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First and Second Year Careers of STEM Students in Italy: A Geographical Perspective

Primo e Secondo Anno di Carriera degli Studenti Italiani di Area STEM: Una Prospettiva Geografica

Antonella D'Agostino, Giulio Ghellini, and Gabriele Lombardi[1]

Abstract The mobility behaviour of Italian university has feed an increasing interest on the public debate. The very particular geographical characteristics of the country, jointly with the recognized persistence of the economic gap between the Southern and Northern regions, push more and more students in moving from the first macro-region toward the latter. This article will focus on the differences in the performance of those students who decide to move for their studies, against those who remain close to their hometowns. In order to analyse this issue, we conduct multilevel modelling techniques, using administrative microdata from the Italian Ministry of Education, University and Research (MIUR) referring to the first two years of the career of students from the cohort 2014/2015, enrolled in STEM fields.

Abstract *La mobilità degli studenti universitari italiani sta permeando sempre di più il dibattito pubblico. Le peculiari caratteristiche geografiche della nazione, unitamente al persistente gap tra il Nord e il Sud della penisola, spingono una frazione sempre più grande di studenti meridionali a spostarsi verso le regioni settentrionali. Questo lavoro si focalizza sulle differenze di performance tra gli studenti che decidono di emigrare per i loro studi e quelli che decidono di restare a studiare vicino casa. A livello metodologico verrà impiegata una tecnica di modellizzazione multilivello, utilizzando microdati amministrativi provenienti dal Ministero dell'Istruzione, Università e Ricerca (MIUR) riferiti ai primi due anni di carriera degli studenti appartenenti alla coorte di immatricolati 2014/2015 a dei corsi di studio STEM.*

Key words: student mobility, STEM, performance, multilevel model, transfer shock

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1 Introduction

The issue of internal mobility within countries is acquiring a growing interest among scholars, as one of the main events suitable for the analysis of transition through adulthood (see among the others, D'Agostino et al. 2019a; Contini et al. 2015; Dotti et al 2013). In particular, this paper explores the differences in the first academic year's performance among those Italian freshmen newly-graduated at the high school, who have decided to move away for their hometowns for their higher education studies in STEM (science, technology, engineering, and math), or remain in the nearby of their residences. This investigation is particularly important in light of the strong gap between the Northern and Southern regions of the country and it is related to the crucial role played by STEM fields for the local development (D'Agostino et al., 2019b). Indeed, few students who migrate return home to take advantage of their investment and many students stay in the host region to escape low returns on education in their region of origin (Attanasio and Enea, 2019).

In the international literature, several contributions are available concerning about earning a STEM degree and the migration of students pursuing STEM degrees. As an example, Crisp et al. (2009) evidence how, despite to the fact that these fields are acquiring constantly a greater importance in those public programs stimulating higher education attendance, it seems still to be present a difficulty in pursuing successfully a STEM degree by some categories of people, such as women or ethnic minorities. Public support seems to not play any role in mitigating this evidence, while the presence of a strong cultural capital seems to be much more effective. There is an evident stratification in the kind of people who decide to enrol a STEM course, and the growing interest in these fields is globally causing an increasing adoption of strategies in order to stimulate enrolments. This has to come with a bigger attention to the speed of students in adapting themselves to the new context (Lopez and Jones, 2017), with the awareness that the presence of better economic opportunities is the strongest pull factor for STEM students (Gesing and Glass,2019).

Although the importance of studying STEM field in educational analysis from different perspective, the number of empirical analysis on this topic are still poor in Italy. Some exceptions are, for instance, Chise et al. (2019) and Granato (2018), who both highlight the importance of environmental and cultural factors in explaining the main differences in STEM attendance.

Our goal is to contribute towards filling this gap. Precisely, focusing on the specific issue of the so-called *transfer shock* (Hills, 1965). Indeed, movers could suffer a decrease in their own performance after the transition to higher education, namely during their first year of enrolment, then gradually recovering the original achievement. Indeed, all transfer students generally present some degree of transfer shock in the transition from an educational context to another, and a low performance in the first year of studies can be just a sign of the emergence of this phenomenon. The youngest freshmen are usually the most affected by transfer shock, as the lowest performers in previous institutions. More specifically, Glass and Harrington (2002) find that movers in the long run seem to perform better than stayers, but they

experience a drop in their performance during the first semester. Regarding specifically to STEM students, Cejda (1997) finds that freshmen in this area experience a stronger transfer shock with respect to their colleagues in other fields.

2 Data Structure

The analysis is based on micro-data provided by the Italian Ministry of Education, University and Research (MIUR) and collected into the Italian University Student Register (ANS)[1], referring to the Italian university system as a whole. In particular, the database is restricted to 38,773 freshmen enrolled in STEM fields in the academic year 2014/2015 and that have information on their academic credits earned for the first and second year of their university career[2].
The working sample that resulted from this procedure is composed of 77,546 repeated measures clustered in 658 university courses.
The response variable that we use in this paper is the students' academic performance measured using the academic credits earned in each a.y. Indeed, as regulated by the Ministerial Decree 509/1999 by the MIUR, academic credits are a measure used by Italian Universities to estimate the workload required in order to graduate. In particular, we normalized it, as suggested by Leckie (2013)[3]. Firstly, the N observations are ranked basing on their original scores. Then, the standard normal score for the j^{th} ranked observation in the data is calculated as:

$$\boldsymbol{\Phi^{-1}\left[\frac{j-0.5}{N}\right]},$$

where Φ^{-1} denotes the inverse of the standard normal cumulative distribution function. The advantage behind this simple transformation is that it is order preserving and students with the same number of credits will also receive the same standard normal score. As independent variables in the econometric model we used the set of variable available in dataset. The main object of this study concerns the effect of the mobility indicator from South to North. Thus, in order to exploit this effect, we fix stayers and movers from North/Centre as the baseline, comparing them with both movers and stayers from South, separately. Additionally, in our control strategy, the following variables are included: gender (male – baseline), grade earned at high school coded as a dummy variable (grade lower than the 75th percentile – baseline), type of high school classified into three categories: scientific lyceum (baseline), classic lyceum,

[1] Database MOBYSU.IT [Mobilità degli Studi Universitari in Italia], research protocol MIUR – Universities of Cagliari, Palermo, Siena, Torino, Sassari, Firenze and Napoli Federico II, scientific reference Prof. Massimo Attanasio (UNIPA), Data Source ANS-MIUR/CINECA.
[2] All students enrolled in Italian universities' STEM fields in a.y. 2014/2015 are 51,821. About 13% of these freshmen drops-out the system and about the 3% of them changes course during the first a.y. Another 11% of them has missing information about their performance.
[3] It is worth note that we use this data transformation for using a simple econometric model in the empirical analysis. Nevertheless, more complex approach for such kind of data exist in literature (see for instance, Grilli et. 2016)

technical and or other diploma in secondary education. Then, another binary indicator informs if student, enrolled university later than one year after the end of the high school (less than one year – baseline). Finally, a dummy variable for time effect (a. y. 2014/2015 – baseline) has been considered, aiming at investigating the pattern of student's performance over time and to test the hypothesis of a transfer shock effect through its interaction effect with the mobility indicator.

3 Methodology

In a nutshell, Multilevel Analysis is a typology of hierarchical linear model, which allows to compute regression analysis for data with several nested levels. The underlying idea is that each level should be a potential source of unexplained variability (see among the others, Hox et al. , 2017).
The importance of relying in such a technique in educational studies is widely addressed by Grilli and Rampichini (2009). Consequently, this kind of methodology allows to characterized our three-level longitudinal design that includes repeated measures on students nested in STEM courses (Hair and Fàvero, 2019).
Our preferred specification considers the following three-level variance-components model:

$$\boldsymbol{CFU_{tjk} = \beta_0 + v_k + u_{jk} + \beta_{Time} year_{jk} + \beta_{SS} x_{jkSS} + \beta_{MS} x_{jkMS}}$$
$$\boldsymbol{+\beta_{tSS} year_{jk} \cdot x_{jkSS} + \beta_{tMS} year_{jk} \cdot x_{jkMS} + \sum_{h=1}^{H} \beta_h x_{hjk} + \varepsilon_{tjk}.} \qquad (\mathbf{1})$$

Equation (1) states that CFU_{tjk} (the normalized credit earned) in year t for the student j ($j=1,\dots,J$) in STEM course k ($k=1,\dots,K$) is a linear function of student level explanatory variables **x** and a time indicator variable (year). Whereas, $\beta_{Time}, \beta_{SS}, \beta_{MS}, \beta_{tSS}, \beta_{tMS}$ and β_h $(h = 1, \dots, H)$ are the unknown parameters to be estimated. The errors components $\boldsymbol{\varepsilon_{tjk}}$., v_k and u_{jk} are assumed to be mutually uncorrelated and i.i.d. normally with mean 0 and variance σ_ε^2 , σ_v^2 and σ_u^2, respectively. The main parameter of interest is $\boldsymbol{\beta_{tMS}}$ that indicates whether movers from South actually experiment a transfer shock in the transition toward the new environment. A positive sign of such parameter suggests in which measure they are able to overcome the transfer shock effect in the second year of their STEM studies.

4 Results and Discussion

Table 1 present the results of the model specified in equation 1 (see Model 4). The four models presented differ for the number of variables included in the estimation

process. Findings show that credits earned in the second year tend to decrease. In STEM studies women seems to have lower performances than men. The top-performing students, who come from a Scientific Lyceums, who apply on time for a STEM degree course are more likely to outperform during their university career. Finally, both stayers and movers from South appear to perform worse than their northern colleagues. Nevertheless, the positive estimate of the coefficient of the interaction effect ($\boldsymbol{\beta_{tMS}}$) clearly shows that movers from the South recover part of the performance lost during the transition experimented as freshmen. These results, to be confirmed by some in-depth analysis on previous cohorts of STEM freshmen, might suggest that South of Italy is experimenting a strong loss in its best human capital, emigrating far away for attending higher education studies in STEM.

Table 1: *Estimate results – Dependent Variable is the normalized credit earned.*

	Model 1	Model 2	Model 3	Model 4
Year (baseline 2014/2015)		-0.568***	-0.568***	-0.565***
Gender (baseline male)			-0.0324***	-0.0324***
HS Grade (baseline less than 75 percentile)			0.566***	0.566***
Classic Lyceum			-0.0992***	-0.0992***
Other Diploma			-0.229***	-0.229***
Late (baseline enrolled HE less than one year after HS)			-0.141***	-0.141***
Stayers From South			-0.306***	-0.274***
Movers From South			-0.154***	-0.239***
Year#StaySouth				-0.0649***
Year#MovSouth				0.170***
Constant	-0.0561***	0.228***	0.295***	0.294***
sd(course)	0.348***	0.348***	0.318***	0.318***
sd(student)	0.492***	0.568***	0.508***	0.509***
sd(Residual)	0.785***	0.675***	0.675***	0.673***
K	658	658	658	658
J	38,773	38,773	38,773	38,773
N	77,546	77,546	77,546	77,546

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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