University as a "parking place".

The dropout determinants. The case of the Trieste University

Laura Chies
Grazia Graziosi
Francesco Pauli
DEAMS `Bruno de Finetti' - Università degli Studi di Trieste

Preliminary draft[1]

Abstract

In this paper we study the factors influencing dropout in the second year of the bachelor programs at the University of Trieste. We control for the different withdrawal causes. In doing so, we apply the Lasso method for the selection of the covariates determining the dropout event described in Tibshirani (1996). We use administrative data on 23,333 undergraduates students enrolled in three-years bachelor programs from 2003 to 2011 and perform a binomial GLM model with logistic link. Our aim is to improve the general understanding of the students' withdrawing focusing on personal characteristics of students and on institutional aspects of the university. We demonstrate that a high secondary school final mark and a low individual students' performance increase significantly the risk of dropping out, the same is true for the choice of a "weak" degree. In general, the low entry barriers permit to the students coming from lower socioeconomic background to limit dropout along the whole academic path. Our results reveal, also, that obtaining a job in the first year of study or being "old" or residing in the region, will increase the dropout probability. Thus, to promote degree completion and decreasing dropout and "parking time", universities should enlarge the tools provided to students in order to manage failure.

---

[1] Please don't quote this preliminary draft.

1. Introduction and Literature review

The probability of withdrawing for Italian university students is higher than that of the other European countries. While, in Italy, the graduation rate has risen from 19% in 2000 to 31,9% in 2011, completion rates of tertiary programs at 45% are the lowest among all the countries belonging to the Organization for Economic Cooperation and Development (OECD, 2013) with comparable data and substantially below the OECDs average of 70,1%. The problem for the policy maker is insofar relevant. The common belief that students withdraw because of academic failure is questioned by the literature on university drop-out, while the educational background is sponsored as a main influence along with some personal characteristics of the student. We want investigate further this issue in the present paper, in order to the distinguish about two different types of motivation detected in the administrative data: the leave on the second year and the "parking hypothesis". As Belloc et al. (2011) underline in their recent analysis, the drop-out from the single university course can happen in many different ways. Retention and withdrawal have not to be treated as the only two possible alternatives that students face. In fact, some students may leave the university system, and others may withdraw from the program without dropping-out of the university but changing degree course, faculty or institution or suspending their academic experience for a while relating to the hypothesis of university as a "parking place". The explanations that guide the abandonment of the study can be very different, so considering the dropout tout -court could present serious problems of overestimation (Cipollone and Cingano , 2007).

The attention to the type of withdrawal is an important factor in determining the rate of drop-out. It presents very different sizes in the literature depending on the lack of information or on spatial/time aggregation of the data. Estimates of dropouts are indeed based on different aggregate indicators such as the ratio between the number of graduates and the amount of registered students at the beginning of the degree program obtainable in general surveys (Almalaurea or Istat). In this case, the attrition rate is very high and sometimes exceed 50 % of the members: Cipollone and Cingano (2007: 10) calculate a rate of drop-out equal to 58.5%. An alternative definition is given by the administrative content of dropout: a student who is no longer enrolled in the same course the following year (ibid., 28%), or distinguishing by type of changed registration. In the case of longitudinal studies the ability to capture the different types of drop-out is higher, since you have data of students' careers (giving up, transfer to another university or another degree course, delay and work-study-work careers). In the present analysis, the choice fell on the latter type of data. Evidence corroborating this choice is provided also both by the international (Smith and Naylor , 2001; Arulampalam et al., 2004; Scott and Kennedy, 2005), and the Italian literature (see among others Boero et al., 2005; Broccolini 2005; Clerici et al., 2011; Belloc et al. 2011), whose core analysis focuses on the determinants of university career (examinations passed and marks obtained) (Boero et al. , 2005; Bratti et al. , 2010), which is widely reflected in the literature in conjunction with social aspects (income, type of school attended and its high school mark, family characteristics) (Checchi 2000; Di Pietro 2004, Di Pietro and Cutillo 2008 Cappellari and Lucifora 2009; Aina 2013), or on job opportunities (youth employment/unemployment rate in the local market or job offers) (Di Pietro 2006 Cappellari and

Lucifora 2008; Aina et al. 2011). The reasons that may lead to decisions to abandon university are also constrained by the allocation of human and physical capital at universities (libraries, study halls, students report professors , seating in the classroom) (Light and Strayer 2000), by integration in the social and academic environment (Tinto, 1975; Bean 1982) and finally by the credit constraint and the university grants (Carneiro and Heckman 2002; Mealli and Rampichini, 2012).

In this work we aim at determining the factors which mainly affect drop-out probabilities. We tackle this issue by considering a relatively large set of variables related to factors which are plausibly related to drop-out probability and selecting a subset of them by Lasso method (Tibshirani, 1996). Moreover, we employ a bootstrap technique in order to allow for model selection uncertainty in final inference.

While the analysis of the individual and social characteristics have been widely analyzed in the Italian literature, less known is the real role of an opportunity cost increase due to the onset of a job opportunity. Thanks to the availability of the data relating to the timing of the university-to-work transitions during the university careers in the labor market of the region Friuli Venezia Giulia, we are able to explain this kind of withdrawal risk. This is only a partial measure of employment probability, as it doesn't explores the possibilities of working outside the region and is limited only to the private sector in the years 2003-2007. The underestimation is likely to be limited, given that, according to statistics from the Ministry of Education and University, the choice of a regional university for a citizen of Friuli Venezia Giulia is high (61.7% of those registered in Trieste University). This figure is probably even higher for working students, who prefer a university close to their home. The data relating to the Almalaurea surveys on career opportunities of graduates one year after graduation confirm that the percentage of those who find a work outside the home region is quite limited in the case of Trieste graduates (36.7%). The change in program degrees, as well as the prolonged duration of the study (*university parking*) may be determined by opening of job opportunities to the students. This result is also in line with the results of surveys on graduates, which highlights how a large proportion of Italian university graduates state to work before graduation (Almalaurea , 2013). The employment rate is particularly high in our case study referred to students of the University of Trieste.[2]

A factor enhancing "migration" among program degrees is related to the courses with a limited enrollment number[3], especially those of medicine. The high barrier to this courses increase the dropout from other related courses (biology, chemistry, pharmacy). Also the policy intended to facilitate the enrollment in scientific courses (the PLS program)[4] have a similar result.

The policies that the university system can put forward to limit the costs of dropouts can, and should therefore have different focus. In particular, if we consider policies aimed at increasing participation or restricting it, the need to know the dimension of the consequent internal/external migration deriving from this is of particular interest. Previous studies (Arias and Dehon , 2011) highlight how in the early years of studying the effect of strong mathematical education is

---

[2] 71% affirms to have worked during the university, the half continually.
[3] In Italian: "Corsi a numero progammato".
[4] PLS stay for "Progetto Lauree Scientifiche".

important, but in the academic progress his explanatory power decreases. In this preliminary work we will focus only on the withdrawal in the second year of study.

2. The dataset

Most empirical work on tertiary education in Italy is based on specific survey data or administrative data on individual students from particular universities, because Italy doesn't dispose of a census of all university students. The empirical analysis in this section is based upon a data set that we have constructed unifying some administrative register data provided by the administrative office of University of Trieste and by the job market Agency of the Region Friuli Venezia-Giulia, covering the years 2003-11.

We concentrate our analysis on students who have entered university for the first time starting in academic year 2003-04 in the reformed system. Therefore our sample excludes individuals who moved from a pre-reform course. Moreover, we did consider those individuals who transferred to a different degree course from the one initially undertaken, following their progression only at the University of Trieste. We have 12 faculties and the data base that we constructed for the dropout analysis consists of 23,333 students (16,205 regular, 2,723 with interruption spells and 4,405 dropped from university registers). In constructing our data base, the students' status and careers were observed at a cut-off date that we fixed at the end of December 2011 (first term of the final year). For the dropout analysis, we consider the effective dropout rate, rather than the formal dropout recognised by the university. The tax identification number of the student is used to merge the different registers.

In Table 1 we report information on the composition of the population under study, distinguished by gender, for the overall sample and for the dropout sample. The Table 1 shows that, in the eight years considered 18.9% (20.2% male and 18% female) of new entrants have effectively dropped out during the first two years, whereas 12,6% of the students change course or interrupt for a while their progression. The gender differences are not very high, even if the females present in the time considered a higher graduation rate (46.6% of regular students) than males (36.7%). The analysis of the data in Table 1 clearly suggests that only a marginal fraction of students are likely to complete their degree program within the established three-year period, ranging from 22.8% in 2005 to 27.6% in year 2011. Despite the increasing quotas of graduation, this is in sharp contrast with the expectations of the Reform and very much in line with the national trends before the Reform (see also Boero et al. on this issue).

Table 1 – Dropout rates by gender

	N. of enrolled students	Dropout	Irregular Academic Path	Regular students	
				Total	Of which degree in 3 years
Female	13,244	2,373 (18%)	1,263 (9%)	9,608 (73%)	3,364 (28%)
Male	10,089	2,032 (21%)	1,460 (14%)	6,597 (65%)	1,872 (20.5%)

In Table 2 we briefly outline the dropout rate by gender and faculty. The higher dropout rate regards Pharmacy and Education Sciences both for female and male students whereas the lower withdrawal rate is observed for Medicine and for the Advanced School of Modern Languages for Interpreters and Translators, both fixed number courses.

Table 2 – Dropout rates by gender and faculty

Faculties	Enrolled students	Dropouts
Female		
Architecture	507	60 (12%)
Economy	1358	248 (21%)
Pharmacy	364	100 (27%)
Law	470	74 (16%)
Engineering	456	73 (16%)
Literature and Philosophy	1683	322 (19%)
Medicine	876	70 (8%)
Psychology	1268	259 (20%)
Educational Sciences	2580	663 (26%)
Mathematics, Physics and Natural Sciences	1380	269 (19%)
Political Sciences	1252	170 (14%)
Advanced School of Modern Languages for Interpreters and Translators	1050	65 (6%)
Male		
Architecture	484	74 (15%)
Economy	1398	288 (21%)
Pharmacy	117	34 (29%)
Law	275	54 (20%)
Engineering	2682	472 (18%)
Literature and Philosophy	744	174 (23%)
Medicine	454	46 (10%)
Psychology	498	133 (27%)
Educational Sciences	797	236 (30%)
Mathematics, Physics and Natural Sciences	1405	306 (22%)
Political Sciences	1062	203 (19%)
Advanced School of Modern Languages for Interpreters and Translators	173	12 (7%)

Definitions and descriptive statistics of the variables used in our econometric models are summarised in Tables 3-5 and figure 1, where we report more detailed information on the dropout rates and on student progression distinguished by other specific characteristics. These are: age, sex, grade and year of graduation, citizenship, region and city of residence, year and age of enrollment and course of study. The data on carrier information regard the number of exams taken and passed, mark, credits, date and grade of degree.

As far as the income data are concerned, unfortunately we don't cover the complete set of students. The University of Trieste does not request information on the financial position of the students. This information is provided voluntarily by the student only if she/he might be entitled to an adjustment in the payment of tuition fees based on her/his household income (Iseeu indicator). In this case, the Secretariat assigns the student to an income range. Where the information is not present the student pays the higher amount. The average lack rate of income is 45.4% ranging from 50.8% in 2003 to 32.4% in year 2010. We treat the underprovided income as highest income group. The best students receive also a tax refund directly from the secretariat if they fulfill the merit criteria foreseen in the University regulation (18.1%).

The administrative dataset of students is enriched with information on job enrollment provided by the Job Agency of Region Friuli Venezia Giulia.

This register contains the contracts for dependent employment with the following characteristics: open-ended, fixed term, short term, part-time, full-time contracts, activity sector and number of worked days. The data cover the private sector contracts from 2003 to 2007 and both private and public sector from 2008. This allows us to verify if the students work during the degree program weighting the effort required with the worked time. The withdrawals from university are influenced by the employment opportunities. The average rate of employed students is 14.3% for female (20.8% for dropout female students) and 13.9% (18.2%) for males.

Descriptive analysis

The educational background of the students is reported in figure 1. In this graph the high school mark is distinguished in 3 classes. The lowest includes the mark from 60 (the minimum) to 70. The medium goes from 71 to 90 and the highest ranges from 91 to 100 (the maximum).

The poorest students in terms of high school profile choose Educational Sciences, where the dropout rate is the highest (see table 2). On the contrary, the best students decide on Advanced School of Modern Languages for Interpreters and Translators and Engineering.

Figure 1 – Enrolled Students by High School Mark and Faculty
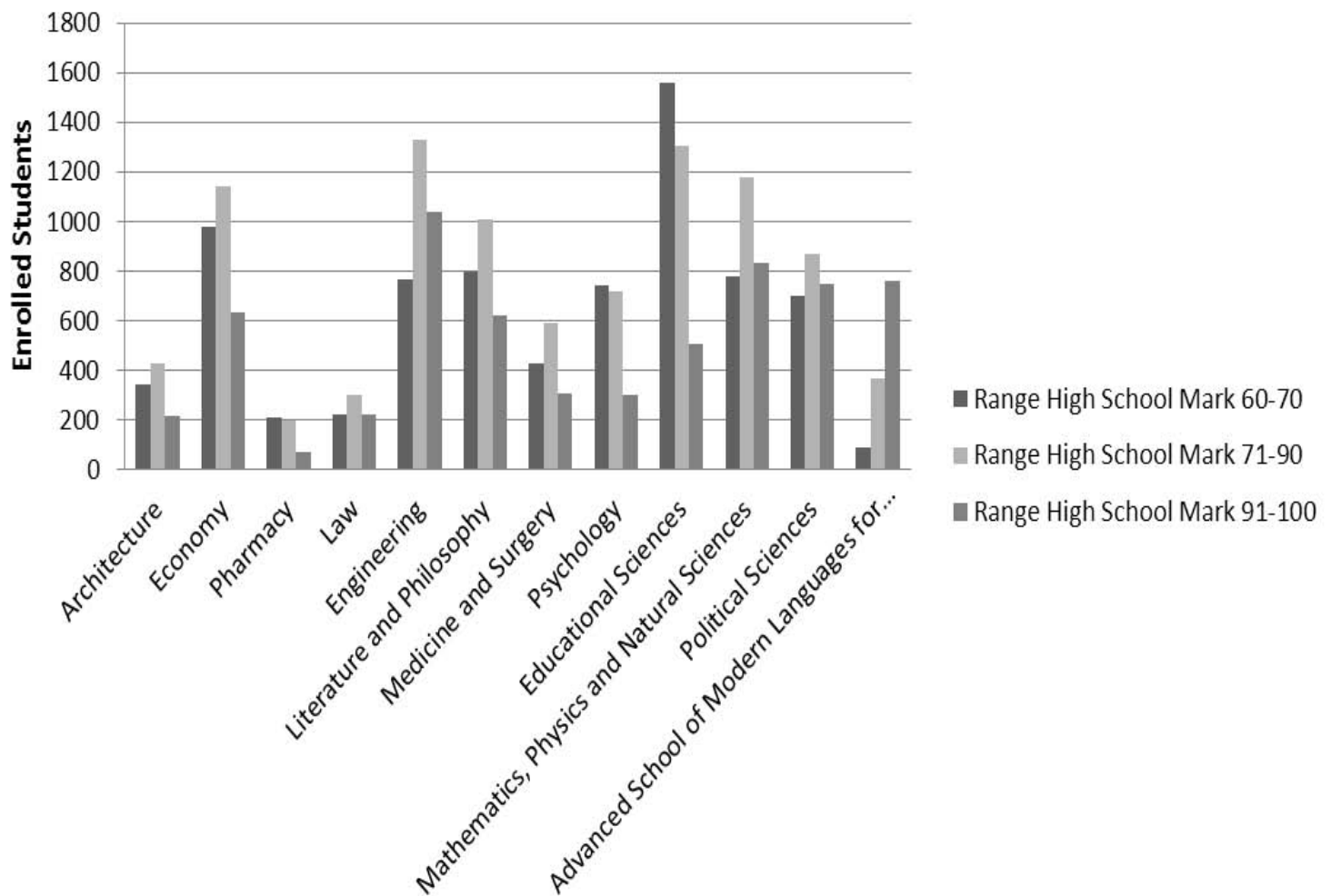
As far as the job information is considered, table 3 presents the number of students involved in some work activity distinguished by gender, full-time, part-time and mixed-form contracts during the observed period. The percentage of students devoted to some work activities is 15.4% of our population with similar gender employment rate, but different success in term of quality of contracts.

Table 3 – Number of working students by gender and contract

	Part-time		Full-time		Mixed form		Total	in % of Population
	Absolute	%	Absolute	%	Absolute	%		
Female	436	23.5	824	44.5	593	32.0	1853	15.5
Male	179	12.9	793	57.0	419	30.1	1391	15.2
Total	615	19.0	1617	49.8	1012	31.2	3244	15.4

Outcome and independent variables

The outcome of interest is a binary variable Y that assume 1 if the student drops out during the first year and 0 otherwise.

In our analysis the significant characteristics to model 2nd year enrolment are listed in table 4. We report some descriptive statistics for the covariates included in the model. It is worth to note that number of working days both per year and during the summer period is also weighted in order to account for part-time workers: one working day part-time is equal to 0.75.

We also include some interactions between relevant covariates in table 5.

Table 4. - Individual characteristics

Covariates:	Representative value	
Academic Year		
Sex	43.20	% male
Age	21.75	average
Residence FVG	64.51	%
High school score	78.35	average
Type of high school diploma:	14 levels	
Number of working days during first year*	101	median
Number of working days during summer period of the first year*	61	median
Number of working days during first year (weighted)*	91	median
Number of working days during summer period of the first year (weighted)*	46.5	median
Number of working days during second year*	102	median
Number of working days during summer period of the second year*	62	median
Number of working days during second year (weighted)*	90	median
Number of working days during summer period of the second year (weighted)*	46.5	median
Exam marks	24.70	average
Credits	38.95	average
Range of income		
I Class (<average income by year)	29.67	%
II Class (>average income by year)	22.42	%
III Class (Missing value)	47.91	%
Winner of scholarship	10.85	%
Students enrolled in fixed number courses	28.13	%
PLS (Scientific Degrees Project)	5.61	%

*Computed only on working students.

Table 5. – Interaction between relevance covariates.

Sex and High School Mark
High School Mark and type of High School Diploma
High School Diploma and Faculty
Residence and Sex
Faculty and PLS (Scientific Degree Project)

3. Model and Results

We model the drop-out probability using a binomial GLM with logistic link, hence the dropout probability for the i-th individual, π_i, is given by:

$$log \frac{\pi_i}{1 - \pi_i} = \alpha + x_i^T \beta, \;\; i = 1, \dots, n \qquad (1)$$

where x_i is the (column) vector of the covariates. Estimates for α and β for a fixed set of covariates are obtained by maximizing the log-likelihood

$$l(\alpha,\beta) = \sum_{i=1}^{n} \left(y_i \log \pi_i + (1 - y_i) \log(1 - \pi_i) \right)$$

where y_i is the drop-out indicator which equals 1 if the i-th subject has dropped.

Variables to be included in the linear predictor (1) are to be chosen among those described in Section 2 – Table 4, including the interactions in Table 5. Eventually, there is a set of 229 variables to choose among.

For the task of choosing the variables we employ the Lasso technique (Tibshirani, 1996; Hastie et al 2005), a sort of continuous variable selection procedure. The Lasso entails maximizing the penalized likelihood:

$$l(\alpha,\beta) - \lambda \sum_{i=1}^{P} |\beta_i|, \ \lambda > 0.$$

The role of the penalization is to shrink the estimated parameters toward zero similar to ridge regression; unlike ridge regression, however, due to the shape of the absolute value function, the Lasso penalty leads to some parameter estimates being zero, thus serving as a model selection procedure. The tuning parameter λ drives the amount of shrinkage, a higher λ implying more shrinkage and fewer non zero β parameters.

As suggested by Wu et al. (2009) in the context of a genomic study where relevant SNPs[5] for celiac disease were sought, we employ Lasso to select a fixed number of covariates. That is, we fix a priori the number *p* of variables which are to be included in the final model and seek for the value of λ leading to *p* non null coefficients. The model is then re-estimated without the penalty including only those variables which were not null in the Lasso results.

In order to make inference keeping into account the uncertainty due to model selection, we implement a bootstrap procedure in which the Lasso and the final estimation on the restricted subset of covariates are repeated on bootstrap samples. The output of such a procedure includes the percentage of times that the variable is included (the coefficient is non zero) which can be seen as an indicator of importance of each variable. It also allows to obtain *s.e.* of estimates which keep into account the uncertainty of the selection procedure. Results in terms of average bootstrap estimates and bootstrap standard errors are reported in Table 6.

---

[5] Single-Nucleotide Polymorphisms (SNPs).

Table 6 – Estimates based on bootstrapped Lasso

	Estimates	s.e.
2008 Academic Year	0.298	0.061
Residence FVG	0.364	0.077
Age > 22	0.010	0.085
Age 20-21	-0.315	0.050
Male and Residence FVG	-0.141	0.084
Male	-0.159	0.057
III Class (range of income)	0.100	0.040
Scientific Lyceum	-0.101	0.091
High School Mark	0.013	0.002
High School Mark and "Istituto tecnico commerciale"	0.002	0.002
High School mark and Foreign Diploma	-0.007	0.003
"Istituto tecnico per il turismo" and Law	-27.705	0.163
"Liceo socio-psico-pedagogico o istituto magistrale" and Pharmacy	-2.553	4.013
Foreign Diploma and Economics	-0.735	0.255
"Liceo Scientifico" and Engeneering	-0.503	0.156
"Liceo scientifico" and Economics	-0.462	0.139
Technical Institute and Educational Sciences	0.122	0.126
"Istituto tecnico commerciale" and Literature and Philosophy	0.292	0.161
"Liceo classico" and Pharmacy	1.244	0.408
"Liceo socio-psico-pedagogico o istituto magistrale" and Law	1.736	0.369
Foreign Diploma and Law	4.529	3.047
Engeneering	-0.247	0.108
Economics	-0.234	0.081
Educational Sciences	0.234	0.110
Literature and Philosophy	0.340	0.087
Political Sciences	0.431	0.108
PLS	-0.330	0.112
Number of working days during second year	-13.198	2.017
Number of working days during summer period of the second year	1.115	4.126
Number of working days during first year (weighted)	0.003	0.003
Number of working days during first year	0.002	0.003
Number of working days during summer period of the first year	0.009	0.008
Number of working days during summer period of the first year (weighted)	0.003	0.012
Mixed forms contracts	0.666	0.183
Full-time	0.531	0.126
Credits	-0.093	0.003

Exam marks	-0.037	0.003

Conclusion

Taking into consideration the preliminary results shown above, we may summarise the most salient findings considering three categories that affect the probability to enrol in the second year for the students of Trieste's University: education and social-economic background; labour position and academic carrier.

In the first category we find that the gender, residence and age are relevant: males drop less in particular if resident in FVG; foreigners also drop less. As far as age is concerned it appears that students enrolling late (older than 22) drop more frequently compared in particular to students enrolling at 20-21.

Educational background also has a significant effect: a higher school mark leads to a higher probability of dropout in particular for technical schools (tecnico-commerciale) and to a lesser extent for foreigners; on the other hand those with a "liceo scientifico" drop less frequently.

The estimates also show that the "matching" between high school and faculty is relevant in explaining the drop out probability. For example, students enrolling to law with a "liceo socio-psico-pedagogico" or "istituto magistrale" drop out significantly more than the baseline, on the contrary those with the *maturità* from the scientific lyceum, who enrol at engineering drops less than average. These kind of results may be important for university guidance purposes.

The personal story of the students during the first year and the following year are also relevant: the fact of having a job during the first year leads to a higher probability of drop out, while having a job during the second year is of less importance (or even lesser the drop out probability).

Finally, a good performance during the first year – in terms of acquired credits and marks – reduces the probability of drop out.

The analysis also shows that some faculties have dropout probabilities significantly higher (lower) than average.

We are conscious that the present analysis is lacking of some relevant aspects. The probability to extend the time of graduation has to be investigate separately. On the contrary, we don't observe in our data a very different gender drop out behaviour, but we can perform a separate estimation to control for. We can't be conclusive on the income effect on the student withdrawal decisions, because of the lack of data on the family profile of students. Therefore, we may explore some other information disposable at the university (such as surveys or qualitative data).

Literature

Aina, C. (2013), "Parental background and university dropout in Italy", High Educ (2013) 65:437–456. DOI 10.1007/s10734-012-9554-z

Aina, C., E. Baici e G. Casalone (2011), "Time-to-Degree: Students' Abilities, University Characteristics or Something Else? Evidence from Italy", *Education Economics*, Volume 19, No.3,. 311-325.

Almalaurea (2013), *XV Indagine - Condizione occupazionale dei laureati*, Bologna.

Arias, E., and Dehon, C. (2008), "What are the Factors of Success at University? A case study in Belgium", *CESifo Economic Issues*, Special Issue on Economics of Higher Education, 54, 121-148.

Arulampalam W., Naylor R.A., Smith J.P. (2004), "A hazard model of the probability of medical school drop-out in the UK", *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 167, 157-178.

Bean, J. P. (1980). "Dropouts and turnover: The synthesis and test of a causal model of student attrition", *Research in Higher Education*, 12: 155–187.

Belloc, F., Maruotti, A., Petrella, L. (2011), "How individual characteristics effect university students drop-out: a semiparametric approach to an Italian case study", *Journal of Applied Statistics* Vol.38 n.10 pp.2225-2239.

Boero G., Laureti T., Naylor R. (2005), "An econometric analysis of student withdrawal and progression in post-reform Italian Universities", *Working Paper CRENoS* 2005/04, Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia.

Broccolini C. (2005), "Una prima valutazione degli effetti della riforma universitaria: Il caso dell'Università Politecnica Delle Marche", *Quaderni di Ricerca* n. 244, Ancona.

Cappellari L. and Lucifora C. (2009), "The Bologna process and college enrolment decisions", in *Labour Economics*, 16 (6), pp. 638-347.

Carneiro P., Heckman J.J. (2002), "The Evidence on Credit Constraints in Post-Secondary Schooling", *The Economic Journal*, 112, 705-734.

Checchi, D. (2000), "University Education in Italy", *International Journal of Manpower*, 21(3-4): 177–205.

Cingano F. and Cipollone P. (2007), "University drop-out: the case of Italy", Banca d'Italia, *Temi di discussione* n. 626, Roma.

Clerici et al., (2011) "Le carriere universitarie tra successo formativo, abbandono, cambio di corso e ritardo. Un'analisi per coorte attraverso gli archivi dell'Ateneo di Padova", *Technical Report Series*, N.1, July 2011.

Cutillo.A e Di Pietro.G. (2008), "Degree flexibility and university drop-out", *Economics of Education Review*, vol. 27, issue 5, pages 546-555.

D'Hombres B. (2007), "The impact of university reforms on dropout rates and students' status: Evidence from Italy", *JRC Scientific and Technical Reports*, European Commission.

Di Pietro G. (2004), "The determinants of university dropout in Italy: A bivariate probability model with sample selection", *in Applied Economics Letters*, 11 (3), pp. 187-191.

Hastie T., Tibshirani R., Friedman J., and Franklin J. (2005), "The elements of statistical learning: data mining, inference and prediction", *The Mathematical Intelligencer* 27, 2: 83-85.

Light, A. E Stayer, W. (2000), "Determinants of college completion: School quality or student ability?" *Journal of Human Resources*, 35(2): 299–332.

Mealli F., Rampichini C. (2012) "Evaluating the effects of university grants by using regression discontinuity designs", *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 175, 775-798.

OECD (2013), *Education at a Glance 2013: OECD Indicators*, OECD Publishing.

Schizzerotto, A. (2002). "Dinamiche e motivazioni dell'abbandono degli studi universitari: L'esperienza di Milano Bicocca", *Workshop su Valutazione dell'Università, Accreditamento del processo, Misurazione del prodotto*.

Scott, M. & B. Kennedy (2005), "Pitfalls in Pathways: Some Perspectives on Competing Risks Event History Analysis in Education Research", *Journal of Educational and Behavioral Statistics*, 30(4), 413-442.

Smith J.P., Naylor R.A. (2001) "Dropping out of university: a statistical analysis of the probability of withdrawal for UK university students", J*ournal of the Royal Statistical Society: Series A (Statistics in Society)*, 164: 389-405.

Tibshirani R. (1996), "Regression Shrinkage and Selection via the Lasso", *Journal of the Royal Statistical Society*. Series B (Methodological), Vol. 58, 1: 267-288.

Tinto, V. (1975). "Dropout from higher education: A theoretical synthesis of recent research", Review of *Educational Research*, 45(1): 89–125.

Wu T. T., Chen Y. F., Hastie T., Sobel E., and Lange K. (2009), "Genomewide association analysis by lasso penalized logistic regression", *Bioinformatics* 25, 6: 714-721.