

Is Well Begun Half Job Done? Educational Production Functions of University Students

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Abstract

Although Italian tertiary education system has been widely analysed over the recent years, very little is known about the mechanism that lies behind students academic performance. This paper aims at investigating undergraduates performance by estimating their educational production functions. We use administrative records on students performance from one of the largest Italian universities. We estimate models of students performance in which we pay special attention to the extent to which early performance translate into final success at degree. Our data cover the years before and after the implementation of the “Bologna process”. Moreover, the specific institution that we analysed went through some ‘policy changes’ (i.e. change of admission procedures) over the period investigated. These changes occurred in some fields of studies and not in others, generating the frameworks for a difference-in-difference evaluation. Results indicate that initial performance is a strong predictor of final success. Furthermore, students for whom admission at university was based on entry tests are more likely to complete college, but are penalised in terms of graduation time and marks. Finally, we estimate dynamic models of yearly performance that account for unobserved heterogeneity which suggest that students apply an inter-temporal substitution when choosing how many exams to pass in a year, while the dynamics of the average marks obtained in those exams are consistent with learning effects.

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1 Introduction

This paper estimates the relationship between indicators of individual academic performance (quantity and quality) measured at different points in time over an individual's career and a number of outcomes, namely likelihood of graduation and likelihood of graduating with top marks, on time and on time with top final grade. Our data set, the administrative data from a large and private university in Italy over the period 1990-2008, provides a comprehensive set of measures of observed students' characteristics along with a number of department-specific institutional setups which are helpful for the identification strategy. The main purpose of this analysis is hence to enlarge the evidence about the mechanism that drive academic performance as we know fairly little about it. The emerging question is related to understand whether students who start well their university career – good starters – are more advantaged to attain their qualification. In addition, we aim at detecting what dimensions of early performance drive final outcomes. We are aware that undergraduates face a trade-off between quantity and quality. Furthermore, we are interesting in highlighting if there is persistence in the way students perform from an academic year to the next as well as if good starters' performance is a good sufficient statistic to analyse this issue. Clearly, this study may have policy implications as to how universities may want to identify progression problems as early as possible in order to reduce dropout rates, students' failure, elapsed time to degree. A better knowledge about academic career of students may help to devise new policies which may facilitate students to succeed at university. Overall measuring educational performance and understanding its determinants are important. Most of the previous studies focus on methods for modelling the production function for cognitive achievement in a way that captures theoretical notions that child development is a cumulative process depending on the history of inputs applied by families and schools as well as on children's inherited endowments (Hanushek, 1994; Todd and Wolpin, 2003). A link between school expenditures and student performance has been analysed as well (Hanushek, 1979; Krueger, 1999). There is also a wide empirical evidence on the relationship between early career progression after school-to-work transition to stress what are the most important determinants in being successful in the labour market, whether prior school choices and family characteristics do matter (Ryan, 2001; Flinn, 1986; Jensen and Westergard-Nielsen, 1987; Wolpin, 1987). These issues are economically important because the identification of a production function has a strong impacts on individual's life at different levels, for example on their labour market outcomes.

In this paper we attempt to define an educational production functions for university students in order to facilitate a comprehension of the way undergraduates cope with their academic experience, mainly focusing attention on the first year performance.

The main findings of this paper indicate that initial performance is a strong predictor of final success. Furthermore, students for whom admission at university was based on entry tests are more likely to complete college, but are penalised in terms of graduation time and marks. Finally, dynamic estimates of yearly performance suggest that students apply an inter-temporal substitution when choosing how many exams to pass in a year, while the dynamics of the average marks obtained in those exams are consistent with learning effects.

The paper is organized as follows. Section 1 presents a brief review of the empirical literature. Section 2 describes the data set and provides descriptive statistics. Section 3 shows the empirical strategy used. Section 5 presents the results of the analysis. Finally section 6 concludes.

2 Data, sample selection criteria, and variables

2.1 The Data

The data used to examine the performance of undergraduate students in terms of probability of getting a degree, graduating on time, with top marks as well as both on time with the highest final grade are drawn from the administrative dataset of a large private Italian university, which offers undergraduate and graduate degrees in several subject areas, namely teaching, law, economics, the humanities, foreign languages, maths, banking sciences, political science, psychology, agricultural science, and motor sciences. Although it differs in many ways from the rest of the Italian university system, which is almost public, it offers the opportunity of analyzing undergraduate students' behavior thanks to the great number of faculties belongs to this college. In this analysis we focus our attention solely on students who achieved a degree, are still enrolled or withdrew from one of the aforementioned faculties. About the last two categories we include in our empirical exercises only individuals who are entitled to graduate, i.e. enrolled at least for a period equals to the legal length. In particular we take into the estimates only students enrolled in the following university centres: Milano, Piacenza and Brescia. Milan offers a wide choice of faculties, since each person may decide whether or not to enrol at this university centre choosing between all the faculties mentioned earlier on, apart from maths and agricultural sciences as these course programmes are available only at the sites of Brescia and Piacenza, respectively. Furthermore, students may attend also economics, law and teaching at Piacenza, instead at Brescia they may enrol in the following faculties as well: the humanities, foreign languages and education. This data source provides us with a large and reliable sample of students, collected during the academic years 1990 to 2008. However, we must be aware that the Italian university system has been interested in 2001 by an extensive reform, which has envisaged a major change in the structure of degrees (see Appendix for more details). As a matter of fact we run separate regressions for students enrolled in the four years undergraduate programmes (old system), and for those enrolled in the three years cycle (new system)¹. The final total sample contains 52,176 individuals, whereof 38,426 of the old system and 13,750 of the new one, but when we consider the graduate sample we have 44,565 students on the whole, whereof 34,213 and 10,352 enrolled in four years and three years courses, respectively.

2.2 Sample Selection Criteria

In our analysis we are interested in the behaviour of students enrolled at university. The main idea is to attempt and to extend our knowledge of the way undergraduates carry on their academic career, i.e. to define a sort of value-added production functions. We are conscious that, due to the private nature of this university

¹ Given that results of students enrolled in the fifth years programmes (old system) are in line with those found for the fourth years programme we do not show any estimates for the sake of brevity.

along with the high levels of tuition applied², this college might attract students with specific preferences, tastes and abilities regarding the standards of Italian public universities, but it certainly represents an opportunity of exploring the mechanism through which students achieved their degrees. Clearly, the key advantages of using these administrative records are the chances of having a heterogeneous bunch of students, as there are several subject areas of studies, and the possibility of handling individuals coming also from far away, contrary to the situation noticed in the other Italian colleges³.

To evaluate the major factors that influence college progression towards the degree attainment we apply the following restrictions to the initial sample at our disposal:

- a) Firstly, we drop from the sample students whose information on pre-conditions, such as high school final grade, type of high school, are missing;
- b) Secondly, we exclude from the analysis individuals having missing values on dates and/or marks obtained in some exams. In addition, we drop also those who passed the exams before the year of matriculation, come from another university or are already graduated, have shifted to the new system, and students who got a degree in less years than expected. We eliminate then graduates with a number of exams below the minimum threshold required together with those who do not graduate yet, even if they have passed all the exams. We decide to apply these limitations since missing values in such pieces of information may bias our effort to understand students' behaviour;
- c) Thirdly, we do not include students enrolled at Motor Sciences both in the old system and in the new one, because this course programme is definitely different from all the others, for example in terms of workloads required. Moreover, we drop from the analysis those who are enrolled for a period shorter than the legal length. The idea is to limit the analysis only to students who are at risk of graduation;
- d) Finally, we exclude from the three years programmes sample students enrolled in the following faculties: agricultural sciences and psychology. This restriction is applied in order to run homogenous analysis between the two regimes as regards the field of studies.

The empirical work that follows is based upon the sample resulted from the restrictions applied above. Additional reductions in the sample size have been imposed on the strength of the goal to be reached every time across our analysis.

2.3 Variables

2.3.1 Dependent Variables

Our empirical investigation can be divided into several sections. Basically, we split our analysis into two parts according to the type of system under which students are enrolled, old system and new system,

² Upon enrolment in each academic year, students are assigned to different tuition levels on the basis of their income assessed by the university administration through the income tax declaration of the student's household and through further inquiries.

³ In Italian university, students' mobility is generally quite narrow, instead in the analysed university, because is private and has a good reputation, on average attracts also several students who were used to live in another region or at least province.

respectively. Within each sub-sample we then study the probability of getting a degree, instead regarding the graduates' sample, the probability of graduating with top marks, or getting a degree on time or both on time with top final grade.

About the first issue – probability of college completion – we use the dummy variable *degree*, which takes value 1 for students who graduate during the observation period and 0 when they are at risk of completion.

Regarding the graduates' sample, we define three outcomes: *degree_top*, *degree_time* and *degree_toptime* which takes value 1 for students who get a degree with the highest mark, on time or on time along with top final grade, respectively, and 0 otherwise.

2.3.2 Explanatory Variables

The choice of covariates is informed by the received literature and related to the set of information available in our data. We may grouped those variables into different categories, such as personal characteristics, students' abilities prior to university enrolment, academic performance and other information.

We now go on to present the variables included in each category in detail:

- **Personal characteristics:** administrative records contain information about gender of students included in the sample. This information is useful because it allows us to take into account the existence of differences across gender;
- **Students' abilities prior to university enrolment:** we have at our disposal information about the final high school grade, the type of institution attended and whether is private or not. All these variables may enable us to analyse how much the level of knowledge achieved before college enrolment counts in terms of academic success;
- **Academic performance:** the data include follow-up information about the academic career of each student. Specifically, we have the exams passed in each academic year and the related grades⁴, the faculties at which a student is enrolled along with the years of matriculation and of graduation; the latter only if it occurs during the period observed. Using all these information we built our performance indicators, which are the core variables of our analysis. We define for each academic year the percentage of exams passed as a fraction of the number of exams passed in year t out of the total number due, multiplied by 100. Instead, the average mark of each academic year is calculated as the weighted mean of the grades obtained in a specific year. All this measures are provided for each student exclusively for the legal length. Also the differences between average mark of one year and the previous one are provided;
- **Other information:** we generate dummies variables about the type of faculties, the centres where they are placed, and the academic year of enrolment (to control for time variation over the period considered). We built also a dummy indicating if an individual enrolled at university immediately after having obtained a high school diploma or later. We define then the regional dummies according

⁴ Each student who passes an exam may record a grade varying from a minimum of 18 to a maximum of 31. Every course programme sets a specific number of exams that a student has to pass in order to be entitled to draw up the final dissertation, and so getting the degree.

to the province where a student got a high school diploma. For the case of Lombardy the province of Milan is excluded from the region, and it is considered in a separate dummy, as most of the students are coming from this province. Finally, only for students enrolled in the four-years undergraduate programmes on the basis of the faculty and the academic year, we define a dummy reporting if admission at this private university was based on running a selection⁵. Furthermore, still for this category, it is reported also a variable which indicates if enrolment in the third academic year is conditional on having reached any requirements, namely having passed some exams out of the total amount due, during the first two academic years⁶.

Summary statistics for the estimation sample are provided in Table 1, showing that the fraction of women enrolled at this college is rather stable in the two university system. Regarding the variables referred to students' abilities prior to university experience, we note that the rates of enrolment by type of high school diploma is almost unchanged between the two systems, apart from the increase in leavers coming from non-conventional upper secondary school, i.e. high school graduates in a foreign country. Instead, high school final grade signals that, on average, students who enrolled after the reform have higher marks than their counterpart, namely two points more once we look at the sample on the whole and three additional points if the graduate sample is considered.

About the portion of exams passed during each academic year, the larger percentage shown for the new system with regard the old one is clearly due to the diverse length of the course programmes which is of three years and four years, respectively. It is interesting to note, instead, that students overall enhance the number of exams taken as time passes by. Finally, the dynamic of the average marks is almost steady between the two systems.

3 Empirical strategy

We model the associations between students' attainments and first year performance indicators by means of the following econometric model

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \varepsilon_i \quad (1)$$

where $i=1 \dots N$ indexes individuals and ε_i is an error term. Y_i is an outcome measure (getting a degree, graduating on time, graduating with top marks, and graduating on time with top marks). x_i is a vector of controls including gender, type of high school attended (general or vocational, public or private) and the final high school mark, type of faculty attended, temporal dummies defined according to the year of matriculation, regional dummies, university site, and postponement in enrolment. First year performance indicators are denoted q_{1i} and Q_{1i} , representing a quantity measure (q_{1i} the proportion of exams passed during the first year) and a quality measure (Q_{1i} the average mark obtained in the exams passed in the first year).

⁵ This specific policy rule - *numerus clausus*- was working at the faculty of economics and political sciences till the academic year 1992/93, instead at the faculty of banking sciences up to the academic year 1993/94.

⁶ Restrictions on enrolment were working at the faculty of economics till the academic year 1992/93. Instead, up to the academic year 2000/01 at the faculty of political sciences and maths.

In a second step of the analysis, we investigate to what extent the impact of first year performance on final outcome works through performance in intermediate years of university attendance. To this end, we augment the baseline specification in (1) with quality and quantity indicators referring to intermediate years, and we include them into the baseline model in a progressive way, so that our estimating equation becomes either:

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \delta_2 q_{2i} + \gamma_2 Q_{2i} + \varepsilon_i \quad (2.a)$$

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \delta_2 q_{2i} + \gamma_2 Q_{2i} + \delta_3 q_{3i} + \gamma_3 Q_{3i} + \varepsilon_i \quad (2.b)$$

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \delta_2 q_{2i} + \gamma_2 Q_{2i} + \delta_3 q_{3i} + \gamma_3 Q_{3i} + \delta_4 q_{4i} + \gamma_4 Q_{4i} + \varepsilon_i \quad (2.c)$$

where additional performance indicators and associated parameters refer to students performance in intermediate years.

As discussed in the previous section, some “policy” changes occurred during the sample period. Specifically some faculties that were adopting *numerus clausus* and restrictive admissions procedures to the third year (i.e. third year enrolment was conditional on performance in the first two years) abandoned such practices around the mid-1990s. These changes meant that starting from a certain period onward, students enrolling at a given faculty were not exposed to the policy, whereas their predecessors were. Considering that other faculties have never adopted this kind of selection mechanisms, our data therefore offer the possibility to conduct a difference-in-difference exercise to evaluate the impact of the “policies” on students performance. Noting that the vector of controls x_i already includes time (i.e. year of university enrolment) and faculty fixed effects, the difference-in difference model can be written as:

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \phi P_i + \varepsilon_i \quad (3.a)$$

Where P_i is a dummy indicating presence of the relevant policy in a given faculty in a given year, and the parameter ϕ is the difference-in-difference estimator, and we illustrate the estimating strategy using the model in (1). Moreover, given the specific focus of our paper, we are also interested in the second order effects of the policies, i.e. the ones they exerted through first year performance, which we estimate by interacting the policy dummy with first year performance indicators:

$$Y_i = x_i' \beta + \delta_1 q_{1i} + \gamma_1 Q_{1i} + \phi P_i + \Delta_1 q_{1i} P_i + \Gamma_1 Q_{1i} P_i + \varepsilon_i \quad (3.b)$$

The models laid out above rely on variations across individuals for estimating the parameters of interest; as such, no control for individual specific unobserved heterogeneity can be included and the resulting parameter estimates may suffer from unobserved heterogeneity bias. In this context, students' ability is an obvious source of unobserved heterogeneity. Final college outcomes are observed only once for each individual which prevents integrating out individual specific unobserved heterogeneity. In order to gain some sense about the relevance of unobserved heterogeneity in this context, we investigate a dynamic model of yearly

performance, in which performance at time t (in terms of either q or Q) is regressed on controls and performance indicators at time $t-1$, plus an individual specific term which is identified thanks to the fact that we have multiple observations per individual on yearly performance indicators:

$$q_{it} = x_{it}'\beta + \lambda q_{it-1} + \theta Q_{it-1} + \alpha_i + \varepsilon_{it} \quad (4)$$

Equation (4) is specified in terms of q for illustrative purposes, but we also estimate models in which Q is the dependent variable. We integrate out the individual specific component using fixed effect estimator, and we account for the potential endogeneity of lagged dependent variables using the Arellano-Bond estimator. Besides yielding insights on the relevance of unobserved heterogeneity, the dynamic model also offers the possibility of estimating the degree of state-dependence in yearly performance, which is the mechanisms that lies behind the association between initial and final performance that we investigate with models (1) to (3).

4 Results

A first set of results is shown in table 2 which includes only students performance indicators associated to the first university academic year. For each outcome, namely probability of getting a degree, graduating on time, with top marks, and on time with top marks, the estimates are provided for both the old system and the new one, separately. In addition, every regression model contains also the following covariates: gender, type of high school and the relative final grade, private or public high school, faculties, temporal dummies defined according to the year of matriculation, regional dummies, university site, and postponement in enrolment. All these aforementioned variables allow us to control for personal characteristics, students' abilities and preferences together with organizational changes occurred within each faculty over time.

Looking at column (1) estimates underline a positive correlation of both first year indicators with the probability of getting a degree. These results suggest that being an active student reduces the risk of college non-completion since the start. Especially, the coefficient of the portion of exams reveals that a 1% increase enhances such probability by 1.5% if a student is enrolled in a four years course programme and by 2.4% if under the new cycle. Graduates' sample confirms the positive effects of the two performance measures regardless of the outcomes considered. However, as expected, graduation with top marks is mainly affected by the first year average mark recorded instead of the fraction of exams passed; a unit change in the average grade increases this probability by 5.5% for 4 years students and by 9.5% for the three years ones. To the contrary, a positive correlation between both indicators and the outcome is found, once graduation on time and on time with top marks are analysed. Despite any outcomes, the observed relationship stresses the considerable importance of undergraduates' preferences. In fact, for example, if a student gives great value to graduation with top marks the perfect strategy to reach this final goal is to devote more energies to the marks scored rather than the number of exams passed.

Estimates about the complete regression model are reported in table 3. Specifically, to the performance measures of the first year the corresponding indicators for the subsequent ones are added; up to the legal duration expected. Despite including these additional controls, the estimated impact of the fraction of exams

passed in the first year remains statistically significant as regards graduation's probability, but the size is small. On the contrary, the coefficient associated with average mark, still for the first year, is insignificant. On the whole, considering quality and quantity indicators referring to the entire academic history within the length due, on the whole what it matters more is the portion of exams; suggesting that the best tactic is clearly to pass exams irrespective of the related grades. Not surprisingly, the magnitude of this coefficient is large as time passes by. An increase in the fraction of exams passed during the last year of course programme, clearly, has a great effect on the probability of getting a degree, as it is more likely to have less exams left before graduation. Considering the sample of graduates and comparing the performance measures relative to any outcomes, we notice that correlations are dissimilar. In particular about graduation on time with top marks for old system students, the effects of portion of exams together with average mark are positive and almost identically distributed over time. To reach this target, students have to jointly balance their behaviour between number of exams and related grades. For both old and new system with regard to graduation with highest final grade, the solely considerable factor is average mark which is positively correlated with the outcome as opposed with the fraction of exams, which is negligible and when statistically significant negatively correlated. Finally, about getting a degree within the legal duration course programme, it is even more pronounced the mechanism through which this aim is scored. Of course, the number of exams passed in each academic year out of the total amount due is the driving force to this target. It is interesting to highlight, however, that it is the portion of exams recorded over the first year that strongly influenced this outcome. The emerging path suggests that only being able to get into the academic life immediately may ensure graduation on time, if a student does not pass the exams due in the first year, hardly can make up for lost time. The latter is mainly observed under the old system as the coefficient associated to the last portion of exams is negatively correlated with the outcome. To sum up, we observe that the first academic year is the one which influences the entire university experience, besides students are overall conscious of facing a trade off once they set the main objective. As soon as the decision is made, they have to adapt their behaviour according to it in the manner showed above.

Furthermore, with reference to the old system⁷, in tables 4 and 5 we show the specification presented above including gradually the dummies on policy rules. This additional estimates allow us to understand the impact of both quota and conditional progression policy on students performance.

For each outcome three columns are displayed, namely the first one is based on the basic specification plus the dummy indicating if a student has been exposed to a selection process or not, the second one instead, in addition to the baseline model, considers the effect of restrictions on enrolment at the third academic year. Finally, the last one includes at the same time both those two policies. Overall, it is important to note that the inclusion of those variables does not have any effects on the statistical significance and magnitude of the quantity and quality indicators considered each time.

As regards the probability of getting a degree both policies are not statistically significant if we consider specification including only first year students performance. However, once those measures about all the

⁷ We limit the analysis on students enrolled in four years course programmes as only for them such rules were working.

academic years are considered, we notice that students who were exposed to a running selection face a great probability of completing tertiary education experience (2.9%) (see column (1)). In terms of policy implications, such result is performing in the direction expected, i.e. increasing the probability of university completion and reducing the risk of withdrawal. On the whole, Italian tertiary education system is widely criticised for failing to limit especially the dropouts phenomenon. Several explanations have been provided, such as students consider university as a parking lot, are misguided, with lack of motivations; in order to devise some plausible interventions for limiting this problem. Many researchers suggested, amongst the bunch of solutions identified, the introduction of a running selection which may help students to detect their abilities and preferences, hence according to them is more easier to choose faculty. Similar results are noticed (see column (2)), with regard to conditional progression. On the contrary once we consider both those policy dummies, only the selection one remains statistically significant and positively correlated with this outcome. The latter result reveals that once both the two policy rules are taking into account only the quota has a positive effect, suggesting that such policy was reaching its goal.

Looking at column 2, the estimates regarding graduates' sample and the related outcomes considered show a negative effect of conditional progression. This negative correlation is on line with the idea of such variable. On the one hand, it aims at forcing students to pass exams in the academic year due, on the other hand it increases elapsed time to degree, because of the first limitation. According to the latter aspect, it is hence clear why the probability of graduating with top marks is lower by 3% in respect to those who are not exposed to this restriction. In general students, who are not satisfied with the mark obtained, may resit the exam, however being at risk of staying one year stuck force them to confirm any grades obtained, even if under their average mark. It is, at first sight, puzzling the result associated to the running selection. Column (1) in table 5 shows that running test has a negative impact on all the outcomes considered. This result remains confirmed even in column (3). The only complete specification in which quota is significant is about graduation on time, reducing by more than 7% such outcome. The negative sign associated with the running selection variable seems then not encouraging. Although, it appears controversial with what found about the probability of getting a degree, the negative sign may be interpret bearing in mind that we are now considered only graduates, so the fact of not being advantaged must be interpret according to the final aim of such rule, namely increasing the chances of graduation overall and not directly to improve in terms of quality and quantity the graduation outcome. Moreover, students, for whom admission was based on running test, represent by definition a selected sample, because of only a limited number of the high school leavers decided to take such test. In addition, as the ranking is defined on the basis of the results reported by each participant, it is not assured that from this selection process are chosen the best students in absolute terms, but just in relative terms.

Finally, table 6 reports estimates from the dynamic model of yearly performance that provided us with some insights about the mechanism through which initial and final performance are linked. In the first column results about the portion of exams at time t are regressed on both quantity and quality performance at time $t-1$, instead in column two the average mark at time t is analysed.

Looking at the quality measure we find a positive state-dependence between average mark over time. Overall students adopt a sort of “smoothing” behaviour with regard to this indicator. Students who, since the beginning of their academic career, got good marks will do the same even later, suggesting a standard learning process. On the contrary, about the portion of exams passed, column two shows that the mechanism is completely different from what discussed above. The quantity performance at time t is negatively associated with the one obtained in year $t-1$, such as if they pass in the first year all the exams due they will not adopt the same strategy in the second one, and so on. Dynamic model hence produces the idea that individuals apply an inter-temporal optimization behaviour relative to the number of exams passed during each academic year, with the aim of making up for lost time in case of low productivity, or taking a rest in the opposite situation.

5 Concluding remarks

Our research suggests that initial performance of university students is definitely a strong predictor of final success. Furthermore, once we look at the graduates’ sample with regard to any outcomes, we found dissimilar results. In particular about graduation both on time and with top marks for four years programmes, the effects of portion of exams together with average mark are positive and almost identically distributed over time. On the contrary, for both old and new system with regard to graduation with highest final grade, what it matters is solely the average mark. Instead, about getting a degree within the legal duration course programme, it is even more pronounced the mechanism the importance of the number of exams passed over each academic year. The emerging path suggests that only being able to get into the academic life immediately may ensure graduation on time, if a student does not pass the exams due in the first year, hardly can make up for lost time. To sum up, we observe that the first academic year is the one which influences the entire university experience, besides students are overall conscious of facing a trade off once they set the main objective. As soon as the decision is made, they have to adapt their behaviour according to it in the manner showed above.

Moreover, once we analyse the impact of reform policies – quota and conditional progression - within each department, we found that it increases the likelihood of graduating , but are penalised in terms of graduation time and marks.

Finally, the dynamic models of yearly performance that account for unobserved heterogeneity suggest that students apply an inter-temporal substitution when choosing how many exams to pass in a year, while the dynamics of the average marks obtained in those exams are consistent with learning effects.

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Tables

Table 1: Sample descriptive statistics by university system

	Old System	New System	Old System	New System
	All students		Only graduates	
Female	0.67	0.68	0.68	0.70
Licei	0.61	0.60	0.62	0.62
Ist. Tecnici	0.26	0.25	0.26	0.24
Teaching	0.08	0.04	0.08	0.04
Ist._Professionali	0.03	0.03	0.02	0.02
Others	0.02	0.08	0.02	0.07
Private high school	0.27	0.24	0.26	0.22
High school final grade	80.36	82.54	80.83	83.84
Fraction exams passed 1st year	15.94	23.94	16.50	26.27
Fraction exams passed 2nd year	17.60	26.89	18.29	29.98
Fraction exams passed 3rd year	19.11	33.91	20.06	37.55
Fraction exams passed 4th year	25.00		26.43	
Average mark 1st year	25.58	25.74	25.65	26.09
Average mark 2nd year	25.35	25.66	25.44	26.06
Average mark 3rd year	25.66	25.84	25.80	26.27
Average mark 4th year	25.95		26.10	
Economics	0.28	0.31	0.29	0.30
Law	0.17	0.06	0.16	0.05
The Humanities	0.13	0.20	0.12	0.21
Banking Sciences	0.05	0.02	0.05	0.02
Teaching	0.18	0.13	0.18	0.13
Foreign Languages	0.14	0.19	0.14	0.19
Political Sciences	0.05	0.08	0.05	0.09
Maths	0.01	0.01	0.01	0.01
Milan	0.84	0.78	0.83	0.78
Brescia	0.09	0.14	0.09	0.13
Piacenza	0.07	0.08	0.07	0.08
Postponement in enrolment	0.12	0.14	0.11	0.12
Selection	0.14		0.14	
Restrictions on enrolment in the 3rd year	0.16		0.17	
Number of observations	38,426	13,750	34,213	10,352

Table 2. Specification including first academic year performance by type of tertiary education system

	Degree		Degree_top		Degree_time		Degree_toptime	
	Old System	New System	Old System	New System	Old System	New System	Old System	New System
Fraction exams passed 1st year	0.015***	0.024***	0.006***	0.004***	0.017***	0.028***	0.006***	0.008***
Average mark 1st year	0.003***	0.017***	0.055***	0.095***	0.009***	0.025***	0.015***	0.077***

Table 3. Specification including all academic years performance by type of tertiary education system

	Degree		Degree_top		Degree_time		Degree_toptime	
	Old System	New System	Old System	New System	Old System	New System	Old System	New System
Fraction exams passed 1st year	0.006***	0.014***	0.000	-0.001	0.010***	0.029***	0.003***	0.004***
Fraction exams passed 2nd year	0.006***	0.014***	-0.000	-0.001***	0.009***	0.027***	0.003***	0.003***
Fraction exams passed 3rd year	0.007***	0.015***	-0.000	-0.002***	0.010***	0.020***	0.003***	0.000
Fraction exams passed 4th year	0.012***		-0.002***		-0.005***		-0.004***	
Average mark 1st year	-0.001	0.000	0.023***	0.042***	0.000	0.002	0.006***	0.033***
Average mark 2nd year	-0.001	0.003**	0.030***	0.047***	0.003***	0.009***	0.009***	0.038***
Average mark 3rd year	-0.001*	0.003**	0.021***	0.056***	-0.001	0.010***	0.002***	0.043***
Average mark 4th year	-0.001		0.032***		0.005***		0.006***	

Table 4. Specification including first academic years performance and policy rules by type of tertiary education system

	Degree			Degree_top			Degree_time			Degree_toptime		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Fraction exams passed 1st year	0.015***	0.015***	0.015***	0.005***	0.005***	0.006***	0.017***	0.017***	0.017***	0.006***	0.006***	0.006***
Average mark 1st year	0.003***	0.003***	0.003***	0.055***	0.055***	0.055***	0.010***	0.010***	0.010***	0.015***	0.015***	0.015***
Selection	0.002		0.002	-0.026***		-0.029**	-0.068***		-0.063***	-0.005		-0.012*
Restrictions on enrolment in the 3rd year		0.001	-0.000		-0.020**	0.004		-0.060***	-0.007		0.000	0.010

Table 5. Specification including all the academic years performance and policy rules by type of tertiary education system

	Degree			Degree_top			Degree_time			Degree_toptime		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Fraction exams passed 1st year	0.006***	0.006***	0.006***	0.000	0.000	0.000	0.010***	0.010***	0.010***	0.003***	0.003***	0.003***
Fraction exams passed 2nd year	0.006***	0.006***	0.006***	-0.000	-0.000	-0.000	0.009***	0.009***	0.009***	0.003***	0.003***	0.003***
Fraction exams passed 3rd year	0.007***	0.007***	0.007***	-0.000	-0.000	-0.000	0.009***	0.010***	0.009***	0.003***	0.003***	0.003***
Fraction exams passed 4th year	0.012***	0.012***	0.012***	-0.003***	-0.002***	-0.003***	-0.005***	-0.005***	-0.005***	-0.004***	-0.004***	-0.004***
Average mark 1st year	-0.001	-0.001	-0.001	0.023***	0.023***	0.023***	0.000	0.000	0.000	0.006***	0.006***	0.006***
Average mark 2nd year	-0.001	-0.001	-0.001	0.030***	0.030***	0.030***	0.003***	0.003***	0.003***	0.009***	0.009***	0.003***
Average mark 3rd year	-0.001	-0.001*	-0.001	0.021***	0.021***	0.021***	-0.001	-0.000	-0.001	0.002***	0.002***	0.003***
Average mark 4th year	-0.001	-0.001	-0.001	0.033***	0.032***	0.033***	0.005***	0.005***	0.005***	0.006***	0.006***	0.005***
Selection	0.029***		0.031***	-0.037***		-0.038***	-0.075***		-0.057***	-0.012***		-0.015**
Restrictions on enrolment in the 3rd year		0.023***	-0.003		-0.030***	0.002		-0.072***	-0.024**		-0.009*	0.004

Table 6. Dynamic model of yearly performance

	Portion of exams	Average mark
Lagged portion of exams	-0.032***	0.010***
Lagged average mark	0.127***	0.095***
yr1993	2.172***	0.186***
yr1994	5.103***	0.455***
yr1995	7.467***	0.774***
yr1996	10.549***	0.958***
yr1997	13.051***	1.261***
yr1998	15.453***	1.589***
yr1999	17.658***	1.805***
yr2000	19.362***	1.989***
yr2001	23.857***	2.455***
yr2002	26.727***	2.763***
yr2003	29.388***	3.100***
yr2004	34.359***	3.260***
Constant	0.996**	21.586***

Appendix: The Italian University System: Institutional Background

The Italian tertiary education system is basically university-based, contrary to other European countries, i.e. Germany, where also a well established system of higher vocational education is available. Thence, after secondary school completion, high-school leavers can choose to enrol into university, go into the labour market, or both.

Before 2001, the Italian University system was mainly constituted by one degree only – called *Diploma di Laurea* – which legal length required could vary from a minimum of 4 and a maximum of 6 years, depending on the subject. After the law n. 341/1990 was passed, individuals had an additional option: enrolling at a short degree programme (*Diploma Universitario*) of only two years, and courses were mostly related to vocational studies. However, individuals continued to prefer the “traditional degree”. In fact, national statistics show that only three out of 100 young individuals (aged 24-34) have a *Diploma Universitario*, whereas the percentage of those who obtained a *Diploma di Laurea* kept rising (20%)⁸, pointing out that long courses are considered by far the most relevant form of university education under the old system.

After a 4-6 years degree then, individuals might pursue their studies either by following to a Ph.D programme or some specialization courses (see fig. A1).

Although this university framework had the merit of having removed all the existing restrictions⁹ to college enrolment, apart from few exceptions still working for some faculties, for example medical ones which apply some formal rules - like accepting only a small number of applicants, or running selection tests- this free and open admission to all leavers of upper secondary school led to overcrowding in some universities. Consequently, the selection process started to take place after admission resulting in the withdrawal process from university. Despite the general attempt to enlarge the opportunity of going to college, this system was hence extensively criticised because of the copious existing inefficiencies, namely high incidence of dropouts, elapsed time-to-degree (beyond the legal length), high rigidity of curricula (people cannot decide themselves which subject they desire to attend at large), and selectivity based on social origins (Perotti, 2004). The latter aspect can be better understood by considering the features of secondary education. After compulsory schooling students, who wish to go into upper secondary school, may enrol at an academic oriented track (the Licei, which can be either focused on the Humanities, Science, or Foreign Languages) or at a labour market oriented one (the Istituti Tecnici and Istituti Professionali,

⁸ Source: Istat 2002.

⁹ The law 910/1969 widens the university access to any high school leavers regardless of the type of diploma achieved. Before the implementation of this reform, only individuals with an academic oriented high school diploma were allowed to enrol at university.

aimed at educating individuals for white collar or skilled blue collar careers, respectively). Furthermore, as mentioned above, there are no formal restrictions to track admissions (e.g. based on test scores reported in compulsory education or on teachers' recommendations), so that the choice rests entirely on the individual and her family. Individuals from favourable parental background mostly select into the academic oriented track, which naturally leads to university enrolment, whereas the opposite pattern characterizes labour market oriented tracks. This “diversion effect” induced by school tracking, therefore, is a source of intergenerational correlation in educational attainment (Hanushek and Wößmann, 2006; Brunello and Checchi, 2007; Checchi and Flabbi, 2006).

In 2001 the reform introduced with Law 509/1999, commonly known as “3+2”, reached its implementation stage. On the one hand, the plan of this convention was to harmonize the education system across the countries involved and to stress the central role of universities in the dimension of European culture and their paramount importance in promoting citizens’ mobility and scientific knowledge. On the other hand, it was an opportunity of dealing with the problems of the old system. The reform has developed along two main routes. The first, has envisaged a major change in the structure of degrees. In fact university studies are now organised in three cycles:

- ✓ **First cycle** (*First Level Degree*): corresponds to undergraduate studies aimed at guaranteeing an adequate command of the general scientific methods and contents as well as specific professional skills. Again, as general rule, college admission is only subject to having obtained any high-school diploma. In order to achieve this short degree the legal length required is three years and each student must earn 180 credits¹⁰;
- ✓ **Second cycle** (*Second Level Degree*)¹¹: graduate studies which include *Corsi di Laurea Magistrale* (CLS- Laurea Magistralis) and *Corsi di Master Universitario di primo livello* (CMU1- first level master degree). CLS are aimed at providing graduates with an advanced level of education for the exercise of a highly qualified activity in specific areas. To access to this second level degree is necessary to have attained the first degree or a foreign comparable one. The legal duration of the aforementioned degree is two years, and it is awarded to graduates who have earned the prescribed 120 credits;
- ✓ **Third cycle**: postgraduate studies consist of three different typologies of degree courses: *Ph.D degrees*, *specialisation courses* and *second level master degree* (CMU2). The *Ph.D degrees*’ aim is to training postgraduates for very advanced scientific research by suitable

¹⁰ Degree courses are structured in credits (*crediti formativi universitari*). A university credit corresponds to 25 hours of work per student. The average annual workload of a full time student is conventionally fixed at 60 credits.

¹¹Only a limited number of CLS, namely the CLS in architecture, dentistry, medical studies, pharmacy and veterinary medical studies, shares the following different features: access is by high-school diploma, admission is always subject to entrance examinations, length is 5 years (medical school 6 years).

methodologies, update technologies and study period abroad (official length is minimum three years); *specialisation courses* provide postgraduates with knowledge and abilities as requested in the practice of some professions; *second level master degrees* consist in advanced scientific courses or higher continuing education studies, open to the holders of an CLS and the legal length is one year (see fig.A2).

This new university reform has several objectives, such as implementing teaching autonomy. In other words, to allow universities to lay down the regulations for their degree courses, establishing the names and learning outcomes, the general framework for different teaching or learning activities that must be included in the curriculum, the credits allocated to each subject course and the type of final exam to obtain the qualification; and finally, to increase flexibility and quality within the tertiary education system at large. Procedures have been simplified so that universities are entitled to adapt their courses according to the demand for education and to changes in the labour market, along with effective quality assessment systems. Naturally, several outcomes are expected from the introduction of this new university's scheme, such as a fall in drop-out rates, a reduction in time to get a degree, an increase in number of people with university qualifications, a lower average graduation age, and an improvement in employability's conditions. The reform is likely to have had an impact on human capital investments through the reduction in the length of studies (i.e. one-year shortening of the legal duration to get a first cycle degree) and the reduction in the number of exams (and possibly their complexity), both reducing the costs of investing in tertiary education. Moreover, the wider menu of degrees available and the possibility to prolong education further to obtain a second cycle degree, might also have increased the expected returns of human capital investment, by allowing a better match between supply and demand of higher education. All this amounts at an increase in the expected net benefit of higher education, which should translate into higher enrolment, particularly from individuals that were somehow constrained in the old system. After the reform people may perceive an increase in the expected net benefits of college education thanks to a reduction in the minimum length of studies required to obtain a college degree: from 4 (or 5) to 3 years. While this is plausible over the years close to the reform, it cannot be excluded that in the longer term other effects would work in the opposite direction. For example, firms may value the new first cycle degrees less than old degrees (e.g. because of reduced complexity of studies), such that students may respond prolonging their studies to obtain the additional two-year degree, thus accumulating more human capital than before. In such a case, the reform would enhance the length of university studies and the long-term effect would be the opposite of the ones discussed. One may also think of mechanisms that reinforce the positive short term effects. For example, after the reform, going to college may become the norm for a wider social group

(Cappellari and Lucifora, 2009). Moreover, the two-cycle structure introduced by the new scheme may positively impact on enrolment behaviour if individuals value the size of their opportunities set or if they are risk averse. Finally, despite all the changes occurred to the Italian University system, it is remarkable to note that, even under the new system, the “legal” value of undergraduate degrees still holds. Any given degree at any University in Italy produces legal effects in terms of getting into public sector jobs and to specific regulated occupations (i.e. lawyer, engineer, notary, physician, etc.). Besides this, a university degree also awards the honorific title of “dottore”, which (still) conveys an important status to individuals both socially and on the labour market. Both these aspects of the Italian university system (legal value and honorific title) are likely to reinforce a “credential” value of the degree, as opposed to a “market” value.