mobility is more beneficial for the graduation bonus of female students.
Focusing on regression coefficients estimated for the different faculties, it is possible to note that Reg has no effect only for the students enrolled in Medicine and Surgery (MS), whereas HSGrade has an important effect for students enrolled in Economics, Law and Political Sciences (ELPS). Moreover, the main effect of IExp becomes not significant for students enrolled in the Engineering and Architecture (EA) and Sciences (S) faculties. The interaction effects indicates different degree of joint associations between IExp with the interacting variable and δ. In particular, (IExp $\times$ Reg) has a negative effect on δ in the faculties ELPS and S; (IExp $\times$ HDegree) has a negative effect on δ in the faculty of Pharmacy and Biology (PB) only; (IExp $\times$ B4) and (IExp $\times$ HSGrade) have a negative effect on δ in ELPS only whilst (IExp $\times$ M2) has a negati effect on δ in the faculties ELPS and Human Sciences (HS). Importantly, the net effect of IExp is always positive for the whole sample (UNI), as well as for students enrolled in Biology and Pharmacy (BP), EA and ELPS since their associated $\min(\boldsymbol{\eta})$ is higher than zero.
Moving to the 3yr Bachelor degree (Table 5) it emerges that for UNI IExp, Reg, HDegree and Gender maintain the same sign (and significance) of the previous analysis. At the faculty levels, interaction effects presents different signs and significance. In MS, males that experience international mobility receive important benefits in terms of graduation bonus (see the estimated coefficient for IExp $\times$ Gender in the MS column). In EA, a similar positive effect is observed for students who graduated cum laude, whilst in the ELPS faculty international mobility is not impacting positively on the graduation bonus as a negative effect for regular students, as well as for males and for students graduating cum laude is observed. Instead, regularity is very important for students of HS experiencing international mobility as in this case δ increases significantly. Overall, the model estimated for UNI indicates a positive net effect of international mobility for bachelor students, but this effect is confirmed in the MS, EA and HS faculties only.
The results obtained for Master students are reported in Table 6. Here, an important positive effect is observed in the BP and ELPS faculties only. In the first case, it depends form the international experience per se as no interaction effect is large. In the second case, an important positive effect of Gender is observed, indicating that female students experiencing international mobility increase their graduation bonus more than their male colleagues.
Finally, the subset of the students enrolled in 4yrs Bachelor has been analyzed. In this case, the results are referred at only three faculties the uniques that activate this typology of degree. Table 7 shows that IExp has a positive effect on δ in UNI and BP. Moreover, Reg is significant in MS (negatively) and ELPS (positively). Significant interactions are observed in UNI (HSGrade $\times$ IExp) and in MS (Reg $\times$ IExp). Finally, with the exception of ELPS, η is always positive, particularly in BP. To sum up it is possible to state that in general the international experience has positive effect on δ, which differ according to the faculty and the type of degree. In most of the cases, regularity, gender and high school grade have a significant association with the graduation bonus.

Table 4: University and Faculties

	(exp sgn)	UNI	Sig	MS	Sig	BP	Sig	EA	Sig	ELPS	Sig	S	Sig	HS	Sig
(Intercept)		1.210	***	3.117	***	2.277	***	1.920	***	0.593	**	2.388	***	1.247	***
IExp	(+)	0.844	***	0.821	*	1.112	*	0.245		1.198	***	0.754		0.465	*
Reg	(+)	0.326	***	0.071		0.291	*	0.146	*	0.658	***	0.610	**	0.233	***
HDegree	(+/-)	0.496	***	0.244	**	0.590	**	0.047		0.739	***	0.216		0.570	***
Gender		0.158	***	-0.026		-0.076		0.061		0.006		-0.079		-0.021	
B4 Y		0.291	***	0.151		0.293	*	0.246	*	0.218	**	-		0.570	*
M2 Y		-0.066	*	-0.367	**	-0.441	*	-0.232	***	0.136	*	-0.351		0.129	*
HSGrade	(+/-)	0.004	***	-0.011	**	-0.002		0.003	*	0.008	***	-0.006		0.000	
(Reg × IExp)	(+/-)	-0.083	*	-0.133		0.053		0.021		-0.264	**	-0.716	*	0.074	
(HDegree × IExp)	(+/-)	-0.043		-0.128		-0.390	*	0.045		-0.105		0.365		0.048	
(Gender × IExp)		-0.077	*	-0.035		-0.026		0.005		-0.009		-0.108		-0.019	
(B4 × IExp)		0.004		0.101		0.208		0.065		-0.217	*	-		-0.596	
(M2 × IExp)		-0.030		0.226		0.011		-0.012		-0.381	***	-0.155		-0.141	*
(HSGrade × IExp)	(+/-)	-0.008	***	-0.008		-0.011		-0.002		-0.008	*	-0.002		-0.003	
Adj. R^2		0.214		0.082		0.208		0.103		0.411		0.142		0.304	
n		3,812		434		298		712		1,084		124		1,016	
$\max(\boldsymbol{\eta})$		0.848		1.047		1.373		0.381		1.198		1.119		0.587	
$\min(\boldsymbol{\eta})$		0.611		-0.475		0.696		0.233		0.439		-0.225		-0.150	

Notes: Estimated coefficients for the whole dataset (UNI) and the six faculties concerning the model introduced in Eq. 1. Sig indicates significance of the t-test performed on the estimated regression coefficients: ***, **, * and $^{\cdot}$ indicate a pvalue lower than 0.001, 0.01, 0.05 and 0.10, respectively. $\max(\boldsymbol{\eta})$ ($\max(\boldsymbol{\eta})$) indicates the maximum (minimum) value of the net effect introduced in Eq. 3. Finally, exp sgn reports the expected sign of the coefficients.

5.2 Impact of the type of international mobility on the graduation bonus

In the following, we investigate if possible differences in the graduation bonus obtained by graduated students are attributable to the type of mobility program they were involved in. The performance of students participating to different mobility programs is also compared with those who did not move. To this purpose, we apply the Tukey's Honest Significant Difference test to investigate about significant differences in the mean values of δ comparing the results obtained by the students who moved and those who did not move as well as by comparing different Erasmus mobility programs (Placement, Studio and Traineeship).

Results are summarized in Table 8. Reported values of the test statistics are still obtained using the resampling strategy based on the case-control setting and results averaging used to average estimated regression coefficients of Eq. 1. Table 8 highlights new results that allow us to add additional findings to those obtained from the regression analysis. It is possible to note that the difference in graduation bonus for students experiencing Erasmus Studio, if significant, is always positive: this happens with respect to students who did not move, particularly in the faculties Biology and Pharmacy (BP), Science (S) and Human Sciences (HS) and for the comparison between the Erasmus Studio and the Erasmus Placement programs. In the latter case, the superiority of the first over the second in terms of δ is sometimes evident. Focusing on single faculties, it emerges that in the Science (S) faculty the differences are always positive, when significant, whilst the opposite result is found in the Medicine and Surgery (MS) faculty. Overall, these post-hoc tests also emphasize that the effect of the international mobility on academic performance is faculty-specific and/or type-of-degree-specific and thus it is not possible to retrieve generalizable findings. This positive recorded impact is in line with the literature. Also authors as Sanz-Sainz and Roldán-Miranda (2006); Meya and Suntheim (2014); González-Baixauli et al. (2018); Czarnitzki et al. (2018) have evidenced a general positive effect of international mobility on the GDP and the final vote. To sum up, it is possible to state that Erasmus influences the entire course of study becoming an important tool for professional and personal growth.

Table 5: 3yrs Bachelor

	(exp sgn)	UNI	Sig	MS	Sig	BP	Sig	EA	Sig	ELPS	Sig	S	Sig	HS	Sig
(Intercept)		0.857	***	3.078	***	1.877	**	1.756	***	0.303		1.892	.	1.028	***
IExp	(+)	0.787	***	0.148		-0.915		0.377		0.500		0.181		0.853	***
Reg	(+)	0.389	***	0.155		0.395	*	0.252	**	0.803	***	0.748	*	0.243	***
HDegree	(+/-)	0.600	***	0.266		0.599	*	-0.03		1.024	***	0.201		0.757	***
Gender		0.229	***	-0.021		-0.091		0.075		0.041		0.038		-0.004	
HSGrade	(+/-)	0.008	***	-0.011		0.003		0.005	*	0.011	**	-0.002		0.003	
(Reg × IExp)	(+/-)	-0.077		-0.034		-0.135		-0.038		-0.313	*	-0.321		0.129	*
(HDegree × IExp)	(+/-)	0.023		-0.123		-0.085		0.384	*	-0.674	**	0.000		0.060	
(Gender × IExp)		-0.065		0.969	***	0.246		-0.036		-0.314	*	0.293		0.003	
(HSGrade × IExp)	(+/-)	-0.008	**	-0.004		0.013		-0.004		0.003		0.000		-0.008	*
Adj. R^2		0.250		0.315		0.380		0.181		0.472		0.177		0.372	
n		1,748		80		92		294		384		52		846	
max($\boldsymbol{\eta}$)		0.810		1.240		-0.669		0.761		0.500		0.474		1.045	
min($\boldsymbol{\eta}$)		0.645		0.114		-1.135		0.303		-0.801		-0.140		0.853	

Notes: Estimated coefficients for the whole dataset (UNI) and the six faculties concerning the model introduced in Eq. 1 and the students enrolled in the 3-years Bachelor degree programs. Sig indicates significance of the t-test performed on the estimated regression coefficients: ***, **, * and $^{\cdot}$ indicate a pvalue lower than 0.001, 0.01, 0.05 and 0.10, respectively. max($\boldsymbol{\eta}$) (max($\boldsymbol{\eta}$)) indicates the maximum (minimum) value of the net effect introduced in Eq. 3. Finally, exp sgn reports the expected sign of the coefficients.

Table 6: Master

	(exp sgn)	UNI	Sig	MS	Sig	BP	Sig	EA	Sig	ELPS	Sig	S	Sig	HS	Sig
(Intercept)		1.918	***	0.767		3.141	***	2.095	***	1.229	***	3.563	***	2.051	***
IExp	(+)	0.166		1.302		1.893	*	0.061		0.457		0.088		-0.076	
Reg	(+)	0.195	***	0.002		0.005		-0.081		0.423	***	0.181		0.175	*
HDegree	(+/-)	0.368	***	-0.928		-0.158		0.098		0.754	***	0.482	*	0.395	***
Gender		0.061		0.683		-0.102		0.032		-0.030		-0.361		-0.103	
HSGrade	(+/-)	-0.003		0.007		-0.007		-0.001		0.003		-0.021	*	-0.007	
(Reg × IExp)	(+/-)	-0.030		-1.153		-0.083		0.149		-0.056		-0.454		-0.047	
(HDegree × IExp)	(+/-)	-0.027		0.006		-0.388		-0.125		-0.135		0.103		-0.065	
(Gender × IExp)		0.073		-1.082		0.051		-0.026		0.301	**	-0.138		-0.037	
(HSGrade × IExp)	(+/-)	-0.001		0.000		-0.02	*	0.000		-0.007		0.004		0.004	
Adj. R^2		0.114		0.153		0.141		-0.005		0.343		0.228		0.108	
n		1,408		14		90		386		538		72		308	
max($\boldsymbol{\eta}$)		0.189		1.308		1.944		0.210		0.758		0.191		-0.076	
min($\boldsymbol{\eta}$)		0.059		-0.933		1.422		-0.090		0.266		-0.504		-0.225	

Notes: Estimated coefficients for the whole dataset (UNI) and the six faculties concerning the model introduced in Eq. 1 and the students enrolled in the Master degree programs. Sig indicates significance of the t-test performed on the estimated regression coefficients: ***, **, * and $^{\cdot}$ indicate a pvalue lower than 0.001, 0.01, 0.05 and 0.10, respectively. max($\boldsymbol{\eta}$) (max($\boldsymbol{\eta}$)) indicates the maximum (minimum) value of the net effect introduced in Eq. 3. Finally, exp sgn reports the expected sign of the coefficients.

Table 7: 4yrs Bachelor Degree

	(exp sgn)	UNI	Sig	MS	Sig	BP	Sig	ELPS	Sig
(Intercept)		2.549	***	3.878	***	2.594	**	1.942	***
IExp	(+)	1.188	**	0.711		2.509	*	0.136	
Reg	(+)	0.122		-0.235	*	0.424		0.439	**
HDegree	(+/-)	0.648	***	0.249	.	0.864	**	0.533	***
Gender		-0.114		-0.101		-0.254		-0.067	
HSGrade	(+/-)	-0.007	*	-0.016	**	-0.003		-0.004	
(Reg × IExp)	(+/-)	0.093		0.247	*	-0.008		-0.132	
(HDegree × IExp)	(+/-)	-0.175		-0.324		-0.500		0.216	
(Gender × IExp)		-0.144		-0.154		0.035		-0.199	
(HSGrade × IExp)	(+/-)	-0.011	*	-0.005		-0.024		0.001	
Adj. R^2		0.162		0.098		0.220		0.401	
n		656		340		116		162	
max($\boldsymbol{\eta}$)		1.281		0.958		2.544		0.352	
min($\boldsymbol{\eta}$)		0.869		0.233		2.001		-0.195	

Notes: Estimated coefficients for the whole dataset (UNI) and the six faculties concerning the model introduced in Eq. 1 and the students enrolled in the 4-years Bachelor degree programs. Sig indicates significance of the t-test performed on the estimated regression coefficients: ***, **, * and $^{\cdot}$ indicate a pvalue lower than 0.001, 0.01, 0.05 and 0.10, respectively. max($\boldsymbol{\eta}$) (max($\boldsymbol{\eta}$)) indicates the maximum (minimum) value of the net effect introduced in Eq. 3. Finally, exp sgn reports the expected sign of the coefficients.

Table 8: Tuckey post hoc tests outcomes

University and Faculties	UNI	Sig	MS	Sig	BP	Sig	EA	Sig	ELPS	Sig	S	Sig	HS	Sig
Erasmus Placement - No Mob	-0.07		-0.35	***	-0.18		-0.19		0.43		0.08		0.43	
Erasmus Studio - No Mob	0.13	***	-0.13		0.30	***	-0.06		-0.04		0.35	***	-0.04	
Erasmus Traineeship - No Mob	-0.05		-0.38	***	-0.08		-0.16		-0.51		0.23	***	-0.51	
Erasmus Studio - Erasmus Placement	0.20	***	0.22		0.48	***	0.13		-0.47		0.27	***	-0.47	
Erasmus Traineeship - Erasmus Placement	0.03		-0.03		0.11		0.03		-0.94		0.15		-0.94	
Erasmus Traineeship - Erasmus Studio	-0.17		-0.25		-0.38		-0.10		-0.47		-0.12		-0.47	
Bachelor Degree	UNI	Sig	MC	Sig	BF	Sig	IA	Sig	SEGP	Sig	S	Sig	SU	Sig
Erasmus Placement - No Mob	-0.06		-0.78	***	-0.07		-0.05		0.31		0.25		0.19	***
Erasmus Studio - No Mob	0.22	***	0.08		0.13		-0.06		0.05		0.66	***	0.30	***
Erasmus Traineeship - No Mob	0.00		-0.82	***	0.01		-0.02		0.00		0.29	***	0.15	***
Erasmus Studio - Erasmus Placement	0.28	***	0.86	***	0.20		-0.02		0.00		0.40	***	0.11	
Erasmus Traineeship - Erasmus Placement	0.06		-0.04		0.08		0.03		0.00		0.04		-0.04	
Erasmus Traineeship - Erasmus Studio	-0.22		-0.89		-0.12		0.05		-0.26		-0.37		-0.15	
2yr Master Degree	UNI	Sig	MC	Sig	BF	Sig	IA	Sig	SEGP	Sig	S	Sig	SU	Sig
Erasmus Placement - No Mob	-0.02		-0.20		-0.10		0.05		0.96		-0.32	***	0.16	
Erasmus Studio - No Mob	0.09		0.51		-0.09		0.11		0.18		-0.11		0.12	
Erasmus Traineeship - No Mob	-0.02		-0.20		-0.25		-0.01		-0.23		-0.04		-0.04	
Erasmus Studio - Erasmus Placement	0.11		0.71		0.00		0.06		-0.78		0.21		-0.03	
Erasmus Traineeship - Erasmus Placement	0.00		0.00		-0.15		-0.06		-1.20		0.29	***	-0.20	
Erasmus Traineeship - Erasmus Studio	-0.11		-0.71		-0.15		-0.13		-0.42		0.08		-0.16	
4yr Master Degree	UNI	Sig	MC	Sig	BF	Sig	IA	Sig	SEGP	Sig	S	Sig	SU	Sig
Erasmus Placement - No Mob	0.01		-0.15		-0.04		0.00		0.00		0.31	***	0.00	
Erasmus Studio - No Mob	-0.05		-0.07		0.26		0.00		0.00		0.14		0.00	
Erasmus Traineeship - No Mob	0.03		-0.17		0.34		0.00		0.00		0.19		0.00	
Erasmus Studio - Erasmus Placement	-0.05		0.08		0.29		0.00		0.00		-0.17		0.00	
Erasmus Traineeship - Erasmus Placement	0.02		-0.01		0.38		0.00		0.00		-0.13		0.00	
Erasmus Traineeship - Erasmus Studio	0.08		-0.09		0.08		0.00		0.00		0.05		0.00	

Notes: Test statistic of the Tukey's Honest Significant Difference test for the whole dataset (UNI) and the six faculties. The test compares the graduation bonus obtained for students participating in different Erasmus programs as well as with the group of students who did not move. Sig indicates significance of the t-test performed on the estimated regression coefficients: ***, **, * and · indicate a pvalue lower than 0.001, 0.01, 0.05 and 0.10, respectively.

6 Concluding remarks

This paper analyzed the effects of international students mobility, in particular the participation of university students to the Erasmus mobility programs, on students academic performance. The statistical analysis focused on the effects of international mobility on the graduation bonus, that is the bonus attributed in Italian universities to graduates. In practice the base score is incremented with a bonus that depends on many factors, including regularity, quality of the presentation of the degree thesis and international mobility experience. The latter might, in some cases, specifically increase the graduation bonus by some points or it can reduce the student carrier period thus impacting positively on students regularity. In any case, in our opinion it is important to consider the effect of international mobility on the graduation bonus as the former influences all the other factors concurring to the determination of the final degree grade, in particular the average grade at the exams, the regularity and the quality of the degree thesis. The study presents the results of the analysis of the academic performance of students enrolled at the university of Cagliari (Italy) observed from 2015 to 2017. A linear regression model assessing the dependence of the graduation bonus on variables characterizing students' carrier (international experience, regularity, degree cum laude, gender and high school grade) is estimated for the whole sample and separately for students enrolled in the six faculties and with respect to the type of degree (bachelor or master). Moreover, we have checked through the Tukey post hoc test if possible differences in the graduation bonus obtained by graduated students are attributable to the type of Erasmus mobility program they were involved in (Placement, Studio and Traineeship).
Results provide evidence that the effect of international mobility on students' performance is context specific. In particular, this effect is differs significantly among faculties and degree programs. In summary, we observed a very positive net effect of international mobility experience on the graduation bonus in the faculties of Biology and Pharmacy (for the Master and 4-year Bachelor degree only), a positive effect in the faculty of Medicine and Surgery (for the Bachelor degrees only). In the other faculties the same effect is in some cases slightly positive. The results of the post-hoc tests evidenced that the Erasmus Studio program has generally a positive effect on graduation bonus, particularly in the faculty of Science.
Overall, our analysis documents that some efforts are required to improve the benefits of international mobility on academic performance. Managerial actions should be carried out in order to strengthen the professional value of temporary study in other European countries. A suitable action is improving the promotion, information and dissemination of the features of the mobility programs. Improving information about mobility allows to make students aware of the importance and significance of the Erasmus program as well as allows them to drive the experience towards a maximization of the benefits related to academic performance. In our opinion, in the case of the Erasmus Studio program students' selection process and the full correspondence between the topics required to pass the exam in the home university and those of the destination university are both crucial to improve the quality of the international mobility outcome. As for the Traineeship and the Placement programs, even more promotional activity should be carried out

by university managers. This activity should be accompanied by some efforts aimed at creating a strong network of foreign companies whose business is strictly connected to the main topics of the university degree courses. A specific appreciation of the internship activity and a link to the academic score of the student is missing in most of the cases.

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