

Measurements and potential outcome models for estimating the outcome effect of Italian Universities reform: delay at graduation, income, employment

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Description of steps presentation

Statement 1

The paper is aimed at providing a draft evaluation of the impact the reform, implemented in 1999 and better known as the “3+2 reform”, has had on the Italian university system. The graduates’ viewpoint has been adopted, with their characteristics and performances, in relation to both their course of study and placement in the labour market. More specifically, the main research question the paper intends to reply to is: how has the delay at graduation been changing because of the reform, given the characteristics of students, context and university? Evidently, since the reform has structurally changed university studies¹, it actually defines now different “objects” than the old courses of study. In theory, since they are different, they cannot be compared in the changeover from the pre- to the post-reform system.

Moreover, in order to reply to the question mentioned above, it is also possible to claim that the issues about measurement and treatment of delay at graduation (whether exogenous or endogenous) must be dealt with, provided that the reform intervened exactly by changing the definition and structure of the prescribed graduation time. It is furthermore necessary to keep in mind that the reform is not a past event which can be clearly defined over time, and yet, 13% of Italian graduates earned an “old system” qualification still in 2008.

The paper starts with the description of the used database. Further on, through an entirely *data-driven* approach, the focus is on some measurement tests performed by means of micro-econometric models and other multivariate tools so as to estimate the differential impact of the four different types of treatment, namely three-year degree courses (L), master’s degree courses (LS), single-cycle specialist degree courses (LSE) and old-system degree courses (CDL). Those tests were all checked by using individual-level covariates related to all graduates’ socio-demographic characteristics, their university and pre-university education career, along with environmental and geographical variables that can potentially impact on their labour market performance.

¹ This was also the result of both the increased number of universities and the heterogeneous implementation strategies of the reform criteria.

The present analysis was made possible thanks to the survey on graduates' employment status the AlmaLaurea Interuniversity Consortium² carries out on a yearly basis.

Statement 2

The attention paid to causal inference in general and to the application of the “Rubin potential outcome”: propensity score methods for estimating causal effects in particular has been considerably increasing over the last three decades.

Though randomized experiments are frequently considered as the “gold standard” for causal inference, randomization is frequently not possible due to ethical, administrative, or budgetary reasons. In the case of a general reform is impossible the application of randomization, because of self-selection mechanism in order to choice the new type of university courses or the old type.

In such cases quasi-experimental methods like regression-discontinuity designs, interrupted time series analysis, instrumental variable approaches, or non-equivalent control group designs might be employed to estimate the treatment effect of an intervention or a public program.

In comparison to a randomized experiment, quasi-experimental methods do not involve randomization but are instead confronted with different types of selection processes.

The selection process involved might be known as for regression-discontinuity designs, where subjects get assigned to a treatment and control condition based on a continuous assignment variable and a strict cutoff.

Or, it might be unknown as it is the case with non-equivalent control group designs where subjects select themselves or are assigned by administrators or third persons into a treatment or control condition.

Studies involving non-equivalent control groups or instrumental variables are also referred to as observational studies.

In observational studies, the problem associated with differential selection into treatment and control conditions is that unadjusted treatment effects are very likely biased. For instance, if unemployed persons most promising for getting a job in the near future are assigned into a labor market program their average employment rate after program participation is very likely higher than the average employment rate of the non-participating unemployed persons—not necessarily because of the treatment effect but because of the better initial position participants were in (this effect is frequently called “creaming”). In such a situation we can estimate unbiased treatment effects only if we are able to adequately model the selection procedure, statistically control for observed selection differences, or identify a reliable source of exogenous variation—otherwise bias due to differential selection remains. The assumptions required for an unbiased estimation of causal treatment effects are well known and formulated in statistical theories about causal inference but also in structural causal modeling approaches.

However, the crucial question in applied research is whether these assumptions required for an unbiased estimation of the treatment effect are actually met for an observational dataset in hand. If the assumptions are not met the estimated treatment effect is very likely biased and the causal claims drawn from the observational study might be invalid. While some of the assumptions involved in a causal inference from observational data are testable like assumptions about the statistical model (e.g., normality or homoscedasticity of the error term) many design assumptions like strong ignorability or exogeneity are not. Unfortunately, effect estimates are

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frequently much more sensitive to violations of untestable assumptions than testable ones. Thus, violations of untestable assumptions are especially a potential threat to the validity of causal inferences, unless we can convincingly rule them out by carefully chosen design elements like non-equivalent outcome measures or multiple comparison groups.

Statement 3

In our case, the issue was tackled by referring to an approach that in the literature is better known as propensity score, which was developed by Rosembaun e Rubin (1983). These authors show that, having information available about the subjects under treatment, that is prior to the treatment itself, it is possible to develop an indicator not conditional on similarities between individuals, so as to compare the sample of treated and non-treated subjects in relation to a target variable Y and leaving the possible self-selection effect aside. The authors show all this under the condition that the indicator is truly not conditional, i.e. when the so-called offset condition is ensured. The latter entails that, in short intervals of this indicator, the distribution of available variables between treated and non-treated subjects is probably the same as the one on pre-treatment subjects.

In our paper on the analysis of delay at graduation determinants, a recently developed methodology was used that allows to test the conditions of multi-varied offset in sub-groups univocally defined out of a set of possible covariates. The approach exploits some techniques developed for factorization of inertia matrix of categorical data by experts in the framework of multivariate statistics in the 1970s. Moreover, we introduced a multivariate approach to the selection bias problem, which was defined by a test on a (MIC test). This makes it possible to understand whether the subgroups are still biased for a selection bias process or not and if they can be used as reference subspaces for direct matching or to estimate local models.

In our case, the strategy to form subgroups made it possible to define a minimum number of 34 clusters that are acceptable to segment our graduate population, by means of the iterative technique linked to the MIC test. From the operational viewpoint, this means that per each cluster, based on the strategy shown in Camillo and D'Attoma (2009) and in Peck, Camillo and D'Attoma (2010), it is possible to make comparisons for an outcome variable external to covariates that potentially defined the biased selection process in a treatment instead of another. This is only possible by virtue of the offset property which exists in each cluster by algorithmic construction of the solution.

Statement 4

A Table will show the estimate offset of the reform's effect and the information is organised by subgroups. The organisation criterion adopted is the delta between the percentage of late graduates among the old system graduates (CDL) and new three-year degrees graduates (L). Hence, at this point of the paper, we focus on one of its key points, that is the comparison between CDL and L, which is deepened further on.

The percentage of late graduates may be interpreted in frequentist terms as the likelihood to graduate late that is conditional on being included in the specific cluster, within the framework of the specific cluster.

Using a visual representation of the difference between the values relating to the 34 segments, sorted by the kind of treatment they received. It is interesting to observe that CDLs score a high level of likelihood and never below 78%. Conversely, the likelihood trend for three-year graduates (L) shows how some groups recorded late graduate levels below a nearly physiological rate.

Indeed, we may regard as successful those sub-groups where likelihood is below 50%, i.e. in the event of making decision when information is missing, so that the likelihood value of a dichotomous event (namely delay or no delay) is 50%.

The most successful post-reform cluster is sub-group 5, followed by sub-group 4 with a delta of 58-59 percentage points as compared to the CDL base value.

The overall results seem to confirm what emerged from both the econometric and the discriminant functions analysis.

In short, the following conclusions can be drawn up:

- (a) New three-year degree courses are much more appealing to students of low social backgrounds and school qualifications than old-system ones. This even results in a clearly positive effect on the likelihood to graduate on time.
- (b) New three-year degree courses involve much weaker likelihood of delay if students attend classes on a full-time basis and do not work.
- (c) Some specificities exist relating to both degree subject grouping and geographical location.

The comparative profiles of the two best groups in terms of deviation between the CDL and L group are shown below as an example.

CLUSTER 5: *These graduates are women who live and studied in southern Italy. They come from culturally and economically less advantaged families: their parents generally have a primary school-leaving certificate at most and belong to the working class. They did not have any work and study period abroad experience while at university. They attended over 75% of classes and graduated without delay. They mainly graduated in subjects as Chemistry/Pharmacology and Geo-Biology and earned post-reform first-level degrees.*

CLUSTER 4: *These are male graduates who live and studied in central or southern Italy. They come from culturally and economically less advantaged families: their parents generally have a primary school-leaving certificate and belong to the working class. During university, they have mainly worked, and indeed their class attendance rate is less than 25%. No study abroad period was enjoyed, but they graduated on time. They mainly studied subjects in the Medicine and Teaching groupings, and earned both first and second level degrees of the post-reform university system.*

The description of the two clusters including graduates with the lowest deviation between likelihood of delay in the old (L) and new (CDL) university system, namely the subgroups 10 and 33.

CLUSTER 10: *These graduates live and went to universities in southern Italy. They are male graduates from the most advantaged social backgrounds. No work experience was performed during university. They attended most of the classes offered and graduated beyond the prescribed time limits. They graduated in subjects such as Law, Economics/Statistics and Arts/Humanities under the old university system.*

CLUSTER 33: *These graduates live in central-southern Italy and attended a big city university in central Italy. They are female graduates from middle socio-cultural backgrounds. They worked while studying at university, attending classes quite regularly. They did not enjoy study periods abroad and graduated beyond the prescribed time limits. They completed reformed first-level degree courses, more likely in subjects such as Political/Social Sciences, Psychology and Arts/Humanities.*

Statement 5

This part of the analysis focused on the elementary variable working/not-working one year on from graduation. Here too the 4 treatments were considered (L, LSE, LS, CDL) by using as a variable the Istat definition the labour force gives of the 'employed status'. Similarly to income, the focus was on the 2007 graduation year only, for the sake of stability models.

The first step was estimating a multinomial logit model by means of exogenous variables, which represent the available information at the end of university.

Estimates show a good significance for the 4 possible treatments, the variables related to the degree subject groupings, the types of school-leaving certification and information about studying attitude, with some obvious

details about geographical location, as either living or having attended university in southern Italy is certainly a penalising factor.

However, some key aspects should be underlined in the overall parameter estimate. (i) Parents' social background is not so useful to explain the different likelihood to join either the working group or the other. (ii) Parents' education qualification seems to be fundamental both in general terms and in the different modalities. This seems to be the lead indicator of all the socio-economic facts. (iii) In any case, as to the magnitude each CATEGORY transfers to the model, the fact of having gained a post-reform three-year degree ($\beta=0.1054$, but p-value is 7%) or a postgraduate degree ($\beta=0.3620$, with a highly significant p-value) proved to have a positive influence, whereas as to CDLs there seems to be no effect to calculate.

The way the types of treatment (degree courses) are articulated does not show a high significance on the likelihood to find a job one year on from graduation. This can be partially explained by an interesting interaction between degree course type (L, CDL, LSU, LSE) and parents' education qualification. The introduction of gender differences does not substantially alter the interest parameters, but for a remarkable difference in favour of males.

The parameter subgroup stemming from the same model as before, but only marginal parameters such as degree course type and those related to the interaction between parents' qualification and degree course type were reported.

An evident parameter sign reversal occurs, especially in the three-year course category. The parameter becomes negative (-0.1004) in relation to the LSE base parameter=0. Even if we consider it in terms of Wald confidence interval, it is in a negative region and this happens although the p-value is very far from the null value, which means that it is negative and unsteady nonetheless.

Conversely, it is possible to show the parameters estimated in the same complete model, but only as regards the interaction between parents' qualification and degree course type. The result involves some heterogeneity of effects, as, being "at least one graduate parent" the base, the interaction parameter is negative for "primary school-leaving certificate at most" and it becomes positive for both "middle school-leaving certificate" and "high school-leaving certificate". If in marginal terms the "new" graduates' segment gives a negative but highly unsteady contribution and, thus, not probabilistically significant, this could be due to the fact that very different attitudes are shown within the segment. The difference is between those having parents with mid-level school qualifications, such as middle or high school leaving certificate (positive impact on the likelihood to find a job), and those having parents with really basic or high school qualifications (negative or null impact).

This bears witness to the fact that decisive network factors still exist in relation to parents' education qualification rather than to their social background.

The discriminant analysis carried out with the same technique already used in the paper provides results for each of the 4 analysis segments.

As compared to the original variables, a synthetic categorical variable was also included. It derives from the graduate clusterization in relation to the answer pattern they gave to the 8 items (career, relevance to their university studies, earnings, independence, pertinence to their cultural interests, professionalism, job security, free time) about their key job expectations at graduation.

A data mining analysis provides a graphic description of the subgroups (clusters) mentioned above, and it illustrates the significance test values for the different expectation between the subgroup and the general mean per each item. For instance, subgroup 1 is highly characterised by a great expectation for free time and a small expectation for all the other features of an ideal job. Notwithstanding, features such as professionalism, job security and relevance to their university studies rank higher in this trade-off.

Moreover, a variable that categorises the distribution of standardised degree grade was developed. Categorisation follows three classes, namely high, middle and low. These classes are related to the joint partial distribution by degree subject grouping and university, and were segmented by using the two 33% and 66%

quantiles per each distribution. This was done to analyse the degree grade in terms of both degree subject grouping of the given degree and relevant university of graduation, so as to avoid possible local and subject-related effects specifically used in the scale of values intrinsic to the degree grade.

The correlation matrix enables us to summarize a draft result pattern of the 4 different discriminant functions.

As to the likelihood to be in work one year after graduation, it is interesting to notice that the two most similar parameter sets are those related to the “postgraduate degree – pre-reform degree course” binomial, instead of the “pre-reform degree course – post-reform three year degree course” one, as it yet occurred for delay at graduation.

This could give a first clue to how push factors linked to the various labour market determinants are segmented on human capital, so as to treat pre-reform and post-reform postgraduate degree courses alike. As an example, if we think of a newly graduate and the labour market he is faced with after graduation, our model results show that the likelihood to be in work one year on after graduation depends on the same determinants for both post-reform postgraduate and pre-reform degree holders, rather than for post-reform three year graduates.

This has an obvious implication when individuals apply market placement and job-seeking strategies. It seems as if, during the reform changeover, labour markets ended up by considering pre-reform degrees as post-reform postgraduate degrees rather than as pre-reform three year degrees.

APPENDIX

AlmaLaurea information and data mart used

The present analysis was made possible thanks to the survey on graduates’ employment status the AlmaLaurea Interuniversity Consortium³ carries out on a yearly basis.

The cohorts analysed were divided into pre-reform (CDL) and post-reform ones. The pre-reform cohort then is composed of first-level (L), second-level (LS), and single-cycle specialist degree holders (LSE). Data reported here in particular are referred to pre-reform 2003, 2004, 2005, 2007 and post-reform 2005, 2007 graduate surveys one year on from degree completion.

The available variables were gathered from two interview types. The first is generally carried out shortly before graduation and is related to all variables providing a graduate profile with respect to socio-demographic background and course of study. The second interview is carried out one year on from degree completion and pertains to employment and education status of the same subjects.

For the sake of clarity, it is helpful to report a list of all variables determined shortly before graduation on tables from 1 to 5

Table 1 - SOCIO-DEMOGRAFIC VARIABLES (a)

VARIABLE	CATEGORY LABEL CATEGORY
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³ AlmaLaurea was established in 1994 by the University of Bologna Statistical Observatory and it became a Interuniversity Consortium in the year 2000. It currently includes (May 2011) 64 universities and represents 77% of Italian graduates. AlmaLaurea is aimed at supporting graduates, universities and businesses by making available reliable and updated documentation on highly qualified human capital. Moreover, it publishes an on-line databank of both recent and highly experienced graduates, also available in English, to help matching labour supply with demand on the domestic market and encourage trans-national mobility. For further details about the survey methodology, see www.almalaurea.it; Cammelli and others (2009).

Gender	1	Male graduate
	2	Female graduate
Age at graduation		Continuous Variable
Area of residence	1	North-West
	2	North-East
	3	Centre
	4	South
	5	Islands
	6	Abroad
	99	Not available
Social background^(b)	0	Not classifiable/ Not available
	1	Middle-class
	2	Clerical middle-class
	3	Petty bourgeoisie
	4	Working class
Parents' education qualification	0	Not classifiable/ Not available
	1	Primary school-leaving certificate
	2	Middle school-leaving certificate
	3	Secondary school-leaving certificate
	4	At least one graduate parent

Notes:

(a) Variables in the list are available for all the surveyed cohorts;

(b) The system devised by A. Schizzerotto (2002) was adopted for graduates' social background, which is the highest resulting from the comparison between the socio-economic situation of the graduate's father and mother.

Table 2 – EDUCATION QUALIFICATIONS ^(a)

VARIABLE	CATEGORY	CATEGORY LABEL
Type of secondary education	1	Classical Lyceum (secondary school specialising in classical studies)
	2	Scientific Lyceum (secondary school specialising in scientific studies)
	3	Teacher-training school
	4	Languages Lyceum (secondary school specialising in the study of languages)
	5	Artistic Lyceum (secondary school specialising in the study of art)
	6	Technical high school
	11	Vocational school
	12	Other type of certificate
	13	Foreign high school-leaving certificate
	Year of enrolment Pure or hybrid?^(b)	0
1		pre-reform
2		pure
3		hybrid
Degree subject grouping	1	Agriculture

	2	Architecture
	3	Chemistry and pharmacology
	4	Economics and statistics
	5	Physical education
	6	Geo-biology
	7	Law
	8	Engineering
	9	Teaching
	10	Arts and humanities
	11	Languages
	12	Medical
	13	Political and social sciences
	14	Psychology
	15	Sciences
University	1	Bari
	2	Basilicata
	3	Bologna
	4	Bolzano
	5	Cagliari
	6	Calabria
	7	Camerino
	8	Cassino
	9	Castellanza-LIUC
	10	Catania
	11	Catanzaro
	12	Chieti and Pescara
	13	Ferrara
	14	Florence
	15	Foggia
	16	Genoa
	17	L'Aquila
	18	Messina
	19	Milan - IULM
	20	Milan-Vita Salute San Raffaele
	21	Modena and Reggio Emilia
	22	Molise
	23	Naples - II Università
	24	Padua
	25	Parma
	26	Perugia
	27	Perugia Foreigners
	28	Eastern Piedmont
	29	Reggio Calabria
	30	Rome - Campus Bio-Medico
	31	Rome - Foro Italico
	32	Rome La Sapienza
	33	Rome - LUMSA
	34	Rome Tre
	35	Salento
	36	Salerno

	37	Sassari
	38	Siena
	39	Turin Polytechnic
	40	Turin University
	41	Trento
	42	Trieste
	43	Tuscia
	44	Udine
	45	Valle d'Aosta
	46	Venice Cà Foscari
	47	Venice IUAV
	48	Verona
University Geographical Area	1	North-West
	2	North-East
	3	Centre
	4	South and Islands
Degree course		
Graduation grade		

Notes:

(a) Variables in the list are available for all the surveyed cohorts;

(b) AlmaLaurea defines as “pure” the graduates who enrolled on a reformed course (that is a two-level one), while “hybrid” are the graduates who completed a reformed course thanks to the credits earned during pre-reform courses. Not surprisingly, this last type of graduates generally show more modest academic performances.

Table 3 – EDUCATION STATUS

VARIABLE	CATEGORY	CATEGORY LABEL
Regular degree completion times	0	Within the prescribed time limits
	1	Within 1 year beyond the prescribed time
	2	Within 2 years beyond the prescribed time
	3	Within 3 years beyond the prescribed time
	4	Within 4 years beyond the prescribed time
	5	Within 5 or more years beyond the prescribed time limits
Duration of university studies		Continuous variable
Class attendance rate(b)	1	Lower than 25%
	2	Between 25% and 50%
	4	Between 50% and 75%
	5	Over 75%
Delay at graduation(c)		Continuous variable

Notes:

(a) Not available for the 2003 and 2004 CDL cohorts

(b) It measures the time interval between the agreed day of enrolment for the university year, that is November 5th, and the graduation date. As for master's degree courses, it is the time interval between November 5th of the enrolment year for a final two-year course and the graduation date.

(c) It measures the time employed by students to finish their university course after the expiration of the prescribed graduation time. It counts months and days elapsed between the end of the university year (April 30th) and the graduation date.

Table 4 – EVALUATIONS AND INTENTIONS^(a)

VARIABLE	CATEGORY	CATEGORY LABEL
Intention to further one's education	1	Yes
	2	No
Evaluation of crucial aspects for job seeking(f)	1	Absolutely not
	2	Judgement 2
	3	Judgement 3
	4	Judgement 4
	5	Very much

Notes:

(a) Variables in the list are available for all the surveyed cohorts;

(b) Eight elements have been reported as crucial while seeking for a job: (1) earning prospects, (2) career prospects, (3) job security, (4) skills development, (5) relevance to one's studies, (6) pertinence to one's cultural interests, (7) independence or autonomy at work; (8) free time.

Table 5 – OTHER EXPERIENCES

VARIABLE	CATEGORY	CATEGORY LABEL
Study abroad experiences	1	yes
	2	No
	99	No reply
Work during university	1	Student worker ^(b)
	2	Working-student
	3	No work experience
	4	Not derivable

Notes:

(a) Variables in the list are available for all the surveyed cohorts;

(b) By working student we mean here the graduates who had full-time permanent employment for at least half of their course of studies, whether in parallel with scheduled university courses or not.

Secondly, for the sake of clarity, again, Table 6 shows the variables determined one year on from graduation.

Table 6 – VARIABLES DETERMINED ONE YEAR ON FROM GRADUATION

VARIABLE	CATEGORY	CATEGORY LABEL
Did you enrol again after the three-year degree course? ^(a)	1	Yes, on a postgraduate degree course
	2	Yes, on a different three-year course
	3	Yes, on an old system degree course
	4	Yes, on conservatory of music or art academy
	5	No
Employment status	1	employed
	4	Not seeking employment
	5	seeking employment
Continuation in the former job	1	continuing in the previously held job
	2	Not continuing in the previously held job
	3	Started working after graduation
Time interval between seeking of a job and finding a new job	99	No reply
		Continuous variable
	98	Never looked for
Type of contract	99	No reply
	1	Self-employed
	2	Permanently employed
	3	trainee employment/training contracts/ apprenticeships
	4	fixed-term c.
	5	Contract work
	6	Other contract work
	7	With no contract
Aggregation of type of contract	99	No reply
	1	permanent employment
	2	trainee employment/training contracts/ apprenticeships
	3	Contract work
	4	With no contract
Public or private sector ^(b)	99	No reply
	1	Public

	2	Private/with government participation
	99	No reply
Branch of economic activity ^(c)	1	Agriculture
	2	Light engineering and precision engineering
	3	Building
	4	Chemistry/Energy
	5	Other manufacturing industries
	6	Trade
	7	Credit, insurance
	8	Transport, communication and telecommunication
	9	Consultancy
	10	IT
	11	Other services to enterprises
	12	Public administration, armed forces
	13	Education and research
	14	Healthcare
	15	Other services
	99	No reply
Sector of activity ^(c)	1	Agriculture
	2	Industry
	3	Services
	99	No reply
Region of work ^(b)	1	Piedmont
	2	Valle d'Aosta
	3	Lombardy
	4	Trentino A.A.
	5	Veneto
	6	Friuli V.G.
	7	Liguria
	8	Emilia R.
	9	Toscana
	10	Umbria

	11	Marche
	12	Lazio
	13	Abruzzo
	14	Molise
	15	Campania
	16	Puglia
	17	Basilicata
	18	Calabria
	19	Sicily
	20	Sardinia
	21	Abroad + RSM (Republic of San Marino)
	99	No reply
Area of work ^(b)	1	North-West
	2	North-East
	3	Centre
	4	South
	5	Islands
	6	Abroad
	99	Not specified
Use of competences	1	High
	2	Low
	3	None
	99	No answer
If degree is required	1	Required by law
	2	Not required but necessary
	3	Not required but useful
	4	Neither required nor useful
	99	No answer
Degree effectiveness	1	Very effective/effective
	2	Fairly effective
	3	Little/ not effective at all
	6	Not specified

Looking for a job?	1	yes
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Notes:

- (a) question asked only to three-year degree holders, therefore available here only for 2005 and 2007 three-year degree holders;
- (b) variables available only for the pre-reform cohorts of 2003, 2004, 2005;
- (c) variables not available for the post-reform three-year degree holders of 2005.

Before concluding this paragraph, it is helpful to specify the selections that have been included in the surveyed cohort. As mentioned before, “pure” graduates are students who directly enrolled on a post-reform degree course from the very beginning; “hybrid” graduates are those who completed a post-reform degree with credits earned under the pre-reform system.

Considering the purposes of this analysis and to avoid any ambiguities connected to hybrid course of studies, the surveyed cohort included “pure” graduates only. The studied population showed different behaviour related to pursuing post-graduate education, and a direct comparison to the employment situation could penalize especially first-level degree holders. Indeed, they mostly pursue their studies and enrol on a master’s degree course, and by doing so they delay their full entry into the job market. That is why this survey involved only the first-level graduates who did not enrol on a master’s degree course after graduation.