

# Can the Students' Career be Helpful in Predicting an Increase in Universities Income?

Massimo Attanasio, Giovanni Boscaino, Vincenza Capursi,  
and Antonella Plaia

**Abstract** The students' academic failure and the delay in obtaining their final degree are a significant issue for the Italian universities and their stakeholders. Based on indicators proposed by the Italian Ministry of University, the Italian universities are awarded a financial incentive if they reduce the students' attrition and failure. In this paper we analyze the students' careers performance using: (1) aggregate data; (2) individual data. The first compares the performances of the Italian universities using the measures and the indicators proposed by the Ministry. The second analyzes the students' careers through an indicator based on credit earned by each student in seven academic years. The primary goal of this paper is to highlight elements that can be used by the policy makers to improve the careers of the university students.

## 1 Introduction

The Article 5 of the Law 537 of 1993 ([Legge 2003](#)) issued by the Italian Government is the first step towards the evaluation of the Italian University System (IUS). It marks the beginning of the financial autonomy of the universities with the hope to contain public expenditures. The law identifies the evaluation criteria of the various aspects of the IUS with the aim to obtain a fair distribution of the financial resources. The same Article has created an Evaluation Committee (“*Nuclei di Valutazione*”)

---

M. Attanasio (✉) · G. Boscaino · V. Capursi · A. Plaia  
Dipartimento di Scienze Economiche, Aziendali e Statistiche e Matematiche “Silvio Vianelli”,  
Università degli Studi di Palermo, Palermo, Italy  
e-mail: [massimo.attanasio@unipa.it](mailto:massimo.attanasio@unipa.it); [giovanni.boscaino@unipa.it](mailto:giovanni.boscaino@unipa.it); [vincenza.capursi@unipa.it](mailto:vincenza.capursi@unipa.it);  
[antonella.plaia@unipa.it](mailto:antonella.plaia@unipa.it)

within each university and a National Assessment Committee, named “*Osservatorio Permanente*”, whose primary scope is the management of the resources allocation.

Since late 1993 the law has experienced many modifications, such as the Ministerial Decree 509 in 1999. These reforms were created in order to improve the efficiency and the effectiveness of the universities due to the high number of drop outs and of long survivor students, defined as those students who stayed much more over the legal duration of the degree course (Lambert and Butler 2006). To cope with these aspects, the M.D. 509 introduced a new structure of university curricula, introducing (1) University Educational Credit (*Credito Formativo Universitario*—CFU), as a measurement student academic workload; (2) two qualifications (for both public and private institutions): first degree (L) or 3-year Bachelor, second degree (LS) corresponding to two cycles of courses or 2-year Master degree. Since 2004 a part of the National University Funding System (*Fondo di Finanziamento Ordinario*—FFO) have been distributed to the universities following new criteria on *university performance*, essentially based on teaching and research. In spite of the fact that the 509 reform was implemented in the academic year 2001/2002 and was revised in 2004, the problems of dropouts and of long survivor students is still unchanged.

Monitoring students' careers allows us to monitor our system in order to improve efficiency for the benefit of the students, and it allows real time monitoring of the performance indicators provided by the Ministry of Education of the University to better distribute the competitive funds (which was around 10% of the Total Funds—FFO—in 2010). Indeed, monitoring of the students' CFUs rates is both a commitment and a source of essential knowledge for those responsible for the creation of university degree programs. It also allows to collect information on the strengths and weaknesses of specific education programs; to acquire important data for programming and prevention and to establish checks and confirmations in order to create a process that is constantly under control. Furthermore, in order to improve educational services and identify appropriate ways to improve weak students' performance it is important to analyze the determining factors of university courses successes and failures (Boscaino et al. 2007).

In this paper the student career performance (SCP) is analyzed using both aggregate data, taking into account the FFO criteria and the outcome of the 2010 universities fund allocation (Sect. 2), and individual longitudinal data, taking into account the heterogeneity of students and the monitoring of their careers (Sect. 3).

The SCP data analysis raises several questions. For instance, is it possible to figure out simple and straightforward actions to accelerate the improvement FFO's indicators? Is it possible to figure out a policy to improve FFO's indicators in the long term? Are there simple numbers or indicators, useful to address university policies, which can be *extracted* from individual SCP analysis? All these questions lead to the ultimate purpose of this paper: which policy *my* university will/could adopt to improve the SCPs?

## 2 Aggregate Data: FFO Structure and Criteria

Italian FFO has been divided in three parts since 2009: the *QB* (*Quota Base*) corresponding to the general budget, the *MP* (*Modello Premiale*) corresponding to the competitive funds (introduced to reward teaching and research quality), and a residual part mostly related to salary increase (*RE*) (D. M. 2009, 2010). Every year the Ministry sets the FFO amount, the *MP* percentage amount and how to compute the *QB*, while *RE* is obtained as residual.

In 2010 the Ministry established the amount of the funds to be distributed to the universities and set the *MP* to be 10% of the yearly FFO while the *QB* was the 80% of the 2009 FFO. The 2010 FFO is composed by 10% *MP*, 83% *QB*, and 7% *RE*. Moreover, The Ministry has announced that the *MP* will increase to 12% of the 2011 FFO .

The *MP* award is proportional to 6 performance indicators, 2 for teaching and 4 for research. The IUS 54 universities have received the *MP* according to (1):

$$MP = 0.17 \times A1 + 0.17 \times A2 + 0.23 \times B1 + 0.10 \times B2 + 0.20 \times B3 + 0.13 \times B4 \quad (1)$$

The two indicators relevant to the “quality of teaching”,  $A1$  and  $A2$ , will be analyzed in detail in this paper, while we do not analyze the others because  $B1 - B4$  represent the quality of the research outcome, which is not relevant to the paper aims.  $A1$  and  $A2$  consider respectively the demand of each University Education and the number of CFUs earned by the students:

$$A1 = (4 \times STUD_A + 3 \times STUD_B + 2 \times STUD_C + 1 \times STUD_D) \times (K_T + K_A) \quad (2)$$

$$A2 = CFU\_P_A + CFU\_P_B + CFU\_P_C + CFU\_P_D \quad (3)$$

with:

$$CFU\_P_i = \frac{CFU\_E_i}{CFU\_T_i} \times CFU\_E_i \quad (4)$$

where:

1.  $i = A, B, C, D$  (ministerial course classification based on the financial aid allocated to each student).
2.  $STUD_i$  is the number of “active students” attending type  $i$  course.
3. An “active student” is defined as a student with the following features: they have been in the university system for a number of years less or equal to the legal duration of the course; and they have earned at least 5 CFUs per year.

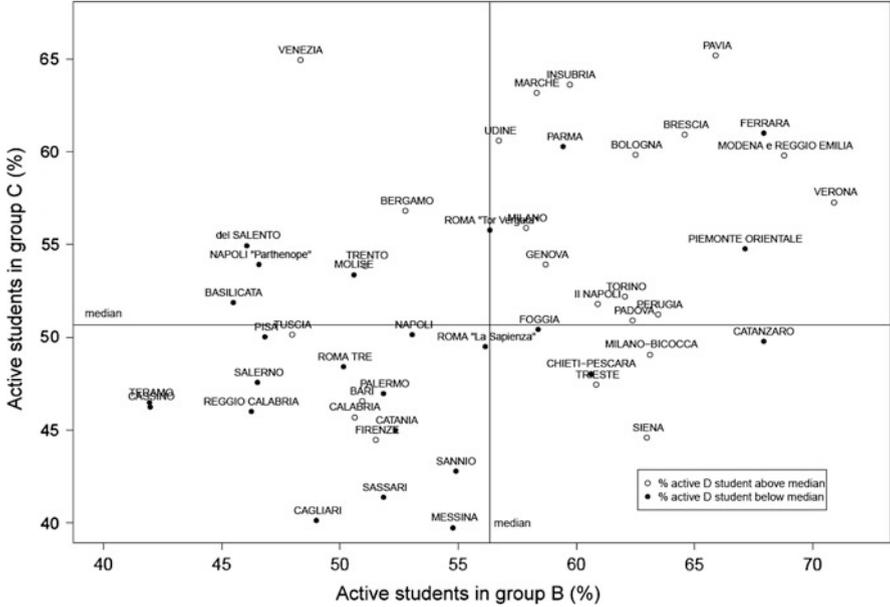


Fig. 1 Active students in groups B, C, and D (%)

4.  $K_T$  and  $K_A$  are correction factors related to the local context (based on the net income distribution of the university region) and to the sustainability of the courses (the ratio between the number of teachers and the number of Degree Courses), respectively.
5.  $CFU\_E_i$  are the CFU earned in a year by the students of the  $i$ -th group.
6.  $CFU\_T_i$  are the CFU correlated to the workload of the full-time students per year in the  $i$ -th group.
7.  $Median_i$  is the median over the rates  $CFU\_E_i/CFU\_T_i$  computed for the 54 universities, in each group.

The  $MP$  could cause high losses/gains which will influence the FFO in the subsequent years, since the  $QB$  is computed as a percentage (80%) of the previous year FFO. In this way, successive losses are summed up each year since the  $QB$  is progressive, so it is crucial to undertake actions to improve  $A1$  and  $A2$  in order to avoid extra losses in the successive years. But how universities can improve their own performance? According to  $A1$ , universities are funded proportionally to the number of “active students”, but nothing is said about the “inactive students”: how do these students affect the total number of students? The graphical representation of the “location” of the single universities (Fig. 1) allows to summarize and compare quickly the students’ performance (in terms of active students percentage) with respect to the groups B, C, and D. Group A is not included because it covers just 4% of the students.

The worst universities performance correspond to the black dots in the III quadrant in the scatterplot (Fig. 1). These are the universities that need to improve

performances for the benefit of the groups (B to D) by increasing the number of students earning at least 5 CFUs per year and/or by reducing the number of long survivor students. In practice, a university should increase the number of “active students” or, eventually, decrease the number of “inactive students”: this target can be achieved by avoiding students to stay in the university system for a period not longer than the legal duration of the course, and by letting them accumulate at least 5 CFUs in a year. This second task, which allows to stimulate earning 5 CFUs per year, will improve A2 too. A great advantage is to be able to identify early those students who could become “inactive” or could earn few CFUs each year.

To cope with these problems, a cohort study, as described in the next section, can give useful information.

### 3 Individual Data: Student Career Performance

In this section we investigate the student career performance applying individual longitudinal data. We will use the CFUs accumulation over 7 years.

The data concern the cohort of the Palermo University freshmen, enrolled in 2002/2003 and followed up till the 31st May 2010. For simplicity's sake, we analyze only those students who never change faculty during 7 years, who have payed university fees in the legal terms every year and never dropped out (the core students). Moreover, we examine 3 faculties (Economics, Engineering, and Arts) belonging to three different cultural areas. The performance is defined as the number of CFUs earned by the  $i$ -th students at the end of the first  $j$  years ( $j = 1, 2, \dots, J$ ) ( $CFU_i(j)$ ). Table 1 reports the distribution of freshmen enrolled in 2002/2003 classified according to the student career status in 2009. Our classification of the students is the following:

Core	The student who never change faculty.
Mover	The student who changed faculty, course, and/or university.
Withdrawal	The student who quits.
Lost	The student who never quitted, but whose follow up ended before 7th year.

The latter is largely represented in Economics and Arts Faculties, but for the purpose of this paper we will not investigate this group issue because it deserves in-depth examination.

Table 1 shows that the most efficient faculty at Palermo University is the Faculty of Engineering. In this Faculty the graduation rate for the bachelor degree is greater than the one of two other faculties, reaching 46% at the end of the sixth year (may be it will be higher if a part of the lost is considered as withdrawal). The low success rate aetiology is difficult to be proved due to its complexity. To simplify we focus our attention to few aspects, with the aim of finding out simple and useful information for the universities.

Based on these findings we investigate the number of CFUs earned at the end of the first year ( $CFU(1)$ ) versus the years needed to obtain the degree.

**Table 1** Distribution of Palermo University freshmen enrolled in 2002/2003 by Status and Faculty

Status in 2009	Faculty					
	Economics	(%)	Arts	(%)	Engineering	(%)
Core	536 (341 <sup>a</sup> )	49.1	1,339 (960 <sup>a</sup> )	54.2	733 (526 <sup>a</sup> )	63.7
Mover to other Faculties	53 (7 <sup>a</sup> )	8.8	67 (12 <sup>a</sup> )	5.1	88 (18 <sup>a</sup> )	9.7
Mover to other Universities	43		60		24	
Withdrawal	141	42.1	304	40.6	95	26.6
Lost	318		700		211	
Total	1,091	100	2,470	10	1,151	100

<sup>a</sup>Students who took a degree (bachelors)

This investigation is needed to figure out if CFU(1) is a good predictor. We restrict our analysis to those students who never changed Degree Course (core) in 7 years. Following Cozzucoli and Ingrassia (2005), we define:

*B* The bachelors, or those students that graduated within 7 years.

*O* The others (with respect to the *B*'s), those students not yet graduated in 2009.

$CFU_i(j)$  The number of CFUs earned by the *i*-th students at the end of the first *j* years ( $j = 1, 2, \dots, J; J = 7$ ).

$X_i$  The number of years expected to obtain a degree by the *i*-th student, considering the number of CFUs earned by the *i*-th student at the end of the first year ( $CFU_i(1)$ ), that is  $180/CFU_i(1)$ , where 180 is the amount of CFUs needed to get a degree. We group *X* into 4 classes:  $\leq 4$ ; 4-|5; 5-|6; and  $> 6$ ; obviously, the students whose  $CFU(1) = 0$  (12% of core students) have been excluded.

$Y_i$  The number of years observed to obtain a degree for *i*-th bachelor (*B*).

$EY_i$  The number of years expected to obtain a degree for the others (*O*).  $EY_i$  is computed extrapolating the student's annual earning speed ( $v_i$ ) based on  $CFU_i(j)$ , and followed to the attainment of 180 CFU:

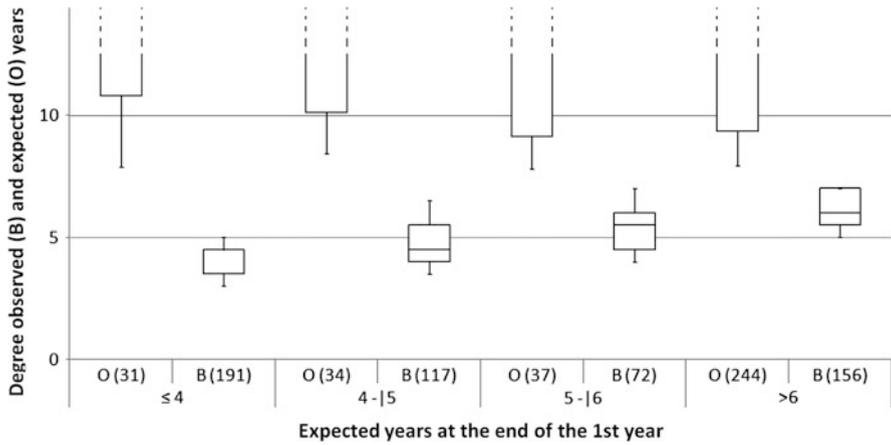
$$v_i = \frac{CFU_i(j)}{j} \quad (5)$$

$$EY_i = \frac{180 - CFU_i(j)}{v_i} + j \quad (6)$$

$EY_i$  first term is the number of years beyond the *j*-th to "get" the degree. For instance, if a student earned 105 CFUs at the end of the first 7 years ( $j = 7$ ), we expect that they will get their degree by the 12th year of attendance:

$$v_i = \frac{CFU_i(7)}{7} = \frac{105}{7} = 15$$

$$EY_i = \frac{180 - CFU_i(7)}{v_i} + 7 = \frac{180 - 105}{15} + 7 = 12$$



**Fig. 2** Box-plots of degree observed or expected years, by expected years at 1st year and student's status (O and B)—Faculty of Engineering, Palermo University. Upper O's boxes are truncated for reason of space

Figure 2 summarizes the results for the Faculty of Engineering because the other faculties' results are quite similar. The X axis is the number of the years to obtain the degree, as expected at the end of the first academic year (computed through X), for bachelors and others. The Y axis reports: for B's the observed number of years to obtain the degree; for O's the expected number of years to obtain the degree (computed through EY). Figure 2 clearly shows in most cases that a good start is a good predictor for success. For instance, 117 B students obtained the degree in 4-|5, as expected by their performance in the 1st year, and only 34 O students did not "keep the promise" held in the 1st year. Interestingly, the ratio between B's and O's decreases towards the class 5-|6, showing the "best" promise for class ≤4. These results suggest the importance of the first year CFUs as predictor of success. The box-plots relative to the expected years to obtain the degree (O's) are very large and their upper bounds are always over 20. This unusual number is due to the large number of students who have earned very few CFUs in 7 years. This dysfunction obviously affects the denominator of  $EY_i$ .

### 4 Concluding Remarks and Future Developments

In conclusion, Palermo University aggregate career students data show that the number of earned CFUs are below the national median while the individual SCPs show the dramatic slowness to obtain a degree.

These analysis are the first step to investigate the current IUS Evaluation. This Evaluation system presents several incongruities, whose analysis deserves specific attention. For instance, there is a need for different policies within the single

university and, more importantly, competitive policies within the different Italian universities. A good example is the FFO implementation by the Ministry for the four types of degree courses A, B, C and D. Nevertheless this is not enough. It is also very important to underline that FFO distributes the competitive fund on the basis of crude indicators. In fact, the process of comparison is conducted using the same set of indicators for all universities, without taking into account the different characteristics of universities and students. Moreover this process is somehow unfair, because good universities can attract more easily good students, and a vicious circle could be boosted by this system of awards (Lambert and Butler 2006).

Further statistical investigations with individual career data will provide detailed information on other covariates that may influence the success/failure of the students. For instance, Fasola (2011) applied a discrete-time competing risks models to the cohort of freshmen of 2002/2003. This model gets in a discrete-time setting simultaneous estimates of the degree and failure risks, including several covariates, such as the high school grades; the high school qualification; the age and the gender (in some faculties). These results may be useful as a basis to create a policy able to address specific actions for specific types of students with the aim to improve the quality of teaching outcomes and to provide recommendations to improve FFO indicators.

**Acknowledgments** The article is the result of the productive collaboration among the authors. In particular, paragraph 1 can be ascribed to Vincenza Capursi, paragraph 2 can be ascribed to Antonella Plaia, paragraph 3 can be ascribed to Giovanni Boscaino, and paragraphs 4 can be ascribed to Massimo Attanasio.

This paper has been supported from Italian Ministerial grant PRIN 2008 “Measures, statistical models and indicators for the assessment of the University System”, n. 2008BWXMLH

## References

- Boscaino, G., Capursi, V., & Giambona, F. (2007). La performance delle carriere di una coorte di studenti universitari, DSSM Working Papers - n. 2007.1.
- Cozzucoli, P. C., & Ingrassia, S. (2005). Indicatori Dinamici di Efficienza Didattica dei Corsi di Laurea Universitari. *Statistica e Applicazioni*, III, special issue 1, 61–68.
- Fasola, S. (2011). *Laurea o abbandono: il buongiorno si vede dal mattino?* Graduation Thesis, University of Palermo.
- Lambert, R., & Butler, N. (2006). *The future of European universities: Renaissance or decay?* London: Centre for European Reform.
- Legge. (2003). 24-12-3, n. 537, Interventi correttivi di finanza pubblica. Italian Government.
- D. M. (2009). 23-9-2009, n. 45, Decreto criteri di Ripartizione del Fondo di Finanziamento Ordinario (FFO) delle Università per l’anno 2009. Italian Government.
- D. M. (2010). 21-12-10, n. 655, Decreto criteri di Ripartizione del Fondo di Finanziamento Ordinario (FFO) delle Università per l’anno 2010. Italian Government.



<http://www.springer.com/978-3-319-00031-2>

Statistical Models for Data Analysis  
Giudici, P.; Ingrassia, S.; Vichi, M. (Eds.)  
2013, XV, 419 p. 75 illus., Softcover  
ISBN: 978-3-319-00031-2